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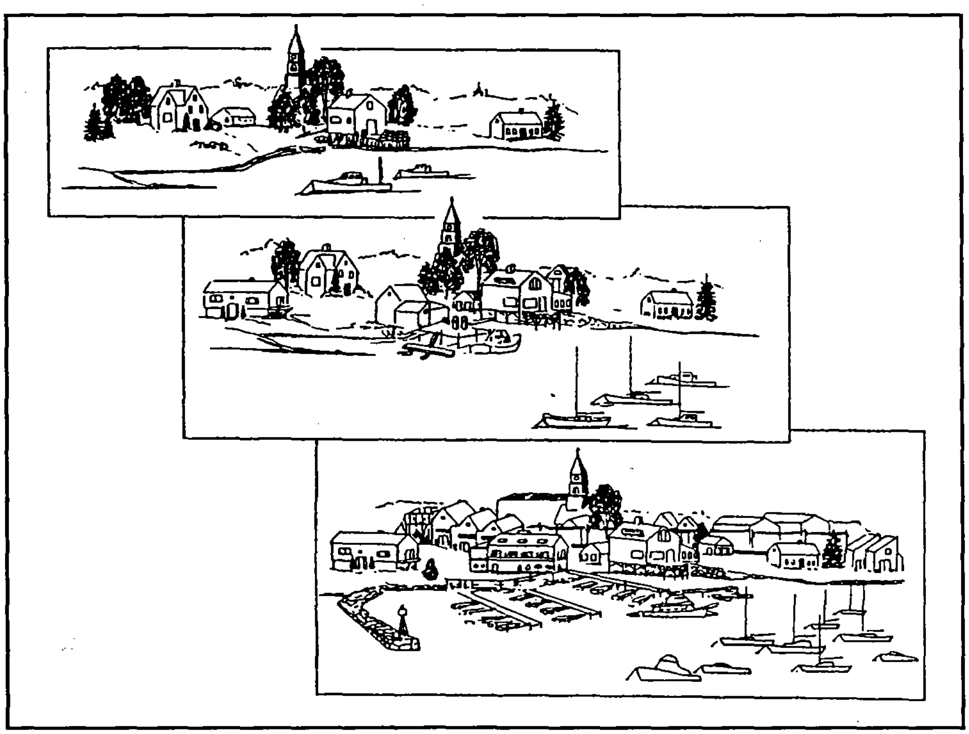
NOAA COASTAL OCEAN PROGRAM
Decision Analysis Series No. 6

METHODOLOGIES AND MECHANISMS FOR MANAGEMENT OF CUMULATIVE COASTAL ENVIRONMENTAL IMPACTS

Part I: Synthesis, with Annotated Bibliography
Part II: Development and Application of a Cumulative Impacts Assessment Protocol

Marine Law Institute, University of Maine School of Law

September 1995



U.S. DEPARTMENT OF COMMERCE
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Part I: Synthesis, with Annotated Bibliography

Barbara Vestal
Alison Rieser
Marine Law Institute, University of Maine School of Law

Part II: Development and Application of a Cumulative Impacts Assessment Protocol

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September 1995

U.S. DEPARTMENT OF COMMERCE
Ronald H. Brown, Secretary
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Donald Scavia, Director

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Note to Readers

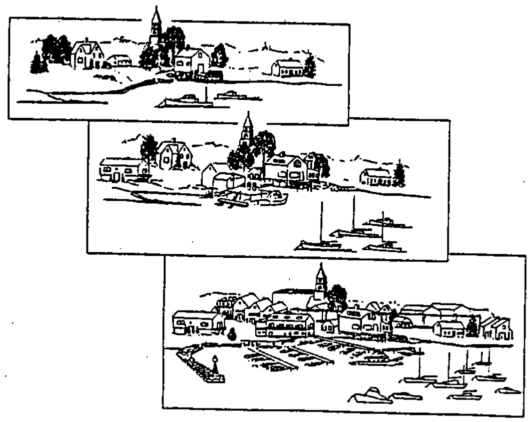
Methodologies and Mechanisms for Management of Cumulative Coastal Environmental Impacts is the result of three years of study by investigators from the University of Maine's Marine Law Institute and the NOAA National Marine Fisheries Service's Northeast Region with funding from the NOAA Coastal Ocean Program (COP). The goals of this project were to collect and synthesize information about advances in the ability to incorporate consideration of cumulative impacts into environmental decision making and to transfer that information to environmental management practitioners at all jurisdictional levels. This report approaches the issue of cumulative environmental impacts from three perspectives--science, law, and environmental management.

COP provides a focal point through which NOAA, together with other organizations with responsibilities for the coastal environment and its resources, can make significant strides toward finding solutions to critical problems. By working together toward these solutions, we can ensure the sustainability of these coastal resources and allow for compatible economic development that will enhance the well-being of the Nation now and in future generations. The goals of the program parallel those of the NOAA Strategic Plan.

A specific objective of COP is to provide the highest quality scientific information to coastal managers in time for critical decision making and in a format useful for these decisions. To help achieve this, COP inaugurated a program of developing documents that would synthesize information on issues that were of high priority to coastal managers. A three-step process was used to develop such documents: 1) to compile a list of critical topics in the coastal ocean through a survey of coastal resource managers and to prioritize and select those suitable for the document series through the use of a panel of multidisciplinary technical experts; 2) to solicit proposals to do research on these topics and select principal investigators through a rigorous peer-review process; and 3) to develop peer-reviewed documents based on the winning proposals. Seven topics were selected in the initial round, but the series is expanding because of the suitability of findings from other COP-funded research to appear in this synthesis format. The documents already published are listed on the inside back cover.

As with all of its products, COP is very interested in ascertaining the utility of the Decision Analysis Series particularly in regard to its application to the management decision process. Therefore, we encourage you to write, fax, call, or E-mail us with your comments. Please be assured that we will appreciate these comments, either positive or negative, and that they will help us direct our future efforts. Our address and telephone and fax numbers are on the inside front cover. My Internet address is DSCAVIA@HQ.NOAA.GOV.

Donald Scavia
Director
NOAA Coastal Ocean Program



METHODOLOGIES AND MECHANISMS FOR MANAGEMENT OF CUMULATIVE COASTAL ENVIRONMENTAL IMPACTS

Part I: Synthesis, with Annotated Bibliography

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Acknowledgments

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Isobel Sheifer, Program Analyst with NOAA's Coastal Ocean Office deserves special thanks for her assistance and oversight of this project. Due to her efforts, the project benefitted from the comments of many reviewers. The contribution of those reviewers is also gratefully acknowledged. We also appreciate the support and encouragement of Dr. Donald Scavia, Director of the Coastal Ocean Office.

As always, we are grateful to Beverly Bayley-Smith, Administrative Manager, Marine Law Institute, for her able assistance with research and workshop preparations, and for overseeing the technical preparation of this report.

As we conclude this three-year study, we are even more convinced of the need to redouble efforts to more effectively consider cumulative impacts in environmental decisions. However, we are also all too aware of the practical impediments, including a political climate which appears to have grown considerably more hostile to environmental protection during the course of this project.

Some might erroneously assert that we shouldn't worry about cumulative impacts when the ability to control even direct environmental impacts is under siege. That position minimizes the fact that numerous small actions and choices can together gradually alter the structure and function of an ecosystem. Environmental managers will not be able to safeguard ecosystem health if they ignore cumulative impacts and focus only on direct, site-specific impacts.

To maintain the momentum in this political climate, environmental managers may need to stress those aspects of cumulative impact assessment that address the concerns of the current political decision-makers. They may do well to emphasize the potential economic benefits of cumulative impact assessment and management; these include its contribution to maintaining or restoring the health of economically-important resources, its usefulness as a tool to focus limited review resources on the most threatened areas, and the potential benefit to developers of more certainty in permit decisions through the advanced identification of habitat to be protected. To maintain existing protections, environmental managers may have to work more closely with scientists to justify critical regulations by documenting the probable effect of a specific action on specific valued resources. And they may also have to develop tools that are less reliant on regulation and more grounded in market-based incentives, stakeholder education, acquisition of the fee or easements in key parcels, voluntary stewardship, and multi-agency cooperative management. Environmental managers will need to use their creative talents and political acumen to convince decision makers of the importance and capacity to manage cumulative impacts. Absent this political commitment, incremental environmental degradation is inevitable.

Barbara Vestal & Alison Rieser
August 1995

EXECUTIVE SUMMARY

INTRODUCTION: CONSIDERING CUMULATIVE COASTAL EFFECTS IN ENVIRONMENTAL DECISION-MAKING

What Are *Cumulative Effects*?

Coastal managers now recognize that many of the most serious resource degradation problems have built up gradually as the combined outcome of numerous actions and choices which alone may have had relatively minor impacts. For example, alteration of essential habitat through wetland loss, degradation of water quality from nonpoint source pollution, and changes in salinity of estuarine waters from water diversion projects can be attributed to numerous small actions and choices. These incremental losses have broad spatial and temporal dimensions, resulting in the gradual alteration of structure and functioning of biophysical systems. In the environmental management field, the term "cumulative effects" is generally used to describe this phenomenon of changes in the environment that result from numerous, small-scale alterations.

Does Traditional Environmental Impact Assessment Adequately Consider Cumulative Effects?

Federal, state and local coastal resource regulatory and management programs have generally relied on traditional environmental assessment, focusing on the causal effects of a single action on a particular resource at the site of the proposed action. Critics contend that these programs are unable to protect coastal resources from incremental degradation due to a willingness to accept a little degradation with each action, the absence of a holistic ecosystem perspective, and the use of "halfway measures" that "simply forestall the inevitable."[1] Minimum thresholds for scrutiny, general permits, limiting the review to on-site impacts, and reliance on regulations contribute to the ineffectiveness of current programs to control cumulative impacts.

How Should Cumulative Effects Be Considered in Environmental Impact Assessment?

Many environmental managers now believe that a more comprehensive assessment approach is required. It would evaluate the proposed action within the context of the impacts experienced over time (past changes and projected future changes) by the larger ecological community which contains the site of the proposed action. The goal would be to evaluate how the proposed action will affect valued environmental functions of the affected ecosystem.

Are There Impediments to Considering Cumulative Impacts in Regulatory Reviews?

Many state and federal environmental laws allow or require regulators to consider cumulative impacts in permitting decisions. However, in actual practice, these programs frequently continue to review only the immediate and direct impacts of a narrow range of activities. Where agencies have attempted to consider cumulative impacts in regulatory reviews, they have typically encountered a variety of difficulties, including:

- the absence of practical, widely accepted methodologies;
- limited scientific knowledge about causes and effects;
- a narrowed interpretation of agency responsibilities;
- the absence of socially-established goals for the resource;
- jurisdictional constraints which impose inappropriate geographic and subject-matter limits on impact assessment and management; and
- uncertainty about the defensibility or fairness of basing individual permit decisions on potential adverse cumulative impacts.

Thus, the scope and adequacy of cumulative impact assessments frequently fail to live up to the intent of the legislative mandate.

Despite these difficulties, during the last two decades, many agencies have experimented with ways to improve consideration of cumulative environmental impacts. With successive efforts, increased environmental monitoring, and the incorporation of technological advances, progress is being made.

How Should Cumulative Impacts Be Considered in Planning and Management Efforts?

Many theorists and practitioners believe that regulatory programs will always be unequal to the task of controlling adverse cumulative environmental effects. They contend the best way to manage cumulative impacts is to emphasize comprehensive, ecosystem-based planning and management. Rational regulatory decisions could then be made within this context.

Ecosystem-based planning and management could increase control of incremental impacts by:

- giving individuals advanced notice of how adverse cumulative impacts will be considered, allowing them to avoid or abandon incompatible land and water development projects before they ever reach the permit review stage;

- allowing regulators to decide whether an incremental change is acceptable by reference to socially-determined, resource-specific goals; and

- increasing the ability to control or influence small-scale activities and projects which would previously have fallen below regulatory thresholds.

Numerous federal and state management programs have been evolving toward an ecosystem management approach. They typically attempt to span political boundaries, break out of compartmentalized, single-resource management regimes, and account for the impacts of the entire range of anthropogenic disturbances over a larger geographic area.

Is Effective Consideration of Cumulative Impacts Any Closer Than It Was Twenty Years Ago?

While most agencies with the legal authority to engage in cumulative impacts assessment have not yet fully realize this mandate, it appears that gradual progress is being made. Advances in coastal and marine science, coupled with new federal environmental initiatives based on ecosystem management, hold promise for incorporating ecosystem principles into management of coastal wetlands and estuarine waters. However, scientific, legal/institutional and environmental management practitioners must coordinate their efforts to sustain progress on management of cumulative coastal environmental impacts.

ABOUT THIS CUMULATIVE IMPACT PROJECT

The goal of this NOAA Coastal Ocean Program-funded project is to transfer to environmental management practitioners information about consideration of cumulative impacts in environmental decision-making. This report views the issue from the perspectives of science, law, and environmental management. It provides a brief overview of key concepts, methodologies and techniques and includes an extensive annotated bibliography to assist the reader in identifying additional materials.

The project team consisted of lawyers, planners and scientists affiliated with the Marine Law Institute of the University of Maine School of Law and the Habitat and Protected Resources Division of the Northeast Region of the National Marine Fisheries Service (NMFS). The team developed this report based on traditional public policy research, questionnaires sent to theorists and practitioners, a two-day workshop for invited participants held in May 1993, and its own efforts to develop a cumulative impacts approach for NMFS to utilize in reviews of Section 404 permit applications.

CHAPTER TWO: ISSUES IN CUMULATIVE IMPACT ASSESSMENT AND MANAGEMENT

The literature is replete with descriptions of serious environmental problems, both coastal and non-coastal, which are cumulative in nature, building up over time as the combined outcome of numerous actions and choices. The overriding coastal problems appear to be land use change and habitat degradation and loss. In some coastal areas, local threats are also posed by nutrient pollution, chemical contamination, fresh water diversion, and microbial contamination.

While any number of scenarios of incremental change could be used as examples of patterns or trends of land and water uses having cumulative impacts on coastal environments, for purposes of illustration, two are discussed in Chapter Two of the full report: threats to estuarine-dependent commercial fisheries and threats to wetlands.

Illustration 1: Incremental Threats to Estuarine-Dependent Fisheries

Estuarine-dependent fisheries account for approximately 71%-77% of commercial fishery landings. According to NMFS, the populations of almost all commercially or recreationally exploited estuarine-dependent species off the U.S. coasts are at "all time low levels of abundance." One factor in the decline is habitat degradation and loss, attributable to wetland loss and degradation, toxic chemical releases, alteration of freshwater flows and nutrient over-enrichment. For the most part, these losses reflect a cumulative pattern of environmental degradation, repeated in numerous small alterations, but adding up to profound loss of ecosystem functioning.

Illustration 2: Incremental Threats to Wetlands

Wetlands provide another illustration of incremental resource degradation. The cumulative loss of wetlands has been extensive, with over half of the original continental United States' wetlands lost since the 1780s. Despite the fact that wetlands are now widely recognized as serving a variety of important functions, incremental loss continues.

Wetlands may be particularly susceptible to cumulative loss and piecemeal degradation because they are widely distributed, take many diverse forms, and are the product of under-appreciated large-scale landscape processes. They are especially difficult to protect because: destructive effects can rarely be traced back to individual actions or causes, the benefits of wetland protection are geographically diffuse and not directly realized by the individual making the protection effort, and the value of a particular wetland is dependent on its function within the landscape.

Need to Control Cumulative Impacts

Cumulative impacts can result from a variety of regulated and managed uses, despite regulatory efforts. This is particularly true if regulators tolerate some degradation with each permit, if mitigation is insufficient to preserve the function of a disturbed landscape, or if they give only perfunctory review to projects directly affecting only a small land area.

Cumulative impacts can also result from traditionally unregulated changes in land and water uses. Actions such as incremental changes in the intensity of use of a site, post-development failure to maintain septic systems, or excessive use of fertilizers may have greater impact than the original regulated activity.

Resource managers should be increasingly attentive to the cumulative impacts of these multiple, small changes for several reasons:

- Multiple small-scale, unrelated land development changes can have even greater harmful effects on natural processes than larger-scale projects.

- The effects of development projects, both large and small, often go far beyond the obvious direct impacts of a project.

- Increasingly, in many coastal areas the land now being proposed for development presents major site-specific challenges.

- Much of the remaining undeveloped land has assumed disproportionate environmental importance because it is being pressed into service to provide critical habitat or fulfill other natural resource functions previously served by now-developed land.

Analysis of Key Terms and Concepts

Scientists, regulators, policy makers and environmental managers have not yet reached agreement on a common language to use in discussing cumulative impact assessment and management issues. Lacking a common language, each study of cumulative impacts must define key terms. The definitions used in this document are included in Figure 2.1.

OVERLAPPING DEFINITIONS OF IMPACT AND EFFECT

As defined for purposes of this document, there is no precise distinction between "impact" and "effect." The term "impact" can be used to describe the inducing action itself, the outcome of the action, and the value judgment about whether the outcome is acceptable to the evaluative society. The absence of a clearer distinction between these terms is not due to oversight or to inability to be more rigorous; rather it is a concession to realities of the regulatory context within which cumulative impact decisions are made.

"CUMULATIVE" INCLUDES BOTH ADDITIVE AND SYNERGISTIC EFFECTS

The definition of "cumulative" adopted for this document includes both simple additive effects and more complex interactive effects. The latter includes magnification effects or synergistic relationships, when the effects combine to produce a greater impact than simple additive effects.

"CUMULATIVE" INCLUDES SAME AND DIFFERENT TYPES OF ACTIONS

The definition of "cumulative" does not limit the incremental addition or loss to a single type of action. While cumulative impacts are most frequently thought of as occurring over a period of time from a repetition of the same type of action, they may also result from a series of different types of perturbations occurring in the same area which affect the same environmental process or valued environmental component.

TYPOLOGIES: WAYS ENVIRONMENTAL EFFECTS ACCUMULATE

To elaborate upon these distinctions, researchers have developed various typologies based on the different ways that environmental effects accumulate. One frequently used typology, developed in a 1986 National Research Council report,[2] states that cumulative environmental effects can occur because of: time-crowded perturbations, space-crowded perturbations, synergisms, indirect effects, nibbling (a category which overlaps the others, including effects of incremental and decremental time and space crowding, as well as removal of habitat piece by piece), and others (threshold developments or projects with effects delayed by time lags or space lags).

Thus, cumulative impacts are defined as the total effect on the environment of a series of land and water use and development activities taking place within a specific region over a particular period of time. They are not merely on-site impacts, but include off-site impacts as well. Cumulative impacts are not limited to synergistic or interactive impacts; they also include simple additive impacts if they are so close in time that the effects of one are not dissipated before the next one occurs or are so close in space that their effects overlap. The evaluation of cumulative impacts will always include consideration of some past period, and should also include consideration of future actions. It assumes two or more actions, which do not have to be the same type of action as long as they affect the same valued environmental component. The projected resource impacts, not the proposed actions, are the focus for determining if there will be adverse cumulative impacts.

The primary characteristics which distinguish cumulative impact assessment from traditional environmental impact assessment are threefold:

- it analyzes off-site synergistic, magnification, growth-inducing or other interactive impacts of actions;
- it considers the additive impacts of multiple small-scale actions which might otherwise have been dismissed erroneously as negligible; and

- it evaluates the impacts of actions in relation to the effects on valued resources, especially through changes affecting larger-scale ecological processes or conditions.

Related Concepts in Environmental Planning

Cumulative impact assessment draws on the conceptual frameworks of several types of environmental planning and management, with no bright lines separating them. In part, this is because the definition of what constitutes cumulative impact assessment has evolved over time. Many theorists now assert that the ideal cumulative impact assessment should encompass a comprehensive mix of monitoring, modeling, permit reviews, planning and management. Closely related concepts include comprehensive land and water use planning, planning for sustainable development, and planning for ecosystem management or ecosystem health. In addition, watershed planning and management, regional risk assessment and risk management, integrated resource management, product life cycle assessment and management, and pollution prevention are all strands of work which draw on conceptual underpinnings which are related to cumulative impact assessment.

CHAPTER THREE: STATE-OF-THE-ART CUMULATIVE IMPACT ASSESSMENT AND MANAGEMENT METHODOLOGIES

There is no single, generally accepted, comprehensive environmental assessment methodology for cumulative impacts. Researchers have used a variety of methods including **checklists** of characteristics, impacts or processes to be considered in the analysis; **matrices** of interactions between activities and environmental conditions; **nodal networks or pathways** to depict likely impacts; **dynamic models** to simulate ecosystem response;[3] **cartographic techniques** to represent the interrelationship between activities and environmental characteristics; **evaluation techniques** to compare the impacts of development with alternatives; and **adaptive or ad hoc** methods utilizing a combination of assessment methodologies. There is a general perception that these methods remain unsatisfactory and need further refinement for practical application.

Recommendations for Systematic Cumulative Impact Assessment

It is probably not yet possible to develop one systematic and comprehensive analytical method for assessing cumulative environmental impacts due, in large part, to an incomplete understanding of ecosystem behavior. However, it may be possible to develop a set of systematic approaches for detecting and eventually quantifying cumulative impacts. One theorist recommends the following as an interim approach:

- Use a technique that clearly recognizes complex ecosystem interactions and process;

- Choose among many possible methods to identify potential environmental impacts (checklists, interaction matrices, nodal pathways analysis, models, etc.) based on the circumstances of the case;

- Once the ecosystem interactions and potential environmental impacts have been defined, using the most applicable and recent information, carefully examine each impact in great detail using a "magnifying glass" (looking for additive, synergistic and indirect effects over both time and space) to determine which, if any, cumulative impacts are likely to occur.[4]

The literature also offers the following additional methodological guidance:

The cumulative impacts assessment should be structured in terms of **goals for a resource and/or resource impact of concern**. The focus of analysis should be on how the proposed action will affect the resource and whether the action will move closer to or farther away from the goals for that resource.

The investigator should define **explicit time boundaries** for use in assessing the incremental impact when added to "past" and "reasonable foreseeable future actions."

The investigator should define **explicit geographic boundaries** which, ideally, should be large enough to encompass major factors that cause variation in the effects and allow for consideration from a landscape perspective.

The methodology should identify the **policy and technical tools** to be used, selecting from many methods and techniques, none of which are necessarily superior to another. Particular attention should be given to identification of **essential indicators** of resource loss, stress or similar impact.

The investigator should explicitly **identify institutional barriers** which may preclude full assessment of cumulative impacts such as limited jurisdiction of the reviewing authority, limited data, limited time or resources.

Examples of Cumulative Impact Assessment and Management Methodologies

Chapter Three reviews five selected state-of-the-art cumulative impact assessment and management methodologies to illustrate how different theorists and agencies have approached cumulative impacts. For the most part, they have been designed to address particular concerns in a terrestrial context; issues about transferability to an estuarine or marine context need to be addressed. This review is by no means exhaustive. Readers should also review the sources cited in the cumulative impacts methodologies section of the annotated bibliography for detailed descriptions of additional methodologies and for systematic comparisons of multiple methodologies.

EXAMPLE 1: ALASKA'S ASSESSMENT OF CUMULATIVE IMPACTS ON FISH HABITAT IN THE KENAI RIVER

Alaska's Department of Fish and Game (ADF&G) Habitat and Restoration Division recently completed an assessment of the cumulative impacts of development and human uses on fish habitat in the Kenai River. Resource managers were increasingly concerned about the impacts of multiple large- and small-scale development projects and land uses requiring river access on the physical and biological integrity of the river's habitat for resident and anadromous fish.

The assessment methodology combined several processes:

Step One: Identify the target resource and develop a fish habitat classification scheme for impact assessment purposes.

Step Two: Develop a baseline description of the conditions occurring along the river correlated to individual land ownership patterns.

Step Three: Select and apply a qualitative fish habitat value model procedure.

Step Four: Complete a development trends analysis.

Step Five: Model future changes in habitat characteristics.

This methodology involves a high level of baseline data development and ground truthing to initially define the habitat characteristics of the study area. The analysis is only as accurate as the indicator species and suitability curves, both of which require a fair amount of best professional judgment. This habitat-based assessment approach can assess impacts of the primary activity and projected secondary impacts, but it is not designed to measure indirect effects nor is it designed to assess the impacts of increased pollutants generated by the action.

EXAMPLE 2: A LANDSCAPE CONSERVATION APPROACH

This example is based on a methodology developed by a group of wetland scientists as part of a long-term project aimed at restoring the Lower Mississippi River Valley. While developed in the context of bottomland hardwood forested wetlands, the methodology is not restricted to that resource.

Researchers were concerned about the rapid decimation of bottomland hardwood forested wetlands because of the resulting loss of ecological services related to habitat, water quality and flood water storage. They focused on cumulative impacts and large-scale landscapes (defined as "large heterogeneous areas composed of several ecosystems that are spatially and temporally linked and that function as an integrated unit") as the key to slow, or perhaps even begin to reverse, the loss. They asserted that regulatory and management procedures should consider impacts on natural landscape units and that regulatory decisions should be made in the context of plans for the entire landscape. The process had to shift from a reactive one to a process informed by prior planning on a landscape scale.

The basic three-step methodology consisted of:

Step One: Ecological Assessment - determining the ecological "health" of the study area through "the characterization of cumulative effects on both ecological structure and the functional ecological processes in a designated landscape unit" using landscape indices that integrate ecological processes over large areas;

Step Two: Goal-setting—setting goals for the study area environment based on its present health through "agreement by public consensus on environmental goals for the assessment area, based on the assessment and consistent with regulations under the [Clean Water Act]"; and

Step Three: Implementation—planning how those goals can be implemented through "the development of specific plans to implement the goals, based on the landscape structure and function of the assessment area. . . ."[5]

A specific application to the Tensas River basin is discussed in more detail in Chapter Three.

The method illustrates the use of a few long-term data sets to produce a landscape-level analysis of major environmental changes and how cumulative impacts can be managed by working within the existing regulatory structure. However, significant issues remain about the appropriate underlying landscape management principles to use in a coastal or estuarine context.

EXAMPLE 3: U.S. FISH & WILDLIFE SERVICE CAUSE/EFFECT PROCESS

The U.S. Fish and Wildlife Service (USFWS) has been working on the problem of cumulative impacts for a number of years in many different contexts including bays and estuaries. One premise underlying the USFWS work is that cumulative impact assessment should be a process, not a particular methodology. A second premise is that efforts should not stop with assessment (scoping and analysis), but should be combined with proactive, long-term management planning.

USFWS recommends that managers emphasize a scientific, cause-effect understanding of the overall situation, each problem, and problem interactions; stress measurable overall action toward progressive goals; use a generation-long, ecosystem-level process to solve problems and generate solutions; and have multiple agencies collaborate in the effort to improve the overall situation.[6]

The basic steps are:

Step One: Scoping—Define the ecological situation in specific terms of individual problem statements and select one strategy for each problem.

Step Two: Analysis—Investigate and document the problems and their causes in detail using the best available data and analytical tools and then set several goals.

Step Three: Interpretation—Develop and document options, estimate changes using mathematical models, and develop a plan.

Step Four: Direction—Implement and incrementally improve the management plan and systematically evaluate, improve and update the problem statements, data, analytical tools, and mathematical models.

This approach is tailored to USFWS' role as a resource agency with the power to review and comment on permit applications and ability to offer its expertise to other agencies. The methodology is particularly useful in offering insights on how to move from problem recognition to selection of management strategies.

EXAMPLE 4: EPA'S SYNOPTIC APPROACH

EPA's "Synoptic Approach to Cumulative Impact Assessment," developed by the Office of Research and Development's Wetlands Research Program, was originally developed for use in wetland permit evaluations under the Clean Water Act. It is designed for cases in which time, resources and information are limited. It is not meant to produce the precise, quantified assessment of cumulative impacts as part of a review of a major or controversial action. Instead it is intended as a tool to augment best professional judgment in decisions about cumulative impacts of minor, "non-controversial" projects requiring Section 404 permits. It is designed to be an inexpensive, rapid assessment method for making some qualitative comparisons of cumulative effects *between* different areas such as watersheds, landscape units or ecoregions.

The synoptic approach involves five major steps, to be carried out by a team composed of at least a manager, resource specialist and technical analyst. They are: (1) define goals and criteria; (2) define synoptic indices; (3) select landscape indicators; (4) conduct the assessment; and (5) prepare synoptic reports.

The major work product is likely to be one or more regional or statewide maps that rank units of the landscape according to a number of landscape variables, or "synoptic indices." The maps and indices allow a permit reviewer to take into account the landscape condition of an area in which a permit activity is proposed and thus the cumulative impact of the proposal.

A synoptic index is composed of variables used to compare landscape subunits, which will generally indicate function, value, functional loss, or replacement potential. To develop the synoptic indices, the assessment team has to develop a conceptual, ecological model of the forces and functions driving the wetlands, identify the stressors in the particular area, and choose which landscape indicators to use to estimate the synoptic indices.

EXAMPLE 5: REGIONAL ECOLOGICAL RISK ASSESSMENT

Regional ecological risk assessment can be used as an approach to cumulative impact assessment, particularly as related to environmental problems of land use change and habitat destruction. It is designed to assess cumulative effects at a scale larger than the individual project or site-specific scale. Ideally, risk assessment would be undertaken ahead of time on a programmatic or regional scale, and would provide a reference base (data, models and plans) which would provide a context for relatively rapid decisions on individual permit applications or planning decisions at the local scale.

Risk assessment goes beyond a typical cumulative or programmatic assessment in that it seeks to *quantify* the probability of impact and the associated uncertainty. Its primary contribution is as a tool to improve scientific assessment and to provide policy makers with relevant quantitative information in a form that will allow them to make the necessary decision for cumulative impact management.

The two general phases of regional risk assessment are:

Phase One: Hazard Definition—an iterative process of selection of endpoints, development of source terms, and description of reference environment; and

Phase Two: Problem Solution—an assessment of the exposure or habitat modification and assessment of the effects, and then a combination of those assessments to determine the risk or probability of a negative event happening.

The assessment stage relies on models of ecological processes and long-term data bases of biological variables. Researchers need to understand landscape patterns and regional ecological processes.

While its advocates assert that regional risk assessment is a potentially powerful tool for resource management, they state that additional research is still needed on theoretical and applied issues before its potential can be realized. In addition, additional financial and agency resources need to be dedicated to development of appropriate national and regional data bases before it can make a significant contribution to assessing cumulative environmental impacts.

Variations in Methodologies

Approaches to cumulative impact assessment and management vary, depending upon the agency mandate, structure, resources and goals. The methodologies examined in Chapter Three illustrate this range. Different approaches stress priority setting, political or management processes, accurate assessment of ecological function, or quantification of the assessment and risks.

These methodologies generally rely on landscape scale assessment of terrestrial resources. A major unanswered question is what modifications as are required to transfer the methodologies to an estuarine, near-shore or coastal context. Additional research is required to identify appropriate landscape organizing principles for estuarine and near-shore ecosystems. Similarly, a transfer to a marine context may have to overcome a more fragmented institutional structure, lack of historical data, absence of goals for future use of marine resources, and differences in ownership patterns and economic incentives.

CHAPTER FOUR: PROGRAMS FOR MANAGEMENT OF CUMULATIVE ENVIRONMENTAL IMPACTS IN COASTAL REGIONS

Chapter Four focuses on existing programs for management of cumulative impacts in coastal regions. It uses "management" in its broadest sense, to denote a full range of governmental responses including regulation, planning, acquisition, public investment and other types of management. It presents an overview of the extent to which selected federal and state management programs allow, or require, decisions to be made based on analyses of adverse cumulative impacts, and identifies some emerging state and federal initiatives that promise to strengthen cumulative impact management efforts.

Treatment of Cumulative Impacts in Federal Programs

SECTION 404 PROGRAM

The federal Section 404 regulatory program is the most important federal permit program applicable to coastal areas. The Corps may not permit a discharge which would "cause or contribute to significant degradation of the waters of the United States."[7] Among the factors to be considered are cumulative effects. However, the Guidelines do not address the methodology to be used to assess cumulative impacts, nor the weight they should be given in environmental decision-making.

Many reports and agencies have criticized the Corps' track record in considering cumulative impacts. The primary weaknesses of the 404 program as a tool for managing cumulative effects are not to be found in the letter of the law, but in the Corps' implementation. There are differences of opinion over whether the program constraints preclude effective consideration of cumulative impacts or whether there is an ability but an unwillingness to base decisions on cumulative impacts. However, this outcome is not inevitable. Instances where the Corps has successfully engaged in aggressive use of cumulative impacts review standards are discussed in Chapter Five.

NATIONAL ENVIRONMENTAL POLICY ACT (NEPA)

NEPA reviews are the second most frequent federal context in which cumulative impacts issues may arise. However, most of the actions which in aggregate cause cumulative effects are themselves minor and lack any federal involvement so that they never require evaluation under NEPA. While the statute itself does not mention "cumulative impacts" or "cumulative effects," those terms are defined and used in the CEQ regulations implementing the procedural provisions of NEPA. Cumulative effects are to be considered in the NEPA process in determining (1) which actions are to be given a categorical exclusion from further assessment (not individually or cumulatively having a significant effect), (2) in the Environmental Assessment process of determining whether a proposed action will have no significant impact (FONSI to consider the severity/intensity of cumulative impacts, among others), and (3) as one of the impacts to be considered if a full Environmental Impact Statement is required.

NEPA has several notable weaknesses as a tool for managing cumulative impacts. Cumulative impacts are only "considered" in an EIS. EISs are costly, rare and time consuming. Because EISs by definition are prepared only to assess "major" actions, cumulative impacts frequently become one among many factors in a complex, contentious and politically driven debate. Finally, due to the procedural nature of NEPA, the CEQ rules emphasize assessment rather than management of cumulative impacts.

WATERSHED PROTECTION APPROACH/NATIONAL ESTUARY PROGRAM

A variety of federal programs attempt to address cumulative impacts from a planning and management rather than regulatory approach. For example, EPA is promoting a "watershed protection" model, which encourages resource-based management in biologically-defined regions. Other notable efforts include the Clean Water Act mandated coastal non-point pollution control program for coastal states, work of NOAA's Strategic Environmental Assessments (SEA) Division of the Office of Ocean Resources Conservation and Assessment (ORCA), EPA's Environmental Monitoring and Assessment Program (EMAP), and EPA's National Estuary Program.

In theory, the National Estuary Program and similar programs have the potential to solve the perennial cumulative impact assessment problem of the mismatch between the scale at which decisions are made and the scale at which impacts are felt. These programs focus on ecological regions rather than political units. In addition the process can facilitate public consensus on specific resource goals and adoption of comprehensive management plans. They can provide a context for decisions on individual projects with potential cumulative impacts.

COASTAL ZONE MANAGEMENT PROGRAM

Additional federal support for management of cumulative impacts takes the form of funding for planning, research and implementation. The best example of this is the federal Coastal Zone Management Act of 1972 (CZMA). The 1990 amendments created a Coastal Zone Enhancement Program, to encourage states to strengthen their coastal zone management programs in eight specified priority areas. Control of cumulative and secondary impacts of development is one of these priority areas.

Treatment of Cumulative Impacts in State Programs

States have had widely varying experiences addressing cumulative impacts issues. Instructive state approaches include state wetlands permitting programs, state mini-NEPA statutes and growth management and coastal zone management approaches in various states.

STATE WETLANDS PERMITTING PROGRAMS

Florida was among the first states to address cumulative impacts through a wetlands permitting statute, initially as a way to allocate fairly that amount of dredging and filling activity which could be done without violation of water quality standards and without being contrary to the public interest. The agency was to consider the additive impacts of past, present and likely future activities on regulated resources within the same waterbody or watershed as the proposed project.

1993 amendments made a subtle shift away from the approach that it was permissible to degrade the resource down to point just short of ecosystem collapse. The Act now emphasizes mitigation of losses through wetlands creation, enhancement and "preservation." However, some critics have identified the reliance on mitigation as seriously compromising the program's effectiveness in halting incremental wetland degradation.

A recent assessment of the effectiveness of state and federal wetlands permitting programs in the Chesapeake Bay Area identified some constraints that appear to be characteristic of this type of program in general: as currently implemented, these programs may slow but fail to halt the loss of wetlands. At best, regulatory programs only control what they receive applications for. Continuing loss should be expected due to illegal wetland destruction, regulatory "loopholes", numerous small requests routinely granted through general permits or expedited procedures, and the frequent failure of required mitigation to replace the functions and values of destroyed or degraded wetlands.

MINI-NEPA STATUTES

At least ten coastal states have followed the lead of the federal government by adopting "mini-NEPA" statutes which require evaluation of the environmental effects of a proposed action. California is a leader in development of comprehensive cumulative impacts standards under its California Environmental Quality Act (CEQA), with detailed guidelines on when cumulative impacts should be discussed and what elements are necessary to an adequate discussion. CEQA review is also required for planning documents, which affords an opportunity to analyze cumulative impacts on a more comprehensive basis. Some state agencies have gone beyond the CEQA requirements to develop their own procedures for cumulative impact assessment.

The interpretation of state-NEPA statutes is a very technical, case-specific process. The success of the statute in managing cumulative impacts depends on very precise procedural provisions, carefully crafted definitions, and ultimately judicial interpretations of the statute and regulations. Without clear definitions and procedures, the statute as applied may be unable to make the transition from traditional environmental impact assessment to cumulative impact assessment.

STATE LAND USE PLANNING TO MANAGE CUMULATIVE IMPACTS

A number of states also try to control incremental coastal environmental impacts with land use planning and non-wetland permitting initiatives. Development of resource goals and long-range comprehensive plans enhance the effectiveness of cumulative impact management by establishing a broader context for site-specific regulatory decisions and guiding development to those areas where it is expected to cause the least harm.

Several states have enacted state-wide or coastal growth management or comprehensive planning laws that expressly require or imply consideration of cumulative impacts. Several of these states, including North Carolina, Maine, California, Rhode Island and New York, are currently grappling with how to strengthen consideration of cumulative impacts. Among techniques under consideration are revising statutes to make cumulative impact standards more enforceable, engaging in special area management planning, enhancing the capacity for multi-jurisdictional cooperative estuary management, developing ecosystem management guidelines for marine ecological communities, assessing natural limits on coastal island development, and using advance designation of habitats of special ecological significance. Some states are also focusing on federal consistency as a tool to gain control over adverse cumulative effects.

Local Efforts to Management Cumulative Impacts

Local efforts to manage cumulative impacts have developed both as part of a state-initiated portion of the state's coastal zone management program and as a locally-initiated response to protect environmental quality. There are numerous examples of local efforts. For illustration, the report describes five initiatives from Maine's communities: a coastal protection overlay zone to address septic systems and non-point source pollution, a local wetlands ordinance which supplements the state statute by regulating wetlands under the state size threshold, a downzoning initiative and transfer of development rights system based on island carrying capacity, a lakes phosphorus allocation planning system for use by municipalities affecting a shared resource, and a demonstration project of the Maine Coastal Program to assist towns in one estuary to develop a cooperative, integrated approach to protecting coastal water quality.

Recommendations to Improve Management

There are a variety of planning and regulatory mechanisms in use by local, state and federal agencies to attempt to manage cumulative coastal environmental impacts. However, most programs that do make explicit reference to cumulative impacts merely direct consideration of those impacts, without giving much guidance on how they are to be considered. Improved effectiveness is possible on several fronts:

Agency action: Improve internal guidance on techniques for cumulative impact assessments, improve permit tracking systems, improve local databases, initiate systematic monitoring of environmental conditions, and explore more creative use of coastal management programs and federal consistency review to reassert state control over natural resource decisions.

Legislative action: Adopt new or clarify existing definitions of "cumulative impacts" and related key terms; adopt regulations to delineate the geographic scope, types of projects, and timeframe to be utilized in a cumulative impact analysis; and amend laws to incorporate more enforceable standards for permit review that are aimed at preventing adverse cumulative impacts.

Multi-jurisdictional action: Experiment with cooperative regional approaches in ecologically-determined areas to overcome political boundaries.

Long-range action: Revisit issues of the proper allocation of development control between state and local government; continue to refine resource-based comprehensive planning designed to establish explicit resource goals to guide individual permit decisions; educate the public about the importance of an ecosystem approach to resource conservation and the importance of managing adverse cumulative impacts.

CHAPTER FIVE: LEGAL ISSUES IN CUMULATIVE IMPACT ASSESSMENT AND MANAGEMENT

Chapter Five examines the legal challenges landowners or others may raise when agencies address adverse cumulative impacts in their regulatory or management programs. This should not be taken as an implication that environmental decisions based upon cumulative impacts grounds are especially vulnerable to legal challenge. The variety of legal claims that could be raised against agency cumulative impact decisions can be successfully withstood by an agency if it carefully compiles its record of decision, if it has reasonably clear statutory authority for applying a cumulative impacts criterion to regulatory or management decisions, and if the regulations do not require public use or go so far as to deprive an owner of all economic value of the property.

While we found a common perception that agency decisions which rely on cumulative impacts are particularly vulnerable to challenge, this was not born out by our review of cases decided in recent years in federal and state courts. But the perception could become a self-fulfilling prophecy; if agencies are not aggressive in documenting and asserting adverse cumulative impacts as the ground for a permit denial or for approval with mitigation conditions, reviewing courts will have no basis for upholding adverse cumulative impacts as an appropriate ground for decision.

Judicial Review of Agency Decisions

Most cumulative impacts issues are presented to the court in the form of a challenge to an administrative agency action. Generally administrative laws allow reviewing courts to set aside agency actions which are "arbitrary, capricious, an abuse of discretion, or otherwise not in accordance with law." The reviewing court can assess whether the agency has complied with the requirement to consider those factors made relevant by the statute. Usually the court will just address whether the factors were adequately considered by the agency, and will not assess whether the weight the agency gave to the factors was appropriate.

Litigation Challenging Agency Cumulative Impacts Efforts

FEDERAL SECTION 404 WETLANDS CASES

As federal agencies have made more concerted efforts to protect regionally significant resources and ecosystems by controlling cumulative impacts, the courts have, in general, upheld these actions. In particular, the courts have upheld the Corps' reliance upon adverse cumulative impacts in the sense of piecemeal or incremental degradation as a basis for denial of Section 404 permits. For example, in *O'Connor v. Corps of Engineers*,[8] the court held that the Corps was neither arbitrary nor capricious in determining that filing .41 acres of wetland, when considered with the cumulative effect of other such minor changes, would have placed the quality of the lake and surrounding wetlands in too much danger to be allowed.

Similarly, another recent decision, *Fox Bay Partners v. U.S. Corps of Engineers,*[9] also supports the Corps' reliance on cumulative impacts to deny permit applications. The Corps denied an application for a large recreational marina after considering the probable increase in large power boat traffic and its likely effects on the aquatic ecosystem, taking into consideration the combination of existing, already permitted and similar reasonably foreseeable future projects. The denial based on the conclusion it would result in significant, cumulative, adverse impacts was upheld by the court.

In a third recent case, *James City County v. EPA,*[10] the Fourth Circuit Court of Appeals upheld EPA's veto of a Corps permit to allow the construction of a dam and reservoir across Ware Creek in the Chesapeake Bay watershed, finding that EPA has the authority to justify its veto solely on the basis of unacceptable adverse effects on the environment. EPA based its decision, in part, on adverse cumulative impacts. The court deferred to the agency judgment that those effects were unacceptable.

DECISIONS UNDER STATE LAWS

There are also many state cases addressing cumulative impacts issues. They are not necessarily legal precedents for decisions in other state courts or in the federal courts, but do illustrate how courts have addressed common issues.

An excellent example of a court upholding a state agency's aggressive stance on control of adverse cumulative effects is a 1994 Florida Court of Appeals case, *Florida Power Corp. v. Department of Environmental Regulation.*[11] The applicant sought a permit to fill .0135 acres of jurisdictional wetlands to install an electrical transmission line over a corridor 60 feet wide and 14 miles long, passing through a high-quality, previously undisturbed forested wetland. The applicant would also clear an additional 5.997 acres, which alone would not have required a permit. Secretary Browner ultimately denied the application on the grounds that, despite the small size of the area disturbed (6 acres of 31,448 acres of contiguous forested wetland), there was nonetheless an unacceptable environmental impact. On appeal, the permit denial was upheld, with the court deferring to the Department's findings of fact and policy judgments regarding the adverse cumulative impacts of disturbance in this kind of wetland ecosystem.

Chapter Five includes several other examples of state courts upholding agency actions designed to control development based on adverse cumulative effects or state courts reversing agency permit approvals for failure to consider cumulative impacts. These judicial reversals frequently occur in the context of state NEPAs or similar state environmental statutes, where the responsible agency has failed to follow the required review procedures.

Not all judicial decisions have been favorable to consideration of cumulative impacts. Decisions have upheld an agency action despite the agency's failure to address adverse cumulative impacts, and have held that there was no statutory requirement for the agency to evaluate cumulative impacts. Courts have also applied standards of review to the factual record in a manner that makes it more difficult for agencies to constrain development on grounds of adverse cumulative impacts.

DECISIONS UNDER NEPA

Dozens of federal cases have considered the proper treatment of adverse cumulative impacts under the National Environmental Policy Act (NEPA). Cases discussed in Chapter Five include those involving challenges to a federal agency's determination that it is not necessary to prepare a detailed environmental impact statement (EIS) and involving challenges to the adequacy of the cumulative impact review once "significance" was found and an EIS was prepared. The specific facts are critical. The courts generally afford the expertise of federal agencies considerable deference. Some cases have upheld the adequacy of the cumulative effects analysis in the EIS. Other cases have found the cumulative impacts discussion in the EIS to be deficient, even using the arbitrary and capricious standard.

Because NEPA establishes procedural rather than substantive requirements, debates about compliance with NEPA's cumulative impacts requirements are usually couched in terms of whether those impacts should have been considered (or were adequately considered) in evaluating the environmental significance of a proposed project or in preparing an EIS. NEPA challenges to approval of a proposed action do not provide a mechanism for reaching the substantive question of whether a decision on a proposed action is appropriate given the disclosed cumulative impacts. Great deference is given to the federal agency; the courts will accept the agency action as long as it is not arbitrary or capricious and is supported by a rational explanation. And even if the federal agency is found to have violated those standards, the remedy is not to deny the proposed action. The matter is usually remanded to the agency for further study and development of a new or supplemental EIS with analysis that comports with the standards.

Given the administrative law standards which afford judicial deference to agency decisions, if agencies begin to more aggressively deny proposed actions with adverse cumulative impacts and have sufficient data to include a rational explanation of the basis for the decision, the courts are likely to uphold the agency's decisions. Conversely, if agencies continue to shy away from making full use of their authority to consider cumulative impacts, courts are likely to defer to that agency judgment as well.

COMMON CUMULATIVE IMPACT ISSUES

In our review of environmental case law involving the question of cumulative impacts, there were several recurrent issues. Many of the state law cases turned on questions of interpretation of state statutes or regulations, typically whether the agency had adequate legal authority to base a decision on cumulative impacts. These decisions are specific to particular states and their environmental laws and programs, and are not controlling on other states. These cases do illustrate that courts can only review an agency action within the context of its authorizing statutes and regulations. If the statute or regulations fail to require consideration of cumulative impacts, do not adequately define key terms, or omit a description of factors the agency is to consider in assessing potential cumulative effects, the courts cannot supply these criteria.

A second common issue was the proper scope of review for staged projects, related facilities and secondary impacts. Frequently projects involve a sequence of actions, raising the issue of how much an agency should review in its initial environmental assessment. Some courts conclude that the agency should consider the cumulative impacts of all stages at the initial assessment; other cases have, however, reached the opposite conclusion. These decisions depend, in part, on the specific procedures, how accurately impacts may be projected at the early stages, and the degree of authority to make substantial modifications or halt a project at later stages.

A closely-linked issue is how related facilities and secondary impacts should be considered in a cumulative impact analysis. Need a cumulative impact analysis consider the probable impact of all anticipated activities which will be part of the operation, whether or not those activities are part of the permit under review? Courts have split on these decisions.

A third issue involves what degree of environmental protection the regulations are designed to afford and how to weigh the precedential effect of a prior or pending permit application. May the agency deny a project if it has already granted a permit for a similar project? May the agency deny the application if it believes the project will set the pattern for a type of future development that the environmental resource receiving these impacts cannot absorb, even if the first project will not, by itself, have a significant adverse impact. Is the intent to allow actions to continue to degrade the resource down to some threshold? Is the agency bound by prior decisions, even though a continuation of that pattern will result in adverse cumulative impacts? Various regulatory programs answer these questions differently.

Some theorists assert that to promote ecosystem conservation or restoration, decision-makers should not be asking whether the proposed development would exceed a minimum threshold, but rather whether it would move the ecosystem closer to or further away from the resource goals. This requires not only express resource goals and proper authorizing legislation, but also comprehensive planning for key natural resources to support this type of judgment. A few state court decisions reflect this sophisticated level of analysis.

A final recurring issue in cumulative impact litigation is whether the information in the record that the agency relied on to make its decision was sufficient to support the decision made. Court decisions on this question run the gamut from deferring to agencies' conclusions as to the information's sufficiency to reversing the agency's decision on grounds that sufficient information was either lacking or present but not credible or persuasive. A variety of cases are discussed in Chapter Five.

Regulatory Takings Without Just Compensation

A final possible challenge to an agency decision is the claim that the regulatory restrictions are so burdensome that they constitute a taking of private property by the government without just compensation. There is nothing unique about restrictions based on adverse, cumulative environmental impacts that requires courts to vary from the standards courts apply in cases where other regulatory takings are alleged.

The court's inquiry will focus on the specific facts of the case, including the stated rationale for the regulation and the circumstances of the affected property owner and similarly situated owners. The court's takings analysis seeks to balance the public benefit of the regulation against the private costs that it imposes to determine when the regulatory burden is so significant and so much greater than that imposed on others that the property owner should receive compensation.

The court will not engage in this balancing of governmental against private property interests, however, if the effect of the regulation is to eliminate totally all economic value of the property. When a property will be considered to have been rendered completely valueless by an environmental regulation is unclear, due in part to the Court's incomplete treatment of this question in *Lucas*.[12] Most commentators, however, believe a total taking will be found in only a very small number of cases.

Because the balancing test courts most often apply is very fact-specific, and because the U.S. Supreme Court is undergoing a shift in doctrine under the takings clause, the outcome of a regulatory takings claim under the federal Constitution remains hard to predict, especially if the regulation can be seen as depriving the owner of all or almost all uses of the land. However, if the agency's application of a cumulative effects standard to prevent degradation of wetlands or other resources vulnerable to cumulative impacts does not eliminate all economic value to the affected property, and if other activities on the land or forms of development are allowed, even if less intensive, the landowner is not likely to prevail on a takings challenge to a cumulative impacts regulation.

It seems likely that most programs aimed at preventing and mitigating adverse cumulative impacts on ecological systems will not involve a requirement that the owner give up the right to exclude others from use of the property, thus will not extinguish an essential private property right. If the owner may still exclude all others, the regulation will not need to satisfy the heightened scrutiny standard of the *Nollan*[13] and *Dolan*[14] decisions.

CONCLUSION: BARRIERS, TRENDS AND OPPORTUNITIES

Cumulative impact assessment, management and monitoring are multi-faceted and complex. Progress in operationalizing the concepts is likely to be very gradual, and is likely to be achieved through iterative, decentralized efforts. It will require multidisciplinary contributions from the fields of science, law, and environmental management.

Managers can increase the likelihood of effectively addressing incremental environmental effects by focusing on the following factors:

- Adequate Definitions of Key Terms
- Consideration of Multiple Types of Impacts
- Broadened Geographic Scope
- Extended Temporal Scope
- Use of Extrapolating Techniques
- Goals Setting and Comprehensive Planning
- Integrated Monitoring, Assessment and Management

Science

The primary scientific barrier to cumulative effects assessment in a marine or coastal context consists of significant gaps in scientific knowledge about cause and effect relationships. Other constraints include: for all ecosystems, the absence of accepted approaches for projection of cumulative impacts; limited historic records for many coastal and marine ecosystems; and basic questions about the transferability of cumulative impact assessment methodologies developed in a terrestrial context to marine ecosystems.

Despite these barriers, some recent developments point to improved scientific capacity to predict cumulative impacts in coastal and marine ecosystems. These include new initiatives to improve the marine data base; progress on techniques to extrapolate from detailed data to simplify the complexity in ways that facilitate decision-making (e.g., indicators of ecosystem health, synoptic approach); and the growing availability of powerful tools to collect, manipulate and depict data.

Legal/Institutional

One of the primary legal barriers to factoring cumulative impacts into environmental decision-making often is the absence of an unambiguous statutory requirement to do so. Some environmental management laws make no mention of cumulative impacts. Others require that they be "considered." In those regulatory programs where consideration is required, the significance for decision-making is frequently lessened by a lack of useful definitions of key terms, by an absence of any further statutory or regulatory guidance on how cumulative impacts should be assessed, and confusion over the weight to give adverse cumulative impacts.

A second legal barrier is posed by the narrow context in which courts have been asked to interpret the statutory and regulatory requirements. Due to the apparent reluctance of agencies to utilize their full authority under cumulative impact provisions, until recently, the majority of cumulative impact cases reached the courts in the form of a challenge to an agency decision to permit a proposed action. Due to basic principles of administrative law, the courts often defer to agency decisions. Thus, most of the cases address the minimum agencies can do to assess cumulative impacts and still be in compliance with their statutory mandate. Only recently have courts been in a position to develop a parallel body of case law addressing how aggressively agencies can use cumulative impact concepts and still be in compliance with their statutory mandate.

Other barriers to legal system support of integration of cumulative impact concepts include: the inherent focus on individual sites in decision-making, public pressure to speed up the permitting process, and the current trend toward greater protection of private property rights.

Despite these barriers, there are legal and institutional trends that bode well for strengthened consideration of cumulative impacts in environmental decision-making. They include a growing body of thoughtful analyses of cumulative impacts components of various programs, continuing state and local efforts to amend their laws and regulations to make cumulative impact standards more enforceable, increased experience with innovative regulatory techniques, and increased reliance on advanced planning or designations rather than end-of-the-line permitting.

Environmental Management

In addition to the science and legal barriers, there are management-specific barriers as well. Resource managers appear to be reluctant to use all of their authority to consider cumulative effects. For a variety of reasons, even if there is a nagging sense that the environment is not being adequately protected when cumulative impacts concerns are minimized, it is difficult for staff to make the shift in approach. The likelihood of such a shift would be enhanced if leadership and resources come from top levels.

A second barrier is posed by the growing political difficulties with relying on regulations as the primary strategy. It appears that environmental managers are going to have to develop new, non-regulatory strategies (e.g., pollution prevention, economic incentives, educational programs) to supplement regulatory programs or to assume a primary role in control cumulative impacts.

The third challenge for environmental managers is the need to develop a longer-term perspective for coastal and marine systems to support cumulative impact assessment in the marine realm. They will need to develop increased knowledge of the predisturbance state and the history of use and development, and will have to work with the public, fragmented single-purpose agencies and others to determine the land and water use goals for the area.

Despite these impediments, some trends bode well for a shift to a cumulative impacts approach. Assessment theorists are beginning to focus on practical constraints faced by environmental managers. Planning for biologically-defined regions is gaining greater acceptance. State and local resource managers continue to experiment with ways to leverage existing programs, like federal consistency reviews, to find the most appropriate forum for cumulative impact concerns.

But the challenge is clear. Resource managers are going to have to use creative, multi-pronged techniques to sustain the momentum toward cumulative impacts analysis, particularly in the face of a growing private property rights movement. Public education about the importance of valued resources and the threat posed by small, incremental impacts will be critical.

There are no easy answers to the problem of adverse cumulative environmental impacts and no one approach that is going to be appropriate in all situations. Within the broad guidance offered by the example of others, agencies must develop their own approach based on the available funding and staff, political will, data, nature of the threat, resources of concern and community goals.

Assessing and managing cumulative impacts requires a substantial shift in focus, to a resource perspective informed by carrying capacity concepts. It will be a gradual, iterative process as data bases, monitoring, the planning context and resource goals are improved and refined. The capacity to engage in cumulative impact assessment may continue to be more advanced for terrestrial ecosystems than for aquatic ecosystems, but some level of cumulative impact assessment and management should be achievable in near shore and more enclosed coastal systems.

Cumulative impact assessment in a permitting or regulatory process should be viewed as but one means of managing cumulative impacts. The most successful strategies will also incorporate non-regulatory elements. This type of management is highly dependent on the public will to protect the resource, and community consensus on resource goals. It will have the greatest chance for success when all of the agencies with overlapping planning, regulatory and management authority are working toward a common goal to address a shared resource of concern. To keep the focus on the combined effect of numerous individual actions and to avoid unrealistic expectations of immediate results, the goal statement should reflect a long-term commitment to gradual improvement over a long period of time.

Ultimately, however, management of cumulative impacts is as much a political issue as it is a technical/methodological issue. Even if scientists and environmental managers develop assessment tools and management techniques capable of identifying and controlling cumulative effects, they cannot succeed on their own. The general public must concur that a resource is important, that incremental change will pose a problem, and that it must be addressed. Similarly, government decision makers must accept the thesis that cumulative impacts are real, that cumulative impact assessment is useful, and that a new decision-making framework is appropriate.

Public education, cooperative ventures by multiple public and private entities, and political commitment will be required. It is a demanding process, and will not be free of controversy as fundamental values are debated. But there is cause for cautious optimism that we are evolving toward greater ability and willingness to management cumulative coastal environmental effects.

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Chapter 1: Introduction

CONSIDERING CUMULATIVE COASTAL EFFECTS IN ENVIRONMENTAL DECISION-MAKING

What Are *Cumulative Effects*?

In recent years, coastal managers have come to recognize that many of the most serious resource degradation problems did not develop overnight or as the result of a single decision, but rather have built up over time and are the combined outcome of numerous actions and choices interacting to affect the land, air and water. Multiple, small land and water use activities and development projects, which alone may have relatively minor impacts, have combined to threaten living marine and estuarine resources along the coastal United States.

For example, alteration of essential habitat through wetland loss, degradation of water quality from nonpoint source pollution, and changes in salinity of estuarine waters from water diversion projects can be attributed to numerous small actions and choices. These incremental losses have broad spatial and temporal dimensions, resulting in the gradual alteration of structure and functioning of biophysical systems (LeBlanc 1992 [Ann. Bib. #52]). In the environmental management field, the term "cumulative effects" is generally used to describe this phenomenon of changes in the environment that result from numerous, small-scale alterations.

Does Traditional Environmental Impact Assessment Adequately Consider Cumulative Effects?

Federal, state and local regulatory and management programs created to minimize adverse effects of development on coastal resources have, for the most part, relied on traditional environmental assessment. Over the past two decades, traditional environmental impact assessment has focused on evaluating the effects of a single action on the environment by determining direct and indirect (or secondary) impacts. The analysis considered the proposed disturbance and the linear, causal effects on particular species and resources at the site of the proposed action.

A growing number of critics contend that existing regulatory programs have been unable to protect coastal resources from incremental degradation. The willingness to accept a little degradation with each action, the absence of a holistic perspective, and the use of "halfway measures" that "simply forestall the inevitable" have been identified as major weaknesses in the traditional approach (Odum 1982 [Ann. Bib. #15], Houck 1988 [Ann. Bib. #12]).

For example, environmental regulations often only require detailed scrutiny of major or "significant" actions, defined as disturbances above a certain level (e.g., subdivisions in excess of five lots, site disturbances in excess of one acre, point discharges). Smaller projects do not receive the same level of review, even though their combined effects could be equally or more serious. Emergence of the "general permit" approach to streamline government permitting has probably exacerbated this problem.[1] Similarly, review is typically limited to the immediate impacts on the site itself, without tracing the full effect of the perturbations or identifying how the immediate effects may interact and combine with others over time and distance to produce significant environmental effects. Finally, a site-specific regulatory approach essentially ignores the other levels of decision-making (plans, policies and programs) which may enable or be the "driving force" behind the individual projects (LeBlanc 1992, 7 [Ann. Bib. #52]).

How Should Cumulative Effects Be Considered in Environmental Impact Assessment?

Recognizing that numerous small-scale alterations, considered insignificant by themselves, could, when taken together, cause significant degradation and damage, many environmental managers now believe that a more comprehensive assessment approach is required.[2] Numerous scholars, regulators and resource managers from the United States, Canada and other countries have sought to supplement traditional, reactive, single project-based environmental impact assessment with a revised system which incorporates assessment of cumulative environmental impacts or **cumulative impact assessment** (Horak and Vlachos 1982 [Ann. Bib. #47]; Vlachos 1982 [Ann. Bib. #65]; Williamson et al. 1986 [Ann. Bib. #67]).

While there is still much debate about definitions, emphasis and methodology, there is general agreement about what should characterize this new approach. Cumulative impact assessment should go beyond an evaluation of site-specific, direct and indirect impacts. It should consider the proposed action within the broader context of the sum of individual impacts occurring over time (usually both past changes and changes projected for the foreseeable future). It should also expand the geographic boundaries to consider the effects over an ecological community which extends beyond the immediate site of the proposed action. Traditional environmental impact assessment has focused on the proposed disturbance; cumulative impact assessment should focus on how the proposed action will affect valued environmental functions (Leibowitz et al. 1992

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1. *See, e.g.*, Laney, Wilson. 1990. "Preliminary Assessment of the Cumulative Effect of Nationwide Permit 26 on Headwaters and Isolated Wetlands and Deepwater Area and Functions with Policy Implications." *in Reports: 1989.* Washington, DC: American Association for the Advancement of Science, Environmental Science and Engineering Fellows Program at 22-28.

2. *See, e.g.*, Protection of Wetlands, Exec. Order No. 11,990, 3 C.F.R. 121 (1977) *reprinted in* 42 U.S.C.A. § 4321 (West Supp. 1993).

[Ann. Bib. #110]; Beanlands and Duinker 1984 [Ann. Bib. #74]; Preston and Bedford 1988 [Ann. Bib. #116]).

One theorist has capsulized the contrasts in the conceptual frameworks as shown in Figure 1.1. Traditional environmental impact assessment corresponds to the "established procedures" and the alternative, cumulative impact assessment, corresponds to the "new emphasis."

Figure 1.1. Conceptual Frameworks for Impact Assessment

Established Procedures (Traditional)	New Emphasis (Alternative)
• Species oriented	• Community/ecosystem-oriented
• Linear/extrapolative	• Non-linear/nonmonotonic
• Causal	• Interactive/mutual causation
• Individualistic/segmented	• Holistic/integrative
• "Snapshot"	• Evolving/dynamic
• Hierarchical/classificational	• Contextural/relevance-selective
• Structural	• Functional

Source: Vlachos 1985, 68 [Ann. Bib. #64].

Are There Impediments to Considering Cumulative Impacts in Regulatory Reviews?

Over time, laws have been amended to allow or require regulators to consider cumulative impacts in permitting decisions. For example, by federal law, Section 404 permit reviews under the Clean Water Act, environmental impact statements prepared pursuant to the National Environmental Policy Act (NEPA), and reviews pursuant to Section 7 of the Endangered Species Act are all subject to certain cumulative impact assessment requirements (see, e.g., Cohrssen 1989 [Ann. Bib. #147]; Schneller-McDonald and Horak 1982 [Ann. Bib. #149]). Similarly, states like California and New York have adopted NEPA-like statutes containing cumulative impact provisions, while other states have adopted more sector-specific environmental laws which require consideration of cumulative impacts of development on particular resources.

However, despite the fact that many federal and some state regulatory agencies are authorized or required to consider cumulative effects, in actual practice, these programs frequently continue to review only the immediate and direct impacts of a narrow range of activities (Muir et al. 1990 [Ann. Bib. #148]; Cairns 1990 [Ann. Bib. #30]). In other cases, where agencies have attempted to consider cumulative impacts in regulatory reviews, they have typically encountered a variety of difficulties. Typical difficulties include:

- **the absence of practical, widely-accepted methodologies** for assessment and evaluation of cumulative impacts and lack of staff resources to devote to developing necessary methodologies and data bases;

- **limited scientific knowledge about causes and effects** (e.g., lack of information about the effects of mixtures of chemicals and other stresses likely to be encountered in the field, an inability to separate natural variability from anthropogenic influences) resulting in an inability to accurately predict the cumulative and secondary impacts of certain perturbations (Cairns 1990 [Ann. Bib. #30], Williamson et al. 1987 [Ann. Bib. #130]);

- **a narrowed interpretation of agency responsibilities** resulting in agencies with cumulative impact review authority voluntarily limiting the scope of their own review (Cairns 1990 [Ann. Bib. #30]; Williamson et al. 1986 [Ann. Bib. #67]);

- **the absence of socially-established goals for the resource** or a resource-specific comprehensive plan to provide the normative context for regulatory decisions-makers rather than misplaced reliance on scientists to determine where on the continuum impacts are no longer acceptable (Childers and Gosselink 1990 [Ann. Bib. #31]);

- **jurisdictional constraints which impose inappropriate geographic and subject-matter limits on impact assessment and management,** including the fragmentation of management authority into politically rather than ecologically-defined jurisdictions, resulting in a significant mismatch between the region of impact and the scale at which the decision is made (Irwin 1991 [Ann. Bib. #50]; Irwin and Rodes 1992 [Ann. Bib. #104]); and

- **uncertainty about the defensibility or fairness** of basing individual permit decisions on potential adverse cumulative impacts.

Under these conditions, the scope and adequacy of cumulative impact assessments frequently fail to live up to the intent of the legislative mandate.

Despite these difficulties, during the last two decades, many agencies have broadened their reviews beyond case-by-case, direct, on-site impacts. For example, some regulatory programs have incorporated ecoregion perspectives and have increasingly informed their decisions utilizing more holistic indices or indicators of ecosystem health. Others have developed specific protocols, matrices, checklists or other techniques used in individual permit reviews to increase the scope and thoroughness of their assessment of incremental impacts of like activities or of activities with like impacts across a broader ecological region. Other agencies have experimented with substituting environmental thresholds for detailed assessment of individual impacts.

These cumulative impact assessment techniques within a regulatory context are currently in their infancy. Very few, if any, practitioners would claim to have perfected the technique. However, with successive generations of efforts, increased environmental monitoring, and the use of technological advances such as computerized mapping systems, enhanced remote sensing capabilities, and expanded computerized data bases, progress is being made.

How Should Cumulative Impacts Be Considered in Planning and Management Efforts?

Many theorists and practitioners believe that regulatory programs will always be unequal to the task of controlling adverse cumulative environmental effects unless regulatory decisions are made within the context of a comprehensive, ecosystem-based planning and management effort (see, e.g., Bedford 1993 [Ann. Bib. #75]; Stakhiv 1986 [Ann. Bib. #123]; Stakhiv 1988 [Ann. Bib. #124]; Williamson 1993 [Ann. Bib. #131]). They contend that cumulative impacts can only be controlled if the emphasis is shifted away from specific regulatory reviews and is instead placed on incorporating consideration of cumulative impacts into broader, anticipatory planning and management initiatives. In their view, refining cumulative impact assessment techniques to supplement traditional environmental impact assessment is only a partial solution. In addition, the context within which private actors and regulators make their individual decisions needs to be recast through objectives-oriented anticipatory planning and management efforts which incorporate a prior consideration of cumulative impacts.

An ecosystem-based planning and management effort may increase control of incremental impacts in at least three ways:

1. an articulated plan for valued resources which puts individuals on notice about how adverse cumulative impacts will be considered may cause them to avoid or abandon incompatible land and water development projects before they ever reach the permit review stage;

2. for projects which do reach the permit review stage, the existence of socially-determined, resource-specific goals will assist regulators by establishing a context within which to make the decision about whether the incremental change projected to be caused by a proposed project is acceptable; and

3. due to consideration of cumulative, incremental changes, the specific measures adopted to implement the management plan may be designed to control or influence small-scale land and water use activities and development projects which would previously have fallen below regulatory thresholds.

Recently, some federal and state management programs have been evolving toward an ecosystem or watershed management approach, characterized by viewing the land and resource base as an integrated entity. By emphasizing ecological integrity of a biologically-defined region, these new management approaches attempt to span political boundaries, break out of compartmentalized, single-resource management regimes, and account for the impacts of the entire range of anthropogenic disturbances. These management efforts usually accept as a major premise that they will be able to preserve or enhance biological integrity only if they understand the cumulative impacts of the full range of development activities over a larger geographic area.

Similar to the efforts being made on the regulatory side, these management programs are making their own contributions which are bringing the field closer to developing the capacity to manage cumulative environmental effects. For example, in some programs, political borders are being replaced by environmentally determined management units, extensive monitoring is providing more information about baseline conditions and the impacts of anthropogenic change, and scientists are beginning to develop a clearer understanding of the interconnections between various components of the ecosystem. In addition, efforts are focusing on changing small-scale activities, such as through the adoption of best management practices for otherwise unregulated activities and the emphasis on individual responsibility for nonpoint source pollution. However, particularly in the marine/estuarine context, in most areas, the cumulative impact assessment and management capacity is still in the very early stages of development.

Is Effective Consideration of Cumulative Impacts Any Closer Than It Was Twenty Years Ago?

It appears that most agencies with the legal authority to engage in cumulative impacts assessment have not yet been able to fully translate this mandate into a meaningful, holistic, resource-based environmental protection approach. Critics occasionally point to the current barriers and a repetitive, cyclical interest in cumulative impact assessment dating back twenty years or more, and contend that we are no closer to realizing this goal now than we were then.[3]

But others strongly disagree, conceding that while there have not been overnight successes, there have been enough accomplishments based on this approach to suggest that advocates of cumulative impacts analysis are on the right track (see, e.g., Contant and Wiggins 1991 [Ann. Bib. #88]; Leibowitz et al. 1992 [Ann. Bib. #110]). A diverse group of scientists, policy-makers, and academics, armed with increasingly powerful tools (e.g., GIS, enhanced remote sensing, computerized data management) are gradually devising ways to overcome current limitations. They are working in the same general direction to refine the science, the planning methods, the regulatory tools, and to develop the necessary institutional flexibility to realize the promise of a resource-based cumulative impacts approach.

The progress in coastal and marine science and the new federal environmental initiatives based on ecosystem management bode well for finally making substantial progress to bridge the gap to incorporate ecosystem and landscape principles into environmental management in coastal wetlands and estuarine waters. However, it is critical that the scientific and regulatory/management communities proceed on parallel tracks. If the legal/institutional and environmental

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3. Sorenson, Jens. 1993. Remarks at Methodologies and Mechanisms for Management of Cumulative Environmental Impacts Workshop, Marine Law Institute/NOAA National Marine Fisheries Service, Northeast Region/University of Rhode Island School of Oceanography, Narragansett, R.I., May 6, 1993.

management capabilities fail to keep pace with the evolving science, the renewed interest in cumulative impact assessment may once again subside without making any substantial progress.

ABOUT THIS CUMULATIVE IMPACT PROJECT

Information Transfer Goal

The goal of this NOAA Coastal Ocean Program-funded project is to transfer technical information to federal, state, and local environmental management practitioners about advances in the ability to incorporate consideration of cumulative impacts into environmental decision-making. This report views the issue from three perspectives—science, legal/institutional, and environmental management—since all three disciplines must work together if the goal of increasing consideration of cumulative effects is to be implemented in actual practice.

This document (1) synthesizes the available literature on cumulative impact assessment and management to provide a brief overview of key concepts, methodologies and techniques; and (2) includes an extensive annotated bibliography to assist the reader in identifying additional materials.

This document is intended to:

- Provide resource managers with background information about actions that are likely to result in cumulative coastal environmental impacts;

- Identify and summarize the key advances in the evolving effort to integrate consideration of cumulative impacts into decision making in the fields of science, law and environmental management;

- Identify and summarize selected methodologies or techniques for assessing and managing cumulative impacts and apply them to a case study; and

- Identify opportunities within the current organizational and legal structure to move closer to the goal of integrating cumulative impact assessment in daily decision-making.

This document is not intended to:

- Debate definitions of key terms; it does define key terms for purposes of this document and identifies the nature of the debate, but does not propose standard definitions.

- Document the existence or scope of cumulative impacts problems; it includes two examples of the problem for purposes of illustration, and additional materials about the nature and scope of the problem are included in Appendix A, Annotated Bibliography.

- Apply to all environments or resources; it focuses on coastal development impacts on living near-shore marine and estuarine resources. It approaches the issue from a habitat orientation typical of natural resource law and decision-making rather than from a pollution control perspective.

Investigatory Techniques

The project team consisted of lawyers, planners and scientists affiliated with the Marine Law Institute of the University of Maine School of Law and the Habitat and Protected Resources Division of the Northeast Region of the NOAA/National Marine Fisheries Service (NMFS). The team used four different investigatory techniques.

The primary research effort involved traditional public policy research in the fields of science, law and environmental management. It identified journal articles, books, reports, agency guidance documents, case law, statutes and regulations through standard and computer-assisted research. The results of this search form the substantive basis for the report. The bibliography accompanying this report lists the literature which was identified and includes annotations to assist the reader in focusing further investigation.

This traditional research was supplemented by questionnaires sent to approximately 200 academics, theorists and practitioners from the private and public sectors, including many state and federal environmental managers. The survey solicited opinions about the extent and success of their involvement with cumulative impact assessment, and requested information about articles, reports and agency guidance documents. The results generally confirmed that there is a major gap between the goal and the actual practice. The insights gained through the survey are incorporated throughout this report; information about specific publications is included in the annotated bibliography.

The research team also convened a two-day workshop on assessment and management of cumulative impacts for twenty-seven invited participants in May 1993. Participants included several federal agency environmental management theorists, several federal agency field workers directly involved with environmental impact assessments, representatives of state environmental protection agencies with explicit cumulative impacts mandates, representatives from state coastal programs involved in special projects on cumulative impacts, the director of a national estuary project, research scientists, representatives from environmental advocacy groups, lawyers, and planners. Two panels analyzed the actual practice of cumulative impact assessment from federal and state perspectives. Individuals also made presentations on selected state-of-the-art methodologies for cumulative impact assessment. Valuable discussions between environmental theorists and field practitioners clarified issues and identified further research needs. The results of the workshop are integrated throughout this report.

The researchers' final investigatory technique was an attempt to apply lessons learned by developing an approach for NMFS to utilize to improve consideration of cumulative impacts in reviews of Section 404 permit applications. Specifically, the research team developed a "protocol" or conceptual framework for decision-making, and then developed two practical approaches for applying the framework to individual project reviews: a key indicator species approach and a habitat-based landscape approach. An explanation of the conceptual framework and the approaches for applying it to reviews are contained in a companion report. The insights gained through the process of translating the theory into practice are incorporated in this report.

Outline of the Report

This first chapter is an introduction to the report. The next chapter discusses the problem of cumulative impacts in more detail from two perspectives. It first reviews issues of definitions, terminology, and differing scientific and regulatory emphases. It then provides examples of land and water uses with cumulative impacts on coastal environments, identifies how regulated and unregulated changes can have incremental impacts, and summarizes reasons to be concerned about cumulative impacts.

Chapter 3 presents a summary of selected state-of-the-art methodologies for cumulative impact assessment and management. These methodologies illustrate different ways theorists and practitioners have attempted to overcome some of the scientific and political impediments. The report analyzes the contribution made by each in moving beyond traditional environmental impact assessment, and the potential for each to integrate effects assessment with a broader anticipatory and management effort.

Chapter 4 reviews existing federal, state and local approaches to management of cumulative impacts. Based on this review, it includes a list of actions that could be taken to improve the effectiveness of management efforts.

The next chapter, Chapter 5, summarizes key legal issues in cumulative impact assessment and management. It presents a synopsis of the federal and state cases which have interpreted the statutory mandates on cumulative impacts. It also examines issues related to the technical information necessary to support a finding of unacceptable, adverse cumulative impacts and the degree of "nexus" required to sustain permit conditions to mitigate adverse cumulative impacts.

Chapter 6 summarizes barriers, trends and opportunities in cumulative impact assessment and management from three different perspectives: scientific, legal/institutional and environmental management. For each field, there is a brief analysis of the barriers to effective consideration of cumulative impacts and the trends that hold promise of improvement.

As this document is intended to be an overview, by necessity, it merely skims the surface of complex, interrelated disciplines. Its intent is to orient readers to the broad outlines of the topic of cumulative impacts, and then assist the reader with identifying opportunities for more in-depth investigation.

To assist with further investigation, the overview is followed by Appendix A, an extensive annotated bibliography of literature on multiple facets of cumulative impact assessment and management. It identifies literature directly related to the issue of assessment and management of cumulative impacts. Additional sources of substantive information about specific environmental changes or impacts can be accessed through the listed literature. Appendix B, a list of participants in the May 1993 cumulative impacts workshop, is also included.

A companion publication, "Development and Application of a Cumulative Impacts Assessment Protocol," Part II of this document, presents the conceptual framework, practical approaches and field results for two cumulative impacts assessment approaches developed for use by the Habitat and Protected Resources Division of the Northeast Region of the NOAA/National Marine Fisheries Service in reviewing Section 404 permit applications.

Chapter 2:
Issues in Cumulative Impact Assessment and Management

EXAMPLES OF CUMULATIVE IMPACTS ON COASTAL ENVIRONMENTS

The literature is replete with descriptions of serious environmental problems which are cumulative in nature, building up over time as the combined outcome of numerous actions and choices. Examples include depletion of the stratospheric ozone layer, global climate change, and species extinction.

The major problems causing damage to coastal habitats and the environment for living marine resources also appear to be cumulative. On a national scale, the overriding coastal problems appear to be land use change and habitat degradation and loss.[1] In some coastal areas, more specific local threats are also posed by problems such as nutrient pollution, chemical contamination, fresh water diversion, and microbial contamination.

While any number of scenarios of incremental change could be used as examples of patterns or trends of land and water uses having cumulative impacts on coastal environments, for purposes of illustration, two are discussed below: threats to estuarine-dependent commercial fisheries and threats to wetlands.

Illustration 1: Incremental Threats to Estuarine-Dependent Fisheries

One way to approach the problem of cumulative impacts is to focus on one particular resource of value. Estuarine-dependent fisheries, i.e., species dependent on estuaries for reproduction, as nursery areas, for food or as migratory pathways, are one such coastal resource with clear recreational and economic value. For example, as of 1985, approximately 71% (by value) to 77% (by weight) of commercial fishery landings were composed of estuarine-dependent species. (Chambers 1991 [Ann. Bib. #3]).

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1. Hunsacker, Carolyn. 1993. "Ecological Risk Assessment," Presentation at the Methodologies and Mechanisms for Management of Cumulative Coastal Environmental Impacts Workshop, Marine Law Institute/NOAA National Marine Fisheries Service, Northeast Region/University of Rhode Island School of Oceanography, Narragansett, Rhode Island, May 6, 1993 [hereinafter Workshop].

According to NMFS, as of 1991, the populations of almost all commercially or recreationally exploited estuarine-dependent species off the U.S. coasts were at "all time low levels of abundance." NMFS attributed the declines to the combined effects of fishery harvests, habitat degradation and loss, and mortality caused by natural factors (ibid.).

In a paper cataloging losses by state and region for NOAA/NMFS's Office of Habitat Protection, James Chambers documented his assertion that primary habitat threats are due to wetland loss and degradation, toxic chemical releases, alteration of freshwater flows and nutrient over-enrichment. The causes of these extensive losses of coastal fishery habitats included:

- "thousands of [f]ederal projects and permit approvals" along the Southeast Atlantic and Gulf of Mexico coasts;

- extensive marsh deterioration in Louisiana and Texas due to canal dredging, flood control levees, and water control structures for marsh management;

- losses in Chesapeake Bay due primarily to increased shading attributable to increased nutrient and sediment discharges from municipalities and agricultural areas;

- upstream federal and state water diversion projects in Chesapeake Bay and California's Central Valley, among other areas, which have effectively eliminated spawning in whole river basins and compromised nutrient transport, habitat maintenance, and salinity control;

- hydroelectric power dams throughout the Pacific Northwest which greatly reduce or entirely block access to historic salmon and steelhead runs, and pose additional hazards of inadequate springtime flows, turbine-related mortality, predation, and reduced genetic diversity of wild races;

- coastal pollution such as organic chemicals and trace metals in urbanized and industrial areas, toxic pesticides from agricultural areas, and other contaminants from inadequate septic systems, sewage discharges and urban runoff (ibid., 2-6).

For the most part, these losses are attributable to a cumulative pattern of environmental degradation, repeated in numerous small alterations, but adding up to profound loss of ecosystem functioning.

Chambers notes that in the Mid-Atlantic coastal region, NMFS scientists have demonstrated that "estuarine wetland productivity is essential for support of offshore fishery biomass." This relationship is based predominantly on "a short, direct food chain" involving coastal wetlands, forage fish species which can digest plant detritus, and commercially sought marine fish species. Due to the fragility of these coastal wetlands, it is of considerable concern to fisheries managers that demographic trends indicate that humans will be moving to coastal regions where fishery estuarine-dependency is highest. The amount of habitat loss already experienced through incremental development projects, coupled with the prospect of escalating land use change, urbanization and coastal pollution, are all considerations which support the need for heightened assessment of cumulative additive and interactive effects on ecological functioning of estuarine areas.

Illustration 2: Incremental Threats to Wetlands

A slightly different way to view cumulative effects is by focusing on the functioning of a particular type of ecosystem, for example, coastal wetlands. The cumulative loss of wetlands has already been extensive. From the 1780s to the 1980s, the continental United States lost 53% of its original wetlands; by the 1980s, seven states had lost 80% or more of their original wetlands (Dahl 1990 [Ann. Bib. #7]). Coastal wetlands are relatively scarce, comprising only about 5% of the total national wetland acreage.[2]

During the last two decades, scientists have greatly improved their understanding of the wetland ecosystem. Wetlands are now widely recognized as serving a variety of important functions including: providing vital resting, breeding, and feeding habitat for birds; providing spawning grounds for commercially valuable fish and shellfish; acting as a filter to purify water before it enters waterbodies; providing flood control services through temporary storage and peak flow reduction; protecting coastal areas from erosion by absorbing and dissipating wave impact; and serving as a passive and active recreational resource.

In theory, there is widespread scientific and societal support to protect wetlands. However, in practice, despite agreement on a philosophical goal of "no net loss," loss of wetland acreage and function continues.[3]

Some theorists have asserted that wetlands are particularly susceptible to cumulative loss and piecemeal degradation because they are widely distributed, take many diverse forms, and are the product of large-scale landscape processes. One wetland expert has observed that the reasons for protecting wetlands stem from their "broader ecological context:"

> [W]e do not protect wetlands in order to save places where a person's feet could get muddy, but to protect larger ecological systems. In the long run, the purposes of wetland protection are landscape-scale purposes. For instance, by trapping nutrients that would trigger eutrophication if they reached the Bay, the presence of healthy riparian wetlands throughout the 64,000 square mile Chesapeake Bay watershed protects water quality and fisheries hundreds of miles away. . . . The goals of wetland protection

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2. Frayer, W.E., T.J. Monahan, D.C. Bowden and F.A. Graybill. 1983. *Status and trends of wetlands and deepwater habitats in the coterminous United States, 1950s to 1970s*. Dept. Forest and Wood Science, Colorado State University, Fort Collins, CO.

3. *See, e.g.,* Blankenship, Karl. 1994. Bay Wetland Losses Unabated in 1980s. *Bay Journal,* Apr., 1 (reporting on the preliminary findings of a Chesapeake Bay wetlands status and trends report).

almost always lie outside the wetlands themselves, in the watersheds, flyways, and fisheries to which they are functionally linked.[4]

Bohlen notes, however, that precisely because wetlands derive their importance from a landscape scale, effective protective policies are likely to be controversial for several reasons, including three related to characteristics of wetland ecosystems:

- The impacts of wetland destruction are generally the consequence not of a single wetland loss, but of the cumulative effects of many losses throughout a watershed, making it difficult or impossible to trace consequences back to individual actions or causes.[5]

- The benefits of wetland protection are diffuse, and often occur far from the wetland itself. . . . The landowner affected by wetlands regulations may receive little direct benefit from his or her own efforts to protect wetlands. While the wetland landowner often receives benefits from the protection of wetlands elsewhere within the watershed, he or she may be unaware of those benefits.[6]

- [P]rotection of landscape values requires protecting the places in which they occur; landscape values are site-specific. Thus landscape functions must be addressed within a comprehensive framework that treats different parts of the landscape differently; all land is not functionally the same.[7]

Cumulative impact assessment and management, if applied successfully, is designed to overcome these particular difficulties of wetland protection. It attempts to obviate the need to prove the direct consequences of a single, individual small-scale action by evaluating the consequences within the context of similar past, present and future actions. It goes beyond a site-specific analysis to try to match the scale at which the impacts are felt, both positive and negative, with the scale at which decisions are made. And finally, cumulative impact assessment attempts to evaluate the proposed action in relation to its likely impact on ecosystem functions.

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4. Bohlen, Curtis C. 1993. Wetlands Politics From a Landscape Perspective. *Maryland Journal of Contemporary Legal Issues* 4(1): 4-5.

5. *Id.* at 8.

6. *Id.*

7. *Id.* at 9. The other three reasons cited by Dr. Bohlen to explain why protection of wetlands is likely always to be controversial are: the difference in moral outrage felt against a person discharging pollutants (high) vs. a person disrupting landscape processes (low); the failure to perceive and appreciate the actual benefits of wetland protection; and the "prisoners' dilemma" decision-making characteristics where economic incentives reward individuals who destroy wetlands even though it is contrary to the collective best interest. *Id.* at 7-9.

Need to Control Cumulative Impacts

Cumulative impacts can result from a variety of regulated and managed uses, despite regulatory efforts. If regulators start with the premise that they will tolerate some level of degradation with each permit, a certain amount of loss will be inevitable. Similarly, if mitigation, such as wetland creation, is required on a per acre replacement basis, it may still result in a loss of wetland functions. Moreover, many programs that regulate particular uses provide for a tiered review, requiring only perfunctory review of proposed actions directly disturbing a small land area; failure to give the same level of scrutiny to off-site impacts of multiple small actions allows cumulative effects which may have substantial impacts.

Cumulative impacts can also result from traditionally unregulated changes in land and water uses, such as incremental changes in the intensity, density or type of use made of industrial, urban, agricultural and marine sites. Many of the activities performed on sites after development are not regulated; once the initial design of a subdivision development is approved, there are typically no further requirements for periodic inspection or pumping of septic systems, controls on excessive use or storage of home garden and lawn fertilizers, or further attempts to control stormwater runoff. A similar problem is the unregulated intensification of uses such as the conversion of formerly seasonal coastal dwellings to year-round use.

In the past, regulators did not focus on small-scale environmental changes or the off-site accumulation of impacts. Activities such as a neighbor filling a small amount of wetland to create more space for a garden, a friend building a small dock for private use, or summer residents enlarging their seasonal home for a year-round retirement home were largely unregulated. But resource managers and citizens are coming to realize that they have to be concerned about the cumulative impacts of these multiple, small changes for several reasons:

Multiple small-scale, unrelated land development changes can have even greater harmful effects on natural processes than larger-scale projects. For example, ten single-family homes each located on one-acre lots scattered along the shore, each with water access, may have much greater adverse impacts than a 10-unit condominium project located in one large structure on a 10-acre shoreland parcel with a community dock. The scattered single-family homes may fragment remaining wildlife habitat, contribute to greater erosion, require disturbance of more land for access roads and water access, and have less efficient sanitary waste disposal systems. Yet, depending on the way the lots were created and state and local regulations, these small-scale single family homes might escape most reviews.

The effects of development projects, both large and small, often go far beyond the obvious direct impacts of a project. For example, the direct effect of dredging a harbor might be removing and burying bottom-dwelling organisms and vegetation, and suspending sediment in the water column. But the indirect and secondary impacts might include an increased suspended load of chemicals, a temporary reduction in phytoplankton production due to the increased turbidity, and increased commercial and recreational boat traffic in the harbor. This increased boat use may, in turn, lead to longer term reductions in water quality due to the discharge of oil, sewage and debris from the vessels. If the harbor has recently been the site of other development projects with similar impacts from which it has not had time to recover or is projected to be the site of additional development in the future, particularly if access is improved by dredging, additional cumulative additive and synergistic impacts on natural processes are likely. Reviewers tend to focus on direct effects, ignoring cumulative indirect and secondary impacts of proposed development.

Increasingly, in many coastal areas the land now being proposed for development presents major site-specific challenges. During the last two decades, people have migrated to coastal areas in greater numbers to establish seasonal and year-round residences. Demographic projections indicate coastal areas will continue to gain population at a faster rate than inland areas. But frequently, the areas that could accommodate growth without major negative effects on coastal ecosystems have already been developed. New developments are frequently proposed for land which has remained vacant precisely because it was not suitable for development. For example, undeveloped sites may contain steep slopes, ledge, or freshwater or coastal wetlands. In addition, new arrivals who do not fully appreciate the full range of the coast's dynamic natural processes (e.g., beach and bluff erosion, winter storms, sea-level rise) may seek to locate in hazardous areas, unaware of the threats to their own structures and the potential harm to the natural systems. To protect coastal ecosystems, development reviews must consider not just on-site impacts, but also the effects on landscape functions.

Much of the remaining undeveloped land has assumed disproportionate environmental importance because it is being pressed into service to provide critical habitat or fulfill other natural resource functions previously served by now-developed land. The primary example of this phenomenon is wetlands. The continental United States has lost of over 50% of the original wetlands since the founding of the nation, primarily through draining and filling. Much of that loss is irreversible due to present incompatible uses, long-altered soils and hydrology, and prohibitive time periods and expenses of alteration. Of the remaining wetlands, a large fraction are ecologically degraded. While varying by region, only a small fraction of the total original wetland resource is likely to be ecologically intact. (For a discussion of this phenomenon in the Great Lakes, see Bedford 1990 [Ann. Bib. #75]). The remaining wetlands are being pressed into service to fulfill functions only recently recognized as critical such as providing fish and wildlife habitat, maintaining groundwater supplies, trapping pollutants and protecting water quality, protecting against shoreline erosion, and storing floodwaters. Thus, both because we know more about the impacts of human disturbances on natural processes and because there is less undisturbed land left, increased emphasis must be placed on recognizing, assessing and managing cumulative effects of human activities.

ANALYSIS OF KEY TERMS AND CONCEPTS

Scientists, regulators, policy makers and environmental managers have not yet reached agreement on a common language to use in discussing cumulative impact assessment and management issues. Many researchers make precise distinctions between key terms such as "action," "effect," "impact," and "impacts." However, one researcher's definition of a particular key term may be completely at odds with another researcher's definition of the same term.[8] The academic background of the author, the research perspective and the focus of the analysis all affect the choice of definitions. Some researchers have suggested that this lack of a standard terminology impedes progress in relating the science of cumulative impacts to regulatory needs.

Lacking a common language, each study of cumulative impacts must define key terms. To clarify the basic terms used in this report, and to promote efforts to develop a shared language, this document generally adopts the same definitions of twelve key terms as articulated by the World Wildlife Fund in its EPA-sponsored publication "Making Decisions on Cumulative Environmental Impacts: A Conceptual Framework" (Figure 2.1).

Overlapping Definitions of Impact and Effect

The definitions shown in Figure 2.1 do not make a precise distinction between "impact" and "effect," but rather stipulate that "impact" may mean the same thing as "inducing action" some of the time, may mean the same thing as "effect" some of the time, and also may imply a societal judgment on whether the outcome of the action is negative or beneficial. Thus, using these definitions, the term "impact" can be used to describe each component: the inducing action itself, the outcome of the action, and the value judgment about whether the outcome is acceptable to the evaluative society.

The absence of a clearer distinction between these terms is not due to oversight or to inability to be more rigorous; rather it is a concession to realities of the regulatory context within which cumulative impact decisions are made. The overarching framework for federal cumulative impact assessment is provided by the Council on Environmental Quality regulations implementing the National Environmental Policy Act (NEPA).[9] Those regulations gloss over most of the nuances debated by research scientists, equate "impact" to "effect," and use "impact"to mean both the inducing action and the effect of the action (Irwin and Rodes, 1992, 40 [Ann. Bib. #104]).

The particular definition of "impact" adopted for this document adds to the basic CEQ definition the caveat accepted by many environmental management theorists that conclusions about "impact" usually incorporate a societal judgment about relative resource values. While "effect" is used to mean the physical outcome of an action, "impact" more usually implies a conclusion

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8. *See, e.g.*, Stakhiv 1988, 727 [Ann. Bib. #124] distinction between "effects" as a scientific assessment of facts vs. "impacts" as an evaluation of the relative importance of these effects by the analysts and the public; Leibowitz et al. 1992, xiv-xv [Ann Bib. #110] distinction between "effect" as a physical, chemical, or biological change in an ecosystem that results from an impact vs. "impact" as a human-generated action or activity that alters the characteristics of one or more ecosystems; Irwin and Rodes 1992, 3 [Ann. Bib. #104], defining "effect" as the reaction, result or outcome of an action vs. "impact" as the action and/or its effect, implies a societal judgment; and Williamson 1992, 3 [Ann. Bib. #131] stating that "effects" are synonymous with "impacts."

9. 40 C.F.R. pts. 1500-1508 (1994).

or value judgment about how the outcome will affect an environmental characteristic or attribute which society seeks to use, protect or enhance.

Figure 2.1. Definitions of Terms Used in This Document

Action. An activity or release from a source that causes a change in the flow of energy or materials. For example, harvesting timber, filling a wetland, applying a pesticide to a crop, or releasing a water pollutant. It may take the form of a proposed project that is reviewed under the National Environmental Policy Act. (See also "decision.")

Boundaries. The temporal and geographic limits that define which actions and effects are covered by a decision. The boundaries may be political, jurisdictional, ecological, economic, or other.

Cumulative. Incremental addition or loss of energy or material. If there is no change in environmental processes, the results are additive. If the changes interact, the result is usually a change in the system's structure or function.

Cumulative impact. This report uses the Council on Environmental Quality's definition: "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions."

Decision. The management or organizational action taken by an institution, such as a governmental program.

Effect. The reaction, result, or outcome of an action.

Environmental process. A process such as decomposition or bioaccumulation that changes the flow of materials.

Impact. The action and/or its effect. When used in contrast to "effect," implies a societal judgment.

Program. Unit of government or private organization with management responsibilities that relate to some aspect of using, protecting, or enhancing the environment.

Scale. Although scale may refer to the magnitude, scope, or level of an action or effect, it is used here as a synonym for temporal and geographic boundaries.

Technique. A means or method, such as a series of overlay maps or a conceptual or computer model, for assessing the nature, magnitude, and extent of cumulative effects.

Valued environmental component. A characteristic or attribute of the environment that society seeks to use, protect, or enhance.

Adapted from Irwin & Rodes, 1992, 3 [Ann. Bib. #104].

"Cumulative" Includes Both Additive and Synergistic Effects

It should be noted that the definition of "cumulative" adopted for this document includes both additive and interactive effects. Research scientists frequently distinguish between simple additive effects and more complex magnification effects or synergistic relationships (when the effects combine to produce a greater impact than simple additive effects). Some scientists have suggested that effects should not be considered "cumulative" unless they combine to produce a greater impact. However, the definition of cumulative impacts used in this document, derived from the CEQ regulations, includes additive effects as well. Regulators and policy-makers typically do not make a distinction between simple additive effects and more complex magnification effects, thus, this document also treats both types of effects as cumulative.

"Cumulative" Includes Same and Different Types of Actions

It should also be noted that the definition of "cumulative" does not limit the incremental addition or loss to a single type of action. Cumulative impacts are most frequently thought of as occurring over a period of time from a repetition of the same type of action. For example, there might be cumulative impacts from several small docks being built over vegetated wetlands in the same small embayment.

The definition used here and the regulations from which it is derived, recognize that cumulative impacts may also result from a series of different types of perturbations occurring in the same area which affect the same environmental process or valued environmental component. For example, in the same small embayment one owner might fill a portion of the wetland, another owner might build an elevated structure over the wetland and a third owner might fail to repair a malfunctioning septic system, all collectively and cumulatively altering wetland functions.

Typologies: Ways Environmental Effects Accumulate

To elaborate upon these distinctions, researchers have developed various typologies based on the different ways that environmental effects accumulate. They are included here because, even though not directly tied to the regulatory framework, they illustrate conditions when cumulative impacts should be expected.

One typology developed in a 1986 National Research Council (NRC) report categorizes the types of cumulative effects. It states that cumulative environmental effects can occur because of:

- **time-crowded perturbations**—perturbations so close in time that the effects of one are not dissipated before the next one occurs;

- **space-crowded perturbations**—perturbations so close in space that their effects overlap;

- **synergisms**—different types of perturbations occurring in the same area interacting to produce qualitatively and quantitatively different responses by the receiving ecological communities;

- **indirect effects**—effects produced after or away from the initial perturbation or by a complex pathway;

- **nibbling**—(a category which overlaps the above) effects of incremental and decremental time and space crowding (e.g., addition of several power plants to a river one at a time or the introduction of several pollutant sources into a lake), as well as removal of habitat piece by piece.

- **others**—such as **threshold developments that stimulate additional activity** in a region or projects whose environmental **effects are delayed** (time lags) or are felt over **large distances** (space lags) if their impacts overlap in time or space or are synergistic with those of other developments.

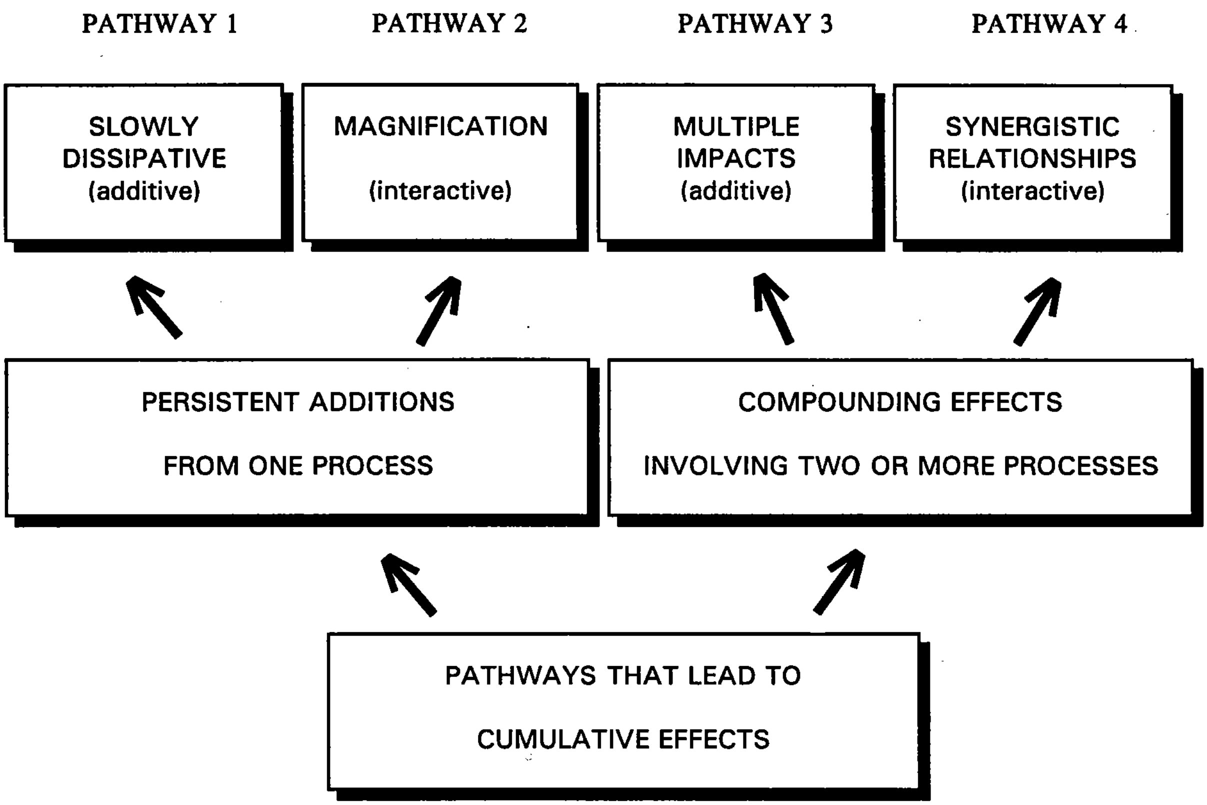
Adapted from Committee on the Applications of Ecological Theory to Environmental Problems 1986, 96-97 [Ann. Bib. #35].

Other theorists have shifted slightly the focus from categorization of cumulative effects to the functional pathways that contribute to cumulative effects. For example, a 1987 background paper prepared for the Canadian Environmental Assessment Research Council included an analysis of the basic functional pathways that contribute to cumulative effects (Figure 2.2). While this illustration is based on progressive increases, the analogous functional pathways could apply to progressive losses, such as loss of fisheries habitat. The authors suggest that the "time-crowding," "space-crowding" and "nibbling" categories of cumulative effects are prominent features of Pathways 1 and 3, and that "synergisms" are prominent features of Pathway 4. There is no separate category of cumulative effects in the NRC typology which corresponds to Pathway 2, biological magnification. (Peterson, 1987, 5-9 [Ann. Bib. #57])

Summary

For purposes of this report, cumulative impacts are defined as the total effect on the environment of a series of land and water use and development activities taking place within a specific region over a particular period of time. They are not merely on-site impacts, but include off-site impacts as well. Cumulative impacts are not limited to synergistic or interactive impacts; they also include simple additive impacts if they are so close in time that the effects of one are not dissipated before the next one occurs or are so close in space that their effects overlap. The evaluation of cumulative impacts will always include consideration of some past period, and should also include consideration of future actions. It assumes two or more actions, which do not have to be the same type of action as long as they affect the same valued environmental component. The projected resource impacts, not the proposed actions are the focus for determining if there will be adverse cumulative impacts.

Figure 2.2.
Basic Functional Pathways That Contribute to Cumulative Effects



Source: Peterson 1987, 5 [Ann. Bib. #57].

Thus, the primary characteristics of cumulative impact assessment which distinguish it from traditional environmental impact assessment are threefold:

1. it analyzes off-site synergistic, magnification, growth-inducing or other interactive impacts of actions;

2. it considers the additive impacts of multiple small-scale actions which might otherwise have been dismissed erroneously as negligible; and

3. it evaluates the impacts of actions in relation to the effects on valued resources, especially through changes affecting larger-scale ecological processes or conditions.

RELATED CONCEPTS IN ENVIRONMENTAL PLANNING

It is beyond the scope of this report to analyze fully the relationship of cumulative impacts assessment to other types of environmental planning. However, given the absence of a single methodology for cumulative impact assessment, practitioners may have nagging questions about whether a particular approach constitutes "real" cumulative impacts assessment. It is not productive to spend much time trying to answer that question, but it may obviate some anxiety if practitioners recognize that cumulative impact assessment draws on the conceptual frameworks of several types of accepted environmental planning and management, and that there are no bright lines separating them.

One reason it is frequently difficult to distinguish cumulative impact assessment from other forms of environmental planning is that it has been changing over time. Originally, cumulative impact assessment was perceived as a specialty within traditional environmental impact assessment, and was viewed almost entirely within the context of individual permit reviews. Over time, as the need to place the reviews within a wider context was identified, the geographic scope of reviews widened. Similarly, as the limitations of the permit review process became apparent, theorists placed increasing emphasis on advanced planning to establish a context for regulatory decisions and on integration of cumulative impacts concerns into ongoing management efforts (see, e.g., Gray 1993, 13 [Ann. Bib. #258]; Williamson 1992 [Ann. Bib. #131]; Stakhiv 1988 [Ann. Bib. #124]).

Definitions of the essential elements of environmental assessment have also broadened over time. It is now widely recognized that meaningful comparisons against baseline values cannot be made without systematic monitoring of past and present development activity and monitoring of changes in environmental parameters. Additionally, accurate models of the responses of natural systems to incremental change are required to make reliable forecasts of probable effects (Contant and Wiggins 1993 [Ann. Bib. #36].

The ideal cumulative impact assessment, to many observers, now encompasses monitoring, modeling, permit reviews, planning and management. It has evolved beyond being a subset of traditional environmental impact assessment. While it has grown out of the environmental impact assessment framework, it has evolved to incorporate concepts from other ecological or environmental efforts with related goals or conceptual underpinnings.

Cumulative impact assessment may be viewed as one part of a continuum of environmental planning which includes project-based impact assessment, policy and program planning, cumulative impacts assessment, regional planning, and planning for sustainable development. Where an effort fits along that continuum will depend upon its particular characteristics.

For example, clearly there is a close conceptual relationship between comprehensive land and water use planning and cumulative impact assessment. Comprehensive planning is recognized as a tool that can establish a context for cumulative impact decision-making. In addition, very detailed, natural resource-focused, comprehensive planning for an ecologically-determined geographic area may embrace the same goals and utilize the same implementation strategies as cumulative impact assessment and management.

Another closely-related concept is "sustainable development." One theorist has observed that:

> [T]he challenge of sustainable development includes arresting or reversing the cumulative depletion and degradation of the natural systems upon which current and future generations depend. On a world scale, cumulative effects and sustainable development are inextricably linked, reflecting the mega environmental problem and the mega environmental solution, respectively.

Beanlands 1992, 3 [Ann. Bib. #25].

He notes that cumulative effects assessment and sustainable development both lack precise definitions, require lateral thinking across a number of disciplines, pose difficulties in establishing practical operational boundaries and tend to overwhelm managers with a sense that "everything is connected to everything else." He concludes, therefore, that in both cases, "our intuitive understanding of the concept involved is much more advanced than our ability to apply that knowledge in a meaningful and practical manner" (ibid., 10). Despite these difficulties, other theorists have asserted that environmental managers look to cumulative effects assessment as a way to "give substance to planning for sustainable development" (Cocklin and Parker 1991, 5 [Ann. Bib. #86]).

Cumulative impact assessment also shares a common purpose with current attempts to establish new goals for environmental management by operationalizing concepts of "ecosystem health" (Costanza et al. 1992 [Ann. Bib. #6]). While this ecosystem health approach focuses on enhancing resilience to stress as the key to preventive ecological medicine, cumulative impact assessment focuses on the converse of predicting and preventing loss of resilience or "distress syndrome." Efforts to define and measure ecosystem health and to foster public debate about proper goals for environmental management have much to offer to cumulative impact assessment and management.

Others have identified work in watershed planning and management, regional risk assessment and risk management, integrated resource management, product life cycle assessment and management, and pollution prevention as being strands of work which draw on conceptual underpinnings which are related to cumulative impact assessment.[10] Depending upon the specific way in which they are carried out, at least the first three could be ways of approaching cumulative impact assessment and management.

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10. Irwin, Frances and William Eichbaum. 1993. Remarks at the Workshop, *supra* note 1.

Chapter 3: State-of-the-Art Cumulative Impact Assessment and Management Methodologies

This chapter starts with a brief synthesis of the literature on cumulative impact assessment methodologies. The remainder of the chapter summarizes five very promising approaches.

MULTIPLE CUMULATIVE IMPACTS ASSESSMENT METHODOLOGIES

There is no single, generally accepted, comprehensive environmental assessment methodology for cumulative impacts. Researchers have used a variety of methods including **checklists** of characteristics, impacts or processes to be considered in the analysis; **matrices** of interactions between activities and environmental conditions; **nodal networks or pathways** to depict likely impacts; **dynamic models** to simulate ecosystem response (from Risser 1988 [Ann. Bib. #119]); **cartographic techniques** to represent the interrelationship between activities and environmental characteristics; **evaluation techniques** to compare the impacts of development with alternatives; and **adaptive or ad hoc** methods utilizing a combination of assessment methodologies (Irwin and Rodes 1992 [Ann. Bib. #104]).

While there has been some stability in the use of these methods over time, there is also a general perception that they remain unsatisfactory and need further refinement for practical application (Risser 1988, 586 [Ann. Bib. #119]). In 1992, Canadian researchers attempting to design specific cumulative effects assessments for uranium mine development in Saskatchewan concluded that while there is much conceptual and theoretical discussion of cumulative effects assessment, "[t]he knowledge base necessary to deal with practical aspects of CEA [cumulative effects assessment] is almost non-existent." Beyond several "recurring themes" of methodological considerations, they asserted there was little else in the literature that was of direct assistance in developing their cumulative effects assessment approach (Sadar et al. 1992 [Ann. Bib. #120]).

Similarly, in 1993, after reviewing methods from the literature, researchers in Alaska seeking to assess the cumulative impacts of development actions on Kenai River fish habitat concluded these methods provided little guidance. "[M]ost cumulative impact methodologies comprise general guidelines or descriptive accounts of potential cumulative impacts, relying heavily upon qualitative and subjective judgments." (Liepitz 1994, 3 [Ann. Bib. #260]). With no single methodology, an investigator must do original work to develop a cumulative impacts assessment approach and identify specific tools and techniques to operationalize that approach.

SYSTEMATIC CUMULATIVE IMPACT ASSESSMENT APPROACHES POSSIBLE

Many researchers assert that it is not yet possible to develop one systematic and comprehensive analytical method for assessing cumulative environmental impacts due, in large part, to an incomplete understanding of ecosystem behavior. However, growing knowledge about ecosystem responses makes it increasingly possible to predict the direction and possible magnitude of responses to a particular action. Thus, despite the inability to make fine-scale predictions, it may currently be possible to develop "a set of systematic approaches for first detecting and eventually quantifying cumulative impacts" (Risser 1988 [Ann. Bib. #119]). While scientific research about ecosystem responses continues, one theorist recommends the following as an interim approach:

- Use a technique that clearly recognizes complex ecosystem interactions and process;

- Choose among many possible methods to identify potential environmental impacts (checklists, interaction matrices, nodal pathways analysis, models, etc.) based on the circumstances of the case;

- Once the ecosystem interactions and potential environmental impacts have been defined, using the most applicable and recent information, carefully examine each impact in great detail using a "magnifying glass" (looking for additive, synergistic and indirect effects over both time and space) to determine which, if any, cumulative impacts are likely to occur (ibid., 587).

These principles establish a very broad conceptual framework for identifying cumulative environmental impacts, stressing that the conceptual approach rather than the particular methodology is the key element. They give the investigator a great deal of flexibility in the selection of methods and allow for the integration of the most up-to-date information in examining impacts without waiting for that information to be integrated into a formal methodology.

ADDITIONAL METHODOLOGICAL GUIDANCE

It is also possible to cull from the literature a supplemental set of recurring themes that give a little more guidance on key considerations in designing a systematic cumulative impact assessment and management approach. They suggest:

- The cumulative impacts assessment should be structured in terms of **goals for a resource and/or resource impact of concern.** The resource or impact of concern should be explicitly identified. The focus of analysis should be on how the proposed action will affect the resource and whether the action will move closer to or farther away from the goals for that resource.

- The investigator should define **explicit time boundaries** for use in assessing the incremental impact when added to "past" and "reasonable foreseeable future actions;" depending upon the availability of historical data and future projections, it could go back as far as pre-settlement conditions and as far forward as one or two human generations. (For further discussion, see Bedford, 1993 [Ann. Bib. #75]).

- The investigator should define **explicit geographic boundaries** which, ideally, should be large enough to encompass major factors that cause variation in the effects (Salwasser and Sampson 1985 [Ann. Bib. #58]) and allow for consideration from a landscape perspective (Bedford 1993 [Ann. Bib. #75]).

- The methodology should identify the **policy and technical tools** to be used, selecting from many methods and techniques, none of which are necessarily superior to another, to select one or more that are appropriate to the circumstances. For example, the investigator might draw upon a combination of public hearings, intergovernmental meetings, memoranda of understanding or long-range regional comprehensive plans to identify policy goals. The investigator might use a combination of scoping checklists, models, time-sequenced maps, indicator species or guilds as technical tools. Particular attention should be given to identification of **essential indicators** of resource loss, stress or similar impact.

- The investigator should explicitly **identify institutional barriers** which may preclude full assessment of cumulative impacts such as limited jurisdiction of the reviewing authority to consider upland or off-site impacts; limited historical data or absence of projections of future development which preclude full consideration of past and future projects; limited time or resources for use of cumulative impacts methodology; etc. Identification of institutional barriers will highlight opportunities to improve the effectiveness of the cumulative impact assessment.[1]

In the last several years, the emerging methodologies have tended to go beyond environmental assessment to incorporate additional guidance for decision-making and management strategies. These decision-making and management strategies are illustrated in more detail below in the context of specific methodologies.

For an additional example of a cumulative impacts assessment methodology, see Part II of this document. It summarizes NOAA/NMFS Northeast Region Habitat and Protected Resources Division's development and application of a protocol for assessing the cumulative environmental impacts of coastal construction activities. It was designed for use in Army Corps of Engineers

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1. Adapted from Irwin, Frances. 1993. "Conceptual Framework and Definitions." Presentation at the Methodologies and Mechanisms for Management of Cumulative Coastal Environmental Impacts Workshop, Marine Law Institute/NOAA National Marine Fisheries Service, Northeast Region/University of Rhode Island School of Oceanography, Narragansett, Rhode Island, May 6, 1993 [hereinafter Workshop].

regulatory programs. While much more elaborate methodologies could easily be envisioned, the approach was shaped by the practical requirement that it be achievable, at least for major applications, within existing staff, information and time constraints. As noted, since NMFS is only advisory to the Corps, the ultimate success of this approach is dependent upon the Corps accepting the protocol and giving due consideration to cumulative impact comments and recommendations it generates.

EXAMPLES OF CUMULATIVE IMPACT ASSESSMENT AND MANAGEMENT METHODOLOGIES

The five selected state-of-the-art cumulative impact assessment and management methodologies presented here illustrate the thinking of different theorists and agencies about the most effective ways to approach cumulative impacts. For the most part, they have been designed to address particular concerns in a terrestrial context; issues about transferability to an estuarine or marine context are discussed at the end of this chapter.

The methodologies included in this chapter were identified through a preliminary literature search and review of questionnaire responses. With the exception of Example 1, a proponent of each of the selected approaches presented the methodology as part of a panel, "Cumulative Impact Assessment and Management Methods," at the May 1993 workshop. Each presentation was followed by comments from designated respondents and group discussion by invited participants.[2] Representatives from Alaska also participated in the workshop, but did not present their methodology as it was still in its formative stages.

These methodologies should not be viewed as a simple cookbook for success. Obviously, environmental managers have to make substantial adaptations to these methodologies for application in their particular situation, depending upon the resource/impact of concern, time and space boundaries, policy and technical tools available, institutional opportunities, and staff and data resources. But the methodologies described below illustrate approaches that have been developed by some experts in the field of cumulative impacts and may offer valuable insight into frameworks, concepts and tools.

Since this review is by no means exhaustive, readers are also referred to the sources cited in the cumulative impacts methodologies section of the annotated bibliography for detailed descriptions of additional methodologies and for systematic comparisons of multiple methodologies.

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2. Presenters: Scott G. Leibowitz, U.S. EPA Environmental Research Laboratory; Carolyn Hunsaker, Environmental Sciences Division, Oak Ridge National Laboratory; Gary Shaffer, Department of Biology, Southeastern Louisiana University; Samuel Williamson, U.S. Fish and Wildlife Service; and William Eichbaum, World Wildlife Fund. Respondents: Thomas Bigford, Habitat and Protected Resources Division, Northeast Region, NMFS; Cheryl Contant, Urban and Regional Planning, University of Iowa; and Alison Rieser, Marine Law Institute, University of Maine School of Law. Participants from Alaska included Glenn Seaman, Alaska Coastal Management Program Coordinator, Department of Fish and Game, Anchorage. Workshop, *supra* note 1.

Cumulative impact assessment methodologies discussed in those documents include a range of ad hoc techniques, checklists, Geographic Information System (GIS) or other cartographic techniques, matrix approaches, modeling methods, network methods, and other assessment methods.

Example 1: Alaska's Assessment of Cumulative Impacts on Fish Habitat in the Kenai River

Alaska's Department of Fish and Game (ADF&G) Habitat and Restoration Division has recently completed an assessment of the cumulative impacts of development and human uses on fish habitat in the Kenai River. The project was undertaken with funding from the Coastal Zone Enhancement Grants program under Section 309 of the Coastal Zone Management Act. The detailed methodology is described in Liepitz 1994 [Ann. Bib. #260]. Additional background is also provided in Liepitz and Muhlberg 1993 [Ann. Bib. #111]. The goal of the assessment was to use it in both planning and regulation.

RATIONALE FOR THE METHODOLOGY

Resource managers were increasingly concerned about the impacts of multiple large- and small-scale development projects and land uses requiring river access to the physical and biological integrity of the river's habitat for resident and anadromous fish. With a drainage area of approximately 2,200 square miles, the mainstem of the river runs 67 miles from the outlet of Kenai Lake to its confluence with Upper Cook Inlet. The Kenai River is extremely important for recreational and commercial fishing, ranking as the largest recreational fishery in the state and accounting for 30-40% of the commercial sockeye salmon harvest in Cook Inlet.

ADF&G developed its methodology in consultation with state, federal and local agencies. While recognizing that most of the recent literature promoted a watershed or ecosystem approach, funding constraints forced the interagency group to chose between (1) a broad-based, general cumulative impact assessment approach that would address the entire watershed or (2) a strategic/detailed assessment approach that would focus on a smaller geographic area and the core problem. The group opted for the latter, focusing on degradation of chinook rearing habitat on the mainstem of the Kenai River. The group reasoned:

> [T]he cumulative impact assessment needed to be detailed enough so as to: (1) clearly define the core problem and the causes and effects; (2) be persuasive to the public, agencies, policy makers that the problem is significant and motivate them to address it; and (3) develop a tool that could be later used in subsequent implementation and monitoring of cumulative impacts. The interagency group felt that the broad-based approach would not accomplish this.[3]

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3. Seaman, Glenn, Alaska Coastal Management Program Coordinator, Department of Fish and Game, Habitat Restoration Division, Anchorage, Alaska, personal communication, April 21, 1995 (on file with authors).

In developing this approach, researchers had to assume that most Kenai River drainage chinook salmon rear in the mainstem and that the quantity and quality of chinook salmon rearing habitat in the mainstem is the primary limiting factor in the production of chinook salmon.

SUMMARY OF THE ASSESSMENT METHODOLOGY

The resulting assessment methodology involved several steps which combined several processes:

Step One: Identify the target resource and develop a fish habitat classification scheme for impact assessment purposes.

While the researchers were concerned about the fish habitat for several recreationally- and commercially-valuable species, they opted to focus the assessment on juvenile chinook salmon. This decision was based on previous studies of the Kenai River which "determined that an impact assessment can be narrowed down to a single fish species which is most prone to adverse effects associated with continued habitat alteration" (ibid., 15). It was determined that the juvenile chinook salmon was most susceptible to adverse effects of habitat alteration due to the length of the freshwater juvenile rearing stage (2-3 years) and its dependence on river shoreline habitat during this life stage. It was also representative of the habitat needs of a variety of species occurring within the study area. Thus researchers concluded juvenile chinook salmon could be used as an indicator species.

After evaluating several fish habitat classification strategies, researchers opted to use a habitat classification scheme defined for the Kenai River in an earlier agency study. That research had determined that the juvenile chinook salmon has very specific needs for stream bank cover, substrate type and water velocity and water depth, and that the requisite habitat occurs primarily in a six-foot (6.0') wide corridor adjacent to the river's banks.

Step Two: Develop a baseline description of the conditions occurring along the river correlated to individual land ownership patterns.

Researchers collected existing information about land ownership, soils and vegetation types. This was supplemented by using existing aerial photography and conducting an extensive field survey to inventory existing bank and fish habitat conditions for the entire 67 miles of river mainstem (1,799 parcels). For each parcel, data was collected on structures, type and dimensions of bank alterations, nearshore substrate composition, vegetation type and coverage at ordinary high water and top of bank, and fish cover characteristics. All of this information was entered into the ADF&G geographic information system (GIS)/database system.

Step Three: Select and apply a qualitative fish habitat value model procedure.

Researchers selected the U.S. Fish and Wildlife Service's Habitat Evaluation Procedures (HEP) to analyze impacts. That process documents the quality and quantity of available habitat for a selected species. It utilizes a rough carrying capacity approach based on key habitat components as variables to evaluate the habitat's ability to provide optimum requirements for that species.

The procedure leads to the calculation of a Habitat Suitability Index (HSI) value, which is supposed to be representative of the carrying capacity for the indicator species. The HSI value is derived by mathematical aggregation of multiple Suitability Indices (SIs), each a ratio of the estimate of actual habitat conditions for the species. The ratio will be a value between 0.0 and 1.0, but the optimum SI for a particular variable may be less than 1.0 to weight the relative importance of a variable. In this study, SIs for velocity, depth, type of vegetation, debris, overhanging vegetation, undercut bank and substrate were combined to calculate an HSI for a study area. This procedure can be used to calculate the total number and geographic distribution of Habitat Units (HUs) currently available to the indicator species in the study area.

Step Four: Complete a development trends analysis.

An analysis of the historic pattern of development was undertaken to provide insight into the rate of habitat loss. Using aerial photograph interpretation of photos from 1963 through 1992 and the 1993 survey to compare conditions at different points in time, researchers found that 76% of modified banks and structures had been introduced since 1963-64, primarily in the form of bank stabilization efforts, boat docks, groins or jetties.

The study concluded that there are 1,482,790 HUs currently available to juvenile chinook salmon in the mainstem of the river. Using this trends data, researchers estimated that the total number of HUs available to juvenile chinook salmon prior to human settlement was 1,523,144; the current conditions represent a 2.2 percent loss in total HUs.

Step Five: Model future changes in habitat characteristics.

Using the database, GIS information, and development trends analysis, for future development, model future changes in habitat characteristics to estimate habitat value benefits or losses associated with the development.

This method can be used to compare the same area at different points in time or under different development scenarios. For example, the impact of a particular development (positive or negative) can be determined by comparing the estimated pre- and post-development product of the mean HSI values multiplied by the area affected by the habitat altering activity area. This comparison of HU changes represents the degree of habitat impact. It can also be used to compare the relative habitat value of two different areas at the same point in time.

Of great importance for considering cumulative impacts, this method can be used to place a proposed site-specific action into the context of the entire river system. This can be accomplished by comparing the available HUs for the entire river system to the change in HUs projected to be caused by the proposed action. Similarly, this method can be used to make a quantitative comparison of alternatives and to guide redesign to offset or compensate for unavoidable losses.

Notably, the study determined that the six-foot wide corridor adjacent to the river's banks, where approximately 80% of all rearing juvenile chinook salmon are found, translated to a maximum potential area of 121 acres. Of this available acreage, the assessment found that 8.7 acres were already developed or impacted, 15.7 acres were of significantly lower quality, and 5.1 acres were heavily trampled or denuded, leaving 91.5 acres of mainstem nearshore rearing habitat. Only 11.0 acres provide ideal rearing conditions.

APPLICABILITY

Liepitz (1994, [Ann. Bib. #260]) identifies a few potential weaknesses in the methodology. The first is the "high level of baseline data development and ground truthing of the database required to initially define the habitat characteristics of [the] study area" (ibid., 56). He suggests, however, that this cost could be minimized through use of increasingly available aerial photography/videography or satellite imagery.

The second concern identified is "the reliability of the use of an individual or group of indicator species and the development of suitability curves for that species for the specific system being evaluated" (ibid., 56). The analysis is only as accurate as the indicator species and suitability curves, both of which require a fair amount of best professional judgment.

Liepitz also points out that while this habitat-based assessment approach is valuable because it can assess impacts of the primary activity and projected secondary impacts (e.g., construction of a boat launch and the projected related impacts of bank trampling and bank scour), it is not designed to measure indirect effects (e.g., that the large increase in boat traffic might affect recreational values) (ibid., 57). Similarly the methodology was not designed to assess the impacts of increased pollutants generated by the action.

The potential for transferability of this methodology to similar riverine systems and wetland systems is high according to Liepitz. The U.S. Fish and Wildlife Service has developed a variety of species-specific suitability curves for avian, mammal and fish species for use in its HEP analysis which can be used to quantify habitat loss for aquatic and wetland habitats (ibid., xvi).

The report suggests this particular analysis would benefit from additional research to extend the methodology to tributary streams to obtain a drainage-wide perspective and evaluate additional indicator species in the Kenai River and tributaries. The GIS database system would then be expanded to include the entire watershed. The analysis could also be refined by additional studies to assess shoreline erosion caused by wave action generated by boat wake activity and analyze the level of littoral drift of food organisms occurring with the river mainstem (ibid., 59).

Alaska's assessment of cumulative impacts is part of a larger effort to manage and control the cumulative loss of fish nursery habitat. Other elements of the management strategy include:

- Public education about the effects of development and river access on fish habitat;

- Revision of existing or adoption of new enforceable review policies and implementation mechanisms to protect the critical habitat as part of the local coastal management plan;

- Development of other state regulations to address these issues;

- Expansion of the Kenai River GIS/database system to include the entire watershed;

- State acquisition of important or threatened lands;

- Habitat restoration and enhancement projects;

- Habitat research and monitoring studies; and

- Establishment of a land trust for conservation easements and possible implementation of other non-regulatory nursery protection programs.[4]

Example 2: A Landscape Conservation Approach

This example is based on a methodology developed by a group of wetland scientists headed by James Gosselink at Louisiana State University as part of a long-term project aimed at restoring the Lower Mississippi River Valley. The detailed methodology is described in Gosselink et al. 1990 [Ann. Bib. #99] and Gosselink et al. 1990 [Ann. Bib. #42]). Lee and Gosselink 1988 [Ann. Bib. #53], Gosselink and Lee 1987 [Ann. Bib. #96], Gosselink and Lee 1988 [Ann. Bib. #97] and Gosselink and Lee 1989 [Ann. Bib. #98] are related articles. This summary is also based on the comments of Gary P. Shaffer, a member of the research team.[5] The approach described in this example differs from the previous one by including distinct assessment, goal-setting and implementation phases, the latter specifically designed for use in the Section 404 Program.

The overall project, coordinated by the Nature Conservancy, includes participants from federal, state and local governmental agencies, universities, conservation organizations, private industry and private citizens. Funding for different parts of the project has been provided by the National Wetlands Research Center, U.S. Fish and Wildlife Service, EPA through the Louisiana Department of Environmental Quality Nonpoint Source Program, and the Nature Conservancy.

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4. Seaman, Glenn, Alaska Department of Fish and Game, Habitat Restoration Division, Anchorage, Alaska, memorandum to participants of May 1993 Cumulative Impacts Workshop (30 Sept. 1994) (on file with authors).

5. Shaffer, Gary P. 1993. "Landscape Level Assessment Approach," Presentation at Workshop, *supra* note 1.

The portion of the project which led to the development of this cumulative impact methodology focused on bottomland hardwood forested wetlands, but the methodology is not restricted to that resource. Its application to this type of wetland is illustrative of how this approach could be used, with modification, in other wetland settings.

LANDSCAPE RATIONALE FOR METHODOLOGY

Researchers were concerned about the rapid decimation of bottomland hardwood forested wetlands in the southcentral and southeastern United States because of the resulting loss of ecological services related to habitat, water quality and flood water storage. Approximately 21 million acres of the large study area used to be forested floodplain prior to extensive human settlement, but approximately 88% of the original forested wetlands were gone by the 1980s. Most of that loss was attributable to clearing for agricultural use and to flood control projects (Gosselink and Lee 1987 [Ann. Bib. #96]).

Starting in 1984, a series of EPA-sponsored workshops were convened to increase the understanding of ecological processes in bottomland hardwood forest ecosystems and the effect of human activities. The first two workshops concentrated on local sites and ecosystems; by the third workshop, there was a growing consensus about the need to focus on cumulative impacts and large-scale landscapes (defined as "large heterogeneous areas composed of several ecosystems that are spatially and temporally linked and that function as an integrated unit") if environmental managers hoped to slow, or perhaps even begin to reverse, the loss (Gosselink et al. 1990, 649 [Ann. Bib. # 42]).

The research team concluded that a landscape approach was most appropriate to address cumulative impacts because:

- Cumulative impacts are usually landscape level phenomena;
- A landscape focus can conserve valued attributes that are not manageable at a finer scale;
- The natural system is optimal and self-maintaining; and
- Landscape conservation also conserves the valued functions of biota of smaller subsystems (Gosselink and Lee 1987 [Ann. Bib. #96]).

The researchers make two recommendations for the regulation and management of forested bottomland wetlands in light of these findings. First, regulatory and management procedures should not only consider site-specific impacts, but should also consider impacts on natural landscape units; and second, regulatory decisions should be made in the context of plans for the entire landscape. The process had to shift from a reactive one to a process informed by prior planning on a landscape scale.

BASIC THREE-STEP METHODOLOGY

James Gosselink and Lyndon Lee developed a basic three-part methodology designed to implement the recommended process. In its most basic form, it consists of an iterative sequence of ecological assessment, goal-setting and planning for implementation:

Step One: Ecological Assessment—determining the ecological "health" of the study area through "the characterization of cumulative effects on both ecological structure and the functional ecological processes in a designated landscape unit" using landscape indices that integrate ecological processes over large areas;

Step Two: Goal-setting—setting goals for the study area environment based on its present health through "agreement by public consensus on environmental goals for the assessment area, based on the assessment and consistent with regulations under the [Clean Water Act]"; and

Step Three: Implementation—planning how those goals can be implemented through "the development of specific plans to implement the goals, based on the landscape structure and function of the assessment area. . . ." (Gosselink et al. 1990, 590 [Ann. Bib. #99]).

Consistent with the landscape scale, Gosselink and Lee recommend that the boundaries included an area that is "to the extent possible, ecologically closed to water and nutrient flows" such as watersheds or drainage basins and "also large enough to satisfy the home range and habitat requirements of the farthest ranging animal species of interest." The boundaries may have to be modified by practical considerations.

The first step, assessment, should focus on landscape-scale processes, not individual sites, and provide information on the condition and potential of the landscape system. The "landscape indices" utilized for characterization are to be used in limited number, and are to be simple, measurable properties that can be used to reflect change in ecological structure, hydrologic, water quality, and biotic functions over time. For example, they could be data on forest structure, land use, and water quality and other widely-available long-term data records.

The goal-setting process, step two, is not a technical or scientific process, but rather should be an expression of public consensus "about the desired future of the total resource, not selected aspects of it" (Gosselink et al. 1990, 654 [Ann. Bib. #42]). It will incorporate public values on issues such as the desirable balance between a healthy environment and development. It is recommended that both the goal-setting and development of landscape plans involve participation of all federal, state and local agencies with jurisdiction and interested members of the public.

The final step, implementation, is envisioned as an integral part of the process. It includes the identification of prioritized actions at specific locations within the assessment unit, continued monitoring of the system to evaluate progress in reaching the goals, and development of a system to record actions as they occur to provide an "institutional memory" (ibid., 654). As part of the implementation process, permit decisions are to be guided by consistency with the goals:

> Within this context, permit decisions should be based on the 'direction' of the impact of the proposed action with respect to the goals (citation omitted). Generally permits would be approved if cumulatively they move the landscape system toward stipulated goals. Permits would be denied if proposed projects move the landscape system away from approved goals (ibid., 654).

Section 404 permit reviews for jurisdictional wetlands are not the only implementing tool. Gosselink and Lee also suggest use of EPA authority for planning in the Advance Identification program to identify critical wetland areas before any permit is requested; use of Army Corps authority for advance planning in Special Area Management Plans; acquisition of key sites, perhaps through outright purchase or use of Section 404 restitution provisions; nonregulatory disincentives to discourage wetland forest clearing and incentives to encourage conservation in national legislation; and other local and state regulations such as strengthened state regulation using state Section 401 water quality authority to review individual Section 404 and Nationwide Permit 26 permits.

TENSAS RIVER BASIN APPLICATION

As part of the regional effort, Gosselink's team applied this methodology to the Tensas River basin in northeastern Louisiana. This area was historically more than 90% forested wetland. Now only about 15% of the original forested wetland area remains. (For a more complete discussion of this case study, see Gosselink et al. 1990 [Ann. Bib. #99]).[6]

Applying the three-step cumulative impacts methodology, they first characterized the ecology at a landscape scale. They used land-cover data and maps to determine forest structure and land use, and used "relatively few widely available long-term data sets" on hydrology (stream stage and discharge), water quality, and biota (breeding bird surveys and Christmas bird counts). Because it is the easiest to quantify, stream water quality was relied upon most heavily as the key indicator. After completing the assessment of landscape functions using these few relatively simple indices, they concluded:

> We judge the environment of the Tensas basin to be seriously degraded, primarily by two types of activities that are both cumulative and interacting. Public works projects have reduced the area of the basin previously subject to flooding during normal spring high-water periods, and bottomland forests have been converted to cropland. . . . This forest conversion, especially the loss of streamside buffer strips, led to poor water quality through increased erosion and fertilizer runoff from the cleared land. . . . Land clearing also contributed to reduction in the diversity of indigenous flora and fauna (ibid., 595-6).

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6. *See also* Shaffer, G.P., D.M. Burdick, J.G. Gosselink, and L.C. Lee. 1991. A Cumulative Impact Management Plan for a Forested Wetland Watershed in the Mississippi River Floodplain. *Wetlands Ecology and Management*, 1(3):199-210.

The second step, goal-setting, drew heavily on the goals already articulated in the Clean Water Act. Refining those goals, the following goals were set for the Tensas basin:

- No further net loss of forested wetlands;
- Improve water quality to full compliance with EPA's suggested minimal standards, as indicated by phosphorus;
- Return stream hydrology in the remaining large forest patches to the natural pattern of spring flooding;
- Conserve existing biota, especially those species that require large forested areas and/or forest interiors (ibid., 596).

The team then developed strategies and specific plans for achieving the goals. Drawing on principles of landscape ecology and island biogeography, the following strategies were identified to address the last three goals:

- Conserve and restore large blocks of bottomland upland forest, appropriately interspersed with smaller tracts;
- Conserve and restore continuity between forest patches by creating or conserving forested corridors, particularly along streams;
- Maintain and restore forest contiguity across the floodplain from stream to upland (ibid., 597, which should be consulted for a more detailed description of how each strategy furthers the goals).

The plan to address the first goal (no further loss of forested wetlands) relied on a combination of strategies to improve the quality of review of permits for alteration of jurisdictional wetlands including: advance identification by EPA, a well-thought out strategy for restitution or mitigation depending upon the priority of the wetland, nonregulatory incentives and disincentives, and outright purchase of key sites.

Not content to leave the strategies at that level, the team researchers identified and carried out very detailed, economically-feasible restoration plans. For example, one of the key strategies is to try to connect patches of forested wetlands. This is most likely to be accomplished using reforested riparian buffer strips. The state nonpoint source runoff program received federal funds to replant areas along streams in the Tensas basin study area. Similarly, marginal agricultural land may be restored to serve as corridors. Toward this end, researchers used satellite imagery to identify formerly "farmed wetlands" (agricultural areas subject to flooding), knowing that current economic conditions preclude profitable farming on them and their owners could be amenable to their sale for restoration or protection through a conservation easement.

A GIS program was developed to find corridors along streams or on marginal agricultural lands meeting their specifications. By considering information about land use, hydrologic features, and transportation features, through iterative application, this program identified a relatively small number of sites that would serve as critical corridors. For example, using this technique, researchers were able to identify approximately 400 ha of corridors among forest patches that would increase the effective size of the largest forest complex from 50,000 to more than 100,000 ha. This program has been used to focus implementation efforts and to prioritize possible corridors in accordance with ecological importance.

The team then used this information to guide efforts to actually reconnect patches. Where a reconnecting corridor involved use of private land, the researchers consulted knowledgeable local individuals to identify whether the owners might be willing to cooperate on a voluntary basis or might be willing to sell the land for an affordable price. Where there was a chance of success, they pursued the idea with the private owners. In other instances, the connecting corridor involved use of publicly-owned lands such as bridges or highway rights of way. By using this flexible, iterative, interactive process, the research team had significant success, and some large-scale restoration projects are underway in the Tensas basin area.

APPLICABILITY

Gosselink et al. conclude that the basic three-step methodology of ecological characterization, goal-setting, and planning is "broadly applicable to resource planning" as a way to contain cumulative impacts. They also assert their work illustrates the appropriateness of focusing on the landscape level and of engaging in landscape planning using ecological principles (ibid., 598).

The method used to complete the ecological assessment illustrates how a few well-chosen, long-term data sets can be used to produce a landscape-level analysis of major environmental changes related to anthropogenic effects. The relative simplicity of the characterization process enhances the usefulness of this methodology to agencies with limited funds or no time for a more detailed analysis.

Another contribution of this methodology is that it illustrates how cumulative impacts can be managed by working within the existing regulatory structure. Gosselink et al. observe:

> Implementing a cumulative impact assessment methodology, such as the one tested in the Tensas basin, requires a change in both current regulatory focus and practice, but not a qualitative change in the legal and regulatory framework governing wetland protection. In general, federal statutes (particularly the CWA) provide a clear incentive for strong environmental protection, and the regulations implementing those statutes are broad enough to provide for an anticipatory, landscape-level management strategy (ibid., 599).

There is, however, a major impediment to using this methodology in a coastal context. The researchers note that in this particular application of the methodology to forested wetlands, they used principles derived from island or insular biogeography (focusing on forest patch dynamics) as the underlying landscape management principles. They appear to relate to biotic diversity, protection of stream water quality and wetland hydrologic values. But they observe:

> In other types of landscapes, other principles may need to be identified. For example, in an estuarine system dominated by bays and marshes, we know of no species whose distribution is related to large, unbroken marsh tracts. Are patch size dynamics important in this kind of system? Numerous studies indicate that hydrology, which is certainly linked to patch size dynamics, is the primary control on estuarine system processes [citation omitted]. It is not yet known, however, what landscape management principles are appropriate under circumstances such as these (ibid., 598).

Thus, additional research and identification of appropriate organizing landscape management principles for estuarine and coastal systems is necessary before this methodology is transferable.

Despite this limitation, the methodology illustrates several components that would be beneficial in any attempt to manage cumulative impacts. First, it has been a collaborative effort of a number of federal, state, and local agencies and university researchers, coordinated by a nonprofit agency, all working toward a common goal. As such, it has been able to draw on a variety of resources and expertise. Information has been produced, shared and refined by multiple entities.

Second, even though it has focused on landscape processes and establishing a regional context for individual decisions, it has also been able to produce information at a site-specific level. The use of GIS technology and prioritization of sites for linking patches has enabled it to present information on a scale relevant to site-specific permit decisions.

It has succeeded in getting participants to think in terms of a 50-year time horizon. This means that there are no unreasonable expectations of immediate results, and the effort is being evaluated using a long enough span of time that results will be observable.

Finally, the effort goes well beyond regulatory standards for no future degradation of the resource; it is making progress toward restoration. The implementation strategy is "proactive," including seeking out acquisition of key land or easements, rather than just reacting to permit applications. In addition, a serious effort has been made to factor in agricultural economics, financial incentives and landowners' willingness to be stewards of the land.

Example 3: U.S. Fish & Wildlife Service Cause/Effect Process

The U.S. Fish and Wildlife Service (USFWS) has been working on the problem of cumulative impacts for a number of years, as the materials in the Annotated Bibliography indicate. It has dealt with the issue in many different contexts, including bays and estuaries. This discussion of the USFWS cumulative impact assessment process is based on the comments[7] and writings of research ecologist Samuel Williamson and various colleagues. He has been involved in work, with others in his agency and with other agencies, in bays and estuaries such as Chesapeake Bay, Colville Delta, Alaska, and Mobile Bay, Alabama. For further detail, see Williamson n.d. [Ann. Bib. #62], Armour et al. 1988 [Ann. Bib. #69], Armour et al. 1985 [Ann. Bib. #72], Williamson et al. 1987 [Ann. Bib. #130] and Williamson 1993 [Ann. Bib. #131].

RATIONALE FOR METHODOLOGY/PROCESS

The first premise underlying the USFWS work is that cumulative impact assessment should be a process, a way of thinking, not a particular methodology. There is no one best methodology for undertaking cumulative impacts assessment. It requires political acumen on the part of the agency and a favorable political milieu before attempts to manage cumulative effects will even be feasible.

The second underlying premise is that efforts should not stop with assessment (scoping and analysis), but should be combined with proactive, long-term management planning because there is a greater potential for achieving long-term goals (Williamson 1993 [Ann. Bib. #131]). "The . . . challenge . . . is to identify what should be done in terms of ecological changes, rather than merely what should not be done" (ibid., 396).

Williamson recommends five threshold tests to determine when it is worthwhile to try cumulative impact assessment:

- If substantial declines of a fish or wildlife species have occurred within the current generation's memory;
- If substantial declines in quantity (not just quality) of several critical habitats have occurred over the last 20 years;
- If several different human actions are causing a decline;
- If the decline has been continuous, without corrective action; and
- If society has recognized the problem and is willing to take corrective action.

All five are not necessarily required, but if all five are present, the time is ripe for cumulative impact assessment and management planning.

Based on the experience of USFWS working with various agencies on regional projects, Williamson stresses the importance of the following components:

7. Williamson, Samuel. 1993. "Fish and Wildlife Service Approach." Presentation at Workshop, *supra* note 1.

- Emphasize a scientific, cause-effect understanding of the overall situation, each problem, and problem interactions.

- Stress measurable overall action toward progressive goals;

- Use a generation-long, ecosystem-level process to solve problems and generate solutions;

- Have multiple agencies collaborate in the effort to improve the overall situation (adapted from Williamson 1993, 396 [Ann. Bib. #131]).

In particular, because it is common for multiple federal, state and local agencies each to have partial responsibility for the natural resource of concern, he stresses the need to achieve an early consensus among all those agencies on whether to conduct a cumulative impact assessment and on the strategy to be used.

> Agency differences can be minimized and support gained from sharing information and understanding of technical issues. Management users from the concerned natural resource management agencies should be involved in the early design of the assessment and again later in the interpretation and direction phases. This creates a sense of ownership, commitment, and responsibility in the participants and their agency and promotes greater coordination, cooperation, and consensus among the natural resource agencies (ibid., 397).

PROCESS

Within this general framework, Williamson recommends the following steps for the cumulative impact assessment and management planning process:

PHASE I: ASSESSMENT

Step One: Scoping—Define the ecological situation in specific terms of individual problem statements and select one strategy for each problem.

A multi-agency group of experts should be convened for the scoping step, to work collaboratively, drawing on best professional judgment. They should identify the highest priority ecological and environmental problems for the ecosystem of concern. At this stage, the team should focus on an analysis of effects (e.g., the species and habitat problems of concern) to produce qualitative problem descriptions.

After the scoping step, the agency should determine whether it is committed to going further into the assessment phase. It may opt not to if the priority species and habitats identified in the first step are not within the jurisdiction of the agency, or if the scoping process suggests that little progress can be made.

Step Two: Analysis—Investigate and document the problems and their causes in detail using the best available data and analytical tools and then set several goals.

If the team decides to continue with the assessment, during this second step the preliminary problem statements are accepted, modified, or rejected based on quantitative problem analyses. This analysis should include documenting, graphing and mapping the current status and historic trends affecting the priority resources, evaluation of additional data and relevant literature, and use of scientific judgment. The team should identify cause-effect linkages. Once the team reaches an adequate cause-effect understanding, progressive goals should be generated for each priority problem. These goals should be justified by the scientific information. The goals should also have the political support of the agencies participating in the process.

Williamson participated in a cumulative impact assessment effort in Chesapeake Bay which further illustrates this process:

1. A multi-agency group developed a subjective description of the problems in the Bay using a nominal group technique in which participants independently listed problems, e.g., degraded water quality, loss of marsh and wetland habitat, and then as a group ranked the five most important;

2. This was followed by development of an objective description of the problems using the resource management team's consensus and review of scientific literature;

3. The team then assessed the situation using cause-effect diagraming, working from the problem statements to identify the causes of the problem and the effects of the problem;

4. Finally, moving to the management planning phase (discussed below), the team developed a plan of specific corrective actions for each identified problem, in this case using a "functional analysis system technique" to identify how to achieve objectives for resource recovery by treating the causes of the problems (Williamson et al. 1987, 379-80 [Ann. Bib. #130]).

One of the challenges of cumulative impact assessment is to find simple techniques to study a complex situation. Williamson recommends focusing on habitat rather than water quality, a particular species or other indicators of ecosystem health. For example, for Chesapeake Bay, they concluded:

> Submerged aquatic vegetation decline is a keystone problem that can be measured, monitored and managed, and it directly relates to declines in abundance of migratory fish and wildlife species (citation omitted). We believe that submerged aquatic vegetation should be a central focus of the restoration of Chesapeake Bay. Distribution and biomass of submerged aquatic vegetation, as opposed to measurements of nutrient concentrations

and toxic chemical loadings, can serve as an integrator of human impacts on the Bay and as a quantitative indicator of the environmental quality of the Bay (ibid., 387).

Williamson emphasizes that in the analysis stage, whether in the initial phase (Step 2) or continuing refinement (Step 4), it is critical that the process start with the question of what managers want to accomplish. It distorts the process to start by assessing what data is readily available, or what models or methodologies have been used before. Once researchers have determined what they want to accomplish with additional cause/effect assessments, there are a wide variety of modeling approaches such as a GIS and landscape ecology approach, or a simulation modeling approach. However, verification and validation of the predictive capacity of the models is key to their ability to assist with controlling cumulative impacts.

PHASE TWO: MANAGEMENT PLANNING

Step Three: Interpretation—Develop and document options, estimate changes using mathematical models, and develop a plan.

The goal of the third step is to identify alternative management plans and then to recommend a plan that "contain[s] the set of effective actions that optimally achieve the multiple goals for the priority resources" (Williamson 1993, 400 [Ann. Bib. #131]). It builds on the quantitative analysis conducted in Step 2, and also integrates consideration of ecological, political, institutional, economic and legal opportunities and constraints. This step should also be conducted as a multi-agency, collaborative process. The responsibilities of individual agencies should be outlined as part of the plan.

During this step, agencies should discuss and agree upon the basic resource management strategy for each problem: restoration, impact minimization (e.g., no net loss), or impact control (allowing some decline down to a perceived threshold). Williamson asserts that serious cumulative impact assessment and management planning will seek to halt the decline and reverse it (ibid.).

Step Four: Direction—Implement and incrementally improve the management plan and systematically evaluate, improve and update the problem statements, data, analytical tools, and mathematical models.

Controlling cumulative environmental impacts is an iterative process, not a fixed plan. The refinement of the analysis and management plan will be a continuing process.

APPLICABILITY

In contrast to the other methods reviewed in this chapter, the USFWS approach describes itself as a process rather than a methodology. It draws on experience in working in many contexts throughout the nation. The approach is necessarily tailored to USFWS' role as a resource agency which reviews and comments on certain permit applications and offers its expertise to other agencies, but does not have direct control over permits. As such, its primary opportunities to influence the process involve application of its scientific expertise to natural resources issues of concern. It can capitalize on this expertise by educating the public and other federal, state and local agencies, and by participating in collaborative, interagency efforts.

The process offers good insights on how to move from a recognition of high priority threatened species or habitats to identification of cause-effect relationships and selection of management strategies. The recommendations generally reinforce key findings of the Gosselink research team. Both stress (1) the need for laypeople to recognize the problem and be willing to devote resources to it before it is realistic to expect progress, (2) the need to collaborate with multiple agencies with partial jurisdiction over the resource to leverage available expertise and forge solutions that overcome political/institutional barriers, (3) the need to adopt positive goals for restoration of the resource rather than just working to halt further degradation or allow continued degradation down to some environmental threshold, and (4) the need to make a long-term commitment to the cumulative impact management process, assuming a twenty- to fifty-year timeframe for implementation and measurement of progress.

Example 4: EPA's Synoptic Approach

EPA's "Synoptic Approach to Cumulative Impact Assessment" was developed by the Office of Research and Development's Wetlands Research Program at the request of the Office of Wetlands, Oceans and Watersheds. The report on the proposed methodology (Leibowitz et al. 1992 [Ann. Bib. #110]), describes it as "an ecologically-based framework in which local information and best professional judgment can be combined to address cumulative impacts and other landscape issues" (ibid., 7). This summary is also based on the comments of Scott Leibowitz.[8]

RATIONALE FOR THE SYNOPTIC APPROACH

The methodology was originally developed for use in wetland permit evaluations under the Clean Water Act, and was designed for cases in which time, resources and information are limited. It is not meant to produce the precise, quantified assessment of cumulative impacts within an area required as part of the review of a major or controversial action. Instead it is intended as a tool to augment the best professional judgment of wetland regulators in their decisions about the possible cumulative impacts of the approximately 9,000 minor, "non-controversial" Section 404 permit applications received each year. It provides a "relative rating of cumulative impacts *between* areas" such as watersheds, landscape units or ecoregions. It is intended to be an inexpensive, rapid assessment method for making some qualitative comparisons of effects between different areas.

The focus is prioritization, protection and restoration, not prediction. Drawing on risk assessment concepts, it uses maps to help compare relative environmental risks among relatively

8. Leibowitz, Scott G. 1993. "A Synoptic Approach to Cumulative Impact Assessment." Presentation at Workshop, *supra* note 1.

large units so that resources can be devoted to the areas that are most at risk. The authors suggest that in addition to Section 404 permitting, depending on the scale of the mapping, it can also be used for research prioritization, wetland protection prioritization, representation of regional context, mitigation planning, water quality standards, advanced identification of special areas, and goal-setting on a watershed or subwatershed scale.

SYNOPTIC APPROACH METHODOLOGY

The synoptic approach involves five major steps, with the substeps outlined in more detail in Table 3.1:

- Define goals and criteria;
- Define synoptic indices;
- Select landscape indicators;
- Conduct the assessment; and
- Prepare synoptic reports.

The methodology assumes these steps will be carried out by a team of three. The manager is primarily responsible for defining overall goals of the assessment, the resource specialist for defining the ecological relationships relevant to the management objectives, and the technical analyst for database management and computerized mapping. More or fewer than three individuals can be involved in fulfilling these roles.

The major work product is likely to be one or more regional or statewide maps that rank units of the landscape according to a number of landscape variables, or "synoptic indices." The maps and indices allow a permit reviewer to take into account the landscape condition of an area in which a permit activity is proposed and thus the cumulative impact of the proposal. The information could also remain in the form of tabular data summaries, but would lack the visual impact and be less effective for the intended use.

The synoptic assessment procedure relies heavily upon the knowledge of the assessment team to fill in the broad outlines. The two most critical steps in the process are defining the synoptic indices and selecting the landscape indicators.

A synoptic index is defined as one of several variables that may be used to compare landscape subunits that have readily definable boundaries such as watersheds, counties, or other subunits used in governmental inventories or maps. The synoptic approach identifies the following four **generic indices** of landscape quality as useful in assessing cumulative impacts and comparing risks among landscape subunits: **function, value, functional loss, and replacement potential.** In many management and regulatory settings, it is very useful to know how a particular area compares with other nearby areas in terms of these indexes. To use the synoptic approach, the assessment team selects one or more of these generic indexes that reflect the management or regulatory goals of the team's program. Once the particular goal-based indices are chosen, the team then selects actual data or measurements available from existing sources that can estimate or represent each of the chosen indices of landscape quality for each landscape subunit. These

Table 3.1. Steps in Conducting a Synoptic Assessment

Steps	Procedures
1. Define Goals and Criteria	1.1 Define Assessment Objectives 1.2 Define Intended Use 1.3 Assess Accuracy Needs 1.4 Identify Assessment Constraints
2. Define Synoptic Indices	2.1 Identify Wetland Types 2.2 Describe Natural Setting 2.3 Define Landscape Boundary 2.4 Define Wetland Functions 2.5 Define Wetland Values 2.6 Identify Significant Impacts 2.7 Select Landscape Subunits 2.8 Define Combination Rules
3. Select Landscape Indicators	3.1 Survey Data and Existing Methods 3.2 Assess Data Adequacy 3.3 Evaluate Costs of Better Data 3.4 Compare and Select Indicators 3.5 Finalize Subunit Selection 3.7 Conduct Pre-Analysis Review
4. Conduct Assessment	4.1 Plan Quality Assurance/Quality Control 4.2 Perform Map Measurements 4.3 Analyze Data 4.4 Produce Maps 4.5 Assess Accuracy 4.6 Conduct Post-Analysis Review
5. Prepare Synoptic Reports	5.1 Prepare User's Guide 5.2 Prepare Assessment Documentation

Source: Leibowitz 1992, 16 [Ann. Bib. #110].

data are the "landscape indicators." Measurements that can serve as landscape indicators include current wetlands acreage, hydric soil acreage, watershed acreage, annual rainfall, land cover, slope, main channel length, length of polluted streams, growth rates of agriculture or population, and numbers of endangered or threatened species.

For a synoptic assessment used for a Section 404 review aimed at cumulative impacts, the synoptic index of functional loss would be appropriate. To estimate the loss in each landscape subunit, the assessor could compare two landscape indicators chosen to represent current and historic wetland areas. To estimate historic wetland extent, the indicator could be the extent of area with hydric soils, identified from Soil Conservation Service maps. Maps from the U.S. Geological Survey could be used to indicate areas of current wetland land cover. The difference between the two areas, multiplied by an estimate of the hydrologic input (estimated by peak discharge during a 50-year flood) becomes the specific index of functional loss for each subunit. The subunits can then be ranked based upon these calculations of cumulative functional loss. When a permit application is received for a proposed discharge to a wetland area in a subunit with a high relative functional loss, the assessor is alerted to the need to consider the cumulative loss factor and either deny the permit or require a higher degree of compensatory mitigation than would be required in a subunit with a lower relative loss.

To develop the synoptic indices, the assessment team essentially has to develop a conceptual, ecological model of the forces and functions driving the wetlands and identify the stressors in the particular area. Similarly, it must choose which landscape indicators to use to estimate the synoptic indices, factoring in management objectives, the required level of confidence, data availability and other constraints (ibid., 63).

In the future, as a second generation improvement, after several years of research, the developers plan to provide validated models of regional landscape function and tested landscape indicators for the prairie pothole region and southeastern bottomland hardwood forests. However, until those are ready and in the other environmental contexts, the methodology notes that:

> *[T]his handbook does not provide a specific, detailed procedure for choosing the synoptic indices, nor does it supply a scientifically-tested list of landscape indicators having known confidence limits.* This is not possible, given our current state of knowledge and the strong dependency of the synoptic indices and landscape indicators on the particulars of the assessment. Instead, *the approach relies on the assessment team to make decisions, since they are best qualified to know their particular needs and constraints* (ibid., 7, emphasis in original).

Depending on the skills and time of the assessment team, the degree of flexibility and required creativity could be either a benefit or a drawback of using this methodology. To assist with these decisions, the handbook includes appendices on typical relationships expected between a series of impacts and the associated wetland degradation, and projected effects of wetland degradation on water quality functions and habitat functions. The impacts described include resource extraction, urbanization and water management.

APPLICABILITY

The major contribution of this method is that it illustrates how to approach the issue of cumulative impacts and landscape scale issues within realistic constraints of limited time, money and information. At least for the first set of maps, it does not envision expensive field work; later generations of maps can be refined as resources allow. It makes use of already available sources of information. The handbook includes detailed guidance on potential sources of mapped and tabular data for landscape indicators of synoptic indices.

However, as the authors clearly recognize, it succeeds in operating within time, information and monetary constraints by making a tradeoff in precision. Whether this will be acceptable depends on the intended use. The authors state:

> If it could lead to litigation, for example, an assessment developed for regulatory applications might require a high confidence level. If the assessment is being conducted for broad-scale planning using best professional judgment, results might be sufficient as long as they are 'more right than wrong.' In other words, results need not be completely accurate; rather the data must be adequate for the stated purposes of the assessment (ibid., 17).

Local users intending to use the assessment as part of a regulatory review process would have to assess whether the higher confidence level required for use in this context would cancel out the possible benefits of this method. If so, they might instead opt to limit use of the inter-area comparisons produced by this methodology for applications such as anticipatory planning and allocation of review resources to areas most at risk.

A final observation about this method is that it encourages managers or permit reviewers to evaluate a proposed action in terms of where they would rather see it take place. Since the methodology is not intended to be predictive, it does not forecast the consequences of allowing a particular development on a particular site. Neither does it attempt to make representations about carrying capacity or thresholds or attempt to provide guidance on when the projected impact becomes unacceptable. For applications in a regulatory context, the information provided by this methodology may not be as useful as it would be in a planning context. The regulatory system is rarely, if ever, structured to allow regulators to chose the preferable location for an activity; they are constrained to approving or disapproving the application at the proposed site.

Similarly, the information gained from this methodology might lead a reviewer to try to concentrate further disturbances in already degraded areas while trying to protect and restore more pristine areas newly at risk. But regulatory mechanisms are generally lacking which would allow a reviewer to condition a permit on mitigation or restoration of a different site which is physically removed by a substantial distance from the site under review. Current Section 404 permit guidelines, for example, express a preference for mitigation that is on-site and in-kind.[9] The emerging concept of mitigation banking, however, could be a trend in the direction of off-site mitigation.[10] The increasing use of statewide wetland conservation plans may provide an opportunity for application of the priority-setting made possible by the synoptic approach.

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9. Department of Defense Memorandums of Agreement; Clean Water Act Section 404(b)(1) Guidelines, 55 Fed. Reg. 9210 (1990).

10. *See* U.S. EPA and Dept. of Army, Regulatory Guidance Letters on Flexibility of the 404(b)(1) Guidelines and Mitigation Banking, 58 Fed. Reg. 47719 (1993).

Example 5: Regional Ecological Risk Assessment

This discussion of ecological risk assessment as an approach to cumulative impact assessment is based on the comments[11] and writings of Carolyn Hunsaker of the Environmental Sciences Division of Oak Ridge National Laboratory. Hunsaker is an ecologist involved with regional assessments of issues such as hydroelectric development, acid rain, and land use change. For further detail, see Cada and Hunsaker 1990 [Ann. Bib. #29], Hunsaker 1993 [Ann. Bib. #101] and Hunsaker et al. 1990 [Ann. Bib. #102].[12]

RATIONALE FOR THE METHODOLOGY

Ecological risk assessment provides a framework for evaluating scientific information about the adverse effects of stressors on the environment. It is designed to produce a systematic comparison of alternatives.

When performed on a regional scale, ecological risk assessment can be a powerful tool for resource management, especially for those environmental problems affecting larger geographic areas. The framework is especially relevant to assessment of cumulative effects such as land use change and habitat destruction as these effects are best addressed at scales larger than the individual project or site-specific scale. When risk assessment is undertaken ahead of time on a programmatic or regional scale, it can provide the reference base of data, models and plans that establish the context for relatively rapid decisions on individual permit applications or planning decisions at the local scale.

Thus, cumulative impact assessment and ecological risk assessment, when applied to large geographic areas or regions, share some common goals. They can both allow decision-makers to make informed decisions and can increase the ability to manage the environment at a large scale (Hunsaker 1993, 485 [Ann. Bib. #101]). However, Hunsaker distinguishes risk assessment from cumulative impact assessment, stating:

> Risk assessment goes beyond a cumulative or programmatic assessment in that it must quantify the probability of impact and the associated uncertainty. Thus, a regional ecological risk assessment is the extreme quantification of a cumulative or programmatic assessment and represents what assessments should be striving to achieve (ibid., 485).

She suggests that ecological risk assessment is a valuable approach to assist scientists with assessing cumulative impacts. It provides a framework for organizing thoughts. It attempts to quantify and admit uncertainty. It is not, however, intended as a cumulative impact management method. Its primary contribution is as a tool to improve scientific assessment and provide policy

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11. Hunsaker, Carolyn. 1993. "Ecological Risk Assessment." Presentation at Workshop, *supra* note 1.

12. For a demonstration of the risk approach, see also Graham, R.L., C.T. Hunsaker, R.V. O'Neill, and B.L. Jackson. 1991. Regional ecological risk assessment. *Ecological Applications* 1(2):146-206.

makers with relevant information in a form that will allow them to make the necessary decision for cumulative impact management.

REGIONAL RISK ASSESSMENT METHODOLOGY

The terminology used in regional risk assessment differs from usual environmental impact assessment terminology because they evolved from different backgrounds. Generally, the geographic area of the assessment is referred to in risk assessment as the "reference environment." Instead of effects resulting from "actions" as in cumulative impact assessment, in risk assessment the effects result from exposure to a "stress" or "hazard." Similarly, while cumulative impact assessment talks about "valued environmental components," risk assessment uses the term "assessment endpoints" (Irwin and Rodes 1992, 3 [Ann. Bib. #104]). Despite these differences in terminology, the underlying concepts are frequently consistent (ibid.).

The two general phases of regional risk assessment are basically the same as for a local or site-specific risk assessment. They are:

Phase One: Hazard Definition—an iterative process of selection of endpoints, development of source terms, and description of reference environment;

Phase Two: Problem Solution—assessment of the exposure or habitat modification and assessment of the effects, and then a combination of those assessments to determine the risk or probability of a negative event happening (Hunsaker et al. 1990, 326 [Ann. Bib. #102]).

The risk assessment may be either predictive of what might happen in the future assuming a particular stress or hazard, or retrospective, assessing what happened as a result of past exposure.

In the definition phase, phase one, researchers must understand the disturbance or stressor of interest; its identification will probably be driven by a policy question. They then have to select the endpoints or indicators of what they are going to measure (or has been measured) in the environment. This involves specifying the entity of concern (or the valued environmental component to be studied) and the quality of that entity, i.e., why it is of concern. Development of source terms means developing qualitative and quantitative descriptions of the source of the disturbance or hazard and its disruptive influence on the ecosystem (e.g., locations and intensity of disruptive activities). Definition of the reference environment requires identification and description of the geographic area and temporal period within which the effects are expected.

During this definition phase researchers should consider not just the ecological processes, but also relevant social, economic and institutional factors (ibid., 325). Endpoint selection should consider social values, both monetary and nonmonetary, so that they will be relevant to the questions policymakers want answered.

Phase two, the solution stage, requires researchers to estimate spatiotemporal patterns of exposure of the endpoint to a hazard or habitat modification. It also requires researchers to assess the effects of that exposure through quantification of how the endpoints are affected by those sources within the reference environment. The goal is to determine the risk and its associated uncertainty.

This stage relies on models of ecological processes and long-term data bases of biological variables. Scientists have to make decisions about the contribution of natural variability in the ecosystem versus the influence of human stress on the environment. Researchers need to understand landscape patterns and regional ecological processes. For example, for coastal areas, these patterns or processes might include the relationship of disintegration of wetland and marsh habitat to species abundance, the relationship between amount of wetland edge and productivity of aquatic systems, the relationship between patch size and distribution of eelgrass beds and resource productivity, and the relationship between land use change and water quality.

The researchers must then present the information resulting from the analysis to policymakers in such a way as to be understandable and useful for making relevant policy decisions. When utilizing powerful GIS systems and large data bases, researchers may determine that maps showing assessment subregions are most effective. Whether text, figures, or a combination of both are used to convey the risk assessment results, a statement of the uncertainties should always be included.

While this regional risk assessment process follows the same general theoretical framework as local risk assessment, unique issues are raised when attempting to apply the framework to a regional scale. For example, at a regional scale, scientists must consider the relationship of spatial heterogeneity to ecological processes. They know that ecological systems operate at different scales and operate differently; the challenge is to determine which indicators to measure or quantify to capture those ecosystem functions or forcing factors of interest. Most of the ecological research and risk assessment has been done at a local scale, so regional researchers have to determine whether they can modify local models to make them appropriate for a regional scale or must develop new models.

Another question that arises at a regional scale is the issue of data resolution and aggregation. Research is ongoing on how to match data resolution with assessment questions, and how to determine the degree of uncertainty introduced through choice of resolution and means of aggregation.

APPLICABILITY

Hunsaker concludes that regional risk assessment is a potentially powerful tool for resource management, that most of the fundamentals are in place, but that additional research is still needed on theoretical and applied issues before its potential can be realized (ibid., 330). Among the issues that need further research are:

- uncertainties introduced by data aggregation in regional studies;

- appropriate models for regional studies and adaptability of local models to regional scales;

- refinement of better tools to reflect important ecological processes at the landscape scale, for both terrestrial and aquatic ecosystems (e.g., GIS at regional scale, remote sensing data, landscape indices) (ibid., 330).

In addition, she emphasizes that regional risk assessment (or any regional assessment) is currently "severely limited" by the "lack of adequate spatial and temporal data for large geographic areas" (ibid., 330). She suggested some federal programs which were being designed in 1993 held the promise of eventual improvements in environmental monitoring (ibid.). A national, long-term ecological monitoring program could make a substantial contribution to identifying regional trends and stressors, and help focus research efforts. Similarly, well-designed national or regional water quality data bases could make a substantial contribution to scientific understanding for regional risk assessment. Hunsaker notes that a lot of environmental monitoring is going on but its lack of consistency and documentation limits its usefulness for quantitative assessments.

Thus, while Hunsaker believes a regional ecological risk assessment approach could significantly advance the ability to assess cumulative environmental impacts, additional resources need to be put into development of appropriate national or regional data bases. In addition, while work is proceeding, many existing tools and ideas still need to be "tested and refined before regional ecological risk assessment can become an effective tool for managing and protecting natural resources" (ibid., 330). Despite the work still to be done, the EPA has developed general guidance that conforms with the basic approach outlined by Hunsaker (US EPA 1992 [Ann. Bib. #63]).

CONCLUSION

The preceding examples illustrate several ways agencies and researchers have approached cumulative impact assessment and management. They vary, depending upon the agency mandate, structure, resources and goals. For example, the EPA Synoptic Approach appears to be most useful to help with **setting priorities** among areas for use of scarce resources; it can identify the areas most at risk and allow resource managers to focus their time and engage in heightened reviews in those areas. The USFWS approach, while using a cause/effect analysis, is unique in its **political/management process** emphasis, designed to marshal the combined resources of overlapping agencies to focus a joint effort on one resource at a politically-opportune time. Others have strong **ecological function assessment** components (e.g., Alaska, landscape conservation, environmental risk assessment); some take that a step farther to incorporate detailed **management plans** (e.g., Alaska and landscape conservation). Some research methods strive to **quantify the assessment** to identify risks and uncertainties associated with particular impacts to better facilitate management activity.

Despite these differences, the landscape conservation approach, EPA's synoptic approach, and ecological risk assessment are grounded in the same basic ecological concepts. They were developed at about the same time based on the same literature. While there are differences in emphasis and terminology, the basic approach is similar in each. All of these methods lend insight into the current thinking about the best way to identify and manage cumulative environmental impacts. But at the same time, they raise questions about the application of methods developed primarily in a terrestrial context to a coastal or marine context.

Instead of trying to trace individual disturbances through multiple layers of effects, most of these examples use a technique to extrapolate from plot and watershed-level investigations to examine the impact over broader regions. They use principles of landscape ecology to bridge the complexity and allow impact assessments on a scale at which cumulative effects are likely to be felt. However, much of the work on landscape scale assessment has taken place in freshwater wetlands. Coastal or marine ecological processes may not involve the same organizing principles and may not lend themselves to mapping with the same ease of terrestrial features. For example, the issues of patch size, ability to move between different patches, and amount of edge and interior may not be as relevant in a coastal/marine context. But at the same time, many of the impacts on coastal marine systems are caused by activities on the land such as land use change, nonpoint source pollution, and increased recreational use of waterfront land. It may be appropriate to use landscape ecology approaches to assess terrestrial effects on marine aquatic resources in these circumstances.[13] Additional research is required to identify appropriate organizing principles to facilitate assessments of different types of environmental impacts at a regional scale for estuarine and near-shore ecosystems.

Different institutional contexts may also pose a unique problem in transferring terrestrial cumulative impact assessment and management methods to a coastal or marine context. While less an issue for land-based actions affecting coastal ecosystems, cumulative impact assessment in marine and estuarine waters will likely encounter substantial institutional differences. Land-based resource use issues are generally within the jurisdiction of established general purpose governments (state and municipal) with extensive experience using land use regulations to make and enforce resource use decisions. In contrast, in marine or estuarine waters, there is usually a lack of any such general purpose entity with clear jurisdiction to resolve resource allocation issues. These waters are typically regulated by multiple local, state and federal agencies, each with a narrow mandate to enforce one or more single-purpose laws. Generally, no single agency will have been designated to develop a comprehensive state policy for the use of coastal resources, to develop long-range goals for future preservation or development of those resources, or to coordinate different agencies with marine responsibilities.

A third, related problem involves the need to use expanded temporal scales in cumulative impact reviews. One of the fundamental shifts required in cumulative impact assessment is to evaluate proposed actions or changes within a much broader temporal context, going both back and

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13. See, e.g., Hunsaker, C.T. and D.A. Levine. 1995. Hierarchical Approaches to the Study of Water Quality in Rivers. *BioScience* 45(3):193-203 for an example of using landscape ecology approaches to assess terrestrial effects on aquatic resources.

forward in time. This requires data bases which, ideally, extend back to pre-settlement conditions. It also requires prior comprehensive planning to determine societal goals for the future use of the area and resources. While this kind of historical data and comprehensive planning and goal-setting may be available for the land-side component of coastal ecosystems, the same level of detail will frequently be lacking for the water-side component. The heightened state interest in coastal and ocean management over the last several years and increased attention to planning for competing uses of public trust waters may begin to rectify this situation. But the necessary historical data base and long-range planning and goals-setting for water-based uses may lag behind the terrestrial uses, making cumulative impact assessment and management more difficult for these resources.

A final issue raised by these examples concerns the transferability of management and implementation techniques from one context to another. Many cumulative impact theorists have identified the need to expand beyond assessment to management, and to gear implementation to a positive, restoration goal, not just to prevent further degradation of the resource. The most progressive resource managers are exploring ways to get beyond regulatory techniques to utilize market forces. In some cases, resource managers have been able to entice private individuals to join in the larger restoration effort by appealing to their economic self-interest, as was done by the Gosselink team in the context of bottomland forested wetlands in Louisiana. Another cumulative impacts researcher has explored ways to utilize economic self-interest to control cumulative impacts by recapturing substances that would otherwise run off agricultural lands.[14]

Harnessing those economic incentives may be an important implementation technique, where is it possible. However, it is also important to recognize that the economic forces may not always allow for this approach. The restoration strategy in Louisiana is working in large part because the land needed for restoration has low value because is not currently profitable for agricultural purposes. In contrast, the demand for the limited supply of shorefront land and for vacant parcels of land in heavily populated coastal areas means that real estate is some of the most expensive in the nation. Those economic realities may preclude land acquisition, conservation easements or market-based restoration strategies. Indeed, given the high value of those lands and the accompanying financial incentive to litigate any development restriction, resource managers would want to support regulatory restrictions with cumulative impact assessments conducted using methods and techniques that would produce a high level of confidence.

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14. Contant, Cheryl. 1993. Respondent comments at Workshop, *supra* note 1.

Chapter 4:
Programs for Management of Cumulative Environmental Impacts in Coastal Regions

MANAGEMENT OF CUMULATIVE IMPACTS

The previous chapter focused on a variety of approaches designed to generate information about processes that contribute to incremental environmental change. Most of those assessment methodologies also address ways the information could be used in management efforts. The emphasis of this chapter shifts slightly from assessment to management, and the focus narrows to coastal resources. It uses "management" in its broadest sense, to denote a full range of governmental responses including regulation, planning, acquisition, public investment and other types of management.

This chapter identifies the opportunities to incorporate information generated by cumulative impact assessments into management decisions about activities that affect coastal resources. It presents an overview of the extent to which selected federal and state management programs allow, or require, decisions to be made based on analyses of adverse cumulative impacts, and identifies some emerging state and federal initiatives that promise to strengthen cumulative impact management efforts. Additional information about these and other federal and state programs that consider cumulative impacts can be found in Sections Four and Five of the Annotated Bibliography.

Recognizing, as most resource managers do, the discrepancy between policy as written and as implemented, we have attempted to gain insight into policy as implemented through our 1993 workshop, our survey questionnaire,[1] and available critiques of particular programs. Participants at the workshop spoke frankly about discrepancies between theory, statutory mandates, and the actual practice in the field as they worked to identify approaches and techniques to bridge those gaps. Similarly, the questionnaire asked respondents associated with state and federal regulatory programs about tensions in their agency's cumulative impacts review. Respondents were asked about the review required by statute, rules or other policies; how their agency complies with the review requirements; and how "successful" their office is in taking cumulative impacts into consideration in commenting or permitting decisions. The last question elicited many thoughtful responses about institutional, political and practical impediments to documenting and acting effectively to address incremental impacts.

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1. See p. 8 for a more detailed description of the questionnaire and workshop, and see Appendix B of this report for a list of workshop participants.

However, it was beyond the scope of this study to engage in detailed evaluations of the effectiveness of specific federal, state and local programs. Readers are cautioned, particularly in the discussion of state and local programs, that there may be a significant gulf between the intent of a statute and its actual implementation. But we believe it is still useful to include examples of innovative or particularly instructive statutory mandates, even if there may be some shortfalls in actual implementation.

TREATMENT OF CUMULATIVE IMPACTS IN FEDERAL PROGRAMS

Federal involvement in coastal resource management takes diverse forms, including regulatory and permitting programs, NEPA environmental impact analyses, and planning initiatives. Perhaps the most significant in the coastal area is the Section 404 Program, which concerns discharges of dredge and fill materials. Focusing initially on the 404 Program, the federal portion of the chapter then looks at the cumulative impact provisions of NEPA, and lastly, relevant federal planning efforts. Special attention is given to the National Estuary Program, a promising model for ecosystem management of cumulative impacts. (For a detailed, agency-specific inventory of federal activities associated with cumulative impact assessment, see Cohrssen 1989 [Ann. Bib. #147]. See also Appendix A, Annotated Bibliography for additional information.)

Section 404 Program

The federal regulatory program to protect U.S. waters established by Section 10 of the Rivers and Harbors Act of 1899 and Section 404 of the Clean Water Act is the most important permit program applicable to coastal areas. The "404 program" as it is known is administered by the U.S. Army Corps of Engineers (Corps) and the Environmental Protection Agency (EPA); the U.S. Fish and Wildlife Service (FWS) and National Marine Fisheries Service (NMFS) have important advisory roles.

An individual permit issued by the Corps under Section 10 or Section 404, depending on the nature of the activity, is generally required for structures or work in or affecting navigable waters of the United States or discharge of dredged or fill material into any waters of the United States, including wetlands. However, many activities that are deemed to be similar in nature and are expected to cause minimal adverse environmental effects, either individually or cumulatively, are allowed under general permits; the Corps is authorized to issue general permits on a State, regional or nationwide basis. Overuse of general permits is a potential weakness of the 404 program as a tool for addressing cumulative impacts issues.

The Corps evaluates Section 404 permit applications to determine whether they comply with Section 404(b)(1) Guidelines[2] and are in the public interest. As part of this "public interest review," the Corps prepares an environmental assessment (EA) under the National Environ-

2. Section 404(b)(1) Guidelines for Specification of Disposal Sites for Dredged or Fill Material, 40 C.F.R. § 230 (1993).

mental Policy Act[3] (NEPA) to determine if the project has significant environmental impacts (discussed below). Generally speaking, if the EA concludes that the activity would "significantly affect the human environment," the Corps is obligated to prepare an environmental impact statement (EIS). The Corps may not issue permits for activities that would violate other applicable laws such as the Endangered Species Act. The state in which the activity is proposed may certify whether the activity complies with state water quality standards and "concur that it meets enforceable standards" of the coastal zone management program, or waive its right to certify or concur. These state authorities are created under Section 401 of the Clean Water Act and Section 307 of the Coastal Zone Management Act. Although used infrequently, EPA retains Section 404(c) authority to "veto" permits issued by the Corps if it believes the activity would have unacceptable adverse effects.

The 404 Guidelines, the regulations that provide the program's most significant resource protection elements, state as a fundamental precept that:

> dredged or fill material should not be discharged into the aquatic ecosystem, unless it can be demonstrated that such a discharge will not have an unacceptable adverse impact either individually or in combination with known and/or probable impacts of other activities affecting the ecosystem of concern.[4]

The Corps may not permit a discharge which would "cause or contribute to significant degradation of the waters of the United States."[5] The Corps must base findings of compliance or non-compliance with the Guidelines on a variety of factors including:

> *(g) Determination of cumulative effects on the aquatic ecosystem.*
>
> > (1) Cumulative impacts are the changes in an aquatic ecosystem that are attributable to the collective effect of a number of individual discharges of dredged or fill material. Although the impact of a particular discharge may constitute a minor change in itself, the cumulative effect of numerous such piecemeal changes can result in a major impairment of the water resources and interfere with the productivity and water quality of existing aquatic ecosystems.
> >
> > (2) Cumulative effects attributable to the discharge of dredged or fill material in waters of the United States should be predicted to the extent reasonable and practical. The permitting authority shall collect information and solicit information from other sources about the cumulative impacts on the aquatic ecosystem. This information shall be documented and considered during the decision-making process concerning the evaluation of individual permit

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3. 42 U.S.C. § 4321 (1994).

4. 40 C.F.R. § 230.1(c) (1993).

5. 40 C.F.R. § 230.10(c) (1993) (except as provided under § 404(b)(2) of the Clean Water Act).

applications, the issuance of a General permit, and monitoring and enforcement of existing permits.[6]

Thus, the Guidelines expressly identify cumulative effects as a determinative factor in the decision-making process. However, they offer no guidance on methodology or the weight they should be given.

Army Corps of Engineers' Regulatory Guidance Letters (RGL) supplement the 404(b)(1) Guidelines by clarifying regulatory policy for division and district engineers. One RGL states the Corps will:

- fully consider comments regarding the site from a watershed or landscape scale, including an evaluation of potential cumulative and secondary impacts;

- consider cumulative impacts in permit decisions; and

- fully consider comments from Federal resource agencies on cumulative impacts.

Corps [Ann. Bib. #167].

The RGL on Special Area Management Plans endorses collaborative interagency planning within a geographic area of special sensitivity as a means of reducing problems associated with traditional case-by-case review. A stated purpose of the RGL is to ensure that "cumulative impacts are analyzed in the context of broad ecosystem needs" (Corps 86-10 [Ann. Bib. #168]). However, noting that the development of special area plans is very labor-intensive, the Corps requires a district engineer to anticipate concrete permit policies will result before participating in the preparation of a special area plan.

The 404 Program has a number of critics, including federal agencies, that question the Corps' track record in translating policy objectives regarding cumulative impacts into meaningful action. A 1984 Office of Technology Assessment review of federal regulation of wetlands found that the Corps had overlooked cumulative impacts in many districts (Office of Technology Assessment 1984 [Ann. Bib. #176]). Difficulties in predicting cumulative impacts and the lack of guidelines for denying permits on the basis of the proposed activity's cumulative impacts were seen as the reasons for this deficiency.

In 1988, the U.S. General Accounting Office (GAO) also reviewed the Corps administration of the Section 404 Program.[7] It found:

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6. 40 C.F.R. § 230.11(g) (1993).

7. U.S. General Accounting Office. 1988. *Wetlands: The Corps of Engineers' Administration of the Section 404 Program*. GAO/RCED-88-110.

> The Corps and resource agency officials we spoke to generally agreed that cumulative impacts have not been adequately addressed because they are not sure how to establish the criteria to be considered. Instead, they said, it is easier to consider each project individually.[8]

The resource agencies, such as USFWS and NMFS, believed the Corps should do more to consider cumulative impacts; the Corps believed that it was constrained by the program's jurisdiction. GAO recommended that the Corps work with the resource agencies to develop consistent definitions and procedures for assessing cumulative impacts.[9]

A follow-up study by GAO in 1993, however, found the Corps had failed to follow that recommendation.[10] Both Corps and resource agency officials agreed that consideration of cumulative impacts was one of the "most troublesome requirements for Corps districts to adhere to."[11] GAO studied 50 randomly selected individual permit applications from each of three district offices and an additional 90 denials. The GAO found the Corps almost without exception considered impacts on a case-by-case basis. The Corps only sporadically addressed cumulative impacts in two of the districts. In the third district studied, where a more concerted effort to address cumulative effects was evident, none of the permit denials reviewed appeared to have been based on adverse cumulative impacts.[12] After noting that the Corps and EPA were independently studying means to address cumulative impacts, the GAO reiterated its earlier recommendation—the Corps and EPA should work together to identify the means for considering the cumulative impacts in 404 permit decisions.

Our own investigation confirmed the findings of the OTA and the GAO. We relied on a survey questionnaire[13] and a May 1993 workshop, which is described in more detail in Chapter 3. Corps regulatory personnel noted that the scope of review of permit applications varies widely depending upon the scope of the project.[14] In the Corps' tiered system of permits (i.e., general,

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8. *Id.* at 28.

9. *Id.* at 34.

10. U.S. General Accounting Office. 1993. *Wetlands Protection: The Scope of the Section 404 Program Remains Uncertain*. GAO/RCED-93-26.

11. *Id.* at 22.

12. *Id.* at 23.

13. The questionnaire was sent to approximately 200 individuals and agencies involved in federal and state resource management, coastal planning, and scientific research on issues related to cumulative impacts in November, 1992. This was not intended to be a scientific sample; comments represent individual opinions, not necessarily the opinion of the agency.

14. Desista, Robert. 1993. "Panel Discussion: Current Practice of Considering Cumulative Effects in Planning and Regulation." Presentation at Methodologies and Mechanisms for Management of

individual and full NEPA Environmental Impact Statement reviews), the Corps reviews individual permits much more closely than general permits. Detailed cumulative impact reviews occur only in the small number of cases requiring environmental impact statements. Respondents, however, generally agreed that their tight time schedule for processing applications and limited resources do not allow more than a "cursory review" of potential future impacts for most applications.

For example, one Corps official noted that in his district, the Corps does not have a GIS system to track approved permits, and thus no ready way to get information about permits previously issued in the area surrounding the pending application. In place of this data, the district office uses a pragmatic, case-by-case approach which is qualitative rather than a quantitative and relies on the best professional judgment of staff.

Corps personnel also reported an unwillingness to rely on adverse cumulative impacts as the chief cause for permit denial. One response, submitted jointly by regulatory personnel in one district, stated:

> We address cumulative impacts; however, they seldom drive our permit decision. Project specific impacts/needs usually take precedence. Mandates are vague and do not explain how to evaluate cumulative impacts or how much emphasis should be placed on them. Our requirement to evaluate projects on a case-by-case basis and on their own merits make it difficult to factor cumulative impacts into [a] decision.

Responses from other Corps officials noted the need for advanced planning to provide the context needed for regulatory decisions based on cumulative impacts. One regulatory branch chief indicated that his office had not been very successful in taking cumulative impacts into consideration unless prior studies on cumulative impacts had been performed in the watershed. Another suggested:

> Until there is sufficient parity between comprehensive planning programs and the permit evaluation process, the [cumulative impact analysis] must contend with the difficulty of balancing social needs and environmental constraints often with an incomplete information base and with the time and funding constraints of a regulatory program.

Survey responses from staff members of federal resource agencies that review and comment on Corps permit actions generally concluded that the inherent limitations of the permit review system, the absence of a single methodology, and lack of staff and data base resources make it extremely difficult to consider cumulative effects in 404 permits. For example, one respondent from NMFS reported that, although his office wished to give cumulative impacts heightened consideration, the lack of a recognized assessment methodology and the failure of regulatory agencies to do follow-up work to determine the effects of past permitting, particularly for

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Cumulative Coastal Environmental Impacts Workshop, Marine Law Institute/NOAA National Marine Fisheries Service, Northeast Region/University of Rhode Island School of Oceanography, Narragansett, Rhode Island, May 6, 1993 [hereinafter Workshop].

nationwide and general permits, presented formidable barriers. Another NMFS respondent shared that concern, stating that little or no information on past or future projects in the water basin is provided by the Corps, and his agency does not have the staff to evaluate the results of Corps permitting actions. Another NMFS respondent characterized his office's lack of success in dealing with cumulative impacts this way: "[n]o one seems to be counting. We are successful at '*considering*' it, but not at providing the 'evidence.'"

On the other hand, other resource agency staff members were less convinced that legal and policy constraints have hamstrung the Corps' consideration of cumulative effects in the 404 permitting process. Many suggested that there are ways to overcome the institutional obstacles, but that the Corps was not willing to accord incremental impacts proper consideration. The following representative response voices this frustration: "[w]e feel we are adequately addressing cumulative impacts; rather it is the regulatory branch (i.e., Corps) that doesn't give them consideration." A USFWS field supervisor concurred, stating that the Corps seldom recognizes cumulative effects as "1) valid impacts or 2) a 'legitimate' impact."

One EPA respondent stated that the only way she could imagine the Corps basing a permit denial on minor incremental impacts would be if the impacts could be evaluated within a watershed or priority wetland context utilizing advanced identification and assessment of cumulative impacts. She noted that EPA has done precisely this type of detailed landscape-scale cumulative impact assessments in limited areas, such as the Tensas River (as described in Chapter 3) but that the Corps still does not use these reports when evaluating permit applications.

In summary, we conclude that the primary weaknesses of the 404 program as a tool for managing cumulative effects are not to be found in the letter of the law, but in the Corps' implementation. Faced with a large number of permit decision, limited staff and limited natural resource information relevant at a watershed or other ecosystem level, and acting in an often politically charged context, the Corps field staff often feels compelled to sacrifice long-term incremental degradation for short-term administrative efficiency. However, this outcome is not inevitable. Instances where the Corps has successfully engaged in aggressive use of cumulative impacts review standards are discussed in Chapter 5.

National Environmental Policy Act (NEPA)

NEPA reviews are the second most frequent federal context in which cumulative impacts issues may arise. However, most of the actions which in aggregate cause cumulative effects are themselves minor and lack any federal involvement so that they never require evaluation under NEPA. Activities that are subject to NEPA regulations include: U.S. Forest Service management plans for National Forests; NOAA regulatory and management programs implementing the Endangered Species Act, the Coastal Zone Management Act, and the Marine Protection, Research and Sanctuaries Act; U.S. Army Corps of Engineers Civil Works and Regulatory Programs; Federal Energy Regulatory Commission licensing of power projects; and the Bureau of Land Management mining permits. In general any project determined to have potential for "significant impact on the human environment" and requiring a federal action, such as a license or permit, is subject to NEPA.

The National Environmental Policy Act of 1969[15] established a national charter, goals and means for securing environmental protection. The primary method of implementation was procedural: every "major federal action significantly affecting the quality of the human environment" required a statement (EIS) assessing the environmental impact of the proposed action. All federal agencies were directed to review their then-existing authority, regulations and policies and to amend them as necessary to bring them into full compliance with NEPA. The Act also established the Council on Environmental Quality (CEQ) and directed it to develop regulations to implement the Act. Many federal agencies have also adopted their own procedures for implementing NEPA which incorporate the CEQ regulations and outline the agency's NEPA process in more detail. (See Cohrssen 1989 [Ann. Bib. #147]).

It is important to note that NEPA imposes only a procedural requirement, designed to ensure that an agency has carefully considered environmental concerns as part of the decision-making process and that important information about projected impacts has been made available to the public before an action is taken.[16] NEPA imposes no requirement that the agency act in a manner that gives full consideration to the identified environmental impacts. NEPA does not preclude an agency from deciding that other values outweigh environmental costs.

NEPA itself does not mention "cumulative impacts" or "cumulative effects." However, those terms are defined and used in the CEQ regulations implementing the procedural provisions of NEPA.[17] The CEQ's use of the concept spawned much of the early research on cumulative impacts and served as a model for subsequent state "mini-NEPA" laws. As a result, the CEQ regulations not only provide the framework for much of the early thinking about cumulative effects, but also define the process of analysis for those projects which are subject to NEPA.

CEQ regulations define "cumulative impact" and "effects" as follows:

> 'Cumulative impact' is the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time. [18]
>
> 'Effects' include:

15. 42 U.S.C.S. § 4321 (1994).

16. Robertson v. Methow Valley Citizens Council, 490 U.S. 332, 349 (1989).

17. 40 C.F.R. pts. 1500-1508, Nov. 29, 1978, *as amended* (1994).

18. 40 C.F.R. § 1508.7 (1993). These general regulations, promulgated by the Council on Environmental Quality (CEQ), are binding on federal agencies. Most federal agencies also have their own regulations which further define their procedures for implementing specific environmental legislation.

(a) Direct effects, which are caused by the action and occur at the same time and place.

(b) Indirect effects, which are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable. Indirect effects may include growth inducing effects and other effects related to induced changes in the pattern of land use, population density or growth rate, and related effects on air and water and other natural systems, including ecosystems. . . .[19]

NEPA requires the preparation of a detailed written statement, called an environmental impact statement (EIS) only for "major Federal actions significantly affecting the quality of the human environment."[20] How "significant impact" is construed determines the level of scrutiny given to a proposed action. NEPA allows different levels of review, depending on the likely significance of the effect on the human environment.

Categories of actions involving relatively small disturbances may be prejudged by a Federal agency to "not individually or cumulatively have a significant effect on the human environment"; they are given a categorical exclusion, which means that no further assessment of environmental impacts is required (except under extraordinary circumstances). Obviously, if these categories are drawn too broadly, many activities with the potential for cumulatively significant impacts would evade all review under NEPA.

The second level of review requires an environmental assessment (EA), a relatively brief study to determine whether the proposed action will have no "significant" effect on the human environment. If the agency makes a finding of no significant impact ("FONSI"), the action can proceed without preparation of an EIS. There is no clear statutory or regulatory guidance on how to determine significance. However, since the definition of "significantly" requires consideration of context (e.g., society, region, interests, locality) and intensity/severity of the impact (e.g., public safety, unique characteristics, risks, precedent setting, cumulative impacts, etc.), cumulative impacts should be considered in this determination of significance.

An action is defined to be significant if "it is reasonable to anticipate a cumulatively significant impact on the environment."[21] If deemed "significant," a detailed, written EIS is required. Actions can include adoption of official policy, plans, or programs, and approval of specific projects (including actions approved by permit or regulatory decision, federal activities and federally assisted activities).[22]

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19. 40 C.F.R. § 1508.8 (1993).

20. 42 U.S.C. § 4332(2)(c) (1994).

21. 40 C.F.R. § 1508.27(7).

22. *Id.* § 1508.18(b).

NEPA has several notable weaknesses as a tool for managing cumulative impacts. Cumulative impacts are only "considered" in an EIS. EISs are costly, rare and time consuming. Because EISs by definition are prepared only to assess "major" actions, cumulative impacts frequently become one among many factors in a complex, contentious and politically driven debate. Finally, due to the procedural nature of NEPA, the CEQ rules emphasize assessment rather than management of cumulative impacts.

As the meaning of many of the operative terms in NEPA and the CEQ regulations have been further defined through extensive litigation, additional analysis of the cumulative impact management potential of NEPA follows discussion of relevant NEPA cases in Chapter Five.

Watershed Protection Approach/National Estuary Program

A variety of federal programs attempt to address cumulative impacts from a planning and management rather than regulatory approach. For example, EPA uses the term "watershed protection approach" for a group of recent, decentralized water protection initiatives, characterized by an integrated, holistic, and locally-tailored approach. EPA is promoting this approach as the new model for protecting and restoring water quality.

The watershed approach embraces the idea that "pollution and habitat degradation problems now facing society can best be solved by following a basin-wide approach that takes into account the dynamic relationships that sustain natural resources and their beneficial uses" (Environmental Protection Agency 1991, 1 [Ann. Bib. #9]). Ecological, physiographic, or hydrologic units such as embayments or aquifers define boundaries of these planning efforts. Comparative risk concepts are used to target resources to high-risk problems. All of these initiatives involve stakeholder participation, risk-based geographic targeting of health or ecological problems in a watershed, and integrated solutions through coordinated actions by federal, state, and local governments and others (ibid., 2). According to EPA, examples of projects utilizing this approach include: the National Estuary Program, interstate watershed protection commissions, federally-initiated watershed protection projects, state-initiated projects such as North Carolina's Whole-Basin Protection Process, and projects under the Near Coastal Waters Program. (One of these, the National Estuary Program, is discussed in greater detail below.)

EPA's watershed protection approach is just one example of the ways federal agencies have supported efforts to manage cumulative impacts by moving toward resource-based management in biologically-defined regions. As part of the 1990 reauthorization of the Clean Water Act, Congress called for creation of state coastal non-point pollution control program for coastal watersheds. To further this initiative, NOAA has developed a working definition of coastal watershed boundaries.[23]

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23. Scavia, Donald. 1993. *Testimony before the Subcomm. on Technology, Environment, and Aviation, Committee on Space, Science and Technology, U.S. House of Representatives, Research Amendments of 1993* (Sept. 23, 1993).

Federal efforts related to watershed protection also include programs aimed at improving the data base for resource management. For example, NOAA's Strategic Environmental Assessments (SEA) Division of the Office of Ocean Resources Conservation and Assessment (ORCA) conducts a strategic assessment program. SEA collects and synthesizes data about human activities and environmental conditions, sources and discharges of pollution, physical and hydrologic features of coastal and ocean waters, and spatial and temporal distribution of ecologically important estuarine and marine resources. Notable efforts include a marine sanctuary management plan for the Florida Keys and an east coast biogeographic characterization designed to assess connections between estuarine and coastal ecosystems and to examine development impacts on species and habitats.[24]

EPA's Environmental Monitoring and Assessment Program (EMAP), initiated in 1990, is a related program to identify and assess trends in the environmental conditions at regional and national scales. Its intent is to monitor indicators of ecological condition in aquatic and terrestrial ecosystems, and air quality and deposition. EMAP was specifically designed to address "cumulative and persistent environmental concerns occurring at regional, national, and global scales . . . [and] represents a long-term commitment to periodically assess and document the condition of the nation's ecological resources."[25] If EMAP evolves as planned, EPA will eventually develop the capacity to use bioindicators to evaluate habitat functioning, greatly enhancing the practicability of cumulative impact assessment.

The remainder of this section takes a more detailed look at the National Estuary Program, as an illustration of the watershed protection approach. The 1987 amendments to the CWA formally established the National Estuary Program (NEP).[26] It evolved from earlier EPA initiatives, including collaborative efforts in the Great Lakes and Chesapeake Bay to protect and restore those waters. The Governor of any state may nominate an estuary as an estuary of national significance and request that a "management conference" (i.e., a collaborative management body) be convened to develop a comprehensive management plan. If so designated, EPA provides significant funding and technical assistance for the conference and management plans. The goal of the management conference process is to develop a cooperative pollution abatement and management system.

As of the end of 1994, EPA had accepted twenty-one estuaries into the National Estuary Program. Comprehensive conservation and management plans (CCMPs) had been completed for six estuaries. While not specifically articulated in the CWA, the NEP approach implies

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24. Strategic Environmental Assessments Division. *Program Plan, Fiscal Year 1992.* Office of Ocean Resources Conservation and Assessment, National Oceanic and Atmospheric Administration, Rockville, Maryland.

25. Saul, G.E. and K.W. Thornton, *Environmental Monitoring and Assessment: A National Priority, in* Stephen G. Hildebrand and Johnnie B. Cannon, eds. *Environmental Analysis: The NEPA Experience.* Boca Raton, FL: CRC Press, at 506.

26. 33 U.S.C. § 1330 (1994).

consideration of cumulative impacts.

Establishment of a formal ecosystem-based mechanism that transcends political boundaries is one of the most powerful aspects of the program. Under the NEP model, officials from federal, state and local agencies in partnership with technical experts, citizens and interest groups develop and implement a management plan for an entire watershed.

The exact process is different for each estuary, but the general methodology has three steps:

- formation of partnerships among people with an active interest in the watershed (the stakeholders);
- joint identification of the problems or primary threats to human and ecosystem health; and
- implementation of problem-solving actions in an integrated fashion (Coastal America 1994, 16 [Ann. Bib. #5]).

The intent is to "move beyond improving chemical water quality to include measures of ecological health (i.e., physical quality, habitat quality, and biological quality)" (ibid.). Almost by definition, to do this, resource managers have to identify, assess and monitor issues related to the impacts of continued, small incremental changes.

However, the program is not without detractors. In 1988, one its sharpest critics, law professor Oliver Houck, wrote:

> How a program such as this, which has proved unworkable even for discrete river systems and identifiable watersheds, will now, under a new label, clean up the myriad of nonpoint industrial and municipal discharges that interact to degrade large and small estuaries, is left unexplained by the amendments and their legislative history. Congress has authorized a coastal version of all that has not succeeded before (Houck 1988, 32 [Ann. Bib. #12]).

In addition, one respondent to our survey questionnaire, the director of an Estuary Project, observed that the database is so limited that detailed consideration of cumulative effects is lacking, despite the best intentions. That estuary project was engaged in ongoing efforts to improve the GIS database and refine it to develop tools to do cumulative impact assessment.

For further examples of cumulative impact assessment and management approaches developed through the National Estuary Program, the reader may want to review (1) the San Francisco Estuary Project study of the effects of changes and intensification of land uses on the San Francisco Bay estuary (McCreary et al. 1992 [Ann. Bib. #112]); (2) the Buzzards Bay National Estuary Project study of nitrogen inputs to Buttermilk Bay, a shallow coastal embayment within Buzzards Bay, and resulting management strategies to keep nitrogen levels below critical levels (Horsely Witten Hegemann, Inc. 1991 [Ann. Bib. #369]); and (3) the Indian River Lagoon, Tampa Bay, and Chesapeake Bay Programs' use of seagrasses as a primary indicator of water quality and health.[27]

In theory, the National Estuary Program and similar programs move closer to solving the perennial cumulative impact assessment problem—the mismatch of the scale at which decisions are made and the scale at which impacts are felt. The strength of these programs lies in their focus on ecological regions rather than political units.

This approach can also make a major contribution if it facilitates an inclusive public process for setting resource goals and reaching consensus on a comprehensive management plan. The plan can establish a context within which decisions can be made about whether cumulative impacts of individual projects are permissible. However, the benefits will be limited unless plans and goals are specific enough to give guidance to permit reviewers.

Coastal Zone Management Program

A final federal approach to cumulative impacts assessment and management makes funds available to states for planning, research and implementation. The best example of this approach is the federal Coastal Zone Management Act of 1972 (CZMA).[28] The stated purpose of the CZMA is to encourage and assist the states in preparing and implementing management programs to "preserve, protect, develop and where possible, to restore or enhance the resources of the nation's coastal zone."[29] In 1990, Congress amended the CZMA to create a Coastal Zone Management Act created a Coastal Zone Enhancement Program, administered by NOAA's Office of Ocean and Coastal Resource Management, to encourage states to strengthen their coastal zone management programs in eight specified priority areas. Control of cumulative and secondary impacts of development is one of these priority areas.

Nine coastal states received FY 1992 Coastal Resource Enhancement Program funding for "projects of special merit" to address cumulative and secondary impacts. Most of these state recipients planned to create or define a process to address these impacts.[30] States which received 309 Enhancement Grants to develop of a methodology for improved assessment and management of cumulative impacts include Alaska, California, Maine and North Carolina. Alaska's methodology is discussed in Chapter Three; some of the planning and management programs developed by other coastal states are discussed in more detail below.

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27. Seagrasses—a Primary Indicator of Water Quality. 4 *Coastlines* 4:1 (Fall 1994).

28. 16 U.S.C.A. § 1451 *et seq.* (1993).

29. *Id.* § 1452.

30. U.S. Department of Commerce. 1992. *Targeting National Coastal Priorities: Coastal Resource Enhancement Program, 1992.* Technical Assistance Bulletin #105 (July 1992).

TREATMENT OF CUMULATIVE IMPACTS IN STATE PROGRAMS

Our survey questionnaire revealed that states have had widely varying experiences addressing cumulative impacts issues. The staff members in some states were particularly high on their own programs. A Connecticut planner felt her state was effectively managing cumulative impacts through the requirement that all regulatory programs be consistent with the Connecticut Coastal Management Act. The Act contains specific policies, standards and adverse impact criteria used to evaluate direct, cumulative and secondary affects on sensitive coastal resources.

A resource manager from Louisiana reported that his office was doing a good job of accounting for cumulative impacts by using 37 years of vegetation and habitat data including an extensive computerized database, high altitude aerial photos at three-year intervals, and chronological vegetation maps, along with computerized records of permit applications.

Similarly, a Maryland resource manager reported that through reviews of ACOE permits and other federal actions for consistency with the state's Coastal Zone Management Plan, the state had been "very successful in modifying project proposals based on cumulative impact considerations." Use of a federal consistency authority supplements other resource protection initiatives, such as the Chesapeake Bay Targeted Watershed Program and the Critical Area Act.

By contrast, other officials surveyed had more reservations about their states' success in addressing cumulative impacts. As one state habitat restoration official stated:

> Our ability to evaluate and address cumulative impacts is restricted by (1) the lack of political will outside [his agency] in state government to deal with it, (2) the lack of adequate staff to address anything but the more direct effects, (3) the lack of information on what the effects are and how to deal with them; and (4) the lack of an easy/cost effective methodology.

He noted that requirements in the state coastal management plan to "consider" cumulative impacts are not specific enough to be effective. Despite the commitment of qualified staff to ensure consideration of cumulative impacts in state and federally permitted actions, he concluded that lack of support or understanding by the policy-makers have largely thwarted efforts to turn consideration into action.

Another state respondent observed that assessing the damage of habitat disruption is a complex undertaking: the damage is incremental and not identifiable without extensive baseline and post-project data. A substantial lag time before impacts are measurable, damages frequently not "amenable to market place valuation," and difficulties in identification of cause/effect relationships are additional complicating factors he cited. He asserted that cumulative impact management efforts must now place heavy reliance on scientific judgment of the "most likely" result of management actions, and general understanding of habitat dependencies and tolerances. "In such cases, the only other alternative is to stand mute and observe a steady erosion of fish and wildlife values—uncorrected and uncompensated for—[so] a judgment decision is necessary."

He implied, however, that regulators and policy-makers were frequently not willing to base their actions on "best professional judgment."

A third respondent, an academic who had studied the effectiveness of one state in meeting a particular cumulative impact objective, highlighted the discrepancy between official policy and actual practice. Despite the existence of a state policy objective to minimize the cumulative impacts of shoreline protection structures, he found that no methods for identifying or evaluating cumulative impacts were in place, that specific cumulative impact concerns had not been articulated, and that cumulative impact assessment was a relatively low priority. He concluded that "[c]umulative impacts rarely if ever play a significant role in decision-making on individual [shoreline protection structures], and virtually no role in the long-range planning for oceanfront development." Another state respondent raised a related concern. He observed that "[i]t is a minor mistake to believe that nothing is being done about a problem because there is no official procedure for it. It is a major mistake to think you are doing something about a problem merely by creating an official procedure."

Thus, state resource managers identified basically the same obstacles as their federal counterparts: lack of political will, lack of resources, lack of scientific information, lack of sufficiently detailed legal guidance, complexity of cause and effect issues, absence of a practical and cost effective methodology, and over reliance on a vague direction to "consider" cumulative impacts in lieu of effective management of those impacts.

As with the federal government, state involvement in coastal resource management takes diverse forms, including regulatory and permitting programs, NEPA-like environmental impact analyses, and coastal zone management, and other planning initiatives. The next section looks at several instructive state approaches: state wetlands permitting programs, the mini-NEPA approach in New York and California, and coastal zone management approaches in California, Rhode Island and New York. (For other state activities associated with cumulative impact assessment, see Appendix A, Annotated Bibliography for additional information.)

State Wetlands Permitting Programs

Florida was among the first states to address cumulative impacts through a wetlands permitting statute, the Warren S. Henderson Wetlands Protection Act of 1984.[31] However, the Act used the term "equitable distribution" rather than "cumulative impacts" in the provision directed at controlling incremental degradation. Prior to passage, this provision was touted as a way to allocate fairly that amount of dredging and filling activity which could be done without violation of water quality standards and without being contrary to the public interest.[32] Potential developers who did not want early projects to exhaust an area's assumed capacity to withstand

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31. FLA. STAT. ANN. § 403.91 (West 1992).

32. Peebles v. Department of Envtl. Regulation, No. 89-3725, 1990 Fla. Env. LEXIS 70, DOAH Case File No. 84-3725 (April 11, 1990).

the loss of wetlands were among its early supporters (Gluckman 1985, 229 in Estevez et al. [Ann. Bib. #317]).

The equitable distribution provision directed the permitting agency to consider not only the impact of the project for which the permit was sought, but also the impact of projects which "are existing or under construction or for which permits or jurisdictional determinations have seen sought," the impact of "projects under review, approved, or vested," and the impact of "other projects which may reasonably be expected to be located within the jurisdictional extent of waters, based upon land use restrictions and regulations."[33] This language codified prior administrative practice (Ankerson 1986 [Ann. Bib. #313]). Reviewers considered additive impacts of past, present and likely future activities on regulated resources within the same waterbody or watershed as the proposed project.

At our project workshop in May 1993, an environmental manager with Florida's Wetland Resource Permitting Program identified the following limitations of that program as then implemented:

- cumulative impacts assessment occurred only in case-by-case regulatory review, with very limited landscape-level planning;

- the scope of the review for isolated wetlands and uplands was narrow;

- definitions of key terms, such as cumulative, additive, secondary, synergistic or aggregate, and clearly delineated geographic limits of the cumulative impact review were lacking;

- it was hard to identify when the ecosystem's capacity to withstand the loss of wetlands is about to be exceeded (e.g., "the straw that breaks the camel's back");

- to keep the political will, regulators could not "push the regulatory envelope" too hard without facing the possibility of new legislatively imposed restrictions;

- wetlands science is evolving so there continued to be uncertainties on key impact issues;

- the statute restricted reviewers from considering future projects which were deemed speculative or not clearly attributable to the project under consideration;

33. FLA. STAT. ANN., § 403.919 (West 1992).

- the natural resource databases available to permitters including satellite imagery and GIS coverages were limited, and permit tracking was inexact, omitting some existing projects and all exempt activities.[34]

He also noted that the regulatory function was performed by Florida's Department of Environmental Regulation (DER) while the wetlands comprehensive planning function was performed by the Department of Natural Resources (DNR). DER was responsible for making permit decisions on a case-by-case basis without responsibility for goal-setting or long-term planning for the resource. There was no lead agency to do modeling or monitoring, no centralized cumulative impact planning, and limited staff and funding.

Effective July 1, 1993, the Florida Environmental Reorganization Act of 1993[35] made significant changes to address perceived deficiencies in the Henderson Act. Those deficiencies included "inadequate wetlands definition, complications presented by the overlapping jurisdictional authority of various agencies, and unsuccessful use of mitigation techniques."[36] Changes made by the Reorganization Act included consolidation of dredge and fill permitting into a single environmental resource permit, merger of DER and DNR into the Department of Environmental Protection, and codification of the cumulative impact analysis.

The Reorganization Act gives explicit authorization to consider "cumulative impacts" and requires those impacts to be considered by all permitting agencies. The Act deletes reference to "equitable distribution" and gives more direction about the geographic scope of the review, directing the reviewer to consider "the cumulative impacts upon surface water and wetlands" that are "within the same drainage basin."[37] It retains almost the same standards for which types of projects to consider, but more precisely defines those regulated by particular provisions. Similarly, it refines "reasonably expected projects" by reference to the same drainage basin. It also expands the documents upon which to project development by adding "comprehensive plans of the local government" to "applicable land use restrictions and regulations."

The amendments may enhance consideration given cumulative impacts if closer coordination between permitting and planning functions result. By express recognition of cumulative impacts, the Act makes a subtle shift away from the approach, embedded in the equitable distribution concept, that it is permissible to degrade the resource down to point just short of ecosystem collapse.

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34. Fry, Douglas. 1993. "Current Practice of Considering Cumulative Effects in Planning and Regulation," Presentation at Workshop *supra* note 15.

35. 1993 Florida Laws, Chapter 93-213.

36. Wiener, Bruce and David Dagon. 1993. "Wetlands Regulation and Mitigation After the Florida Environmental Reorganization Act of 1993," *J. Land Use & Envtl. L.* 8:2 Supp., 521, 543.

37. FLA. STAT. ANN. § 373.414 (West 1995).

Despite the amendments, however, some analysts contend that the law is not intended to halt the cumulative loss of wetlands. The vast majority of undeveloped land in Florida includes wetlands. If any growth is envisioned, analysts argue, "the filling and loss of wetlands is inevitable."[38] The Reorganization Act has been described as a balancing of development and preservation interests which embraces mitigation as the wetland "preservation" means of choice.[39]

Some resource managers contend that the mitigation approach is fundamentally flawed. A 1991 analysis of the effectiveness of permitted mitigation in Florida found major problems with compliance and a general lack of success in mitigation of losses through wetlands creation, enhancement and "preservation."[40] Moreover, during the debate on improving the wetlands permitting program, committee staff contended that requiring consideration of mitigation "when a permit applicant fails to meet the permitting criteria, made those criteria purposeless."[41] If accurate, this weakness in the revised law may seriously compromise its effectiveness in halting incremental wetland degradation.[42]

Clearly, the way Florida has integrated a cumulative impacts standard into its wetlands permitting program is not the only possible approach. Other states have wetlands permitting programs with cumulative impacts provisions, either direct or implied.[43] However, in most of these statutes, cumulative impacts are merely mentioned as one of many criteria to be "considered" and little additional guidance is given on how they should be defined or evaluated.

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38. Wiener, *supra* note 37 at 592.

39. FLA. STAT. ANN. § 373.4135 (West 1994).

40. "[A]t best, the Report concluded, Florida's mitigation program had achieved minimal success. [citation omitted] Of sixty-three permits reviewed for the study, only four were in full compliance with their mitigation requirements. In addition, no mitigation had been performed in roughly thirty-four percent of the permits, despite the occurrence of wetland losses." Wiener, *supra* note 37 at 548.

41. *Id.* at 551 citing Staff of Fla. H.R. Comm. on Nat. Resources, Issues in Wetlands Protection 10 (1991).

42. Florida has other statutes with cumulative impact components. See, for example, the Aquatic Preserve Act [Ann. Bib. #305], the Beach and Shore Preservation Act [Ann. Bib. #306], and the County and Municipal Planning and Land Development Regulation Act [Ann. Bib. #307]. They also have land acquisition and long-term restoration programs, National Estuary Programs, National Marine Sanctuaries and similar initiatives. These supplement the wetlands permitting cumulative impact assessment program.

43. For example, see Connecticut's Tidal Wetlands Act [Ann. Bib. #301]), Louisiana's State and Local Coastal Resources Management Act [Ann. Bib. #335], Maine's Natural Resources Protection Act [Ann. Bib. #341], Maryland's Nontidal Wetlands Protection Act (also applicable to the Chesapeake Bay Critical Area) [Ann. Bib. #363], Michigan's Goemaere-Anderson Wetland Protection Act [Ann. Bib. #370], Mississippi's Coastal Wetlands Protection Act [Ann. Bib. #373], North Carolina's Coastal Area Management Act [Ann. Bib. #394], Texas' Dunes Permits Law [Ann. Bib. #411] and Washington's Permits for Developments on Shorelines of the State [Ann. Bib. #418].

In some instances, the courts have interpreted the statutory mandate. Selected cases are included in Appendix A. A few particularly instructive cases are also discussed in more detail in the following chapter.

Obviously the success of state wetlands permitting programs depends not only on the cumulative impact provisions, but also on the strength of the remainder of the statute and how those provisions are integrated into it. A recent assessment of the effectiveness of state and federal wetlands permitting programs in the Chesapeake Bay Area is instructive. The study found the regulatory programs have "slowed but failed to halt the loss of wetlands in the Bay watershed."[44] Unsurprised by this, the authors note that, at best, regulatory programs only control what they receive applications for; all natural and some anthropogenic activities are unregulated. Moreover, a continuing loss should be expected due to (1) illegal wetland destruction, (2) regulatory "loopholes" which allow specific activities in wetlands without regulation (particularly farming and timbering), (3) the fact that small requests are routinely granted through general permits or expedited procedures (approximately 90% of the requests to impact wetlands), and (4) the failure of required mitigation to replace the functions and values of destroyed or degraded wetlands.[45] The report did note, however, that the programs studied were "largely effective at slowing the rate of loss." The mere existence of the wetlands permitting process, with associated costs and delay, caused developers to try to avoid wetland sites or minimize wetland impacts. On the basis of informal contacts with regulators, applicants tended to revise plans to reduce environmental impacts and make them more "politically acceptable." But given the cumulative adverse impacts, what is approved as "politically acceptable" may not be "ecologically acceptable" (ibid., 10).

Mini-NEPA Statutes

At least ten coastal states have followed the lead of the federal government by adopting "mini-NEPA" statutes. These laws require evaluation of the environmental effects of a proposed action.[46] Some state statutes are broader than the federal statute; they go beyond this procedural

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44. Blankenship, Karl. 1994. "CBF: Permit process slows wetland losses." *Bay Journal*, December 1994, 1, citing Chesapeake Bay Foundation. 1994. "Wetlands Permitting Programs in the Chesapeake Bay Area."

45. *Id.* at 10. The study found "[n]early half the wetland consultants surveyed said that current regulatory requirements frequently 'lead to compensatory mitigation that has little environmental benefit.' Most consultants also said they had difficulty in locating suitable mitigation sites. Further, more than 40 percent said federal and state regulators 'seldom' or 'never' visit mitigation sites to see if their requirements were being met."

46. *See, e.g.*, CAL. PUB. RES. CODE §§ 21000-21178.1 (West 1982); CONN. GEN. STAT. ANN. §§ 22a-14 to 22a-20 (West Supp. 1974-75); D.C. CODE ANN. 36-7091 to 6-974 (West 1981); FLA. STAT. ANN. §§ 380.012-380.27 (West 1988); HAWAII REV. STAT. § 343-1 to 343-8 (West 1985); MA. CODE ANN. ch. 30, §§ 61-62H (West 1992); N.Y. ENVTL. CONSERV. LAW §§ 8-00101 to 8-0117 (McKinney 1984); N.C. GEN. STAT. §§ 113A-1 to 10 (West 1978); P.R. LAWS ANN. tit. 12, §§ 1121-1127 (1977); VA. CODE ANN. §§ 10.1-1200 to 10.1-1212 (subject to redefinition by Virginia General Assembly in

disclosure requirement and give their statute a substantive effect as well. In these states, once effects are assessed, the agency must base its decision on full consideration of environmental impacts (Kamaras 1993, 114 [Ann. Bib. #160]). Some state laws include the phrase "cumulative effects;" others only address cumulative impacts, or closely related concepts, in implementing regulations.

California is a leader in the development of comprehensive cumulative impacts standards under its Act, the California Environmental Quality Act (CEQA).[47] Enacted in 1970, CEQA is designed to ensure full disclosure of significant environmental effects of projects where the state is the developer or regulator. CEQA attempts to reduce any adverse effects through preference for less environmentally damaging alternative actions.

A 1972 amendment to CEQA first added reference to cumulative effects as a factor to consider to determine when an Environmental Impact Report (EIR) is required. The amendment stated that an EIR is required when, among other criteria, "[t]he possible effects of a project are individually limited but cumulatively considerable."[48] Subsequent amendments make the cumulative impact analysis requirement more explicit.[49]

Since 1983, very detailed guidelines have stated:

> (a) Cumulative impacts shall be discussed when they are significant.
>
> (b) The discussion of cumulative impacts shall reflect the severity of the impacts and their likelihood of occurrence, but the discussion need not provide as great detail as is provided of the effects attributable to the project alone. The discussion should be guided by the standards of practicality and reasonableness. The following elements are necessary to an adequate discussion of cumulative impacts:
>
> (1) Either:

1992); WASH. REV. CODE §§ 43.21 010-43.21C.910 (1974); and WIS. ADMIN. CODE NR § 150.01-40. Adapted from O.A. Houck, "Of BATs, Birds and B-A-T: The Convergent Evolution of Environmental Law," 63 *Mississippi Law Journal* 2:403, 435 at n.136 (1994).

47. CAL. PUB. RES. CODE §§ 21000-21080 (Deering 1987 & Supp. 1994). California also uses a cumulative impacts standard in its comprehensive planning and development control statute, discussed below.

48. *Id.* § 21083(b).

49. For a more complete discussion, see Rieser, Alison. 1987. "Managing the Cumulative Effects of Coastal Land Development: Can Maine Law Meet the Challenge?" 39 *Maine Law Review* 2:321, 372-375.

(A) A list of past, present, and reasonably anticipated future projects producing related or cumulative impacts, including those projects outside the control of the agency, or

(B) A summary of projections contained in an adopted general plan or related planning document which is designed to evaluate regional or areawide conditions. Any such planning document shall be referenced and made available to the public at a location specified by the lead agency;

(2) A summary of the expected environmental effects to be produced by those projects with specific reference to additional information stating where that information is available, and

(3) A reasonable analysis of the cumulative impacts of the relevant projects. An EIR shall examine reasonable options for mitigating or avoiding any significant cumulative effects of a proposed project.

(c) With some projects, the only feasible mitigation for cumulative impacts may involve the adoption of ordinances or regulations rather than the imposition of conditions on a project-by-project basis.[50]

Thus, under CEQA "cumulative impacts" encompasses the numerous small impacts of one project and the numerous impacts of two or more projects, including additive and compounding effects. The assessment must consider past, present and reasonably anticipated future projects. These guidelines contain several notable provisions, including alternative methods for determining the scope of projects to be considered in conjunction with the project prompting the EIR, and a discussion of options for avoiding or mitigating any adverse cumulative effects. In addition, the guidelines acknowledge the role of planning in establishing the context for the cumulative impacts review. Planning documents can substitute for the agency's own list of past, present and reasonably foreseeable projects. Comprehensive planning can support the adoption of ordinances or regulations to substitute for imposing conditions on a case-by-case basis. The regulations do not, however, specify the methodologies or techniques to be used in assessing or analyzing the cumulative impacts of relevant projects.[51] CEQA review is also required for planning documents. That affords an opportunity to analyze cumulative impacts on a more comprehensive basis.

Some state agencies have gone beyond the CEQA requirements to develop their own procedures for cumulative impact assessment. For example, California's Department of Forestry reviews

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50. CAL. ADMIN. CODE tit. 14, § 15130 (1994).

51. In actual practice, the cumulative impact assessment of reasonably anticipated future projects may be much more limited than the guidelines would indicate. Except for cumulative traffic analyses, EIRs frequently restrict the analysis to projects in the permitting process. Hyman, Rick, California Coastal Commission. Personal communication, April 1995.

of Timber Harvest Plans (THP) are subject to CEQA's requirements. The Board of Forestry has developed a procedure which uses a lengthy checklist of factors to guide the assessment of potential cumulative impacts of proposed timber operations. The Department analyzes whether the assessment area contains any past, present or reasonably foreseeable probable future projects, whether there are any continuing significant adverse impacts from past land use activities that may add to the impacts of the proposed project, and whether the proposed project, in combination with these other projects, has potential to cause or add to significant cumulative impacts on specific resources (Cumulative Impacts Assessment Checklist 1994 [Ann. Bib. #270]). The Department also has procedures for designation of sensitive watersheds and/or sensitive species. If so designated, resources of concern, mitigation measures to protect those resources, and, possibly new protective regulations, will be used as additional standards in reviews of subsequently proposed harvesting operations (Coast Forest District Rules 1994 [Ann. Bib. #271]).

California's courts have broadly interpreted the CEQA requirements, finding that a cumulative impact analysis is important to assess the true impact of incremental changes. In *San Franciscans for Reasonable Growth v. City of San Francisco* (1984 [Ann. Bib. #293]), decided under the guidelines appearing above, the court addressed the issue of which projects should be included in the EIR analysis as "reasonabl[y] foreseeable probable future projects." The planning commission had only included projects under construction or approved but not yet under construction. The court rejected this narrow view, holding that the Act also required inclusion of related projects that were currently under environmental review (not yet approved), including those projects under the administrative jurisdiction of other city, state, and federal agencies.

The interpretation of state-NEPA statutes is a very technical, case-specific process. The success of the statute in managing cumulative impacts depends on very precise procedural provisions, carefully crafted definitions, and ultimately judicial interpretations of the statute and regulations. In a very detailed comparison of NEPA and the parallel statutes of California, New York and Washington, Kamaras (1993 [Ann. Bib. #160]) identified and examined critical differences in:

- procedural vs. substantive weight of the statutes;

- definitions of cumulative impacts, specifically whether the requisite analysis focuses on the proposed action (how it relates to other actions) or its effects (incremental effect of the proposed project and other projects on a single resource);

- how cumulative impacts are considered in deciding whether a proposal is sufficiently "significant" that an environmental impact statement is required; and

- what projects must be included within the scope of an EIS cumulative impact review, particularly if projects are phased or might be segmented into smaller parts for separate review (ibid., 114-123).

Kamaras' analysis makes a vital point: the cumulative impact assessment goals of NEPA and the state environmental policy acts "succeed or fail in large measure because of the existence or nonexistence of clearly articulated definitions of relevant terms and guidance as to procedural and substantive matters" (ibid., 139). Without clear definitions and procedures, the statute as applied may be unable to make the transition from traditional environmental impact assessment to cumulative impact assessment.[52]

Although state environmental policy acts can be an important part of the overall cumulative impact management effort, there are significant obstacles. First, state regulators generally view cumulative impact assessment as much more difficult than assessment of immediate, direct impacts. Similarly, there is a shorter history of applying these cumulative impact provisions in a state context. Finally, although Kamaras concluded "[g]enerally, the regulatory schemes in place in . . . California, New York, and Washington are well organized systems that function properly and implement the underlying legislative intent," she asserts that further refinements, such as adding or clarifying definitions of key terms, clarification of criteria for determination of significance, and separation of definitions from operational provisions, could enhance their success in meeting stated legislative goals (ibid., 143).

State Land Use Planning to Manage Cumulative Impacts

A number of states try to control incremental coastal environmental impacts with land use planning and non-wetland permitting initiatives. Development of resource goals and long-range comprehensive plans enhance the effectiveness of cumulative impact management in two ways: first, the quality of permit decisions improves if goals and plans establish a broader context for site-specific regulatory decisions; and second, rather than simply reacting to individual decisions, the plans guide development to those areas where it is expected to cause the least harm.

Several states have enacted growth management or comprehensive planning laws that expressly require or imply consideration of cumulative impacts. They include both state-wide[53] and

52. For further discussion of this issue, see Long Island Pine Barrens Society, Inc. v. Planning Board of Brookhaven, 80 N.Y. 2d 500 (1992), and discussion in Chapter 5 in text accompanying notes 41 to 46.

53. For state-wide or special-area comprehensive planning, giving at least implicit attention to cumulative impacts, see, e.g., Florida's Environmental Land and Water Management Act of 1972 (state-wide goals, consistent municipal and county plans, areas of critical state concern, developments of regional impact) FLA. STAT. §§ 380.012-.12 (1988 & Supp. 1995); Maine's Comprehensive Planning and Land Use Regulation Act (state-wide goals, consistent local plans, cooperative planning for shared resource) ME. REV. STAT. ANN. tit. 30-A, §§ 4311-4344 (1989 & Supp. 1995); Maryland's Critical Areas Act (protection of shorelands around the Chesapeake Bay estuary, Chesapeake Bay Critical Area, pier regulations) MD. CODE ANN. NAT. RES. §§ 8-1801 to -1816 (1989 & Supp. 1994); New Jersey's State Planning Act (state planning commission, state-wide planning objectives, designation of growth/limited growth areas) §§ 52.18A-196 to -207 (Supp. 1994); Oregon's Comprehensive Land Use Planning Coordination Act (Senate Bill 100) (comprehensive state-wide growth management program, state-wide goals, areas of critical state concern) OR. REV. STAT. §§ 197.005-.860 (1993); Rhode Island's

coastal[54] management initiatives. Some efforts involve state-wide or regional planning, while others are in the form of state mandates to existing levels of government. Several of these states are currently grappling with how to strengthen consideration of cumulative impacts.

For example, North Carolina's Coastal Area Management Act (CAMA), passed in 1974, augmented existing wetland protection laws by expanding areas subject to regulation and by requiring comprehensive land use planning in the coastal counties. CAMA requires permits for development in any area of environmental concern, including designated coastal wetlands, estuarine waters, renewable resource areas and areas with natural resources of more than local significance. The original Act did not mention cumulative impacts. However, partly in reaction to the proliferation of marinas in sensitive coastal waters, a 1989 amendment gave explicit authority to deny permits for developments that would contribute to "cumulative effects" that would be inconsistent with the review standards.[55] The amendment defined cumulative effects as "impacts attributable to the collective effects of a number of projects" which "include the effects of additional projects similar to the requested permit in areas available for development in the vicinity."[56] In addition, CAMA guidelines for development of marinas require that applications be evaluated giving consideration to the potential for cumulative impacts.

According to a representative of the North Carolina Division of Coastal Management:

> The cumulative impact analysis required by both law and rule give the Department very broad authority for making permit decisions. Unfortunately, there is lacking from the process a good method for assessing such impacts and generating an analysis that can withstand a challenge on appeal. We have denied only three permits based on a finding

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Comprehensive Planning and Land Use Regulation Act (state-wide goals, consistent local comprehensive plans) R.I. GEN. LAWS §§ 45-22.2-3 to -14 (1991 & Supp. 1994); Vermont's State Land Use and Development Plans (Act 250) (capability and development plan, development permits, standards for permit review) VT. STAT. ANN. tit. 10, §§ 6001-6092 (1993); Virginia's Chesapeake Bay Preservation Act of 1988 (local designation of Chesapeake Bay Preservation Area, to incorporate state water quality protection standards) VA. CODE ANN. §§ 10.1-2100 to -2115 (1993); Washington's Growth Management Act (state-wide planning goals, consistent local comprehensive plans, designation of critical areas) WASH. REV. CODE ANN. §§ 36.70A.010-.901 (1991 & West Supp. 1995). Updated and adapted from Liberty, Robert L. 1992. "Oregon's Comprehensive Growth Management Program: An Implementation Review and Lessons from Other States," News & Analysis, 22 *Environmental Law Reporter* 10367 at nn.1-2.

54. *See, e.g.*, North Carolina's Coastal Area Management Act, N.C. GEN. STATE § 113A-120 (1993) and California's Coastal Act of 1976, CAL. PUB. RES. CODE § 30000 (Deering 1994).

55. There are nine specific standards for review, some of which incorporate other more detailed orders, statutes, state guidelines or local land use plans by reference, plus a tenth standard directing denial of the permit application if "the proposed development would contribute to cumulative effects that would be inconsistent with" the guidelines in the first nine standards. N.C. GEN. STAT. § 133A-120-(a).

56. *Id.* § 113A-120(a)(10).

of adverse cumulative impacts. One of these (a proposed marina) has been appealed. . . .[57]

North Carolina received Section 309 Enhancement Grant funds from NOAA to help with the development of enforceable cumulative impact standards. It planned to revise its regulations, designate Cumulative Impact Critical Areas and propose new Areas of Environmental Concern based on the level of cumulative impacts, develop methods to minimize cumulative impacts, and address cumulative impacts through special area management planning.

Several other states employ planning and growth management as the principal tools for addressing cumulative impacts. Frequently the state has adopted state-wide goals and required local governments and state agencies to develop consistent plans and regulations, and to act in concert with the state goals.

Maine is one state that has chosen this model as its primary strategy for managing cumulative impacts. While the studies preceding Maine's 1987 adoption of the Growth Management Act[58] expressly focused on cumulative impacts of development, the Act itself does not use that terminology; consideration of cumulative impacts is implied rather than express. The Act establishes a uniform set of state-wide goals to be addressed by all towns through local comprehensive plans and land use ordinances, requires each town to designate growth and rural areas to guide decisions on where development should and should not be encouraged and requires towns to coordinate their plans for shared resources and facilities.

In addition to the comprehensive planning initiative, Maine also administers a separate natural resource permit system which regulates proposed alterations affecting rivers and streams, great ponds, fragile mountain areas, freshwater wetlands, significant wildlife habitat, coastal wetlands and sand dune systems.[59] Although the law's purpose statement identifies the threat of cumulative impacts, and the regulations require consideration of primary, secondary and cumulative impacts on the areas of concern, inadequate definitions and absence of guidance on how to consider cumulative impacts limit its utility (Rieser 1987 [Ann. Bib. #355]).

Maine is using grants from the Section 309 Enhancement Program to improve its ability to manage cumulative impacts. The state's primary goals are to develop a model for a multi-

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57. Pate, Preston. 1993. Memorandum to Cumulative Impacts Workshop Participants, "Cumulative Impact Review Authority in the N.C. Coastal Area Management Act."

58. Comprehensive Planning and Land Use Regulation Act, ME. REV. STAT. ANN. tit. 30-A, § 4311 et seq. (1994). There are also a few scattered references to cumulative impacts in other statutes or regulations, but they tend to be incomplete or without sanctions for non-compliance such as in the Coastal Management Policies Act, ME. REV. STAT. ANN. tit. 38, § 1801 (3) (West 1992). For further analysis, see Rieser, Alison. 1997. "Managing the Cumulative Effects of Coastal Land Development: Can Maine Law Meet the Challenge?" 39 *Maine Law Review* 2:321.

59. Natural Resources Protection Act., ME. REV. STAT. ANN. tit. 38, § 480-A (West 1992).

jurisdictional, cooperative estuary management plan; to create a classification system for marine ecological communities and to develop associated ecosystem management guidelines; to identify opportunities to amend Maine's laws and programs to strengthen assessment of cumulative impacts in critical marine areas; and to work with the Casco Bay Estuary Program to develop a model coastal watershed nonpoint source program.

A related project, recently completed, focuses on cumulative impact issues unique to Maine's coastal islands. A detailed report examines natural limits on island development (groundwater, social experience, vegetation and soil resiliency, nesting habitat, and scenic quality) and illustrates how to incorporate those limits into management strategy so that island carrying capacity is not exceeded.[60]

Oregon has also utilized a similar comprehensive planning model, but has more implementation experience than Maine. Oregon adopted its Comprehensive Land Use Planning Coordination Act[61] and established a statewide growth management process in 1973. The Act provided for statewide goals to be implemented by requiring all cities and counties to adopt new land use plans consistent with these goals. The goals are more detailed than Maine's, and address 19 areas including estuarine resources, coastal shorelands, beaches and dunes and ocean resources.

Based upon an extensive review of Oregon's experience, one land use law expert observed that the state was much more successful in implementing its development objectives than its conservation objectives. He concluded that "reliance on local governments to implement state conservation policies is one of the fundamental flaws in the Oregon program."[62] He asserts:

> The fact remains that most counties in Oregon remain steadfastly opposed to all of the conservation features of the planning program. This may be a reflection of the major role development interests play in funding campaigns for local governments. (citation omitted) More fundamentally, it reflects local government dynamics; someone seeking a permit for a house or other use has a strong and focused interest. . . . Citizens begin to express their opinions forcefully on development only when the cumulative impacts of development begin to threaten their livelihood or quality of life. However, by that time most of the damage has been done. This is why a state role was necessary in the first place: to balance individual interests in particular projects against public interests in the overall development pattern of land.[63]

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60. Dominie, Holly. 1994. "Exploring Limits: Making Decisions About the Use and Development of Maine's Islands," edited by Katrina Van Dusen, Maine State Planning Office, Augusta, Maine.

61. OR. REV. STAT. §§ 197.005- .860 (1993).

62. Liberty, Robert N. *supra* note 53 at 10389.

63. *Id.*

He recommends that the state complete the shift of power from local governments to the state in areas subject to conservation policies; instead of merely identifying statewide conservation policies, the state should assume responsibility for permit administration in these areas.

California presents a variation on the use of comprehensive planning model to control cumulative impacts. The California Coastal Act of 1976[64] was passed to protect natural and scenic resources, protect ecological balance, and promote carefully planned future developments which are consistent with the policies of the Act. It established the California Coastal Commission to continue coastal planning, and to manage and regulate certain development activities. It also established state policies to guide coastal zone conservation and development decisions. The Act delegates permit control over most new development to local governments as soon as their Local Coastal Program (LCP) is certified by the Commission as conforming to Coastal Act standards. The Act and accompanying regulations require LCPs to consider potential significant adverse cumulative impacts on coastal resources and coastal access of existing and potentially allowable development under the plan.[65]

The primary means for implementing the cumulative impact management goals of the Coastal Act are: (1) application of Coastal Act policies in permit reviews of individual projects (by the local jurisdiction with a certified LCP or by the Commission in other cases), (2) application of Coastal Act standards in the certification, amendment, and periodic review of LCPs and other required plans, (3) special programs developed by the Commission to address cumulative impacts to coastal resources, and (4) incorporation of cumulative impact criteria in federal consistency reviews.

The definition of cumulative impacts in the Coastal Act and in the mini-NEPA CEQA are substantially the same. In addition, pursuant to CEQA, the Commission must perform a cumulative impact analysis in its review of individual permit applications. The Commission is not, however, required to produce an Environmental Impact Report for this type of review.

California's resource managers have developed many techniques to address specific cumulative impact issues. For example, some communities use a wastewater allocation system that reserves capacity for facilities the community wants to encourage (e.g., facilities providing public access to coastal waters). Without this advanced planning, all of the capacity might be taken up by residential development or the like before public facilities could be built. Similar techniques include visibility parameters (height and bulk standards so new development is invisible from major roads), funds from impact fees to purchase accessways, maximum lot coverage standards, and critical habitat guidelines. Some of these protections start as informal guidelines devised by staff and then evolve into more formal regulations as local communities incorporate them into local plans.

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64. CAL. PUB. RES. CODE § 30000 (Deering 1994).

65. *Id.* at § 3015.5 and 14 CCR 13511 (1994).

Comprehensive plans are in a continuing process of review and refinement. A Coastal Commission staff member noted the evolutionary approach of moving from a general state level policy plan to the more specific plan. From the California Coastal Plan and the Local Coastal Program are emerging sub-watershed and other area plans which will be able to produce specific recommendations, such as very specific density and disturbed soil limits. With each iteration, the plans get closer to a level of detail which actually lends itself to implementation through regulations of specific measures designed to address identified cumulative impacts.[66]

California is currently involved in a Section 309 strategy to develop a new regional method of oversight for coastal development permitting called ReCAP (Regional Cumulative Assessment Project). The State's goal is to develop more effective mechanisms for responding to cumulative impacts by identifying broad local coastal development trends and cumulative impacts to major coastal resources not otherwise evident in project-by-project reviews. The primary focus is on wetlands, coastal hazards and public access. The Commission will identify new ways to address these impacts, perhaps through new procedures for statewide oversight of local coastal program implementation. The Monterey Bay region has been selected as the test area for the pilot project.[67]

Another planning approach increasingly used by states to address cumulative impacts is special area management planning (SAMP). For example, Rhode Island uses special area management plans to supplement the standard project review criteria contained in its 1977 Coastal Resources Management Program. These plans are used to focus on cumulative impacts, to address problems that result in environmental degradation, and to develop a comprehensive, multi-agency response on an ecosystem watershed scale.

Rhode Island's first SAMP covered coastal salt ponds (lagoons), their watersheds and barrier beaches of Rhode Island's south shore (Olsen and Lee 1985 [Ann. Bib. #406]). The Salt Pond SAMP was preceded by a study of the ecological history of the coastal lagoons to document the extent of change and define management issues. An extensive scientific research effort focused on declining water quality, sedimentation and overfishing. An advisory committee also developed land use regulations to manage the high concentrations of nitrate in groundwater within the saltpond watersheds which were translated into zoning changes by each of three watershed towns at the same time as the state adopted the SAMP for the region. After a series of public workshops and hearings, the plan was adopted by the Coastal Resource Management Council in November, 1984 (Olsen and Lee 1993 [Ann. Bib. #407]).

Problems related to the cumulative impact of nitrogen loading to the coastal ponds and groundwater as a result of thousands of onsite sewage disposal systems in the watershed are the primary focus of the plan. One strategy would have been to invest in public water and sewer infrastructure. However, that was rejected because of the counter-productive growth-inducing

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66. Hyman, Rick. 1993. "Current Practice of Considering Cumulative Effects in Planning and Regulation." Presentation at Workshop *supra* note 15.

67. *Id.*

effects. Instead the plan recommends keeping the density of residential development low by increasing lot sizes in critical areas, upgrading and maintaining existing individual sewage disposal systems, and severely limiting extensions to public water and sewer systems. The plan also promotes research and implementation of denitrification technology for onsite sewage disposal.

The Salt Pond plan has been described as a "treaty between municipal, state and federal agencies with regulatory powers over land, resources and activities within the watershed" (ibid., 9). It promotes a common set of objectives and strategies and informal sharing of agency expertise and analysis during local and federal reviews. The developers of the plan assert that since 1984, the Salt Pond Plan has "significantly improved the management of this ecosystem" (ibid., 10). Although sedimentation is continuing and fishery resources are not restored, they report water quality has stopped degrading and actually improved in some areas. Local regulations adopted simultaneously with the state SAMP have significantly reduced the ultimate buildout in each town, thus minimizing the cumulative impact of septic waste disposal on groundwater and the salt ponds.[68]

From the myriad ways advanced planning and designation can be used to address cumulative impacts, we draw one final example from the fish and wildlife habitat protection approach of New York's Coastal Management Program. This technique utilizes advanced designation of areas of significant coastal fish and wildlife habitat, focusing not on a specific resource (e.g., shellfish beds or finfish migratory pathways), but rather on the area's ecological function for multiple resources. It "attempts to use an identifiable ecosystem as the unit of habitat management" (Hart and Milliken 1991 [Ann. Bib. #387]).

New York's program identified habitats eligible for designation using existing information, interviews with state biologists, limited field reconnaissance, and a system of public nominations. New York State's Department of State developed criteria for designation and a numerical rating system which deemed a habitat to be significant if it: (1) is essential to the survival of a large portion of a particular fish or wildlife population, (2) supports populations of species which are endangered, threatened or of special concern, (3) supports populations having significant commercial, recreational, or educational value, or (4) exemplifies a habitat type which is not commonly found in the state or in a coastal region. The criteria gave added significance to habitats if they could not be replaced if destroyed.[69]

The Department recommended habitats receiving a score above a numerical threshold for designation. After a series of informal forums and formal hearings, the Secretary of State made final designations of significant coastal fish and wildlife habitats.

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68. Olsen, Stephen. 1995. Personal communication.

69. *Fact Sheet on New York State's Significant Coastal Fish and Wildlife Habitats*. State of New York Department of State, March 30, 1992, 1.

Once designated, New York has sought to gain federal approval for the incorporation of habitat designations in the state's Coastal Management Program. In addition, habitat protection designations may be incorporated into local coastal management programs, which may in turn become part of the state's coastal program after federal approval. If the state habitat designations receive federal approval through either route, the federal consistency provisions of the Coastal Zone Management Act can be used to implement the habitat policy.[70] This means that the state can review federal actions, including federal permits such as Section 404 wetlands permits, for consistency with its approved program and object to those actions which are not consistent.

For example, in 1992, the state coastal program successfully used federal consistency provisions to object to a proposed walkway and 795' dock for a private residence which would have been constructed in a designated habitat. The project had already received all other necessary federal, state and local permits. Under New York's significant coastal fish and wildlife habitats program, each habitat designation is supported by a narrative which shows the calculation of the numerical rating; describes the location, important features of the habitat, fish and wildlife values; assesses impacts that would degrade habitat value; and lists contact people with knowledge about the habitat area. The impact assessment is very detailed and gives advanced notice of activities that would adversely affect fish and wildlife. The Department of State was able to use this narrative to document the threat to the resources and detail the adverse cumulative impacts that would have resulted had the project been allowed.[71]

However, despite the apparent potential of this approach, as of 1991, Hart and Milliken (1991, 64 [Ann. Bib. #387]) reported mixed success:

> Remarkably, in the review of approximately 900 proposed activities over the last three years, the habitat protection policy has been used only on two occasions as the principal basis for stopping a development on the basis of a federal consistency objection under the CZMA.

LOCAL EFFORTS TO MANAGE CUMULATIVE IMPACTS

Many coastal states base a large portion of their coastal zone management program on local government ordinances and plans. For example, as discussed above, the comprehensive planning efforts in Maine, Oregon, and California rely on local governments to adopt plans and regulations which are consistent with state-wide goals. In other instances, local governments

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70. They reported that as of 1991, "[g]aining this federal approval for the incorporation of habitat designations in the state's CMP has been arduous." One hundred Long Island habitats were approved in 1987, but more than 140 were still waiting for approval. Hart and Milliken 1991, 65 [Ann. Bib. #387].

71. Letter from George Stafford, New York State Department of State to Glenn Just, Re: U.S. Army Corps of Engineers/New York District Application #91-0324-L1 (December 21, 1992).

address cumulative impact issues on their own, not as part of a state-mandated growth management effort.

There are numerous examples of local efforts to control cumulative impacts. The following, drawn from Maine, illustrate some of the possible approaches:

Brunswick's Coastal Protection Zone: A study prepared for Brunswick, Maine in 1988 indicated that a severe shellfish kill was caused by algal blooms and oxygen deprivation resulting from nutrient loading from a combination of sources including municipal wastewater treatment facilities, individual residential septic systems, agricultural and lawn fertilizers, and stormwater runoff. In response in 1991, to control adverse cumulative impacts of development on the coastal environment, the town adopted a Coastal Protection Zone, applicable to fragile coastal embayments.

The ordinance established a five-acre minimum lot size, designed to reduce human net density, and set rigorous stormwater management standards for all new development in the zone. As a supplement to state code requirements for new individual sewage disposal systems, the ordinance requires a 150-foot setback from waterbodies and wetlands, requires the system to be designed to withstand an assumed one-foot rise in sea-level over the lifetime of the system, and requires inspection or pumping every two to three years, depending on system size. In addition, the ordinance establishes standards for storage and application of fertilizers and pesticides for agricultural, residential and golf course/playing field/park use.

This ordinance regulates not only large new development, but also activities which may be individually small in scale, but cumulatively significant like the excessive fertilizing of lawns around single family houses.

Cape Elizabeth's Wetlands Ordinance: Cape Elizabeth is one of a handful of towns in Maine which have opted to incorporate specific wetland protection provisions into their zoning ordinances. The 1990 wetlands protection ordinance regulates all identified wetlands, using wetland or aquatic vegetation, hydric soils, and land saturated with water to the surface or covered with shallow water as the means of identification. Unlike the state Natural Resources Protection Act, there is no minimum wetland size below which the ordinance does not apply; it applies to all wetlands, including freshwater wetlands of less than ten acres. The ordinance establishes buffer areas around wetlands (100 to 250 feet, depending on type of wetland, type of separation from other wetlands, and proximity to densely developed areas) which can be more rigorous than the minimums established by the state-mandated shoreland zoning ordinance. These provisions further the protections already incorporated in the state permit review process by removing minimum size thresholds for wetlands review and strengthening the buffer requirements.

Portland Islands Carrying Capacity: The City of Portland used a carrying capacity approach to enact development restrictions on most of its inhabited islands. The 1989 zoning amendments were developed in response to concerns about water quality in Casco Bay and ground water supplies on the islands. A groundwater assessment study asserted that each island should retain the capacity to be self-sufficient with regard to water supply and sewage disposal; development which would interfere with the capacity to be self-sufficient should not be allowed.

Finding that the continued availability of groundwater depends on protecting recharge areas and limiting certain development practices, the City adopted zoning amendments designed to limit the number of additional households that could locate on each island. The goal was to control maximum island build-out so that it would not exceed the "carrying capacity" of the islands, as determined by a finite groundwater supply and a water demand proportional to projected population.

One amendment lowered the allowable density for new subdivisions. Another amendment enacted a "merger" system to control the amount of development that could take place on formerly-grandfathered undersized lots. It increased the minimum buildable lot size for pre-existing lots of record, thus making unbuildable numerous very small lots in old subdivisions; however, to avoid taking all value of those lots, it also implemented a transfer of development rights system, allowing owners of undersized lots to develop if they purchased development rights from other owners of undeveloped lots who agreed to restrict that land so that it would remain undeveloped in perpetuity.

Lakes Phosphorus Allocation Planning: Another way to manage cumulative effects is to establish limits below which a natural resource will not be allowed to drop, and then to develop a system to allocate the "right" to degrade that shared resource among all towns affecting that resource. Innovative work on this approach has been done for Maine's lakes by Maine's Department of Environmental Protection (DEP) and the Androscoggin Valley Council of Governments (Androscoggin Valley Council of Governments, 1990 [Ann. Bib. #344]).

In lakes, phosphorus rather than nitrogen is of primary concern. Too much phosphorus can lead to eutrophication, a condition where the lake is deficient in oxygen, thus endangering fish, plants, and wildlife and threatening drinking water supplies. With an increase in impervious surfaces, surface waters may transport increased amounts of phosphorus into streams and lakes. It may also be introduced via surface waters from timber harvesting, agricultural practices, and road construction, and via groundwater from malfunctioning or poorly sited septic systems.

The DEP's phosphorus control method utilizes a model to determine a maximum allowable increase in phosphorus export into a particular lake from the surrounding watershed. It considers the lake's sensitivity to phosphorus, the current water quality, and the level of protection selected for the lake by the towns in the watershed. This latter consideration is a policy decision, depending on use of the lake and its importance to the region. The determined allowable increase in phosphorus is then allocated on a per acre basis to the areas of the watershed likely to be developed within the next fifty years. This per acre phosphorus allocation establishes the maximum allowable amount of phosphorus that may be exported by future development. The model can be used to control the cumulative effect of new subdivisions or of all new development, including infill development on individual lots, by establishing a standard for phosphorus export per lot. If the proposed development would exceed this figure, various phosphorus control measures would be required.

This allocation system directly ties a scientific model into policy decisions. It contemplates that multiple towns in a single watershed will work together to set resource goals and develop a plan for a shared resource. It allocates the ability to accommodate additional development on a watershed basis rather than allowing each town to assume that it can draw on a disproportionate share of the lake's ability to absorb additional phosphorus.

Maine's Estuary Project: This final example illustrates another way communities with a shared resource can work together to refine local plans and ordinances to accommodate coastal development and human activities with minimal environmental damage. The Maine Estuary Project, sponsored by the Maine Coastal Program, is a multi-year demonstration project to work with a group of communities from the Damariscotta River estuary on key coastal resource issues.

In the first phase of the project, towns along the estuary worked together to identify estuary-wide issues for coordinated action. The local coordinating committee, drawn from a broad range of governmental, user, business, conservation, and other groups, decided to focus on the development of common best management practices to minimize non-point source pollution in the estuary. The committee also plans to review the water quality component of each town's comprehensive plan and the related ordinances to determine whether it would be productive to try to coordinate these ordinances.

State planners will draw on the Damariscotta River estuary experience to examine options for refining state programs to better address cumulative impacts on marine resources. They will also evaluate state-sponsored mechanisms to encouraging local governments to cooperate in the management of shared resources.

CONCLUSION

There are a variety of planning and regulatory mechanisms in use by local, state and federal agencies to attempt to manage cumulative coastal environmental impacts. Some make explicit, but others only implicit, reference to cumulative impacts.

Most programs that do make explicit reference to cumulative impacts merely direct consideration of those impacts, without giving much guidance on how they are to be considered. Some programs have defined the term, with varying success, while others do not even provide an operational definition.

Programs which have only a vague directive to consider cumulative impacts or which have more explicit authorization but aren't using it effectively to control cumulative impacts can be improved in a variety of ways. As illustrated by initiatives throughout the coastal region, improvements are possible on several fronts:

Agency action:

- Develop detailed, internal agency guidance documents on the specific techniques or a range of techniques to be used in cumulative impact assessments;

- Improve GIS permit tracking systems so permit reviewers have complete knowledge of permits already issued in the immediate area;

- Improve local databases, through GIS systems or otherwise, to increase knowledge of baseline conditions, and initiate systematic monitoring of environmental conditions and completed projects to detect environmental change;

- Explore more creative use of coastal management programs and federal consistency review to reassert state control over natural resource decisions;

Legislative action:

- Adopt new definitions or clarify existing definitions of "cumulative impacts" and related key terms;

- Adopt regulations to delineate the geographic scope, types of projects, and timeframe to be utilized in a cumulative impact analysis;

- Amend laws to incorporate more enforceable standards for permit review that are aimed at preventing adverse cumulative impacts;

Multi-jurisdictional action:

- Experiment with cooperative regional approaches in ecologically-determined areas to overcome political boundaries;

Long-range action:

- Revisit issues of the proper allocation of development control between state and local government, assessing whether local control is inherently less likely to protect state-wide and regional interests.

- Participate in iterative, resource-based, comprehensive planning to support additional environmental planning and to establish explicit resource goals to guide individual permit decisions.

- Educate the public about the importance of a watershed or similar ecosystem approach to resource conservation and the importance of managing adverse cumulative impacts to increase support for a more holistic approach to environmental management.

Chapter 5: Legal Issues in Cumulative Impact Assessment and Management

INTRODUCTION

This chapter examines the legal issues and claims landowners or other interested parties may raise when agencies seek to address adverse cumulative impacts in their regulatory or management programs. These potential legal questions fall into three principal areas. The first question would ask whether the scientific and technical information and assumptions upon which the agency action rests were sufficient to justify the action. To answer this question, reviewing courts will usually apply administrative law standards for judicial review of agency decisions. The second potential question area raises issues of statutory interpretation of federal and state laws that involve the assessment and management of cumulative impacts. Courts may be asked whether the agency has been authorized by a legislative body to address cumulative environmental impacts, as distinct from direct and immediate impacts, and if so, of what kind and scope. The third category of potential legal claims would ask the court to decide whether the agency's action, or the law it seeks to apply, serves to deprive the owner of interests in his or her property that are protected by the constitutional law guarantee requiring compensation for governmental "takings" of private property.

A party who might challenge an agency's action that is aimed at preventing adverse cumulative impacts could be a landowner who believes the action interferes with his or her property rights. Other challengers could be parties who believe the public interest has been injured by the agency's failure to consider the adverse cumulative impacts of a permit approval or to implement a resource management program in a manner that is designed to prevent adverse cumulative impacts. The owner may challenge not only the particular decision but the law under which the agency operated. She may claim that the law is unconstitutional on its face, or only as it was specifically applied to her property. The owner might also claim that the agency lacked statutory or regulatory power to base a decision on adverse cumulative impacts, or that the available facts or scientific information do not support the decision. The public interest challenger could raise the claim that the agency has ignored information in the record that suggests adverse cumulative impacts are likely.

By discussing these potential challenges in some detail, we do not mean to suggest that environmental decisions based upon cumulative impacts grounds are especially vulnerable to legal challenge. The goal of this chapter is to demonstrate that the variety of legal claims that could be raised against agency cumulative impact decisions can be successfully withstood by an agency that carefully compiles its record of decision, when that agency has reasonably clear statutory authority for applying a cumulative impacts criterion to regulatory or management decisions, and when the regulations do not require public use or go so far as to deprive an owner of all economic value of the property.

In our questionnaire investigating agencies' existing approaches to cumulative impacts, we found that some agency personnel who review proposed federal permits question whether courts would be likely to uphold, for example, an Army Corps of Engineers Section 404 permit denial if it were justified solely on the basis of adverse cumulative impacts. Some respondents reported that they viewed cumulative impacts as an important factor, but speculated that significant direct impacts would be needed as well to justify a permit denial. Other respondents viewed findings of adverse cumulative impacts as less important in the decision-making process; one respondent, for example, characterized cumulative impacts more as supplemental material, to be added to the agency's written findings after it had already decided to deny the permit based on the high probability of adverse direct impacts.

This perception of the legal infeasibility of decisions relying on cumulative impacts, while perhaps common at this time, is not born out by our review of cases decided in recent years in federal and state courts. It inaccurately minimizes the defensibility of adverse cumulative impacts as a ground for permit denial in several ways.

First, the perception is outdated, reflecting past rather than current experience. But the perception could easily become a self-fulfilling prophecy; if agencies are not aggressive in documenting and asserting adverse cumulative impacts as the ground for a permit denial or for approval with mitigation conditions, reviewing courts will have no basis for upholding adverse cumulative impacts as an appropriate ground for decision.

Second, as stated above, the perception of infeasibility is factually inaccurate. The review of federal judicial decisions presented in this chapter will show that courts have upheld agency decisions that have been based primarily on adverse cumulative impacts, even though relatively few to date have been so based. Moreover, the federal legal framework for addressing adverse cumulative impacts is more constrained than in many state laws. The principal federal cumulative impact laws, the Clean Water Act's Section 404 wetlands permitting program and NEPA, do not confer comprehensive land and water management powers on the agencies, as some state laws do. The Section 404 program has a relatively limited geographic scope and covers only certain kinds of activities. The Army Corps' permit application reviews have time limits, and staffing and budget constraints have led the agency to adopt general and state programmatic permits which may allow many smaller actions with potential cumulative impacts to escape review. Environmental impact statements agencies prepare pursuant to NEPA provide more comprehensive reviews of adverse impacts, but they are prepared for only a small minority of federal decisions, those reaching the threshold of a "major federal action."

In contrast, several state and regional resource management agencies operate under planning and regulatory laws that are often more comprehensive in scope than either Section 404 or NEPA. State agencies, therefore, often have a greater capacity to manage incremental and cumulative environmental impacts. In those states, when the factual record supported their decisions, reviewing courts have upheld project denials or development restrictions designed to prevent adverse cumulative impacts against a variety of legal challenges. Several of these cases are discussed in this chapter.

Finally, some regulatory personnel may have become reluctant generally to deny project permits on environmental grounds for fear that a landowner will claim the denial constitutes an unconstitutional taking of private property without just compensation. Recent developments in the Supreme Court have increased the uncertainty surrounding the constitutional protection of private property, and the "takings" issue has become highly political in state and federal legislatures. Some of the recent Supreme Court takings decisions have in fact involved environmental impacts that are cumulative in nature. Nevertheless, as we discuss in the concluding section of this chapter, decisions based on the adverse cumulative impacts of development on natural resources are no more vulnerable to just compensation claims than others. Further, these court decisions may indirectly suggest ways environmental management agencies can frame their actions and decisions to reduce the likelihood of an adverse ruling on the takings claim.

JUDICIAL REVIEW OF AGENCY DECISIONS

In most state and federal litigation involving issues of cumulative impacts, those issues are presented to the court in the form of a challenge to an administrative agency action. Generally administrative laws allow reviewing courts to set aside agency actions which are "arbitrary, capricious, an abuse of discretion, or otherwise not in accordance with law."[1]

One issue typically raised on review is whether the agency's action was consistent with the statutory mandate. The enabling legislation may direct the agency to consider specified factors in making a particular decision. The reviewing court can assess whether the agency has complied with the requirement to consider those factors made relevant by the statute. Usually the court will just address whether the factors were adequately considered by the agency, and will not assess whether the weight the agency gave to the factors was appropriate.

For example, various environmental review statutes direct agencies to consider cumulative environmental impacts when reviewing permit applications. In judicial review of an agency decision, the court would typically assess whether the agency actually complied with the requirement to consider cumulative impacts by taking the requisite "hard look." The court would not evaluate whether the information produced by this assessment was appropriately balanced with other factors in reaching the final decision.

Another issue frequently raised on appeal is whether the agency had an adequate factual basis for the decision; if that basis is lacking, the court can find the agency made a clear error of judgment and set aside the decision. When reviewing discretionary agency decisions, a court

1. Administrative Procedure Act 5 U.S.C. § 706(2)(A) (1994).

will usually apply an "arbitrary and capricious" or "substantial evidence" test; the decision will be upheld if it was not arbitrary or capricious or if it was supported by substantial evidence. Some courts use these tests interchangeably; other courts imply that the latter test is slightly more stringent. Both tests, however, give substantial deference to the administrative agency. Under either test, the court refrains from second-guessing the factual determinations of the agency; it merely determines whether the agency's factfinding is "within the zone of reasonableness."[2] Administrative decisions are entitled to a presumption of regularity and a reviewing court is "not empowered to substitute its judgment for that of the agency."[3]

If a party claims that a decision based on adverse cumulative impacts was arbitrary and capricious, the court will review the evidence in the record to determine whether there is an adequate factual basis to support the decision made by the agency. Typically, regardless of whether the court would have resolved factual discrepancies in the same way as the agency, the agency decision will be upheld if there are sufficient facts in the record that the agency could have relied on to reach the position it did. In the usual case, a court will not determine which expert witnesses should be believed or otherwise attempt to resolve factual disputes; the court will merely satisfy itself that there was sufficient, competent evidence in the record that, if accepted by the agency, would bring the decision of the agency within the zone of reasonableness.[4]

A third type of issue that might be raised in judicial review of an agency action is whether the decision is consistent with the agency's own policy. If inconsistent, it would be vulnerable to claims that it was arbitrary or an abuse of discretion. Such a claim might be raised, for example, if a decision was contrary to the official policy of the agency or failed to follow the precedent established by prior decisions. However, unlike the practice in the courts themselves, courts do not usually require administrative agencies to follow precedents as closely. Agencies with rational, well-documented justifications can usually deviate from the precedent established by prior decisions.

For example, such a challenge might be raised if, after approving three marinas in the same embayment an agency denies permits for a fourth marina, even though there was no change in the review criteria. The applicant is not likely to succeed in this challenge if the agency can adequately document the reasons for treating similarly situated applicants differently. Perhaps the environmental context has changed and the natural system's ability to assimilate the adverse effects of the fourth marina is less than it was when the first three marinas were approved. If the environmental circumstances have changed so that application of the same criteria yields a different result, the court will generally uphold the agency's decision to deny the proposed

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2. Gellhorn, Ernest and Barry B. Boyer. 1981. *Administrative Law and Process*, 77. St. Paul, Minnesota: West Publishing Co.

3. Citizens to Preserve Overton Park, Inc. v. Volpe, 401 U.S. 402, 416 (1971).

4. A slightly different analysis of substantial evidence may be used in regulatory takings claims. See *infra* notes 79-94 and accompanying text.

project even though it is identical to those previously approved by the agency.[5] The court will generally limit its review to a determination of whether the administrative record of the challenged agency action contains substantial evidence to support the agency's factual findings in that case, without reviewing other permit applications (Rieser 1987, 357 [Ann. Bib. #355]).

Similarly, the courts usually acknowledge that legislative bodies and regulatory agencies have the latitude to change their policies and regulations from time to time to respond to changed conditions or to incorporate increased knowledge. Three marinas in one embayment may have focused attention on, or contributed to, a decline in ecosystem health. Resource managers may have gained better understanding of the effects of marinas and boat traffic on valued resources. As a result, the agency may have amended regulations or policies, and thus be reviewing the fourth marina under different criteria. If the agency has adhered to procedural requirements and has a rational basis for the new regulation or policy, the court is likely to sustain the decision to deny the fourth marina, even though it was reviewed using different criteria than the first three.

While not particularly supportive of the goals of preventing adverse cumulative impacts, a recent South Carolina case illustrates the degree of deference commonly given to agency decisions by the courts under a substantial evidence standard. A citizen organization challenged South Carolina Coastal Council's approval of a permit for a restaurant that was to be built partly within a designated critical environmental zone in Charleston Harbor.[6] The facility was to be part of a joint project with a proposed marine science museum and a National Park Service tour boat facility. Because the restaurant was a non-water dependent structure, the law precluded permit issuance unless the Council was satisfied there would be no significant environmental impact, among other criteria.

Challengers contended the restaurant would cause significant direct impacts through shading of the waters and seabed, and would contribute to the cumulative impact of similar shoreline development. They claimed the agency had set a precedent for denying permits on these grounds in a prior decision that denied a permit for a proposed packing plant, even though it would have affected a smaller area. The court nevertheless upheld the agency's decision to grant the permit. It found the agency decision was supported by substantial evidence, noting that under that test "the possibility of drawing two inconsistent conclusions from the evidence does not prevent the agency's decision from being supported by substantial evidence."[7] The court also noted that an administrative agency is generally not bound by prior decisions, but it "cannot act arbitrarily in failing to follow established precedent."[8] The Court found the Council's

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5. For further discussion of precedent in cumulative impact litigation, see *infra* notes 53-70 and accompanying text.

6. 330 Concord St. Neighborhood Assn. v. Campsen, 424 S.E.2d 538 (S.C. App. 1992).

7. *Id.* at 540.

8. *Id.*

decision not to follow the prior decision was not arbitrary due to distinguishing factors between the cases, most notably the possibility of public benefits from the restaurant.

This case shows how difficult it is to predict the outcome of a particular court's application of the substantial evidence standard of review. Courts in fact give varying amounts of deference to the agency's findings based upon the information in the record. It also illustrates the typical restraint courts use in reviewing agency actions. Courts will not determine whether the agency reached the correct decision, just whether the decision avoided being arbitrary, capricious, an abuse of discretion or otherwise not in accordance with law.

A REVIEW OF LITIGATION CHALLENGING AGENCY EFFORTS TO ADDRESS ADVERSE CUMULATIVE IMPACTS

Federal Section 404 Wetlands Cases

As federal agencies have made more concerted efforts to protect regionally significant resources and ecosystems by controlling cumulative impacts, the courts have in general upheld these actions. In particular, the courts have upheld the Corps' reliance upon adverse cumulative impacts—in the sense of piecemeal or incremental degradation—as a basis for denial of Section 404 permits.

A 1992 decision, *O'Connor v. Corps of Engineers*,[9] involved a lakefront landowner's appeal of the Corps' treatment of his permit application. The Corps had refused to consider his filling of .41 acres of wetland under its general permit, Nationwide Permit #26, but instead required him to apply for an individual, albeit after-the-fact, permit. The Corps then denied that individual permit and ordered the applicant to restore the acreage to its original condition.

Despite the small size of the wetland area filled by the landowner and proposed in the permit application, the Corps determined that, in the particular circumstances, the fill of those .41 acres would in fact *cause* the loss or substantial modification of wetlands beyond the immediate site and would actually affect one to ten acres. The Corps reached this conclusion after taking into account the present, past and future effects of the .41 acre fill on other wetlands or waters that potentially could be lost or substantially, adversely modified by the applicant's project in the future. Because this finding put the application in the category of larger fills, the Corps had the discretion to require an individual permit, apply the full criteria of the Section 404(b)(1) Guidelines, and then deny it on the grounds of adverse impacts.

The federal district court upheld the Corps, finding the decision neither arbitrary nor capricious, but supported by a rational explanation. The court deference to the Corps' findings of fact is consistent with judicial practice in most administrative law cases. It made no difference to the court that the agency decision was a permit denial challenged by the property owner, rather than

9. 801 F. Supp. 185 (N.D. In. 1992).

a permit approval challenged by an interested party other than the owner. The Corps was neither arbitrary nor capricious in determining that filing .41 acres of wetland, when considered with the cumulative effect of other such minor changes, would have placed the quality of the lake and surrounding wetlands in too much danger to be allowed.

In a detailed review of Section 404 of the Clean Water Act and its regulations, the court noted that a permit decision is to be based on an evaluation of the probable impacts, including cumulative impacts, and that unnecessary destruction of wetlands is contrary to the public interest. It stated:

> [t]he regulations specifically target wetlands as a 'productive and valuable public resource . . . the unnecessary alteration or destruction of which should be discouraged as contrary to the public interest.' Where a permit application concerns only a minor alteration of the wetlands, the Corps may still deny it on the grounds that 'the cumulative effect of numerous piecemeal changes [like the one proposed will] result in a major impairment of wetland resources' (citations omitted).[10]

The *O'Connor* decision and others like it indicate judicial support of the Corps in making full use of its responsibility and authority under Section 404 to prevent cumulative degradation of wetlands, and to do so in the context of both its individual permit program and its use of general permits aimed at allowing fills of minimal impact.

Another recent decision, *Fox Bay Partners v. U.S. Corps of Engineers,*[11] also supports the Corps' reliance on cumulative impacts to deny permit applications. This case involved a 512-boat recreational marina proposed for the Fox River, a river in northeastern Illinois already extensively developed for recreational navigation. The marina was to include a yacht club, health club, restaurant and parking facility. Adjacent properties were slated for development as commercial, retail, single- and multi-family residential uses. The marina, however, because of its impact on waters of the United States, required Corps permits under Section 404 and Section 10 of the Rivers and Harbors Act.

The Corps denied the application, finding that on balance it was contrary to the public interest because:

> [t]he Fox Bay Marina Project, in combination with marinas, boat launches and private boat docks that have already been permitted and with similar projects that are reasonably foreseeable in the near future, would result in significant, cumulative, adverse impacts.[12]

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10. *Id.* at 191.

11. 831 F. Supp. 605 (N.D. Ill. 1993).

12. *Id.* at 605 (quoting the Corps' decision).

The Corps' principal concern was not for the direct impacts of the marina's construction, but rather the resulting increase in large power boat traffic and its likely effects on the aquatic ecosystem.

When the developer appealed the application's denial, claiming the decision was arbitrary and capricious, the court upheld the Corps' decision, finding not only that it had applied the correct legal analysis but that it had amply supported its decision with "an impressive array of factual findings" as part of its cumulative impact assessment. The Corps' impact analysis had reviewed the effect of long-term, cumulative increases in suspended sediments from motor boats, expected adverse effects on the physical and biological integrity of the Fox River, and the potential worsening of already oversaturated boating conditions on the river.

The Fox Bay Partners permit action is significant for another reason, in addition to the judicial support of the cumulative impacts criterion. Although this aspect is not discussed in the court's decision, the Corps' permit denial for the marina was part of a broader strategy of the Corps to prevent the cumulative degradation of the Fox River-Chain-O-Lakes aquatic system. The Corps also denied every other pending applications for construction or expansions of projects that would have increased boat traffic on the river, and it initiated an interagency planning effort to manage the impacts of recreational boat traffic.

In 1990, the Corps initiated a Special Area Management Plan (SAMP) process, in coordination with two county governments, a state agency and a regional waterway management agency. Later that year, the Corps began preparation of an EIS to provide a larger framework in which to analyze the cumulative impacts of pending and future Section 404 and Section 10 permitting actions. The draft EIS, released in 1993, concluded the intensity of the existing boating activity on the Fox River and related Chain-O-Lakes is "too overpowering" for the aquatic environment. Although it did consider a strategy of issuing no more permits, the Corps instead endorsed a "no net gain" alternative, allowing new or enlarged boat facilities only if facilities for an equivalent number of boats are removed from the system. Other strategies are being pursued by state and local governments, who also participated in the SAMP process, to reduce boating impacts on this aquatic system, part of whose water quality problems are due to agricultural runoff from land in an adjacent state.[13]

Although there is no direct evidence the reviewing court considered or was even aware that the agency was engaged in this comprehensive, planning approach when it upheld the Corps' decision, it is likely that the EIS and SAMP processes helped the Corps and the other agencies involved to understand the relevance of the individual permit proposals to the overall quality of the aquatic system and to make sound, and legally sustainable, decisions on the basis of adverse cumulative impacts.

13. Hunt, Constance E. 1993. Checking Cumulative Impacts. *National Wetlands Newsletter*, 15(6):11.

In a third recent case, *James City County v. EPA,*[14] the Fourth Circuit Court of Appeals upheld EPA's veto of a Corps permit to allow the construction of a dam and reservoir across Ware Creek in the Chesapeake Bay watershed, finding that EPA has the authority to justify its veto solely on the basis of unacceptable adverse effects on the environment. Using the arbitrary or capricious standard, but this time applying it to the decision to veto a permit rather the decision to grant a permit, the court held that the finding of unacceptable adverse effects was not arbitrary or capricious and was supported by substantial evidence. In addition to direct adverse impacts, EPA based its decision on adverse cumulative impacts, noting that "the incremental loss of functional wetland systems which currently contribute to the environmental well-being of the York River and the Chesapeake Bay and which help maintain and protect the environmental integrity of those systems represents a profound cumulative loss."[15] The court deferred to the agency judgment that those effects were unacceptable.

Decisions Under State Laws

We also examined many state cases addressing cumulative impacts issues. Because these decisions are specific to particular states and their environmental laws and programs, they are not necessarily legal precedents for decisions in other state courts or in the federal courts. They do, however, illustrate how the courts are resolving the most frequent legal questions that seem to arise when environmental programs aimed either explicitly or implicitly at cumulative impacts are challenged in court. We include examples of cases both in which the court has upheld the cumulative impact rationale of the agency and in which it has not, to demonstrate the range of approaches and the manner in which these questions are likely to be resolved in future cases.

An excellent example of a court upholding a state agency's aggressive stance on the problem of adverse cumulative effects is a 1994 Florida Court of Appeals case, *Florida Power Corp. v. Department of Environmental Regulation.*[16] The case may be of particular note because it involved a permit denial based upon cumulative impacts that was issued by Carol Browner, then Florida's Secretary of Environmental Regulation, who is the Administrator of the Clinton Administration's EPA and responsible for oversight of the Section 404 federal wetlands program.

The case involved an essentially after-the-fact application by Florida Power Corporation to install an electrical transmission line over a corridor 60 feet wide and 14 miles long, passing through a high-quality, previously undisturbed forested wetland. Florida Power needed a permit from the Department of Environmental Regulation (DER) in order to place fill on .0135 acres of jurisdictional wetlands; in addition, DER determined that there would be "secondary impacts" on an additional 5.997 acres due to clearing activities, which alone would not have required a permit. By the time Florida Power submitted its application, it had already cut all vegetation within the corridor either to ground level or to the waterline.

14. 12 F.3d 1330 (4th Cir. 1993), *cert. denied* 115 S.Ct. 87 (1994).

15. *Id.* at 1336.

16. 638 So. 2d 545 (Fla. Dist. Ct. App. 1994).

In accordance with Florida's wetlands permitting process, the permit reviewer recommended denial based on adverse cumulative impacts. After a five-day, formal administrative hearing, the hearing officer, however, recommended the application be granted without requiring mitigation conditions. When the Department objected to some of the hearing officer's conclusions, including her failure to consider the cumulative impacts of the proposed project in light of other projects, Secretary Browner remanded the case to the hearing officer for a revised cumulative impact analysis and for additional findings of fact on cumulative and secondary impacts.

On remand, the hearing officer affirmed the original recommendation of approval, reasserting that a conversion from forested to herbaceous wetlands did not diminish wetland function and finding that the Department had presented no credible evidence of cumulative or functional loss of forested wetlands. The Secretary, although bound under Florida law by the hearing officer's findings of fact, but retaining final authority on questions of law and policy, issued a final order denying Florida Power's application. Her grounds were that, despite the small size of the area disturbed (6 acres of 31,448 acres of contiguous forested wetland), there was nonetheless an unacceptable environmental impact.

Florida Power then appealed to the Court of Appeals, which upheld the Department's permit denial, finding the Secretary did not improperly reject the hearing officer's determination of no adverse impact. The court held that under Florida law, the Department could, as a policy matter, base its denial on the unacceptable extent of the environmental impact, even though the actual wetland acreage actually disturbed was small and would be replaced by another wetland type. The court found that the Secretary could reject the hearing officer's implied legal conclusion that Florida's wetland law allows a "*de minimus* exception" for loss of a very small parcel. In rejecting a "*de minimus* exception," Secretary Browner had noted in her decision that to find such an exception "would completely undercut the purpose of the cumulative impact analysis required by Section 403.919."[17]

The court noted also that the Department could consider the secondary impacts of the permit activities that would involve first vegetation clearing and then continuous maintenance cutting over the next 30 years, even though those activities were not within the Department's permitting jurisdiction. In the court's view these actions were the foreseeable result of the Department's issuance of the wetlands filling permit for the installation of the poles.[18]

It is interesting to note that the record of decision in this case involved extensive, conflicting expert testimony as to the extent of loss of forested wetlands, the ecological impact of the increased amount of forest edge, the ecological value of large tracts, similar projects with cumulative impacts, and the effect of conversion from mature, undisturbed forested wetland to disturbed, herbaceous wetland. The court did not attempt to resolve the conflicts in testimony,

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17. 638 So. 2d 545, 561.

18. This determination was made in related litigation, Florida Power Corp. v. Department of Environmental Regulation, 605 So. 2d 149 (Fla. Dist. Ct. App. 1992).

however, and instead deferred to the Department's findings of fact and policy judgments regarding the adverse cumulative impacts of disturbance in this kind of wetland ecosystem.

The court's decision indicates that under the Florida wetlands law, the balancing of adverse effects against public benefits must consider not only the proposed project but also the cumulative impacts of other projects existing, under construction, or for which permits or jurisdictional determinations have been sought, and other projects which may reasonably be expected to be located within the jurisdictional extent of waters under the Florida statute. This supported the earlier assertions of the Department's staff that the permit review in this instance had to consider similar, existing and potential, future corridors through the basin's wetlands for roads, pipelines and powerlines. The court found that the record included substantial evidence to support the Secretary's conclusion that there would be adverse cumulative impacts in conjunction with other projects.

In upholding the Department's permit denial, the court was aware that Florida Power retained the option to reroute the powerline or use the proposed route but mitigate its adverse direct and cumulative impacts. Testimony in the record indicated at least one available alternative would have routed the powerline along an existing corridor 2.5 miles longer at an additional cost of $700,000. Under the Florida statute, the Department is required to grant permits for projects offering adequate mitigation, even if the project fails to meet the other criteria. A staff member had previously indicated that mitigation of at least 10:1 would be necessary in this instance.[19]

The California Coastal Commission is another state agency that has had success in using adverse cumulative impacts as a decision criterion and in meeting the requirement for substantial evidence in the record to support a finding of such impacts. In the 1980s, a court upheld the Commission's denial of a permit for construction of a large residential subdivision on a mountain

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19. For additional decisions by the Secretary of Florida's Department of Environmental Regulation denying permits on the grounds of cumulative impacts, see, e.g., Concerned Citizens League of America, Inc. v. Department of Environmental Regulation, 89 ER FALR 41 (1989) (denial of dredge and fill permit for mining of phosphate rock) and Sarasota County v. Department of Environmental Regulation, 91 ER FALR 55 (1991) (applicant failed to show dredge of inlet clearly in public interest considering cumulative and secondary impacts). An unrelated 1992 action by Florida's Land and Water Adjudicatory Commission (composed of the Governor and Cabinet), Sierra Club v. St. Johns River Water Management District, 92 ER FALR 131 (1992), indicates the extent to which Florida has embraced consideration of cumulative impacts. The Commission declined to reverse the granting of a surface water storage and management permit in question, but it held in the future the water management district would be required to consider cumulative and secondary impacts as part of its permit review, despite the absence of express statutory requirements to do so. The new requirement was based on broad policies of environmental protection, the need for consistency with state water policy, the similarity with policy statements in the dredge and fill program, and related case law. Even though not parties to the action, other water management districts were advised to undertake rulemaking within 120 days on consideration of cumulative and secondary impacts in permit decisions.

ridge, finding the Commission was not wrong in interpreting its authorizing statute to allow it to consider the cumulative effects of this large development.[20]

In an even earlier case, a state court upheld the Commission's predecessor agency's denial of a permit for construction on a coastal bluff of a nine-story motel, which was based on the opinion of experts in environmental planning, and which the court found to constitute "substantial evidence." The experts projected the motel would cause adverse cumulative impacts by accelerating a redevelopment trend, that in turn would adversely affect physical, biotic and human systems, and by committing the best remaining view site.[21]

The preceding cases are examples of the courts upholding agency actions to control development based on adverse cumulative effects. Courts have also supported consideration of adverse cumulative impacts by reversing agency permit approvals for failure to consider cumulative impacts. These judicial reversals frequently occur in the context of state NEPAs or similar state environmental statutes, where the responsible agency has failed to follow the required review procedures.[22] To reverse an agency decision in this context, the challengers generally must convince the court that the agency has abused its discretion under the state law or has made a decision which is not supported by substantial evidence in the record. The actual effect of reversal is frequently more procedural than substantive, requiring a remand to the agency for additional findings, but it does serve to enforce requirements to consider cumulative impacts, if the state NEPA or other law requires it.

A case under California's Environmental Quality Act (CEQA), *Libeu v. Ross,* illustrates this outcome.[23] The California Department of Forestry had reviewed and approved a timber harvest plan pursuant to CEQA's requirement to consider cumulative impacts in significant state decisions that affect the environment. To do so, the Department used a checklist of factors that are to be considered in assessing cumulative impacts, a practice which the court found commendable. The court also found, however, that the agency had failed to respond adequately to public comments on the environmental impacts, particularly with regard to the cumulative impacts of past, present and future logging:

> Given the testimony of [the timber company's] representative that future logging is generally intended, we must conclude future logging is not remote, and the cumulative impact on the plan area must be considered and explained fully to the concerned public.

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20. Bel Mar Estates v. California Coastal Comm'n, 115 Cal. App. 3d 936 (1981).

21. Coastal S.W. Dev. Corp. V. California Coastal Zone Comm'n, 127 Cal. Rptr. 775, 55 Cal. App. 3d 525 (1976).

22. For further discussion of mini-NEPA cases, see Kamaras 1992 [Ann. Bib. # 160].

23. 240 Cal. Rptr. 776 (1987).

> A lesser effort would simply fail to ensure a valid response to the public's significant environmental claims.[24]

The court found the Forestry Department's inadequate response to these claims to be a prejudicial abuse of discretion requiring invalidation of the timber harvest plan and its return to the agency for further evaluation.

Not all judicial decisions are favorable to consideration of cumulative impacts. Some courts uphold the agency action despite the agency's failure to address adverse cumulative impacts. The court may hold that there was no statutory requirement for the agency to evaluate cumulative impacts. Or the court may apply standards of review to the factual record in a manner that makes it more difficult for agencies to constrain development on grounds of adverse cumulative impacts.[25] Some examples of adverse decisions are included in the discussion of common cumulative impact issues, below.

Decisions Under NEPA

Dozens of federal cases have considered the proper treatment of adverse cumulative impacts under the National Environmental Policy Act (NEPA).[26] As we discussed in Chapter Four, NEPA is an important source of federal responsibility to consider cumulative impacts. One group of cases involve challenges to a federal agency's determination that it is not necessary to prepare a detailed environmental impact statement (EIS), either because it has adopted categorical exemptions from the EIS requirement or it has found, upon preparing an environmental assessment (EA), the impacts not to be significant. Typically, the challenger of the agency's decision will contend the finding of "no significant impact" was erroneous on one of four grounds:

1. the agency failed to consider connected actions, for example, that an access road was inextricably linked to the planned logging activities it was to facilitate, and thus

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24. *Id.* at 780.

25. *See, e.g.*, *In re* Permits to Drain Related to Stone Creek Channel, 424 N.W.2d 894 (N.D. 1988); Long Island Pine Barrens Society, Inc. v. Planning Board of Brookhaven, 80 N.Y.2d 500 (1992); 330 Concord St. Neighborhood Assn. v. Campsen, 424 S.E.2d 538 (S.C. App. 1992). *See infra* notes 40-46 and accompanying text.

26. For a more comprehensive annotated list of selected cumulative impacts cases, see the U.S. Federal Legal Authority—Cases section of the associated annotated bibliography. See also Thatcher, Terence L. 1990. Understanding Interdependence in the Natural Environment: Some Thoughts on Cumulative Impact Assessment under the National Environmental Policy Act. *Environmental Law* 20(3):611.

the agency should have reviewed both the road and the logging activities in determining whether a full EIS was necessary;[27]

2. the agency impermissibly segmented one large project for review, and failed to treat interrelated projects as one project to assess the need for an EIS;[28]

3. the agency failed to consider a project in the context of other pending projects in the same area;[29] or

4. the agency inappropriately tiered or phased its review, for example, by preparing a conceptual or programmatic EIS with deferred preparation of site-specific EISs.[30]

These cases frequently focus on NEPA concepts which are closely related to cumulative impacts, including "cumulative actions," "connected actions," "independent utility," "segmentation," "secondary impacts," and "indirect effects." How the issue is characterized can affect the outcome of the EIS determination.[31]

An early NEPA cumulative impacts decision made a distinction between the proper scope of the cumulative impacts review for determining whether an EIS is required, and the scope of the cumulative impacts review as part of the final EIS. The court held that the agency is required to do a broader analysis of cumulative impacts when deciding whether a single proposed action requires an EIS, finding that the threshold determination of "significance" should not focus solely on actions that have required a permit or actions which themselves will be the subject of a NEPA review.[32]

In cases challenging an agency's failure to prepare an EIS, the courts tend to defer to agency expertise in conclusions regarding significance, making sure merely that the decision not to

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27. Alpine Lakes Protection Society v. U.S. Forest Service, 838 F. Supp. 478 (W.D. Wa. 1993) (failure to consider connected actions was arbitrary and capricious).

28. Citizens for Responsible Area Growth v. Adams, 470 F. Supp. 994 (D.N.H. 1979) (several proposals for related actions with cumulative or synergistic impacts upon a region should be treated as one project to assess significance.)

29. LaFlamme v. FERC, 852 F.2d 389 (9th Cir. 1988) (FONSI was unsupported because project was examined in isolation from all such projects in the area).

30. Northern Alaska Environmental Center v. Lujan, 961 F.2d 886 (9th Cir. 1992) (approval of programmatic EIS for mining in national parks which deferred review of site-specific impacts and cumulative impacts until specific permit applications were submitted.

31. For more detailed discussion, see Thatcher, *supra* note 26 at 629-636.

32. Fritiofson v. Alexander, 772 F.2d 1225 (5th Cir. 1985).

prepare an EIS was not arbitrary or capricious. Because the particular facts of a decision are very important in NEPA cases, the decisions vary. Some courts have upheld the agency determination that no new or supplemental EIS was required.[33] Other courts have decided in favor of the challenger and ordered the agency to prepare an EIS.[34]

A second group of NEPA cases involve challenges to the adequacy of the cumulative impact review once "significance" was found and an EIS was prepared. Again, the specific facts are critical and the courts afford the expertise of federal agencies considerable deference. Some cases have upheld the adequacy of the cumulative effects analysis in the EIS.[35] Other cases have found the cumulative impacts discussion in the EIS to be deficient, even using the arbitrary and capricious standard.

A good example of the later holding is *Natural Resources Defense Council v. Hodel.*[36] There the court found that the EIS prepared in connection with an outer continental shelf leasing program failed to adequately consider cumulative impacts of the simultaneous inter-regional development on migratory species, particularly whales and salmon, in Pacific and Alaskan regions. The court agreed with EPA concerns that the analysis should consider the cumulative effects on migratory species whose habitat extends over numerous planning basins and regions, over the full range of their habitat. The cumulative impacts analysis in the EIS was characterized as scant, perfunctory, conclusory and not useful to a decision-maker. The court was without authority

33. *See, e.g.,* 1000 Friends of Oregon v. U.S. Forest Service, 1993, U.S. App. LEXIS 24704 (Sept. 23, 1993) (U.S. Forest Service could rely on past studies and need not address indefinite potential development in determining not to prepare a new or supplemental EIS for a ski lift on Mount Hood); Inland Empire Public Lands Council v. Schultz, 992 F.2d 977 (9th Cir. 1993) (failure to prepare a site-specific EIS was reasonable, not arbitrary or capricious, because the agency had taken the requisite "hard look" and determined no significant adverse cumulative effects even though half of the watershed would be logged within a 30 year span).

34. *See, e.g.,* Bob Marshall Alliance v. Watt, 685 F. Supp. 1514 (D. Mont. 1986) (decision not to prepare an EIS prior to leasing land for oil and gas exploration was unreasonable since later site specific analysis and protective stipulations do not comply with NEPA's mandate to make early informed decisions and to research cumulative effects of major proposed actions); U.S. v. 27.09 Acres of Land, 760 F. Supp. 345 (S.D.N.Y. 991) (Postal Service required to complete an EIS since the EA failed to consider an array of near-certain future development in the vicinity and failed to look at the combined impacts of this runoff and other pollutants to the same key reservoir); and LaFlamme v. FERC, 852 F.2d 389 (9th Cir. 1988) (finding of no potential for significant impact was unsupported because FERC had examined the project in isolation, without considering the overall impact of all such projects in the area).

35. *See, e.g.,* Sierra Club v. Sigler, 532 F. Supp. 1222 (S.D. Tex. 1982) (EIS for proposed deepwater port and crude oil distribution system in Galveston Bay was sufficient because the Corps was not required to evaluate environmental impacts of remote and speculative projects and it was permissible to approve one pending project and then take into account the effects of that project when preparing a statement on the cumulative impacts of remaining proposals.

36. 865 F.2d 288 (D.C. Cir. 1988).

to mandate a substantive result on the pending application, but remanded the matter for further consideration of the cumulative impacts and for revisions to the EIS.

Similarly, in *Oregon Natural Resources Council v. Marsh,*[37] plaintiffs challenged an Army Corps of Engineers EIS for a dam project on several grounds, including that it unreasonably limited the scope of the EIS by failing to consider the cumulative effects of three dam projects in the same river basin, two of which were already completed. The court held that the Corps was required to consider the cumulative impacts of the proposed actions which supplement or aggravate the impacts of past, present, and reasonably foreseeable actions, and that it had failed to give adequate attention to the synergistic impact of the third project. The court directed the Corps to supplement the EIS to address the cumulative impact of the other dams.

In continuing litigation over this same dam project eight years later,[38] the court employed a "rule of reason," deferred to agency expertise in narrowing the focus of the cumulative impact assessment to water quality and fish production impacts, and found that the Corps had subsequently taken the requisite "hard look" at the cumulative impacts as required by the prior decision. However, that did not resolve the cumulative impacts issue. The 1994 decision declared that the federal agency had a continuing obligation to take a "hard look" at the environmental effects of a proposed action even after initial approval. It required the Corps to supplement its EIS to take into consideration significant new information about the danger of extinction of wild coho salmon and summer steelhead trout and the recent determination by another federal agency that the project, even in its present unfinished state, unreasonably diminished the anadromous fisheries of the river.

As these two groups of cases illustrate, because NEPA establishes procedural rather than substantive requirements, debates about compliance with NEPA's cumulative impacts requirements are usually couched in terms of whether those impacts should have been considered (or were adequately considered) in evaluating the environmental significance of a proposed project or in preparing an EIS. Challenges under NEPA to a federal agency approval of a proposed action does not provide a mechanism for reaching the substantive question of whether a decision on a proposed action is appropriate given the disclosed cumulative impacts. Great deference is given to the federal agency; the courts will accept the agency action as long as it is not arbitrary or capricious and is supported by a rational explanation. And even if the federal agency is found to have violated those standards, the remedy is not to deny the proposed action. The matter is usually remanded to the agency for further study and development of a new or supplemental EIS with analysis that comports with the standards.

Three kinds of arguments regarding cumulative impacts are likely to be perceived by the courts as more compelling than others:

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37. 832 F.2d 1489 (9th Cir. 1986).

38. Oregon Natural Resources v. Marsh, 845 F. Supp. 758 (D. Or. 1994).

1. the potential cumulative effects of several actions on one particular "target" resource (e.g., a particular species or a specific habitat type);

2. the potential cumulative effects on a "cohesive land base" or geographic area (e.g., a river basin, national forest, single bay or sound); and

3. the potential cumulative impact of other activities of the same kind as those proposed (e.g., oil leases or timber harvesting or urban development).[39]

Thus, even though the CEQ guidelines do not suggest or require these as the only categories of impacts, it may be true that the courts may be more receptive to arguments concerning like impacts of similar projects on a relatively small geographic area. Perhaps this can be attributed to these being the cumulative impacts that are most easy to grasp and visualize by non-technical review bodies such as courts.

Given the administrative law standards which afford judicial deference to federal agency decisions, if federal agencies begin to more aggressively deny proposed actions with adverse cumulative impacts and have sufficient data to include a rational explanation of the basis for the decision, the courts are likely to uphold the agency's decisions. Conversely, if agencies continue to shy away from making full use of their authority to consider cumulative impacts, courts are likely to defer to that agency judgment as well. In particularly egregious circumstances, challenging environmental groups or other plaintiffs may have some success in having decisions remanded for preparation of an EIS or for preparation of a more complete cumulative impacts analysis within an EIS. These remands have the effect of delaying proposed actions pending supplemental reports, but they frequently have limited substantive impact.

Common Cumulative Impact Issues

In our review of environmental case law involving the question of cumulative impacts, we found that certain issues were recurrent, despite differences in statutory language and programmatic approach. These issues are:

- the adequacy of statutory authority;

- the appropriate scope of review for staged projects, related facilities and secondary impacts;

- the precedent-setting effect of decisions; and

- the amount of information and analysis necessary to support a decision.

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39. Thatcher, *supra* note 26 at 637.

In this section we describe cases that raise these issues. They illustrate the approaches the courts are likely to use. In some instances, lessons can be drawn from these cases for improving the consideration and control of adverse cumulative impacts.

THE ADEQUACY OF STATUTORY AUTHORITY

Many of the state law cases we located in our research turned on questions of interpretation of state statutes or regulations, typically whether the agency had the legal authority to base a decision on cumulative impacts. These decisions are specific to particular states and their environmental laws and programs, and are not controlling on other states. They do, however, illustrate the analysis courts have used for this type of challenge.

A recent North Dakota decision held there was inadequate statutory support for a cumulative impacts challenge. The State Engineer approved a project to drain 18 "type IV" wetlands, some of which covered "prime farmland."[40] The state court rejected a challenge that the State Engineer had failed to address the cumulative impact of wetland drainage in the river basin. In the court's view, no statute or regulation required him to consider the cumulative impacts of the proposed project and possible future projects, nor would it be feasible or practical for the Engineer to evaluate all future possibilities. The Engineer was required only to evaluate the impacts of the specific project under review, as he had done.

In other cases, courts have agreed with claims that some cumulative impact review is mandated by a statute or regulation, but have found that the facts of the particular case did not warrant a cumulative impact review.

For example, in a recent New York case *Long Island Pine Barrens Society, Inc. v. Planning Board of Brookhaven*, challengers claimed that the state's NEPA-like statute, known as SEQRA, required an assessment of the cumulative impacts of 224 recently approved or proposed projects in the Central Pine Barrens, an ecologically unique area of special significance for groundwater and drinking water protection on Long Island.[41] The highest court of New York held that a cumulative impact statement was not mandatory in these circumstances despite the extremely high ecological significance of the pine barrens.

The court's holding involved an interpretation of the SEQRA provisions that outline when an agency must prepare an environmental impact statement. Under SEQRA, an EIS is required for any government-sponsored or government-approved "action" that may have "a significant effect" on the environment. "Significant effect" is defined to include "two or more related actions . . . none of which has . . . a significant effect . . . but when considered cumulatively would meet

40. *In re* Permits to Drain Related to Stone Creek Channel, 424 N.W.2d 894 (N.D. 1988).

41. 80 N.Y.2d 500 (1992).

one or more of the [other regulatory "significant effect"] criteria."[42] In determining whether an action meets the criteria for significance, the agency must consider "reasonably related" actions, including "simultaneous or subsequent actions" which are "(1) included in any long-range plan of which the action under consideration is a part; (2) likely to be undertaken as a result thereof; or (3) dependent thereon."[43]

The court held that the approvals of the 224 projects were not "related actions" under this definition. The court found that the government's general policy of protecting the Central Pine Barrens region, which was evident in numerous statutes and planning directives, is not the same as a governmental long-range plan which would support a finding of related actions, and that only the latter "provided a sufficiently cohesive framework for mandatory cumulative impact review."[44] Constrained by this statutory interpretation, the court determined that a cumulative impacts analysis was not required despite its acknowledgment of the obvious cumulative effects of these proposed developments on a unique, extremely sensitive ecological region.[45] The court reasoned:

> We in the judiciary are not free to piece together statutes and regulations that were never meant to address a problem of this magnitude in order to fill the gap left by the responsible planning entity's inaction. . . . [T]he cumulative impact statement requirement . . . is not fairly applicable in these circumstances, and further, is not an adequate substitute for the specific ameliorative measures that the Legislature has expressly prescribed. To the extent that those measures have proven deficient, the solution must be devised by the Legislature, which is responsible for crafting sensible deadlines and mandating prompt action by the designated planning bodies to address this matter of urgent public concern.[46]

While not mentioned by the *Long Island Pine Barrens* court, another avenue open to the legislature is to amend the statute to clarify what should trigger a SEQRA review. This would be appropriate if the legislature either disagrees with the court's interpretation of the existing

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42. 6 NYCRR 617.11(a)(11). The other regulatory "significant effect" criteria include multiple descriptions of changes in use or damage to environmental resources such as "a substantial adverse change in ground water quality or quantity," "substantial adverse effects on a threatened or endangered species of animal or plant" and "a substantial change in the use, or intensity of use, of land including agricultural, open space or recreational resources, or in its capacity to support existing uses."

43. 6 NYCRR 617.11(b).

44. *Id.* at 1378.

45. *See also* North Fork Environmental Council, Inc. v. Janoski, 196 A.D.2d 590 (N.Y. App. Div. 1993) (projects not sufficiently related just by virtue of location in a designated Critical Environmental Area). *But see* Save the Pine Bush, Inc. v. City of Albany, 512 N.E.2d 526 (N.Y. 1987) (City's plan was deemed to evidence sufficient relatedness, despite separate ownership of pending proposals).

46. 80 N.Y.2d 500, 517-518.

regulations or accepts the interpretation but actually intends to subject a wider variety of related actions to that review.

The above cases illustrate that courts can only review an agency action within the context of its authorizing statutes and regulations. If the statute or regulations fail to require consideration of cumulative impacts, do not adequately define key terms, or omit a description of factors the agency is to consider in assessing potential cumulative effects, the courts cannot supply these criteria. Moreover, if these factors are present in the applicable law but are unclear or ambiguous, the courts may, but will not necessarily, rule in a manner that supports a progressive use of a cumulative impacts standard.

SCOPE OF REVIEW FOR STAGED PROJECTS, RELATED FACILITIES AND SECONDARY IMPACTS

The second common issue concerns what elements of a staged or sequential project, related facilities or secondary impacts should be included in a cumulative impact assessment. Frequently projects involve a sequence of actions, raising the issue of how much an agency should review in its initial environmental assessment. In assessing the impacts of exploratory drilling or mining permits for coastal waters, for example, should the agency consider the potential impacts of the production stage that could eventually result? One court decision concluded the agency should consider the cumulative impacts of all stages of the mining at the initial stage because the statute would not allow a second look at the key findings prior to issuance of a mining lease.[47] In a similar case, the court considered whether the assessment of a state's proposed sale of offshore oil and gas leases should include a detailed look at geophysical hazards (slumping or earthquake potential) or whether it could be deferred until a later time after the actual lease sites are identified and then examined site by site. Alaska's Supreme Court held such a detailed look could not be delayed to a later stage:

> [D]eferring a careful and detailed look at particularized geophysical hazards to later stages of the development process, as DNR evidently intends, entails certain practical risks. First, DNR's method means that particularized geophysical hazards will be considered on a lease-site-by-lease-site basis. This may tend to mask appreciation of any cumulative environmental threat that would otherwise be apparent if DNR began with a detailed and comprehensive identification of those hazards. Second, . . . the more segmented an assessment of environmental hazards, the greater the risk that prior permits will compel DNR to approve later, environmentally unsound permits.[48]

Other cases have, however, reached the opposite conclusion. A New York court held that even though an applicant intended to build a 1 million square foot distribution facility along with 23 retail supermarkets, it was sufficient for the EIS to address only the cumulative impacts of the distribution facility; the environmental effects of each of the 23 stores could properly be subject

47. Kuitsarak Corp. v. Swope, 870 P.2d 387 (Alaska 1994).

48. *Id.* at 1344.

to their own SEQRA review process so did not need to be included in the initial cumulative impact analysis.[49]

A closely-linked issue is how related facilities and secondary impacts should be considered in a cumulative impact analysis. Need a cumulative impact analysis consider the probable impact of all anticipated activities which will be part of the operation, whether or not those activities are part of the permit under review? In looking at a surface coal mining and reclamation operations permit, Alaska's court answered in the affirmative; the agency must consider related support facilities and the impacts thereof before approving the concept (e.g., the cumulative effects of the port, conveyor, airstrip, access roads, gravel pit, solid waste disposal facility, employee housing facilities, coal storage facilities on natural resources), even if the law allowed for separate permits for certain components.[50]

Similarly, a Florida decision held that in considering a permit application for a bridge to a 42-acre island, environmental impacts of the island's proposed development should be considered as part of the bridge permit proceedings so as to avoid "an unconscionable waste of resources" if the bridge were built but the residential development denied.[51] In another Florida case, involving an application for a buried sewage pipeline system from the mainland to a coastal barrier island, the court distinguished between the treatment of cumulative impacts and secondary impacts under its statute, but found that the permitting agency had to consider potential secondary impacts ("what will be at the end of the pipeline") as part of the water quality and public interest analysis.[52]

THE PRECEDENT-SETTING EFFECT OF DECISIONS

A third issue involves what degree of environmental protection the regulations are designed to afford and how to weigh the precedential effect of a prior or pending permit application. May the agency deny the first application if it believes the project will set the pattern for a type of future development that the environmental resource receiving these impacts cannot absorb, even if the first project will not, by itself, have a significant adverse impact. Or is the intent to allow actions to continue to degrade the resource down to some threshold? Or is the agency bound by prior decisions, even though a continuation of that pattern will result in adverse cumulative impacts. Various regulatory programs answer these questions differently.

The most restrictive approach would be for courts to hold that agencies are bound by prior decisions, and are not entitled to revise their position or apply different review criteria. It is fairly unusual for courts to take this position. They generally acknowledge that agencies should

49. Schodak Concerned Citizens v. Town Board of Schodak, 537 N.Y.S.2d 1015 (N.Y. Sup. Ct. 1989).

50. Trustees for Alaska v. Gorsuch, 835 P.2d 1239 (Alaska 1992).

51. del Campo v. Department of Envt'l Regulation, 452 So. 2d 1004 (Fla. Dist. Ct. App. 1984).

52. Conservancy, Inc. v. A. Vernon Allen Builder, Inc., 580 So. 2d 772 (Fla. Dist. Ct. App. 1991).

retain the flexibility to respond to changed conditions or to incorporation lessons learned from experience.

A 1992 South Carolina Supreme Court case, *Weaver v. South Carolina Coastal Council,*[53] illustrates a restrictive interpretation of the precedential effect of prior decisions. A landowner applied for a permit for a private recreational dock that would encroach upon the Folly River, a "critical area" under the state's coastal zone management act. Three similar permits had been issued to adjacent landowners before it was determined that portion of the river was a public oyster ground, an area restocked annually for public harvest of oysters. The full Council upheld its Committee's decision denying the permit, finding the three prior permits had been issued in error without giving due consideration to the existence of the public oyster ground and the impacts of the docks and associated boats on that resource. On appeal, the circuit court reversed the Council, finding there was insufficient evidence in the record that the dock would create an "unavoidable environmental hazard" and that the applicant's equal protection and due process rights had been violated. In a decision which erects a substantial impediment to management of incremental impacts, without addressing the environmental impact, the state's highest court affirmed, holding:

> [T]here is substantial evidence that the circumstances surrounding the application of the respondent and the other three individuals granted permits are similar, and that the existence of respondent's dock would create no effect distinguishable from that occasioned by the other three existing docks. While the three permits issued during the period immediately preceding respondent's application may have been granted in error, absent a showing in the record that Council had taken appropriate remedial action and given due notice thereof, the respondent was entitled to be treated in the same manner as other applicants. We conclude that council violated the equal protection and due process provisions of the state and federal constitutions in treating the respondent in a [different] manner . . . thereby denying her a benefit granted to others similarly situated.[54]

There was contradictory evidence about what remedial action had been taken by the Commission. Presumably this decision would also apply to the precedential effect of decisions which had not been issued in error. As noted above, this South Carolina decision represents the minority approach, and may not even be consistent with other decisions in that state,[55] but it does reflect one possible outcome.

Other states take a significantly different approach. It is much more common for courts to accept that it is appropriate for an agency to amend its review criteria if it has a rational basis

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53. 423 S.E.2d 340 (S.C. 1992).

54. *Id.* at 344.

55. *See, e.g.*, 330 Concord St. Neighborhood Assn. v. Campsen, 424 S.E.2d 538 (S.C. App. 1992) and *supra* text accompanying notes 6-8.

for doing so, and to support the right of an agency to disallow a project if it determines the impacts of a project will be unacceptable, regardless of the action taken in similar prior applications.

There are interesting variations among programs on how to plan to accommodate future actions and how to weigh the possible precedential effect of a proposed action in a permitting decision. The scope of agency review may be spelled out by statute or regulation, or may be further delineated by judicial decisions. Regulatory agencies will almost always consider the existing conditions and the immediate impact of the proposed project. Increasingly, courts and regulations support consideration of future development as well. Pursuant to different authorizing legislation, courts have approved consideration of projects approved by the reviewing agency (or any agency) but not yet built, projects with proposals pending before the reviewing agency (or other agencies) but not yet approved, "reasonably foreseeable" future development based on comprehensive plans and land use regulations, or a future build out assuming that all similarly situated land was developed in the same manner.

For example, a 1980 California decision set aside a California Coastal Commission's denial of a minor subdivision application to create three separate parcels of 25, 26, and 67 acres from rural land located two to three miles from the coast.[56] The Commission found that the minor subdivision would not in itself have a significant adverse effect, but it denied the permit on the basis of a probable future adverse effect. The Commission determined the subdivision would encourage similar division of other large parcels which, in turn, would threaten the low intensity agricultural economy of the area. The court rejected the Commission's reasoning, finding it unjustified by immediate impacts; moreover, the denial was not required to avoid setting a dangerous precedent since even if the Commission approved the pending application, it was not bound to approve similar applications in the future. The court stated:

> The Commission thus erroneously relied on the precedential impact of the owners' proposed minor subdivision and the difficulty of rejecting other future requests for similar minor subdivisions. Further, the Commission could not base its refusal of the permit on such a speculative future contingency. The Commission clearly has the authority to prohibit any future development whose cumulative effect is both significant and adverse.[57]

There are two important aspects of the treatment of precedent in this decision. First, as discussed above, it affirms that the agency is not bound to continue to approve similar development if it determines that new development would have significant adverse effects. Second, however, it limits the ability of this particular agency to base a denial on the future precedential effect of the proposed action. This decision interpreted the precise language of the coastal development permitting statute then in effect. The court found that, unlike the California Environmental Quality Act (CEQA), the Commission's authorizing legislation did not allow it

56. Billings v. California Coastal Comm'n, 103 Cal. App. 3d 729 (1980).

57. *Id.* at 741.

to consider probable future projects in determining whether the project would have a significant effect. This holding did not apply to a CEQA cumulative impact analysis, which clearly stated that foreseeable future development is a necessary part of the cumulative impact assessment. The result of this case may, however, be somewhat of an anomaly. The Coastal Commission successfully denied many rural land divisions for cumulative impact reasons in the late 1970s and early 1980s.

Florida's wetlands permitting statute takes a different approach, not only requiring permitters to consider the impacts of reasonably foreseeable future development, but also attempting to reserve capacity to accommodate similar future development. Florida's original "equitable distribution" concept, a provision important to the legislative support for its initial wetlands regulatory legislation, implies a fair allocation among potential developers of some capacity to degrade the resource. The intent seems to have been that projects causing damage to wetlands would be allowed so long as they do not take more than a fair share of the remaining capacity.

Florida's statute directs the agency to consider the cumulative impact of future projects if the other projects "may be reasonably expected" to occur.[58] In some instances, this requirement has been interpreted very narrowly. Where the agency found no specific projects were reasonably expected in nearby jurisdictional areas, even though the lack of land use restrictions and regulations in the area made development there likely, the hearing officer upheld the decision to issue a permit for a shopping center.[59] In an earlier case involving dredging a series of canals and artificial lakes for development of an industrial park, the reviewing court rejected a challenge based on failure to consider cumulative impacts, holding that the agency needed only to consider the precedential value of granting a permit if there is a reasonable likelihood of a similar project application in the same geographic location in the future.[60]

A 1990 Florida case clarified that even if it is assumed that prior decisions reserved capacity for reasonably foreseeable future projects, the agency is not bound to approve all similar future projects. It retains the right to evaluate each project separately:

> [T]he purpose of the cumulative impact analysis is to distribute equitably that amount of dredging and filling activity which may be done without resulting in violations of water quality standards and without being contrary to the public interest. In order to determine whether the allocation to a particular applicant is equitable, the determination of the cumulative impacts is based in part on the assumption that reasonably expected similar future applications will also be granted.

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58. *See* FLA. STAT. ch. 373.414(8) (1994) for an exact listing of the other projects to be considered.

59. Chipola Basin Protective Group v. Department of Environmental Protection, 11 FALR 467 (1988).

60. Caloosa Property Owners' Assoc. v. Department of Environmental Regulation, 462 So. 2d 523 (Fla. Dist. Ct. App. 1985).

> It does not necessarily follow, however, that all similar future applications must be granted if the current application is granted. Although the Department must be consistent in its permitting decisions to the extent possible and consistent with the public interest, each future application must stand on its own merit and must provide anew the necessary assurances subject to cumulative impact analysis.[61]

While Florida's approach is commendable, at least as originally adopted, it seemed to assume development will be allowed as long as the resource of concern remains above some threshold level just above a point of ecosystem collapse. This raises difficult regulatory issues since there is usually no readily identifiable line marking ecosystem collapse. Similarly, allowing further decline down to some threshold is inimical to cumulative impact goals of halting degradation or even improving the health of the resource.

To promote ecosystem conservation or restoration, the key question is not whether the proposed development would exceed a minimum threshold, but rather whether it would move the ecosystem closer to or further away from the resource goals. This requires not only express resource goals and proper authorizing legislation, but also comprehensive planning for key natural resources to support this type of judgment.

The approach taken in the Columbia River Gorge area appears to be moving in this direction. The 1986 Columbia River Gorge National Scenic Area Act provided for the adoption of interim management guidelines and, by interstate compact, created a bi-state Columbia River Gorge Commission to manage non-urban lands in the scenic area. The Commission turned down two separate requests for subdivision approval, both on the grounds that the subdivisions "would be a 'precedent' for and have a cumulative effect of future parcelization of the area, leading to the diversion of land from agricultural to residential use as well as adversely affecting scenic resources."[62]

The Oregon[63] and Washington Courts of Appeals[64] both upheld the Commission's denials, noting that the Act, the Commission's implementing guidelines and other applicable authority allow the Commission to deny proposals if they will have "more than moderate adverse consequences."[65] Note that for denial the adverse impact only had to be more than moderate, not "significant" as

61. Peebles v. Department of Environmental Regulation, No. 89-3725, 1990 ENV LEXIS 70, 16 (Fla. Feb. 28, 1990) (citations omitted). This case also clarified that DER must consider the impact of projects which are existing, regardless of whether the projects were legal or illegal. Thus DER appropriately considered prior illegal fill in determining remaining capacity.

62. Murray v. Columbia River Gorge Comm'n, 865 P.2d 1319, 1320 (Or. Ct. App. 1993) (quoting the Commission decision).

63. *Id.*

64. Tucker v. Columbia River Gorge Comm'n, 867 P.2d 686 (Wash. Ct. App. 1994).

65. *Id.* at 690.

required in other programs. The agency's ability to make this determination was bolstered by the legislative history, guidelines and planning studies which documented the threat to the area posed by the creation of additional subdivisions and residential housing outside of urban areas. They provided a context for the Commission's judgment about impermissible cumulative impacts.

Earlier case law of the State of Washington also gave support to this outcome. The Washington court relied, in part, on a 1976 decision[66] interpreting the Shoreline Development Act of 1971. In upholding the action of the Shorelines Hearings Board vacating a permit for fill of 93 acres of wetland, the court held that Board consideration of future development, even though out of the control of the applicant, was permissible in determining cumulative environmental harm. Moreover, there was no error in considering the precedential effect of the application. That court stated:

> [t]he finding of insignificant environmental effect [of the applicant's proposed fill itself] and the board's conclusions [that future developments similar to respondent's proposed fill would result in irreversible ecological harm] are in no way inconsistent. Logic and common sense suggest that numerous projects, each having no significant effect individually, may well have very significant effects when taken together.[67]

The court allowed the agency to posit the impact of additional similar development without limiting that inquiry to only reasonably foreseeable future development, and to deny the pending application even though it would, by itself, have an insignificant effect. A 1994 Washington case involving a variance request governed by the same Act reaffirmed this method of analysis.[68] The court indicated that, in considering the cumulative environmental impact of development, the Board should consider what the cumulative effects would be of "additional requests for like actions in the area." If the cumulative effect of those additional requests would be negative, the Board could deny the pending request even if it, by itself, would have insignificant impact.

Thus, precedential effect can be factored into the decision-making process in a variety of ways, depending upon the authorizing legislation. For example, these cases held agencies could deny a project: (1) only if it had not already granted permits for similar projects, (2) if it would have immediate significant and adverse cumulative effects, (3) if it would have probable future adverse effects when reviewed in the context of reasonably foreseeable future development, (4) if it would exceed a fair share of the capacity to use the resource, assuming that reasonably expected similar future applications will also be granted, (5) if it will have "more than moderate adverse consequences" when assessed within a context of resource goals and planning guidelines, or (6) even if it would have an insignificant effect by itself if granting additional requests for like actions would have a negative effect. The variations in these standards reflect underlying differences in

66. Hayes v. Yount, 552 P.2d 1038 (Wash. 1976).

67. *Id.* at 1043.

68. Buechel v. Department of Ecology, 884 P.2d 910 (Wash. 1994).

resource goals, ranging from protecting private property interests to avoiding ecosystem collapse to preventing further degradation.[69]

SUFFICIENCY OF INFORMATION AND ANALYSIS

A final recurring issue in cumulative impact litigation is whether the information in the record that the agency relied on to make its decision was sufficient to support the decision made. Court decisions on this question run the gamut from deferring to agencies' conclusions as to the information's sufficiency to reversing the agency's decision on grounds that sufficient information was either lacking or present but not credible or persuasive.

Cases applying the California's Environmental Quality Act (CEQA) requirement to consider cumulative impacts reveal a tendency of state courts to vary in the amount of information and analysis they will deem necessary to satisfy this requirement. One notable court decision reversed permits granted by the San Francisco Planning Commission for the construction of high-rise office buildings, finding that the Commission had abused its discretion by giving the cumulative impact analysis requirements an unreasonably narrow scope.[70] In assessing the cumulative effects of probable future office developments, the Commission had included projects under construction and projects already approved but not yet under construction, but had not included projects that were still under review by the Commission. While agreeing that an Environmental Impact Review (EIR) need not be exhaustive and is to be reviewed in light of what is reasonably feasible, the court nevertheless found the EIRs were inadequate and incomplete. Assigning great weight to the cumulative impact analysis, it stated:

> Not only do these inadequate cumulative analyses subvert mitigation and color the benefits of the projects, but they also frustrate many of the fundamental policies behind CEQA. For instance, since the EIRs do not describe the true severity and significance of the cumulative impacts adequately, they cannot demonstrate, to an apprehensive citizenry already reeling from the effects of past downtown development, that the Commission has, in fact, analyzed and considered the environmental consequences of its actions. . . . Nor can these EIRs 'enable the public to determine the environmental and economic values of their elected and appointed officials thus allowing for appropriate action come election day should a majority of the voters disagree.'. . . To the contrary, these EIRs never forced the Commission's true values into the public forum. Rather, they allowed the Commission to appear to have acted reasonably.[71]

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69. Restoration goals were not discussed in these challenges to regulatory decisions; those goals are more likely to be addressed by non-regulatory strategies.

70. San Franciscans for Reasonable Growth v. City & County of San Francisco, 151 Cal. App. 3d 61 (1984).

71. *Id.* at 80. See also Kings County Farm Bureau v. City of Hanford, 221 Cal. App. 3d 692 (1990).

In a California case involving state approvals of timber harvesting plans, the court of appeals reversed the Department of Forestry's actions in part and required the Department to analyze additional potential cumulative effects.[72] The court set a fairly low standard for that analysis, however, stating that it was not requiring a formal statistical evaluation of the degree to which logging pursuant to the plan, when "considered with other existing or reasonably expected conditions in the watershed, would increase the risk of landslide and runoff damage." The court asserted:

> What is required is . . . only that Forestry have looked for and in some reasonable manner assessed potential cumulative environmental effects, and that it have given sufficient consideration to any such effect it should reasonably have considered significant. But the administrative record does not reflect that Forestry has done any of these things.[73]

Unlike the prior decision where the court actually reviewed the formulas used to project future development, this court sought merely a "reasonable" assessment, and left the choice of assessment methodology to the agency.

Another California court of appeals decision, interpreting the same CEQA cumulative impact requirements, took a more lenient stand on the sufficiency of the agency's analysis of cumulative impacts. In a case challenging approval of a residential development with potential, adverse cumulative impact on the California tiger salamander, the court found the EIR's two-sentence assessment of cumulative impacts to be adequate. The court concluded the city's finding that there were no statewide or regional cumulative effects was reasonable. The city had sufficiently indicated the reasons for this determination and thus there was no further need to discuss it in detail.[74]

As will be discussed in a later section, recent U. S. Supreme Court decisions applying the regulatory takings doctrine to land use cases have a bearing on cases like the ones discussed above where the landowner's legal claim is under the takings clause. Where a particular kind of takings claim is made against a land use regulation, the Supreme Court's decisions will affect reviewing courts' standards for determining whether an agency had sufficient evidence to support a regulatory decision that is based on adverse cumulative impacts.

The California courts generally seem to require a more complete assessment of cumulative impacts under CEQA than many states. Other states' courts have taken differing approaches when reviewing the sufficiency of evidence of cumulative impacts and on the question of who bears the burden of proof that such impacts will not occur.

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72. Laupheimer v. California, 200 Cal. App. 3d 440 (1988).

73. *Id.* at 466.

74. Sierra Club v. Gilroy City Council, 222 Cal. App. 3d 30 (1990).

For example, extensive litigation in Georgia about a landowner's plan to build a tennis court in a floodplain addressed the weight that is to be given to the likely impact of a repetition of the proposed project.[75] The trial court held construction of the tennis court was prohibited because the cumulative effect of many such projects would significantly affect the river in violation of the River Act. The Georgia Supreme Court reversed, holding that because the statute included standards for granting an exception, the legislature anticipated that some development would be allowed in the protected area.

The agency's environmental planner had testified to the cumulative effect of like construction, stating that "the cumulative effect of the construction of any impervious surfaces, such as the proposed tennis court, would significantly affect the river." The court found this testimony insufficient to meet the agency's burden of proving the site did not meet the standards for an exception, noting that the agency should have introduced specific evidence about the site's geology, hydrology, soils, vegetation, slope and aspect.

The court further held that the agency could not use as its sole test whether the cumulative effect of any construction would eventually affect the river adversely, because the same would be true of any construction, "regardless of its insignificance as a single unit." Giving general support to cumulative impact analysis, the court stated:

> [W]e hold that the trial court was authorized to consider the cumulative effect of additional like construction in the protected area. We have held that the state is justified in considering the cumulative effect of development when it makes land use plans. . . . It naturally follows that in reviewing decisions of a governing authority under such a plan, the superior court is also authorized to consider the cumulative effect of development.[76]

In this decision, however, cumulative impacts were only one of several factors. Unlike other states, the court found the agency had the burden of proving unacceptable adverse cumulative impacts with detailed site-specific evidence that went beyond the fact of the area's designation as a floodplain and the general impact of impervious surfaces on floodplain function.

One of the recent U.S. Supreme Court takings decisions alluded to above involved this question of whether site-specific information is necessary to support a regulatory decision based on a development's contribution to cumulative impacts on the functions of a floodplain. As will be discussed in more detail later, the court's standard of review will change when the landowner is not merely challenging the basis for the agency's decision, but is claiming as well that the decision constitutes a taking of the property. Following the Supreme Court's lead, reviewing courts are now more likely to require site-specific findings that a particular development will contribute an ascertainable amount to the cumulative flooding problem, in order to justify a government requirement that the landowner dedicate a portion of the property to be developed for public uses. If, however, the permit is denied on the basis of more general evidence of cumulative flooding

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75. Pope v. City of Atlanta, 255 S.E.2d 63 (Ga. 1979).

76. *Id.* at 65.

impacts, or if the permit is approved with mitigation conditions that do not require dedication of land for public use, the ordinary standards of review are likely to still apply.

REGULATORY TAKINGS WITHOUT JUST COMPENSATION

Perhaps the most misunderstood yet feared potential legal challenge to agency decisions, is the claim that the regulatory restrictions are so burdensome that they constitute a taking of private property by the government without just compensation. Such challenges may be brought under either federal or state constitutional provisions. While there can be slight variations in the terms used in the analysis depending upon whether federal or state protections are invoked, in both instances, the reviewing courts will make a factual inquiry into the purpose of the regulation and the effect it has on the particular property.

There is nothing unique about restrictions based on adverse, cumulative environmental impacts that requires courts to vary from the standards courts apply in cases where regulatory takings are alleged. A specialized analysis will be used if the restriction imposed requires the property owner to allow the public onto or across the property. In those instances, as will be discussed below, courts will use a more exacting standard to review the governmental regulation.[77]

For restrictions that do not require public use, the courts will look at the nature of the governmental action and the impact it has upon the property in question. If the regulation serves a legitimate governmental interest, the court's analysis will turn on the extent to which the regulation affects the landowner's economic uses of the property. Courts may look at the impact on value in two ways: they may consider the impact on the market value of the property, or may consider the extent to which the restriction interferes with the uses the owner expected to be able to make of the property when the investment in its purchase was made.[78]

The court's inquiry will focus on the specific facts of the case, including the stated rationale for the regulation and the circumstances of the affected property owner and similarly situated owners. The court's takings analysis seeks to balance the public benefit of the regulation against the private costs that it imposes to determine when the regulatory burden is so significant and so much greater than that imposed on others that the property owner should receive compensation.

The court will not engage in this balancing of governmental against private property interests, however, if the effect of the regulation is to eliminate totally all economic value of the property. According to the U. S. Supreme Court's 1992 decision, *Lucas v. South Carolina Coastal Commission,*[79] the landowner is entitled to compensation for that loss regardless of the public

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77. *See infra* notes 87-94 and accompanying text.

78. Penn Central Transp. Co. v. City of New York, 438 U.S. 104, 124 (1978) and Agins v. Tiburon, 447 U.S. 255, 260-261 (1980).

79. 112 S. Ct. 2886 (1992).

purpose the restriction sought to achieve, unless the regulation imposed a restriction on land use that reflects an existing limitation under the state's property or nuisance law. In *Lucas*, the landowner was prevented from building a permanent residential structure on his sand dune property by beachfront erosion setback lines adopted pursuant to the state's coastal zone management program but which were modified to include his property after he made the purchase.

When a property will be considered to have been rendered completely valueless by an environmental regulation is unclear, due in part to the Court's incomplete treatment of this question in *Lucas*. The lower court in *Lucas* had found the value of the property was reduced to zero by the setback lines. The Supreme Court adopted this finding without ruling on its validity, nor indicating whether the entire parcel must be rendered of zero value in order to trigger the test. Most commentators on the *Lucas* decision, however, believe a total taking will be found in only a very small number of cases; moreover, cases decided since the *Lucas* total takings' rule was announced suggest that lower courts are not changing their basic approach to land use regulatory takings cases.[80]

Because the balancing test courts most often apply is very fact-specific, and because the U.S. Supreme Court is undergoing a shift in doctrine under the takings clause, the outcome of a regulatory takings claim under the federal Constitution remains hard to predict, especially if the regulation can be seen as depriving the owner of all or almost all uses of the land. However, if the agency's application of a cumulative effects standard to prevent degradation of wetlands or other resources vulnerable to cumulative impacts does not eliminate all economic value to the affected property, and if other activities on the land or forms of development are allowed, even if less intensive, the landowner is not likely to prevail on a takings challenge to a cumulative impacts regulation.[81]

A case in point is a 1991 New Jersey case where a farm owner claimed that state land use regulations for the New Jersey Pine Barrens was a taking of property.[82] The state employed a range of programs and regulations, including a transfer of development rights system to control land uses and prevent adverse cumulative impacts in the environmentally-sensitive New Jersey Pine Barrens. The regulations, part of a special area management plan, sought to protect agricultural land, preserve unique ecological and cultural features, and discourage piecemeal and scattered development.

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80. *See, e.g.*, Kusler, Jon A. 1993. The *Lucas* Decision: Avoiding 'Taking' Problems with Wetland and Floodplain Regulations. *Maryland Journal of Contemporary Legal Issues* 4:73.

81. *See, e.g.,* O'Connor v. Corps of Engineers, 801 F. Supp. 185 (N.D. In. 1992), and *supra* note 9 and accompanying text. The court rejected the landowner's takings claim, in part, because the owner "still has indiscriminate use of the property upland from the wetlands" and "the [Army] Corps did not excessively interfere with plaintiff's investment backed expectations." *Id.* at 198.

82. Gardner v. New Jersey Pinelands Commission, 593 A.2d 251 (N.J. 1991). See *supra* notes 63-64 and accompanying text.

The farm owner's land was limited either to continued agricultural use or residential development on 40-acre minimum lots, with the option of transferring development rights. The court found the regulations, which severely limit development in order to safeguard the environment and protect the water supply, substantially advanced legitimate and important governmental objectives. It noted that environmental protection is a particularly strong justification for prohibiting inimical uses.[83]

> That land itself is a diminishing resource cannot be overemphasized. . . . Environmentally-sensitive land is all the more precious. Hence, a proposed development that may constitute only a small insult to the environment does not lessen the need to avoid such an offense. The cumulative detrimental impact of many small projects can be devastating.[84]

In the court's view, the development restrictions furthered directly the central purpose of the Pine Barrens Act. They did not, moreover, impair a valuable property right to an impermissible degree as they did not deny all practical use of the property; thus, there was no taking of property.[85]

A 1994 California case concerning the Lake Tahoe mitigation impact fee is another example of a state court that has declined to extend the U.S. Supreme Court's recent takings cases in a manner that would subject land use restrictions aimed at preventing or mitigating adverse cumulative impacts to any higher degree of judicial scrutiny than conventional environmental restrictions.[86] The Tahoe Regional Planning Agency was created by interstate compact to control incremental growth in the Lake Tahoe region. In 1980, Compact amendments required the agency to establish environmental carrying capacity thresholds. As part of this effort, the agency imposed a lake pollution mitigation fee on new building permits, calculated by estimating the total amount of nutrients entering Lake Tahoe as a result of all development and the costs of ongoing maintenance and operation of lagoons.

When property owners challenged this cumulative approach they claimed the fee should have been based only on the needs or burdens created by the proposed project alone, and should not reflect the needs or burdens created by the cumulative impacts produced in conjunction with prior construction. The courts rejected this claim, holding that restrictions on new development do not have to be based solely on the impacts of the proposed project, but could be based on the cumulative impact of the proposed project when viewed in conjunction with other construction.

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83. *Id.* at 258.

84. *Id.*

85. *See also* Ojavan Investors Inc. v. California Coastal Commission, 26 Cal. App. 4th 516 (1994) affirming the validity of a similar transfer of development credits program.

86. Tahoe Keys Property Owners' Ass'n v. State Water Resource Control Bd., 23 Cal. App. 4th 1459 (1994).

The court cited the 1987 U.S. Supreme Court case, *Nollan v. California Coastal Commission,*[87] as support for the proposition that owners of new development can be required to mitigate for conditions created by prior development. The California court noted that in *Nollan*, the Supreme Court implied it would have approved the action had the Commission sought to ameliorate the cumulative impact of reduced visual access to the ocean caused by beachfront construction by requiring the Nollans to build a public viewing spot on their property, even though the burden of the cumulative impact would have fallen on the Nollans alone.

The *Nollan* decision is the first of two recent Supreme Court decisions in which state programs aimed at ameliorating the adverse cumulative impacts of development have run into trouble under the takings clause. These cases have all involved a mitigation requirement that imposed a public easement or use right on the private property as a condition for approval.

In *Nollan*, the Supreme Court considered whether the requirement of an easement for public access as a condition for a coastal construction permit would amount to a "taking" of private property without compensation. The Court decided that there must be a substantial connection, or "nexus" between the public burden created by the proposed development and the condition imposed by the government. If such a connection is missing, the court should infer that the government is simply trying to expropriate property for public use without paying for it. This fit between impact and condition is required in order to satisfy the need for the condition to "substantially advance" a "legitimate state interest."[88]

The Nollans sought to demolish a small, rundown beachfront bungalow and replace it with a three-bedroom house similar in size and grandeur to the recently built surrounding houses. They applied for a development permit from the California Coastal Commission. The Commission was concerned that the larger house, in conjunction with the surrounding development, would adversely affect the public's visual access to the shoreline from the road, and its physical passage along the beach. The Commission conditioned the Nollan's construction on their granting an easement allowing the public to walk along the dry sand portion of their beach below the seawall. The California courts upheld the condition as satisfying the relationship required under state law between a land use condition and the impact of development it seeks to mitigate.

In a five-to-four decision written by Justice Scalia, the U.S. Supreme Court held the lack of "nexus" between the public burden created by the proposed new construction and the condition required by the Commission, which would have allowed the public to pass over the Nollan's property just above the high tide line, meant the Commission was, in effect, taking the Nollan's property without compensation. Justice Scalia did not believe that the proposed new construction would in fact diminish access to the publicly owned shoreline or to nearby public beaches. He believed that if the building's visual access impact had been the real concern, the Commission could have required a public view spot next to the Nollan's house. He therefore reasoned that

87. 483 U.S. 825, 107 S.Ct. 3141, 97 L. Ed. 2d 677 (1990).

88. *Nollan*, 483 U.S. at 834-835, 107 S. Ct. at 3146-3147.

because the condition did not fit the public burden (the loss of visual access), the real purpose of the condition was to obtain a public easement without paying for it.[89]

To satisfy the requirement that land use restrictions "substantially advance a legitimate state interest," the Supreme Court appears to expect lower courts hearing takings claims to engage in a more intensive scrutiny of the condition and the burden caused by the particular development than they would in cases where the condition is challenged under the ordinary administrative law standards. To illustrate how some lower courts have applied the *Nollan* standard in instances of state cumulative impacts regulation, a 1991 California case, *Surfside Colony, Ltd. v. California Coastal Commission*,[90] is instructive.

In *Surfside Colony*, the Commission approved the construction of a revetment (seawall), to protect houses in a private residential development from erosion, only on condition that the association dedicate a public right-of-way along the top of the revetment. The California court found that the Commission's reliance upon studies performed at other beaches indicating that seawalls increase shoreline erosion was insufficient to satisfy the "direct nexus" requirement. The agency needed to have site-specific expert studies to conclude that the particular revetment in question under its likely wave conditions would contribute to coastal erosion.[91]

The court distinguished an earlier case that had upheld a similar condition on the basis of general studies establishing a connection between seawalls and increased erosion and the loss of publicly owned tidelands.[92] The court found that in the early case, which was decided prior to *Nollan,* the court had used a "rational basis" test to uphold the public easement condition.[93] Although the

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89. *Id.* at 837, 107 S. Ct. at 3148. Justice Brennan criticized the majority opinion for insisting on a "precise fit" between burden and condition, thus hindering the delicate balancing of public and private interests that land use planners must undertake, in particular in the face of adverse cumulative impacts. Id. at 847, 107 S. Ct. at 3153.

90. 226 Cal. App. 3d 1260 (Cal. App. 4th 1991).

91. Revetments and seawalls may have different effects at different beaches (citation omitted). We cannot say, as a matter of law, all revetments will exacerbate erosion. Here, the Commission had no evidence at all establishing this revetment would cause erosion at this beach. We must therefore conclude no substantial evidence exists to justify a "nexus" between the revetment and the public access requirement. Under *Nollan* the access requirement must be deemed a "taking" of Colony's property.

Id. at 1268-69.

92. Whaler's Village Club v. California Coastal Comm'n, 173 Cal. App. 3d 240 (1985).

93. The *Surfside* court quoted the following language from *Whaler's Village Club, id.* at 261:

> The Commission had sufficient information before it to conclude that, due to construction of this revetment and others up and down the coast, the erosive nature of the beaches in Ventura County coupled with the tendency of seawalls and revetments to increase the sand loss on beaches with

Surfside Colony court applied a substantial evidence test to the case, it concluded that the *Nollan* test for public easement conditions required site-specific evidence of a contribution to an environmental impact problem that is cumulative in nature to be present in the record in order to satisfy this standard.

The U.S. Supreme Court had an opportunity to clarify what the *Nollan* standard in fact means in application to cumulative impacts-based land use conditions. This opportunity came in the second major U.S. takings decision worth noting for cumulative impacts regulation, *Dolan v. City of Tigard*.

In *Dolan,* the city required the owner of a small shopping plaza to dedicate the portion of her parcel that fell within the floodplain of an adjacent stream as a public greenway, as a condition for expanding the plaza. During heavy rain storms the greenway would absorb the increased stormwater runoff and thereby mitigate the impact of her proposed development and that of other properties. The condition also required that part of the greenway would be used for a pedestrian and bicycle pathway to help reduce the additional traffic congestion caused by the development.

The Supreme Court found that the "essential nexus" existed between the permit condition and the state interests sought to be served. A "takings" problem arose, however, because the city had not demonstrated that the dedications related specifically to the degree of impact on stormwater flooding and increased traffic that the proposed land use expansion would have. Writing for the majority, Chief Justice Rehnquist stated:

> We think a term such as 'rough proportionality' best encapsulates what we hold to be the requirement of the Fifth Amendment. No precise mathematical calculation is required, but the city must make some sort of individualized determination that the required dedication is related both in nature and extent to the impact of the proposed development.[94]

In the Court's view, the city failed attribute a certain amount of increased runoff and traffic to Mrs. Dolan's property in order to meet the requirement announced in *Nollan* that certain land use restrictions must "substantially advance a legitimate state interest." This additional requirement, which is a test that requires more particular information on the degree of contribution to a cumulative impact than is needed to satisfy the test of "substantial evidence" in the record, can in many instances be hard to meet. It comes into play, however, only when the land owner is

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a tendency to recede constitutes a cumulative adverse impact and places a burden on public access to and along state tide and submerged lands for which corresponding compensation by means of public access is reasonable. (Citations omitted.) Staff reports concerning various applications before the Commission referred to surveys of the Army Corps of Engineers and other experts concerning shoreline erosion along the California coast and, in particular, beach erosion in Ventura County. Opinion evidence of experts in environmental planning or ecological sciences is a permissible basis for decision. (Citation omitted.)

94. Dolan v. City of Tigard, 114 S. Ct. 2309, 2319-2320 (1994).

asked to mitigate her contribution to a cumulative impact by giving up an essential private property right, the right to exclude others from use of the property.

It seems likely, therefore, that programs aimed at preventing and mitigating adverse cumulative impacts on ecological systems will not need to satisfy the heightened scrutiny standard of the *Nollan* and *Dolan* decisions. They will not involve conditions that extinguish this essential private property right. Programs that could have trouble include those in which the resource sought to be protected against cumulative loss is public access of some form, because mitigation logically would involve using the developed property in some manner to compensate for this loss. In may turn out that development control programs will have to rely on mitigation conditions that require contributions of impact fees to a fund that can be used to purchase public access facilities to compensate for the cumulative loss of this resource from the development of an area.

CONCLUSION

The preceding review of litigation in which programs aimed at cumulative impacts were challenged supports our initial conclusion of the legal feasibility of many of the best approaches to the management and control of adverse cumulative impacts. A key factor is the need to have adequate statutory authority to include cumulative impacts as a basis for agency decisions and management measures. With that in hand, agencies must be sure to have a reasonable information base and understanding of the resources or ecosystems for which it is responsible to support a conclusion that a particular use or form of development contributes to adverse cumulative impacts. The methodologies described in Chapter 3 as well as the growing literature on particular kinds of cumulative impacts, some of which is presented in the Annotated Bibliography, can help agencies to develop this information base and to proceed with confidence that the courts will sustain their efforts.

Chapter 6: Conclusion: Barriers, Trends and Opportunities

Cumulative impact assessment, management and monitoring are multi-faceted and complex. Progress in operationalizing the concepts is likely to be very gradual, and is likely to be achieved through iterative, decentralized efforts. It will require multidisciplinary contributions from the fields of science, law, and environmental management.

The preceding analysis identified several basic components of successful cumulative impact assessment and management approaches. Managers can increase the likelihood of effectively addressing incremental environmental effects by focusing on the following factors:

- **Adequate Definitions of Key Terms.** It is important to define key terms within each statute, set of regulations, analysis or other document since there is not yet accepted common usage. Clear and consistent internal definitions are more important than unanimity in definitions from program to program.

- **Consideration of Multiple Types of Impacts.** The selected approach should have the capacity to assess not only like impacts from one type of environmental disturbance such as multiple dams on one river, but also cumulative impacts resulting from a combination of different types of impacts. They may include additive impacts of several different types of activities on a common resource, or compounding impacts which exceed the simple sum of additive impacts due to their interactive effects.

- **Broadened Geographic Scope.** The geographic scope should be broadened beyond the site to a larger region, ideally a biologically-defined area of sufficient size to encompass major factors that cause variation in the effects on the resources of concern. These boundaries may have to be modified by practical considerations of data availability, jurisdiction of participating agencies, and boundaries of political subdivisions.

- **Extended Temporal Scope.** The period covered by the assessment should consider not only immediate impacts, but should extend back in time to identify change from historic baseline conditions, and should project reasonably foreseeable future development activities and planning policies over at least a generation.

- **Use of Extrapolating Techniques.** The methodology should have the capacity to simplify complexity. Instead of tracing individual disturbances through multiple layers of effects, the methodology should be able to extrapolate from plot and watershed level investigations to project the impact over landscapes or similar broad regions, using concepts and techniques from landscape ecology, hierarchy theories, GIS, and remote sensing.

- **Goals Setting and Comprehensive Planning.** Advance planning should be used to take some pressure off permitting programs by directing development to areas where it is likely to have the fewest adverse effects. The community should set explicit goals for conservation and restoration of targeted natural resources to guide planning and permitting decisions. Through iterative efforts, the community should produce increasingly detailed implementation plans and statements of resource priorities.

- **Integrated Monitoring, Assessment and Management.** Effective control of cumulative anthropogenic impacts will require coordinated use of all three components—modeling or assessment to project impacts, management to implement strategies to minimize or reverse negative impacts, and monitoring to determine if the modeling was correct and to detect environmental changes. Continuing progress is needed on all three fronts.

Some progress is being made to incorporate these basic components in the fields of science, law and environmental management. The following sections briefly summarize the barriers, promising trends, and opportunities to achieving this more holistic environmental approach in each of these fields.

SCIENCE

The primary scientific barrier to cumulative effects assessment in a marine or coastal context consists of significant gaps in scientific knowledge about cause and effect relationships. Traditional marine research has tended to focus on either a very gross level (e.g., tracing total carbon through the system) or a very detailed level (e.g., impacts of one perturbation on a particular species in a particular location), with comparatively few mid-level studies on issues such as biodiversity, functional roles of different types of species, assessments of how much redundancy is needed in the system, or use of indicator species as a means of gauging ecosystem health. As noted in a paper prepared for the project's cumulative impacts workshop in May, 1993:

> The current capabilities of marine environmental science usually do not allow predictions of the effects of alterations to the marine environment with the accuracy, precision, and confidence that may be desired to support management decisions. On the other hand, the results of any alterations have been observed and at least some general, if imprecise,

prediction as to the consequences of alterations is often possible.[1]

As these mid-level studies come into greater currency, they may advance the level of cumulative impact assessment in coastal and marine systems.

There are several other constraints as well. For all ecosystems, there is no single accepted methodology or single accepted approach for projection of cumulative impacts. A basic debate continues over whether it is more appropriate to focus on vegetation, animals, or water quality as indicators of cumulative change. The answer may well vary from situation to situation, depending upon the available data and resources of concern.

In addition, for many coastal and marine ecosystems, historic records are very limited. In contrast to the large data base on terrestrial systems (e.g., soil and water conservation service data, U.S. Geological Survey data, aerial photographs) the data base for marine systems is generally over a much shorter duration, is much less comprehensive, and often is not collected so that it can be compared from study to study. This restricts the ability to establish historic baselines or compare with current measurements to determine the degree of change over time.

A final significant constraint is that a major portion of the work on cumulative impact assessment has been done in a terrestrial context. That work may not be easily transferable to the coastal and marine contexts. To the extent that impacts on coastal marine systems are caused by activities on the land, landscape ecology approaches may appropriately be applied to assessing terrestrial effects on aquatic resources. But in other contexts, marine ecosystems have properties which make them fundamentally different from terrestrial ecosystems including:

- The marine environment is a three-dimensional fluid environment with inhabitants in the fluid itself;

- Marine environments often have a heavy reliance on planktonic primary production; and

- Pelagic dispersal of planktonic larvae is a means of reproduction and dispersal for most benthic marine animals.[2]

Salt marshes, mangroves, and similar brackish environments with emergent vegetation represent a transition between marine and terrestrial environments and may incorporate properties of both environments. Similarly, marine-related, air breathing species without gills may have needs more akin to terrestrial species.[3]

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1. Hinga, Kenneth. 1994. "Predicting the effects of changes to the marine environment; the effects of multiple changes." Appendix C, C-1 of this report.

2. *Id.* at C-2.

3. *Id.* at C-1, C-4.

While some of the very fundamental approaches to cumulative impact assessment and management may provide models for the marine environment, the actual techniques utilized may have to be completely different. For example, James Gosselink relied on organizing principles drawn from habitat fragmentation and landscape ecology in developing his methodology for cumulative impact assessment and management in freshwater wetlands. He noted that in other types of landscapes, such as marine ecosystems, different organizing principles may very well be appropriate (Gosselink et al. 1990, 598 [Ann. Bib. #99]). Habitat fragmentation may not be a problem or may not be a problem of the same magnitude for marine and coastal species.

Other terrestrial cumulative impact techniques use indicator species or collections of species based on the premise that if these particular species are doing well, the ecosystem is generally healthy. While there is some interest in testing this approach in aquatic systems, it may hold less promise in that setting due to a current lack of understanding of how the aquatic ecosystem functions. Research has not focused on issues such as functional roles of different types of species, the necessary level of redundancy, or the contributions of rare species to the functioning of the whole.[4]

In addition, aquatic ecosystems may be subject to many more influences than terrestrial systems. They are affected by ocean currents, ocean-borne pollutants, and diseases that can travel greater distances in an aquatic medium. Distinguishing anthropogenic influences in wide open areas such as the Gulf of Maine or offshore areas may be virtually impossible. It is, however, much more likely that anthropogenic influences can be identified in very near shore areas and enclosed embayments.

There are also fundamental differences between terrestrial and aquatic research techniques. Key terrestrial cumulative impact techniques rely heavily on habitat fragmentation and loss identified by mapping of visible features (e.g., visible travel corridors, density and type of vegetative cover, etc.) and use landscape structure cartographic modeling to identify alternative solutions to terrestrial habitat fragmentation and loss. Aquatic habitat modification and deterioration is usually much less visible; at this time, only limited features can be readily identified and mapped through the use of remote sensing (e.g., contours of the seabed, materials forming the bottom surface). Moreover, key determinants of the availability of nutrients to valued marine species are not visible nor are they stationary because coastal systems are decomposer-driven. Ecosystem function simulation modeling usually has to be used to get a handle on habitat modification and deterioration in an aquatic setting. While progress has been made on this front, as evidenced by Chesapeake Bay and Long Island Sound models, it tends to be very costly. Unlike the way terrestrial GIS-assisted mapping has become common-place in local planning agencies, ecosystem function simulation modeling for aquatic habitats is not yet readily available.

Despite these barriers, some recent developments point to improved scientific capacity to predict cumulative impacts in coastal and marine ecosystems. First, several new nationally-funded or -coordinated efforts have been initiated to improve the marine data base, including national

4. Watling, Les, University of Maine Department of Oceanography. Personal communication, July 1993.

estuary programs, EPA's Environmental Monitoring and Assessment Program, and NOAA's Strategic Environmental Assessment Program. They should help address incremental environmental change by documenting baseline conditions and identifying change in key variables over time.

A second promising development are efforts to extrapolate from very detailed data in ways designed to simplify the complexity, compress the data-gathering process, and present information in a form that is comprehensible to policy makers. Examples include development of indicators of ecosystem health, increased use of indicator species or guilds, and the synoptic approaches for wetlands assessment. While very different in some respects, they share common goals; they try to avoid decision-making paralysis caused by the perception that there is never enough information upon which to act. Similarly, techniques like using indicators of ecosystem health, the synoptic wetlands approach, and regional environmental risk assessment attempt to bridge the gap between science and management by presenting information in a way comprehensible to non-scientists. They also make specific provisions for the community to articulate its values by identifying target resources, setting priorities, and identifying levels at which resource degradation is no longer acceptable.

A final promising factor is the growing availability of powerful tools to collect, manipulate and depict data. They include geographic information systems, other computerized data bases, underwater television cameras, other remote sensing systems and increasingly sophisticated computer models of estuarine processes such as those developed for Chesapeake Bay and Long Island Sound. These tools enhance the ability to analyze and accurately depict complex interaction patterns of water currents and pollutants, reduce the uncertainty in predicting causal relationships within complex natural systems, and allow evaluation of alternate management strategies.

LEGAL/INSTITUTIONAL

One of the primary legal barriers to factoring cumulative impacts into environmental decision-making often is the absence of an unambiguous statutory requirement to do so. Some environmental management laws make no mention of cumulative impacts. Others require that they be "considered." In those regulatory programs where consideration is required, the significance for decision-making is frequently lessened by a lack of useful definitions of key terms, by an absence of any further statutory or regulatory guidance on how cumulative impacts should be assessed, and confusion over the weight to give adverse cumulative impacts. Even in statutes that contain more explicit direction about how cumulative impacts should be considered, it is frequently unclear whether cumulative impacts alone can constitute grounds for permit denial, how significant those impacts have to be to justify a denial, and what evidence is required to substantiate the action.

The most detailed federal guidance on consideration of cumulative impacts is contained in NEPA regulations. While NEPA reviews are important, the number of actions fully reviewable under these standards are relatively few. Moreover, in the federal program, the review is procedural rather than substantive.

The federal program with broadest impact on the coastal area is the Section 404 program, administered by the Army Corps of Engineers. Despite express directions to consider cumulative impacts in the 404(b)(1) guidelines, it is not a priority in most Corps district offices. Many federal resource agency staff members assert the Corps is not receptive to their cumulative impact concerns, but also concede that the time and resource constraints of the 404 permit review process makes it ill-suited to managing incremental environmental change.

Some states have attempted to control adverse incremental effects through an assortment of mini-NEPA, wetlands permitting and other comprehensive planning and implementing programs. They vary greatly in their strengths and weaknesses. But even the most comprehensive planning and regulatory programs, such as Maryland's wetlands permitting efforts and Rhode Island's Salt Pond Plan and implementing ordinances, report that at best they have slowed the pace of resource degradation.

A second legal barrier is posed by the narrow context in which courts have been asked to interpret the statutory and regulatory requirements. Due to the apparent reluctance of agencies to utilize their full authority under cumulative impact provisions, until recently, the majority of cumulative impact cases reached the courts as a citizen group challenge to an agency's grant of a permit on the grounds that the agency had failed to give adequate consideration to cumulative impacts. (The case law of a few more aggressive states with explicit directions on consideration of cumulative impacts (e.g., California, Florida, and New York) is a notable exception.) Due to basic principles of administrative law, the courts often defer to agency decisions. Thus, most of the cases address the least amount agencies can do to assess cumulative impacts and still be in compliance with their statutory mandate. Only recently have courts been in a position to develop a parallel body of case law addressing how aggressively agencies can use cumulative impact concepts and still be in compliance with their statutory mandate. These cases illustrate how the same principle of judicial deference will cause courts to support agencies if they make more aggressive use of cumulative impact concepts in permit denials.

A third barrier to legal system support of integration of cumulative impact concepts is the inherent focus on individual sites in decision-making. In most cases, the regulatory and permitting laws are designed to determine whether a proposed use may be made of a particular site, without allowing a judgment through an analysis of alternatives that a particular activity would be better at a different site. There are few mechanisms for trading off acceptable degradation in, for example, an already degraded area if other off-site areas are kept pristine. Cumulative impact assessment encourages a regional perspective but traditional legal mechanisms operate from a site-specific perspective.

Attempts to foster greater efficiency in regulatory systems pose another impediment to the use of a cumulative impacts approach. Often legislatures have responded to calls to speed up the permitting process by adopting systems of general permits, permits-by-rule or similar categorical exclusions keyed to specified types of activities which it presumes will have minimal adverse impacts. This approach is antithetical to the premise underlying the cumulative impacts approach—that individual small changes can together have significant impacts. With greater knowledge of the function of a particular ecosystem, it might be possible to gain efficiency in other ways while still meeting cumulative impact goals. For example, instead of exempting all activities of a certain type, it might make more sense to adopt a tiered system requiring heightened scrutiny where adverse cumulative effects are most likely. Examples would include the first encroachment into an undisturbed area, proposed development in an already seriously threatened area, or a particular type of proposed development with likely wide-spread impacts such as a marina or bridge. Or society might determine that the threat posed by continuing incremental change is so significant that it overrides efficiency concerns and individual reviews should be required regardless of activity or size.

There is mounting evidence that the legal pendulum is swinging back toward protection of private property rights, at least at the federal level. This trend may pose a very significant impediment to incorporation of a cumulative impacts approach in environmental decision-making. In the last seven years, the U.S. Supreme Court has revisited constitutional takings issues in several key cases. While there is considerable debate over these cases, there is general agreement that the Court has articulated some new constraints on regulation of private use of land. Similarly, actions of the legislative branch show increased support for the idea that a landowner should be able to develop in accordance with investment-backed expectations; some go further and assert that a landowner should be able to develop free of any environmental constraints unless the landowner is compensated for restrictions on use. Amending regulations to address cumulative impacts may be a lower priority concern if the environmental community is forced to fight to retain even basic controls on direct adverse impacts.

Despite these barriers, there are also legal and institutional trends that bode well for strengthened consideration of cumulative impacts in environmental decision-making. For example, there is a growing body of thoughtful analyses of cumulative impacts components of NEPA, state mini-NEPA regulations, wetlands permitting programs and others, which include recommendations on amendments to strengthen those laws. Some states are actively involved in efforts to amend their laws and regulations to make cumulative impact standards more enforceable.

As different states experiment with innovative techniques, they are also acquiring more skill in the use of mechanisms designed to prevent a great disparity in gains by some landowners and losses to others based solely on the environmental characteristics of their land. For example, transfer of development rights programs allow landowners to receive some compensation for the restrictions. Other programs are experimenting with mitigation banking as a way to institutionalize tradeoffs which protect some property in exchange for the right to develop other property. Use of these types of techniques may be necessary to counterbalance the growing concern with private property rights.

Similarly, there is increased acceptance of the idea that it is preferable to limit the range of possible land uses in the first place rather than relying on a permit system to control undesirable uses. As dissatisfaction with end-of-the-line permitting grows, management strategies are giving increased attention to advanced planning, comprehensive planning, special area management, critical areas designations and similar techniques. This responds to legal constraints in two ways. It takes advantage of the fact that a court might grant an agency more discretion in adopting a long-range plan than in denying a permit application for a specific site. In addition, it is a way to limit the investment-backed expectations of landowners. Using techniques like advanced planning, special area designation, and comprehensive planning puts landowners on notice of probable restrictions on future use of the land; if they purchase after adoption of the plan or designation, their expectations should be tempered by those restrictions.

ENVIRONMENTAL MANAGEMENT

While there is significant overlap with the barriers previously identified in the fields of science and law, three additional management impediments warrant separate discussion. First, resource managers appear to be reluctant to use all of their authority to consider cumulative effects. It is very difficult for a single staff member to deviate from site-by-site assessment of direct impacts if that is the way it has always been done in a particular agency. Scientists are unable to identify definite thresholds where incremental degradation will cause system collapse. Legal mandates do not give precise directions on how adverse impacts should be balanced in reaching a decision. The workload may be daunting without taking on the additional task of trying to get reluctant colleagues, boards, and other agencies to accept a revised approach. Even if there is a nagging sense that the environment is not being adequately protected when cumulative impacts concerns are minimized, it is difficult to make the shift in approach. While not necessarily required, it is more realistic to believe that such a shift in approach could be accomplished if the leadership and resources come from top levels.

Due to growing political difficulties with relying on regulations as the primary strategy, environmental managers are going to have to develop new, non-regulatory strategies to control cumulative impacts. For example, they may need to place more emphasis on working with the individuals causing the environmental disturbance; market-based strategies like pollution prevention or economic incentives to recapture potential pollutants are possibilities. Similarly, resource managers may have to increase public education efforts so they can appeal to landowners' willingness to be good stewards of their land. They will have to communicate not just an overall vision for that part of the ecosystem, but will also have to provide landowners with very specific information about where their land fits into ecosystem functions.

A third impediment to be tackled by environmental managers is the need to develop a longer-term perspective for coastal and marine systems. Resource managers working with a terrestrial area generally have fairly good knowledge of its predisturbance state, the history of development over a period of fifty or more years, the existing regulations governing the current and future use of land, the general land use goals for the area, and the projected buildout over a period of twenty or more years. The comparable knowledge for the aquatic components of the coastal system are frequently lacking. Not only is some form of water use zoning generally absent, but usually no agency has the authority to control future use; a variety of single-purpose agencies have control over different fragments. It is rare to find long-range projections of aquatic development. In the last several years, some states have begun to take responsibility for comprehensive ocean management. These efforts will need to continue and become more detailed to support cumulative impact assessment in the marine realm.

Despite these impediments, some trends bode well for a shift to a cumulative impacts approach. Theorists understand the need to make cumulative impacts methodologies more practical and are developing techniques geared to practical constraints. There is increased receptivity to use of new institutional management structures like interstate compact agencies and cooperative associations of agencies with jurisdiction over estuaries to get beyond fragmented decision-making. Recent initiatives, often supported with federal funding, focus on planning for a biologically-defined region, typically a watershed, using a multiple-shareholder, resource-based approach to ecosystem management. State and local resource managers continue to experiment with ways to leverage existing programs, like federal consistency reviews, to find the most appropriate forum for cumulative impact concerns.

Resource managers are going to have to use creative, multi-pronged techniques to sustain the momentum toward cumulative impacts analysis in the face of a growing private property rights movement. It is important to emphasize the focus on valued resources. This may require public education through simple goals statement. For example, while the phrase "no net loss of wetlands" has always been vague and subject to multiple explanatory footnotes, it has served as a widely-recognized reminder of the importance of wetlands. Other efforts might focus on phosphorus loading, submerged aquatic vegetation or another indicator of ecosystem health. An easily articulable goals statement could further public acceptance of regulatory controls and enlist their participation in voluntary efforts to minimize harm to that resource.

In times of tight budgets and aversion to regulations, it might also be useful to stress positive, non-regulatory capabilities of cumulative impact assessment. Certain methodologies can be used to identify areas most at risk so that scarce planning and review resources can be focused on those areas. The capacity assessment capabilities can be used to promote equity among multiple communities with control over some portion of a shared resource or equity over time as a community seeks to maintain a level of environmental quality. In addition, cumulative impact assessment can be used in the nature of a diagnostic tool as communities increasingly seek to reverse past degradation and achieve habitat restoration.

SUMMARY

There are no easy answers to the problem of adverse cumulative environmental impacts and no one approach that is going to be appropriate in all situations. Each of the approaches reviewed in this report has something to commend it, but agencies must develop their own approach based on the available funding and staff, political will, data, nature of the threat, resources of concern and community goals.

Assessing and managing cumulative impacts of a proposed development or action requires a substantial shift in thinking. Reviewers have to retrain themselves to start from a resource perspective informed by carrying capacity concepts. An approach to management of cumulative impacts will not spring forth in full form, but rather will require a gradual refinement over time, using an iterative process to get closer to the goals.

Because of the need to manipulate large amounts of data, the use of computer-assisted mapping and modeling techniques will enhance the ability to extrapolate up to a more comprehensive view of ecosystem function. Similarly, monitoring of environmental changes is critical to assessment of the impact of existing changes and projection of future effects.

The capacity to engage in cumulative impact assessment may continue to be more advanced for terrestrial ecosystems than for aquatic ecosystems given the more closed nature of the system, the ability to see a greater portion of its components, the more extensive history of investigation, and the current monitoring and assessment technologies, but some level of cumulative impact assessment and management should be achievable in near shore and more enclosed coastal systems.

Cumulative impact assessment should not be viewed as an end in itself, but rather as a means of achieving the larger goal of management of cumulative impacts. Similarly, taking cumulative impacts into account in the permitting or regulatory process is just one means of managing cumulative impacts. The most successful strategies will also incorporate comprehensive planning, strategic acquisition, conservation easements, and market-based mechanisms to complement the regulatory approach.

Cumulative impact assessment and management approaches can be designed to accomplish a variety of purposes. They can set priorities for focusing scarce agency resources by, for example, identifying for heightened scrutiny permit applications in the most vulnerable areas or requiring heightened review of specified types of development likely to result in serious negative cumulative impacts. They can establish cause and effect relationships and sort out anthropogenic influences to allow a determination of how the resource decline can be reversed. In theory, with enough data, they can produce quantitative assessments of the risks of certain impacts being generated by particular activities, expressed in a manner which will allow comparisons of the relative risks of alternative uses of the resource. The sophistication of the approach will be determined by the intended application of the information and the array of resources available to the agency.

Attempts to utilize regulatory reviews to minimize adverse cumulative impacts should take place within the context of a comprehensive plan. The plan should address the particular resources of concern in a fair degree of detail so that the permit reviewers have guidance from the community on the value placed on the resource, the relative scarcity of the resource, appropriate tradeoffs between development and resource goals, and resource conservation and restoration strategies.

Cumulative impact assessment and management strategies have the greatest chance for success when all of the agencies with overlapping planning, regulatory and management authority are working toward a common goal to address a shared resource concern. It is important to have an easily stated goal to keep the effort focused. The goal should be stated in positive terms of resource restoration, not just prevention of further degradation. The goal should reflect a long-term commitment to gradual improvement over a long period of time.

Ultimately, however, management of cumulative impacts is as much a political issue as it is a technical/methodological issue. Even if scientists develop the tools to assess cumulative environmental effects, lawyers refine the necessary statutory mandates and regulatory processes, and environmental managers develop the techniques to control cumulative effects, they will not be able to manage those resources alone.

Government decision makers must accept the thesis that cumulative impacts are real, that cumulative impact assessment is useful, and that traditional decision-making protocols can change. Similarly, the general public must be persuaded that in a particular ecosystem, continued incremental change will pose a problem, that the problem is significant, and that it must be addressed. The public must endorse the importance of the resource and embrace the proposed decision-making framework.

Any such effort will require widespread public education about the effects of incremental change on valued ecosystem functions. Once educated, multiple jurisdictional authorities, regulated individuals, resource users, and other interested parties will have to act cooperatively to reach an agreement on the importance of managing cumulative environmental impacts. They will need to commit the political resources to do so.

It is a demanding process, and will not be without controversy as fundamental environmental values are debated. But the myriad of approaches and examples discussed in this synthesis give cause for cautious optimism we are evolving toward greater ability and willingness to manage cumulative coastal environmental effects.

Glossary of Terms

ACOE. U.S. Army Corps of Engineers.

ACTION. An activity or release from a source that causes a change in the flow of energy or materials (Irwin & Rodes 1992 #104).

ANADROMOUS FISH. Fish that spend most of their life cycle in marine waters but migrate upstream to spawn in rivers or streams.

BLM. Bureau of Land Management.

BOUNDARIES. The temporal and geographic limits that define which actions and effects are covered by a decision; may be political, jurisdictional, ecological, economic, or other (Irwin & Rodes 1992 #104).

CARRYING CAPACITY. The maximum population density for a given species in an environment which could be supported without degradation of that environment; ability of a natural or man-made system to absorb population growth or physical development without significant degradation or breakdown (Schnieder et al. 1978 #59).

CEQ. Council on Environmental Quality.

CEQA. California Environmental Quality Act, establishes California's environmental impact review process.

CIA. Cumulative impact assessment or cumulative impact analysis.

CLEAN WATER ACT OF 1977. Section 404 of the Federal Water Pollution Control Act, 33 U.S.C. § 1344 (1994).

CORPS. U.S. Army Corps of Engineers.

CUMULATIVE. Incremental addition or loss of energy or material. If there is no change in environmental processes, the results are additive; if the changes interact, the result is usually a change in the system's structure or function (Irwin & Rodes 1992 #104).

CUMULATIVE IMPACT. The impact on the environment which results from the incremental impact of the action when added to other past, present and reasonably foreseeable future actions (CEQ).

CWA. *See* CLEAN WATER ACT.

DECISION. The management or organizational action taken by an institution, such as a governmental program (Irwin & Rodes 1992 #104).

DOT. Department of Transportation.

EA. Environmental assessment, performed pursuant to NEPA to determine whether an environmental impact statement is required.

ECOLOGICAL FUNCTION. An aggregate behavior that arises from one or more physical, chemical, or biological processes (Leibowitz et al. 1992 #110).

ECOSYSTEM. A biological community together with the physical and chemical environment with which it interacts (Coastal America 1994 #5).

EFFECT. The reaction, result, or outcome of an action (Irwin & Rodes 1992 #104).

EIS. Environmental Impact Statement required pursuant to NEPA.

ENVIRONMENTAL PROCESS. A process such as decomposition or bioaccumulation that changes the flow of materials (Irwin & Rodes 1992 #104).

EPA. United States Environmental Protection Agency.

ESA. Endangered Species Act of 1973, as amended, 16 U.S.C. §1531 (1994).

ESTUARY. The area of coastal waters where fresh water from rivers and other upland sources meets and mixes with salt water from the ocean.

FAA. Federal Aviation Administration.

FEIS. Final Environmental Impact Statement.

FERC. Federal Energy Regulatory Commission.

FHA. Federal Highway Administration.

FONSI. Finding of no significant impact pursuant to a NEPA EA.

FWS. United States Fish and Wildlife Service.

GIS. Geographic information system.

IMPACT. The action and/or its effect. When used in contrast to "effect," implies a societal judgment (Irwin & Rodes 1992 #104).

LANDSCAPE ECOLOGY. The study of interactions among ecosystems (Leibowitz et al. 1992 #110).

LANDSCAPE. Large heterogeneous area composed of several ecosystems that are spatially and temporally linked and that function as an integrated unit (Gosselink et al. 1990).

MINI-NEPA. Used to refer to state laws which require that the environmental effects of a proposed action be disclosed, similar to the federal NEPA statute.

NATIONWIDE PERMIT 26. Applicable to headwaters and isolated waters discharges, this is one of multiple general permits issued by the ACOE which authorizes specific activities to proceed without requiring individual permit approval. 33 C.F.R. Part 330.

NEPA. National Environmental Policy Act of 1969, as amended, 42 U.S.C.S. § 4321 (1994), requires environmental impact statements for major federal actions.

NEP. National Estuary Program.

NMFS. National Marine Fisheries Service.

NOAA. National Oceanic and Atmospheric Administration.

NONPOINT SOURCES. Diffuse sources of contaminants or pollutants that cannot be attributed to a single discharge point (Coastal America 1994 #5).

PROGRAM. Unit of government or private organization with management responsibilities that relate to some aspect of using, protecting, or enhancing the environment (Irwin & Rodes 1992 #104).

RISK ASSESSMENT. A process for evaluating scientific information on the adverse effects of stressors on the environment to determine risks; ecological risk assessment evaluates ecological effects caused by human activities (US EPA 1992 #63).

SAMP. Special area management plan.

SCALE. Although scale may refer to the magnitude, scope, or level of an action or effect, it is used here as a synonym for temporal and geographic boundaries (Irwin & Rodes 1992 #104).

SECONDARY EFFECTS. Indirect effects of a perturbation, typically off-site, diffuse, and lacking a direct cause/effect relationship.

SECTION 10. Refers to Section 10 of the Rivers and Harbors Act of 1899, 33 U.S.C. §403 (1994), to maintain the navigability of waters of the United States.

SECTION 309. Refers to Section 309 of the Coastal Zone Management and Improvement Act of 1990, 16 U.S.C. § 1451 (subtitle C of the Omnibus Budget Reconciliation Act of 1990), established programs to encourage coastal states to improve management in specific areas.

SECTION 404. Refers to Section 404 of the Federal Water Pollution Control Act, 33 U.S.C. § 1344 (1994), also known as the CLEAN WATER ACT, provides the principal federal authority to regulate wetlands use.

SEQRA. New York's State Environmental Quality Review Act, requires environmental impact statements for particular actions having a significant effect on the environment.

SYNERGISTIC. Simultaneous effects from separate actions which, together, have greater total effect than the sum of their individual effects.

TECHNIQUE. Used here to connote a means or method, such as a series of overlay maps or a conceptual or computer model, for assessing the nature, magnitude, and extent of cumulative effects (Irwin & Rodes 1992 #104).

USFWS. United States Fish and Wildlife Service.

VALUED ENVIRONMENTAL COMPONENT. A characteristic or attribute of the environment that society seeks to use, protect, or enhance (Irwin & Rodes 1992 #104).

WATERSHED. A geographic area in which water, sediments, and dissolved materials drain to a common outlet which can be a point on a larger stream, a lake, an underlying aquifer, an estuary, or an ocean; also called the drainage basin of the receiving water body (EPA 1991 #9).

Appendix A:
Annotated Bibliography

CUMULATIVE COASTAL ENVIRONMENTAL IMPACTS

Human activities are adversely affecting living marine and estuarine resources along the coastal United States and the Great Lakes through destruction or alteration of habitat, degradation of water quality, and changes in salinity of estuarine waters. During the last two decades, many policy-makers and resource managers have coalesced around the idea that increased consideration of cumulative impacts of anthropogenic activities is critical to improving the success of environmental management efforts. While this is generally viewed as a laudatory goal, implementing the goal has proved to be more elusive.

There are currently a number of impediments to effective consideration and management of adverse cumulative impacts (discussed in detail in the main report). These impediments include a lack of information on the nature of impacts, assessment methods, and approaches used in other resource protection programs.

This annotated bibliography is intended to lower this information impediment. It provides coastal resource managers with an easy-to-use collection of references to documents which address many of the complex issues associated with cumulative impacts in the regulatory and management contexts. The references collected here reflect the progress that has been made to date in the evolution of cumulative impact assessment from an abstract goal into an actual factor in environmental decision-making.

Scope

An extensive list of published articles, books, scholarly journals, government agency publications, conference proceedings, statutes, regulations and case decisions were examined to include bibliographic entries on different facets of cumulative impact assessment. This annotated bibliography contains material drawn from scientific, management and legal perspectives. In selecting items for this bibliography, our primary goal was to identify assessment methodologies. However, to assist with understanding those methodologies, the bibliography also encompasses several other types of materials. It includes a small selection of background references on ecosystem health and ecosystem management. It includes extensive references on the concept of cumulative impact assessment. A separate section contains selected citations to sources of legal authority and/or responsibility to consider cumulative environmental impacts. Selected federal and state cases which contribute to the evolving interpretation of pertinent cumulative impact provisions of statutes and regulations are also included.

Substantive Focus

The bibliography focuses primarily on coastal and estuarine environments. It does, however, also include some material related to cumulative impacts in non-marine or -coastal environments because of potential applicability of the concepts to coastal or marine systems. For example, it includes material related to assessment and management of cumulative effects in freshwater wetlands. It does not, however, include the large body of material on cumulative impacts of fragmentation of terrestrial habitat on particular species such as the grizzly bear.

Abstracts

The abstracts consist of summaries prepared by the Marine Law Institute of relevant portions of the publication. The intent of the abstracters was to describe the concepts addressed in the document in sufficient detail so that the reader could determine whether the publication contains information likely to be relevant to his or her particular research. While every effort was made to prepare accurate abstracts, they merely summarize or identify the portions of the publication the abstracter deemed to be most pertinent to this bibliography. In each instance, the abstract is provided to alert the reader to issues related to cumulative impacts assessment, and to assist the reader in identifying which publications should be obtained for more complete review. The abstract is not intended as a complete summary of the document and should **not** be used as a substitute for consulting the original document.

ANTICIPATED USERS

This bibliography is designed to be used by state and federal coastal resource managers, and by environmental groups, private individuals and others who are concerned about protecting the integrity of coastal resources. Due to the high level of current interest, it was assumed that the primary audience will be resource managers who are seeking a more complete understanding of cumulative coastal environmental impacts, particularly for purposes of improving their own management efforts. However, this bibliography will assist with many other research needs as well. For example:

- One user may need arguments to convince a board or local citizens of the importance of adopting an ecosystem management approach which has the capacity to make decisions based on cumulative environmental impacts. The general background section contains pertinent information on coastal wetlands, estuaries and fisheries habitat from an ecosystem-management perspective.

- Another user may want insights into essential characteristics of regulatory or management systems which have the capacity to incorporate assessment of cumulative impacts into decision-making. The section on general cumulative impacts literature includes many publications from different resource perspectives.

- A resource manager assigned the task of modifying an existing regulatory system to address cumulative impacts may want very detailed information about a range of techniques and methodological approaches that have been used by other federal and state agencies. The manager will want to consult both the general cumulative impacts literature and the section on cumulative impact assessment methodologies.

- An environmental group may want to determine what legal authority and responsibility a particular federal agency has to consider cumulative impacts of a particular proposed action. The bibliography includes summaries of basic statutes and regulations mandating cumulative impact review by selected federal and state agencies, agency guidance documents on cumulative impact assessment methodologies, selected cumulative impacts litigation involving that agency, and, if available, scholarly evaluations of agency actions. These documents are collected or referenced in the federal or state sections of the bibliography.

- A resource manager or an agency's legal counsel may need to research issues of legal defensibility of particular techniques of addressing cumulative environmental impacts to assist with developing their agency's approach. Selected federal and state cases addressing cumulative impacts in specific regulatory and management contexts are included in the litigation subsections of the federal and state sections. Pertinent law review articles are also included under specific agencies.

MORE DETAILED DESCRIPTION OF CONTENTS

More detailed descriptions of the contents of each major section and the criteria used to select the entries in that section appear at the beginning of each section. Those descriptions should be consulted for a more complete statement of the scope and limits of this bibliography. In addition to being divided into the sections indicated, the federal agency section includes cross references to pertinent documents appearing in the general cumulative impact and cumulative impact methodology sections. The bibliography is followed by an author and subject index.

Section 1

General Background Literature: Coastal Wetlands, Estuaries and Fisheries Habitat from an Ecosystem Management Perspective

The documents included in this introductory section are examples of a much larger body of literature on coastal ecosystem management. It is not intended as an exhaustive list of relevant materials, but rather contains a range of materials that establish the context for concerns about cumulative coastal environmental impacts. The publications address one or more of the following:

(1) documentation or illustration of incremental threats to living marine resources through cumulative habitat degradation and loss (wetland loss, alteration of freshwater flows, toxic chemicals and nutrient over-enrichment);

(2) critical assessments of the degree to which fragmented governmental environmental protection efforts have failed to halt the incremental destruction of coastal resources;

(3) descriptions of emerging, innovative resource-based watershed approaches for aquatic ecosystem protection and management; and

(4) explorations of concepts and complexities associated with ecosystem management. These include questions concerning how to operationalize ecosystem concepts of "health" and "integrity", the connection between environmental health and biological diversity conservation, and the integration of public values in policy choices.

1. Bickford, Walter E., and Mark S. Tisa. 1992. Flawless fisheries through watershed management. In *Proceedings of the American Fisheries Society Symposium 13: Fisheries Management and Watershed Development*, ed. Richard H. Stroud, 13: 95-103. Newport, RI, November 12, 1991. Bethesda, MD: American Fisheries Society.

The authors point to the decline in the American land ethic and fragmented environmental protection efforts as cause for the continuing decline in water quality, ecosystem integrity and species preservation. The success of the Nashua River Watershed Association in Massachusetts, which turned one of the nation's ten most polluted rivers into a greenway corridor with protected lands, cleaner water and thriving fisheries, is

cited to illustrate what fisheries professionals working in concert with citizens groups and other governmental agencies can accomplish.

2. Chambers, James Ross. 1991. Coastal degradation and fish population losses. In *Stemming the tide of coastal fish habitat loss, Proceedings of the Marine Recreational Fisheries Symposium*, ed. Richard H. Stroud, 14: 45-51. Baltimore, MD, March 7, 1991. Savannah, GA: National Coalition for Marine Conservation.

   This paper discusses the impacts of cumulative habitat degradation and loss on estuarine-dependent fishery resources. Primary habitat threats discussed are wetland loss, alteration of freshwater flows, toxic chemicals and nutrient over-enrichment.

3. Chambers, James Ross. 1991. Habitat degradation and fishery declines in the U.S. In *Coastal Zone '91: Proceedings of the Seventh Symposium on Coastal and Ocean Management*, 46-60. NY, NY: American Society of Civil Engineers.

   The author identifies U.S. commercial fisheries which are estuarine-dependent and discusses the economic value and trends in level of abundance of those fisheries. He summarizes information about the primary habitat threats of wetland loss and degradation, toxic chemical releases, alteration of freshwater flows and nutrient over-enrichment, and highlights the implications of demographic trends for living marine resources.

4. Chambers, James Ross. 1992. U.S. coastal habitat degradation and fishery declines. In *Transactions of the Fifty-Seventh North American Wildlife and Natural Resources Conference*, ed. Richard E. McCabe, 11-19. Charlotte, NC, March 27, 1992. Washington, DC: The Wildlife Management Institute.

   In this paper, the author outlines how coastal and riverine habitat degradation are adversely affecting living marine resources. He also discusses human demographic trends indicating that, unless controlled, future human development will occur in coastal regions where concentrations of estuarine-dependent fish species are highest.

5. Coastal America. 1994. *Toward a watershed approach: A framework for aquatic ecosystem restoration, protection, and management*. Washington, DC: Coastal America.

   This document explains the basic concepts involved in using watershed approaches to aquatic ecosystem protection and management. It stresses that problems of aquatic ecosystems are most effectively addressed in a watershed context, and that the optimum watershed approach requires collaboration of multiple parties with jurisdiction over the resource. It is written for the interested layperson, and contains multiple examples and illustrations to explain the importance and implications of a watershed-based management approach.

6. Costanza, Robert, Bryan G. Norton, and Benjamin D. Haskell. ed. 1992. *Ecosystem Health: New goals for environmental management*. Washington, D.C.: Island Press.

This volume is a collection of essays by ecologists, philosophers and economists analyzing issues related to ecosystem health. Among issues analyzed are how to operationalize definitions of "health" and "integrity," how to measure ecosystem health, and how to foster the necessary public and scientific debate to make informed societal decisions about the proper goals for environmental management. The authors analyze new ways of approaching environmental management to maintain an ecological system which is stable and sustainable, that is, active, maintaining its organization and autonomy over time, and resilient to stress. One of the essays is written by James Kerr, developer of the Index of Biotic Integrity, a measurement of ecosystem health as reflected in water quality based on characterization of the fish community.

7. Dahl, Thomas E. 1990. *Wetlands losses in the United States: 1780's to 1980's*. Washington, DC: U.S. Department of the Interior, Fish and Wildlife Service.

This report to Congress documents historical wetland losses from colonial times through the 1980s. It estimates that the lower 48 states lost 53% of their original wetlands, Alaska less than 1%, and Hawaii 12%. Data are presented for each state.

8. Donovan, Michael L., and John Paul Tolson. 1987. *National Estuarine Inventory: Land use and the nation's estuaries*. Rockville, MD: Strategic Assessment Branch, Ocean Assessments Division, Office of Oceanography and Marine Assessment, National Ocean Service.

This paper presents summary information on the uses of land surrounding major estuaries of the US, examines simple land use relationships across the Nation's estuaries, and suggests ways to utilize land use information to develop national policies and programs to improve or maintain the environmental quality of the Nation's estuarine resource base.

9. Environmental Protection Agency, Office of Water. 1991. *The watershed protection approach*. Washington, DC: US EPA, Office of Wetlands, Oceans and Watersheds.

This EPA publication contains an overview of the "watershed protection approach" to water quality protection. It advocates an approach to pollution and habitat degradation problems based on a "basin-wide approach that takes into account the dynamic relationships that sustain natural resources and their beneficial uses." The proposed system utilizes integrated solutions, stakeholder participation, and risk-based geographic targeting. The publication includes examples of local, multistate and federal watershed protection projects and lists potential technical and financial resources.

10. Field, Donald W., Anthony J. Reyer, Paul V. Genovese, and Beth D. Shearer. 1991. *A special NOAA 20th anniversary report: Coastal wetlands of the United States: An accounting of a valuable national resource*. Washington, DC: NOAA, Strategic Assessment Branch, Ocean Assessments Division.

This report describes a coastal wetlands data base developed by employing the grid-sampling technique. The data base is a component of NOAA's National Estuarine Inventory, whose ultimate objective is to provide a national estuarine assessment capability. The report includes brief summaries of data in the following categories: coastal wetlands, salt marshes, coastal fresh marshes, coastal forested and scrub-shrub wetlands, and tidal flats. The authors caution against using the data for site-specific decisions, but state that it is useful for broader based decisions. An appendix contains specific coastal wetlands data, presented by region, state, Estuarine Drainage Area, and county.

11. Giles, Robert H., Jr., and Larry A. Nielsen. 1992. The uses of geographic information systems in fisheries. In *Proceedings of the American Fisheries Society Symposium 13: Fisheries Management and Watershed Development*, ed. Richard H. Stroud, 13: 81-94. Newport, RI, November 12, 1991. Bethesda, MD: American Fisheries Society.

The authors explore the capacity of geographic information systems (GIS) as a tool for improved watershed management by discussing basic capabilities of GIS, representative GIS applications in resolving watershed development problems, and limitations. They conclude that GIS can facilitate a more comprehensive approach by helping articulate watershed objectives and system-performance measures, and then producing estimates of the difference between the objectives and the proposed post-development state.

12. Houck, Oliver A. June 1988. America's mad dash to the sea. *The Amicus Journal* 21-36.

This article chronicles the destruction of coastal resources and reviews the inadequacies of current laws to reverse the conversion to other uses such as transmission and transportation corridors. He discusses coastal pollution, municipal sewage treatment works, and the limits of the National Estuary Program. The author advocates suspension of federal assistance to all activities that contribute to degrading a coastal area, and outlines several positive steps to get away from current halfway measures that "simply forestall the inevitable."

13. Houck, Oliver A. December 1988. Ending the war: A strategy to save America's coastal zone. *Maryland Law Review* 47(2): 358-405.

This article analyzes why current laws have been unable to halt the destruction of coastal and estuarine resources. It focuses on development pressures on the coastal zone and wetlands. He asserts that the current regulatory system is overwhelmed by these pressures and that the coastal zone cannot be saved without a fundamental change in the governmental approach.

14. Keiter, Robert B. March 1994. "Symposium: A New Era for the Western Public Lands": Beyond the Boundary Line: Constructing a Law of Ecosystem Management. *University of Colorado Law Review* 65: 293-333.

This analysis of a new law of ecosystem management in western public lands focuses on ecosystem management initiatives of the Forest Service, Bureau of Land Management, National Park Service and U.S. Fish and Wildlife Service. It explores the scientific, legal and institutional complexities embedded in the concept of ecosystem management. It also discusses the related concepts of watershed management, biological diversity conservation, and cumulative impact assessment. The author analyzes potential obstacles to ecosystem management, including the organic laws governing the public land management agencies, the revitalized taking doctrine, bureaucratic reluctance, local political resistance, evolving scientific knowledge, and the need to integrate public values in policy choices.

15. Odum, William E. 1982. Environmental degradation and the tyranny of small decisions. *BioScience* 32(9): 728-29.

    The author discusses the usually less than optimal process of making big decisions in a post hoc fashion as an accretion of a series of small, apparently independent decisions, termed the "tyranny of small decisions," in relation to environmental issues. He recommends that scientists, planners, politicians and environmental science teachers all develop a more holistic perspective.

16. Odum, William E. 1970. Insidious alteration of the estuarine environment. In *Transactions of the American Fisheries Society, Proceedings of the American Fisheries Society*, No. 4: 836-847. Bethesda, MD: American Fisheries Society.

    This paper reviews several important characteristics of the estuarine environment to emphasize the delicate nature of estuaries and to explain their vulnerability to alteration from apparently innocuous causes. The author discusses the estuary as a nutrient and pollution trap, estuarine food webs (including importance of organic detritus, other sources of primary production, interruption of energy flow in input), vulnerability of estuarine organisms, and sedimentary control of estuarine waters (including dredging and filling, lowered dissolved oxygen, bulkheading) and the role of freshwater inflow.

17. Pawlowski, Robert J., and Merton C. Ingham. 1992. *Quantifying resource loss through habitat degradation: Proceedings of the first NMFS Northeast Environmental Workshop*. Gloucester, MA, March 13-14, 1991. Washington, DC: NOAA.

    This is a summary of a workshop held March 13-14, 1991 in Gloucester, Massachusetts on the problem of quantifying living marine resources losses as a result of habitat degradation. Panels addressed expanding fishery habitat protection through the regional Fishery Management Councils and the Atlantic States Marine Fisheries Commission, existing scientific information concerning resource and habitat loss, and policy aspects of habitat loss, mitigation and restoration. Assorted workshop handouts are included in the appendices.

18. Royce, William F., Larry A. Nielsen, C. L. Dominy, John S. Gottschalk, and Carlos Fetterolf. 1992. Session summaries. In *Proceedings of the American Fisheries Society Symposium 13: Fisheries Management and Watershed Development*, ed. Richard H. Stroud, 13: 253-262. Newport, RI, November 12, 1991. Bethesda, MD: American Fisheries Society.

    Section 6 contains session summaries for each of the six sessions of the American Fisheries Society Symposium, "Fisheries Management: Dealing with Development in the Watershed." Of particular interest, Session 2 Summary discusses watershed level evaluation, and Session 3 Summary discusses mitigation of watershed impacts.

19. Scholfield, Carl L. 1992. The watershed as an experimental unit in fisheries research. In *Proceedings of the American Fisheries Society Symposium 13: Fisheries Management and Watershed Development*, ed. Richard H. Stroud, 13: 69-79. Newport, RI, November 12, 1991. Bethesda, MD: American Fisheries Society.

    The author explores the potential of watershed-level research programs as sources of watershed-function knowledge. Work at the Hubbard Brook and Adirondack Mountain watershed research stations is described as having been highly successful for evaluating the effects of watershed treatment such as timber harvest and liming.

20. Stroud, Richard H., ed. 1992. Proceedings of the American Fisheries Society Symposium 13: Fisheries Management and Watershed Development. Newport, RI, November 12, 1991. Bethesda, MD: American Fisheries Society.

    The proceedings, divided into five technical sessions, include discussions of watershed evaluation techniques for fisheries management, and habitat loss mitigation and prevention strategies.

21. Tiner, Ralph W., Jr. 1987. *Mid-Atlantic wetlands: A disappearing natural treasure*. Newton Corner, MA: U.S. Fish & Wildlife Service.

    This publication is the first State report completed by the National Wetlands Inventory Project of the U.S. Fish and Wildlife Service. It includes discussions of wetland concepts and classification, National Wetlands Inventory techniques, wetland formation, hydric soils, wetland vegetation, wetland values, wetland trends and wetland protection.

22. Wade, Jeffry S. July 1992. *Maintenance and restoration of freshwater flows to estuaries for fisheries habitat purposes*. Technical Report No. 65. Gainesville, FL: Florida Sea Grant College Program.

    This report examines Florida's regulatory programs and planning initiatives to evaluate their contribution to maintaining freshwater inflow to estuaries. Describing the freshwater inflow as an important factor in maintaining the biological health of an estuary, the report makes recommendations to strengthen consideration of freshwater needs of estuarine habitat in establishing minimum flows and levels, in consumptive use permitting, in surface water management, in water supply needs and sources assessments and in water shortage plans. The report addresses cumulative decisions which fail to consider the freshwater habitat-based needs of estuarine fisheries.

Section 2
General Cumulative Impact Literature

The documents included in this section of the bibliography all examine specific facets of cumulative environmental impacts, but do not have as their primary focus specific cumulative impact assessment methodologies or techniques. Publications which focus on specific assessment methodologies are included in the following section; however, the materials included in this section may be highly relevant to the consideration of specific assessment methodologies, so both sections should be consulted.

These publications address one or more of the following:

(1) analyses of cumulative effects, cumulative impacts, assessment of cumulative effects, and cumulative impact assessment, and how they differ from traditional environmental impact assessments;

(2) discussions of conceptual foundations and practical requirements for successful management of cumulative environmental impacts, such as boundary issues, scales of assessment, thresholds and carrying capacity analyses, and comprehensive planning context;

(3) exploration of scientific issues involved in cumulative environmental impact assessment;

(4) analyses of concepts related to cumulative effects management such as sustainable use, sustainable development, regional planning, integrated resource management, and regional ecological risk assessment; and

(5) examination of cumulative impacts associated with particular activities (e.g., small boat navigation, timber harvesting, hydroelectric development), particular stresses (e.g., concurrent stresses from point and nonpoint sources, internal and external habitat modifications, other anthropogenic stresses), or particular types of species (e.g., migratory birds, anadromous fish).

As noted previously, some of these documents focus on non-coastal systems, for example bottomland hardwood wetlands, urban landscapes, or uranium mining. They were included either because of a potential impact on coastal ecosystems, or because of the potential for transferability of the cumulative impact concepts from the terrestrial to the marine environment.

23. Barr, Bradley W. 1993. Environmental impacts of small boat navigation: Vessel/sediment interactions and management implications. In *Coastal Zone '93: Proceedings of the Eighth Symposium on Coastal Management*, ed. Orville T. Magoon, 1756-1770. New York, NY: American Society of Civil Engineers.

Responding to interest about cumulative and indirect effects of small shoreline development projects, the author draws together existing information to project environmental impacts of small boat navigation due to vessel operation-induced turbidity in shallow coastal environments. He describes the ways vessel operation may cause sediments to be suspended or resuspended in the water column or otherwise increase ambient turbidity in shallow coastal environments through bank erosion, propeller wash and direct contact (e.g., prop dredging); discusses biological impacts and briefly explores management options.

24. Baskerville, Gordon. 1985. *Some scientific issues in cumulative environmental impact assessment.* Paper presented at the Canadian Environmental Assessment Workshop on Cumulative Impacts Assessment on 5-7 Feb. 1985, Vancouver, B.C. Vancouver, B.C., February 5, 1985.

The author advocates increased scientific rigor in cumulative environmental impact assessment to properly account for highly variable terrestrial systems over geographic area and over time. He analyzes the scientific issues of how to design quality research and how to approach impacts that accumulate in different manners, and identifies substantial practical difficulties of maintaining scientific rigor as researchers move from site-specific to national scales.

25. Beanlands, Gordon E. 1992. *Cumulative effects and sustainable development.* Paper presented at the United National University International Conference on the Definition and Measurement of Sustainability: The Biophysical Foundations on 22-25 June 1992, Washington, DC.

In comparing the concepts of cumulative effects management and sustainable development, the author identifies common roots and similarities. While both evoke an intuitive understanding of the complexity of the related issues, he asserts it has proven difficult to translate either concept into practice. He describes "cumulative effects" as "the long-term accumulation of residual environmental changes resulting from all previous developmental actions" (p.1) and identifies the expanded nature of time, space and organizational scales used in interpreting the effects as distinguishing cumulative effects assessments from single project reviews. He notes there has been a proliferation of methodologies, techniques and approaches, but suggests that it is often hard to distinguish these methods from basic principles involved in regional planning, river basin planning and integrated resource management, and suggests that the utility of the guidance may be open to question. He concludes that the intuitive understanding of the concept is more advanced than the ability to apply that knowledge. Finally, characterizing cumulative effects as a slow, unidirectional change, he hypothesizes that ambivalence over when to take corrective action will be affected by the nearness of the cumulative variable to a threshhold; the length of time between observations of the trends; and an abrupt change in the rate of change.

26. Beanlands, Gordon E., W. James Erckmann, Gordon H. Orians, Jon O'Riordan, David Policansky, M. Husain Sadar, and Barry Sadler, ed. 1986. *Proceedings of the workshop on cumulative environmental effects: A binational perspective.* Cat. No. EN 106-2/1985: Toronto, February 4, 1985. Ottawa, Ontario: Canadian Environmental Assessment Research Council and the U.S. National Research Council Board on Basic Biology, Committee on Applications of Ecological Theory to Environmental Problems.

This document contains papers prepared for a joint Canadian/United States workshop, a synopsis of discussions and recommendations of the workshop. Issues of cumulative effects assessment were explored primarily from the perspective of natural sciences and their relationship with management decisions. It includes four sets of scientific and management papers addressing terrestrial, fresh water, marine and atmospheric systems.

27. Bedford, Barbara L., and Eric M. Preston. 1988. Developing the scientific basis for assessing cumulative effects of wetland loss and degradation on landscape functions: Status, perspectives, and prospects. *Environmental Management* 12(5): 751-771.

This article is a synthesis of a series of articles in this volume on the scientific basis for assessing cumulative effects of freshwater wetland loss. It discusses the mismatch between the national and regional impacts of wetland losses and the site-specific scale at which regulatory decisions are made, summarizes scientific understanding, and reviews a landscape approach to cumulative impact assessment as a means of bringing the scales of research and regulation into closer alignment with the scales of effects.

28. Bregha, Francois J., Jamie Benidickson, Don Gamble, Tom Shillington, and Ed Weick. 1990. *The integration of environmental considerations into government policy*. The Rawson Academy of Aquatic Science Cat. No. EN107-3/19-1990. Hull, Quebec: Canadian Environmental Assessment Research Council.

This report focuses on methodological issues of how to integrate environmental factors into the policy-making process, and procedural issues of how to adapt environmental impact assessment techniques to the decision-making process. It analyzes issues to be addressed in implementing integrated assessment, and scientific and methodological issues to be addressed, particularly in examination of cumulative impacts.

29. Cada, Glenn F., and Carolyn T. Hunsaker. 1990. Cumulative impacts of hydropower development: Reaching a watershed in impact assessment. *The Environmental Professional* 12: 2-8.

This paper presents a conceptual framework for cumulative impact assessment, including a discussion of functional pathways that contribute to cumulative effects, modified to reflect specific effects of hydroelectric development. To illustrate the importance of geographic scale in cumulative impact assessment, this article briefly describes three basin-wide cumulative impact studies conducted by FERC and compares the various assessment approaches taken. It also discusses a nationwide FERC study conducted pursuant to the Electric Consumers Protection Act of 1986. It concludes that cumulative impact analysis useful to decision-makers can be conducted and that the level of detail in the assessment depends upon both the availability of data and the scale of the assessment.

30. Cairns, John Jr. 1990. Gauging the cumulative effects of development activities on complex ecosystems. In *Ecological Processes and Cumulative Impacts: Illustrated by Bottomland Hardwood Wetland Ecosystems*, edited by J. G. Gosselink, L. C. Lee, and T. A. Muir. 239-256. Chelsea, MI: Lewis.

The author analyzes the barriers to precisely judging the aggregate impact of a variety of human-induced stresses, including fragmentation of management authority, failure to test the effects of mixtures of chemicals and other stresses, and narrowed perception of agency responsibilities. He discusses the need for integrated resource management, barriers, and the need to recognize different levels of risk and the information to be generated in each.

31. Childers, Daniel L., and James G. Gosselink. 1990. Assessment of cumulative impacts to water quality in a forested wetland landscape. *Journal of Environmental Quality* 19: 455-464.

The researchers applied a landscape approach and large-scale analysis to study the cumulative impacts in bottomland hardwood forests in the Tensas Basin, Louisiana. Using historical records, researchers identified trends in nutrient concentration, and identified nutrients affecting aquatic productivity. They identified goal-oriented management practices, and recommended that individual permits be reviewed within the context of a comprehensive management plan.

32. Cobourn, John. 1989. Is cumulative watershed effects analysis coming of age? *Journal of Soil and Water Conservation* 44: 267-270.

The author evaluates whether cumulative watershed effects analysis is gaining acceptance as the key to protection of water quality and sustained forest yield, specifically from the perspective of state and federal agencies operating in California's forests. Describing cumulative watershed effects analysis as an advanced means of controlling nonpoint-source pollution, the author reviews the regulatory context, resource use conflicts between timber harvest and anadromous fisheries, and evolving methodologies for cumulative effects analysis. Future directions identified include coordinated resource management planning and use of geographic information systems for tracking and inventories.

33. Cocklin, Chris, Sharon Parker, and John Hay. 1992. Notes on cumulative environmental change. I: Concepts and issues. *Journal of Environmental Management* 35(1): 31-49.

This paper analyzes the potential for assessment of cumulative environmental change to address the failing that environmental impact assessment, as generally practiced, is reactive and single project-based. After a brief analysis of the evolving significance of the concept of cumulative change, sources of cumulative change, pathways of accumulation, and impact accumulation, the authors summarize key considerations in cumulative effects assessment, including: boundary issues, system response characteristics, monitoring, cumulative socio-economic impacts, and evaluation. It also discusses the institutional arrangements and procedures (with an emphasis on New Zealand), and conceptual links to sustainable development.

34. Comer, Robert D. 1984. Understanding secondary effects of development on wildlife resources in mitigation planning. In *Issues and Technology in the Management of Impacted Western Wildlife: Proceedings of a National Symposium*, ed. Robert D. Comer, 16-31. Boulder, CO: Thorne Ecological Institute.

In this paper, the author focuses on indirect (secondary) effects (as opposed to direct (primary) or cumulative effects) of development on wildlife. These effects are typically off-site, diffuse, and do not show a direct cause/effect relationship. The author reviews biological and institutional constraints to dealing with secondary effects, and discusses mitigation of secondary effects.

35. Committee on the Applications of Ecological Theory to Environmental Problems, et al. 1986. The special problem of cumulative effects. In *Ecological Knowledge and Problem Solving: Concepts and Case Studies*, 93-103. Washington, DC: National Academy Press.

Chapter 9 draws, in part, on the 1985 joint U.S./Canadian workshop (see Gordon E. Beanlands, et al., at record number 26). It discusses the biological nature of the cumulative effects problem, kinds of cumulative effects and definitions of key terms, predictive difficulties, problems with selection of appropriate spatial and temporal scales, and the need to move beyond a site-specific approach. It includes general recommendations for research and management.

36. Contant, C. K., and L.L. Wiggins. 1993. Toward defining and assessing cumulative impacts: Practical and theoretical considerations. In *Environmental Analysis: The NEPA Experience*, ed. Hildebrand, Stephen G. and Johnnie B. Cannon, 336-356. Boca Raton, FL: CRC Press.

This chapter explores the conceptual foundations and practical requirements of cumulative impact assessment. It examines definitions of cumulative impacts as derived from regulatory references, the courts, researchers and practitioners. It then analyzes impact assessment methodologies (programmatic assessments, suitability studies, and carrying capacity studies), comparing them to an ideal cumulative impact assessment methodology.

The authors discuss potential improvements to cumulative impact assessment through enhanced monitoring of actions and impacts over time and space, advancements in scientific modeling of complex natural systems, and improved management through mitigation and graduated levels of analysis.

37. Davies, Katherine. 1992. *Report of a workshop on monitoring cumulative environmental effects*. Report prepared for Federal Environmental Assessment Review Office and The Environmental Assessment Division, Environment Canada. Orleans, Ontario: Ecosystems Consulting Inc.

This paper summarizes the presentation and discussion at a workshop on monitoring cumulative environmental effects, held in anticipation of implementation of the proposed Canadian Environmental Assessment Act. The Act requires analysis of cumulative effects of proposed projects and implicitly requires that follow-up monitoring programs include monitoring for cumulative effects. The proceedings include an overview of cumulative environmental effects and presentations on various environmental monitoring programs by practitioners.

38. Davies, Katherine, and Gregg Sheehy. 1991. *Workshop on Cumulative Environmental Effects and the Proposed Canadian Environmental Assessment Act (Bill C-78)*. Paper prepared for Federal Environmental Assessment Review Office. February 21, 1991. Orleans, Ontario: Ecosystems Consulting Inc.

This paper reports on a one-day workshop intended to begin the process of developing a prescriptive approach for conducting assessments of cumulative environmental effects in compliance with the proposed Canadian Environmental Assessment Act. Among topics addressed are whether to address cumulative impacts in policy development and planning or in project-specific reviews, the appropriate roles and responsibilities for proponents and government departments, and how to develop guidelines for the process of and context for assessment of cumulative environmental effects.

39. Foran, Jeffrey A. 1990. *Assessment and regulation of cumulative stresses in aquatic ecosystems*. Paper prepared for workshop on making decisions on cumulative impacts. Background paper no. 2. June 27, 1990. Washington, DC: The Conservation Foundation.

This paper was prepared for the conference which formed the basis for the Irwin et al. report, "Making Decisions on Cumulative Environmental Impacts." It describes some cumulative stresses on aquatic ecosystems (e.g., toxic pollutants, conventional pollutants, acidification, habitat modification within streams and lakes and in the watershed, changes in physical parameters, and selective harvesting) and their effects, and reviews the limited current regulations to control cumulative stresses (point and nonpoint source regulatory approaches under the Clean Water Act and state Water Quality Standards, Great Lakes Water Quality Agreement). The author calls for future integrated assessment and regulation of cumulative stresses in aquatic ecosystems at the ecosystem

level, which addresses concurrent stresses from point and nonpoint sources, internal and external habitat modifications, and other stresses of natural or human origin.

40. Gilliland, Martha A., and B. David Clark. 1981. The Lake Tahoe Basin: A systems analysis of its characteristics and human carrying capacity. *Environmental Management* 5(5): 397-407.

The article provides insight into the role of carrying capacity in cumulative impacts management. The authors state that a large proportion of the Lake Tahoe Basin's environmental deterioration is the result of cumulative impacts and that environmental planning often fails to account for cumulative impacts. To establish the carrying capacity of the Lake Tahoe Basin, as mandated by President Carter, the authors state that system input must be limited. They describe two methods for imposing limits upon system input: Environmental Threshold Standards Approach and External Limits Approach. The article concludes that management of growth within a socially defined carrying capacity is the only way to prevent additional environmental degradation.

41. Good, James W. 1987. Mitigating estuarine development impacts in the Pacific Northwest: From concept to practice. *Northwest Environmental Journal* 3(1): 93-113.

The author discusses cumulative impacts issues as a component in developing a strategy for mitigating the adverse effects of estuarine development. He advocates conducting cumulative impact analysis on a regional or estuary-wide scale, especially when considering migratory birds, anadromous fish, and particular marine species. The author identifies questions and sources of information which provide a starting point from which to assess cumulative impacts of estuarine loss.

42. Gosselink, James G., Lyndon C. Lee, and Thomas A. Muir. ed. 1990. *Ecological processes and cumulative impacts: Illustrated by bottomland hardwood wetland ecosystems*. Chelsea, MI: Lewis.

This book reports on three workshops sponsored by EPA, beginning in 1984, to describe ecological processes in bottomland hardwood forest ecosystems and the effect of human activities. The workshops were precipitated by concern about rapid decimation of this type of freshwater wetland. The first two workshops concentrate on local sites and ecosystems; the third workshop reflects a growing recognition of the importance of cumulative impacts and focuses on large scale landscapes. Individual papers include: "Federal Statutes and Programs Relating to Cumulative Impacts in Wetlands" by Thomas A. Muir, et al., "Gauging the Cumulative Effects of Development Activities on Complex Ecosystems" by John Cairns, Jr., and "Cumulative Impacts of Bottomland Hardwood Forest Conversion on Hydrology, Water Quality, and Terrestrial Wildlife" by Larry D. Harris and James G. Gosselink. In assessing the implications of the workshops (Chapter 19), the authors make detailed observations about the shortcomings of current wetland regulations to address cumulative impacts, the need for effective management to focus on the landscape scale, the importance of current permit reviews giving greater weight

to landscape ecology principles and cumulative impact evaluation, and the overarching importance of advanced planning at landscape scales to provide the appropriate context for regulatory reviews. The book also includes an appendix on governmental and private sources of aerial photography, maps, data on climate, hydrology, vegetation, soils, geology, and other baseline environmental information pertaining to wetlands. (See also entries under Muir #148, Cairns #30, and Harris #43.)

43. Harris, Larry D., and James G. Gosselink. 1990. Cumulative impacts of bottomland hardwood forest conversion on hydrology, water quality, and terrestrial wildlife. In *Ecological Processes and Cumulative Impacts: Illustrated by Bottomland Hardwood Wetland Ecosystems*, edited by J. G. Gosselink, L. C. Lee, and T. A. Muir. 259-322. Chelsea, MI: Lewis.

The authors review the ecological functions and processes performed by bottomland hardwood forested wetlands, review the history of conversion of bottomland forests, and analyze in detail the cumulative impacts of human activities on those forests. They argue that evolving concepts of ecosystem integrity must guide policy and decision-making.

44. Harris, Larry D. 1988. The nature of cumulative impacts on biotic diversity of wetland vertebrates. *Environmental Management* 12(5): 675-693.

The author analyzes examples of cumulative impacts on vertebrate biotic diversity, looking at trophic and habitat pyramids and different types of accumulations of impacts. He discusses the difficulties facing land use managers trying to maintain species diversity due to complexity of interactions, limits on predictive ability, and lack of understanding, and stresses the need for impact assessment on a landscape or regional scale.

45. Hemond, Harold F., and Janina Benoit. 1988. Cumulative impacts on water quality functions of wetlands. *Environmental Management* 12(5): 639-653.

The authors describe major processes that take place in wetlands, illustrating that wetlands are not mere filters, but rather embody chemical, physical and biotic processes that affect wetland and downstream water quality. They suggest the need for additional field measurements to supplement traditional assessment methods to assist in predicting the effects of cumulative impacts.

46. Hirsch, Allan. 1988. Regulatory context for cumulative impact research. *Environmental Management* 12(5): 715-723.

After documenting a continuing loss of wetlands despite Section 404 of the Clean Water Act, the author asserts that to make politically and legally defensible decisions, regulators need to enhance their ability to describe wetland values and development impacts, including the cumulative effects of site-specific decisions. He outlines information and research needs, analyzes the federal wetlands regulatory program, discusses the limitations on considering cumulative impacts in individual permits, evaluates evolving basinwide or regional approaches, makes practical recommendations for research, and details approaches regulators can use while acting within the existing framework (correlate historic wetland losses with loss of wetland functions and values; conduct regional case studies; develop guidelines for regional field studies; devise indices of cumulative impact for use in permit review, especially when expensive data collection and analyses are not possible)

47. Horak, Gerald C., and Evan C. Vlachos . 1982. Cumulative impacts and wildlife. In *Issues and Technology in the Management of Impacted Western Wildlife: Proceedings of a National Symposium*, edited by R. D. Comer. 7-13. Technical Publication No. 14, Boulder, CO: Thorne Ecological Institute.

This an overview of the cumulative impact issue in general, applicable to other resources, as well as fish and wildlife. It mentions various methodologies, specifically focusing on threshold determination. It advocates basing cumulative impact assessment upon a holistic perspective and offers recommendations in the areas of education, research, data bases and institutions.

48. Horak, Gerald C., Evan C. Vlachos, and Elizabeth W. Cline. 1983. Fish and wildlife and cumulative impacts: Is there a problem? Kearneysville, W.VA: Dynamac Corporation under contract with the U.S. Fish and Wildlife Service, Eastern Energy and Land Use Team.

One of three documents written for a U.S. Fish and Wildlife study entitled "Methods for Determining Cumulative Effects of Coal Activities on Fish and Wildlife Resources," this discussion of cumulative impacts issues is written for policymakers and the public. It discusses cumulative impacts as they relate to Section 7(a) of the Endangered Species Act, 16 U.S.C. 1536(a) and presents three hypothetical cases which illustrate how cumulative impacts issues may be addressed.

49. Institute for Environmental Negotiation, University of Virginia. 1991. *Management of cumulative impacts in Virginia: Identifying the issues and assessing the opportunities.* Virginia Council on the Environment's Coastal Resource Management Program.

This study, prepared as background material for Virginia's Coastal Resources Management Program, examines concepts of cumulative impact management and its actual current practice, both in Virginia and in other states. It discusses definitions of cumulative impacts, identifies various obstacles to managing cumulative impacts, analyzes issues identified by interviewees in Virginia, and reviews selected approaches from other states (focusing on statutory language/case law issues, environmental impact laws, planning approaches, permitting practices, organizational structure, and technical support). Findings address opportunities for improvement in Virginia. A separate technical appendix includes 101 selected program descriptions, statutes and regulations pertaining to cumulative impact management.

50. Irwin, Frances H. 1991. An integrated framework for preventing pollution and protecting the environment. *Environmental Law* 22(1): 1-76.

The author describes a vision for the next generation of environmental laws to create an integrated framework for pollution prevention and control. Among other concepts, the article describes the need to shift the focus to regions or ecosystems as the appropriate scale for environmental assessment, to utilize risk assessment as a common way to compare impacts within or across media, and to develop technical tools (such as ecological risk assessment and geographic information systems) to organize information to make decisions on the basis of total risk reduction.

51. Kusler, Jon A., and Patricia Riexinger, ed. 1986. *Proceedings of the national wetland assessment symposium*, ASWM Technical Report 1: Portland, ME, June 17, 1985. Chester, VT: Association of State Wetland Managers.

These proceedings of a symposium sponsored by federal and State of Maine environmental and regulatory agencies consist of a collection of 60 short papers on conducting wetland assessments and evaluating approaches. Comprehensive wetland evaluation methods emphasize the Adamus (Federal Highway Administration) method. Papers also consider special assessment needs for regulatory purposes, data sources, boundary definition, impacts of particular activities, buffers, mitigation, legal issues and regional perspectives. Chapter 9 focuses on assessing cumulative impacts. See also entries under Witmer #133, Estevez #94 and Stakhiv #123.

52. LeBlanc, Patrice. 1992. The assessment of cumulative environmental effects (Draft). 52 pp. Ottawa: Federal Environmental Assessment Review Office.

This publication contains a good overview of cumulative environmental effects assessment, including discussion of definitions, relationship to environmental assessment, and cumulative effects assessment methodologies. It also describes the Canadian Environmental Assessment Research Council's research agenda and discusses the new Canadian Environmental Assessment Act.

53. Lee, Lyndon C., and James G. Gosselink. 1988. Cumulative impacts on wetlands: Linking scientific assessments and regulatory alternatives. *Environmental Management* 12(5): 591-602.

This article draws on earlier work of the authors on bottomland hardwood ecosystems to analyze and apply the major concepts discussed in the Preston and Bedford article (Rec. # 116) appearing earlier in the same journal. It gives examples to illustrate the need for a landscape focus, and discusses the requirements for goal-setting or pre-planning to provide the context for regulatory decisions. The authors also discuss appropriate spatial and temporal scales, and the need to link technical information on effects with the evaluation of impacts in a regulatory program.

54. NUS Corporation. 1976. *Overview environmental study of cumulative effects of electric power development in the Delaware River Basin, 1975-1989*. Prepared for submission to the Delaware River Basin Commission. NUS 3085. Rockville, MD: NUS Corporation.

This regional study of the cumulative effects of new electrical generating facilities on the Delaware River Basin was prepared for water resource planning and regulatory/administrative decisions on siting of new major facilities. After looking at several possible impacts, it concludes that the only major cumulative, interactive or interrelated effects to be expected from the planned development which are important (but not necessarily limiting) are the aquatic effects of once-through cooling and the consumptive use of fresh water.

55. O'Brien, Arnold L. 1988. Evaluating the cumulative effects of alteration on New England wetlands. *Environmental Management* 12(5): 627-636.

Looking specifically at New England's patterns of glacial deposition, the author discusses wetland occurrence and function. He finds that additional research is required before hydrologic function can be reliably correlated with physical properties of wetlands and landscapes, and proposes a model for future research.

56. Orians, Gordon H. November 1990. Ecological concepts of sustainability. *Environment* 32(9): 10-39.

This article discusses limits on the sustainable use of physical processes in the environment and the decisions presented by the choice of "valued ecosystem components" as guides in decisionmaking. The author discusses factors which favor short-term nonsustainable development, including unknown rates of critical processes, time frames that are too short, spatial frames that are too small, and economic incentives for overuse.

57. Peterson, E. B., Y. H. Chan, N. M. Peterson, G. A. Constable, R. B. Caton, C. S. Davis, R. R. Wallace, and G. A. Yarranton. 1987. Cumulative effects assessment in Canada: An agenda for action and research. Hull, Quebec: Canadian Environmental Assessment Research Council.

This report presents a review of state-of-the-art cumulative effects assessment in Canada. It identifies several different types of cumulative effects, distinguished by different functional pathways. It also discusses a conceptual framework for cumulative effects assessment based on three linked components: ecosystem, research and management, looks at alternative institutional arrangements for responding to cumulative effects, and reviews some Canadian case studies with cumulative effects assessment (leaded gasoline, aquatic systems, land use practices, radiation hazards, Great Lakes water quality). It presents an action program and research agenda to enhance ecosystem-management, research-ecosystem and research-management links.

58. Salwasser, Hal, and Fred B. Sampson. 1985. Cumulative effects analysis: An advance in wildlife planning and management. In *Transactions of the Fiftieth North American Wildlife and Natural Resources Conference: Taking Stock: Resource Management in the 50th Year*, ed. Kenneth Sabol, 313-231. Washington, DC, March 15, 1985. Washington, DC: Wildlife Management Institute.

Welcoming cumulative effects analysis as a major advance in wildlife management and planning, the authors discuss concerns for keeping cumulative effects analysis practical and useful. They recommend limiting the complexity to major causes and effects, addressing a sufficiently large geographic area to encompass the major factors that cause variation in the effects, and distinguishing causes and effects of natural processes from human-induced events. The article also reviews recent advances in wildlife planning which are important to cumulative effects analysis.

59. Schnieder, Devon M., David R. Godschalk, and Norman Axler. 1978. The carrying capacity concept and its planning applications. In *The carrying capacity concept as a planning tool*, 1-10. Chicago, IL: American Planning Association.

Drawing on ecosystems management concepts, the authors extend the carrying capacity concept to include man-made as well as natural systems, and discuss its potential use as a planning tool. After outlining underlying assumptions, they examine applications to development of land use controls and as an early warning system for environmental protection. They suggest that the carrying capacity concept as a way of thinking about planning may have more value than specific, very complex, capacity studies.

60. Siegel, Donald I. 1988. Evaluating cumulative effects of disturbance on the hydrologic function of bogs, fens, and mires. *Environmental Management* 12(5): 621-626.

The author reviews the current understanding of the hydrologic function of bogs, fens, and mires, and discusses possible cumulative impacts on hydrologic function. Predicting cumulative impacts on bogs, fens and mires is characterized as extremely difficult due to limited quantitative studies, complexity of geologic settings, and use of inexact methods to measure wetland streamflow, groundwater flow, and evapotranspiration.

61. Soulé, Michael E. 1991. Land use planning and wildlife maintenance: Guidelines for conserving wildlife in an urban landscape. *American Planning Association Journal* 57(3): 313-323.

Based on a case study of the fate of birds in chaparral fragments around San Diego, the author discusses island biogeography and conservation biology in an attempt to develop planning guidelines for protecting wildlife in fragmenting systems. When prevention of fragmentation is not possible, the author discusses options for linking of habitat elements by habitat corridors, contiguous space set-asides, mitigation banking, artificial transportation of organisms, and urban design modification.

62. Truett, Joe C., Henry L. Short, and Samuel C. Williamson, n.d. Ecological impact assessment. In *Wildlife Management Techniques*, ed. T. Bookhout, Washington, DC: The Wildlife Society.

This chapter reviews the practice of environmental impact assessment and wildlife management, recommending that impact assessment focus on habitat factors. The concluding portion of the chapter discusses cumulative impact assessment, and recommends emphasizing scientific, cause-effect progressive goals; using a generation-long, ecosystem-level problem-solving process; and "ratifying an interagency collaborative drive toward extensive improvement in the situation." The authors anticipate that cumulative impacts assessment will probably be undertaken by interdisciplinary teams of biologists, other scientists and decision-makers.

63. U.S. Environmental Protection Agency. February 1992. *Framework for ecological risk assessment*. EPA/630/R-92/001. Washington, DC: US EPA.

One of several EPA publications on risk assessment, this framework document introduces the concepts of ecological risk assessment, analyzes problem formulation, analysis of exposure and ecological effects, and risk characterization. Among analysis phase issues identified are "quantifying cumulative impacts and stress-response relationships for multiple stressors".

64. Vlachos, Evan C. 1985. Assessing long-range cumulative impacts. In *Environmental Impact Assessment, Technology Assessment, and Risk Analysis*, ed. V. T. Covello, Jeryl L. Mumpower, Pieter J. M. Stallen, and V. R. R. Uppuluri, G4: 49-79. New York, NY: Springer-Verlag.

This article provides an excellent overview of the theory of cumulative impact assessment, including its background and then-current status. It includes a conceptual "map" of cumulative impacts; a matrix of impacts over time showing causal chain and aggregative emphasis; and a discussion of additive, interactive, and diachronic effects and methods of assessment. The author characterizes impact assessment as the starting point in a long-range, comprehensive planning process and explains its relationship with other types of assessment. He states that the lack of a generally accepted methodology has limited its effectiveness in the planning process. In addition, he advocates a holistic approach that recognizes beneficial, as well as adverse, impacts. Asserting that new procedures and standards must be created, the author cautions against using modified traditional environmental assessment procedures to assess cumulative impacts.

65. Vlachos, Evan C. 1982. Cumulative impact analysis. *Impact Assessment Bulletin* 1: 60-70.

This article outlines an approach to the study of cumulative impacts, focusing on the definition of cumulative impacts within the existing legal framework, reviewing the current practices of cumulative impact assessment, and presenting strategies for

assessment and evaluation. It raises a series of pragmatic questions facing environmental managers.

66. Williamson, Samuel C., and Karen Hamilton. 1989. *Annotated bibliography of ecological cumulative impacts assessment*. U.S. Fish Wild. Serv. Biol. Rep 89(11). Fort Collins, CO: National Ecology Research Center.

This annotated bibliography collects cumulative impact literature from a variety of published documents. Some of the abstracts are reprinted from the original publication while others are added by the authors of the bibliography. Approximately 150 publications are included which relate to cumulative impacts on a wide range of fish and wildlife resources.

67. Williamson, Samuel C., Carl L. Armour, and Richard L. Johnson. 1986. In *Preparing a FWS Cumulative Impacts Program: January 1985 Workshop Proceedings*, U.S. Fish Wildl. Serv. Biol. Rep. 85 (11.2): U.S. Fish and Wildlife Service, Western Energy and Land Use Team.

This publication reports the results of the second in a series of FWS workshops concerning the development of an effective cumulative impacts assessment program. It concludes that there is a technical deficiency in resource-based methods and processes for cumulative impact assessment, and an "institutional hesitance" in responsible agencies. It provides a list of cumulative impacts problems affecting fish and wildlife resources. It also includes a list of items that inhibit assessment and briefly discusses the following categories of inhibiting factors: definition of terms, lack of understanding and support, inadequacy of assessment tools, and institutional mechanisms. The report identifies methods of eliminating assessment inhibitors, and offers recommendations for improving the existing program.

Section 3
Cumulative Impact Assessment Methodologies

All documents in this section have as their primary focus specific methodologies or techniques for assessment of cumulative environmental impacts. Some of the methodologies were originally designed for traditional environmental impact assessment, but are included if the author discusses the potential for application in a cumulative impact assessment context. Publications which do not focus on specific assessment methodologies but look more generally at the conceptual foundations and practical requirements of cumulative impact assessment are included in the preceding section. These materials may be highly relevant to the consideration of specific assessment methodologies, so both Sections 2 and 3 should be consulted.

These publications consist of the following:

(1) detailed cumulative impact assessment processes and cumulative effect modeling methods developed by or for specific agencies;

(2) cumulative impact assessment methodologies or detailed conceptual frameworks for cumulative impact assessment developed by non-agency environmental management theorists; and

(3) specific wetland or habitat assessment techniques, perhaps not specifically designed to anticipate the cumulative impacts of various activities, but with potential for modification for cumulative impact assessment purposes.

While pertinent literature identified in categories 1 and 2 was included, this section contains only selected literature described in category 3. The detailed processes and modeling methods developed by or for a specific federal agency are also cross-referenced by agency in Section 4.

These documents span the range from generic, multi-step assessment processes for considering cumulative impacts to discussions of very detailed techniques for focusing on particular key resources. Most are based on mainstream scientific knowledge, but a few attempt to synthesize traditional ecological knowledge possessed by non-scientists, such as native peoples or local resource harvesters. A wide range of cumulative impact assessment approaches are described including the use of indicator species, response guilds, basin-wide stream surveys, indices of biological integrity and integrated surface water quality monitoring, hydrologic condition modeling, science-determined carrying capacities, policy-determined thresholds (i.e., for acceptable land disturbance or nitrogen inputs), sequential geographical analyses, and landscape integrity or landscape conservation approaches. These approaches uses a range of procedural techniques including ad hoc techniques, checklists of characteristics or processes to be considered, matrices of interactions, nodal network or pathways, dynamic models to simulate ecosystem responses, and geographic information systems or other cartographic techniques.

A few items appear under the heading "items identified but not abstracted." These documents are very specialized and appear to be adequately described by the title, but may only indirectly relate to the coastal environment, so full abstracts were not included.

68. Adamus, Paul R., Lauren T. Stockwell, Ellis J. Clairain, Jr., Michael E. Morrow, Lawrence P. Rozas, and R. Daniel Smith. 1991. In *Wetland evaluation technique (WET). Volume I: Literature review and evaluation rationale.* Vicksburg, MS: U.S. Army Corps of Engineers, Waterways Experiment Station.

The first of two-volumes on the wetland evaluation technique is a revision of a 1983 report by P. Adamus for the Federal Highway Administration entitled "A Method for Wetland Functional Assessment Vol. I." It examines eleven wetland functions for important processes and interactions with other functions. The authors characterize WET as "a broad brush approach to wetland evaluation," useful as a screening tool to decide whether more quantitative analysis is required. They caution that WET can be used to assess the impact of different scenarios on the ratings of a particular wetland, but is not designed to anticipate the cumulative impacts of various combined activities over time. Volume II (Adamus, et al. 1987, Wetland Evaluation Technique; Volume II, Methodology (Operational Draft Report). Environmental Laboratory, U.S. Army Corps of Engineers Waterways Experiment Station, Vicksburg, MS) outlines implementation steps, applications and limitations, and discusses computer-assisted data analysis.

69. Armour, Carl L., Richard E. Ellison, Richard L. Johnson, and Samuel C. Williamson. 1988. Description of the Fish and Wildlife Service's cumulative impacts project. In *Proceedings of the National Wetland Symposium: Mitigation of Impacts and Losses*, ed. Jon A. Kusler, M. L. Quammen, and G. Brooks, 211-220. New Orleans, LA, October 8, 1986. Berne, NY: Association of State Wetland Managers.

This paper contains a detailed description of the research and development project undertaken by the Fish and Wildlife Service to provide Ecological Services field office specialists with the necessary tools for addressing cumulative impacts. In particular, the paper outlines what the project has accomplished since its commencement in 1984, and it describes the project's objectives for the future. It also explains a seven-step assessment process developed by FWS: 1) determining that a problem exists; 2) conducting scoping; 3) performing problem analysis; 4) determining actions and developing a plan for the project; 5) implementing the plan; 6) monitoring; and 7) determining whether project objectives were achieved. Various methods could be used for each step, depending on the specific problem.

70. Armour, Carl L. January 1986. *Method for modeling causes and effects of environmental actions*. Review Draft. Ft. Collins, CO: U.S. Fish & Wildlife Service, Western Energy and Land Use Team, Div. of Biological Services, Research and Development.

This paper, part of the FWS Cumulative Impact Series, advocates analyzing causes and effects of environmental actions by creating models to summarize complex information in an understandable format. The information derived from this method of analysis may form the basis for determining the role each component plays in creating the cause or effect. The modeling method described in this paper is said to promote a comprehensive approach to address environmental problems, and to facilitate understanding of complex problems through well-organized, logically formatted information.

71. Armour, Carl L. January 1986. *Method for use of multiattribute value theory for environmental decisions*. Review draft. Ft. Collins, CO: U.S. Fish and Wildlife Service, Western Energy and Land Use Team.

One of several papers in the Cumulative Impact Series, this paper explains how field workers can use a multiattribute value theory to evaluate alternative actions in making environmental decisions. This method includes six steps: (1) defining the objective for a resource, (2) specifying alternative actions to achieve the objective, (3) determining the criteria that will affect the decision, (4) weighting the criteria, (5) scoring each criterion and alternative combination, and (6) calculating the total score for each alternative, based on steps (4) and (5). The author cautions against basing decisions solely on the numerical values derived from this method.

72. Armour, Carl L., Richard Johnson, and Samuel C. Williamson. 1985. *Problem analysis and planning for the FWS cumulative impacts program: August 1984 workshop proceedings*. U.S. Fish Wildl. Serv. Biol. Rep. 85 (11.1). Ft. Collins, CO: U.S. Fish and Wildlife Service, Western Energy and Land Use Team.

This publication discusses an analytical approach to and results of a FWS workshop on analyzing cumulative impacts problems and planning a comprehensive assessment program. The analytical approach employed by workshop participants included: (1) formulation of a problem statement, (2) use of backstep analysis to identify causes and effects of cumulative impacts, and (3) use of FAST (Functional Analysis Systems Technique) diagramming to determine specific solutions. It provides guidelines for developing an assessment program.

73. Army Corps of Engineers. 1990. *A habitat evaluation system for water resources planning*. Vicksburg, MS: US ACOE, Lower Mississippi Valley Division, Environmental Analysis Branch, Planning Division.

This report presents the methodology for the Habitat Evaluation System (HES) developed by the Lower Mississippi Valley Division as a habitat approach to evaluating the environmental impacts of water resources development projects. It was intended that this version be modified periodically in response to new data and increased experience, and to include other ecosystem types such as coastal habitats and freshwater marshes.

74. Beanlands, Gordon E., and Peter N. Duinker. 1984. An ecological framework for environmental impact assessment. *Journal of Environmental Management* 18: 267-277.

This paper summarizes the findings of a study to investigate the scientific adequacy of environmental impact statements and to develop an ecological framework for environmental impact assessment (EIA) in Canada. The study found that the environmental impact assessment community "is capable of much more rigorous and productive applications of the science of ecology in impact assessment studies." It proposes criteria for determining whether an impact is significant in an environmental impact assessment; articulates considerations in establishing time and space boundaries; advocates greater quantification in baseline and monitoring studies and other field investigations; identifies a carefully planned study strategy as key to an effective use of EIA resources; cites the need to use the best available evidence in making predictions and need to acknowledge any limitations; and advocates an ecosystem approach tracing project impacts through ecological linkages to losses or gains in valued ecosystem components. It argues that utilizing a more rigorous scientific approach to EIA will focus time and funds to produce more useful and reliable information.

75. Bedford, Barbara L. 1993. Increasing the scale of analysis: The challenge of cumulative impact assessment for Great Lakes wetlands. In *Wetlands of the Great Lakes: Protection and Restoration Policies; Status of the Science, Proceedings of an International Symposium*, ed. Jon A. Kusler, and Richard C. Smardon, 186-195. Niagara Falls, NY, May 16, 1990. Madison, WI: Omni Press.

The author presents a conceptual framework for cumulative impact assessment for Great Lakes wetlands. Primary emphasis is on shifting the level of analysis upward from the individual site to the landscape level (watersheds, lake basins, entire Great Lakes Basin). Spatial boundaries have already been established as individual and aggregated watersheds of the Great Lakes Basin. The author recommends redefining temporal boundaries, with the past to consider the pre-settlement area of wetlands, and the future boundary to be 20-40 years into the future. To simplify the diversity of wetland types, the author recommends development of a functional classification scheme (provisionally lakeshore/ fringe, estuarine, riverine and other watershed basin wetlands). Other key elements include providing a context for decision-making by development of a common geographic information system (GIS) and establishing goals for the resource under consideration. It includes a detailed discussion of how to integrate the goals with regulatory decision making.

76. Berwick, Stephen H., Robert A. Nisbet, and Kenneth L. Reed. 1982. Spatial analysis for determining "region of influence" when predicting impacts on wildlife and other resources. *In Issues and technology in the management of impacted western wildlife*. Edited by R. D. Comer. Technical Publication No. 14. Boulder, CO: Thorne Ecological Institute.

This paper was written with the premise that previous methods for determining region of influence, that portion of an area affected by development which is included in an EIS, are too simplistic. The authors assert that properly defining the region of influence is of critical importance, as it is the initial step in collecting data for the EIS, and thus, influences the subsequent steps. The paper describes computer-assisted method of overlaying and manipulating mapped variables to ascertain the area in which a resource is at risk. It includes a list of mapped variables which may be used in the computer assisted analysis.

77. Brinson, Mark M. 1988. Strategies for assessing the cumulative effects of wetland alteration on water quality. *Environmental Management* 12(5): 655-662.

The author asserts that cumulative impacts are much more difficult to describe and predict than local-scale alterations due to the spatial and temporal scale. He suggests that the scale of the problem requires a different approach than research which examines one process at a time or one ecosystem at a time. The presented strategy advocates scaling up to interpretation of interecosystem processes by recognition of the geomorphic setting of the wetland and use of hydrologic records to make inferences on biogeochemical changes in wetlands over time.

78. Brooks, Robert P., Edward D. Bellis, Carl S. Keener, Mary Jo Croonquist, and Dean E. Arnold. A methodology for biological monitoring of cumulative impacts on wetland, stream, and riparian components of watersheds. In *Wetlands and River Corridor Management*, 387-398. Charleston, SC, July 5, 1989. Berne, NY: Association of Wetland Managers.

The proposed methodology involves biological monitoring, using response guilds, as well as analyses of landscape patterns, hydrology, and water quality. Changes in biotic diversity are used as an indicator of cumulative impacts on the landscape level. The article states that a regional sampling method for determining the extent of watershed disturbance must be developed before this methodology may be utilized effectively by permit reviewers. In addition, it describes the sampling procedures used by the authors to compare biotic communities in different watersheds, as well as the results of the study they conducted.

79. Canadian Arctic Resources Committee, Environmental Committee of Sanikiluaq, and Rawson Academy of Aquatic Science. 1992. Sustainable Development in the Hudson Bay - James Bay Bioregion. Ottawa, Ontario: Hudson Bay Program.

This report describes a three-year research program being conducted to identify key cumulative impacts on the Hudson Bay and James Bay bioregion and to propose a cooperative decision-making process to foster sustainable development. Particular focus is placed on hydroelectric developments. A unique element is an effort to synthesize existing scientific knowledge with traditional ecological knowledge possessed by Inuit and Cree elders and active harvesters living in the region.

80. Canter, Larry W. 1977. Environmental impact assessment. McGraw-Hill Series in Water Resources and Environmental Engineering, New York, NY: McGraw-Hill.

This 1977 overview of environmental impact assessment focuses on NEPA and its implementation. Chapter 5 discusses prediction and assessment of impacts on the water environment. Chapter 10 and Appendices D-F identify, describe and evaluate 48 methodologies for impact analysis. The book does not focus on indirect and secondary impacts, but the discussion of specific methodologies does identify their adaptability for dealing with secondary or indirect impacts.

81. Chen, Glenn K. 1992. Use of basin survey data in habitat modelling and cumulative watershed effects analyses. In *Region 5 Fish Habitat Relationship Technical Bulletin*, 8: 1-11. U.S. Forest Service, Pacific Southwest Region.

This technical bulletin explains the processes used in habitat modeling and watershed effects assessment using basin-wide stream survey methodologies. It describes how empirical models linking habitat features and fish abundance have been used to assess cumulative effects of logging activities on fish habitat. Work in the Elk River basin is presented as an example of how the cumulative effects model has been used.

82. Clark, John R., and Jeffrey A. Zinn. 1978. Cumulative effects in environmental assessment. In *Coastal Zone '78: Symposium on Technical Environmental, Socioeconomic and Regulatory Aspects of Coastal Zone Management*, IV: 2481-2492. San Francisco, California, March 14, 1978. New York, NY: American Society of Civil Engineers.

The authors suggest that assessment of cumulative environmental effects in the coastal zone and other aquatic ecosystems are made more difficult by far-reaching effects ranging from miles to thousands of miles (e.g., waterfowl breeding areas). It proposes systematic guidelines to set up a framework for project review, to classify cumulative effects, set interaction boundaries, determine level of significance, and approach alternatives and mitigation. The proposed review-assessment process identifies a linear sequence of identification of activities, identification of potential disturbances, evaluation of disturbances and effects, determination of additive effects, determination of extended and cumulative effects, evaluation of significance, and delineation of project conditions. The specific procedure for evaluation of cumulative effects includes delineation of a local effects field and regional and expanded effects fields if required, estimate of present condition and trends, and reviewer judgment of significance and acceptability of each final effect in relation to accumulation trend.

83. Cline, Elizabeth W., Evan C. Vlachos, and Gerald C. Horak. 1983. *State-of-the-art and theoretical basis of assessing cumulative impacts on fish and wildlife*. Kearneysville, WVA: U.S. Fish and Wildlife Service, Eastern Energy and Land Use Team.

One of three documents on cumulative effects of coal activities on fish and wildlife, this study focuses on state-of-the-art methods of biological assessment and monitoring. The report outlines the limited then-present knowledge of cumulative impact assessment methods, develops a theoretical and definitional basis for cumulative impact assessment, and makes recommendations. Among others, it describes an early 1970s unpublished Stanford Research Institute effort for the Army Corps of Engineers to incorporate consideration of interactive, secondary and cumulative effects into their Environmental Impact Computer System; a 1980 INTASA, Inc. paper on assessment of cumulative impacts of hydropower development; the Dames and Moore, Inc. 1981 Handbook for ACOE and subsequent field testing; and other then-pending projects. It concludes that much more work is needed on interaction and synergism, the theoretical and definitional bases of cumulative impacts, and the adequacy of biological, historic and demographic data.

84. Cocklin, Chris, and Sharon Parker. 1990. Cumulative environmental change: Concepts revisited and a case study. Environmental Science Occasional Publication No. CEC-03. Auckland, New Zealand: University of Auckland.

The authors recommend that cumulative effects analysis and management be adopted as an integral component of environmental and social planning in New Zealand. They discuss the conceptual approach of cumulative impact assessment, finding that its regional approach is more consistent with the traditional perspective of the Maori culture. After a discussion of methodological issues (boundaries, ecological response characteristics, monitoring, cumulative socio-economic impacts, and evaluation), and the institutional context, the authors present a case study of the Meremere Ecological District. The case study methodology uses a checklist and geographic information system.

85. Cocklin, Chris, Sharon Parker, and John Hay. 1992. Notes on cumulative environmental change II: A contribution to methodology. *Journal of Environmental Management* 35(1): 51-67.

The second of two articles, this paper focuses on evaluation methods to assess cumulative change. It reviews the suitability of existing evaluation methods for cumulative effects assessment, including checklists, several matrix approaches, and network methods. The authors then describe use of a checklist for scoping and a geographic information system (GIS) for spatial representation of information within the context of a case study of a region of New Zealand. They note as the major weakness of GIS that it does not "draw the causal links between processes." The authors assert that cumulative effects assessment will benefit from use of several methods of analysis ("methodological eclecticism") rather than being constrained to one single method, and discuss different ways to structure the analysis, depending on the nature of the question (e.g., effects of a single activity on a single environmental attribute, effects of a single activity on multiple environmental attributes, effects of multiple activities upon a single environmental component, effects of multiple activities upon multiple environments, and project assessment).

86. Cocklin, Chris, and Sharon Parker. 1991. Planning for cumulative environmental change. In *Aspects of Environmental Change*, edited by T. R. R. Johnston and J. R. Flenley. 1-11. Miscellaneous Series 91/1, New Zealand: Department of Geography, University of Auckland.

The authors discuss the evolution of cumulative environmental impacts concepts, project vs. regional analysis, and the conceptual links between cumulative effects and sustainable development. They also discuss methodological issues of choice of boundaries, non-linear biophysical responses and complexities of monitoring, and how to collapse information into summary form to simplify evaluation. Geographic information systems are discussed as providing one framework for analysis.

87. Conover, Shirley A. M., Kim W. Strong, T. Earle Hickey, and Finn Sander. 1985. An evolving framework for environmental impact analysis: I. Methods. *Environmental Management* 21: 343-358.

The authors present a systematic approach to environmental impact assessment that is capable of recognizing cumulative impacts. This biophysical Environmental Impact Analysis proposes to evaluate potential impacts using predetermined ecologically-based impact definitions (major, moderate, minor or negligible impact). It is also necessary to define three types of boundaries: space, time, and population. This approach involves eight steps: (1) project description, (2) delineation of environmental conditions, (3) identification of potential project-environmental interactions, (4) detailed investigation of relevant project attributes (gathering more specific, detailed information than that of Step 1), (5) detailed investigation of relevant environmental attributes, (6) impact evaluation, (7) identification of potential mitigation measures and (8) evaluation of potential residual impacts.

88. Contant, Cheryl K., and Lyna L. Wiggins. 1991. Defining and analyzing cumulative environmental impacts. *Environmental Impact Assessment Review* 11: 297-309.

This article described an approach analyzing the cumulative impacts of an individual project which the authors developed to produce a more comprehensive assessment than existing methods. This approach involves consideration of the cumulative impacts of the development within two contexts: the relationship to other development activities, and the effects upon multiple natural systems. It offers a new comprehensive analysis approach which stresses the importance of monitoring environmental conditions and past development activities, and modeling development patterns and natural system responses. It includes a brief legal and regulatory history of cumulative impacts.

89. Contant, Cheryl K., and Leonard Ortolano. 1985. Evaluating a cumulative impact assessment approach. *Water Resources Research* 21(9): 1313-1318.

This article briefly describes a cumulative impact assessment approach, based in part on a carrying capacity analysis, which was implemented on a trial basis by the ACOE for projects in the Oakland Estuary. The goal of the study was to evaluate the effectiveness of the new approach. The authors discuss hypotheses, identify independent and dependent variables, devise measures and scoring procedures, and discuss data. However, statistical arguments about the effectiveness of the new assessment approach could not be made since there were only two permit applications in the estuary during the study period. The study design describes a systematic evaluation approach for cumulative impact assessment which was tested and applied in a typical regulatory context.

90. Croonquist, Mary Jo, and Robert P. Brooks. 1991. Use of avian and mammalian guilds as indicators of cumulative impacts in riparian-wetland areas. *Environmental Management* 15(5): 701-714.

This article provides an in-depth discussion of using "response guilds," species groups that react similarly to habitat disturbance, as an assessment method. In addition, it describes a Pennsylvania watershed study which illustrates the utility of response guilds as indicators of cumulative impacts in riparian-wetland regions. The authors hypothesized that given limited time and resources, it was more efficient to use a response-guild approach than a single-species approach to determine how wildlife communities change in response to environmental impacts. They found avian response guilds to reflect habitat disturbance more predictively than mammalian response guilds.

91. Dames and Moore, Inc. [1981]. 1988. *Methodology for the Analysis of Cumulative Impacts of Corps Permit Activities.* IWR Policy Study (July 1981). Ft. Belvoir, VA: US Army Corps of Engineers, Institute for Water Resources.

This handbook was one of the interim products of an effort to assist US ACOE regulatory personnel in assessment of cumulative impacts. E. Stakhiv notes in the 1988 Foreword to the reissue of the 1981 report that the original handbook was never intended to be an official set of guidelines without much more development and testing, that the regulatory context has changed substantially since 1980, and that this should be regarded as a research reference document rather than official methodology. The methodology, designed to allow the Corps' public interest review to consider natural and human environments, uses a tiered system with the degree of analysis determined by whether projects are large scale and strongly growth inducing and/or controversial (Tier I); large scale but growth accommodating, growth inducing but of smaller scale, located in a stressed environment, or located in a developmental "hotspot" (Tier II); small scale growth accommodating and located in unstressed environment (Tier III); or general permits. "Bottom Up" analysis (tracing identified primary disturbances outward and upward to direct and indirect biological effects) is used for growth accommodating or growth neutral projects. "Top Down" analysis (tracking potential growth inducing aspects back through the socioeconomic sphere) is used for growth-inducing projects. The methodology assumes a good data base and experienced, multidisciplinary staff.

92. Dickert, Thomas, and Andrea E. Tuttle. 1985. Cumulative impact assessment in environmental planning: A coastal wetland watershed example. *Environmental Impact Assessment Review* 5: 36-64.

This articles describes a land disturbance target approach to cumulative impact assessment, using as an example the impact of development on coastal wetlands in the Elkhorn Slough watershed in California. The method is based on a threshold approach utilizing an assumed acceptable amount of land use change over time, rather than a threshold based on intrinsic ecological limits. The technique is designed for planning as well as for providing a context for individual permit reviews. The underlying study focused on hydrologic analysis, upland erosion and deposition, land use change in upland and wetland areas over 50 years based on aerial photographs, and measurement of impervious surface and bare ground for dominant land uses. Based on these studies, a set of land disturbance targets for subunits within the watershed (% of subwatershed area that can be disturbed) and erosion-susceptibility maps were developed; development permits would not be issued where existing use exceeds target levels until bare ground in the subwatershed is reduced. The authors identify a need for more work on systems for allocation of development rights once a threshold is set.

93. Emery, Richard. 1986. Impact interaction potential: A basin-wide algorithm for assessing cumulative impacts from hydropower projects. *Journal of Environmental Management* 23: 341-360.

Emery contends that the proposed Cumulative Impact Assessment Procedure (CIAP) developed by FERC to analyze the cumulative impacts of hydropower projects is deficient due to CIAP's failure to examine "cumulativity," the potential for impacts of projects in one subbasin to interact and accumulate with impacts of projects in different subbasins. The article describes a method to measure cumulativity, by adding an Impact Interaction Potential Assessment Loop to CIAP's Multiple Project Assessment Phase. An appendix includes a BASIC program for computing the IIP.

94. Estevez, Ernest D. 1986. Assessment and policy approaches to managing cumulative impacts in wetlands. In *Proceedings of the National Wetland Assessment Symposium*, ed. Jon A. Kusler, and Patricia Riexinger, Portland, ME, June 17, 1985. Association of State Wetlands Managers.

This paper considers two techniques for establishing acceptable levels of impacts: reference systems against which impacts may be rated and management approaches establishing policy-determined (rather than science-determined) threshold levels (with regard to total wetland area, species diversity, maximum sustainable yield, or other measures of wetland condition) below which permits will not be issued. The author argues that management of cumulative wetland impacts through prescriptive policies may be less costly and result in more explicit goal statements.

95. Galloway, G. E. 1978. Assessing man's impact on wetlands. UNC-SG-78-17. Raleigh, N.C.: University of North Carolina Sea Grant.

This publication includes a short background section on federal interest in wetlands, discussion of human impacts, analysis of impact assessment and presentation of a proposed Wetland Evaluation System (WES). WES, designed by a former head of a U.S. Army Corps of Engineers field unit, is presented as practitioner's approach to evaluation. It is not specifically designed to address cumulative impacts, but is designed to assess human impact on six of nine wetland qualities (endangered species, fish, wildlife, waterfowl, uniqueness, appearance, natural protection, life-cycle support and historical-cultural).

96. Gosselink, James G., and Lyndon C. Lee. 1987. *Cumulative impact assessment in bottomland hardwood forests*. Baton Rouge, LA: Center for Wetland Resources.

This report characterizes the cumulative impacts resulting from the extensive destruction of bottomland hardwood forest ecosystems in the southern United States as devastating. It states that current procedures do not provide adequate tools for addressing the problem of cumulative impacts and proposes a methodology that uses the landscape approach of island biogeography. This approach is designed to conserve bottomland forest functions and to conserve landscape pattern. The report provides specific suggestions for cumulative impact assessment and describes the various elements of the analysis.

97. Gosselink, James G., and Lyndon C. Lee. 1988. Cumulative impact assessment principles. In *Proceedings of the National Wetland Symposium: Mitigation of impacts and losses*, ed. Jon A. Kusler, Millicent L. Quammen, and Gail Brooks, 196-203. New Orleans, LA, October 8, 1986. Berne, NY: Association of State Wetland Managers.

This paper describes the methodology developed by Gosselink and Lee for bottomland hardwood forest wetlands, stating that it is applicable to other wetland types as well, with some modification. It suggests taking a landscape level approach, which requires guidelines for establishing assessment unit boundaries, a broad-scale regional inventory of resource status, and a basic set of indices of landscape integrity to use to characterize the status of assessment units. It presents an 8-step, iterative cumulative impact assessment procedure which incorporates goal-setting, refinement of information based on goals, and development of an institutional memory into a permit evaluation/regulatory decision-making process.

98. Gosselink, James G., and Lyndon C. Lee. 1989. Cumulative impact assessment in bottomland hardwood forests. *Wetlands* 9: 93-174.

This special issue of this journal reports on a method for cumulative impact assessment in bottomland hardwood wetlands using a landscape ecology approach. The report provides background information on bottomland hardwood forests (conversion rates, functions and values, cumulative impacts) and general cumulative impacts issues;

discusses resource management from the perspectives of natural reserves and island biogeography; and outlines a method for cumulative impact assessment in this type of resource, focusing on large-scale landscape integrity. Specific goals (regulate to conserve functions and to conserve landscape pattern) are outlined, and necessary tools are identified (determination of appropriate scale, regional survey of present condition, and indices to characterize current health). An impact assessment and management procedure is outlined, which includes assessing the status of the unit, setting goals, using the cumulative impact management plan to improve regulatory permitting, and maintaining an institutional memory.

99. Gosselink, James G., Gary P. Shaffer, Lyndon C. Lee, David M. Burdick, Daniel L. Childers, Nancy C. Leibowitz, Susan C. Hamilton, Roel Boumans, Douglas Cushman, Sherri Fields, Marguerite Koch, and Jenneke M. Visser. 1990. Landscape conservation in a forested wetland watershed. *BioScience* 40(8): 588-600.

The authors assert that cumulative impacts are frequently ignored during the Section 404 permit review process and that current regulatory practices are primarily reactive. They contend that ecological planning is a necessary component of cumulative impacts management. To incorporate both planning and a landscape focus into the assessment and management processes, the authors suggest using the methodology developed by Gosselink and Lee, comprised of assessment, goal-setting, and implementation. The article presents a case study, in which this methodology was applied, to illustrate the use of cumulative impacts assessment in planning.

100. Horak, Gerald C., Evan C. Vlachos, and Elizabeth W. Cline. 1983. *Methodological guidance for assessing cumulative impacts on fish and wildlife*. Contract No. 14-16-0009-81-058. Prepared for the U.S. Fish and Wildlife Service, Eastern Energy and Land Use Team, Office of Biological Services, Kearneysville, WVA:

This document, one of three prepared on methods of determining cumulative effects of coal activities on fish and wildlife resources, is designed to provide interim guidance for the field biologist. It offers broad methodological guidance, not a detailed manual, for conducting cumulative impact assessments. After examining the theoretical and definitional bases, it examines "state-of-the-art" and current practice approaches. Asserting that cumulative impact assessment requires a complete restructuring of the problem and shift in emphasis, it rejects traditional environmental impact assessment procedures as inappropriate for the task. It stresses the need for an extended time horizon, broader perspectives, and an ecosystem-oriented, holistic, evolving, nonlinear approach. After summarizing "state-of-the-art" methods and current practices, it evaluates 64 of those methods for their ability to meet eight cumulative impact assessment criteria. It concludes that all, used singly, are inadequate to determine the cumulative impacts of large-scale projects, primarily due to failure to consider in sufficient depth interaction, synergism and additional factors. The document presents a new cumulative impact assessment procedure, using carrying capacity and tolerance as organizing concepts. The procedure includes 37 guiding questions on the action site, system and impact evaluation, further refined to a 10-step process. It also articulates 30 assumptions on the goals and objectives of CIA, the premises for the impact method, and assumptions as to predictions of effects on resources, all of which need to be reviewed, accepted, modified or rejected as part of step 1. The document identifies continuing concerns about complexities, insufficient methodological capacity and guidance, the tension between public participation and expert judgment, and the gap between theory and practice.

101. Hunsaker, Carolyn T. 1993. Ecosystem assessment methods for cumulative effects at the regional scale. In *Environmental Analysis: The NEPA Experience*, ed. Hildebrand, Stephen G. and Johnnie B. Cannon, 480-493. Boca Raton, FL: CRC Press.

This paper describes how regional ecological risk assessment can be used as an approach to assessing cumulative impacts. It outlines the definition and solution phases of regional risk assessment, discusses issues of selection of regions and subregions for assessment, and considers the contributions to assessment uncertainty from boundary definition, data resolution and aggregation and spatial heterogeneity. The author illustrates these issues using examples based on research on the effects of acid precipitation on fish in Adirondack lakes.

102. Hunsaker, Carolyn T., Robin L. Graham, Glenn W. Suter II, Robert V. O'Neill, Lawrence W. Barnthouse, and Robert H. Gardner. 1990. Assessing ecological risk on a regional scale. *Environmental Management* 14(3): 325-332.

This article describes an approach for regional risk assessment combining regional assessment methods and landscape ecology theory with more traditional ecological risk assessment. It focuses on the hazard definition phase and the problem solution phase, outlining differences between local and regional risk assessments. The authors also describe the sources of uncertainty in regional assessments, and conclude that additional spatial and temporal data for large areas and additional testing and refinement of tools and ideas are required before regional ecological risk assessment can become an effective tool.

103. Hyman, Eric L., and Bruce Stiftel. 1988. Combining facts and values in environmental impact assessment: Theories and techniques. Social Impact Assessment Series 16, Boulder, CO: Westview Press.

Chapter 7 presents a critical analysis of fourteen environmental assessment models developed out of different contexts in response to NEPA. The methods represented include land suitability analysis; checklists, matrices and networks; multiple-objective decision analysis; and simulation modeling. The authors evaluate each model on the basis of seven criteria, one of which is the extent to which it considers cumulative and indirect effects. Although certain models ranked relatively high for addressing particular criteria, the authors conclude that none of the models is completely satisfactory. Thus, in Chapter 8, the authors offer their own assessment model, SAGE, (Social judgment capturing, Adaptive, Goals-achievement Environmental Assessment), which builds on the best features of the other models and incorporates a technique for factoring in diverse values from a broad array of groups. SAGE consists of four tasks: predicting the effects of alternative actions, scaling related effects into a few accounts, eliciting value weights that groups attach to each objective, and presenting the findings in a form useful to decision makers. Chapter 8 illustrates the application of SAGE to a watershed management problem.

104. Irwin, Frances H., and Barbara Rodes. 1992. Making decisions on cumulative environmental impacts: A conceptual framework. Washington, DC: World Wildlife Fund.

This very useful document is designed to assist program managers identify types of cumulative impact problems, understand how to select appropriate techniques for assessing cumulative effects, and evaluate organizational and legal capacity to address cumulative effects. It works from the premise that the mismatch between scales at which environmental impacts occur and the scale at which decisions are made presents a significant obstacle to effective management. It develops a detailed conceptual framework to match the boundaries of decisions and of cumulative impacts, and includes appendices on definitions of cumulative impacts, statutory references to cumulative impacts, a brief discussion of techniques for assessing cumulative impacts (ad hoc techniques, checklists, matrices, networks, cartographic techniques, mathematical modeling, evaluation techniques, and adaptive methods), and selected bibliography.

105. Johnston, Carol A., Naomi E. Detenbeck, John P. Bonde, and Gerald J. Niemi. 1988. Geographic information systems for cumulative impact assessment. *Photogrammetric Engineering and Remote Sensing* 54(11): 1609-1615.

This article discusses how Geographic Information Systems (GISs) can be used in cumulative impact assessment. It describes the methodology used by the authors, which established an empirical relationship between wetland abundance and downstream water quality in the Minneapolis-St. Paul metropolitan area. In addition to GIS techniques, the methodology also involved use of water quality data, aerial photointerpretation, and multivariate statistical analysis. The article concludes that GIS provides an essential tool to compile, process and evaluate data collected over a long period of time for a large area to quantify location and rates of resource loss, and to facilitate reliable prediction of ecological consequences of resource loss.

106. Jourdonnais, J. H., J. A. Stanford, F. R. Hauer, and C. A. S. Hall. 1990. Assessing options for stream regulation using hydrologic simulations and cumulative impact analysis: Flathead River Basin, USA. *Regul. Rivers: Res. Manage.* 5(3): 279-293.

The authors describe a process used by a multi-agency technical working group to assess management options for a lake in Montana. The options assessed were suggested by agencies with particular management authority and were designed to conserve or enhance the particular ecological or societal resources for which the agency had management responsibility. Using an interactive process of hydrology simulation, for each scenario accepted as being within the legal and physical constraints of the system, cumulative impacts on key resources were assessed. The scenarios were ranked; rankings varied substantially depending on whether only ecological resources or all resources were evaluated. The authors suggest that computing weighted cumulative impacts of different scenarios may assist with mediating resource conflicts and may be a useful tool for developing informed water management recommendations.

107. Karr, James R. 1991. Biological integrity: A long-neglected aspect of water resource management. *Ecological Applications* 1(1): 66-84.

The author describes an approach to assess the integrity or ecological health of water resources through an Index of Biotic Integrity (IBI). He cites the development of integrative ecological indexes, the development of the ecoregion approach, and a recognition of the importance of cumulative impact assessment at regional scales as factors contributing to rapid advances in water resource management. After reviewing impediments to an integrative ecological approach, the author outlines the IBI, a method for assessing water resource quality by sampling biological communities (originally fish) in the field, rating twelve attributes of the community, and then summing those ratings to provide an IBI value. He describes it as a "cost-effective procedure" to derive an integrative and quantitative assessment of local biological integrity. While designed to evaluate biological conditions in streams in the midwestern United States, the article discusses how it can be adapted for other geographic regions, and recommends that efforts should be made to develop similar indexes for other environments and other communities.

108. Klock, G. O. 1985. Modeling the cumulative effects of forest practices on downstream aquatic ecosystems. *Journal of Soil and Water Conservation* 40: 237-241.

This article presents a Watershed Cumulative Effects Analysis (KWCEA) model designed to determine a watershed's hydrologic condition. It uses key watershed parameters affecting water quality and quantity to produce index values which indicate the potential for increased impact on the downstream aquatic ecosystem. The author asserts the model is particularly useful for evaluating forest practice options within a watershed during planning, and could be used to coordinate activities among several landowners within one watershed.

109. Laurance, William F., and Eric Yensen. 1991. Predicting the impacts of edge effects in fragmented habitats. *Biological Conservation* 55: 77-92.

This paper presents a protocol for "assessing the ecological impacts of edge effects in fragments of natural habitat surrounded by induced (artificial) edges." It involves use of a Core-Area Model to estimate the total area of pristine habitat remaining within fragments, and can be used with fragments of any size or shape.

110. Leibowitz, Scott G., Brooke Abbruzzese, Paul R. Adamus, Larry E. Hughes, and Jeffrey T. Irish. 1992. *A synoptic approach to cumulative impact assessment: A proposed methodology*. Edited by S. G. McCannell, and A. R. Hairston. EPA/600/R-92/1672. Corvallis, OR: U.S. Environmental Protection Agency, Environmental Research Laboratory.

This report presents a proposed methodology for use by wetland regulators reviewing Section 404 permits to assist with the assessment of cumulative effects of individual projects on the landscape. The authors suggest other prioritizing and planning applications as well. The proposed synoptic approach produces statewide maps which rank portions of the landscape according to synoptic indices (landscape variables). One assessment is prepared for the state or region, then referred to in the course of case-by-case reviews. Cumulative impacts are factored in by using the maps and indices to consider the landscape condition in the permit application area. The methodology assumes limited time, resources and information. This approach to assessing cumulative impacts or environmental risk provides a broad overview of environmental and landscape factors, and facilitates qualitative comparison of conditions within landscape subunits. The approach is intended to augment the best professional judgment of wetland managers. The five steps are: define goals and criteria, define synoptic indices, select landscape indicators, conduct assessment, and prepare synoptic reports. Case studies, a discussion of ecological response to stress, a review of wetland functions and the effect of wetland impacts are included. Appendix A reviews other methods for assessing cumulative impacts (conceptual frameworks, descriptive cause/ effect methods, map overlay methods and methods based on statistical data analysis or simulation).

111. Liepitz, Gary S., and Gay Muhlberg. 1993. The assessment and control of cumulative impacts of coastal uses on fish habitat of the Kenai River, Alaska: Study area, habitat classification and cumulative impact assessment methodology. Anchorage, AK: Alaska Department of Fish and Game.

This reports on the first phase of a two year study undertaken by the Alaska Department of Fish and Game to quantify fish habitat loss and to assess mechanisms and policies to control the cumulative impacts of shoreline development on Kenai River fish habitat. It describes the development of a functional fish habitat classification system and a cumulative impact assessment method. The juvenile chinook salmon is used as an indicator species. The report briefly reviews some cumulative impact assessment methodologies (sequential geographical analysis using aerial photography, geographic information system, "back-step analysis" of cause-effect modeling, Habitat Evaluation Procedures (HEP) of the U.S. Fish and Wildlife Service, and the EPA's Synoptic Approach) and fish habitat classification methodologies. The project opted to use a GIS impact assessment method. The report summarizes steps to be undertaken in the impact assessment efforts.

112. McCreary, Scott, Robert Twiss, Bonita Warren, Carolyn White, Susan Huse, Kenneth Gardels, and Dominic Roques. 1992. Land use change and impacts on the San Francisco

Estuary: A regional assessment with national policy implications. *Coastal Management* 20(1): 219-254.

This article reports on the findings of a major study, "The Effects of Land Use Change and Intensification on the San Francisco Estuary," conducted for the San Francisco Estuary Project as part of the National Estuary Program. The study involved development of a geographic information system (GIS) using the Geographic Resources Analysis System (GRASS) software package to project impacts from future growth scenarios on wetlands, streams and water quality for the San Francisco Estuary. The specific impacts assessed were nonpoint source pollution associated with runoff from urbanized areas, preemption of wetland habitats, and modification of stream environment zones. The application of this methodology to the entire 12-county estuary study region enabled researchers to examine the cumulative contribution of nonpoint source urban runoff and resulting decrease in water quality of the estuary. It also reviews the institutional arrangements for land use management, and concludes that improvements are needed in the goals, management strategies and institutional arrangements within the estuary. The authors review estuarine management options to improve control of cumulative impacts and recommend the use of watersheds and receiving waters as the appropriate unit for analysis and planning.

113. Miller, David L., Paul M. Leonard, Robert M. Hughes, James R. Karr, Peter B. Moyle, Lynn H. Schrader, Bruce A. Thompson, Robert A. Daniels, Kurt D. Fausch, Gary A. Fitzhugh, James R. Gammon, David B. Halliwell, Paul L. Angermeier, and Donald J. Orth. 1988. Regional applications of an index of biotic integrity for use in water resource management. *Fisheries* 13(5): 12-20.

The authors advocate an integrated approach to surface water quality monitoring that includes both physical/chemical monitoring (e.g. to pinpoint pollutants) and direct biological monitoring (to detect and measure extent and severity of water resource problems). This is necessary because physical/chemical monitoring may not reflect a decline in other factors, such as physical habitat, which may affect the biological integrity. This paper is based on an index of biotic integrity (IBI) which "integrates 12 measures of stream fish assemblages for assessing water resource quality," developed in the Midwest. It examines adaptations of the IBI to other settings, including Louisiana estuaries.

114. Nestler, John. 1992. Cumulative impact assessment in wetlands. In *Wetlands Research Program Bulletin*, 1: 1-8. Vicksburg, MS: U.S. Army Corps of Engineers, Wetlands Research Program.

This Bulletin briefly summarizes the need for Army Corps of Engineers cumulative impact assessment in wetlands. Stating that no tools presently exist for systematic assessment of the effects of cumulative impacts on wetland ecosystem integrity, the author then outlines ACOE research efforts. The research is attempting to formulate indices to summarize changes in spatial and hydrologic patterns in wetlands, and then relate changes in hydrology to changes in vegetation patterns using Geological Information System technology. Eventually, changes in hydrology will be related to changes in landscape or spatial patterns, which in turn will be related to changes in habitat value for wildlife.

115. Power, Garrett. 1975. Watergate Village: A case study of a permit application for a marina submitted to the U.S. Army Corps of Engineers. *Coastal Zone Management Journal* 2(2): 103-124.

This 1973 case study by an interdisciplinary team concludes that a proposed marina expansion project would itself have negligible direct adverse effects, but when considered in conjunction with other pending projects, portends significant environmental degradation. The model methodology for review by existing regulatory agencies, intended to improve their ability to consider incremental development, evaluates federal, state and local regulatory authority; collects information on existing conditions on site and in the surrounding locality for water quality, biota, land use (existing and projected) and water use; identifies similar pending applications for Back Creek; and assesses the effects of the proposed project based on the construction activity, the resulting structure, and the facility "as an increment to overall development" of the region. It finds significant negative cumulative impacts on boat-traffic congestion, public access, and water quality. The study concludes that regulatory agencies have ample powers to review the proposal, but that the decision process is inadequate to analyze projects as an increment to overall development. Similarly, the Army Corps of Engineers has the power but lacks the capacity to evaluate the effects of the proposal on the "public interest" due to budget/staff constraints and absence of societal decisions about resource goals. As one effect of the study, the district office of the Corps of Engineers commissioned a programmatic environmental impact statement on the effects of shoreline alterations in the region to be used in assessing cumulative impacts of pending applications.

116. Preston, Eric M., and Barbara L. Bedford. 1988. Evaluating cumulative effects on wetland functions: A conceptual overview and generic framework. *Environmental Management* 12(5): 565-583.

This article is one of five published in a special issue, which formed the basis of discussions at an EPA-sponsored workshop about the development of a scientific framework for assessing cumulative effects on wetlands. It discusses the issues (scale, thresholds, size, shape and position in landscape) which must be addressed when developing a scientific framework within the context of freshwater wetlands. Stressing the critical importance of establishing boundaries, it offers guidelines for delineating spatial boundaries, based on the magnitude of exchanges among wetlands, and temporal boundaries, using time scales of recovery. It also provides a "generic framework" for evaluating cumulative effects on three wetland functions: flood storage, water quality, and life support.

117. Proett, Michael A. 1987. Cumulative impacts of hydroelectric development: Beyond the cluster impact assessment procedure. *Harvard Environmental Law Review* 11(1): 77-146.

This article discusses small hydroelectric development in the United States and the resultant cumulative impacts. It briefly examines the legal background and contains a detailed critical analysis of the Cluster Impact Assessment Procedure (CIAP) developed by the Federal Environmental Regulatory Commission (FERC) in response to public criticism of FERC's treatment of the cumulative impacts issue. It proposes an alternative assessment procedure to address the shortcomings of the CIAP.

118. Rabeni, Charles F. 1992. Habitat evaluation in a watershed context. In *Proceedings of the American Fisheries Society Symposium 13: Fisheries Management and Watershed Development*, ed. Richard H. Stroud, 13: 57-67. Newport, RI, November 12, 1991. Bethesda, MD: American Fisheries Society.

This article examines three types of Habitat Evaluation Methods. The author states that the various stream fishery management goals require differing levels of "biological realism." Hence, the effectiveness of a HEM depends upon the management goal for which it is used. The article explores how HEM's, currently used to evaluate only a small portion of a stream, may be used at the watershed level.

119. Risser, Paul G. 1988. General concepts for measuring cumulative impacts on wetland ecosystems. *Environmental Management* 12(5): 585-589.

The underlying premise of this article is that while the present incomplete understanding of environmental impacts has prevented the establishment of a single, generally accepted, comprehensive environmental assessment method for cumulative impacts, it is currently possible to develop a set of systematic approaches for detecting and quantifying cumulative impacts. Further research on ecosystem behavior may eventually result in the development of such a comprehensive approach. The author reviews environmental impact analytical techniques (employing checklists of characteristics or processes to be considered, matrices of interactions, nodal networks or pathways, and dynamic models to simulate ecosystem responses) and the growing understanding of ecosystem processes. Asserting that fine-scale predictions of responses are beyond current capabilities, the author nevertheless contends that general principles can predict the direction and possible magnitude of ecosystem responses. He offers as an interim approach a Cumulative Impacts Matrix as a "magnifying glass" to focus the reviewer on all of the possible forms of additive, synergistic and indirect impacts over time and space. Existing methods would be used to identify potential impacts, then each impact would be examined within the matrix, utilizing the most recent scientific information.

120. Sadar, M. Husain, David R. Cressman, and Dianne C. Damman. 1992. Assessing cumulative effects of Saskatchewan uranium mines development. 1420/02/1420MSTR RED. Waterloo, Ontario: Ecologistic, Ltd.

This study, prepared by an independent team of specialists for a joint federal-provincial panel reviewing the proposals, asserts that while there is much conceptual and theoretical discussion of cumulative effects assessment, the knowledge base necessary to deal with practical aspects of cumulative effects assessment is "almost non-existent." Noting that they could not find any suitable model to assist with their design, the team developed its own methodology. The team used an impact analysis framework based on ecosystem pathways to identify impact linkages among past, present, and proposed uranium mining projects, and other activities and projects in the mines' zone of influence. The team developed its own preliminary criteria for determining which impacts were significant.

121. Sebastiani, M., A. Sambrano, A. Villamizar, and C. Villalba. 1989. Cumulative impact and sequential geographical analysis as tools for land use planning: A case study: Laguna La Reina, Miranda State, Venezuela. *Journal of Environmental Management* 29: 237-248.

This paper describes the use of sequential geographical analysis as a means for assessing cumulative impacts of development on the case study site, Laguna La Reina, Miranda State, Venezuela. The study looks at land occupation and associated changes over a 37 year period. The authors stress the utility of incorporating ideas from the environmental assessment process into land use planning.

122. Shopley, J. B., and R. F. Fuggle. 1984. A comprehensive review of current environmental impact assessment methods and techniques. *Journal of Environmental Management* 18: 25-47.

This 1984 article surveys methods and techniques for environmental impacts analysis including: ad hoc approaches, checklists (simple and descriptive, scaling, weight-scaling), matrices (presentational, mathematical), networks (Sorensen, system diagrams), cartographic techniques, modelling procedures, evaluation techniques and adaptive methods. The author concludes that most techniques are unable to address secondary impacts; however mathematical matrices, some networks, and modelling procedures have the potential to identify and quantify (modelling only) secondary impacts. The fact that in the United States environmental impact analysis is usually used for post-design appraisal separate from the planning and development of a project is identified as a characteristic that restricts the transferability of U.S. techniques to a degree. The authors conclude that inadequate attention has yet been given to techniques for evaluating secondary impacts.

123. Stakhiv, Eugene Z. 1986. Cumulative impact analysis for regulatory decisionmaking. In *National Wetlands Assessment Symposium*, ed. Jon A. Kusler, and Patricia Riexinger, 213-222. Portland, ME, June 17, 1985. Chester, VT: Association of State Wetland Managers.

This paper discusses experience with the U.S. Army Corps of Engineer regulatory program public interest review, including consideration of potential cumulative effects. It argues that cumulative impact analysis ought to be conducted at policy, program, and project/permit application levels as a form of "comprehensive evaluation." It discusses an evaluation framework composed of two functions: goals-oriented planning evaluation and analysis of the consequences or impacts of an action; but recommends that local or regional master planning level is the appropriate vehicle for establishing public interest goals. The author presents an evaluation model for assessing cumulative impacts in regulatory permit review.

124. Stakhiv, Eugene Z. 1988. An evaluation paradigm for cumulative impact analysis. *Environmental Management* 12(5): 725-748.

The author contrasts assessment of cumulative effects (ACE) (an orientation that stresses scientific, fact-driven tracing of the effects of perturbations throughout an ecosystem) against cumulative impact analysis (CIA) (a decision-making perspective which also incorporates values and socio-economic aspirations). He asserts that ACE is based on a narrow reading of NEPA, and that the Act contemplated the multiobjective, comprehensive planning approach represented by CIA. The author identifies differences between evaluation frameworks based on constraint-oriented regulations and objectives-oriented anticipatory planning, concluding that the latter is better suited for considering the desired carrying capacity of an area or resource and identifying the appropriate trade-offs. The Corps permit program is used to illustrate the incongruities of trying to conduct CIA within an "end-point" regulatory program. The author reviews several evaluation methods of assessing wetlands, concludes that none is ideal, and offers a heuristic mathematical model using a linear programming approach to demonstrate essential ingredients of CIA.

125. Stout, David J. 1988. Preventing cumulative impacts: The Washington experience. In *Proceedings of the National Wetland Symposium: Mitigation of Impacts and Losses*, ed. Jon A. Kusler, Millicent L. Quammen, and Gail Brooks, 204-206. New Orleans, LA, October 8, 1986. Berne, NY: Association of State Wetland Managers.

This paper discusses an approach developed to address the inadequacies of previous methodologies used to assess cumulative impacts of hydropower plants in the state of Washington. The author asserts that implementation of the Fish and Wildlife Service Mitigation Policy of no net loss of habitat value provides the best means of preventing cumulative impacts. However, the author adds that this approach will only be effective if projects are evaluated "in context," (evaluating the significance of impacts from the project within appropriate geographic boundaries, with knowledge of resource status and trends and development trends, over an appropriate time frame, given impacts of past, present and reasonably foreseeable projects on important resources). It briefly describes the five basic steps (scoping, conducting appropriate studies to determine existing conditions and facilitate prediction of impacts, evaluating significance of project-specific impacts, evaluating the proposed activity "in context," and developing mitigation plans) used in Washington to assess and prevent cumulative impacts.

126. Stull, E. A., M. B. Bain, J. S. Irving, K. E. LaGory, R. D. Olsen, and G. W. Witmer. 1987. *Cumulative impact assessment: Issues to consider in selecting a cumulative assessment method.* CONF-8708189--1. NTIS.

The authors were involved in developing criteria and methods for assessing cumulative environmental effects of hydroelectric development under the Columbia River Basin Fish and Wildlife Program. The authors specified four methodological criteria for appropriate cumulative effects assessment. It must be able to: 1) evaluate the combined impact of several actions on a common resource, 2) assess both additive and nonadditive impact accumulation, 3) assess a variety of direct and indirect environmental effects on fish and wildlife and aggregate different types of impacts into an overall impact estimate, and 4) consider multiple impacts on multiple species. The study evaluated 16 potential assessment methods, and found only three met the stated criteria without further modification: FERC's Snohomish and Salmon River Basins methodology, the Argonne multiple matrix methodology and the cluster impact assessment procedure. However, the authors determined that for their purposes, they needed a method which would explicitly calculate the magnitude of an impact in terms of cumulative fish and wildlife population loss rather than using evaluative criteria to express the importance and significance of the impact. Because all three methods used evaluative criteria, the authors concluded they needed to develop a new method, to be released by the Bonneville Power Administration.

127. Walker, Donald A., Patrick Webber, Marilyn Walker, Nancy Lederer, Rosa Meehan, and Earl Nordstrand. 1986. Use of geobotanical maps and automated mapping techniques to examine cumulative impacts in the Prudhoe Bay Oilfield, Alaska. *Environmental Conservation* 13(2): 149-160.

The paper analyzes past physical disturbances in the Prudhoe Bay region. This analysis combines detailed geobotanical mapping 'legends' that have been developed for the region with automated mapping techniques. The map, termed an Integrated Geobotanical and Historical Disturbance Map permits a detailed time-series analysis of areas covered by geobotanical, natural and anthropogenic disturbances. The authors recognize that the maps depict relatively major physical changes to the terrain, and that they cannot depict total cumulative impact, which includes other factors such as the actual effects on wildlife populations. This method is presented as a necessary first step towards a comprehensive methodology for evaluating cumulative impacts.

128. Westman, Walter E. 1985. *Ecology, impact assessment, and environmental planning*. New York, NY: John Wiley & Sons.

Chapter 4, (pages 131-167) Quantitative Approaches, discusses a variety of approaches to impact assessment, defined as analysis and evaluation of the ecological effects of human activity upon an ecosystem. The first section discusses impact identification techniques of checklists, matrices and networks. The second section examines methods of evaluation in two categories: those that aggregate public values and those that disaggregate public values. Various weight-scaling techniques are examined as

approaches that aggregate public values. Approaches examined which disaggregate public values include the planning balance sheet, goals-achievement matrix, priority-trade-off scanning matrix, and simple trade-off matrix.

129. Whitworth, Molly R., Lee S. Ischinger, and Gerald C. Horak. 1985. Guidelines for implementing natural resource information systems: The River Reach fisheries information system. Ft. Collins, CO: U.S. Fish and Wildlife Service, Western Energy and Land Use Team.

This publication discusses the River Reach Fisheries Information System (RRFIS), a computer-assisted information system designed by the Fish and Wildlife Service to organize natural resource data for use in fishery and aquatic habitat management. It provides interactive data base management and geographic information system capabilities. The type of information contained in RRFIS may be useful to a reviewer evaluating cumulative impacts and considering mitigation measures. The report provides detailed instructions for designing, implementing and customizing a RRFIS for the user's specific needs. The system also has the potential for use in the area of wetland planning and management.

130. Williamson, Samuel C., Carl L. Armour, Glenn W. Kinser, Steven L. Funderbunk, and Timothy N. Hall. 1987. Cumulative impacts assessment: An application to Chesapeake Bay. In *Transactions of the Fifty-Second North American Wildlife and Natural Resources Conference*, ed. Richard E. McCabe, 377-388. Quebec City, Quebec, March 20, 1987. Washington, DC: Wildlife Management Institute.

This paper describes the efforts of U.S. Fish and Wildlife Service (USFWS) to participate in a multiagency program to restore Chesapeake Bay. Stressing the need to identify what is meaningful rather than what is readily quantifiable, the process relied on the abilities of resource management experts working collaboratively in a workshop setting, using an ecological problem-solving approach. Starting with the premise that cumulative impacts are not being adequately addressed, participants identified high priority problems within the responsibilities and concerns of the USFWS, identified contributing problems, agreed on keystone problems, analyzed and documented keystone problems using cause-effect diagramming, and planned corrective actions. In this particular example, the decline of submerged aquatic vegetation was identified as the keystone problem. Under this approach, the distribution and biomass of submerged aquatic vegetation is to serve as the long-term measure of the success of restoration efforts.

131. Williamson, Samuel C. 1993. Cumulative impacts assessment and management planning: Lessons learned to date. In *Environmental Analysis: The NEPA Experience*, ed. Hildebrand, Stephen G. and Johnnie B. Cannon, 391-407. Boca Raton, FL: CRC Press.

This paper asserts that cumulative impacts assessment (total impacts to date of all past actions and natural events on the affected ecosystem) should be closely associated with

management planning for an ecosystem of concern to increase the potential to reach long-term goals. The author predicts that natural resource agencies will shift from scrutinizing individual permits to developing a new capability to provide ecosystem-level guidance. The author recommends that a successful assessment will "emphasize scientific, cause-effect understanding and communication; stress measurable overall action toward progressive goals; use a generation-long, ecosystem-level, problem-solving and solution achieving process; and ratify an interagency collaborative drive toward cumulative improvement of the situation." The author recommends specific steps for the scoping, analysis, interpretation and direction phases of the cumulative impacts assessment and management planning process, and then discusses cumulative impacts assessment projects with which the U.S. Fish and Wildlife Service has been involved.

132. Winter, Thomas C. 1988. A conceptual framework for assessing cumulative impacts on the hydrology of nontidal wetlands. *Environmental Management* 12(5): 605-620.

This article summarizes hydrologic concepts related to nontidal wetlands, examines uncertainty in understanding and measuring hydrologic processes, and then based on this limited information base and "hydrologic intuition," discusses cumulative effects of specific disturbances on the hydrology of wetlands (weather modification, alteration of plant communities, storage of surface water, road construction, drainage of surface water and soil water, alteration of groundwater recharge and discharge areas, and pumping of groundwater). The author concludes that effective management of the hydrologic continuum is hampered by inadequate understanding of hydrologic processes and lack of consideration of uncertainties in measuring atmospheric water, surface water and groundwater components.

133. Witmer, Gary W. 1986. Assessing cumulative impacts to wetlands. In *Proceedings of the National Wetlands Assessment Symposium*, ed. Jon A. Kusler, and Patricia Riexinger, 204-208. Portland, ME, June 17, 1985. Chester, VT: Association of State Wetland Managers.

This paper analyzes the differences between standard environmental impact assessment and cumulative impact assessment, and reviews existing methods that can be adapted for use in cumulative impact analysis (checklists/ matrices; overlay maps; networks or flow diagrams; panels of specialists in workshop to establish thresholds, contribute interdisciplinary knowledge, reduce scope; models to monitor impacts or resources over time for use in predicting changes over time; gaming optimization; and analysis of alternative scenarios or management strategies). The author recommends more effective scoping, better integration of quantitative methods and statistics, improved regional data bases, incorporation of ecological principles (e.g., thresholds, minimum viable population), improved ways to aggregate impacts, and monitoring programs.

134. Witmer, G. W., M. B. Bain, J. S. Irving, R. L. Kruger, T. A. O'Neil, R. D. Olsen, and E. A. Stull. 1987. *Cumulative impact assessment: Application of a Methodology*. CONF-8708124--1. NTIS.

This paper, prepared for a presentation at the Waterpower '87 Conference of American Society of Civil Engineers, describes the Argonne Multiple Matrix methodology for cumulative impact assessment. It expands upon FERC's Cluster Impact Assessment Procedure (CIAP) to develop a "practical methodology for assessing potential cumulative impacts from multiple hydroelectric projects within a river basin." It involves five steps: 1) set scope, organize data, create model (geographic and resource sort, construction of impact, weighting and interaction matrices); 2) calculate total cumulative impact rating for all possible combinations (matrix algebra calculations using computer program); 3) screen combinations by multiple criteria (using project-specific flags and total cumulative impact rating score); 4) identify preferred project combinations (combinations remaining after screening); 5) describe and summarize cumulative impacts of preferred project combinations. The paper describes use in the Snohomish and Salmon River Basins. Despite improvements made, the authors discuss difficulties encountered: variability in data quality and quantity; inadequacies in coefficients reflecting nonlinear (synergistic or antagonistic) environmental effects; absence of established thresholds or goals for resources, populations and habitats; absence of considering duration of impacts; and difficulty in analysis of hydroelectric and non-hydroelectric alternatives.

135. World Wildlife Fund. 1992. Statewide wetlands strategies. Washington, D.C.: Island Press.

The chapter entitled "Understanding Cumulative Impacts" briefly discusses some of the issues surrounding cumulative impact assessment, as well as some factors which should be considered when conducting an assessment. It states that assessment should proceed on a landscape level. An excellent resource, Section IV.2, authored by Paul R. Adamus, provides a comprehensive review of wetlands information sources and evaluation methods. The methods review includes two categories of "rapid" methods: those that may be used anywhere, and those that are applicable to specific regions or types of wetlands. It also includes "intensive" methods for individual wetlands. The EPA's Synoptic Approach is the only method included in the review which is specifically designed to assess the cumulative effects of wetlands loss. Some of the factors considered in each method reviewed are: inclusion of essential indicators, consideration of temporal dynamics, consideration of bounding/scale issues, consideration of physical/landscape context, and time and labor requirements. Section IV.2 concludes with a table which compares the evaluation methods based on the indicators they use.

CUMULATIVE IMPACT ASSESSMENT METHODOLOGIES: ITEMS IDENTIFIED; NOT ABSTRACTED

136. Frissell, C. A., W. J. Liss, C. E. Warren, and M. D. Hyrley. A hierarchical framework for stream habitat classification: Viewing streams in a watershed context. *Environmental Management* 10(2): 199-214.

137. Klopatek, J. M. 1988. Some thoughts on using a landscape framework to address cumulative impacts on wetland food chain support. *Environmental Management* 12(5): 703-711.

138. Lumb, A. M. 1982. Procedures for assessment of cumulative impacts of coal mining on the hydrologic balance. Open-File Report 82-334. Lakewood, CO: U.S. Geological Survey.

139. Moy, Wai See, Eugene Stakhiv, and David Moser. 1985. A multiobjective linear programming model for wetlands permits evaluation. In *Environmental Quality Planning Course*, Institute for Water Resources, May 6, 1985.

140. Mulvihill, E. G., C. A. Francisco, and J. B. Gilad. 1980. Biological impacts of minor shoreline structures on the coastal environment: State of the art review. Washington, DC: Fish and Wildlife Service, U.S. DOI.

141. Powers, Joseph E. 1987. *Statistical criteria for evaluating impacts to ecological habitats.* American Association of Advancement of Science, EPA Environmental Science and Engineering Fellowship. Working Paper. Miami, FL: U.S. National Marine Fisheries Service, Southeast Fisheries Center.

142. Stull, E. A., M. B. Bain, J. S. Irving, K. E. LaGory, and G. W. Witmer. 1987. Methodologies for assessing the cumulative environmental effects of hydroelectric development of fish and wildlife in the Columbia River Basin: Volume 1. Recommendations: Final Report. DOE/BP/19461-3. U.S. DOE.

143. Stull, E. A., and R. M. Emery. 1988. Key fish and wildlife species and habitats in the Columbia River Basin potentially affected in a cumulative manner by hydroelectric development: Final report. DOE/BP/19461-1. U.S. DOE.

144. Stull, E. A., K. E. LaGory, and W. S. Vinikour. 1988. Methodologies for assessing the cumulative environmental effects of hydroelectric development on fish and wildlife in the Columbia River Basin: Volume 2: Example and procedural guidelines: Final report. DOE/BP/19461. U.S. DOE.

145. Weller, Milton W. 1988. Issues and approaches in assessing cumulative impacts on waterbird habitat in wetlands. *Environmental Management* 12(5): 695-701.

146. Whigham, D. F., and C. Chitterling, et al. 1988. Impacts of freshwater wetlands on water quality: A landscape perspective. *Environmental Management* 12: 663-671.

Section 4
Federal Cumulative Impact Assessment Authority and Practice

This section collects documents pertaining to the legal authority and responsibility of federal agencies to consider cumulative environmental impacts in decision-making. It includes only those federal agencies most likely to be players in the coastal context or federal agencies which have been involved in cutting-edge issues related to the inclusion of considerations of cumulative effects in decision-making: the Army Corps of Engineers, Bureau of Land Management, Environmental Protection Agency, Federal Energy Regulatory Commission, Fish and Wildlife Service, National Marine Fisheries Service, and U.S. Forest Service.

The sections on agency-specific statutes, regulations and policies used the *Inventory of Federal Agency Activities on Cumulative Impact Assessment,* prepared by the Conservation Foundation for the Council on Environmental Quality in 1988 (see Annotated Bibliography #147) as a foundation, but updated that information to the extent possible. That document should be consulted for additional information, including pre-1989 examples of the treatment of cumulative impacts in environmental impact statements and additional agency guidance documents, and information about cumulative impact assessment activities of federal agencies not included in this bibliography.

The first subsection is an overview, which contains documents that discuss multiple federal agencies. The next two subsections collect information about two statutes with cumulative impact requirements that apply to all federal agencies: the National Environmental Policy Act and the Endangered Species Act. The remaining subsections collect material about individual federal agencies. Within each agency subsection, the statutes, regulations and official agency policies appear first, followed by reports, analyses and critical assessments of how each agency has implemented the cumulative impact requirements.

At the end of each subsection, there is a list of the documents prepared by or for the agency which appear in the earlier sections of this bibliography. For example, the Fish and Wildlife Service has devoted significant effort to developing cumulative impact assessment protocols and methodologies; those documents are included in the General Cumulative Impact Literature and Cumulative Impact Assessment Methodologies sections rather than in the agency subsection, but those documents are cross-referenced at the end of the agency subsection by reference number.

The final subsection of the Federal portion collects selected federal court cases. These cases were located through computer-assisted research using a variety of search term combinations, all including "environmental" and "cumulative impact" or "cumulative effect." Not all cases identified by the search were included. Cases which merely included claims that the cumulative impact assessment was deficient or findings that the cumulative impact assessment was or was not adequate, without further elaboration, were generally not included. Similarly, if a case involved a non-coastal environment and merely cited prior decisions without advancing the discussion of cumulative impact concepts, it was not included. In many of the cases, the issues were complex and involved cumulative impact assessment as only one of several grounds. The abstracts summarize only the portion of the decision related to cumulative impacts. The last date of search and last date of Shepardizing for later developments was October 1, 1994. A few of the cases were not available in federal reporters; references for those cases are to the LEXIS electronic database maintained by Mead Data Central.

U.S. FEDERAL - GENERAL OVERVIEW

147. Cohrssen, John H., ed. 1989. Inventory of federal agency activities on cumulative impact assessment and summary of November 30, 1988 Interagency Meeting on Cumulative Impact Assessment. Washington, DC: Council on Environmental Quality.

This inventory was prepared by the Conservation Foundation for the Council on Environmental Quality in an effort to promote an exchange of information about federal activities associated with cumulative impact assessment. For each of 22 agencies, it includes a department-specific inventory of cumulative impact initiatives and authorities including current activities, legal provisions, guidance documents, court cases, examples of cumulative impact assessment from environmental impact statements, related literature and key agency contacts. The publication also includes a summary of a one-day meeting discussing the inventory, cumulative impact issues and needs/opportunities for federal agencies to improve cumulative impact assessment methodologies.

148. Muir, Thomas A., Charles Rhodes, and James Gosselink. 1990. Federal statutes and programs relating to cumulative impacts in wetlands. In *Ecological Processes and Cumulative Impacts: Illustrated by Bottomland Hardwood Wetland Ecosystems*, ed. James G. Gosselink, Lyndon C. Lee, and Thomas A. Muir. Chelsea, MI: Lewis.

This overview summarizes the cumulative impacts components of the Clean Water Act, NEPA, and non-regulatory programs (Advance Identification areas under CWA, National Estuary Program, Near Coastal Waters Program, non-Point Source Program, etc.). It concludes that the numerous programs have not been successful in stemming the loss of wetlands due to lack of necessary information, lack of resources for a sufficient monitoring program, lack of regulatory authority by individual agencies, and misplaced focus on sites rather than a larger landscape unit.

149. Schneller-McDonald, Karen, and Gerald C. Horak. 1982. *Cumulative impact assessment: Legal and regulatory status*. Review draft. Ft. Collins, CO: Prepared for the U.S. Fish and Wildlife Service, Western Energy and Land Use Team.

This publication discusses legislation that requires cumulative impact assessment, with reference to pertinent provisions of the NEPA, Surface Mining Control and Reclamation Act, Federal Water Pollution Control Act, and the Clean Water Act. It identifies regulations and policies concerning cumulative impact assessment, promulgated by the following authorities: CEQ, Forest Service, Corps of Engineers, Office of Surface Mining, Northwest Power Planning Council, FERC, and the Bureau of Reclamation. It examines twenty-six federal cases (through 1985) which contain significant discussion of cumulative impacts issues and also contains a section on state and regional activity.

150. White House Office on Environmental Policy. 1993. *Protecting America's wetlands: A fair, flexible, and effective approach.* Washington, DC:

This White House Office on Environmental Policy statement presents the Clinton Administration's package of wetlands reform initiatives. The accepted principles for federal wetlands policy include: an interim goal of no overall net loss of remaining wetlands, a long-term goal of increasing the quality and quantity of the wetlands resource base, and reduced reliance upon regulatory programs through increased emphasis on non-regulatory programs including advance planning. The statement organizes the specific reform initiatives by key issues. The statement asserts one of the key issues is that the current practice of making decisions on a project-by-project, permit-by-permit basis often precludes consideration of cumulative effects and fails to integrate conservation objectives. The document advocates advance comprehensive planning on a watershed basis as the best means to address these issues and lists multiple actions that should be taken to further this objective.

U.S. FEDERAL - ALL AGENCIES-ENDANGERED SPECIES ACT

151. Endangered Species Act of 1973, as amended, 16 U.S.C. § 1531 et. seq. (1994).

One purpose of this Act is to conserve ecosystems upon which endangered and threatened species depend. All federal departments and agencies are to utilize their authorities in furtherance of the purposes of the Act, and are to cooperate with state and local agencies. Section 1536 provides for interagency cooperation, which requires each federal agency to consult with the Secretary of the Interior or Commerce to insure that a proposed agency action is not likely to jeopardize the continued existence of an endangered or threatened species or "result in the destruction or adverse modification of habitat of such species" which is determined to be critical. Specifically a biological assessment is to be prepared if a species which is listed or is proposed to be listed may be present in the area of the proposed action to determine if the species is likely to be affected by such action. It authorizes the promulgation of regulations to carry out the Act.

152. Fish and Wildlife Service and National Marine Fisheries Service, Interagency Cooperation--Endangered Species Act of 1973, as amended, Final Rule, 51 Fed. Reg. 19926 (June 3, 1986).

This final rule establishes the procedures for interagency cooperation under Section 7 of the Endangered Species Act, replacing the 1978 rule. The final rule addresses cumulative effects in § 402.02, stating that the consulting agency will consider both the effects of the action and the cumulative effects of other activities in determining whether the action is likely to jeopardize the continued existence of a listed species or result in the adverse modification of critical habitat. The statement asserts that a cumulative impacts assessment is required as part of an Endangered Species Act Section 7 consideration because of the requirements of NEPA. Indirect effects of unrelated actions are also to be considered in the biological assessment to determine whether any jeopardy exists. See also 50 C.F.R. Part 402.02.

153. Associate Solicitor. August 27, 1981. Letter to Director, Fish and Wildlife Service, U.S. Dept. of Interior.

This letter outlines the legal requirements for cumulative effects to be considered under Section 7 of the Endangered Species Act.

154. Solicitor, Conservation and Wildlife. August 26, 1981. Letter to Director, Fish & Wildlife Service, U.S. Dept. of Interior.

This letter withdraws the withdrawal of prior solicitor's opinions on cumulative effects analysis under Section 7 of the Endangered Species Act.

U.S. FEDERAL - ALL AGENCIES - NATIONAL ENVIRONMENTAL POLICY ACT

155. National Environmental Policy Act of 1969, as amended, 42 U.S.C.S. § 4321 (1994).

This 1969 Act established a national charter, goals and means for securing environmental protection, including procedural requirements that every major federal action significantly affecting the quality of the human environment be accompanied by the preparation of a statement assessing the environmental impact of the proposed action. All federal agencies were directed to review their present authority, regulations and policies, and bring them into full compliance with NEPA. The Act also established the Council on Environmental Quality and authorized it to develop regulations to implement the Act.

156. Council on Environmental Quality, Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act of 1969, 40 C.F.R. Parts 1500-1508, Nov. 29, 1978, as amended (1994).

These CEQ regulations, authorized by the National Environmental Policy Act (NEPA), define applicable terms and establish the requirements for complying with the NEPA process. Section 1508.7 defines "cumulative impact" as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonable foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time." Other relevant regulations include § 1508.25(a)(1) which states that to determine the scope of an EIS, agencies shall consider three types of actions as "connected" (automatically trigger other actions, will not proceed unless other actions taken previously or simultaneously, or interdependent parts of a larger action). Section 1508.27(7) directs agencies evaluating the intensity of a proposed action to determine its significance and whether an EIS is required to consider whether "the action is related to other actions with individually insignificant but cumulatively significant impacts. Significance exists if it is reasonable to anticipate a cumulatively significant impact on the environment. Significance cannot be avoided by terming an action temporary or by breaking it down into small component parts." Definitions of "effects" and other important terms are also included in the regulations.

157. Blumm, Michael. 1990. Introduction: The National Environmental Policy Act at twenty: A preface. *Environmental Law.* Symposium on NEPA at Twenty. 20: 447-483.

This article, adapted from remarks opening a symposium, "NEPA at Twenty," establishes the context for the following symposium articles.

158. Cohen, William M. 1994. *Connected actions and cumulative and synergistic impacts under NEPA. ALI-ABA Course of Study, C933 ALI-ABA 131.*

In this paper, a U.S. Department of Justice attorney summarizes the CEQ regulations and reviews twelve notable federal cases interpreting NEPA requirements on issues of connected actions, and cumulative and synergistic impacts.

159. Hapke, Peter. 1985. Thomas v. Peterson: The Ninth Circuit breathes new life into CEQ's cumulative and connected actions regulation. *Environmental Law Reporter* News and Analysis, 15: 10289.

This analysis reviews *Thomas v. Peterson*, the first appellate ruling construing the CEQ's connected action and cumulative effect regulations.

160. Kamaras, Gail. 1993. Cumulative Impact Assessment: A Comparison of Federal and State Environmental Review Provisions. *Albany Law Review* 57: 113.

The author develops a detailed comparison of the cumulative impact assessment provisions of the federal NEPA and sibling provisions in New York, California and Washington. She reviews not only statutory references to cumulative impacts and definitions of cumulative impacts, but also related issues of whether the definitional focus is on project, action or proposal; how cumulative impacts are considered in deciding whether an EIS is required (e.g., whether cumulative impacts can "significantly" affect); whether cumulative impacts are within the scope of review if an EIS is required; and related concepts of program EISs, tiering or phased review, segmentation. The author concludes that the environmental review processes generally function properly, but that regulations pertaining to cumulative impacts would be improved by clearly articulated definitions of key terms and additional guidance on procedural and substantive matters, specifically outlined in the article.

161. Merson, Alan, and Kristine Eastman. 1979. Cumulative impact assessment of western energy development: Will it happen? *Colorado Law Review* 51(1): 551-586.

This 1979 article analyzes the potential for cumulative impact assessment of a variety of energy development actions, looking at local, state and federal mechanisms, including NEPA mandates and CEQ regulations. It concluded that conscientious compliance with NEPA requirements and judicial willingness to ensure agency responsiveness to CEQ regulations and correlative rules will be key.

162. Thatcher, Terence L. 1990. Understanding interdependence in the natural environment: Some thoughts on cumulative impact assessment under the National Environmental Policy Act. *Environmental Law.* Symposium on NEPA at Twenty. 20(3): 611-647.

The author, a litigator who has argued notable NEPA cases, examines NEPA's cumulative impacts requirements. He outlines legislative history, discusses Kleppe v. Sierra Club and related cases, and analyzes closely related concepts such as "independent utility", "cumulative actions" and "connected actions." He analyzes how NEPA's direction to assess cumulative impacts has been treated by the courts, and whether that has advanced or hindered the goal of environmental review.

U.S. FEDERAL - ARMY CORPS OF ENGINEERS

163. Army Corps of Engineers, General Regulatory Policies, 33 C.F.R. Part 320.4 (1993).

This section contains the general policies for ACOE evaluation of permit applications under the Rivers and Harbors Act, the Clean Water Act, and the Marine Protection, Research and Sanctuaries Act of 1972. It outlines the public interest review process, stating that "the decision whether to issue a permit will be based on an evaluation of the probable impacts, including cumulative impacts, of the proposed activity and its intended use on the public interest." It directs a balancing of all relevant factors, including the cumulative effects thereof, including among other considerations, conservation, general environmental concerns, wetlands, fish and wildlife values, water quality, economics, and considerations of property ownership. It also contains a specific identification of wetlands which perform functions important to the public interest, and states that the cumulative effect of numerous minor wetland alterations can result in major impairment of wetland resources. The district engineer is authorized to consult with other agencies to review particular wetland areas to assess the cumulative effect of activities in such

areas. Permit applications to alter important wetlands are to be evaluated using the EPA 404(b)(1) guidelines on practicable alternatives (40 C.F.R. 230.10(a)(1)(2)(3)).

164. Army Corps of Engineers, Department of the Army, Processing of Department of the Army Permits, 33 C.F.R. Part 325, Appendix B-9(b)(7) (1993).

These final rules for the regulatory program incorporate by reference the environmental consequences provisions of 40 CFR 1502.16 (CEQ EIS regulations) which require consideration of direct and indirect effects and their significance.

165. Army Corps of Engineers, Procedures of Implementing NEPA, 33 C.F.R. Part 230, (1993).

Section 230.9 lists categorical exclusions for actions which under ordinary circumstances are deemed not to have significant effects when considered individually and cumulatively and therefore are excluded from NEPA documentation. Section 230.13 details the requirements for Environmental Impact Statements including supplements and tiering.

166. Army Corps of Engineers and Environmental Protection Agency, Clean Water Act Regulatory Programs, 58 Fed. Reg. 45008 (Aug. 25, 1993).

This document contains the August 1993 final rules and a discussion of the comments received on the draft rules concerning the following actions under section 404 of the Clean Water Act: 1) modification of the definition of discharge of dredged material; 2) clarification of when placement of pilings is a discharge of fill material; and 3) codification of the policy that prior converted croplands are not waters of the United States. Some sections have the effect of decreasing the threshold of adverse effects for the *de minimis* exception (below which a 404 permit application is not required) to a very low one to bring within review certain prior practices developers had used to escape review. According to the comments on discharge of dredged material as a result of excavation activities (including incidental redeposition of dredged material however small or temporary) "an identifiable adverse individual or cumulative effect on any aquatic function is sufficient to subject an activity to section 404 jurisdiction."

167. Army Corps of Engineers Regulatory Guidance Letter (RGL 92-1), 58 Fed. Reg. 17209 at 17216 (Apr. 1, 1993).

ACOE Regulatory Guidance Letters (RGL) interpret or clarify existing regulatory program policy for its division and district engineers. RGL 92-1 on federal agencies' roles and responsibilities clarifies the ACOE's leadership and decision-making role for permit applications under Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act; states that the Corps will fully consider other Federal agencies' project related comments when determining compliance with NEPA, Section 404(b)(1) guidelines, the ESA and other statutes, regulations and policies; states that the Corps will "fully consider comments regarding the site from a watershed or landscape scale.

including an evaluation of potential cumulative and secondary impacts"; and that the Corps "must consider" cumulative impacts in permit decisions, and in addition to its own expertise will fully consider comments from the Federal resource agencies on cumulative impacts. This RGL expires December 31, 1997 unless sooner revised or rescinded.

168. Army Corps of Engineers Regulatory Guidance Letter (RGL 86-10) (April 11, 1993) Special Area Management Plans (SAMPs), 58 Fed. Reg. 17209 at 17219.

ACOE Regulatory Guidance Letters (RGL) interpret or clarify existing regulatory program policy for its division and district engineers. RGL 86-10 on Special Area Management Plans (SAMPs) has been extended to December 31, 1997. It endorses collaborative interagency planning within a geographic area of special sensitivity as a means of reducing problems associated with traditional case-by-case review, stating that "[d]evelopment interests can plan with predictability and environmental interests are assured that individual and cumulative impacts are analyzed in the context of broad ecosystem needs." However, noting that SAMPs are very labor intensive, it outlines ingredients that should exist before a district engineer becomes involved with a SAMP.

169. Clean Water Act of 1977, 33 U.S.C. § 1344 (1994).

This section of the Federal Water Pollution Control Act or Clean Water Act established the Army Corps of Engineers administered 404 permit program regulating discharge of dredged or fill material into navigable waters, authorizes 404(b)(1) guidelines for permit review, and provides for state, regional and nationwide general permits. By statute, general permits may only be issued if the Secretary determines the activities "will have only minimal cumulative adverse effect on the environment." It also includes a list of non-prohibited discharges.

170. Intent to prepare a Draft Environmental Impact Statement (DEIS), Red River of the North Cumulative Impact Evaluation Study of Impoundments, 58 Fed. Reg. 68635 (Dec. 28, 1993).

This is a notice of intent to prepare a draft EIS for the Red River of the North basin in Minnesota to evaluate the potential for the construction of multiple surface water impoundments with pending section 404 permit applications to result in significant cumulative impacts on natural, cultural and socioeconomic resources. The joint EIS is being prepared with the Minnesota Department of Natural Resources, with the draft EIS expected in March 1995.

171. Addison, Thomas, and Timothy Burns. 1991. The Army Corps of Engineers and Nationwide Permit 26: Wetlands protection or swamp reclamation? *Ecology Law Quarterly* 18: 619-676.

The authors examine the history and evolution of Nationwide Permit 26, and discuss the administration and enforcement, focusing on Northern California. Among their conclusions are that NWP 26 fails to generate information adequate to evaluate individual and cumulative adverse environmental impacts of permitted wetland fills.

172. Crawford, James P., and Alan D. Randall. 1983. New England Division's general-permit methodology. In *Coastal Zone '83: Proceedings of the Third Symposium on Coastal and Ocean Management*, ed. Orville T. Magoon, and Hugh Converse, III: 2054-2072. San Diego, CA, June 1, 1983. New York, NY: American Society of Civil Engineers.

This publication reviews the findings of a review of individual permits, development of new general permits, and State Program General Permits. The authors assert that this general permit program will eliminate the need to issue individual permits for environmentally benign work, permitting more attention be given to environmentally sensitive projects.

173. Hunt, Constance E. The Section 404 Program as a stream corridor planning tool. In *Wetlands and River Corridor Management*, ed. Jon A. Kusler, and Sally Daly, 446-449. Charleston, SC, July 5, 1989. Berne, NY: Association of Wetland Managers.

This paper presents suggestions for employing the Section 404 Corps regulatory program to achieve national conservation objectives. Special area management planning (SAMP) is discussed as a means of protecting valuable wetland areas from incompatible development and making the permit review process more predictable. Through SAMP, the Corps may engage in comprehensive planning and negotiations to identify those areas which should remain undeveloped and those in which development is permissible, so long as appropriate mitigation measures are taken. Also included are two case studies illustrating the use of SAMPs in two Illinois districts.

174. Landin, Mary C., Ellis J. Clairain, Jr., Russell F. Theriot, William L. Klesch, and Jessee A. Pfeiffer, Jr. 1991. In *Proceedings of the US Army Corps of Engineers Wetlands Workshop*, Final Report: Aurora, CO, September 13, 1989. Vicksburg, MS: US ACOE, Waterways Experiment Station.

During this workshop to identify needs and concerns related to US ACOE wetland activities, cumulative impacts assessment issues were among the priority needs. Needs included: develop new cumulative impact analysis technology to assess how much wetland loss is tolerable now and in the future, develop better internal accounting procedures for regulatory and civil works activities to determine cumulative impacts, and revise US ACOE SAMPs and 404c advance resource identification policies to allow US ACOE to initiate and implement resource management plans to address cumulative impacts.

175. Lovely, Jeffrey M. 1990. Comment: Protecting wetlands: Consideration of secondary and economic effects by the United States Army Corps of Engineers in its wetlands permitting process. *Boston College Environmental Affairs Law Review* 17: 647-686.

The author argues that the Corps must be allowed to consider reasonably foreseeable social and economic effects of proposed wetland development in order to attain the goal of no net wetland loss. The article discusses the pertinent provisions of NEPA, the Corp's jurisdiction over wetlands activity and the judicial review process. It also reviews the case law which has addressed the role of secondary effects in the permit review process. Although the case law is inconsistent on the issue of Corps consideration of secondary effects, the author outlines the guiding principles contained therein which indicate that the consideration is a permissible one. The article also describes a framework for considering secondary effects.

176. Office of Technology Assessment (OTA). 1984. Wetlands: Their use and regulation. Washington, DC: U.S. Congress, Office of Technology Assessment.

This report discusses the roles of various federal agencies in the implementation of Section 404 of the Clean Water Act, focusing on the Army Corps of Engineers. The OTA found that the Corps perceives its primary function as protecting water quality, whereas other agencies believed that the Corps should be primarily concerned with wetlands. It lists the criteria used by the Corps in conducting a public interest review. It includes a brief discussion of the treatment of cumulative impacts in Corps' permit review decisions, concluding that the difficulties in predicting cumulative impacts, combined with the lack of guidelines for denying permits on the basis of the proposed activity's cumulative impacts, led the Corps to overlook cumulative impacts in many districts. The report suggests use of "wetlands reviews" (estuary-wide inventory of wetland resources) in areas of intense development pressure, as a means of making the review process more efficient and suggests factoring cumulative impact considerations into the permit review process. It discusses the use of the Snohomish Estuary Wetland Study as a means of determining Corps jurisdiction, reducing the need for site visits, scoping in preapplication conferences, and providing baseline data for preparing environmental assessments of proposed 404 permit activities.

177. Stakhiv, Eugene Z. September 1988. *An evaluation paradigm for cumulative impact analysis*. Policy Study 88-PS-3. Fort Belvoir, VA: US Army Corps of Engineers Institute for Water Resources.

Also published in slightly modified form in Environmental Management. For a description see record number 124.

178. U.S. General Accounting Office. April 1993. *Wetlands protection: The scope of the section 404 program remains uncertain*. GAO/RCED-93-26. Washington, DC: US GOA.

This 1993 General Accounting Office report to Congressional committees examines the U.S. Army Corps of Engineers administration of Section 404 of the Clean Water Act. It finds, in part, that action has not been completed on the GAO's 1988 recommendation that the Corps develop guidance for considering the cumulative impacts of numerous individual permit decisions. This GAO report outlines why it continues to recommend that the EPA and Corps should complete certain actions, including assessing the means for considering the cumulative impacts of section 404 permit decisions. The report also contains a good overview of the interaction of the Corps and resource agencies in the 404 review process and an assessment of the apparent priorities of the Corps in administering the program.

For additional documents prepared by or for this agency *see also* Annotated Bibliography #s 68, 73, 91, 114, 123 and 124.

U.S. FEDERAL - BUREAU OF LAND MANAGEMENT

179. Department of Interior, Bureau of Land Management, National Environmental Policy Act handbook. 1988. BLM Handbook H-1790-1, Release 1-1547.

This Bureau of Land Management's National Environmental Policy Act Handbook contains policy and procedural guidance for compliance with the CEQ regulations for implementing the procedural provisions of NEPA, including identification of actions exempt from NEPA, use of categorical exclusions, and determining whether impacts are significant.

180. Federal Land Policy and Management Act of 1976, 43 U.S.C. § 1701 (1994).

The FLPMA establishes national policies for the management of public lands and resources. It allows for the designation of areas of critical environmental concern, and addresses the concept of "multiple use," but contains no specific reference to cumulative impacts. The land use planning provisions are the subject of resource management planning regulations found at 43 C.F.R. 1601.0-1, et seq., designed to "maximize resource values for the public" and promote "multiple use management." Approval of a resource management plan is a federal action subject to NEPA procedural requirements.

181. Regulations Relating to Public Lands, Bureau of Land Management, Minerals Management, Coal, Competitive Leasing, Activity Planning: The Leasing Process, 43 C.F.R. Part 3420.3-4 (1994).

This regulation establishes a tract ranking process to determine desirability for coal leasing, taking into consideration coal economics, impacts on the natural environment and socioeconomic impacts. The Bureau of Land Management is directed to prepare a regional lease sale environmental impact statement on selected tract combinations in accordance with NEPA, considering site specific impacts and the intraregional cumulative environmental impacts of the proposed leasing action and alternatives, and other coal and non-coal development activities.

U.S. FEDERAL - ENVIRONMENTAL PROTECTION AGENCY

182. Environmental Protection Agency, Subchapter H - Ocean Dumping, Part 288, Criteria for the Management of Disposal Sites for Ocean Dumping, 40 C.F.R Part 228.6 (1994).

These regulations for management of ocean disposal sites list multiple factors to be considered in site selection, including "existence and effects of current and previous discharges and dumping in the area (including cumulative effects)".

183. Environmental Protection Agency, General, Part 6, Procedures for Implementing the Requirements of the Council on Environmental Quality on the National Environmental Policy Act, 40 CFR Part 6.100 et seq. (1994).

These regulations establish EPA policy and procedures for the identification and analysis of environmental impacts of EPA-related activities and the preparation and processing of EISs.

184. Environmental Protection Agency, Subchapter H - Ocean Dumping, Part 230, Section 404(B)(1) Guidelines for Specification of Disposal Sites for Dredged or Fill Material, 40 C.F.R. Part 230.10 et seq. (1994).

In reviewing section 404 permit applications, the Corps has to determine if the proposed activity is in compliance with these environmental guidelines (referred to as the Section 404(b)(1) guidelines) promulgated by the Environmental Protection Agency. Section 230.1(c) states the precept that no discharge into an aquatic ecosystem should be allowed unless "it can be demonstrated that such a discharge will not have an unacceptable adverse impact either individually or in combination with known and/or probable impacts of other activities affecting the ecosystems of concern." Section 230.10(a)(1)-(3) contains key guidelines prohibiting discharge of dredged or fill material if there is a practicable alternative; the guidelines presume that practicable alternatives exist if the proposed activity is not water dependent. Section 230.11 outlines the factual determination to be made in assessing compliance with 230.10, and directs that many factors are to be considered both individually and cumulatively. Part 230.11(g) outlines the required determination and consideration of cumulative effects on the aquatic ecosystems, stating they should be predicted "to the extent reasonable and practical." Part 230.11(h) requires consideration of secondary effects such as fluctuating water levels, leachate and runoff. Cumulative effects are to be taken into consideration in evaluation of individual permit application, issuance of General permits, and monitoring and enforcement of existing permits.

185. Perry, Robert M. March 17 1983. Letter to Frederic A. Eidsness, Jr., Assistant Administrator for Water, Environmental Protection Agency.

This 1983 legal memorandum from the general counsel of the EPA to the EPA's assistant administrator for water addresses some legal issues concerning section 404(b)(1) guidelines under the Clean Water Act including whether the guidelines must consider secondary impacts. The memo concludes that secondary impacts (reasonably foreseeable impacts of the discharge itself that occur away from the immediate site of the discharge) must be included in the guidelines. Additionally, impacts caused by the subsequent operation of a project or by associated development, should generally be considered, within a "rule of reason," if there is a direct causal connection and the impacts are reasonably predictable.

For additional documents prepared by or for this agency *see also* Annotated Bibliography #s 9, 42, 63, 110, and 116.

U.S. FEDERAL - FEDERAL ENERGY REGULATORY COMMISSION

186. Federal Power Act, 16 U.S.C. § 791a (1994).

This Act provides for federal regulation of the development of water power and resources through the Federal Energy Regulatory Commission (FERC). NEPA may require FERC to prepare an EIS or EA in granting licenses for natural gas, hydroelectric and electric power projects. In § 803(a) the statute outlines factors to be considered in granting licenses including that the project will be the best adapted to "a comprehensive plan for improving or developing a waterway or waterways" for a variety of purposes including "for the adequate protection, mitigation, and enhancement of fish and wildlife (including related spawning grounds and habitat)." In making the comprehensive plan determination, the Commission is to consider plans prepared by federal or state agencies and recommendations of particular federal and state agencies.

187. Federal Energy Regulatory Commission, Regulations Implementing National Environmental Policy Act, 52 Fed. Reg. 47897 (Dec. 17, 1987).

These final rules of FERC state that the Commission will abide by CEQ regulations at 40 C.F.R. Parts 1500-1508 unless those regulations are inconsistent with the Commission's statutory authority. Specifically, the Commission accepts the CEQ definition of cumulative impacts, and agrees that the cumulative impacts of all past, present and reasonably foreseeable future actions must be assessed before licensing projects.

188. Federal Energy Regulatory Commission, Procedures for Assessing Hydropower Projects Clustered in River Basins: Request for Comments, 50 Fed. Reg. 3385 (Jan. 24, 1985).

This request for comments presents a proposed procedure for assessing the environmental effects of hydropower projects that are proposed to be clustered in river basins and licensed under the Federal Power Act. The "cluster impact assessment procedure" (CIAP) was developed by the staff for use where staff review indicates the clustering of projects presents a potential for adverse impacts but the extent of impacts is uncertain.

The CIAP is described (geographic sort, resource sort, multiple project assessment, and NEPA document preparation). Proposed application to the Snohomish, Owens and Salmon River Basins are also outlined.

189. Use of Reserved Authority in Hydropower Licenses to Ameliorate Cumulative Impacts; Notice of Extension of Time for Comments; November 1, 1993, 58 Fed. Reg. 59423.

Prompted by the unusual context of 167 original hydropower licenses expiring in 1993, FERC issued this proposed policy statement on the process it would use to ameliorate the cumulative impacts of multiple hydropower projects in the same river basin. For projects with licenses expiring at disparate times, it proposes to consider using reserved authority to reopen unexpired licenses to address cumulative impacts, and also to consider adding a special article to new licenses reserving the authority to revisit the cumulative impact issue for that licensee in connection with analysis of later license reviews for other projects in the same river basin. The public comment period was extended to January 5, 1994.

190. Cada, Glenn F., and Richard B. McLean. 1985. An approach for assessing the impacts on fisheries of basin-wide hydropower development. In *Proceedings of the Symposium on Small Hydropower and Fisheries*, ed. R. H. Hanre, 367-372. Aurora, CO, May 1, 1985. American Fisheries Society, Western Division and Bioengineering Section.

The paper presents a matrix approach to basin-level cumulative impact assessment of hydropower development on resident trout in the upper San Joaquin River basin, California.

191. Eckberg, David K. Cumulative impacts of hydropower development under NEPA. *Environmental Law* 16: 673-703.

The author discusses possible cumulative impacts of hydropower development and reviews key legal issues in the assessment of proposed hydropower development under NEPA. He recommends that FERC require assessment on a basin-wide scale, and consider the impacts of all existing and reasonably foreseeable future actions (both hydropower and non-hydropower activities) affecting a common resource.

192. Eckberg, David K. 1985. Cumulative impacts of hydropower development under the National Environmental Policy Act: The requirement of a basin-wide approach. In *Proceedings of the Symposium on Small Hydropower and Fisheries*, ed. R. H. Hanre, 357-366. Aurora, CO, May 1, 1985. American Fisheries Society, Western Division and Bioengineering Section.

The author analyzes the opportunity for FERC to require assessment of cumulative impacts of hydropower development from a basin-wide perspective. He considers the ways in which the interrelationship of agency actions and the timing of those actions affect the scope of the study.

193. Feldman, Murray D. 1988. *National Wildlife Federation v. FERC* and *Washington State Department of Fisheries v. FERC*: Federal Energy Regulatory Commission ignores Ninth Circuit rebuke on hydropower permitting. *Ecology Law Quarterly* 15(2): 319-360.

This article discusses two Ninth Circuit decisions involving Federal Energy Regulatory Commission's consideration of cumulative impacts during the preliminary permit process. Indicating that cumulative impacts constitute a relevant factor that FERC must consider pursuant to 4(e) of the Federal Power Act, the court vacated the preliminary permits issued by FERC, in part, due to its failure to address cumulative impacts. Nevertheless, FERC reissued the permits for hydropower development without requiring the permitees to provide any cumulative impacts data. The author contends that FERC's disregard of the Court's criticism reflects FERC's characteristic resistance to new environmental policy demands. Finally, he concludes that legislation is necessary to compel FERC to engage in comprehensive planning and to consider cumulative impacts prior to issuing preliminary permits.

194. Leathe, Stephen A., Michael D. Enk, and Patrick J. Graham. 1985. An evaluation of the potential cumulative bioeconomic impacts of proposed small-scale hydro development on the fisheries of the Swan River Drainage, Montana. In *Proceedings of the symposium on small hydropower and fisheries*, ed. R. H. Hanre 377-387. Aurora, CO, May 1, 1985. American Fisheries Society, Western Division and Bioengineering Section.

This paper presents an economic value analysis of the impacts of total dewatering of project areas and increased stream sedimentation of small hydropower and forest development in the Swan River basin of Montana. The value to anglers of a fish loss was estimated using a contingent valuation method.

195. Mentor, Joe, Jr. 1985. Cumulative impacts and comprehensive planning: A problem of synergism and a policy dilemma. In *Proceedings of the Symposium on Small Hydropower and Fisheries*, ed. R. H. Hanre, 351-356. Aurora, CO, May 1, 1985. American Fisheries Society, Western Division and Bioengineering Section.

The author reviews the federal law of hydroelectric licensing, potential cumulative impacts, the Cluster Impact Assessment Procedures, and the continuing need for comprehensive planning.

196. Paquet, Peter J., and Gary W. Witmer. 1985. Cumulative impacts of small hydropower developments: An overview of the issues. In *Proceedings of the Symposium on Small Hydropower and Fisheries*, ed. R. H. Hanre, 343-345. Aurora, CO, May 1, 1985. American Fisheries Society, Western Division and Bioengineering Section.

This is a brief discussion of cumulative impact definition issues, methodological difficulties and potential impacts of hydropower, drawing examples from the Columbia River basin.

197. Russo, Thomas N. 1985. Perspectives on analyzing impacts related to multiple hydroelectric development. In *Proceedings of the Symposium on Small Hydropower and Fisheries*, ed. R. H. Hanre, 246-350. Aurora, CO, May 1, 1985. American Fisheries Society, Western Division and Bioengineering Section.

In this paper, a FERC ecologist summarizes a study of environmental impacts of 12 small-scale hydroelectric projects in the Upper San Joaquin River Basin (California). The approach was generally consistent with the Cluster Impact Assessment Procedure.

198. Stout, David J. 1985. A practical approach to cumulative impact assessment. In *Proceedings of the Symposium on Small Hydropower and Fisheries*, ed. R. H. Hanre, 373-376. Aurora, CO, May 1, 1985. American Fisheries Society, Western Division and Bioengineering Section.

The author, an employee of US Fish & Wildlife Service, reports on the *Snohomish Guidelines for the Evaluation of Hydropower Projects*, a negotiated procedure said to provide a clear path for impact assessment of project-specific and cumulative impacts. It includes requirements for biologist-determined management goals and assessment techniques, established "thresholds of significance," detailed studies by project proponents of selected parameters, and analysis of cumulative impacts in "project impact" zones.

U.S. FEDERAL - FISH AND WILDLIFE SERVICE

199. Fish and Wildlife Coordination Act, 16 U.S.C. § 661 (1994).

One purpose of the Act is to ensure that wildlife conservation receives equal consideration in project decisions. The Secretary of the Interior is authorized to provide assistance to other agencies in the protection of wildlife and their habitat, and any reports and recommendations prepared in furtherance of the Act on the wildlife aspects of projects shall be an integral part of any report prepared by or submitted by any agency of the federal government for authorization for the construction of water-resource development projects.

200. Army Corps of Engineers, General Regulatory Policies, 33 C.F.R. § 320.4 (1993).

As part of the public interest review, the ACOE is authorized to undertake reviews of particular wetland areas in consultation with U.S. Fish and Wildlife Service and National Marine Fisheries Service. Similarly in accordance with the Fish and Wildlife Coordination Act, pursuant to § 320.3(e), the ACOE is required to consult with the regional director of U.S. Fish and Wildlife in individual permit reviews.

For additional documents prepared by or for this agency *see also* Annotated Bibliography #s 7, 21, 48, 62, 66, 67, 69-72, 83, 100, 129-131, 140, 149 and 198.

U.S. FEDERAL - FOREST SERVICE

201. Department of Agriculture, U.S. Forest Service, National Environmental Policy Act Revised Policy and Procedures, 56 Fed. Reg. 19718 (Apr. 29, 1991).

This notice of revised policy and procedures and request for comments revises the Forest Service policy and procedure for implementing NEPA and the CEQ regulations. It incorporates the CEQ definitions of cumulative action and cumulative impact by reference. It provides for the assessment of impacts to be prepared by an interdisciplinary team with the professional capability to identify potential direct, indirect and cumulative social, economic, physical and biological effects of the proposed action and its alternatives. The team is to estimate direct, indirect and cumulative effects for each alternative. Paragraph 15.1 specifically addresses cumulative effects, directing the team to consider the "incremental effects of past, present, and reasonably foreseeable related future actions of the Forest Service, as well as those of other agencies and individuals".

202. Eastside Ecosystem Management Strategy, Pacific Northwest Region, 59 Fed. Reg. 4680. (February 1, 1994).

This is a notice of intent to prepare an environmental impact statement of a "coordinated ecosystem management strategy" for forests and public lands east of the Cascade Mountains in Oregon and Washington. It was issued in response to President Clinton's July 1993 mandate for a scientifically sound ecosystem-based management strategy for these lands. This land area overlaps with the area addressed by a prior draft supplemental EIS concerning old-growth forest and the Northern spotted owl. In support of the EIS, it proposes a basin-wide assessment to characterize and assess broad ecosystems, and describe ecological processes and functions. Conditions are to be analyzed at the "biophysical province scale" (land areas having relatively similar landform, climate, and other biological and physical properties that lead to certain potential vegetation types). The draft EIS is expected in November 1994, and the final approximately six months after publication of the draft EIS.

203. Sample, V. Alaric. 1991. Assessing cumulative environmental impacts: The case of national forest planning. *Environmental Law* 21(3): 839-862.

This article reviews the current framework for cumulative effects analysis in national forest planning and management. The author examines approaches taken by the Forest Service and obstacles confronted, and concludes that other agencies may learn from the Forest Service's experience.

204. Scott, Myron L. 1991. Defining NEPA out of existence: Reflections on the Forest Service experiment with "case-by-case" categorical exclusion. *Environmental Law* 21(3): 807-838.

In an attempt to minimize unnecessary NEPA documentation, the CEQ created the "categorical exclusion" provision to allow an agency to avoid the procedural mandates of NEPA if the proposed activity belongs to a category of actions which "normally produce no significant environmental effects." Individual agencies were authorized to identify such categories of activities. The author asserts the Forest Service's "case-by-case" categorical exclusion expands upon this concept by granting a categorical exclusion from NEPA documentation if the Forest Service official determines that the proposed action will have no more environmental impact than the listed "typical classes". The author finds that the practical effect of the case-by-case exclusion undermined NEPA and its long-term planning process, led to incremental decision-making, and precluded effective cumulative impact analysis. He suggests that contemplated revisions to the Forest Service's exclusion categories are an improvement, and may serve as a model for other agencies. The author states the Forest Service is curtailing use of the "case-by-case" categorical exclusion and implementing procedural changes to facilitate integrated planning consistent with the goals of NEPA.

For additional documents prepared by or for this agency *see also* Annotated Bibliography # 81.

U.S. FEDERAL - NATIONAL MARINE FISHERIES SERVICE

205. National Marine Fisheries Service, Northeast Region and Marine Law Institute. In Press. *Methodologies and Mechanisms for Management of Cumulative Coastal Environmental Impacts, Vol. II: Development and Application of a Cumulative Impacts Assessment Protocol for Coastal Environmental Impacts*. Washington, D.C.: U.S. National Oceanic and Atmospheric Administration, Coastal Ocean Program.

A companion publication to this report, Volume II presents the conceptual framework, practical approaches and field results for two cumulative impacts assessment approaches developed for use by the Habitat and Protected Resources Division of the Northeast Region of the National Marine Fisheries Service in reviewing Section 404 permit applications. The research team developed a conceptual framework for decision-making and then developed two practical approaches for applying the framework to individual project reviews: a key indicator species approach and a habitat-based landscape approach. The key indicator species approach used the Atlantic silverside (*Menidia menidia*) for the initial application, but researchers suggested increasing the number of species as time and funds permit. The approaches are applied to seven case study permit reviews, each of which includes an assessment of the utility of the approach in that context.

206. Army Corps of Engineers, General Regulatory Policies, 33 C.F.R. § 320.4 (1993).

As part of the public interest review, the ACOE is authorized to undertake reviews of particular wetland areas in consultation with U.S. Fish and Wildlife Service and National Marine Fisheries Service. Similarly in accordance with the Fish and Wildlife Coordination Act, pursuant to 320.3(e), the ACOE is required to consult with the regional director of the National Marine Fisheries Service in individual permit reviews.

207. Comments of the United States Department of Commerce on the Federal Energy Regulatory Commission's Proposed Policy Statement on Use of Reserved Authority in Hydropower Licenses to Ameliorate Cumulative Impacts, National Marine Fisheries Service, (Dec. 21, 1993) Dkt. No. RM93-20-000.

These comments constitute NMFS response to 55 F.R. 48944, FERC's proposed policy on strategies to ameliorate cumulative adverse impacts of hydropower projects. NMFS calls for working discussions, and suggests some modifications of the proposal, but believes the proposed policy will improve damage mitigation and offer opportunities for enhancement of fisheries resources. The comments include specific recommendations on comprehensive planning, criteria for reopening licenses, equity among licenses and treatment of exempted projects.

208. Fish and Wildlife Coordination Act, 16 U.S.C. § 661 (1994).

One purpose of the Act is to ensure that wildlife conservation "receives" equal consideration" The Secretary of the Interior is authorized to provide assistance to other agencies in the protection of wildlife and their habitat, and any reports and recommendations prepared in furtherance of the Act on the wildlife aspects of projects shall be an integral part of any report prepared by or submitted by any agency of the federal government for authorization for the construction of water-resource development projects.

209. Evans, William E., James E. Douglas, Jr., and Bill A. Powell. 1987. *National Marine Fisheries Service: Program development plan for ecosystems monitoring and fisheries management*. Washington, D.C.: NOAA, National Marine Fisheries Service.

This 1987 report outlines an NMFS Ecosystem Monitoring and Fisheries Management Initiative. The Program Development Plan is designed to reorient the NMFS living marine resource research and management program to a multi-species/ecosystem approach. The impetus for the shift is to develop a capability to forecast changes in the ecosystem, giving increased recognition to the fact that all marine organisms are biologically and environmentally linked, and that there are pronounced natural fluctuations in the stocks. This new approach is made more feasible by the availability of satellite sensors, computer technology and conceptual advances in ecosystem modeling. One of the program areas identified as needing further research is habitat and productivity relationships, including information on the effects of habitat degradation.

210. Mager, Andreas, Jr. 1990. National Marine Fisheries Service habitat conservation efforts in the Southeastern United States for 1988. *Marine Fisheries Review* 52(1): 7-13.

This article provides data on National Marine Fisheries Service recommendations on proposals requiring Federal permits or licenses to alter wetlands in the coastal zone of the southeastern United States during 1988. Among other information, it reports on a follow-up survey of the disposition of 339 permits handled by the U.S. Army Corps of

Engineers, finding that 65% of NMFS recommendations were accepted, 15% partially accepted, 17% completely rejected and 2% withdrawn.

211. National Marine Fisheries Service, Southeast Regional Office, Habitat Conservation Division. 1992. *National Marine Fisheries Service guidelines for proposed wetland alteration in the Southeastern United States.*

These guidelines include general considerations and specific guidelines by project type. Included in the general considerations for assessment of the potential impacts of proposed projects are: "[t]he extent to which the activity would directly and indirectly affect the occurrence, abundance, health, and continued existence of fishery resources;" and "the extent to which an unacceptable precedent may be established or potential for a significant cumulative impact exists."

For additional documents prepared by or for this agency *see also* Annotated Bibliography #'s 2-4, 17 and 141.

U.S. FEDERAL LITIGATION

212. 1000 Friends of Oregon v. U.S. Forest Service, 1993 U.S. App. LEXIS 24704 (9th Cir. Sept. 23, 1993).

The court affirmed the district court's refusal to grant a preliminary injunction, finding that the U.S. Forest Service did not fail to comply with NEPA when it approved construction of a ski lift on Mount Hood. The court disagreed with plaintiff's contention that the Forest Service was required to prepare a new or supplemental EIS to address cumulative impacts, holding it could rely on past studies and need not address indefinite potential development.

213. Alpine Lakes Protection Society v. U.S. Forest Service, 838 F. Supp. 478 (W.D. Wa. 1993).

Plaintiffs challenged a Forest Service decision to issue a permit for an access road without an EA or an EIS and sought to compel consideration of connected and cumulative environmental effects associated with this project and six additional projects for which access road permit applications were pending. The court found that the access road was inextricably intertwined with the logging activities it was to facilitate, thus it was arbitrary and capricious to fail to consider a connected action -- logging activities -- in determining whether an EA or EIS was required for this project. In addition, the court found that the six other pending access road applications, which were close in time and geography, were cumulative actions. Failure to consider all seven applications together in evaluating the potential for any cumulative impacts as a result of connected and cumulative actions was arbitrary and capricious.

214. Bob Marshall Alliance v. Watt, 685 F. Supp. 1514 (D. Mont. 1986), *affirmed on non-NSO leases and ESA, reversed in part,* 852 F.2d 1223 (9th Cir. 1988), *cert. denied,* 489 U.S. 1066 (1989).

This action was brought pursuant to NEPA and the Endangered Species Act challenging the Department of Interior's decision not to prepare an EIS prior to leasing land for oil and gas exploration. The court held the decision not to prepare an EIS was unreasonable, based in part on the assertion that later site specific analysis and protective stipulations do not comply with NEPA's mandate to make early informed decisions and research cumulative effects of major proposed actions.

215. City of Carmel-By-The-Sea v. DOT, 1994 U.S. Dist. LEXIS 6823 (N.D. Cal. May 16, 1994).

Plaintiffs challenged a highway improvement project alleging US DOT failed to comply with NEPA and the State CEQA on several grounds including failure to adequately analyze cumulative and growth-inducing impacts. The court held for Defendant, conceding that the EIS "lacks breadth as well as depth," but nonetheless found that a very minimal analysis of cumulative impacts was sufficient under both statutes.

216. City of Grapevine v. DOT, 17 F.3d 1502 (D.C. Cir. 1994).

This decision by then-Circuit Judge Ginsburg, upheld the FAA's decision approving a plan to expand the Dallas/Fort Worth International Airport. However, in addressing whether the "overall cumulative impacts of the proposed action and consequences of subsequent related actions" were considered, the court commented that if "speculative" elements of the expansion project were not considered in the FEIS, they cannot be deemed part of the approved plan. If review was premature for speculative elements, such cumulative impacts review must be done when the matter is no longer too speculative to warrant it.

217. City of Rochester v. U.S. Postal Service, 541 F.2d 967 (2d Cir. 1976).

The court held that the Postal Service determination that construction of a $12 million postal facility, abandonment of the old facility, and transfer of employees did not require an EIS was erroneous. Even though construction was underway, it ordered preparation of an after-the-fact EIS.

218. City of Tenakee Springs v. Franzel, 1992 U.S. App. LEXIS 6320 (9th Cir. April 9, 1992).

The City of Tenakee Springs and native Alaskan subsistence users appealed denial of permanent injunctive relief based on its underlying challenge to an EIS prepared by the U.S. Forest Service for timber harvest in a contract sale area. The court upheld denial of the permanent injunction, stating that its original concerns about lack of attention to cumulative impacts on subsistence users had in large part been addressed by the intervening passage of the Tongass Timber Reform Act which established a methodology for assessing impact of individual sales (rather than a 5-year plan), and replaced a contract-driven planning process with one designed to comply with applicable environmental laws and standards.

219. C.A.R.E. v. FAA, 844 F.2d 1569 (11th Cir. 1988).

In making a finding of no significant impact, the FAA did not improperly fail to consider the cumulative effects of proposed runway extension in context of broad expansion plan for the airport. Although other projects at the airport may contribute to its use by larger aircraft, those projects are unrelated to the proposed runway extension.

220. Conner v. Burford, 848 F.2d 1441 (9th Cir. 1988), *cert. denied*, 489 U.S. 1012 (1989).

This case reviewed the issuance of oil and gas leases on 1.3 million acres of national forest land without the prior preparation of an EIS pursuant to NEPA or a comprehensive biological opinion pursuant to ESA. The court of appeals affirmed the district court finding that both NEPA and ESA were violated by the federal agencies, except that the appellate court held that NEPA was not violated with regard to that subset of leases with "no surface occupancy" (NSO) provisions if they absolutely prohibit surface disturbance in the absence of specific governmental approval. The court confirmed that a comprehensive EIS at the lease sale stage is necessary to project and analyze the cumulative effects of successive, interdependent steps culminating the oil and gas development and production. The court held federal agencies to a higher standard for the ESA, requiring a comprehensive biological opinion for NSO lease sites as well, citing the important substantive mandate of ESA in contrast to the merely procedural requirements of NEPA.

221. Conservation Law Foundation of New England v. FHA, 24 F.3d 1465 (1st Cir. 1994).

Plaintiffs sought preliminary injunction against proposed construction of proposed Jamestown Connector, from Jamestown-Verrazzano Bridge to Newport Bridge. The Court of Appeals affirmed District Court's denial, finding that the lower court did not abuse its discretion when it found that the Environmental Assessment and prior studies adequately considered cumulative effects.

222. Enos v. Marsh, 769 F.2d 1363 (9th Cir. 1985).

Plaintiff unsuccessfully challenged a deep draft harbor project on ESA, NEPA and WRDA claims. On one ground, failure to adequately discuss secondary impacts which significantly affect the environment, the court applied a "rule of reason" standard to conclude that the discussion, while not extended, was acceptable.

223. Environmental Defense Fund v. Higginson, 655 F. 2d 1244 (D.C. Cir. 1981).

The court held that the Department of Interior could change its position and decide not to prepare a comprehensive, basin-wide EIS for the Colorado River Basin, but instead, to fulfill NEPA by preparing project or site-specific EIS's which addressed any cumulative and synergistic environmental impacts. In remanding to allow Plaintiffs to challenge the Departments's decision, the court stated that this decision was within the Department of Interior's discretion, and should be found invalid only if it was arbitrary and capricious.

224. Friends of Walker Creek Wetlands v. BLM, 19 ELR 20852 (D. Or 1988).

BLM adequately considered the cumulative impacts of proposed timber sales in the area, even though no cumulative impact analysis was included in their EA. However, court held that BLM must amend its timber sale EA to include or refer to documentation of agency's consideration of cumulative effects.

225. Fritiofson v. Alexander, 772 F.2d 1225 (5th Cir. 1985).

Principally because the Corps did not adequately consider cumulative impacts, the district court enjoined a home developer from dredging canals in navigable waters around Galveston under a Corps permit. NMFS had raised concerns about cumulative effects of the proliferation of this type of waterfront housing development, and recommended that the Corps require an EIS. The court of appeals agreed that the cumulative impacts analysis was inadequate, and held that when deciding whether a single-proposed action requires preparation of an EIS, a broader analysis of cumulative impacts is required; the threshold determination should not just focus on actions that have required a permit or will be the subject of NEPA review. The decision elaborates upon the contents of a "meaningful cumulative-effects study." The court of appeals modified what it found to be excessive relief ordered by the district court, but still remanded with instructions to order the Corps to conduct a cumulative impacts analysis of the specific proposed development and to reassess its environmental significance (and whether an EIS is required) in light of that analysis.

226. Inland Empire Pub. Lands Council v. Schultz, 992 F.2d 977 (9th Cir. 1993).

Environmental groups unsuccessfully challenged a timber sale on the grounds that the Forest Service did not consider the cumulative environmental effects of past logging and road-building activities on the watershed. The court affirmed the finding that the agency's decision not to prepare a site-specific EIS was reasonable. Plaintiff challenged the methodology used by the Forest Service as inaccurate, since it found that it would exceed the "threshold of concern" since more than half of the watershed would be logged within a 30 year span, but also found no significant degradation of the watershed was likely. The court deferred to agency expertise on questions of methodology (unless it completely failed to address an essential factor), found the agency had taken the requisite "hard look", and found the conclusion of no significant adverse cumulative effects was not arbitrary or capricious.

227. James City County v. EPA, 12 F.3d 1330 (4th Cir. 1993).

The court upheld EPA's veto of a Corps permit to allow construction of a dam and reservoir across Ware Creek in the Chesapeake Bay watershed, finding that EPA has the authority to justify its veto solely on the basis of unacceptable adverse effects on the environment. It further found that the finding of unacceptable adverse effects was not arbitrary and capricious and was supported by substantial evidence. In addition to direct adverse impacts, the EPA cited adverse cumulative impacts noting "the incremental loss of functional wetland systems which currently contribute to the environmental well-being of the York River and the Chesapeake Bay and which help maintain and protect the environmental integrity of those systems represents a profound cumulative loss".

228. Kleppe v. Sierra Club, 427 U.S. 390 (1976).

The primary issue in this 1976 U.S. Supreme Court case was whether NEPA requires the Department of Interior to prepare a single EIS on the entire Northern Great Plains region prior to additional coal development. In holding that a regional EIS was not required, the Court found that there was no major federal action. It did agree with the need to consider together several proposals for coal-related actions if they are pending concurrently before an agency and will have cumulative or synergistic environmental impacts; but contemplated projects do not have to be considered in an impact statement until they become actual proposals. Similarly, the agency can approve on pending project pursuant to an impact statement, and then take into account the effects of that project when preparing a comprehensive statement on the cumulative impact of the remaining proposals. [Subsequently the CEQ issued regulations defining the circumstances under which multiple related actions must be covered by a single EIS.].

229. LaFlamme v. FERC, 852 F.2d 389 (9th Cir. 1988).

After finding that the development of a hydropower project in the Sayles Flat area of the American River in California had no potential for "significant adverse cumulative impacts on target resources of the area," FERC decided not to prepare an EIS and issued a license for the project. The Ninth Circuit concluded that FERC's finding of no potential for significant impact was unsupported because FERC had examined the project in "isolation," without considering the overall impact of all such projects in the area. Thus, the court held that FERC's decision not to prepare an EIS, including an EIS on the project's cumulative impacts, was unreasonable, and it suspended the license subject to rehearing before the FERC.

230. Marble Mt. Audubon Socy. v. Rice, 914 F.2d 179 (9th Cir. 1990).

Environmental groups successfully appealed from a summary judgment in favor of the U.S. Forest Service. The Court held that the FEIS for a fire-recovery timber sale failed to adequately consider the unique value of the only significant biological corridor between Marble Mountain and a wilderness area. The Service failed to take a "hard look" but merely concluded without apparent study or supporting documentation that preservation of a ½-mile wide strip would be sufficient to maintain the corridor.

231. Morgan v. Walter, 728 F. Supp. 1483 (D.C. Idaho 1989), *motion to dismiss granted without prejudice,* 758 F. Supp. 597 (1991).

The court granted plaintiff's motion for a preliminary injunction to halt development of a water diversion and propagation facility to be built on federal lands managed by BLM pending completion of an EIS. In examining the issue of "connected actions," the court found those two aspects to be "links in the same bit of chain" and that the impacts of both should have been considered by Corps in preparing the EA.

232. National Wildlife Federation v. FERC, 801 F.2d 1505 (9th Cir. 1986).

Plaintiffs contended that FERC's issuance of seven preliminary permits for hydropower development along the Salmon River violated the Federal Power Act on the grounds that FERC had failed to develop a comprehensive plan and to require the permit applicants to provide cumulative impacts data prior to granting the permits. FERC argued that these steps are requisite to the issuance of a license, but not to the granting of a preliminary permit. The court declined to hold that the FPA requires a comprehensive plan and production of cumulative impacts data by the applicant prior to the granting of a permit in every instance. However, based upon the evidence produced at FERC hearings indicating the necessity of fulfilling these FPA requirements prior to the granting of the seven permits, the court held that FERC's decision to issue the permits without developing a comprehensive plan and without requiring permittees to collect cumulative impacts data, among other options, was not sustainable on the record.

233. Natural Resources Defense Council v. Callaway, 524 F.2d 79 (2d Cir. 1975).

Plaintiff appealed from dismissal of the complaint alleging, among other grounds, violation of NEPA in issuance of permit to the Navy to dump polluted dredged spoil at a particular dump site in Long Island Sound. The court found that the discussion of cumulative effects in the EIS was inadequate since it failed to analyze the cumulative effect of several substantially similar proposed projects that might make use of the same dump site. Given the geographic area, nature of project, potential problems of pollution and likely dump area the projects were closely enough related so that they could be expected to produce a cumulative environmental impact which should be evaluated as a whole. The Navy was required to prepare a supplemental statement curing the deficient EIS.

234. Natural Resources Defense Council v. Hodel, 865 F.2d 288 (D.C. Cir. 1988).

The court found that the EIS prepared by Secretary of the Interior in connection with an outer continental shelf leasing program failed to adequately consider cumulative impact of the simultaneous inter-regional development on migratory species, particularly whales and salmon, in Pacific and Alaskan regions. The court responded to EPA concerns that the analysis should consider the cumulative effects on migratory species whose habitat extends over numerous planning basins and regions, over the full range of their habitat. The court characterized the existing cumulative impacts analysis as scant, perfunctory, conclusory and not useful to a decisionmaker, suggested directions for more fruitful analysis, and remanded for further consideration and revisions.

235. Neighbors Organized to Insure a Sound Environment, Inc. v. Engen, 665 F. Supp. 537 (M.D. Tenn. 1987), *vacated and remanded to be dismissed on grounds of mootness*, 878 F.2d 174 (6th Cir. 1989).

Subsequent to the 1980 preparation of an EA concerning the development of a new terminal at the Nashville Metropolitan Airport, the FAA issued a FONSI. The EA included no discussion of a proposed runway, since a study commissioned by Nashville Metropolitan Airport concluded that its construction would not be necessary until at least 1990. However, in 1985, the Airport started building a new runway. The Court rejected the plaintiff's argument that the runway development was a "reasonably foreseeable future action" that should have been included in the 1980 EA. Thus, the Court held that the FAA's decision not to assess the cumulative impacts of the proposed runway in its assessment of the Airport's original development was valid under NEPA. The Court of Appeals subsequently remanded the case to the District Court to be dismissed on mootness grounds because the runway was finished and defendant's actions were not capable of repetition evading review.

236. Northern Alaska Environmental Center v. Lujan, 961 F.2d 886 (9th Cir. 1992).

Environmental groups appealed from an order of the District Court dissolving the 1988 injunction issued by that court ordering the Park Service to prepare EISs that studied the cumulative environmental effects of mining before approving any further mining in three national parks in Alaska. The Court of Appeals affirmed the order dissolving the injunction, concluding that the district court did not abuse its discretion in ruling that the EISs were adequate under the "rule of reason" since further study of effects will occur prior to granting any specific mining permit. The Park Service had developed four alternatives for dealing with cumulative effects (Alternative A: qualitative, case-by-case; Alternative B: case-by-case measured against quantitative resource protection goals; Alternative C: quantitative and qualitative assessment coupled with mining claim acquisition program; Alternative D: Park Service purchase of mining claims as funds are available and continued processing of applications under Alternative C). The Park Service selected Alternative D. The court concurred that when a programmatic EIS is prepared, site-specific impacts and related cumulative impacts need not be fully evaluated until a specific application for a permit is submitted.

237. O'Connor v. Corps of Engineers, 801 F. Supp. 185 (N.D. Indiana 1992).

Plaintiff, a lakefront landowner, appealed the Corps' refusal to consider his filling of .41 acres of wetland under nationwide permit 26 (requiring instead an after-the-fact individual permit) and the Corps' subsequent denial of an individual permit and order to restore the acreage to its original condition. The District Court affirmed the Corps' decision, finding that it was not arbitrary or capricious and was supported by a rational explanation. Specifically, even though the area to be filled was less than one acre, the Corps had the authority to determine that the proposed fill of .41 acres would "cause" loss or substantial modification beyond the immediate site, affecting one to ten acres when taking into account present, past and future effects on waters, including wetlands. The Corps correctly asserted that in determining whether a proposal falls within nationwide permit 26 "it can take into consideration not only the harm to wetlands actually filled, but also the harm to other wetlands or water that potentially will be lost or substantially adversely modified by the proposal in the future." Once the activities fell in the one to ten acre category, the Corps had the discretionary authority to require an individual permit. The court held that it could not find that the Corps was arbitrary or capricious in determining that filling .41 acres of wetland, when considered with the cumulative effect of other such minor changes, placed the lake and surrounding wetlands in too great a danger to be allowed.

238. Oregon Natural Resources Council v. Marsh, 832 F.2d 1489 (9th Cir. 1986), *reversed on other issues*, 490 U.S. 360 (1989).

Plaintiffs challenged Corps' EIS on several grounds, including that it unreasonably limited the scope of the final supplemental EIS by failing to consider the cumulative effects of three dam projects in the same river basin, two of which were already completed. The court held that the Corps was required to consider the cumulative impacts of the proposed actions which supplement or aggravate the impacts of past, present, and reasonably foreseeable actions, that it had failed to give adequate attention to the synergistic impact of the third project, and that the Corps must supplement the EIS to address the cumulative impact of the other dams. (The cumulative impact issue was not appealed to the U.S. Supreme Court.)

239. Oregon Natural Resources v. Marsh, 845 F. Supp. 758 (D. Or. 1994).

In part, this case concluded the litigation reported at 832 F.2d 1489 in which the Corps was ordered to supplement its EIS to address the cumulative impact of other dams. In this case, employing a "rule of reason," the court found that the Corps two supplements to the original EIS had taken the requisite "hard look" at the cumulative impacts as required by the prior decision. The court accepted the focus on water quality and fish production as being appropriate to the order on remand. However, the court also found that the Corps failed to live up to its continuing obligation to continue to take a "hard look" at the environmental effects even after initial approval. It required the Corps to supplement its EIS to take into consideration significant new information about the danger of extinction of wild coho salmon and summer steelhead trout and the recent determination by BLM and the Forest Service that the dam in its present unfinished state unreasonable diminishes the anadromous fisheries of the Rogue River.

240. Park County Resource Council v. U.S. Dept. of Agriculture, 817 F.2d 609 (10th Cir. 1987).

Plaintiffs contended the Forest Service environmental assessment of federal oil and gas leases in forests in the Rocky Mountain Region was insufficient for lease issuance, and that a comprehensive EIS should be required prior to lease issuance because of the eventual cumulative and foreseeable effects of exploratory drilling and then full field development. The court suggested that a one-in-one hundred chance that development activities will occur on a leased site made leasing and full field development not so interdependent as to require a cumulative impact EIS. While not required in this case, as an overall regional pattern or plan evolves, at some point a region-wide analysis will be required.

241. Preston v. Yeutter, 1994 U.S. App. LEXIS 22737 (9th Cir. August 19, 1994).

In affirming the district court's judgment for the Secretary of Agriculture in approving a development project, the court held the decision not to prepare an EIS was not arbitrary or capricious. It observed that the Forest Service had appropriately considered the need to ensure that migratory corridors for grizzly bears remained intact through a cumulative effects analysis process. That process examines the effects of all activities over large Bear Management Units and requires a minimum of 70% of the cumulative affects area to remain freely available to bears at all times. It also maintains 600-foot travel corridors between cutting units.

242. Public Utilities Comm'n of California v. FERC, 900 F.2d 269 (D.C. Cir. 1990).

FERC was not required by NEPA to assess cumulative impacts from successive similar pipelines when determining whether to issue an Optional Expedited Certificate to construct a pipeline where successive pipelines were not reasonably foreseeable, especially where the Commission included conditions in the final OEC that would allow it to mitigate the cumulative effects from construction of two pipelines.

243. Resources Limited, Inc. v. Robertson, 8 F.3d 1394 (9th Cir. 1993).

Plaintiffs challenged a forest management plan and the forest-wide EIS claiming violations of NEPA and the ESA. The plan was designed to accommodate threatened and endangered species while allowing logging and other uses. Using a "rule of reason" to review the adequacy of the EIS in addressing cumulative impacts of non-federal actions on grizzly bears, the court held the Forest Service must consider cumulative impacts in the EIS, that impacts from non-federal actions must be considered but that non-federal cumulative impacts do not need to be analyzed in a programmatic EIS so long as cumulative impacts of non-federal actions and synergistic effects from implementation of the plan are analyzed before specific sales.

244. Save the Yaak Comm. v. Block, 840 F.2d 714 (9th Cir. 1988).

The court of appeals reversed the grant of summary judgement for the Forest Service, finding that the agency did not take the required "hard look" and failed to adequately consider cumulative impacts including both connected actions and unrelated but reasonably foreseeable future actions which may result in cumulative impacts. It found an "inextricable nexus" between road reconstruction and logging operations.

245. Sierra Club v. Marsh, 769 F.2d 868 (1st Cir. 1985).

The effects of a proposed Sears Island project to build a causeway and cargo port would be significant and require preparation of an EIS. The agencies should have considered the secondary impacts, such as anticipated development of an industrial park, and other "growth-inducing effects."

246. Sierra Club v. Sigler, 532 F. Supp. 1222 (S.D. TX, 1982), *affirmed in part, reversed in part without reaching cumulative impact issues, and remanded,* 695 F.2d 957 (5th Cir. 1983).

Plaintiffs challenged the adequacy of an FEIS prepared for a proposed deepwater port and crude oil distribution system in Galveston Bay on the grounds, among others, that the cumulative impacts analysis failed to discuss the environmental impact of a proposed deepdraft channel to Texas City and failed to consider the impacts of proposed bulk commodities facilities to utilize the expanded deepwater capacity of the Port of Galveston. The court found the cumulative impact assessment was sufficient because the Corps was not required to evaluate environmental impacts of remote and speculative projects, and it was permissible under NEPA to approve one pending project which is fully covered by an impact statement, and then take into account the environmental effects of that project when preparing a statement on the cumulative impacts of remaining proposals. The Corps' decision to issue the permit was affirmed.

247. Sierra Club v. Penfold, 857 F.2d 1307 (9th Cir. 1988).

This case involved separate actions concerning federal regulation of placer mining on public lands in Alaska, which were consolidated for review. In Appeals No. 87-4094 and 87-4209, Plaintiffs challenged the adequacy of environmental assessments (EA's) pursuant to NEPA and subsistence evaluations (SE's) under the Alaska National Interest Lands Conservation Act prepared by the Bureau of Land Management (BLM) for Plan mining operations (disturbing more than five surface acres per year). Specifically, it was alleged that they failed to address the cumulative impacts of Plan mines in four specific watersheds. BLM conceded that the EA's were inadequate to analyze cumulative impacts. Uncontroverted evidence indicated after a surge in placer mining, the water quality was substantially degraded, resulting in reduced fish population and deterred recreational use. The court held that the district court was correct in enjoining approval of Plan mines in the watersheds until adequate EIS's were prepared. The district court was entitled to retain jurisdiction to review the adequacy of the BLM studies.

248. Sierra Club v. U.S. Forest Service, 843 F.2d 1190 (9th Cir. 1988).

The court held the Forest Service violated NEPA by not preparing an EIS for nine timber sales in the Sequoia National Forest. The court found testimony had raised substantial questions about cumulative adverse impacts on wildlife, watersheds and soils, forest recreational and aesthetic qualities, and fisheries which were not discussed in the EIS. The court granted preliminary injunction.

249. Sierra Club v. Watkins, 808 F. Supp. 852 (D.D.C. 1991).

Sierra Club urged that importation of spent fuel rods from Taiwan must be considered as part of the government's larger policy of accepting fuel rods from foreign nations. Court held that a cumulative impacts assessment was unwarranted since in this particular case no decision had been made as to what port would accommodate the spent fuel. The proposed actions do not fit with the paradigm of a project with many interrelated parts that will together substantially impact the environment in an entire region.

250. Thomas v. Peterson, 753 F.2d 754 (9th Cir. 1985).

In this challenge to enjoin construction of a timber road in a national forest roadless area, the court held NEPA requires an EIS that analyzes combined impacts of the road and timber sales the road is designed to facilitate. Interpreting the CEQ regulations on "connected and cumulative actions," the court found the road construction action, and contemplated timber sales to be connected and cumulative actions requiring a single EIS, which must be prepared before deciding whether to prepare the proposed road.

251. U.S. v. 27.09 Acres of Land, 760 F. Supp. 345 (S.D. NY 1991).

The court enjoined the Postal Service from constructing a new mail facility pending completion of an EIS. Among other shortcomings, the court found that the EA failed to consider the cumulative impacts of an array of near-certain future development in the vicinity in combination with the effects of the proposed facility. The court also found the EA framed the cumulative impacts analysis too narrowly on the two immediate neighbors, and failed to look at the impacts of runoff from the facility reaching the Kensico Reservoir (source of drinking water for 8 million people) in interaction with other pollutants to the same reservoir from whatever source.

Section 5

State Cumulative Impact Assessment Authority and Practice

This section collects documents pertaining to the legal authority and responsibility of individual states to consider cumulative environmental impacts in decision-making and studies, reports or similar efforts of those states to incorporate cumulative impact assessment methods. It places primary emphasis on coastal states, but includes non-coastal states if they appear to have innovative or transferable approaches.

Within each state entry, there are subcategories for a) codes, statutes and policies, b) literature and reports, and c) litigation. Due to the need to draw boundaries within a vast and potentially overwhelming array of statutes, regulations, policies and reports, this bibliography examined for inclusion only those statutes and documents which by their own description expressly addressed cumulative environmental impacts or effects.

Without question many of the regional planning initiatives, state-wide growth management programs, nonpoint source pollution prevention efforts and related estuary projects have evolved out of an attempt to control incremental change and manage cumulative impacts. These efforts are extremely important. They promote or require institutional coordination or cooperation, foster development of a body of scientific information about causes and effects of environmental change in the region, and articulate or formulate a set of shared values which provide the requisite context for decisions about cumulative impacts. However, despite the significance of these efforts to management of cumulative impacts, comprehensive planning statutes and related reports were generally not included in this bibliography for two reasons. First, it was assumed that researchers from a particular state would already be aware of their own comprehensive or regional planning efforts or would have access to that information in their own state. Second, it was determined that limited project resources should be focused on issues unique to achieving effective cumulative impact assessment, and should not be dissipated by trying to amass a catalog of comprehensive planning efforts.

The sections on state-specific statutes, regulations and policies used computer-assisted research to identify all documents in the electronic data base using the phrases "cumulative impact(s)" or "cumulative effect(s)" in combination with "environment(al)." Not all statutes containing these keywords were included; they were reviewed for relevance. This computer-assisted search was supplemented with additional research in cumulative impact assessment literature.

In the state literature and reports subsections, there are cross-references to documents prepared by or for the state which appear in the earlier sections of the bibliography. The index should also be consulted for additional documents pertaining to a particular state.

The final subsection for each state collects selected state court cases. These cases were located through computer-assisted research using a variety of search term combinations, all including "environmental" and "cumulative impact" or "cumulative effect." Not all cases identified by the search were included. Cases which merely included claims that the cumulative impact assessment was deficient or findings that the cumulative impact assessment was or was not adequate, without further elaboration, were generally not included. Similarly, if a case involved a non-coastal environment and merely cited prior decisions without advancing the discussion of cumulative impact concepts, it was not included. In many of the cases, the issues were complex and involved cumulative impact assessment as only one of several grounds. The abstracts summarize only the portion of the decision related to cumulative impacts. The last date of search and last date of Shepardizing for later developments was October 1, 1994. A few of the cases were not available in regional reporters; references for those cases are to the LEXIS electronic database maintained by Mead Data Central.

ALABAMA - CODES, STATUTES AND POLICIES

252. Surface Mining Control and Reclamation, ALA. CODE § 9-16-83 (b) (10) and 9-15-85 (b) (3) (1992).

The statute requires the applicant to provide "a determination of the probable hydrologic consequences of the mining and reclamation operations, both on and off the mine site" with respect to various factors and the collection of sufficient data, both on and off site so that the regulatory authority can assess the "probable cumulative impacts of all anticipated mining in the area upon the hydrology of the area and particularly upon water availability." This requirement is not triggered unless certain baseline information is made available from a federal or state agency. Pursuant to Ala. Code § 9-15-85 (b)(3), no permit will be issued without this "assessment of the probable cumulative impacts of all anticipated mining in the area on the hydrologic balance," if required, and the applicant must have demonstrated that the proposed operation has been designed "to prevent material damage to the hydrologic balance outside the permit area."

ALASKA - CODES, STATUTES AND POLICIES

253. Alaska Land Act, ALASKA STAT. §38.05.035 (1992).

The sale, lease or other disposal of interests in public lands require a written finding that the interests of the state will be best served. For oil and gas lease sales, among the factors that must be considered and discussed in the finding are "the reasonably foreseeable cumulative effects of oil and gas exploration, development, production, and transportation on the sale area, including effects on subsistence uses, fish and wildlife habitat and populations and their uses, and historic and cultural resources." See also §38.06.070 (1992) for criteria to be considered by the Alaska Royalty Oil and Gas Development Advisory Board, including secondary development.

254. Alaska Coastal Management Program, ALASKA STAT. § 46.40.210 (5)(c) (1992).

As part of the definitions applicable under the Alaska Coastal Management Program, "uses of direct and significant impact" are defined to include uses which proximately contribute to a material change in the natural or social characteristics of a part of the state's coastal area and in which "the use would, of itself, constitute a tolerable change or alteration of the resources within the coastal area but which, cumulatively, would have an adverse effect."

255. Surface Coal Mining, ALASKA STAT. § 27.21.180 (c)(3)- (5) (1992).

The Commissioner of DNR may not approve a permit application unless the Commissioner has made an "assessment of the probable cumulative impact of all anticipated surface coal mining in the area on the hydrologic balance" and determined that the proposed operation has been designed "to prevent material damage to the hydrologic balance outside the permit area." Additional standards are provided concerning not being located in areas designated as unsuitable for surface coal mining, not impacting farming on particular alluvial valleys, and not materially damaging quantity or quality of water supplied for alluvial valley floors.

256. Alaska Department of Fish and Game. n.d. *Statement of policy on mitigation of fish and game habitat disruptions*.

This statement outlines the need and authority for the policy, and establishes a hierarchy of mitigation measures when administering permits pursuant to AS16, based on NEPA mitigation policies. Regional planning in advance of significant land or water use programs is identified as a means of reducing cumulative effects.

257. Condon, Wilson L. July 16 1982. Letter to Murray Walsh, Coordinator, Office of Coastal Management, Office of the Governor. Re: Scope of Alaska Coastal Management Program consistency determinations, 1982 Alas. AG LEXIS 377.

This is a memo on the breadth of matters which may be reviewed by state agencies in their coastal management consistency determinations on development projects in the coastal zone. It concludes that the Act required consideration of cumulative impacts of development and that this may expand the scope of review of state agencies under pre-existing authorities.

ALASKA - LITERATURE AND REPORTS

258. Gray, Glenn. July 1993. *Regulation of cumulative and secondary impacts in Alaska*. Juneau, AK: Division of Governmental Coordination, Alaska Office of the Governor.

This report contains general material about obstacles to and opportunities for consideration of cumulative and secondary impacts, a complete list of statutory references to cumulative impacts in all states, and an analysis of selected enforceable provisions from other states, as well as an in-depth analysis of regulation of cumulative and secondary impacts in Alaska. It recommends changes to Alaska's Coastal Management Program including clearer direction on procedures to implement existing state laws and regulations; improved definitions of cumulative, secondary and significant impacts; and development of a handbook to provide further guidance on implementation of regulations.

259. Liepitz, Gary S., and Gay Muhlberg. January 25, 1993. The assessment and control of cumulative impacts of coastal uses on fish habitat of the Kenai River, Alaska: Study area, habitat classification and cumulative impact assessment methodology. 33 pp. and appendix Anchorage, AK: Alaska Department of Fish and Game. See abstract at record number 111.

260. Liepitz, Gary S. July 1994. *An assessment of the cumulative impacts of development and human uses on fish habitat in the Kenai River*. Technical Report No. 94-6. Anchorage, AK: Alaska Department of Fish and Game, Habitat and Restoration Division.

This final report of a two-year cumulative impact study funded under the CZMA 309 Enhancement Grant Program describes the Alaska Department of Fish and Game's identification and evaluation of the cumulative impacts of development actions on the Kenai River fish habitat. The study used the U.S. Fish and Wildlife Service's Habitat Evaluation Procedures (HEP) for impact assessment. The project also developed a habitat classification process using aerial photographic assessment, field inventory and a GIS. Using a Habitat Unit (HU) and focusing on the impact on habitat for the chinook salmon population, the study estimated that 2.2% of the total HUs originally available have been lost. It also assessed the nature and amount of change over the last 30 years. The results of the analysis provide baseline information, will assist in the development of coastal management plan policies, and can be used in bringing a cumulative impact/ watershed perspective to individual permit reviews. The author asserts that now that the data base and procedures have been developed, the Kenai River Cumulative Impact Assessment process can be used by inexperienced personnel with minimum training in HEP procedures and FWS software. The author also believes the process is applicable to similar riverine systems, is applicable to initial and secondary impacts, and could be used to evaluate the effects of cumulative impacts on wetland habitats within Alaska and in other states.

261. Walker, Donald A., Patrick Webber, Marilyn Walker, Nancy Lederer, Rosa Meehan, and Earl Nordstrand. 1986. Use of geobotanical maps and automated mapping techniques to examine cumulative impacts in the Prudhoe Bay Oilfield, Alaska. *Environmental Conservation* 13(2): 149-160. See abstract at record number 127.

ALASKA - LITIGATION

262. Kuitsarak Corp. v. Swope, 870 P.2d 387 (Alaska 1994).

After determinations that it would be in the best interest of the state and would be consistent with the Cenaliulriit Coastal Management Plan, the Department of Natural Resources approved certain Offshore Prospecting Permits (OPPS) for two coastal bays. The superior court affirmed, but using a "reasonable basis" standard, the supreme court reversed and remanded to DNR on several grounds, one of which was that DNR impermissibly declined to adequately analyze the impacts of offshore mining. DNR contended that it did not need to determine the potential impacts of mining since the permits were only for exploration. The court disagreed, finding the statute did not allow for a second look at the best interest finding prior to authorization of a mining lease. It found that there was no indication that DNR had considered the cumulative impacts of mining in the region.

263. Trustees for Alaska v. State, 851 P.2d 1340 (Alaska 1993).

In this continuation of litigation reported in 795 P.2d 805, environmental groups continued to challenge the State's sale of oil and gas leases in Camden Bay, arguing that DNR's determination that the sale is consistent with the Alaska Coastal Management Program was inadequate. The superior court upheld the consistency determination. The supreme court reversed and remanded to DNR, finding the DNR had erred in failing to identify known geophysical hazard areas and archeological sites prior to the lease sale. The court asserted that deferring a detailed look at geophysical hazards until a lease-site by lease-site examination involved unacceptable risks that cumulative environmental threats would be masked. The court reaffirmed its insistence upon early review of cumulative environmental impacts.

264. Trustees for Alaska v. Gorsuch, 835 P.2d 1239 (Alaska 1992).

This case involved an appeal of a superior court decision upholding the Commissioner of Natural Resources issuance of a surface coal mining and reclamation operations permit. In a 3-2 decision, the Supreme Court of Alaska reversed and remanded to the superior court to remand to DNR for consideration of the cumulative effects of all activities which are part of the "surface coal mining operation." The majority held that DNR may not ignore cumulative effects under the statutory language of the Alaska Surface Coal Mining Control and Reclamation Act by unreasonably restricting its jurisdiction (e.g., by ignoring related support facilities and their impacts, such as the cumulative effects of the port and conveyor on moose) or by permitting facilities separately. At least in a "concept approval", it must consider the probable cumulative impact of all anticipated activities which will be part of the operation, including the conveyor, airstrip, access roads, gravel pit, solid waste disposal facility, employee housing facilities, port and coal storage facilities, whether or not those activities are part of the permit under review. The two dissenting justices also would have remanded for consideration of cumulative effects, but stated that a single permit should be required for the entire operation rather than "concept approval" plus separate permits as allows by the majority. The dissent argued that requiring a single permit will compel the applicant to plan and design the components in greater detail prior to review, thus allowing the cumulative or synergistic effects to be assessed in a more careful and comprehensive manner.

265. Trustees for Alaska v. State, 795 P.2d 805 (Alaska 1990).

Environmental groups filed an administrative appeal seeking to overturn a competitive sale of oil and gas leases. One issue was whether DNR's "best-interest" decision was arbitrary, capricious or unreasonable due to insufficient discussion of possible cumulative impacts of the sale combined with other oil and gas developments in adjacent areas. The court found that a discussion which concluded that cumulative effects are not likely to be of great significance since all of the developments are subject to informed government scrutiny was sufficient. The decision was reversed in part and remanded on other grounds.

ARIZONA - CODES, STATUTES AND POLICIES

266. County Flood Control Districts, Watercourse Master Plans, ARIZ. REV. STAT. ANN. §48-3609.01 (E) (1992).

County flood control districts are authorized to complete and adopt "watercourse master plans" which are defined to mean "a hydraulic plan for a water course that examines the cumulative impacts of existing development and future encroachment in the floodplain and future development in the watershed on potential flood damages and establishes technical criteria for subsequent development. . . ."

ARKANSAS - CODES, STATUTES AND POLICIES

267. Surface Coal Mining Regulation, ARK. CODE ANN. § 15-58-503 (a)(2) (Michie 1992).

Similar to parallel acts in other states, it requires a consideration of the probable hydrologic consequences, both on and off site, and a consideration of the probable cumulative effects of all anticipated mining in the area upon the hydrology of the area, particularly upon water availability.

CALIFORNIA - CODES, STATUTES AND POLICIES

268. California Coastal Act of 1976, CAL. PUB. RES. CODE § 30000 (Deering 1994).

Finding that the California coastal zone is a delicately balanced ecosystem, the Act was created to protect the natural and scenic resources, protect the ecological balance, and promote carefully planned future developments which are consistent with the policies of the Act. It established the California Coastal Commission (CCC) to continue state coastal planning, management and regulation of certain development. The Act also established state policies to guide coastal zone conservation and development decisions. The CCC permit control over most new development is delegated to a local government as soon as the CCC certifies that their Local Coastal Program (land use plan, zoning ordinances, other implementing actions) conforms to Coastal Act standards. The Act (§ 3015.5) and accompanying regulations (14 CCR 13511 (1994)) require local coastal programs to consider potential significant adverse cumulative impacts on coastal resources and access of existing and potentially allowable development under the plan. It also requires new development to be located so it will not have a significant adverse effect on coastal resources, either individually or cumulatively (§ 30520(2)).

269. California Environmental Quality Act, CAL. PUB. RES. CODE § 21000 (Deering 1987 & Supp. 1994).

This statute (CEQA) establishes California's environmental impact review process. It requires an environmental impact report if a project will have a significant effect on the environment. It will be deemed to have a significant effect if the "possible effects of a project are individually limited but cumulatively considerable." Incremental effects are to be assessed as "considerable" by viewing them in connection with the effects of past projects, current projects, and probable future projects. The statute directs that previously approved land use documents may be used in cumulative impact analysis.

270. Forest Practices, Coast Forest District Rules, Cumulative Impacts Assessment Checklist, CAL. CODE REGS. tit. 14, § 912.9 (1994).

The State of California Board of Forestry has developed a cumulative impacts assessment procedure, utilizing a checklist approach, to guide the assessment of cumulative impacts of proposed timber operations. It analyzes whether the assessment area of resources that may be affected by the proposed project contain any past, present, or reasonably foreseeable probable future projects; whether there are any continuing significant adverse impacts from past land use activities that may add to the impacts of the proposed project; and whether the proposed project, in combination with either of the above has a reasonable potential to cause or add to significant cumulative impacts on specified resource subjects. The analysis is to address effects on watershed resources, soil productivity, biological resources, recreational resources, visual resources and vehicular traffic impacts. Within each category, specific changes of concern are identified (e.g., sediment, water temperature, organic debris) and potentially significant cumulative impacts of those changes are discussed.

271. Forest Practices, Coast Forest District Rules, CAL. CODE REGS. tit. 14, §§ 919.12 and 916.8 (1994).

These regulations provide more detailed guidelines for designation of sensitive watersheds as part of the watercourse and lake protection effort, and designation of sensitive species as part of the wildlife protection practices. If further timber operations within the watershed will "create a reasonable potential to cause, or contribute to ongoing, significant adverse cumulative effects(s)" on specified resources and mitigation of those cumulative effects requires protection measures beyond those required by the Forest Practice Rules, a nomination procedure is outlined for designation as a sensitive watershed. If designated as a sensitive watershed, valued resources and mitigation measures to protect those resources will be specified. Similarly, factors related to forest management and harvesting may result in the designation of a sensitive species if threats, including cumulative effects, may affect population viability or status of the species. Designation as a sensitive species might result in adoption of mitigation measures or new regulations for the protection of the species.

272. Guidelines for Implementation of the California Environmental Quality Act, CAL. CODE REGS. tit. 14, §§ 15130, 15300.2, 15355 (1994).

These guidelines for implementation of the California Environmental Quality Act contain a definition of cumulative impacts ("two or more individual effects which, when considered together, are considerable or which compound or increase other environmental impacts") and indicate they can result from a single project or number of separate projects. The impact from several projects is to be measured as the incremental impact of the proposed project plus closely related past, present and reasonably foreseeable probable future projects. Cumulative impacts are to be discussed in environmental impact reports "when they are significant." The guidelines elaborate on the necessary elements of an adequate discussion of cumulative impacts. Categorical exemptions are inapplicable when the cumulative impact of successive projects of the same type in the same place over time is significant.

273. San Joaquin Valley Air Quality Management District, CAL. HEALTH & SAFETY CODE § 41111 (Deering 1993).

The San Joaquin Valley Air Quality Management District is directed to consider, among other factors, the "cumulative impacts of vehicular and non-vehicular emissions on the ecosystems of the Sierra Nevada Mountains" in developing and adopting air pollution control plans.

274. Streamflow Protection Standards, CAL. PUB. RES. CODE § 10000 (Deering 1993).

In establishing Streamflow Protection Standards, the Legislature declares that there has been an increase in the number of requests to appropriate water from streams, especially for the purpose of generating electrical energy, and that if approved without considering cumulative effects, the appropriations could adversely affect fish and wildlife resources.

275. Tahoe Regional Planning Compact, CAL. GOV'T CODE §66800 (Deering 1994).

This compact, enacted by the States of Nevada and California and approved by the Congress of the United States in 1969, established an interstate mechanism to "ensure an equilibrium between the region's natural endowment and its manmade environment." The Tahoe Regional Planning Agency (TRPA) was empowered to establish environmental "threshold carrying capacities" (including air, water, soil conservation, vegetation preservation and noise) and to adopt plans and ordinances to enforce those capacities.

276. Timberland Wildlife Study, CAL. PUB. RES. CODE ANN. § 4800 (Deering 1993).

This statute on the Timberland Wildlife Study attempts to provide coordination on wildlife and timberland issues, improve the state data bases used to analyze the cumulative impacts of timber harvesting, and to improve the technical basis for recommendations to mitigate site-specific and cumulative effects on wildlife from timber harvesting activities.

CALIFORNIA - LITERATURE AND REPORTS

277. Adams, M. Andriette. 1985. The cumulative impact assessment in CEQA: Is the standard in San Francisco for reasonable growth attainable? *Western State University Law Review* 12: 801-817.

This note reviews the 1984 decision of the California Court of Appeals holding that the City and County of San Francisco violated the provisions of the California Environmental Quality Act by omitting analysis of cumulative impacts of other closely related projects currently under environmental review. It includes a detailed history of cumulative impact assessment in CEQA and analysis of the decision.

278. Coats, Robert N., and Taylor O. Miller. 1981. Cumulative silvicultural impacts on watersheds: A hydrologic and regulatory dilemma. *Environmental Management* 5: 147.

The authors focus on cumulative hydrologic and water quality effects of timber harvesting activities in California, identifying secondary as well as direct effects. They review the physical problems and state and federal regulatory framework, and make recommendations for a collaborative state-private planning process responsive to geologic and hydrologic variables in watershed characteristics.

279. Eichbaum, William M., and Brock B. Bernstein. 1990. Current issues in environmental management: A case study of southern California's marine monitoring system. *Coastal Management* 18: 433-445.

In this report of a case study analyzing the monitoring systems in the Southern California Bight, the panel found that larger-scale and cumulative impacts were not well monitored. The permit-by-permit approach to monitoring was not conductive to assessing multiple activities affecting resources at a single location; did not allow for a determination of how widely spread resources are effected by activities occurring in different locations; and failed to address non-point sources of contaminants which are not covered by permits.

280. Gilliland, Martha A., and B. David Clark. 1981. The Lake Tahoe Basin: A systems analysis of its characteristics and human carrying capacity. *Environmental Management* 5(5): 397-407. See abstract at record number 40.

281. Standiford, Richard B., and Shirley I. Ramacher, ed. Cumulative effects of forest management on California watersheds: An assessment of status and need for information. *Proceedings of the Edgebrook Conference*, June 2, 1980. The Department of Forestry and Resource Management and Cooperative Extension Service, University of California, Berkeley.

This collection of technical papers from a 1980 conference approaches the issue of cumulative impacts of timber harvesting from the perspective of specialists in soils, ecology, forestry, economics and the law. Each participant was asked to describe potential cumulative effects, identify measurement and evaluation techniques, identify how the effects could be predicted, controlled or mitigated, and to identify research needs.

282. Strnad, Les, and Rick Hyman. 1993. A watershed approach to coastal zone management of the Elkhorn Slough estuarine complex. In *Coastal Zone '93: Proceedings of the Eighth Symposium on Coastal Management*, ed. Orville T. Magoon, 1569-1585. New York, NY: American Society of Civil Engineers.

This case study recounts the twenty year history of efforts toward scientifically-based watershed planning and management for Elkhorn Slough. It identifies advances and deficiencies of planning, regulatory and management programs.

CALIFORNIA - LITIGATION

283. Bel Mar Estates v. California Coastal Commission, 115 Cal. App. 3d 936 (1981).

The court upheld the California Coastal Commission's denial of a permit for a large ridge-top residential subdivision in the mountains overlooking the Pacific Coast Highway. The court found that the record contained significant evidence that the development would produce a major increase in traffic, a major change in the natural environment and would be inconsistent with the policy to protect the scenic and visual quality of the coastal area as a resource of public importance. It held that based on the evidence in the record, it would not say that the commission and trial court erred in regarding the cumulative effect of this large development as falling without the permitted development envisioned by the statute.

284. Billings v. California Coastal Commission, 103 Cal. App. 3d 729 (1980).

In upholding the reversal of the Coastal Zone Conservation Commission's action in denying a permit for a minor subdivision to create three parcels of 25, 26, and 67 acres in rural land two to three miles from the coast, the court found the owners were not exempt from the permit requirement, but were entitled to a permit. In part, the decision construed § 30250 of the 1976 Coastal Act, establishing a policy of concentrating development in existing developed areas unless the development will not have significant adverse effects, either individually or cumulatively, on coastal resources. The CCC found that the project had future adverse effects in that it would encourage similar division of other large parcels and threaten the low intensity agricultural economy of the area. The court rejected this reasoning, stating that the Commission erroneously relied on the precedential impact of the subdivision and the difficulty of rejecting future minor subdivision requests; it emphasized that the Commission has the authority to prohibit any future development whose cumulative effect is both significant and adverse.

285. Californians for Native Salmon v. Dept. of Forestry, 221 Cal. App. 3d 1419 (1990).

A number of environmental organizations brought a declaratory action against the California Department of Forestry, alleging as one ground that the agency had a policy in each of the timber harvest plans (THP, the functional equivalent of an environmental impact report under CEQA) of failing to evaluate and mitigate the cumulative impacts of logging activities. The trial court concluded declaratory relief was inappropriate because there was no justiciable controversy. Citing the need for judicial economy, the court of appeals reversed and directed the trial court to overrule the Department of Forestry demmurer.

286. Citizens Association for Sensible Development of Bishop Area v. County of Inyo, 172 Cal. App. 3d 151 (1985).

The court held the Board failed to consider the cumulative effects of a development project because it improperly described a shopping center development as two projects which were reviewed separately. The court found this to be an abuse of discretion requiring reversal. Upon remand, the defendant was also to consider the reasonably foreseeable probable future projects added in the shopping center area (e.g., satellite buildings). The defendant was also to consider any physical deterioration of the downtown area if taking business away from downtown shopping area (and related physical deterioration) is demonstrated to be a secondary effect of the project.

287. Citizens to Preserve the Ojai v. County of Ventura, 176 Cal. App. 3d 421 (1985).

In considering modification of two pre-existing conditional use permits to enable the permittees to expand an oil refinery, respondent prepared an environmental impact report. The EIR contained only a brief discussion of cumulative air quality impact and concluded that no significant impacts were involved. This conclusion was based solely upon a previously conducted air quality projection study, which excluded the impact of outer continental shelf emissions. The court held that the analysis of cumulative air quality impacts was inadequate to fulfill the requirements of CEQA and directed the trial court to void Ventura County's certification of the final EIR.

288. Coastal S.W. Dev. Corp. v. California Coastal Zone Conservation Commission, 55 Cal. App. 3d 525 (1976).

The California Coastal Zone Conservation Commission denied a permit for a nine-story Holiday Inn motel proposed for a bluff overlooking the sea. Among other grounds for denial were that the applicant failed to show that the project would not have adverse cumulative effects on coastal resources and that it would not have adverse growth-inducing effects. The trial court reversed the permit denial, finding the Commission's decision was based on speculation and conjecture. The court of appeals reversed the trial court, finding that the decision was largely based on opinion evidence of experts in environmental planning and that constituted substantial evidence. The adverse cumulative impacts cited included accelerating a redevelopment trend, adversely impacting physical, biotic and human systems, and commitment of the best remaining viewing site.

289. Kings County Farm Bureau v. City of Hanford, 221 Cal. App. 3d 692 (1990).

Plaintiffs appealed from a trial court determination that an Environmental Impact Report (EIR) for a proposed coal-fired cogeneration plan was sufficient. The court of appeals reversed, concluding that the EIR was inadequate because it contained insufficient information in several respects. One challenge was to the adequacy of the discussion of this and similar projects with regard to their cumulative impacts on air quality, water use and waste disposal. The decision reiterates the importance of cumulative impact analysis to assess the true impact of incremental changes, and examines the appropriate geographic scope of the review.

290. Laupheimer v. California, 200 Cal. App. 3d 440 (1988).

The California Department of Forestry approved two timber harvesting plans (THP) to harvest timber from 160 acres on ridges above residential homes in an area which had been subject to serious erosional damage in the past. The trial court denied a petition for an injunction to prevent the logging. On appeal, the court reversed in part, directing Forestry to set aside approval of one THP, on the grounds that Forestry had failed to analyze potential adverse cumulative effects once it was put on notice of those issues. The court took care to state that it was not requiring a statistical analysis of the probability that logging would increase the risk of landslide and runoff damage, but rather that Forestry look at those potential impacts it considered significant in "some reasonable manner".

291. Libeu v. Ross, 195 Cal. App. 3d 517 (1987).

In this case, the court found that the director of the California Department of Forestry failed to provide an adequate response to the public's environmental concerns, particularly with regard to the cumulative impacts of past, present and future logging. Finding the director abused his discretion, the court reversed the logging operation approval decisions. The timber harvest plan (THP) review process is governed by CEQA's cumulative impact requirements. The court identified inadequate responses to concerns about cross-stream logging sites, downstream water quality impacts from sedimentation, and foreseeable additional future logging in the area. While commending CDF for developing a lengthy and thorough checklist of various factors to be considered in the assessment of cumulative impacts, in this specific case it was found that the Director's responses to public comments were insufficient.

292. Ojavan Investors Inc. v. California Coastal Commission, 26 Cal. App. 4th 516 (1994).

In order to control adverse cumulative impacts of development in the coastal zone, the California Coastal Commission adopted a transfer of development credits program (TDC program). The program permits only a finite amount of development in the area, but lets the market determine which parcels will remain undeveloped. It allows the Commission to condition subdivision approval on the requirement that the project proponents arrange to extinguish the development capacity of other lots—either by dedication of a scenic easement or by filing a Declaration of Restrictions merging separate lots into one parcel. In this case, the court upheld a Commission cease and desist order restraining developers from selling as separate lots land which had been merged into one parcel through the TDC program.

293. San Franciscans for Reasonable Growth v. City & Cty. of San Francisco, 151 Cal. App. 3d 61 (1984).

The San Francisco Planning Commission accepted four EIRs and issued permits for downtown high-rise office buildings. The superior court upheld the Commission but the court of appeals reversed, holding that omitting projects currently under environmental review from the cumulative impact assessment was an unreasonably narrow interpretation of CEQA guidelines. The Commission had used projections to assess cumulative effects of "probable" future office development based on projects under construction and projects already approved but not yet under construction. The court held that failure to also consider projects which were under review by the Commission (easily available information) resulted in reversible understatement of adverse effects, subverted the mitigation conditions, skewed the ability to accurately determine whether benefits from a project override impacts which are not mitigated, and hampered the ability of citizens to participate in the processes by failing to disclose actual probable cumulative effects.

294. Sierra Club v. Gilroy City Council, 222 Cal. App. 3d 30 (1990).

Petitioners sought to build a residential development with potential impact on the California Tiger Salamander. The city council certified an EIR and approved a general plan amendment to make the development possible. The trial court affirmed, rejecting appellant's contention, among others, that the EIR failed to include adequate discussion of a cumulative impact report discussing other projects statewide. The court declined to read CEQA to require public agencies to deny approval of any project where the perpetuation of rare or endangered species on the site cannot be guaranteed. It also found that a two-sentence cumulative impact report was sufficient in these circumstances.

295. Stanson v. San Diego Coast Regional Commission, 101 Cal. App. 3d 38 (1980).

Petitioner filed for an after-the-fact permit to remodel the ground floor of a building into 16 shops with a public walkway to a nearby beach, and convert a former second floor storage area to a small restaurant. The Regional Planning Commission denied the permit and the superior court upheld the denial. The court of appeals, reversing and remanding on other grounds, held that under the California Coastal Act, the Commission was allowed, even though in this instance perhaps not required, to take into account the cumulative effect of future restaurants in reaching its decision to deny the permit. The court stated that failure to consider cumulative effects in applying the California Coastal Act "would reduce the Regional Commission's planning function to a shambles, resulting in a piecemeal approach which would guarantee the destruction of coastal resources".

296. State of California v. Tahoe Regional Planning Agency, 766 F.2d 1308 (9th Cir. 1985).

The court of appeals affirmed the district court's grant of a preliminary injunction enjoining the TRPA from approving any development in the Lake Tahoe Basin without adopting amendments to the regional plan which were in compliance with the 1980 amendments to the Compact. Specifically, the 1980 amendments required the establishment of environmental threshold carrying capacities. While the TRPA adopted numerical standards and management standards to establish the thresholds, the court found that portions of the plan were contrary to the Compact. The court found a danger of irreparable harm from noncompliance with the Compact, including evidence that a continuation of the growth rate of planktonic algae would lead to the loss of Lake Tahoe's clarity in only 40 years. It held that no project could be approved without written findings that show how each project will not cause the environmental carrying capacity thresholds to be exceeded.

297. Tahoe Keys Property Owners' Ass'n v. State Water Resource Control Bd., 23 Cal. App. 4th 1459 (1994).

A property owners' association challenged a lake pollution mitigation fee required for building permits. The trial court denied the preliminary injunction. On appeal, the court upheld that determination, finding the association had failed to show a substantial likelihood of success on its regulatory takings claim. The court held that the justification for a restriction is not limited solely to the needs or burdens created only by the proposed project, and cited *Nollan* as support for the position that in imposing conditions, the state could consider the effect of the project alone or by reason of the cumulative impact produced in conjunction with other construction. It asserted that in *Nollan*, the U.S. Supreme Court would have approved dedication of a viewing spot to address the cumulative impact of beachfront construction even though the burden would have fallen on the Nollans alone. It found a sufficient nexus between the mitigation fee (calculated based on estimates of quantities of nutrients entering Lake Tahoe as a result of development and ongoing maintenance and operation of lagoons) and the objectives it was supposed to advance, and found that the regulation provides an average reciprocity of advantage.

298. Whitman v. Board of Supervisors of Ventura Cty., 88 Cal. App. 3d 387 (1979).

After review and acceptance of an EIR, the County Board of Supervisors granted an oil and gas corporation a conditional use permit for a single exploratory oil and gas well in an undisturbed, natural chapparal in an extreme fire hazard area. The site provided significant wildlife habitat as well. Petitioners filed to have the permit set aside on the grounds, among others, that the EIR was insufficient due to its failure to adequately address cumulative impacts. The trial court denied the relief, but the court of appeals reversed and remanded for preparation of an adequate discussion of cumulative impacts. In discussing the requirements of an adequate cumulative impacts analysis, the decision surveys prior CEQA and NEPA decisions. Due to the language of then-existing guidelines, the court does not require an analysis of probable future projects, but does require an assessment of existent and planned related projects in the region. The EIR not only fails to make adequate reference to existing or planned drilling, but the two projects that were mentioned were dismissed by conclusory statements that "failed to crystallize issues" and afforded no basis for comparison among alternatives.

CONNECTICUT - CODES, STATUTES AND POLICIES

299. Connecticut Environmental Policy Act Regulations, Department of Environmental Protection, 1507.2 (1979).

These regulations apply to actions undertaken by a state agency, funded by the state or other activities for which an agency exercises judgment or discretion as to the propriety of that action. An environmental assessment must be performed to determine significance, and if significant (i.e., a substantial adverse impact on the environment) an environmental impact evaluation (EIE) must be prepared. In evaluating significance, direct, indirect and cumulative impacts are to be considered. Cumulative impacts are defined as "the incremental impact of the action when added to other past, present or reasonably foreseeable future actions to be undertaken by the sponsoring agency." The regulations also address preparation of a single EIE for a sequence of actions.

300. Connecticut Environmental Policy Act, CONN. GEN. STAT. § 22a-1b (1992).

State agencies responsible for the primary recommendation or initiation of actions which may significantly affect the environment are required to make a detailed written evaluation of the environmental impact, including direct and indirect effects which might result during and subsequent to the proposed action.

301. Tidal Wetlands Act, CONN. GEN. STAT. § 22a-28 through 22a-35 (1992).

The Act declares it to be a state policy to preserve the remaining wetlands and prevent their despoilation and destruction. It establishes a permit system for defined regulated activities (e.g. draining, dredging, erection of structures, etc.) and allows the state to inventory all tidal wetlands within the state to establish tidal wetlands boundaries. The accompanying regulations establish detailed criteria for permit review, which require an assessment of the impact of the proposed regulated activity on wetlands, adjoining coastal and tidal resources, navigation, recreation, erosion, sedimentation, water quality and circulation, fisheries, shellfisheries, wildlife, flooding and natural disasters and water dependent use opportunities.

302. Water Pollution Control, CONN. GEN. STAT. § 22a- 430b(c)(6) (1992).

This statute on discharges which are exempt from Water Pollution Control Permits allows the commissioner of environmental protection to issue a general permit for any minor activity in various circumstances if the activity would cause "minimal environmental effects when conducted separately and would cause only minimal cumulative environmental effects," and would meet other specific standards.

303. Zoning, CONN. GEN. STAT. § 8-2(b) and 8-3b (1991).

These sections which apply to zoning regulations and regional planning agencies plans of development were amended in 1991 to increase regional efforts in the clean up of Long Island Sound. The amendments require that any regulations or plans adopted by municipalities and regions contiguous to Long Island Sound consider environmental impact on Long Island Sound and are designed to reduce hypoxia, pathogens, toxic contaminants and floatable debris in the Sound.

DISTRICT OF COLUMBIA - CODES, STATUTES AND POLICIES

304. Environmental Impact Statements, D.C. CODE ANN. § 6-983 (1992).

This statute requires a detailed Environmental Impact Statement (or its functional equivalent) if a major action is likely to have a substantial negative impact on the environment. The EIS is to analyze, among other factors, the relationship to the goals of the comprehensive plan, "the cumulative impact of the major action when considered in conjunction with other proposed actions," and the effect of future expansion or action if a reasonably foreseeable consequence of the initial major action.

FLORIDA - CODES, STATUTES AND POLICIES

305. Aquatic Preserves, FLA. STAT. ch. 258.43 (1993).

In evaluating applications for activities within an aquatic preserve or which may impact an aquatic preserve, the Board of Trustees are to adopt and enforce regulations to regulate human activity so as not to interfere with traditional uses. This authority may be delegated to local governments. The regulations, 18-20.006, Florida Administrative Code, detail that applications are to be reviewed for the cumulative impact on the preserve's natural systems, viewing them as part of a complete and interrelated system. Several elements are to be considered in the cumulative impact review including: similar human actions (number and extent) which have previously affected or are likely to affect the preserve, similar activities currently under consideration, reasonably expected direct and indirect effects, consistency with management plans for the preserve, whether the activity is in accordance with local comprehensive plans, the extent to which the loss of beneficial hydrologic and biologic functions would adversely impact the quality or utility of the preserve, and possible mitigation measures.

306. Beach and Shore Preservation, FLA. STAT. ch. 161.041 (2)(c) and 161.053 (5)(a) (1992).

As part of the permitting process required for the construction or reconstruction of any structure or for conducting any shore protection activity upon sovereignty lands of Florida, in reviewing applications for excavation or erection of a structure, the department must consider potential impacts, including potential cumulative effects, upon the beach-dune system or coastal inlet. The same standard is also used for review of proposed excavation or erection of a structure seaward of an established coastal construction control line.

307. County and Municipal Planning and Land Development Regulation, FLA. STAT. ch. 163.3178(2)(j) (1994).

This Act establishes standards for the coastal management element of local government comprehensive plans, including a requirement that each contain "an identification of regulatory and management techniques that the local government plans to adopt or has adopted in order to mitigate the threat to human life and to control proposed development and redevelopment in order to protect the coastal environment and give consideration to cumulative impacts." It anticipates several types of plans including port master plans, local comprehensive plans and countywide marina siting plans.

308. Department of Environmental Protection, FLA. STAT. ch. 20.255 (1994).

By amendments to prior law, in 1993, Florida created a new Department of Environmental Protection, replacing and merging the prior Departments of Environmental Regulation and Natural Resources. It created the position of an Executive Coordinator for Ecosystem Management, added an Office of Ecosystems Planning and Coordination to assure the implementation of the ecosystem management provisions of Ch. 93-213.

309. Minimum Criteria for Review of Local Government Comprehensive Plans, Coastal Management, FLA. ADMIN. CODE ANN. r. 9J-5.012 (1994).

The coastal management element of the criteria for local government comprehensive plans outlines data and analysis requirements; requirements for goals, objectives and policies; a requirement that participating local governments incorporate a marina siting plan; and requirements that each deepwater port include a port master plan. Each plan is required, among other elements, to identify regulatory and management techniques for "limiting the specific impacts and cumulative impacts of development or redevelopment upon wetlands, water quality, water quantity, wildlife habitat, living marine resources, and beach and dune systems."

310. Permitting of Activities in Wetlands, Wetlands Protection Act, FLA. STAT. ch. 403.919 (1992) (repealed effective July 1, 1993 and recodified at 373.414(8)).

The Florida Dept. of Environmental Regulation (DER) was required to take into consideration the cumulative impacts of similar projects which are existing, under consideration, or reasonably expected in the future in determining whether reasonable assurance has been provided that the project will not result in violations of water quality standards and will not be contrary to the public interest. Specifically, it was to look at the impacts of the proposed project; projects existing, under construction, or for which permits or jurisdictional determinations have been sought; and impacts of projects which may reasonably be expected, considering land use restrictions and regulations. (See below, # 312 Water Resources, for recodification).

311. Rules and Procedures for Coastal Construction and Excavation (Permits for Construction Seaward of the Coastal Construction Control Line and Fifty-foot Setback), Department Policy Statement on Permits, FLA. ADMIN. CODE ANN. r. 16B-33.005 and 16-B-41.002 (1994).

These policies address under what circumstances the Department of Natural Resources will consider allowing construction or excavation seaward of the coastal construction control line and 50-foot setback. As one of nine policies, it states that as a general rule, "the Department may not authorize any construction or activity whose cumulative impact will threaten the beach or dune system or its recovery potential following a major storm event." By definition, the Department is to consider the impacts which would result if the proposed coastal construction were permitted as a general practice on other coastal properties in the same general area or if the proposed construction were added to the adverse impacts from existing coastal construction.

312. Water Resources, Management and Storage of Surface Waters, FLA. STAT. ch. 373.414(8) (1994).

This new section on additional criteria for activities in surface waters and wetlands recodifies the prior cumulative impact standard with modifications, effective July 1, 1993. This new standard specifically uses the phrase "cumulative impacts," establishes the same drainage basin as the relevant geographic area of review, and directs projections of future impacts to consider comprehensive plans of local governments. In summary, it directs consideration of cumulative impacts of: 1) the activity for which the permit is sought; 2) projects existing or regulated activities under construction or projects for which permits or determinations have been sought; and 3) activities under review, approved or vested or other regulated activities which may reasonably be expected to be located within surface waters or wetlands in the same drainage basin, based upon certain local comprehensive plans or land use restrictions and regulations.

FLORIDA - LITERATURE AND REPORTS

313. Ankersen, Tom. March 1986. Cumulative impacts in Florida environmental decisionmaking: Finding the straw that breaks the camel's back and equitably distributing all the others. *The Florida Bar Journal* 21-28.

An excellent review of legal barriers to cumulative impact review, this article details Florida's struggle with cumulative impacts under the Henderson Act (1984). Particular attention is paid to the difficulties of administering cumulative impact regulations.

314. Canter, Bram. May 1984. The consideration of cumulative impacts in Department of Environmental Regulation dredge and fill permits.

This statement briefly summarizes DER's position with regard to consideration of cumulative impacts under Chapter 403 and Chapter 253, and includes examples of application in practice.

315. Canter, Bram, September 1986. Models for cumulative effects management in non-wetland regulatory programs. In *Proceedings of the Conference: Managing Cumulative Effects in Florida Wetlands*, ed. Ernest D. Estevez, Jono Miller, Julie Morris, and Richard Hamman, Publication No. 37: 285-297. Sarasota, FL, October 1985. Madison, WI: Omnipress Publishers, Inc.

The author compares cumulative effects evaluation mandated by wetlands regulations with that required by non-wetlands regulatory programs. Specifically, the author examines the approach for evaluating cumulative effects embodied in Florida water use, water quality, and air quality regulatory programs, to illustrate the uniform exclusion of predictions of future events and their effects. He concludes that excluding this component is advisable. Canter's argument is based on the assertion that the prediction of future events requires the permit reviewer to rely upon insufficient and often unreliable data. Moreover, a decision that cannot be supported by concrete information is vulnerable to legal attack. Finally, Canter suggests modifying the wetlands approach and offers specific methods for implementing the principles underlying the non-wetlands approach.

316. Dye, James D. 1986. DER Regulatory Jurisdiction: *Department of Environmental Regulation v. Goldring* (477 So.2d 532 (Fla. 1985). *Journal of Land Use and Environmental Law* 2: 85-98.

This case note analyzes the *Goldring* decision ruling on DER's dredge and fill jurisdiction under Chapter 403 and related rules, essentially giving DER jurisdiction over all wetlands which drain into the state's waters.

317. Estevez, Ernest D., Jono Miller, Julie Morris, and Richard Hamman, ed. 1986. *Proceedings of the Conference: Managing Cumulative Effects in Florida Wetlands*. Sarasota, Florida, October 1985. Madison, WI: Omnipress Publishers, Inc.

This two-volume publication contains the proceedings of conference held to begin the process of Florida's Department of Environmental Regulation developing a workable rule to implement statutory directive to consider cumulative effects of development on wetlands. The papers include general discussion of terms and key concepts in cumulative impact assessment methodology, documentation of Florida's cumulative wetlands losses, case studies of specific areas including a coastal lagoon and marine wetlands, an overview of the federal experience in managing cumulative effects, and analysis of the legislative history of the new Henderson Act.

318. Hamman, Richard. September 1982. *Wetlands loss in south Florida*. Center for Governmental Responsibility, University of Florida College of Law.

This publication reports on a study of the loss of wetlands in South Florida and assessment of the effectiveness of regulatory programs. The author finds that cumulative impacts are not given adequate consideration in Section 404 Clean Water Act permit reviews because of political difficulty of denying permits, legal pressure to allow every landowner at least some fill, lack of scientific data projecting cumulative effects, and inadequate staffing.

FLORIDA - LITIGATION

319. Brown v. Department of Environmental Regulation, 1987 Fla. Env. LEXIS 38, DOAH Case No. 85-0517 (March 11, 1987).

This case involved an application for dredge and fill to construct a house and boardwalk. The hearing officer concluded that application of the cumulative impact analysis was unnecessary. The Secretary of DER rejected that part of the recommended order and held that consideration of cumulative impacts is not discretionary with the Department. The consideration of the cumulative impacts of other existing valid permits that could affect the same property is also a proper permitting concern of the Department.

320. Caloosa Property Owners' Assoc. v. Department of Environmental Regulation, 462 So. 2d 523 (Fla. Dist. Ct. App. 1985).

Developers obtained a dredge and fill permit from the Department of Environmental Regulation to construct a series of canals and artificial lakes as part of an industrial park. Property owners appealed on several grounds, including that the Department failed to apply the cumulative impact doctrine appropriately. The district court of appeals held that the issuance of the permit was supported by substantial evidence. It held that the DER only needs to consider the precedential value of granting a permit if there is a reasonable likelihood of a similar project application in the same geographic location in the future.

321. Chipola Basin Protective Group v. Department of Environmental Regulation, 11 FALR 467 (1988).

Chipola challenged the Department's intent to issue developers a permit to conduct dredging and filling in conjunction with the development of a shopping center. The hearing officer found that there were no other specific projects reasonably expected in nearby jurisdictional areas, so there was no adverse cumulative impact. Even though there was a lack of land use restrictions and regulations in the area making future development likely, the Secretary found this speculative. The decision on cumulative impacts is made with regard to development that "may be reasonably expected" to occur.

322. Concerned Citizens League of America, Inc. v. Department of Environmental Regulation, 1989 Fla. Env. LEXIS 35, DOAH Case No. 88-1681 (March 29, 1989).

Petitioner applied for a dredge and fill permit for the mining of phosphate rock and reclamation of a 162 acre site, including 131 acres of jurisdictional wetlands. The hearing officer recommended denial of the permit on the grounds that the petitioner failed to provide reasonable assurances that existing and foreseeable cumulative impacts would not adversely and significantly affect certain functions of the prairie and a prong of a river. The Secretary of the Department of Environmental Protection refused to set aside the findings of the hearing officer, finding the petitioner had failed to carry its burden of giving reasonable assurance that cumulative impacts do not cause the project to be contrary to the public interest.

323. Conservancy, Inc. v. A. Vernon Allen Builder, Inc., 580 So. 2d 772 (Fla. Dist. Ct. App. 1991).

Appellants challenged a final order of the Department of Environmental Regulation granting a dredge and fill permit to construct an imbedded sewage pipeline system from the mainland to a coastal barrier island designated as part of the federal coastal barrier resource system. The pipeline was proposed to serve an existing vacation resort as well as a proposed new development of 75 exclusive estate homes intended to be built by the applicant. The pending permit application was only for the pipeline; additional permits would have been required for the new development. The hearing officer had excluded most evidence regarding cumulative impacts and future development of 75 homes, concluding that the equitable distribution provisions of the statute did not require consideration of construction activities beyond the precise scope of this permit (pipeline only). The court of appeals reversed and remanded on the exclusion of evidence regarding the potential cumulative and secondary impacts of the permitted project. It analyzed the distinction between cumulative and secondary impacts, found that 403.919 may in fact only require consideration of those impacts created by the cumulative effects of similar future projects, but also held that the hearing officer needed to consider potential secondary impacts ("what will be at the end of the pipeline") as part of the water quality and public interest analysis.

324. del Campo v. Department of Environmental Regulation, 452 So. 2d 1004 (Fla. Dist. Ct. App. 1984).

The Department of Environmental Protection issued an order allowing a private developer to construct a bridge which would connect an island to the mainland. The 42 acre island was likely to be developed for residential use, but that was not part of the pending application. Local residents and environmental groups objected and requested a hearing. At the hearing they unsuccessfully attempted to introduce information about the proposed development's possible environmental impact on the island. The court held that DER and the hearing officer erred in limiting the scope of the hearing to the bridge itself; the proposed development of the island should be considered as part of a proceeding concerning the application to build a bridge so as to avoid "an unconscionable waste of resources" if the bridge was built but the residential development denied.

325. Florida Power Corporation v. Department of Environmental Regulation, 638 So. 2d 545 (Fla. 1994).

This case involved an application by Florida Power Corporation, in part after-the-fact, to cut down vegetation in a swath sixty feet wide and 14 miles long for the installation of an electrical transmission line. The proposal would have resulted in clear cutting of forested wetlands, converting them to herbaceous wetlands. The proposed action would have resulted in the destruction of approximately 6 acres within 31,448 acres of contiguous forested wetlands. The application was reviewed under the Wetlands Protection Act of 1984, including Florida's "equitable distribution" criteria codifying the cumulative impacts doctrine. In a decision which includes extensive summaries of the expert testimony on direct and cumulative impacts, the court upheld the decision of then-DER Secretary Carol Browner to reject several findings of the hearings officer, to reject the hearing officer's recommended approval, and to deny FPC's permit application. The court upheld Secretary Browner's rejection of the contention that in general one type of wetland may be replaced with another with no adverse impact and found it was within her discretion to reject the finding that there was no adverse cumulative impact. The decision outlines Secretary Browner's findings on the loss of 6 of 31,448 acres not being acceptable, the absence of a "de minimis exception" to the cumulative impact analysis, how an increase in species diversity can be an adverse impact if the natural undisturbed ecosystem has a lower species diversity, and the similarity of impacts criterion for projects to be considered in a cumulative impact analysis.

326. Peebles v. Department of Environmental Regulation, No. 89-3725, 1990 Fla. Env. LEXIS 70, DOAH Case File No. 84-3725 (April 11, 1990).

The applicant proposed to dredge and fill an area of wetlands on a lakefront lot and to build a 452 square foot dock (exempt from permitting). The hearing officer recommended that the application be granted. The Department of Environmental Regulation (DER) took exception, and the Secretary of DER declined to accept the recommendation of the hearing officer, holding that the applicant had not provided reasonable assurance that when cumulative impacts are taken into consideration the project is not contrary to the public interest. The burden of proof was on the applicant to provide reasonable assurance that water quality standards will not be violated and that the project is not contrary to the public interest, taking into consideration the cumulative impacts of similar projects which are existing, under construction or reasonably expected in the future. The hearing officer could not ignore prior filling because it was done illegally; regardless of the illegality, they constituted existing projects. The equitable distribution doctrine is based on the assumption that reasonably expected similar future applications will also be granted. However, it is not mandatory that all similar future applications be granted; each must provide reasonable assurances anew.

327. Sarasota County v. Department of Environmental Regulation, 1991 Fla. Env. LEXIS 63, DOAH Case No. 90-3533 (April 4, 1991).

Sarasota applied for a dredge and fill permit to dredge an inlet between the waters of Little Sarasota Bay and the Gulf of Mexico. The western boundary of the bay is designated as class III waters, and outstanding Florida waters. In order to obtain a permit in an outstanding Florida water, the applicant must show that the project is clearly in the public interest (section 403.918(2)). The hearing officer concluded the applicant failed to make that showing. The Secretary of DER, at that time Carol Browner, affirmed. The factors taken into account included manatee protection, turtle nesting impacts, fisheries impacts, seagrass impacts, wetlands impacted, wading birds impacts. In taking water quality impacts into account, the applicant must show that secondary impacts of the project and that cumulative impacts of reasonably foreseeable similar projects in the same geographical location will not result in violations of water quality standards, and will not result in the project being not clearly in the public interest.

328. Sierra Club v. St. Johns River Water Management District, 1992 Fla. Env. LEXIS 105, Case No. RFR-92-001 (July 21, 1992).

This matter was heard by the Governor and Cabinet sitting as the Florida Land and Water Adjudicatory Commission. Petitioner appealed the St. Johns River Water Management District granting a Management and Storage of Surface Water (MSSW) permit to the Department of Transportation for the construction of three miles of interstate highway. The Department of Environmental Regulation essentially concurred with the Sierra Club. The only issue on appeal was whether the District was required to consider cumulative and secondary impacts as part of its MSSW permit review. After reviewing the express statutory mandates, the broad policies of environmental protection, the need for consistency with state water policy, the similarity with policy statements in other Chapters, and the pattern of implementation of other policy statements on cumulative and secondary impacts by case law, the Commission held that the MSSW should consider cumulative and secondary impacts for both isolated and non-isolated wetlands. It directed the District to initiate rulemaking on consideration of cumulative and secondary impacts within 120 days, and advised other water management districts of a similar necessity to undertake rulemaking within the same timeframe.

329. White v. Metropolitan Dade County, 563 So. 2d 117 (Fla. Dist. Ct. App. 1990).

The court held that Dade County violated its comprehensive plan by authorizing the development of an "environmentally sensitive area" without complying with the guidelines for developing such an area. The court based its holding, in part, upon the appellee's failure to evaluate the impacts of developing the tennis complex. Furthermore, the development also contravened statutory law. Because the tennis complex and proposed 12,000 seat stadium would have a substantial effect on the citizens of more than one county, and constituted a "unified plan of development," it was subject to Development of Regional Impact Review. The developer could not start limited construction of a portion of the project, but rather had to obtain a final development order or preliminary development agreement before commencing construction.

GEORGIA - CODES, STATUTES AND POLICIES

330. Environmental Policy, GA. CODE ANN. § 12-16-8 (1992).

Pursuant to this statute on preparation of environmental effects reports by governmental agencies, the director is required to issue guidelines to assist in the preparation of those reports which include provisions for the "possibility of the preparation of single-program environmental effects reports if a series of governmental actions taken individually are of minimal adverse significance on the environment but the cumulative effect of the proposed government actions on the environment is significantly adverse or if a series of proposed government actions are related either geographically or as logical parts in a chain of contemplated actions."

GEORGIA - LITIGATION

331. Pope v. City of Atlanta, 255 S.E.2d 63 (Ga. 1979).

In extensive litigation about Plaintiff's right to build a tennis court in a flood plain on her property, the trial judge ruled permit denial was appropriate because the cumulative effect of the proposed tennis court would significantly affect the river in violation of the River Act. On appeal, the supreme court agreed that the trial court was authorized to consider the cumulative effect of additional like construction in the protected area; cumulative effects could be considered by the state in making land use plans and by the court in reviewing decisions of a governing authority under such plan. However, the court held that general testimony that the cumulative effect of the construction of any impervious surfaces in the flood plain would significantly affect the river was insufficient. Since the statute provided standards for land use exceptions, it anticipated that some land use would be allowed in the protected area. The governing authority denying the request had to introduce specific evidence (e.g., geology, hydrology, soils, vegetation, slope or aspect) that the proposed land use in the specific site does not meet the minimum standards.

HAWAII - CODES, STATUTES AND POLICIES

332. Special Management Areas, HAW. REV. STAT. § 205A- 26(2)(A) (1992).

The special management area guidelines within the coastal management provisions establish minimum standards for review of developments proposed in special management areas. They require that no development be approved unless it will not have "any substantial adverse environmental or ecologic effect" except as minimized to the extent practicable and clearly outweighed by "public health, safety, or compelling public interests." By definition "adverse effects" includes "the potential cumulative impact of individual developments" and "the elimination of planning options."

HAWAII - LITIGATION

333. McGlone v. Inaba, 636 P.2d 158 (Haw. 1981).

Plaintiffs appealed the trial court's denial of their request for a permanent injunction to prohibit the Board of Land and Natural Resources from approving the construction of underground utilities on conservation land to serve a new single family dwelling on an adjacent lot without first requiring an environmental impact statement. The court held that the construction of underground utilities on conservation land as properly exempt from the preparation of an EIS, even though the criteria for significance included an action with substantial secondary impacts and an action which is "individually limited but cumulatively has considerable effect upon the environment." Noting that categorical exemptions are inapplicable when an action that is normally insignificant may be significant in a particularly sensitive environment, the court still found it was not clearly erroneous for BLNR to conclude that the proposed construction would probably not have a significant effect on the sanctuary.

LOUISIANA - CODES, STATUTES AND POLICIES

334. Coastal Resources, Op. Att'y Gen., No. 89-640, 1989 La. AG LEXIS 568 (Dec. 29, 1989).

This opinion of the Office of the Attorney General addresses which state agency has the authority to issue regulations to protect the state's coastal cheniers (long narrow wooded beach ridge). It describes the Coastal Management Program permitting authority in the coastal zone, stating that it evaluates both individual and cumulative impacts in applying performance standards. However, the opinion concludes that the protection through the CMP permitting process would be indirect at best. Most cheniers, being 3-6 meters high, would fall outside the 5 feet above mean sea level jurisdictional limit, unless a particular activity would have a "direct and significant impact on coastal waters".

335. State and Local Coastal Resources Management Act, LA. REV. STAT. ANN. § 49:214.21 (West 1993).

The State Coastal Zone Management Act provides for promulgation of guidelines (rules and regulations) to assist the coastal use permitting authority in evaluating compliance with the Act. The regulations (State and Local Coastal Resource Management Act, Coastal Use Guidelines, Title 43, Part 1, Chapter 7, Section 701 (1980)) list information to be utilized including "likelihood of and extent of impacts of resulting secondary and cumulative impacts." The guidelines also list twenty-one specific adverse impacts to be avoided to the maximum extent practicable, including "adverse effects of cumulative effects," "fostering of detrimental secondary impacts in undisturbed or biologically highly productive wetland areas," and "reduction in the long term biological productivity of the coastal ecosystem."

LOUISIANA - LITERATURE AND REPORTS

336. Craig, N. J., and J. W. Day, Jr. 1977. *Cumulative impact studies in the Louisiana coastal zone*. Baton Rouge, LA: Louisiana State Planning Office.

337. Houck, Oliver A. October 1983. Land loss in coastal Louisiana: Causes, consequences, and remedies. *Tulane Law Review* 58(1): 3-168.

In this article, the author analyzes the problem of coastal land loss in Louisiana, looking at a variety of natural and human-induced causes and identifying the consequences on a range of resources. He develops an assessment of the value of the coastal zone, and examines legal options for structural and non-structural measures to restore the coastal zone.

338. Mendelssohn, I. A., and W. H. Patrick Mendelssohn, Jr. 1978. *A potential indicator of the cumulative impact of sublethal stress in coastal plant communities*. Final Report. Baton Rouge: Louisiana Department of Natural Resources.

339. Stone, J. G., and G. F. McHugh. 1977. *Simulated hydrologic effects of canals in Barataria Basin: A preliminary study of cumulative impacts*. Baton Rouge, LA: Louisiana State Planning Office.

MAINE - CODES, STATUTES AND POLICIES

340. Coastal Management Policies Act, ME. REV. STAT. ANN. tit. 38, § 1801 (3) (West 1992).

This Act establishes nine policies to reduce the threat of coastal development to natural resources and traditional livelihoods. State, local, and specific federal agencies with responsibility for regulating, planning, developing or managing coastal resources are to conduct their activities consistent with these policies. Policy 3 is to "support shoreline management that . . . considers the cumulative effects of development on coastal resources." Other Acts incorporate these policies by reference (e.g., Comprehensive Planning and Land Use Regulation Act, 30A MRSA § 4311) and require that regulations adopted pursuant to those Acts be consistent with these coastal management policies.

341. Natural Resources Protection Act, ME. REV. STAT. ANN. tit. 38, § 480-A (West 1992).

The Natural Resources Protection Act includes a legislative finding that "the cumulative effect of frequent minor alterations and occasional major alterations of these resources poses a substantial threat to the environment and economy of the State and its quality of life." It establishes standards for review of proposed alterations affecting rivers and streams, great ponds, fragile mountain areas, freshwater wetlands, significant wildlife habitat, coastal wetlands and sand dune systems.

342. Planning and Land Use Regulation; Subdivisions, ME. REV. STAT. ANN. tit. 30-A, § 4404 (11), (12) and (18) (West 1992).

This Act requires that municipalities review the subdivision of land (defined in the Act) in accordance with standards no less stringent than the minimum standards established in this Act. Of the eighteen review criteria, many require no unreasonable adverse impact on specified resources; in addition, Standard 11 requires that the subdivision have no adverse affect on the quality of surface waters or unreasonably affect the shoreline; Standard 12 requires that the proposed subdivision "will not, alone or in conjunction with existing activities, adversely affect the quality or quantity of ground water," and Standard 18 requires that "the long-term cumulative effects of the proposed subdivision will not unreasonably increase a great pond's phosphorus concentration during the construction phase and life of the proposed subdivision."

MAINE - LITERATURE AND REPORTS

343. Adamus, Paul R. 1986. The cumulative impacts of development in Southern Maine: Wetlands: Their locations, functions and value. Maine State Planning Office's Study of the Cumulative Impacts of Development, Augusta, ME: Maine State Planning Office.

This report is one of a series of coordinated studies prepared for the State Planning Office Cumulative Impacts Project. This study focuses on wetlands in a specified region to determine which wetlands are most important for specific wetland functions, to determine physical and biological characteristics and relation to functions, and to assess whether nationwide models or procedures are transferable to Maine. It includes findings on distribution of wetlands with high value functions, extent of regulation by wetland laws, and extent of filling.

344. Androscoggin Valley Council of Governments, and Maine Department of Environmental Protection. July 1990. *Comprehensive planning for lake watersheds*. Augusta, ME: Maine Department of Environmental Protection.

This study and companion volumes, "Phosphorus Control in Lake Watersheds: A Technical Guide to Evaluating New Development" and "Implementation Strategies for Lake Water Quality Protection" outline a system for managing cumulative effects by establishing limits below which a natural resource will not be allowed to drop. In this case, the maximum allowable increase in phosphorus export into a particular lake from a surrounding watershed is established. The towns in the watershed develop a plan for how they will allocate the ability to accommodate additional development.

345. Arbuckle, J., and Melissa Lee. 1987. *The cumulative impacts of development in Maine: A study of habitat changes in five coastal towns*. Augusta, ME: Maine State Planning Office.

This study was prepared for Maine Audubon Society to complement the State Planning Office cumulative impact study. It analyzed land use trends and their impacts on wildlife in the towns of Machias, Trenton, Rockport, Scarborough and Damariscotta.

346. Dennis, Jeff, Joyce Noel, Debra Miller, and Caroline Eliot. September 1989. *Phosphorus Control in Lake Watersheds: A Technical Guide to Evaluating New Development*. Augusta, ME: Maine Department of Environmental Protection.

This report describes a process for reviewing development proposals in lake watershed areas, based upon comprehensive planning to determine the level of impact municipalities should permit within the watershed. During the planning stage, the towns in the watershed determine what amount of increase in phosphorus export is acceptable, and then distribute this amount equally over space, on a per-acre basis, and over a specific period of time (fifty years). Using these figures, the project reviewer calculates the amount of phosphorus that the proposed development may export. If the estimated actual export is greater than the development's proportionate share of acceptable phosphorus export, approval will be made contingent upon the developer taking specific measures to control the export of phosphorus.

347. Dominie, Hollie, and Jean Scudder. December 1987. *Land Use and Cumulative Impacts of Development: A Study Summary*. Augusta, ME: Maine State Planning Office.

This report synthesizes the components of the State Planning Office study of cumulative impacts, focusing on the impact of development on the landscape, visual character and land-based resources. The major conclusion is that negative cumulative effects are caused by haphazard growth, and these effects can be minimized by planning to appropriately site land uses to avoid harmful impacts. Additional findings and supporting research are outlined.

348. Droege, Mary F. 1986. *The Cumulative Impacts of Development in Southern Maine: A Scenic Landscape Assessment: Mousam River Watershed*. Augusta, ME: Maine State Planning Office.

This was one of eight studies prepared for the State Planning Office cumulative impact study. It developed a replicable inventory method for assessing visual impacts of development and inventoried the scenic Mousam River Watershed area.

349. Jones, Jody. 1986. *The cumulative impacts of development in southern Maine: Important wildlife habitats*. Augusta, ME: Maine State Planning Office.

This report, prepared by Inland Fish and Wildlife, is one of a series of studies prepared for the State Planning Office cumulative impact study. It identified and mapped critical nongame, game and aquatic habitats and researched sensitivity of populations and habitats to encroachment by development in nine towns in the study area.

350. Land Use Consultants, Inc. February 1978. *Coastal policy study: Cumulative impact of incremental development on the Maine coast*. (Draft for Technical Review): Governor's Advisory Committee on Coastal Development and Conservation.

This working paper reviews past development trends and probable development trends for cumulative impacts on land use and aesthetics, public utilities, natural resources and socio-economic factors. It assesses the ability of municipal regulations and state laws to deal with cumulative impacts, and briefly reviews legislation in other states. It makes specific findings and recommendations including the dominance of economic forces, the absence of cumulative impacts concerns in state planning and land use controls, and the need to amend most state environmental laws to enable regulators to give full consideration to negative cumulative impacts.

351. Mann, Diana. January 24, 1980. Loss of wildlife habitat from Site Location of Development in Cumberland County, Maine 1970 to 1979.

This study quantifies loss of wildlife habitat from developments permitted under Site Location Law in Cumberland County. From 1970 to 1980, 4,762 acres approved for development under Site Law were wildlife habitat.

352. Marine Law Institute. January 1994. *Managing cumulative environmental impacts of coastal development*. Citizen's Guides to Ocean and Coastal Law: Pamphlet #14. Portland, ME: Marine Law Institute.

This publication summarizes issues involved in incorporating cumulative impacts into environmental decision-making, including why cumulative impacts are of concern, activities likely to have cumulative impacts, and policy issues in management of cumulative impacts (scientific uncertainty, geographic and temporal scope, allocation of development "rights"). It reviews Maine's land use regulation laws to evaluate the capacity to consider cumulative impacts and reviews examples of local efforts to control incremental growth (Casco Bay Estuary Project, coastal protection overlay zone, local wetlands ordinance, island carrying capacity studies, lakes phosphorus allocation planning and regional planning efforts for shared natural resources).

353. Pyne, Surran. August 31, 1984. *Maine's coastal sand dune regulations and the cumulative impact standard*. Augusta, ME: Maine Department of Environmental Protection.

This paper reviews Maine's Sand Dune regulations and related federal and state decisions. It proposes specific statutory and regulatory changes to give greater effect to cumulative impact considerations by including a definition and statement of factors to be evaluated.

354. Rieser, Alison, and Josie Quintrell. 1986. *Managing the cumulative effects of development on the Maine coast: An analysis of legal and policy issues*. Augusta, ME: Maine State Planning Office, Maine Coastal Program.

The authors review general concepts and issues of cumulative impact assessment, analyze Maine's management of cumulative impacts, contrast it with management approaches in other jurisdictions, review conceptual issues of scope of review, boundaries, equity, and

the necessary relationship to comprehensive planning. The report makes recommendations for regulatory changes, for improved non-regulatory measures to facilitate regulatory reviews, and suggestions for further policy research.

355. Rieser, Alison. 1987. Managing the cumulative effects of coastal land development: Can Maine law meet the challenge? *Maine Law Review* 39(2): 321-389.

The author reviews the consideration of cumulative effects under state coastal management laws, analyzes constitutional due process, taking and delegation of legislative authority issues, and contrasts Maine's approach with cumulative effects management in Florida and California. The article concludes with specific recommendations to improve management of cumulative effects in the Alteration of Coastal Wetlands Act, Site Location of Development Act and local land use laws.

356. Southern Maine Regional Planning Commission. November 1986. *The cumulative impacts of development in southern Maine: Assessment of municipal capacity to manage growth.* Augusta, ME: Maine State Planning Office.

This study analyzes development activity and trends in nine towns in Southern Maine and then assesses the capabilities of the towns and utility districts to plan for growth and minimize negative cumulative impacts. It makes multiple specific findings in support of the general finding that the towns were not adequately prepared for current and future projected growth.

MAINE - LITIGATION

357. In Re Spring Valley Development, 300 A.2d 736 (Me. 1973).

This early case challenged the constitutionality of the Site Location Law as applied to the mere subdivision of land without additional construction. The court held that the law which requires persons intending to construct or operate a development which may substantially affect the local environment to notify the state of their intent is constitutional and does not deny equal protection of the law. The state may require that development not have an "unreasonable effect" upon natural resources, and may require that owners temper their use to preserve the environment from anything more than "minimal" destruction.

358. Valente v. Bd. of Environmental Protection, 461 A.2d 716 (Me. 1983).

In response to a topsoil mining application to strip the topsoil from 40 acres which constituted 28% of the town's prime cropland, the Department of Environmental Protection denied the application. The denial was upheld by the superior court but reversed by the law court in a 4-3 decision. The majority interpreted the Site Location Law as being primarily directed at the effects of the development upon the natural

environment of the locality surrounding the site, not the impact on the site itself. Using that interpretation the development would have no more than a minimal adverse impact on the natural environment surrounding the site. The dissent was very critical of that statutory construction, arguing that the statute applies to protect natural resources on the site as well as outside of the site. It also would have found that the regulations are not exhaustive or exclusive and that the Board could determine that agriculture warrants protection as an existing use and that topsoil can be included as a "natural resource".

MARYLAND - CODES, STATUTES AND POLICIES

359. Chesapeake Bay Critical Area Protection Program, MD. CODE ANN., NAT. RES. § 8-1801 (1992).

The findings of the Act establishing the Chesapeake Bay Critical Area Protection Program state there is limited capacity to withstand continuing demands on this sensitive part of the estuary and assert that the quality and productivity of these waters have declined due to the cumulative effects of human activity "that have caused increased levels of pollutants, nutrients, and toxics in the Bay System" and declines in forest and agricultural land.

360. Cost Sharing--Water Pollution Control, MD. CODE ANN., AGRIC. § 8-703(b)(i) (1992).

As part of a program establishing state financial assistance for water pollution control programs, this Act establishes a system for identifying higher risk areas, establishing priority areas, and for making selection of projects to receive financial assistance, in part, based on "water quality improvements to be achieved, with consideration given to the cumulative effect of other projects on the same body of water."

361. Interdepartmental Task Force on Preservation of State Streams, MD. CODE ANN., GOV.--EXEC. & ADMIN. PROV. § 18-302 (1992).

This Act established a task force to study state streams, impacts on streams, and methods to prevent those impacts. The task force was to consider information from the Watershed Targeting Initiative of the Chesapeake Bay Program, develop options for state and local, public and private coordination, and identify "specific management measures that could be adopted by state and local government agencies, including measures to control the cumulative impacts of growth and development."

362. Maryland Environmental Policy Act, MD. CODE ANN., NAT. RES. § 1-304(b)(2) (1992).

Maryland's Environmental Policy Act requires that state agencies prepare an environmental effects report in conjunction with certain proposed state actions significantly affecting the environment. It contains a provision allowing the guidelines to provide for the preparation of single program environmental effects reports "if a series of actions taken individually are of minimal significance but if the cumulative effect . . . is significant or if a series of actions are related either geographically or as logical parts in a chain of contemplated actions."

363. Nontidal Wetlands Protection Act, MD. CODE ANN., NAT. RES. § 8-1203 and -1208 (1992) (*as amended by* Md. HB 225 (1993)).

This Nontidal Wetlands Protection Act, as of October 1, 1993 also applicable to certain activities within the Chesapeake Bay Critical Area, establishes a statewide program concerning planning for and regulating nontidal wetlands. Among the duties of the Department of Natural Resources are to "conduct periodic monitoring, cumulative impact assessment and evaluation of activities" authorized under the Act. The Act also provides for the Department to prepare comprehensive watershed management plans which address protection, creation, restoration, cumulative impacts, flood protection and water supply concerns and will be used in decisions on permitting, creation and restoration of nontidal wetlands.

364. Nontidal Wetlands Protection Act Regulations, MD. REGS. CODE tit. 08.05.04.01 (1991).

These guidelines elaborate upon the permit process and criteria for conducting a regulated activity in a nontidal wetland. A permit may not be granted unless the activity is water-dependent or is not water-dependent but has no practicable alternative, avoids and minimizes adverse impacts, does not cause or contribute to degradation of ground waters or surface waters and is consistent with any comprehensive watershed management plan. Adverse impact is defined as any diminishment of acreage or function. Wetland functions are further expressly defined.

365. Sediment Control, MD. CODE ANN., ENVIR. §4-101 (1992).

This Act creates procedures to implement and enforce water management soil erosion control programs. The procedures for obtaining immediate compliance with the law to correct violations are justified based on the cumulative effect on the environment of violations "whether the project creating the violations is large or small."

MARYLAND - LITERATURE AND REPORTS

366. Anne Arundel County, Maryland Department of Agriculture, Maryland Department of Environment, et al. April 1992. *Strategy for Sawmill Creek Restoration: A Targeted Watershed Project*. SGM-TAR-92-1.

The background studies conclude that the cumulative environmental impacts of suburban/urban development in the watershed have been diverse in origin and synergistic in effects. The primary problems to be addressed involve water quantity, water quality, habitat and citizen involvement. The goal of this strategy is to reverse the decline in water quality and the loss of habitat. This is one of four small watersheds in Maryland's Targeted Watershed Project.

367. Maryland Power Siting Program. February 1982. *Power plant cumulative environmental impact report*. PPSP-CEIR-3. Annapolis, MD: Maryland Department of Natural Resources.

This report, prepared pursuant to the Maryland Power Plant Siting Act, addresses the impact of hydropower plants upon the aquatic ecosystem. It identifies four sources of harm to aquatic species presented by the physical processes involved in water intake and discharge (entrapment, impingement, entrainment, discharge effects and habitat modification) and provides a detailed analysis of the broader impact caused by these four sources of harm within each salinity zone/habitat type.

MASSACHUSETTS - CODES, STATUTES AND POLICIES

368. Massachusetts Environmental Policy Act (MEPA) Regulations, MASS. REGS. CODE tit. 301, § 11.00.

These regulations establish the procedures for review under the Massachusetts Environmental Policy Act, for review of activities of all state agencies, activities with state financial assistance, and activities requiring state permits. The analysis of effects is to include direct and indirect effects, which are to be "traced through to their ultimate influence on man." The analysis is to consider the "cumulative effects of the proposed project and other projects in the area." It also provides for the preparation of generic ENFs and EIRs for program and policy implementation "where the combined results of activities under such programs or policies may result in cumulative damage to the environment not otherwise susceptible to adequate review." A related program for designation of Areas of Critical Environmental Concern is addressed in MASS. REGS. CODE tit. 301, § 12.00.

MASSACHUSETTS - LITERATURE AND REPORTS

369. Horsely Witten Hegemann, Inc. January 1991. *Quantification and control of nitrogen inputs to Buttermilk Bay: Buttermilk Bay Project*. Barnstable, MA:

As part of the Buzzards Bay National Estuary Project, a detailed study was conducted of the nitrogen inputs to Buttermilk Bay, a shallow coastal embayment within Buzzards Bay. The increasing nitrogen levels were attributable primarily to septic system effluent and lawn fertilizers. The study identified the area contributing ground and surface water to Buttermilk Bay; determined existing and potential levels of development within the contributing area; evaluated nitrogen loading from all anthropogenic sources within the contributing area (e.g., on-site sewage disposal systems, lawn and cranberry bog fertilizers, roof and road runoff); calculated the existing and critical (maximum beyond which the Bay may be critically impacted) nitrogen loading rates (lbs/yr); and calculated a minimum lot size for currently undeveloped areas which would be necessary to keep nitrogen levels below critical levels. The plan also developed management strategies including a zoning overlay district to control nitrogen loading, drainage and erosion controls, more stringent regulations on siting of on-site sewage disposal systems, and vegetated buffer zones.

MICHIGAN - CODES, STATUTES AND POLICIES

370. Goemaere-Anderson Wetland Protection Act, MICH. COMP. LAWS § 281.701 (1992).

This wetland conservation statute establishes a permit program to regulate dredging, fill, and other alterations of wetlands. It requires that a permit not be issued unless it is in the public interest, and requires consideration of numerous factors, including "the probable impact of each proposal in relation to the cumulative effect created by other existing and anticipated activities in the watershed."

371. State of Michigan, Recommended Environmental Review Procedures, Michigan Council on Environmental Quality, June 4, 1990.

These review procedures, promulgated pursuant to Executive Order, establish procedures for environmental review of "state actions" (nonministerial actions undertaken by the state or for which the state will issue a lease, permit, license, certificate, other permission, grant or loan). Cumulative effects are to be considered in the determination of significance and in the EA or EIS, should one be required. "Cumulative effect" is defined as "the effect on natural and environmental resources which results from the incremental effect of an action when added to other past, present, and reasonably foreseeable future actions regardless of what agency or person undertakes such other actions" and may be individually minor but collectively significant over a period of time.

MICHIGAN - LITIGATION

372. In Re Goemarie-Anderson Wetland Act Appeal of Holland Fish and Game Club, 1990 Mich. Env. LEXIS 15, Cause No. 87-9-58W (May 17, 1990).

Petitioner proposed to place 46 cubic yards of fill in a wetland and construct a boardwalk over the wetland to provide lakeshore access for owners of land in a residential subdivision. In approving the permit, the Natural Resources Commission found the proposed boardwalk was consistent with the Act and in the public interest. One of the considerations for review was the probable impact of the proposal in relation to the cumulative effect created by other existing and anticipated activities in the watershed. When considering the small size of the project, the similarity to already approved projects, and the possibility that each property owner would seek to construct their own walkway if this permit were denied, a common boardwalk was determined to be preferable.

MISSISSIPPI - CODES, STATUTES AND POLICIES

373. Coastal Wetlands Protection Act, MISS. CODE ANN. § 49-27-1 (1993).

This wetlands act establishes protections for preservation of the natural state of coastal wetlands and their ecosystems, except where a higher public interest consistent with public trust purposes would be served. The regulations provide that in making decisions about whether to permit regulated activities, one of thirteen factors to be considered is "precedent setting effects and existing or potential cumulative impacts of similar or other development in the project area."

MONTANA - CODES, STATUTES AND POLICIES

374. Water Leasing Program, MONT. CODE ANN. § 85-2-141(6) (1992).

This Act, providing for a state-administered water leasing program, requires completion of an environmental impact statement "whenever the cumulative effect of more than one application for a lease would constitute a probable significant environmental impact."

NEBRASKA - LITIGATION

375. Upper Big Blue Natural Resources District v. City of Fremont, 495 N.W.2d 23 (Neb. 1993), *modified on other grounds,* 499 N.W.2d 548 (1993).

Appellants filed water diversion applications to make intrabasin and interbasin diversions of unappropriated waters from the Platte and Blue Rivers. After extensive hearings and project modifications, the Department of Water Resources denied the applications on the grounds that the applicant had failed to carry the burden of proving that the project would not jeopardize nongame or endangered species, or their habitat. The specific species for which they failed to carry the burden were the pallid sturgeon, the burying beetle, the prairie fringed orchid, the piping plover and the interior least tern. The Fish and Game commission evaluated the cumulative impacts of the projects in assessing impacts on whooping crane, bald eagle, least tern and piping plover. The adverse impacts on habitat were held to be an appropriate component in determining whether denial of the application is demanded by consideration of the public interest.

NEW HAMPSHIRE - CODES, STATUTES AND POLICIES

376. Supervision of Navigation, N.H. REV. STAT. ANN. § 270:1 (1992).

This statute, providing for state inspection on public waters of commercial and private boats, specifically finds that "the cumulative effect of boats congregated as 'rafts' differs from that of the same number of boats scattered, and, therefore, requires specific appropriate regulation."

NEW JERSEY - CODES, STATUTES AND POLICIES

377. Pinelands Protection Act, N.J. REV. STAT. § 13:18A-1 (1993).

Based on a finding that the pinelands area is a high quality unique habitat threatened by development pressures, the act creates a regional planning and management commission to prepare and oversee the implementation of a comprehensive management plan for the pinelands area by August 1980. A portion of the pinelands area was designated as a preservation area. One of the stated goals of the comprehensive management plan for the "protection area" (outside the preservation area) is to accommodate compatible regional growth while protecting the environment from individual and cumulative adverse impacts from that growth.

NEW JERSEY - LITIGATION

378. Gardner v. New Jersey Pinelands Commission, 593 A.2d 251 (N.J. 1991).

A farm owner challenged the application of state regulations controlling the land use of the environmentally-sensitive New Jersey Pine Barrens as constituting a taking of private property without just compensation and a denial of equal protection. The regulations which sought to protect agricultural land, preserve unique ecological and cultural features of the Pinelands and discourage piecemeal and scattered development, were part of a special area management plan. A federal statute directed the state to create a planning commission. The commission developed a comprehensive management plan which identified management area based on ecological characteristics. The implementation program consisted of some acquisition plus a land use control system using forms of zoning and a transfer of development rights program. Even though the owner of a 217 acre farm was restricted to residential development on 40-acre lots, the court held the Act substantially advances legitimate and important public purposes (avoids cumulative detrimental small insults to diminishing environmentally-sensitive land); fulfills its public purposes in a lawful manner (distinguishing *Nollan*); does not deny the property owner of "all practical use" of the property (leaving agricultural use, large-tract development, offsetting benefits for transferring development rights) so is not a taking without just compensation; is not an illegal "exaction" since there is a rational nexus, and does not deny the applicant equal protection of the laws.

379. Last Chance Development Partnership v. Kean, 556 A.2d 796 (N.J. Super. Ct. App. Div. 1989).

The issue on appeal was whether the Department of Environmental Protection (DEP) exceeded its statutory authority in amending the Waterfront Development Permit Rules to expand the regulatory jurisdiction of the DEP over upland developments in certain coastal areas. The amendments altered the definition of "waterfront" to include properties over one mile away from wetlands (e.g., large tracts with inland depths of a mile or more from the waterline). The amendments were promulgated, in part, to give the DEP jurisdiction over cumulative environmental effects of developments of 24 dwelling units or less, which were not regulated under the Coastal Area Facility Review Act. The court held that the Waterfront Development Act was not designed to empower the DEP to regulate upland area distant from any coastal waterway and that the DEP exceeded the scope of its statutory authority when it promulgated the changes in the regulations expanding the jurisdiction. The legislative exemption of 24 units or less from DEP review prevailed.

380. Orleans Builders & Developers v. Byrne, 453 A.2d 200 (N.J. Super. Ct. App. Div. 1982).

A developer challenged a denial of its application for a major development and the constitutional validity of legislative and executive action imposing a building moratorium in the New Jersey pinelands. The appeal was dismissed on all grounds. A portion of the decision discusses the Pinelands Protection Act, the development of a comprehensive management plan, and the imposition of a temporary moratorium pending development of the plan. One of many contentions of the developer was that the proposed project would not result in substantial impairment of the resources of the Pinelands because development of the contested 33.5 acres would only have a "minute" adverse effect upon the one million acres within the Pinelands National Reserve. The court rejected the argument as a basis for granting exemptions, stating that "the cumulative effect of such exemptions would defeat the legislative goals of the Pinelands Protection Act".

NEW YORK - CODES, STATUTES AND POLICIES

381. Environmental Quality Review, N.Y. ENVTL. CONSERV. LAW § 8.0101 to -0117 (McKinney 1984 & Supp. 1994).

This State Environmental Quality Review Act (SEQRA) provides for review of direct State actions, actions with funding assistance from the state, or actions requiring permission from a State agency. Environmental impact statements are required for actions which may have a significant effect on the environment. The statement is to include an analysis of growth-inducing aspects and other direct and indirect effects. The cumulative effects analysis is detailed in the implementing regulations.

382. General Functions, Powers, Duties and Jurisdiction, Department of Environmental Conservation, N.Y. ENVTL. CONSERV LAW § 3-0301 (Consol. 1993).

The Department of Environmental Conservation is given the power to promote and coordinate management of water, land, fish, wildlife and air resources to assure their protection, enhancement, provision, allocation, and balanced utilization and "take into account the cumulative impact upon all of such resources" in licenses, orders, permits, certification or similar actions.

383. Lake George Park Commission, N.Y. ENVTL. CONSERV. LAW § 43-0107 (Consol. 1993).

This Act establishing the Lake George Park Commission directs the Commission to take the cumulative impact upon all park resources into consideration in making any determination or taking any action.

384. Special Provisions, Uniform Procedures, Environmental Conservation Law, N.Y. ENVTL. CONSERV. LAW § 70-0117(6) (Consol. 1993) (as amended by N.Y. Laws 60 (1993)).

As part of the state pollutant discharge elimination system permit process, there are provisions for issuance of general permits to cover ballast discharges from vessels under certain conditions, including if the discharge will result in "minimal adverse cumulative impacts."

385. State Environmental Quality Review Regulations, 6 N.Y. COMP. CODES R. & REGS., tit. 6, § 617 (1987).

Reiterating that environmental factors should be considered at the earliest possible time to be given appropriate weight with social and economic considerations in determining public policy, these guidelines outline the procedural requirements for compliance with SEQR. Important concepts defined include designation of critical environmental areas, criteria for determination of significance (including changes in two or more elements of the environment which when considered together result in a substantial adverse impact or related actions which cumulatively meet the criteria for significance), and generic environmental impacts statements. The guidelines outline the fact that the act imposes not just procedural requirements for the preparation of an EIS in particular circumstances, but also a substantive requirement that, consistent with social, economic and other essential considerations, adverse environmental effects have been minimized, avoided or mitigated to the maximum extent possible.

386. New York State Department of Environmental Conservation, Division of Regulatory Affairs. 1992. The SEQR Handbook. NY, NY: NYS DEC.

This handbook is a guide to the procedures required by the State Environmental Quality Review Act. It includes discussions of cumulative impacts and synergistic effects in relation to the threshold issue of significance of an action for purposes of determining whether an environmental impact statement is required. It states that cumulative impacts must be assessed when "actions are proposed to or will foreseeably take place simultaneously or sequentially in a way that their combined impacts may be significant" but the assessment is limited to probable, not speculative impacts. Cumulative impact assessment is required for "interdependent parts of a larger action or part of a long range plan; actions likely triggered by the proposed action; actions dependent on another; or related or unrelated actions with incrementally significant impacts if the impacts themselves are related (e.g., close geographically). The handbook clarifies that cumulative impacts can include indirect, secondary, and long term impacts and synergistic effects.

NEW YORK - LITERATURE AND REPORTS

387. Hart, Thomas F., Jr., and Andrew S. Milliken. 1991. Significant coastal fish and wildlife habitat protection in New York's Coastal Management Program. *Coastal Management* 19: pp. 55-72.

The authors explain the state's use of an ecological approach to habitat protection through the designation of significant coastal fish and wildlife habitats. Steps included identification of significant habitats for potential designation; use of habitat evaluation criteria (a detailed rating system reflective of federal and state regulations); identification of habitats qualifying for designation; a public information exchange and hearing process; final decision on designation by the Department of State; and development of a supporting narrative describing the area's importance, identifying areas with potential impacts on the viability of the area as habitat, and suggesting management guidelines for habitat protection. The authors explain interesting use of the habitat protection designations in federal consistency reviews.

388. Marsh, Langdon. 1982. Commentary: Unresolved issues. *Albany Law Review* 46: 1298-1305.

This commentary concludes a symposium on New York State's Environmental Quality Review Act (SEQRA). It analyzes the substantive effect of SEQRA, addresses the lead agency problem, and examines the scope and financial burden of preparing cumulative impact reviews.

389. Thornton, Scott A. September 1991. Cumulative impacts in environmental review: The New York standpoint. *Pace Environmental Law Review* 9(1): 253-277.

This article examines State Environmental Quality Review Act's (SEQRA) regulation of cumulative impacts, as well as recent cases which have addressed the necessity for and sufficiency of cumulative impacts analysis. The survey includes a specific discussion of cases before DEC Administrative Law Judges involving wetlands and critical habitat areas, finding that cumulative impacts are a crucial aspect of the application and that DEC has denied permits based on cumulative impacts arguments.

NEW YORK - LITIGATION

390. Long Island Pine Barrens Society, Inc. v. Planning Bd. of Brookhaven, 606 N.E.2d 1373 (N.Y. 1992).

Plaintiff environmental and planning groups (supported by the Attorney-General for the State of New York, amicus curiae) asserted the SEQRA mandated assessment of the cumulative impacts of 224 recently approved or currently proposed projects proposed for the Central Pine Barrens, a special groundwater protection area, and that further action on proposed projects should be enjoined without prior compliance with the SEQRA cumulative impact assessment requirements. The highest court of New York, the court of appeals, reversed the lower court's decision that SEQRA mandated cumulative impact assessment in this context, and held that "the cumulative impact statement requirement . . . is not fairly applicable in these circumstances." The decision recites that the remaining 100,000 acres of relatively undeveloped land (down from the original 250,000 acres) are an indispensable component of the aquifer system that is the sole source of drinking water for 2.5 million inhabitants of Long Island; that it is especially vulnerable to the risk of pollution; that it has unique ecological significance including high concentrations of endangered, rare or protected species; that particular caution is required to avoid unforeseen consequences in interconnected parts of the region; and that development may interfere with ecologically necessary wildfires. Nonetheless, after surveying the myriad of laws and policies adopted at all levels to protect this resource, the court held that it would be inappropriate to use the SEQRA cumulative impact review provisions to, in effect, force the requisite regional long range planning, particularly because 1987 legislation mandated that the Long Island Regional Planning Board develop a comprehensive management plan (which it had yet to finalize). The court declined to craft a judicial solution, and instead placed the responsibility on the legislature to take action to address noncompliance with expressly prescribed ameliorative measures.

391. North Fork Environmental Council, Inc. v. Janoski, 196 A.D.2d 590 (N.Y. App. Div. 1993).

The appellate court affirmed the finding of the trial court that the environmental impact statements accepted by the town in granting permits for construction of a condominium development were not defective. The proposed development was located in the Saw Mill Creek basin, an area which has "allegedly" been designated a Critical Environmental Area. Appellants contended that the EIS should have considered the cumulative environmental effects of the project along with other proposed projects located within the

Saw Mill Creek basin. Interpreting the specific provisions of the SEQRA regulations, the court held that consideration of cumulative impacts was only mandatory for actions which are "included in any long-range plan of which the action under consideration is a part." The projects were not sufficiently related just by virtue of location in a designated Critical Environmental Area; there had to be a "larger plan" for development, not just a common geographical base.

392. Save the Pine Bush, Inc. v. City of Albany, 512 N.E.2d 526 (N.Y. 1987).

The City of Albany enacted a new floating zone, Commercial-Pine Bush, to facilitate commercial development in the Pine Bush while maintaining ecological integrity. It created a Pine Bush Site Plan Review District. Finally, it approved the defendant's request to change the zoning classification of 29.9 acres of Pine Bush land to C-PB to allow office complex development. The court held that challenges to the first two ordinances were untimely under SEQRA, but it held that the City's failure to consider the cumulative impact of up to 10 pending proposals for development in the Pine Bush in the EIS for defendant's project was a violation of SEQRA. Despite separate ownership, it found that the applications were related, and thus subject to cumulative impact analysis. They were all part of the City's larger plan "designed to resolve conflicting specific environmental concerns in a subsection of a municipality with special environmental significance." Granting the rezoning without considering cumulative impacts was arbitrary and capricious, and the ordinance was declared null and void.

393. Schodak Concerned Citizens v. Town Board of Schodak, 537 N.Y.S.2d 1015 (N.Y. Sup. Ct. 1989).

Applicant intended to build a 1 million square foot distribution facility along with 23 retail supermarkets. The EIS only addressed the cumulative impacts of the distribution facility, excluding any discussion of the cumulative impacts of the 23 retail stores. The court held the EIS cumulative impact discussion was adequate and did not improperly segment the review in violation of 6 NYCRR 617.11(c)(6) and 617.3(k). The environmental effects of each of the 23 stores to be built at yet to be determined sites, could properly be subject to their own SEQRA review process.

NORTH CAROLINA - CODES, STATUTES AND POLICIES

394. Coastal Area Management Act, N.C. GEN. STAT. § 113A-120(a)(10) (1993).

The standards for permit review under the Coastal Area Management Act include nine specific standards, some of which incorporate other more detailed orders, statutes, state guidelines or local land-use plans by reference, plus a tenth standard dealing with cumulative effects. The permit application is to be denied if "the proposed development would contribute to cumulative effects that would be inconsistent with the guidelines set forth in Subdivisions (1) through (9) of this subsection." It defines cumulative effects as "impacts attributable to the collective effects of a number of projects and include the effects of additional projects similar to the requested permit in areas available for development in the vicinity."

395. Water and Air Resources, N.C. GEN. STAT. § 143- 215.1(b)(2) (1992).

This Act requires a permit to conduct specified alteration or discharge activities with water pollution potential. The Commission is given the power to act on permits "so as to prevent violation of water quality standards due to the cumulative effects of permit decisions." Cumulative effects are defined as "impacts attributable to the collective effects of a number of projects and include the effects of additional projects similar to the requested permit in areas available for development in the vicinity."

NORTH CAROLINA - LITERATURE AND REPORTS

396. Gale, Judith A., and David A. Adams. 1984. *Cumulative impacts of peat mining project: Final project report*. CEIP Report No. 40. Raleigh, NC: North Carolina Department of Natural Resources.

397. Hegenbarth, Jane L. 1985. A carrying capacity study of Hatteras Island. In *Coastal Zone '85: Proceedings of the fourth symposium on coastal and ocean management*, ed. Orville T. Magoon, Hugh Converse, Dallas Miner, Delores Clark, and L. Thomas Tobin, 2: 1848-1854. Baltimore, MD, July 30, 1985. New York, NY: American Society of Civil Engineers.

This briefly reports on the findings of a study done on Hatteras Island. The introduction includes a short overview of the concept of carrying capacity, the underlying assumptions and its use in formulating land use policy.

398. Parker, Francis, David Brower, and Dirk Frankenberg. 1976. *Ecological determinants of coastal area management*. 2 Vols. Raleigh, NC: University of North Carolina Sea Grant Program.

This study analyzes the barrier island and lagoon-estuary systems of North Carolina, recognizing the coastal area as a unified ecological system. The goal of the report was to make natural science information available to coastal managers to facilitate management and regulation to maintain the viability of the natural systems and environments.

NORTH DAKOTA - LITIGATION

399. In re Permits to Drain related to Stone Creek Channel, 424 N.W.2d 894 (N.D. 1988).

The State Engineer approved an application for a White Spur Drain. The district court reversed the State Engineer, but was reversed by the supreme court which affirmed the decision of the State Engineer. The project included the draining of 18 type IV wetlands, which by statute shall not be drained "unless overriding circumstances exist." Some of these wetlands were "in the only available path" for the proposed drain, and others covered "prime farmland." One ground for challenge was that the State Engineer failed to address the cumulative impact of wetland drainage in the river basin. The court held that no statute or regulation specified that the State Engineer was to consider the cumulative impact of the current project and possible future projects, that it would not be feasible or practical, and that he only needed to evaluate the impacts of the specific project under review, as he had done.

OREGON - CODES, STATUTES AND POLICIES

400. Hydroelectric power projects, preliminary permits, determination of cumulative impacts of proposed hydroelectric power projects, OR. REV. STAT. § 543.255 (1993).

This statute provides that for applications to appropriate water for hydroelectric power or for a hydroelectric permit or license, the commission shall determine whether the impacts of the project would be cumulative with impacts of other proposed hydroelectric projects in the same river basin. If there is no possibility of cumulative effects, consolidated review is not required. If they may have cumulative effects, a consolidated review is required before approving any application in the affected river basin.

401. Oregon Forest Practices Act, OR. REV. STAT. § 527.620 (1991).

Oregon's Forest Practices Act defines cumulative effects as the "impact on the environment which results from the incremental impact of the forest practice when added to other past, present and reasonably foreseeable future forest practices regardless of what governmental agency or person undertakes such other actions." The State Board of Forestry is directed to adopt rules to assure the continuous growing and harvesting of forest tree species, which will also provide for the overall maintenance of air quality, water resources, soil productivity, and fish and wildlife resources and certain scenic resources. If necessary to protect forest resources, the board may adopt rules to reduce "to the degree practicable the adverse impacts of cumulative effects of forest practices on air and water quality, soil productivity, fish and wildlife resources and watersheds. The rules may include a process for determining areas where adverse cumulative effects have occurred or are likely to occur.

402. Regulation of Energy Facilities Siting, OR. REV. STAT. § 469.372 (1991).

This Act concerning siting of hydroelectric projects establishes a specific process for cumulative impact review. For each application for a hydroelectric project, the Energy Facility Siting Council must determine whether the impacts of the project will be cumulative with impacts of other proposed hydroelectric projects for which an application is pending or with existing hydroelectric projects in the same river basin. If the proposed project and the pending or with existing projects may have cumulative effects, the council shall conduct a "consolidated" review, which shall include a "study of the individual and cumulative effects of proposed hydroelectric projects for which applications are pending . . . and existing hydroelectric projects."

OREGON - LITIGATION

403. 1000 Friends of Oregon v. Land Conservation and Dev. Commn., 706 P.2d 987 (Or. Ct. App. 1985).

This case illustrates the interplay of comprehensive state land use goals, the Coos Bay Estuary Management Plan, state acknowledgement of comprehensive plans and land use regulations, and justifications for exceptions from state goals. While not discussing cumulative impacts *per se*, it contributes to an understanding of a state wide planning context, cooperative efforts to manage an estuary in accordance with natural rather than political boundaries, and a process of balancing economic development (industrial water-dependent and water-related, and marina) against environmental goals.

404. Murray v. Columbia River Gorge Comm'n, 865 P.2d 1319 (Or. Ct. App. 1993).

Petitioner sought to subdivide land subject to the Columbia River Gorge National Scenic Area Act. The Columbia River Gorge Commission denied the application. On appeal the Court held that the Commission had adequate authority to deny the application on the grounds that it would be a "precedent" for and have a cumulative effect of future parcelization in the area, would lead to conversion of land from agricultural to residential, and would affect scenic resources.

RHODE ISLAND - LITERATURE AND REPORTS

405. Howard-Strobel, Mary M., Terry G. Simpson, and Timothy P. Dillingham. May 1987. *The Narrow River Special Area Management Plan: Adopted December 8, 1986*. Wakefield, RI: Coastal Resources Management Council.

This special area management plan supplements the State Coastal Resources Management Program by providing a detailed, ecosystem-based management strategy for this designated subarea. Among specific components addressed are water quality; breachways, channels and sedimentation; fish and fisheries; and storm hazards.

406. Olsen, Stephen, and Virginia Lee. June 1985. *Rhode Island's salt pond region: A special area management plan: adopted November 27, 1984*. 113 pp. Providence, RI: Coastal Resources Management Council.

The Narrow River Special Area Management plan utilizes a watershed management approach, incorporating mechanisms for intergovernmental coordination. It focuses on impacts to water quality, critical habitats, flood and storm hazards and impacts of future development. The management strategies are specifically designed to allow consideration of cumulative impacts on the ecosystem.

407. Olsen, Stephen, and Virginia Lee. 1993. Rhode Island lagoons. In *Coastal Zone '93: Proceedings of the Eighth Symposium on Coastal Management*, ed. Orville T. Magoon, Paper included in a Coastlines of the World volume. New York, NY: American Society of Civil Engineers.

The case study describes the process of developing a special area management plan for selected salt ponds, highlighting the scientific research on causes, linkages and significance of loss of environmental quality, and the inter-agency planning and negotiation effort. It notes that trends in environmental degradation have not been halted or reversed.

SOUTH CAROLINA - LITERATURE AND REPORTS

408. South Carolina Coastal Council. March 15, 1991. Guidelines for Preparation of Dock Master Plans.

These guidelines outline a process for submission of a dock master plan for any new subdivision or new phase of an existing subdivision subject to review by the South Carolina Coastal Council. Stated goals include protecting geographic areas of particular concern, values of a water body and critical areas, and encouraging the use of community docking facilities in lieu of private docks when possible.

SOUTH CAROLINA - LITIGATION

409. 330 Concord St. Neighborhood Assn. v. Campsen, 424 S.E.2d 538 (S.C. Ct. App. 1992).

This case involves a challenge to a South Carolina Coastal Council approval of a permit application for a restaurant to be built partly within the critical zone of the waters in Charleston Harbor. The circuit court affirmed the decision, as did the court of appeals. As a nonwater dependent structure, the restaurant was prohibited from the critical area unless there is "no significant environmental impact," there is an overriding public need, and no feasible alternatives exist. Appellants challenged the finding of no significant environmental impact, asserting that the Coastal Council failed to follow the precedent established in a prior administrative decision. In that administrative decision, a packing plant which would have shaded less area than the restaurant was denied based on significant environmental impact from the shading and "the possible cumulative effects of this type of development could be devastating to the coast line of South Carolina."

Here the court found the grant of the permit for the restaurant was supported by substantial evidence, noting that "the possibility of drawing two inconsistent conclusions from the evidence does not prevent the agency's decision from being supported by substantial evidence."

410. Sierra Club v. Kiawah Resort Assocs., 1994 S.C. LEXIS 166, Opinion No. 24121 (July 18, 1994).

A developer intending to develop a portion of an island known as Rhett's Bluff applied to the Coastal Council for 78 dock permits. It submitted a comprehensive plan for development of waterfront property in support of its application, as encouraged by the Coastal Council. After opposition from fish and wildlife groups and others, it amended its application for 36 rather than 78 docks and agreed to place $50,000 in trust to help defray the cost of protecting shellfish in the area. Requisite permits were issued, and the circuit court affirmed the issuance. On appeal, the supreme court affirmed as well, holding that there was substantial evidence in the record to support the issuance of the permits. Among issues considered were water quality impacts. The court found that the cumulative effect of the docks on water quality was sufficiently considered, even though it was difficult to assess the cumulative impact where there is no comprehensive plan addressing dock development for the coastal area or the island. There was evidence of estimated water quality impact of the proposed 36 docks, and that, coupled with the overall plan for the island, was held to show that the hearing officer's cumulative impact decision was supported by sufficient evidence. A rehearing was granted August 10, 1994.

TEXAS - CODES, STATUTES AND POLICIES

411. Dunes Permits, TEX. NAT. RES. CODE ANN. § 63.054 (West 1993).

This portion of the dunes permitting law requires the reviewing body to consider cumulative impacts in determining whether a proposed conduct will not materially weaken the dune or materially damage vegetation on the dune or reduce its storm protection effectiveness.

VERMONT - CODES, STATUTES AND POLICIES

412. Management of Lakes and Ponds, VT. STAT. ANN. tit. 29, § 405 (1992).

Vermont's law on management of publicly-owned lakes and ponds allows a permit to be issued for an encroachment into a lake or pond only if the proposed encroachment will not adversely affect the public good. In making this determination, the reviewer is to consider the effect of the encroachment and the "potential cumulative effect of existing encroachments on water quality, fish and wildlife habitat, aquatic and shoreline vegetation, navigation and other recreational and public uses."

413. Regional Planning Commissions, VT. STAT. ANN. tit. 24, § 4345a (1992).

This Act defines duties of a regional planning commission as including assistance to municipalities in the preparation of capacity studies, preparation of regional plans and capacities studies, identification of areas of regional significance, and development of strategies "specifically designed to assist municipalities in defining and managing growth and development that have cumulative impacts." It also defines the role of the regional planning commission in coordinating the way individual municipal plans address activities with substantial regional impact and in reviewing adequacy of municipal plans to mitigate adverse effects on adjoining municipalities.

VERMONT - LITERATURE AND REPORTS

414. Cowart, Richard H. 1986. Vermont's Act 250 after 15 years: Can the permit system address cumulative impacts? *Environmental Impact Assess Review* 6: 135-144.

The author reviews growth patterns in Vermont and analyzes its Environmental Conservation Act, specifically for its ability to control cumulative impacts. He identifies the absence of adequate planning as presenting a major difficulty for case-by-case reviews, and assesses proposed legislation to foster capacity studies and cumulative impact assessments in specified high growth areas.

WASHINGTON - CODES, STATUTES AND POLICIES

415. Council on Environmental Policy, State Environmental Protection Act Rules, WASH. ADMIN. CODE § 197-11-060 (1992).

These regulations outline the content of an environmental review for consideration of direct, indirect and cumulative impacts. They discuss the scope of an environmental review, directing that closely related actions shall be evaluated in the same document, and that "similar actions" may be analyzed in a single environmental document. The lead agency is directed not to limit its consideration of impacts to only those aspects within its consideration. Impacts to be analyzed include cumulative, growth causing and precedent setting effects. The guidelines also detail the circumstances under which phased review is appropriate.

416. Forest Practices Board, Watershed Analysis, WASH. ADMIN. CODE § 222-12-046 and 222-22-010, et seq. (1993).

A statement filed in July 1992 by the Forest Practices Board identifies a variety of ways in which the forest practices rules address changes to the environment caused by cumulative effects, defined as "the interaction of natural ecosystem processes with the effects of two or more forest practices." One pioneering approach, detailed in Chapter

222-22 and a related manual, addresses cumulative effects on the public resources of fish, water, and capital improvements of the state or its political subdivisions through a watershed analysis. The stated goal is to protect and restore fish, water, and capital improvements and the productive capacity of fish habitat adversely affected by forest practices while maintaining a viable forest products industry. The rules set up a mechanism to develop prescriptions to protect and allow the recovery of fish, water and capital improvements, to enforce forest practices rules, to encourage voluntary mitigation measures, and to allow monitoring, subsequent watershed analysis and adaptive management. A detailed watershed analysis system is outlined which uses interdisciplinary scientific assessment teams to 1) inventory current conditions, 2) assess the likelihood that watershed processes will be adversely changed by one or more forest practices, 3) assess the vulnerability of potentially affected resource characteristics, 4) identify areas where a management response is required due to resource sensitivity, and 5) prepare a causal mechanism report to demonstrate the team's determinations were made in accordance with the manual.

417. Growth Management Planning by Selected Counties and Cities, WASH. REV. CODE § 36.70A.130 (1994).

This first portion of the Growth Management Act pertaining to planning by selected counties and cities requires that, except in an emergency, amendments or revisions to the comprehensive plan are to be considered no more frequently than annually and all proposed amendments or revisions are to be considered concurrently so the cumulative effects can be ascertained.

418. Permits for Developments on Shorelines of the State, Review criteria for variance permits, WASH. ADMIN. CODE § 173-14-150 (1993).

The review criteria for variance permits for shoreline development, both landward of ordinary high water and waterward of ordinary high water, stipulate that "consideration shall be given to the cumulative impact of additional requests for like actions in the area." A variance should only be granted to one property if other developments in the area in similar circumstances could receive the same variance and remain consistent with the master program and not result in substantial adverse effects to the shoreline environment.

419. Puget Sound Water Quality Authority, WASH. REV. CODE § 90.70.090 (1991).

The Puget Sound Water Quality Authority is empowered to form a Puget Sound Foundation, a public non-profit corporation, to promote research and education concerning Puget Sound's water quality, and to promote research and education on cumulative effects of decisions on the Puget Sound ecosystem.

420. State Environmental Policy, WASH. REV. CODE § 43.21C.010 to .914 (West 1993 & Supp. 1993).

The Washington Environmental Policy Act establishes a policy for reviewing the environmental impact of legislative actions and other major actions significantly affecting the quality of the environment. It stresses a systematic, interdisciplinary approach, which gives appropriate consideration to "presently unquantified environmental amenities and values" and recognizes the "world-wide and long-range character of environmental problems."

421. Water Resources Act of 1971, WASH. REV. CODE § 90.54.170 (1991).

The Water Resources Act sets out standards for evaluation of projects involving a new water supply and an electric generation facility. The applicant is required to provide sufficient information on, among other topics, "cumulative effects of the project and similar projects that are built, under construction or permitting in the relevant river basin or basins."

WASHINGTON - LITERATURE AND REPORTS

422. Geppert, Rollin R., Charles Lorenz, and Arthur G. Larson. ed. February 1984. *Cumulative effects of forest practices on the environment: A state of the knowledge*. Project No. 0130. Olympia, WA: Prepared for Washington Forest Practices Board.

This comprehensive report was commissioned by the Washington State Forest Practices Board to help the Board evaluate the effectiveness of its regulatory program. Chapter Five contains a detailed discussion of the cumulative effects of forest practices. Section 5.1 addresses the direct cumulative effects caused by the following forest practices: timber harvests, roads, site preparation, reforestation, stand maintenance, and combined practices. Section 5.2 includes an analysis of the indirect cumulative effects on the aquatic ecosystem, resulting from the direct effects to the earth, water and flora. It also includes a 1982 historical review of cumulative environmental effects and cumulative impact assessment in California.

423. Stout, David J. 1988. Preventing cumulative impacts: The Washington experience. In *Proceedings of the National Wetland Symposium: Mitigation of Impacts and Losses*, ed. Jon A. Kusler, Millicent L. Quammen, and Gail Brooks, 204-206. New Orleans, LA, October 8, 1986. Berne, NY: Association of State Wetland Managers. See abstract at record #125.

WASHINGTON - LITIGATION

424. Hayes v. Yount, 552 P.2d 1038 (Wash. 1976).

A substantial development permit was issued by Snohomish County to fill 93 acres of wetlands. The Shorelines Hearings Board vacated the permit. The superior court reinstated the permit and on appeal by the Department of Ecology and others, the supreme court reversed, finding that the decision of the Shorelines Hearing Board was supported by substantial evidence. The supreme court rejected the lower court's characterization of board's consideration of cumulative effects as being arbitrary. The court accepted the importance of the concept of cumulative environmental harm, and found the Shoreline Management Act supported a consideration of the cumulative environmental impact of future developments by others, even if the applicant had no control over future filling off site.

425. Tucker v. Columbia River Gorge Comm'n, 867 P.2d 686 (Wash. Ct. App. 1994).

A landowner applied to the Columbia River Gorge Commission for subdivision approval for 5-acre lots in a scenic area and was denied. The trial court affirmed. On appeal the court affirmed, holding that denial of the application was not arbitrary nor capricious. The Commission could consider potential future development and precedential effects, and could deny the application based on the cumulative effect of potential future development and adverse impacts on a scenic area.

Author Index

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Subject Index

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Appendix B:
Cumulative Impacts Workshop Invited Participants

CUMULATIVE IMPACTS WORKSHOP: METHODOLOGY AND MECHANISMS FOR MANAGEMENT OF CUMULATIVE COASTAL ENVIRONMENTAL IMPACTS
University of Rhode Island, Narragansett Campus
Narragensett, RI
May 6-7, 1993

Sponsored by Marine Law Institute, University of Maine School of Law, in conjunction with NOAA/National Marine Fisheries Service, Northeast Region and University of Rhode Island School of Oceanography as part of NOAA Coastal Ocean Program-funded research project.

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Appendix C:
Predicting the Effects of Changes to the Marine Environment: The Effects of Multiple Changes*

Human society is continuously changing marine environments. These changes include alteration of the physical environment through construction activities, alteration of the chemical environment through discharge of chemicals into marine waters, and predation on marine populations through fisheries. How well can the effects of a change in the marine environment be predicted? Specific to this review, how well can the effects of multiple alterations be predicted?

It is perhaps useful to organize the different kinds of alterations into a few categories. These are:

1. Additions of an agent to the marine environment (chemicals, fertilizers, heat).

2. The alteration of the physical properties of habitat (introduction of hard substances, disturbances through dredging).

3. Loss of habitat (such as through the filling of wetlands).

4. Fragmentation of habitat (barriers dividing marine ecosystems into smaller contiguous parcels).

5. Removal of populations (fishing).

6. Species introductions (the introduction of non-native species through deliberate or accidental acts).

It should be recognized that a single action may provide an alteration in more than one category. For example, the addition of organic carbon to an estuary, an alteration in Category 1, may eventually lead to changes in Category 2 (change in sediment properties and reduced water oxygen concentrations) and Category 3 (a complete lack of oxygen prevents all organisms except bacteria from using the habitat).

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* This paper by Dr. Kenneth R. Hinga, University of Rhode Island Graduate School of Oceanography, Narragansett Bay Campus, is based on his 1993 workshop presentation, "The Limits of Ecological Science as a Constraint on Cumulative Impact Assessment."

Marine ecosystems have properties which make them fundamentally different from terrestrial ecosystems. Marine ecology textbooks invariability point out major differences including:

- The marine environment is a three-dimensional fluid environment with inhabitants in the fluid itself. (Few terrestrial organisms actually live in the air and, high-soaring birds excepted, the third dimension in terrestrial environment is only as high as the vegetated canopy.)

- Marine environments often have a heavy reliance on planktonic primary production (i.e. phytoplankton vs. trees).

- Pelagic dispersal of planktonic larvae is a means of reproduction and dispersal for most benthic marine animals (few land animals disperse by wind driven transport).

With such fundamental differences, it is reasonable to expect the guiding principles necessary to describe the effects of alterations to marine environments are different from those for alterations to terrestrial environments. We must also consider marine and brackish environments with emergent vegetation, such as salt marshes and mangroves. These environments may be thought of as a transition between marine and terrestrial environments and may be expected to incorporate properties of both environments. The current capabilities of marine environmental science usually do not allow predictions of the effects of alterations to the marine environment with the accuracy, precision, and confidence that may be desired to support management decisions. On the other hand, the results of many alterations have been observed and at least some general, if imprecise, prediction as to the consequences of alterations is often possible.

This paper puts forward a set of theorems to describe the response of marine environments to multiple alterations. Multiple alterations include any combination of alterations in space or time. These theorems should be regarded as working hypotheses. The term theorems was deliberately chosen to emphasize the tentative nature of the working hypotheses. These theorems will be verified, altered, and perhaps rejected as our understanding of the marine environment increases. It would be useful to have an adequate understanding of individual alterations, or at least a thorough review of our knowledge, before considering cumulative impacts. Unfortunately, the presumably simpler task of prediction of individual alterations is far from a mature and reliable practice. Nor does there appear to be a single, or even few complimentary works, that would serve as adequate and comprehensive review of the state-of-the-knowledge. Such a review is well beyond the scope of this paper. Recognizing the lack of foundation, the theorems listed below are specifically directed to the effects of cumulative impacts as distinct from the list of principles which might be generated for single alterations. The first theorem though not restricted to marine or cumulative impacts provides a context for following theorems.

Theorem 1. An alteration of the environment will result in a change in the biological community in the environment.

A basic tenet of ecology is that each species is adapted to a particular niche. Every environment will provide a number of niches which may be inhabited by corresponding species. If an environment is altered so that different niches are available, the species inhabiting that environment will change in response. Changes may be brought about by alterations in all six of the categories listed above. (New species in an environment may act to alter the physical environment.) The time it will take the assemblage of species to change will depend upon the rate of introduction of new species.

One cannot safely state that any anthropogenic alteration is undesirable. Indeed, this theorem is the foundation for many actions where an environment is deliberately altered to accomplish a desired change. This includes both restoration actions, to return an environment to what it once was (or at least perceived to have been), and actions taken simply to create an environment with a more desirable assemblage of species.[1]

An example of the non-restorative alteration is the introduction of hard substrates and three-dimensional structure, i.e. artificial reefs, to a soft-bottomed environment to create a desired community. The hard substrates and the new structure introduce new niches. Of course, minor changes to an environment may not result in a readily observable change in the community structure. Many marine populations have a very variable abundance in both space and time. This property often makes it hard to observe changes in the community brought about by alterations to the environment.

This theorem puts a different perspective on alteration than may be presented elsewhere. It is often assumed that a section of the marine environment, say a portion of an estuary, which has been altered is under stress. The original community which inhabited the estuary was clearly put under stress when the conditions in the estuary were first altered. However, if a new community of organisms is established, which are adapted to the new conditions, then the new community is not under stress. It may be difficult to imagine a community (except perhaps of bacteria and fungi) which would be adapted to an estuary full of toxics. However, one would expect new, well adapted, and unstressed communities to establish where just the physical conditions of the environment have been altered.

Theorem 2. The effects of a given local environmental concentration of a chemical (or agent such as heat) are the same whether from single sources or from multiple sources.

There are no special cumulative aspects to the prediction of effects from multiple sources of a chemical vs. a single source except that the distribution of the chemical may be different for the two cases, at least close to the sources. This theorem does not provide any insights to the problem of repeated doses (over time) to a community.

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1 Although there is a distinction between the use of assemblage of species and community of species in ecology, community is used here without its more restrictive meaning.

Theorem 3. The risks of carcinogens (cancer causing chemicals and ionizing radiation) are additive.

It is usually assumed that the risks of developing a cancer from low environmental concentrations of carcinogens are directly proportional to the amount of exposure with no threshold (lower limit). Twice as much exposure from an individual carcinogen results in twice as much risk. The total risk from a suite of carcinogens is the simple sum of the individual risks from each carcinogen. This theorem is a common assumption for analysis of human health risk where, if even a few cancers in a significant sized population are predicted, the consequences may be considered very unacceptable. The effects of cancers on marine populations when small numbers of individuals from a population may be affected, are seldom an issue of concern.

Theorem 4. The effects resulting from simultaneous exposure to multiple toxins may be considered additive for most purposes.

Stated differently, the effects of multiple toxins may be treated as if they act independently. However, both synergistic and antagonistic effects have been shown to occur from exposure of marine organisms to multiple toxins. A synergistic effect is where the effect of two or more toxins produce a greater effect than would be expected from the sum of the effects of the toxins exposed independently. An antagonistic effect is where there is less effect from exposure to multiple toxins than would be expected from the sum of effects of the toxins exposed independently. The greatest concern is with synergistic interactions.

The worst case scenario, is where two toxins are present at very low concentrations relative to the levels at which they individually exhibit toxicity. But, the combination of the two toxins promotes significant toxicity. Such cases may occur. However if they do occur, they are as yet undocumented or rare. The magnitude of measured synergistic and antagonistic effects is usually fairly small. In the case where one toxin is found in sufficient concentration to be clearly exhibiting its toxicity and another toxin is present in only a small portion of the concentration needed to exhibit toxicity, the effects of the second toxin are likely not discernible. A prediction of based upon the dominant toxin alone would not be different than the combination. Uncertainties arising from ignoring possible synergistic or antagonistic effects are likely small relative to the task of simply determining when a chemical is toxic. Different species used in toxicity assays (e.g. amphipods, oyster larvae, or Microtox bacteria) exhibit effects of toxics at concentrations as much as a factor of 100 from each other. (This does not include species noted for their resistance to toxics.) None of the standard test organisms is always the most sensitive.

Theorem 5. Habitat fragmentation is not usually a problem for marine species.

Marine species are defined here as those with gills. Marine-related, air-breathing species, are not covered by this theorem and probably can be viewed as terrestrial species. A reasonable working assumption is that habitat fragmentation problems are not common in the marine environment. For example, a small salt marsh is similar to a large salt marsh when viewed on a per square meter basis. If the large and small marshes have the same physical environment (salinity, sediment substrate, etc.) they will develop a similar community, regardless of size.

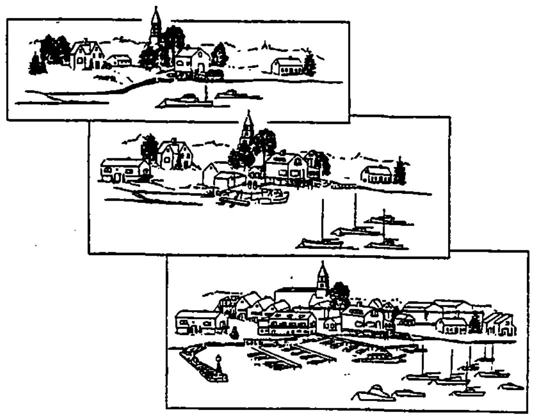
This theorem does not imply that structures dividing marine habitats will not cause changes to the communities. It is hard to imagine that a structure dividing a marine environment could be built which would not affect the physical properties of the habitat. However, it is the change in physical properties, as addressed in Theorem 1, which is responsible for the alteration, not the change in contiguous habitat size which would be responsible.

Theorem 6. The need for, or use of, transportation corridors is unlikely to be important in the marine environment.

This property of marine environments is a consequence of the typically high dispersal capacity of most species. Plankton and nekton species are either passively dispersed by water movements or are able to swim to suitable habitats. Even the majority of benthic sessile species have pelagic larvae (about 80%) which are readily dispersed by water movements. There are two general groups of planktonic larvae, planktotrophic, which may remain and feed in the plankton for long periods of time, and lecithotropic larvae, which do not feed while in the plankton, and will remain planktonic one to a few tidal cycles and will have shorter dispersal. In either case, dispersion while in the plankton will provide opportunities for larvae to be introduced to new areas. Exceptions to this theorem might be found among sessile or slow moving benthic organisms which do not have planktonic larvae. Examples of these include some gastropod mollusks (snails and welks) which lay a small number of eggs firmly attached to hard substrate. One may expect these slow moving and non-larval dispersing organisms to be ineffective, or at least very slow to surmount significant artificial barriers.

Theorem 7. Size of habitat. — Habitat loss does not have scale-dependent effects in marine environments.

Expressed differently, the carrying capacity of a population is directly proportional to the amount of habitat available. Therefore, if half the habitat is lost, the steady state population size will be reduced by half. The same is assumed to be true where the adult population size is limited by the size of the breeding area or a nursery area. A reduction in the size of a breeding or nursery area could reduce the standing stock of the adult population in a different area. As a practical matter, the problem may often be the lack of clear knowledge as to whether the population size of a species is limited by the carrying capacity of breeding, nursery, adult areas.



METHODOLOGIES AND MECHANISMS FOR MANAGEMENT OF CUMULATIVE COASTAL ENVIRONMENTAL IMPACTS

Part II: Development and Application of a Cumulative Impacts Assessment Protocol

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APPENDICES:

Chapter 1
Introduction

This report summarizes the development and application of a protocol for assessing the cumulative environmental impacts of coastal construction activities in the context of the Army Corps of Engineers Section 10/404/103 regulatory program. The Northeast Region of the NOAA/National Marine Fisheries Service (NMFS) developed the protocol and tested its effectiveness in contributing to environmental assessments of various wetland and waterway development projects. NMFS' emphasis in creating and revising the protocol reflected the agency's statutory mandates, and thus focused on impacts to living marine resources and their habitats. It is important to recognize, however, that other important types of impacts should be included in assessments of the cumulative effects of coastal development (e.g., impacts to public access along the shore).

SCOPE OF THE CUMULATIVE IMPACTS STUDY

NMFS undertook this cumulative impacts study in conjunction with the Marine Law Institute at the University of Maine School of Law, with funding by the NOAA Coastal Ocean Program. Under the cumulative impacts project proposal, NMFS assumed primary responsibility for four tasks:

(1) Develop a preliminary protocol for cumulative impacts assessment for use by NMFS in permit reviews. The protocol should balance state-of-the-art methodologies, considerations of legal defensibility, and practical agency applicability.

(2) Apply the preliminary protocol to NMFS reviews of and comments on selected Corps of Engineers permit applications.

(3) Assess the effectiveness of the protocol, identify weaknesses and modifications, and refine the protocol.

(4) Prepare a report, including a statement of the protocol, illustrations of its application through selected case studies, a discussion of necessary adjustments, and a description of additional information needs.

OVERVIEW OF THE REPORT

This document introduces the Cumulative Impacts Assessment Protocol developed by staff of the NMFS Habitat and Protected Resources Division and describes NMFS' experience in applying the protocol to several proposed coastal development projects. The report presents a conceptual outline of the protocol and discusses two approaches used by NMFS to implement the protocol: the Key Indicator Species Approach and the Habitat-based Landscape Approach. After discussing the results of field-testing the two approaches, the report concludes by evaluating the protocol, identifying additional work needed to refine the protocol, and offering recommendations for the use of cumulative impacts assessments in the environmental permit review process.

Chapter 2
The Cumulative Impacts Assessment Protocol

OBJECTIVES AND APPROACH

Pursuant to the Fish and Wildlife Coordination Act, NMFS provides technical resource management advice to federal agencies proposing to authorize, undertake, or fund projects that could adversely affect living marine, estuarine, or anadromous resources or their habitats. Along the coast, these activities typically involve dredging, filling, and/or building structures in wetlands or waterways. Such projects are authorized under permits issued by the Army Corps of Engineers pursuant to Section 404 of the Clean Water Act, Section 10 of the Rivers and Harbors Act, and/or Section 103 of the Marine Protection Research and Sanctuaries Act. Most of these projects contribute to the overall environmental impacts of coastal development, including cumulative impacts to marine resources. Moreover, the consideration of cumulative impacts is a mandatory part of the decision making process for the evaluation of permit applications involving discharges of dredged or fill material under Section 404 (see the Section 404(b)(1) Guidelines at 40 CFR 230.11(g)).

For a Cumulative Impacts Assessment Protocol to be useful to NMFS in managing coastal development through the Corps of Engineers regulatory program, the Protocol should link (1) the potential for adverse effects from the proposed development, (2) the resulting impacts of those effects, (3) the ecological value of the resources at risk, (4) NMFS' mandates to protect and enhance living marine resources and (5) the decision making process that would benefit from the Cumulative Impacts Assessment Protocol. The result, when combined with other information gathered during project reviews, must provide sufficient justification for project authorization, authorization with conditions for resource protection, or denial.

To control the adverse consequences of coastal development, regulators need to relate anthropogenic activity to specific resource impacts. Thus, site specific resource assessments generally are based on habitat characteristics and the ecological requirements of individual organisms. The rationale for this approach is straightforward: without useable habitat and a forage base, restoration and enhancement of desired stocks will not be possible.

People seeking to quantify the cumulative environmental impact of any single action within a group of similar or dissimilar activities have been repeatedly frustrated by an inability to determine the relationships between spatial and/or temporal modification of habitat and identifiable living resource losses. Without first determining these relationships, it is virtually impossible to relate any specific set of habitat impacts with a subsequent decline or increase in population size.

Habitat-based assessments rely on valuations of the environmental characteristics. How much habitat is available and is it useable? At what level of productivity is it useable? Do activities in one part of the habitat influence use or biological value of other components of the area? These questions are often answered in a relative fashion (e.g., impacting habitat "A" will alter its ability to provide functional values 1, 2, and 3). However, it remains difficult to translate a loss of functional habitat values into measurable population declines, either for one species or for an entire community. In view of this problem, we decided to pursue two approaches for assessing cumulative impacts: one based on the ecological requirements of a key indicator species and one based on overall spatial and temporal effects to habitat.

Although habitat is critical, the question of impact actually revolves around how specific resources utilize that habitat and what effect a diminishment of the habitat's functional values will have on a population. The life histories of individual species are understood to varying degrees. However, life history compilations do not usually interrelate biological functions with the functional values of the supporting habitat. Thus, we remain uncertain as to the full range or extent of importance of specific habitats for specific species. This is particularly problematic when it comes to assessing influences on biological functions such as reproductive success. Because of these handicaps, regulators are often unable to quantify the importance of "loss" within a population or habitat when addressing only a tiny fraction of the entire entity. The quandary remains; are the individual organisms which are displaced from a habitat that portion of the population that is "surplus" (a portion of the naturally occurring mortality) or are they members of the "replacement" population destined to be the recruitment (survivors) of a "stable" population? Loss of the former has little impact; loss of the latter represents the depletion of the stock. For the first of the two approaches developed by NMFS for implementing the Cumulative Impacts Assessment Protocol, NMFS selected a process that relates life history and biological needs to the specific impacts of anthropogenic activities, using an indicator species with a vital role in coastal ecology.

Regulation of coastal development requires site-specific impact evaluations. However, there is a growing sense that ecological units, rather than elements of the whole, are the more appropriate management scale. This type of management philosophy has been termed "landscape ecology" or "watershed management," and it requires both historical perspective and ecological considerations. Because this approach provides a more complete view of an area's ecological role, it is a field with a growing constituency. It can be useful in addressing cumulative (rather than just site-specific) impacts because it provides a functional overview of a system. The second of the two approaches developed by NMFS for implementing the Cumulative Impacts Assessment Protocol invokes this management perspective.

OUTLINE OF THE CUMULATIVE IMPACTS ASSESSMENT PROTOCOL

With the objectives and limitations described above, and using the available literature on cumulative environmental impacts as a basis, we developed the following outline of the Cumulative Impacts Assessment Protocol. The two approaches for implementation both derive from this outline, which provides an overall methodology for cumulative impacts assessment.

Our intent was to ensure that the two approaches share a common basis and that they would produce comparable results.

Cumulative Impacts Assessment Protocol

I. DETERMINE WHETHER TO REVIEW IN DEPTH FOR CUMULATIVE IMPACTS

For each proposed coastal development project, determine whether detailed cumulative impacts review is appropriate. In general, projects may be considered appropriate for review under the Protocol if the project site, surrounding area, and/or types of resources at risk have been subject to substantial yet incremental environmental impacts, resulting in a decrease in the amount or quality of environmental functions and values.

II. COLLECT AND SYNTHESIZE INFORMATION

1. For each project that warrants more detailed cumulative impacts review, select and define a coastal geographic area that constitutes a landscape unit and has definable ecological boundaries to be studied for cumulative impacts.

a) Conduct a literature search to identify major components of the ecosystem, its former and existing condition (if different), and its specific functions and values which could be affected cumulatively from coastal development. Possible sources include National Estuary Program Comprehensive Conservation & Management Plans, NOAA/EPA northeast strategic estuaries study, general marine science literature, etc.

b) Seek out researchers who have conducted or are conducting investigations that could prove helpful in understanding specific resource functions, processes, and impacts. Sources include NOAA programs, EPA, Sea Grant, universities, state agencies, and private conservation groups.

2. Document resource use of and reliance upon identified landscape unit.

a) Collect, review, and cite life history information for ecologically important species such as Atlantic silversides, lobster, bluefish, striped bass, fluke, winter flounder, etc.

b) Cite coastal ecology literature for habitat functions and values.

c) Use life history and habitat information to describe use of the selected geographic area by species, including food web relationships, shelter from predators, etc.

3. Identify indicators of ecosystem condition in the project area such as water quality, sediment quality, or the presence of sensitive resources (e.g., eelgrass beds).

4. Document possible anthropogenic sources of stress to the selected area, e.g., pollutant inputs, changes to freshwater flow and salinity, habitat alteration or destruction, and fishing pressure. Obtain historical information on habitat loss or degradation due to permitted and unregulated activities.

III. IDENTIFY GOALS AND OBJECTIVES FOR PROJECT AREA

Identify the desired future condition for the resource area within its geographic context. This information may be obtained from existing planning documents such as Fishery Management Plan habitat sections, state Coastal Zone Management plans, Special Area Management Plans, and the general goals of the Clean Water Act and 404, including no net loss, net gain of wetland functions.

IV. EVALUATE INDIVIDUAL PROJECTS USING THE PROTOCOL

1. Determine what functions or processes would be affected by the project in the selected area, using site visits, review of project files, Environmental Assessment documents, literature about the area, and/or state, local, or regional plans.

2. Quantify the amount of habitat loss or degradation from the project, including types of habitat functions/values lost and the acreage lost or degraded.

3. Assemble historical information on habitat quantity and quality in the watershed and landscape area surrounding the project site to determine previous conditions and cumulative losses to date. Use sources such as existing habitat maps, old aerial photos, Corps of Engineers permit files, historical records, and interviews with landowners and local officials.

4. Project any potential future habitat impacts to the project area due to other foreseeable activities. Include impacts from similar types of projects or different activities affecting the same landscape area, and use any available trends information from town planners, chambers of commerce, regional planning documents, etc.

5. Project or calculate the additive total of habitat loss or degradation from similar projects in a given geographical area (watershed, county, state, etc.).

6. Combine data generated in 1-5 above to gauge the cumulative impact of the project together with past and anticipated future projects in the area, and draw ecological connections between the types of impacts identified and the species of concern to NMFS.

7. Consolidate and incorporate the cumulative impacts data into NMFS' comments to the Corps of Engineers.

8. Document the Corps' response to these comments and recommendations.

Chapter 3
Two Approaches for Implementing the Protocol

NMFS devised two approaches for implementing the Cumulative Impacts Assessment Protocol outlined above. The first approach stresses the cumulative effects of specific development-related impacts on the ecological requirements of a population of an indicator species. The second approach emphasizes the cumulative effects of the incremental degradation and loss over time of important habitat functions throughout an ecologically defined landscape setting.

THE KEY INDICATOR SPECIES APPROACH

Under the Key Indicator Species Approach, resource managers identify the factors necessary for the survival of the indicator species that could be affected, either positively or negatively, by anthropogenic activity. Using a qualitative approach, field ecologists determine whether a construction activity has a positive, negative, or neutral impact on each factor. These determinations are incorporated with other valuations to assess the impacts and need for mitigation using a matrix based on species-specific information.

The first steps for this approach are to define habitats of concern and select one or more indicator species. For habitat type we selected nearshore tidal estuarine habitat dominated by vegetated wetlands. This choice was made primarily because of the preponderance of construction activity occurring in this habitat type. We focused on emergent tidal vegetation, predominantly saltmarsh cordgrass (*Spartina alterniflora*), or high marsh species such as saltmeadow cordgrass (*Spartina patens*) and spike grass (*Distichlis spicata*). For an indicator species we selected the Atlantic silverside (*Menidia menidia*), an important food web resource that relies heavily on vegetated marsh habitat. In an attempt to develop a cause/effect relationship between coastal development and impacts to living marine resources, we assessed the literature pertaining to vegetated marsh habitat and the silverside, and identified pertinent survival factors, including water temperature, dissolved oxygen, predation avoidance, spawning requirements, and feeding substrates.

We chose the Atlantic silverside as an indicator species because it is an important forage organism that reaches high abundance in the nearshore zone during warm weather months. Occurring from Nova Scotia to Florida, the species contributes to the estuarine food web as prey for species such as striped bass (*Morone saxatilis*), bluefish (*Pomatomus saltatrix*), and Atlantic mackerel (*Scomber scombrus*). The fish are also routinely captured in surveys up to 112 miles offshore. Because of the silverside's migratory movements it serves as year round forage.

After selecting an indicator species, we reviewed the scientific literature and identified factors necessary for the survival of the Atlantic silverside which could be affected by anthropogenic activity (Appendix B). We examined biological factors including water temperature, dissolved oxygen, predation avoidance, spawning and feeding substrates. Field ecologists then determined qualitatively whether a construction activity would exhibit a positive, negative, or neutral effect on each factor (Appendix C). Based on the literature search, we predicted the potential impact of the project by using a matrix that assesses the effects of common development activities on various biological conditions (Appendix D). The environmental assessment relied on a variety of techniques including scaling, checklists, matrices, and mapping.

In southern New England, Atlantic silverside spawning takes place from early May through much of July. Spawning is triggered by full moon tides that allow access to the inner portions of high marshes. The fish deposit eggs on the lower stems and exposed roots of saltmarsh plants and within associated detrital mats. These sites appear to minimize dehydration of the attached eggs, and provide predation protection for the spawning adults, eggs and early life stages. Exposed area egg deposition is doomed by the likelihood of desiccation. It has been suggested that use of vegetated areas is an adaptive practice to control desiccation and predation. Females have multiple, group spawning events with up to five events occurring during the season. There is some evidence that the more southern spawners spread out their reproduction efforts for a longer period of time.

Survival to hatch is best in the upper portion of the intertidal zone with high marsh habitats providing the best hatching success. Juveniles can be found (water temperature dependent) from early June through late July/early August in the region north of New Jersey. As water temperatures decline the population moves offshore. The movement, in eastern Connecticut, begins in October so that numbers are greatly reduced by early November. This is, again, temperature dependent. It appears that about 99% of the population is cropped every year, a significant portion of that cropping is by carnivorous species during offshore over wintering.

Atlantic silversides appear to be omnivorous, having gut contents that range from copepods and shrimp to smaller fish and plant material. Obviously, the larger the silverside, the larger the prey items. The presence of plant material in their gut contents is not continuous and there is some question as to its nutritive value. However, the consumption of plant material appeared relatively consistent throughout the size (age) classes studied. In inner estuary areas the stomach contents were dominated by plant material (often *Spartina alterniflora*). This could be a problem if wetlands are not available, since silversides may be forced to compete with higher trophic level predators of more direct value to humans. It appears that the fish are cannibals, consuming small silversides as well as *Fundulus*, shrimp (*Crangon* and *Palaemonetes*) and sporadically (probably availability dependent) *Nereis* spp. and horseshoe crab larvae. Availability of plant material or the fish's location in the estuary may also influence the dietary habitats. Because of its trophic level and value within the food webs of larger organisms, the Atlantic silverside is an excellent indicator species for the Cumulative Impacts Assessment Protocol.

THE HABITAT-BASED LANDSCAPE APPROACH

The Habitat-based Landscape Approach uses information gathered from a variety of sources to trace the progression of coastal development and habitat loss in a given landscape setting over time. Pending proposals for new coastal development are then viewed in the context of this data to assess cumulative environmental impacts. This approach increases the information base typically used by decision makers, allowing regulatory evaluations to account for the historical record of environmental impacts in a given area. Using this approach, proposed projects are judged based on the overall effects of similar development on the surrounding landscape over time, rather that viewing the impacts from a single project in isolation from its surroundings.

In general, the Habitat-based Landscape Approach is best suited to cases where a variety of habitat types or functions appear to have been affected by development, so that an analysis of impacts to indicator species may not adequately represent the cumulative effects of coastal development.

Under the habitat-based approach, resource managers compile information related to past, currently proposed, and anticipated future coastal development in a given area from diverse sources such as site visits, resource maps, site-specific literature, old aerial photographs, Corps of Engineers permit records, interviews with landowners and local officials, and other historical information sources. The objective of this data search is to compile a record of habitat degradation and loss in a specific landscape setting over time. Resource managers try to determine what habitat conditions existed in the area prior to development, and what types of habitat impacts occurred as development progressed. Assuming enough information is available, the record would show the degree to which habitats important to fish and shellfish have been changed over time and would provide a relatively complete picture of the net environmental effects of past impacts and additional development.

The selection of an appropriate geographic scale of analysis is critically important, and must be evaluated on a case-by-case basis. The geographic scale should be based on relevant ecological criteria related to the scope of potential environmental impacts under study. For example, to evaluate cumulative impacts associated with the construction of a small pile-supported fishing wharf built over unvegetated shallow water habitat, one might restrict the analysis to the immediate surrounding area (e.g., the same cove) and examine the number of similar structures having similar impacts (displacement of substrate by piles, scour around the base of piles, shading under wharves, etc.). To evaluate a major new industrial development that entails considerable dredging and filling, the scale of analysis should be broader, perhaps extending over an entire estuary or major section of coast to determine how comparable habitats have been impacted by other sizeable projects. In general, if the selected geographic scale is too large cumulative impacts will be underestimated, but too small a scale may exaggerate the contribution of a given project to cumulative coastal environmental impacts.

Once the pertinent information has been compiled, resource managers evaluate the ecological significance of the development-related impacts that have already occurred within the landscape. This assessment, based on the scientific literature on habitat functions and values, reveals the additive total of habitat degradation and loss from coastal development in the watershed. The impacts of pending development proposals, determined through site-specific evaluations by field ecologists, can then be evaluated within the context of past and anticipated future development to gauge cumulative environmental impacts.

Chapter 4

Results of Field Testing the Protocol

NMFS evaluated three proposed coastal development projects using the Key Indicator Species Approach, and four proposed projects using the Habitat-based Landscape Approach. For the Key Indicator Species Approach, the examples include a municipal harbor improvement project (Case Study A), a shoreline protection project (Case Study B), and an expansion to an existing aquaculture operation (Case Study C). For the Habitat-based Landscape Approach, the examples include a marina expansion project (Case Study D), a lobster pound expansion (Case Study E), a commercial boat yard redevelopment (Case Study F), and a new residential subdivision on an undeveloped island (Case Study G). Summaries of the cumulative impacts analyses conducted for these projects follow.

KEY INDICATOR SPECIES APPROACH

Case Study A: Milford Head of the Harbor Development

PROJECT DESCRIPTION

The Milford (Connecticut) Harbor Commission proposes to expand and improve the city's public access and berthing facilities in the harbor. They are proposing to maintenance dredge the existing federal channel, removing 4,250 cubic yards (cy) of sand. Additional dredging of 14,760 cy of sand will occur from a riverine, intertidal depositional area along the western edge of the inner harbor. Other elements of the proposal include:

a) the installation of 185 feet of sheet-pile bulkhead,
b) the rehabilitation of 120 feet of pile and timber bulkhead,
c) the installation of 16,185 square feet of floating dock,
d) the construction of a pedestrian foot bridge spanning the head of the harbor where the Wepawaug River enters,
e) the placement of riprap for shoreline erosion control, and
f) the expansion of existing wetland habitat dominated by cordgrass (*Spartina alterniflora*).

PROJECT AREA

As identified in the Cumulative Impacts Assessment Protocol outline, we documented the existing condition of Milford's inner harbor (e.g., water quality, habitat type and amount, competing uses, and goals for management). This information was used to enumerate how the existing habitat may be affected by the proposed activities, and what impact those activities may have on living marine resources.

Milford's inner harbor is fed by seasonally fluctuating water flows from the Wepawaug River. The mouth of the harbor opens onto Long Island Sound approximately 2/3 of a mile eastward of the project. During high flow periods the river deposits coarse grained sands and cobble. During lower flow periods the deposition is composed of finer grained materials. Erosion energy is also variable, related to the discharge velocity from the river. Thus, the substrate in the vicinity of the proposed development areas is composed of lenses of coarse/medium sand and silty materials. The federal navigation channel to the south is comprised primarily of fine sand and silt.

The amount of residential development adjacent to the harbor is limited to several modest condominium complexes and a few private homes. The central portion of the harbor is used for recreational vessel moorings. Dominant waterfront uses are recreational marinas, boat yards, and private access docks. During the summer season, the harbor accommodates a resident and transitory vessel population of between 800 and 1000 vessels.

There is no industrial use of the harbor, and runoff is confined to suburban lawn and street flows. The harbor is relatively well flushed during tidal cycles which average approximately 6.6 feet, and water quality is good. This may be partly attributable to the restriction of discharges such as occurred with the closing of the sewage treatment plant located at the head of the harbor. During its later years of operation, the facility contributed significant amounts of nutrients and bacteria to the water body.

EXISTING RESOURCES

Healthy stands of cordgrass (*Spartina alterniflora*) fringe the riverine deposition area on the western shore north and south of the city's launch area. This area provides spawning habitat and cover for estuarine forage fish species such as killifish (*Fundulus* spp.), and Atlantic silverside. Landward of the *Spartina alterniflora* fringe, common reed (*Phragmites australis*) is the dominant vegetation. Some natural upland areas still exist, and are composed of a mixture of soft and hardwood species. The intertidal flat north of the launch is composed primarily of course sandy sediments, providing suitable substrate for shellfish and other invertebrates. Resources found in this area include soft-shelled clam (*Mya arenaria*), hard clam (*Mercenaria mercenaria*), ribbed mussel (*Modiolus demissus*), and mud whelk (*Ilynassa obsoleta*). The biological value of the harbor is high and considerable populations of hard clams, soft clams, and oysters can still be found there. On the eastern shore, a rock/cobble intertidal margin provides substrate for a macroalgal community.

EVALUATION OF ECOLOGICAL IMPACT

We evaluated the potential effects of the project on selected habitat characteristics of the Atlantic silverside, using a matrix of habitat parameters and types of impacts (see Appendix D). This information was based on documentation of life history information (see Appendix B). The matrix helped us to determine the specific potential effects of additional development.

To verify our conclusions in the field, we completed an investigation form that evaluated the effects of the proposed activities on each one of the biological factors identified as important to the Atlantic silverside (Appendix C). The investigation form was completed for each project activity (dredging, filling, etc.), and the activities were ranked as either positive, negative, or neutral based on their potential to affect the indicator species. This evaluation was based solely on the best professional judgment of the on-scene biologist. Following the completion of the forms, they were reviewed for accuracy and given appropriate reference numbers where applicable.

These field investigation forms were then used to identify the most detrimental activity to habitat functions and values. This was done by comparing the "score" (positive, negative, or neutral) of each individual activity to determine which features of the project proposal had the greatest potential (largest number of negative aspects) to adversely impact the indicator species.

ECOLOGICAL IMPACT

Based upon the documented effects associated with the above activities, we concluded that the new and maintenance dredging proposal carried the greatest potential to adversely impact the Atlantic silverside. Bulkhead construction, riprap, and float installation also had negative attributes, albeit minor.

The mechanical dredging would elevate suspended sediments in the vegetated shallows. If conducted during spawning periods, these elevated levels could impede spawning by restricting fertilization and the attachment of the eggs to vegetation, and the hatchability of the eggs could be reduced by suffocation. Dredging also would temporarily affect the availability of food sources such as zooplankton, fish eggs, and organic plant material. However, the dredging induced limitation of prey is a short term impact and unlikely to significantly affect survival of the population. The dredging would also limit access to vegetated spawning habitat. These effects could culminate in a decrease of year class strength. A seasonal restriction on dredging activity can mitigate these impacts.

Placement of riprap in front of the vegetated intertidal habitat, although generally viewed as environmentally beneficial, would also adversely impact resident or migratory species by impeding access to intertidal vegetation.

The installation of floating docks would shade a portion of the harbor, reducing primary productivity. However, the most severe impact associated with installation of floats would likely be the resultant impacts to water quality from the discharge of oil, grease, and bacterial inputs from vessel use of the facilities and the additional boats using the harbor.

Bulkhead installation would require the removal of some cordgrass. This could result in a decline in vegetative material available as forage, and in the amount of suitable spawning habitat. However, the loss of vegetation would be offset by the expansion of the adjacent cordgrass area.

Counterbalancing the negative aspects of the project are several positive features. These include a short term, slight reduction in predatory pressure on the Atlantic silverside during dredging activities; a potential increase in the availability of substrates suitable for the establishment of vegetation in the lee of the marina facilities; a reduction in wave energy created by the floats and boats, and an augmentation of hard substrate created by the increased surface area of the floats, boats and riprap.

CONCLUSION

Based upon an on-site assessment of the proposal, discussions with the applicant, and review of the field data sheets, we determined that the potential for this project to adversely affect the environment in general (or specifically, the Atlantic silverside population) is minor. Although we identified that there will be a diminishment of the ecological health of the system, these impacts could be alleviated through design changes to protect the productive habitats and the use of mitigative and compensatory measures in the remainder of the project.

UTILITY OF THE APPROACH

The Key Indicator Species Approach proved to be suitable for evaluating the ecological impacts of additional development in Milford Harbor. Through this approach we were able to assess each aspect of the proposal in terms of its effect on the needs of the indicator species, requiring us to move beyond the site specific focus normally afforded project reviews. The conclusions drawn were based on a broader base of facts and situations encompassing the entire harbor and the amount and type of existing habitat suitable for Atlantic silversides. The assessment also placed the existing development in a framework that should help to predict the effects of future residential and recreational development in the system.

Based on a limited amount of information, NMFS was able to develop a series of ecologically sound recommendations to minimize project related impacts, and was also successful in identifying methods to mitigate impacts from unavoidable aspects of the project. Additionally, the process provided an avenue to more thoroughly understand the functions and values of vegetated and open water habitats within Milford Harbor, and to distinguish what type of development activities have the potential to adversely impact estuarine dependent finfish species in a cumulative manner.

Case Study B: Town of Fairfield, Pine Creek Bulkhead

PROJECT DESCRIPTION

The Fairfield Connecticut Department of Public Works proposes to install and maintain 3000 feet of bulkheading along the south side of Pine Creek. The project includes the installation of new steel and wood bulkhead and the replacement of failed, existing wood bulkheading. In many instances the replacement would include positioning structures and fill below high water, and would entail encroachment into the creek. Substantial encroachment into the creek could significantly reduce the existing tidal prism of the area and jeopardize the Fairfield Shellfish Commission's ongoing wetland restoration activities.

PROJECT AREA

Pine Creek is a small tributary system that drains to Long Island Sound. Its lower reach is tidally influenced. Sediments at the mouth of the Pine Creek complex are composed primarily of coarse sand and pebbles. Further up the creek the sediments are predominantly silty sand and organic mud. The adjacent upland is residential, with the exception of the town landfill and sewage treatment facilities that are located to the northeast. Additionally, on the north side of the Creek, a flood control/hurricane berm was created in the late 1960's to provide the residential development protection from coastal flooding. The berm rises directly from the banks on the northern shore of the creek. The slope is quite steep, and reaches a height of more than fifteen feet above sea level. Only minor development has occurred in this area. Water quality within the creek is influenced by suburban runoff, as well as the landfill and treatment plant discharges, but has improved in recent years. However, tidal flushing is not complete and the discharges are the most difficult to limit. Shellfish harvesting for consumption is presently prohibited.

Seaward of the creek and the hurricane berm is a barrier beach known as Fairfield Beach/Pine Creek Point. The barrier beach has experienced intensive residential development. A large proportion of the development has occurred along Fairfield Beach Road which borders the creek. The route is the only connection from the barrier beach to the mainland. Because of its exposed location, the community routinely experiences flooding and storm damage. Many residential structures line the bulkheaded, landward side of the barrier beach which forms the south side of Pine Creek. As a result of the development encroaching into Pine Creek, water flow is restricted along the entire 3000 feet of the construction zone. In many instances, piers, decks, garages, and houses extend channelward of the high water line.

EXISTING RESOURCES

Oysters (*Crassostera virginica*), hard clams (*Mercenaria mercenaria*), and mussels (*Mytilus spp.* and *Geukensia spp.*) can be found within the intertidal and subtidal zones of the lower creek. Isolated patches of intertidal vegetation, dominated by saltmarsh cordgrass (*Spartina alterniflora*), fringe the channel. Because the hurricane barrier was built in a straight line a several hundred acre wetland was isolated from the creek. North of the hurricane berm, in the wetland area, the local community has attempted to restore the saltmarsh vegetation. In addition to saltmarsh cordgrass, saltmeadow cordgrass (*Spartina patens*), spike grass (*Distichlis spicata*), and marsh alder (*Iva frutescens*) are abundant. Upstream of the construction site, flow is controlled in two areas by self-regulating tide gates. The waterway above and below the tidegates contain a significant quantity of intertidal flat habitat. Silty-sand is the dominant substrate type in the upper creek and soft-shell clams (*Mya arenaria*) outnumber the oysters and hard clams here. Wetland restoration caused by tide gate regulation has rejuvenated 130 acres of intertidal vegetation.

EVALUATION OF ECOLOGICAL IMPACTS

We evaluated the impacts of additional bulkhead construction and the replacement of the existing structures on the life cycle and selected habitat characteristics of the Atlantic silverside using the project activity matrix (Appendix D) and supporting documentation (Appendix B). We verified our conclusions by completing a field evaluation (Appendix C).

ECOLOGICAL IMPACTS

By altering the hydrology of the system, the proposed project could indirectly impact the continued success of the town saltmarsh restoration activities. Consequently, the proposed work has a high potential to influence the reproduction and survival of Atlantic silverside. Because the Town of Fairfield's saltmarsh restoration site is removed from the main creek, water velocity and tidal prism are important components of that effort. The additional encroachment required for replacement of some bulkheads may restrict flow, alter current velocity and induce a significant reduction of the tidal prism. These impacts would affect the amount of vegetated habitat receiving regular inundation. A loss of vegetation would reduce the amount of spawning and nursery habitat available for the Atlantic silverside, and could increase the likelihood of egg desiccation. These impacts would result in the diminishment of Atlantic silverside year class strength from the entire Pine Creek complex. Additionally, there is the likelihood that tidal current velocity would be increased as a result of narrowing the width of the creek.

Directly, bulkhead construction would result in only minor changes to silverside habitat. The bulkheading of presently unprotected parcels may alter the dynamics of those areas, reducing the amount of habitat available to provide protection from predators. Fortunately, these areas are relatively small in size and the bulkheading would be placed at or above the high water line. In addition, wave deflection off the bulkhead would increase erosion within the creek and decrease the stability of the existing cordgrass patches. However, some erosion of these vegetated areas is presently occurring.

CONCLUSION

We concluded that the cumulative impacts of this project would have a minimal effect on the Atlantic silverside population provided that mitigative measures were properly implemented. Operation of the self-regulating tide gates at the entrance to the saltmarsh restoration site provide a hydrologic barrier (or breach) to the wetland. Any reduction in tidal prism caused by the bulkhead installation could be compensated for by an adjustment of the gate operation. Our final determination on this project was based on the availability of the tide gates to be used to artificially manipulate the hydrology of the area, and on the existing level of development in the creek. Because the level of residential development is highest in the lower creek and has little room for expansion, and the existing saltmarsh is both locally and federally protected, additional residential development is unlikely to further threaten the stability of the emergent wetland vegetation. Any additional stress on the system is likely to come from the adjacent landfill. The refuse operation is the generator of a significant amount of leachate and debris, which appears to be entering the adjacent water body. Additional proposals, with the potential to adversely affect the water quality of the system, should be carefully scrutinized.

UTILITY OF THE APPROACH

Use of the Key Indicator Species Approach for this project allowed the investigators to understand how a slight alteration of the creek's hydrology would severely affect the reproductive success of what appears to be a large population of Atlantic silversides. In addition to providing a basis for a sound ecological connection, NMFS staff identified mitigative measures that, when implemented, should enhance the productivity of the saltmarsh complex and still provide adjacent property owners with erosion control and some additional level of flood protection.

Case Study C: Gardner Aquaculture Development

PROJECT DESCRIPTION

Jeffrey T. Gardner proposes to retain an existing 1.5 acre aquaculture operation in Winnapaug Pond, one of a series of salt ponds located along the south shore of Rhode Island. He also proposes to expand the operation to incorporate an additional 1.5 acres for the culturing of hard clams (*Mercenaria mercenaria*), Eastern oyster (*Crassostrea virginica*), and bay scallop (*Argopectin irradians*). The existing hard clam operation consists of placing seed in the natural substrate then covering them with screens to prevent predation. When in place, the screens float approximately 6 inches off the bottom and are held in place by concrete reinforcing rods. Harvesting of the hard clams is undertaken by hand rake. Oyster and scallops are raised from seed in polypropylene bags that are placed in wire cages elevated 6 inches off of the bottom.

PROJECT AREA

To evaluate the potential ecological impacts of the proposed project on the Atlantic silverside (*Menidia menidia*), we documented the existing condition of Winnapaug Pond. Information utilized in our review included historic and current data pertaining to water quality, commercial fish landings, aquatic resource abundance, history of development, and coastal pond management plans.

Winnapaug Pond is open to the tidal flushing of Block Island Sound by the Weekapaug Breachway. The coastal barrier (Misquamicut State Beach) that lies between the pond and the ocean is a very dynamic environment constantly being reshaped and changed by wave activity and gradually rising sea level. During the 1700's the pond was seasonally open to oceanic flushing, and during the 1800's and early 1900's the pond was regularly managed to maximize the harvest of oysters, white perch (*Morone americana*), and alewives (*Alosa pseudoharengus*). This was accomplished by manipulating the temporary breachway openings so that salinity and water depth were kept at optimum levels for the growth of the target species.

The installation of a permanently stabilized breachway altered conditions in the pond significantly. These changes included a decrease in the depth of the pond as water elevations equilibrated with sea level, elevated levels of suspended sediments, rapid flushing, periodic events of low water, and an alteration in the salinity regime. In addition, sand from Misquamicut Beach was carried through Weekapaug Breachway into the pond where the accumulated sediments formed flood tidal deltas. The resulting changes in depth, along with the increase in residential and commercial development, contributed significantly to a decline in water quality.

The upland areas on the north shore of the pond are zoned primarily for residential development. As such, bacterial contamination and nutrient enrichment is a primary threat to water quality. Development on the south shore of the pond is focused around a single route (Atlantic Avenue) that provides the only vehicular access to the beach. Most of this perimeter is zoned for commercial use and accommodates restaurants and other businesses catering to the summer tourist industry. Road runoff and other non-point source discharges from these commercial operations contribute to the degradation of water quality in the pond.

Winnapaug Pond is used primarily for recreational activities such as bird watching, water sports, and boating. However, boating activity in the pond has become severely limited because of the abundance of sand shoals and rock reefs. Water depths average between one and two feet of water at mean low water. Because of the dynamic nature of the pond, substrates consist mainly of coarse sand. However, in the vicinity of the western terminus the bottom consists of organic material and fine sand. This area is farthest from the influence of the breachway.

Although residential development on the north shore of the pond appears to be nearing maximum capacity, there is some privately owned open space that could be the target of future development. Additionally, the outwash plain of the pond is the site of two agricultural developments. These properties have the potential to undergo subdivision for residential development. Presently, conservation easements for many of these properties are being pursued.

EXISTING RESOURCES

Most of the pond's perimeter is fringed by healthy stands of cordgrass (*Spartina alterniflora*). Subordinate marsh species include common reed (*Phargmites australis*), glasswort (*Salicornia* spp.), marsh alder (*Iva frutescens*), and sea lavender (*Limonium carolinianum*). Portions of the southern shore are protected as part of the Misquamicut State Park complex. Here broad expanses of salt marsh comprised of cordgrass, saltmeadow cordgrass (*Spartina patens*), and spike grass (*Distichlis spicata*) can be found. This emergent vegetated environment provides valuable spawning, feeding, and nursery habitat for many species of aquatic finfish and invertebrates including killifish (*Fundulus* spp.), Atlantic silverside, and fiddler crab (*Uca* spp.).

Unvegetated intertidal habitat of importance to benthic invertebrates such as clam worm (*Nereis virens*), mud whelk (*Ilynassa obsoleta*), and green crab (*Carcinus maenas*), is also very abundant. In the near shore submerged habitat, widgeon grass (*Ruppia maritima*) and eelgrass (*Zostera marina*) was once plentiful. However, alteration of salinity and nutrient levels in the pond, combined with an increase in shoaling and suspended sediments, has extirpated the widgeon grass population, and severely diminished the eelgrass. Currently, sparse eelgrass beds can be found growing in patchy distribution around rocks in scattered depressions. Water depths here average between three and five feet.

Shellfish populations have fluctuated dramatically since completion of Weekapaug breachway. The once abundant oyster population has declined to a remnant of its original size. Bay scallops, hard clams, and soft-shelled clams are also not as plentiful as were recorded in historical accounts. Eutrophication, alteration of salinity levels, and habitat modifications are probably responsible. Important commercial fish species that regularly use the coastal ponds of Rhode Island for spawning, feeding, and nursery habitat include winter flounder (*Pleuronectes americana*) and scup (*Stenotomus chrysops*).

EVALUATION OF ECOLOGICAL IMPACT

To evaluate the impacts associated with the aquaculture operation, we assessed the effects of the project on water quality, substrate, aquatic habitat, vegetation, cover, and other selected habitat characteristics. Based on the information compiled in the Key Indicator Species matrix (Appendix D), we developed a series of predictions regarding each one of these essential biological characteristics.

Following compilation of these preliminary predictions, an evaluation form was completed in the field that assessed the effects of the aquaculture operation on each one of the biological characteristics selected as important to the Atlantic silverside (Appendix C). Best professional judgement was used to impart a ranking of these anticipated impacts (either positive, negative, or neutral) on the biological characteristics identified above. The field investigation form was then used to identify the most detrimental effects of the project.

ECOLOGICAL IMPACT

Based upon the results of the documented life history information, the completed field investigation, the existing public use and condition of the pond, and future management goals, we concluded that direct impacts associated with the continued operation and expansion of the project will have, at most, minimal negative impacts on the Atlantic silverside population in Winnapaug Pond.

Surprisingly, analysis of the field investigation forms indicated that there were a number of positive aspects associated with the placement of shellfish cages in Winnapaug Pond. Because the water body is of such a dynamic and unstable nature, the installation of cages on or near the bottom would provide a fixed substrate for the attachment of a variety of aquatic organisms. These aquatic organisms are likely to enhance existing food sources for the Atlantic silverside. Additionally, the array of cages would also beneficially affect substrate characteristics, the quality and quantity of habitat, and the availability of protective cover in the pond. The cages would provide a more stable, safe and productive environment by increasing the available surface area, creating crevices for the refuge of small finfish species, enhancing the setting potential of natural shellfish populations, and increasing overall biological productivity. The enhancement of all of these characteristics would improve the quality of the pond for the reproduction and survival of Atlantic silversides.

We identified one biological characteristic for silversides that could be negatively affected by operation of the culture project. This factor was the presence and/or absence of predators.

Because placement of the shellfish cages are likely to result in increased biological productivity in and around the enclosures, the magnification of forage activity is likely to attract additional predatory species. This could affect the survival to maturity of the juvenile silversides. However, we determined that the number of positive aspects associated with the project would completely mitigate any enhanced predatory pressure placed on the species.

CONCLUSION

The on-site assessment in conjunction with the Key Indicator Species field forms, matrix, historical information, and pond management plan allowed us to determine that the expansion and continued operation of the project was in the best interest of the Atlantic silverside. However, ecological impact is not the only factor to be evaluated in considering the issuance of a permit for an aquaculture operation. Conflicts between competing user groups often arise, and projects may affect disease proliferation, market competition, and the potential for genetic repercussions to natural stocks.

UTILITY OF THE APPROACH

The Key Indicator Species Approach proved to a valuable asset in evaluating the ecological impacts of aquaculture on Winnapaug Pond. Application of the this approach improved the thoroughness of the review by increasing the intensity and geographic scope of our evaluation. The historical review, in combination with an enhanced understanding of future management needs, provided a template for predicting the type and amount of future development activities that might occur within the system.

Because of the similarity of the coastal Rhode Island salt ponds in terms of development, biology, and use, the results of the assessment are probably applicable for the evaluation of shellfish culture in other areas. Fortuitously, NMFS is presently evaluating the ecological impacts of three similar projects in a neighboring pond, and will utilize the information from this case study in our evaluation of those projects.

Cumulative impacts analysis successfully expanded our knowledge of the functions and values of vegetated and open water habitat in the Rhode Island salt pond complex. It allowed us to confidently predict how shellfish culture will affect the ecology of this area.

HABITAT-BASED LANDSCAPE APPROACH

Case Study D: Strouts Point Wharf Company

PROPOSED PROJECT

The applicant proposes to expand an existing marina and boat yard in South Freeport, Maine. The project includes dredging by mechanical means approximately 1433 cubic yards of sand and silt from an area beneath an existing marina, building a new rock bulkhead roughly 400 feet long across an intertidal area, and disposing of the dredged material (along with clean fill from an upland source) inside the bulkhead to create fast land for additional boat storage.

LANDSCAPE SETTING

The project is located in the Harraseeket River, a sheltered estuarine environment in Casco Bay fed by several small streams. The existing facility consists of a marina with approximately 85 boat slips. Shoreward of the marina are wood and concrete bulkheads supporting a boat storage and maintenance area, support buildings, and associated facilities. A yacht club, another boat yard, a town landing, and other waterfront developments are located nearby. The upland adjacent to these developments has steep topography, with only a narrow band of relatively flat land next to the shore. The overall setting is rural/residential, with private homes scattered in the surrounding uplands. Aside from the cluster of development surrounding the applicant's property, the shoreline is largely undeveloped.

TYPE/AMOUNT OF HABITAT AFFECTED

The proposed project would eliminate 6000 square feet of valuable intertidal estuarine habitat, and would result in the permanent loss of the important ecological functions that habitat provides to the Harraseeket estuary. A subtidal area of approximately 10,000 square feet would be altered by dredging, although the area has been dredged previously.

HABITAT FUNCTIONS AND VALUES AT RISK

The area of the proposed fill is a high quality intertidal mud flat which supports a soft shell clam community as well as important food web resources including blood worms, clam worms, common periwinkles, northern yellow periwinkles, green crabs, and horse mussels. Additionally, this soft-bottom flat provides valuable foraging habitat at higher tidal stages for a variety of fish and crustaceans. Cumulative losses of this type of habitat in the project area appear to have been great over the years. Based on surrounding topography, the applicant's boat yard probably was constructed on fill material over similar intertidal flats, and other waterfront development in the vicinity also appears to be built on intertidal fill.

HISTORICAL CONTEXT OF DEVELOPMENT

A federal navigation channel was established in the Harraseeket River in 1890, and completed in 1896. According to the Freeport Historical Society, the area surrounding the project site was used for ship building in the 19th century and four barges were built there in the 1940s for use during World War II. A town landing has existed in this area, north of the project site, since the 19th century.

In 1962-63, Rings Marine Services began renting moorings near the town landing. By 1968, Rings Marina was established on the project site, although the exact extent of habitat impacts from that development is unclear. Rings Marina expanded in 1977, and in 1981-84 Rings dredged approximately 4000 cubic yards of silty material. In 1986 Strouts Point Wharf Company took over Rings Marina, although Rings continues to control about 50 moorings.

Strouts received authorization in 1987 to conduct maintenance and improvement dredging, build a boat ramp, construct a new bulkhead seaward of the existing bulkhead, and fill the area behind the new bulkhead.

South Freeport Yacht Corporation, located north of the project site, was established in 1947 and became Harraseeket Marine Services in 1967-69. Harraseeket received permits in 1971 to dredge a shallow area just north of the town wharf to -5 feet MLW, build a new bulkhead, and dispose of 9000 cubic yards of dredged material behind the bulkhead, presumably on intertidal mudflats. A restaurant was subsequently built on the filled area, and still exists today. In 1983 and 1990 it changed ownership, and today exists as Brewer's South Freeport Marina.

The shoreline development at present, from north to south, consists of Brewer's South Freeport Marina, the town landing, with associated ramps and floats, the Lunch and Lobster restaurant (which also has floats), Strouts Point Wharf Co., and the Harraseeket Yacht Club.

POTENTIAL FUTURE HABITAT IMPACTS

Future habitat impacts in the project vicinity would likely be limited to incremental expansion of existing facilities (e.g., additional floats and boat slips), and perhaps non-point source runoff from upland areas if additional residential development occurs. Due to topography, there is essentially no room for additional waterfront development other than by expansion further out into the water.

NET HABITAT LOSS/DEGRADATION OVER TIME

A longtime resident and native of the area notes that blueback herring runs existed in the river in his youth. Other sources mention the historic presence of smelt runs and striped bass, but these runs were diminished, presumably due to discharges of raw sewage until 1970. Striped bass have returned but apparently are not spawning due to pollution and siltation. Eelgrass was abundant in the 19th century, although the current extent of this resource has not been mapped.

Filling and dredging in the area surrounding the South Freeport town landing, and in particular at the site of Strouts Point Wharf Company, appears to have resulted in the incremental loss of considerable intertidal mudflat habitat over time, and the deepening of a large area of soft bottom shallow water habitat to accommodate increasing boat activity. The impacts are difficult to quantify, but appear to total several acres.

CUMULATIVE EFFECTS

At the Strouts Point site, a marina was developed in 1968 and expanded in 1977, 1981-84, and 1987-88. Similar developments have occurred nearby, with similar impacts to subtidal and intertidal habitats. Viewed collectively, these impacts represent a substantial loss of valuable environmental resources.

RECOMMENDATIONS

NMFS commented on this project to the Corps of Engineers by letter dated December 20, 1993. NMFS' letter stated that the potential impacts of the project exceed the "minimal impact" threshold under the Maine State Program General Permit, and that an individual Corps permit should be required for this project, including an evaluation of less damaging alternatives and compensatory mitigation for any unavoidable project impacts.

RESULTS

Due to environmental concerns raised by NMFS, Strouts Point has withdrawn their application. However, Strouts plans to re-apply for the maintenance dredging with open water disposal at the Portland Disposal Site rather than on intertidal mudflats.

UTILITY OF THE HABITAT-BASED LANDSCAPE APPROACH

Using the Habitat-based Landscape Approach, NMFS was able to document a series of coastal development activities and associated environmental impacts that have occurred in the project area, and to use that information in support of NMFS' recommendations to seek alternatives that would not require filling additional coastal habitat. However, the information available was imprecise regarding the exact amount of habitat (and thus the scope of habitat functions and values) lost over the years due to development. Additional information called for in the Cumulative Impacts Assessment Protocol was not available, including site-specific fisheries data or regional planning documents establishing management goals for the project area. Nevertheless, examining impacts to surrounding habitats over time provided important perspective regarding the cumulative impacts of coastal development on intertidal habitat, and the resulting scarcity of that habitat type within the project area.

Case Study E: West Brothers Lobster Pound

PROPOSED PROJECT

The applicant proposes to expand an existing lobster pound in Steuben, Maine. The project includes constructing and maintaining a concrete dike adjacent to an existing earthen dike to create a new 1 acre impoundment for storing lobsters. The dike would be roughly 400 feet long and 2 feet wide. The project also calls for blasting 7500 cubic yards of exposed ledge in the proposed pound expansion area and relocating a culverted intermittent stream so that it drains directly into the open intertidal zone rather than into the new pound area. A trench would be excavated (blasted) through ledge to allow drainage of the proposed pound expansion and the remaining ponded area (about 0.5 acre) to the north.

LANDSCAPE SETTING

The project site is on Pigeon Hill Bay in Steuben, Maine. The existing facility consists of two separate lobster pounds; one approximately one acre in size and the other approximately two acres. The pounds were built at the upper edge of the intertidal zone, creating pools for storing and corralling lobsters purchased from commercial fishers. The northern impoundment was constructed just shoreward of a ledge that is mostly submerged at high tide. The ledge extends to the north of the northern impoundment, through the proposed expansion area and beyond. The intertidal zone shoreward of this ledge is impounded (approximately 1.5 acres) by the ledge and the dike surrounding the northern pound, but is not used for lobsters. Apparently, the natural drainage for this area ran through what is now the northern lobster pound.

A culverted intermittent stream drains into the partially impounded area north of the northern lobster pound. The surrounding area is essentially undeveloped rocky coastline with scattered fringing marshes and mudflats. The habitat conditions are typical for this section of the Maine coast.

TYPE/AMOUNT OF HABITAT AFFECTED

The project as proposed would impound approximate 1 acre of intertidal habitat, most of which is already partially impounded due to the presence of the existing northern pound. A portion of the intertidal zone would be filled by the footprint of the dike. The remaining ponded area (about 0.5 acre) would be restored to fully flushed intertidal conditions.

HABITAT FUNCTIONS AND VALUES AT RISK

The proposed expansion area is partially degraded already. The existing pound restricts tidal flushing in the expansion area, creating a large tide pool perched above the mean low water line. When the intermittent stream flows it discharges into this pool, creating a brackish environment and probably resulting in osmotic stress for organisms within the pool as they switch from saline to brackish conditions with every tide. Fill for the dike would be placed on ledge, with negligible environmental impact. Half an acre of impounded rocky intertidal habitat would be restored.

HISTORICAL CONTEXT OF DEVELOPMENT

The applicant's property has been extensively manipulated over time by creating the two existing lobster pounds, building roads, and re-routing the intermittent stream. Approximately 4.5 acres of intertidal habitat has been either filled, dredged, or flooded.

POTENTIAL FUTURE HABITAT IMPACTS

Additional development in this area would likely be limited to expansions to the pound operations and pile-supported piers built for recreational boating access from nearby residences.

NET HABITAT LOSS/DEGRADATION OVER TIME

The proposed expansion would not expand the footprint of impact from past development, and in fact would restore an area previously impacted. A total of approximately 4.0 acres would continue to be affected.

CUMULATIVE EFFECTS

This project will have a negligible contribution to net cumulative environmental impacts to coastal habitat in the vicinity.

RECOMMENDATIONS

NMFS commented on this project to the Corps of Engineers verbally at a joint permit review meeting on July 19, 1994. Based on a site visit and review of the historical record of development at the site, NMFS did not object to the project, but recommended that the permit include a condition that no riprap from the proposed ledge removal be used to armor the shore of the proposed new lobster pound or the surrounding area, which is fringed by salt marsh.

RESULTS

The project has not yet been authorized by the Corps, but will likely receive a permit in the near future.

UTILITY OF THE HABITAT-BASED LANDSCAPE APPROACH

In this case, the Habitat-based Landscape Approach was useful to the extent that it helped to place the proposed lobster pound expansion in perspective by highlighting the role of previous disturbance in changing the ecology of the project site. However, many aspects of the Cumulative Impacts Assessment Protocol were not applicable to this case since the project area is largely undeveloped and is not subject to other apparent environmental stresses.

Case Study F: Southwest Boat Marine Services

PROPOSED PROJECT

The applicant proposes to expand an existing boat yard and service facilities in Southwest Harbor, Maine. The project includes constructing and maintaining two pile-supported wharf extensions measuring roughly 48' x 62' and 70' x 98', building a new granite bulkhead, filling approximately 490 square feet of intertidal habitat, and removing an old marine railway.

LANDSCAPE SETTING

The project site is located on the northern shore of Southwest Harbor, Maine, an active fishing and recreational boating port. The shoreline is heavily developed with commercial and recreational facilities. The existing facility consists of two large wharves extending into Southwest Harbor, one of which is used by commercial fishing vessels, with the other used by recreational vessels. An inactive marine railway extends into the harbor between the two wharves. The applicant rents wharf space to vessel owners, but apparently provides no other marine services. However, the site appears to have been used as a more active boat yard in the past. A small parking lot and two large buildings are on the property. One of the buildings is built on one of the wharves.

The intertidal area in the vicinity of the marine railway has been heavily degraded by activity associated with the boat yard. In particular, virtually the entire area, extending to the adjacent property east of the facility, is blanketed by a thick layer of a black, sandy, oily-smelling material that apparently was used for sandblasting vessel hulls. The area covered with this material is largely azoic, although adjacent areas where the material has eroded have a more natural and productive soft substrate with a typical intertidal community of rockweeds and benthic invertebrates.

The western portion of the site, where the applicant proposes to build the smaller of the two wharf extensions, is a far more natural and undisturbed area. This region is rocky in the upper intertidal zone and supports a dense macroalgal community, and the subtidal area is shallow with soft substrate. The entire area is a transition zone between the developed portion of the coastline and a small undeveloped cove to the northwest.

TYPE/AMOUNT OF HABITAT AFFECTED

The project as proposed would substantially degrade the undeveloped area west of the existing wharves by shading the intertidal and shallow subtidal areas under and around the proposed wharf extension, increasing disturbance and activity in the area, and increasing the potential for introduction of debris and pollutants. The project would also further degrade the intertidal and subtidal habitat in the vicinity of the existing marine railway, and would eliminate 490 square feet of intertidal habitat which, although presently degraded, could be restored in the future.

HABITAT FUNCTIONS AND VALUES AT RISK

Given the extent of cumulative habitat loss and alteration in the vicinity, the undeveloped cove to the west of the project site likely provides valuable refuge and foraging habitat for finfish, lobsters, and crabs, as well as waterfowl and other wildlife. The intertidal area under the proposed western wharf expansion provides suitable habitat for amphipods and other microorganisms, as well as crustaceans and foraging finfish. The subtidal region under both proposed wharf expansions has a shallow, gently-sloping soft substrate that provides highly suitable habitat for a variety of fish and shellfish.

HISTORICAL CONTEXT OF DEVELOPMENT

Several other major developments line the shore in the vicinity of the proposed project. The Mount Desert Oceanarium is located adjacent to the project site, including major wharves and possible historical fill. The Coast Guard Station is located adjacent to the Oceanarium near the end of the peninsula at Clark Point, and its shoreline is armored with riprap. The amount of habitat loss at this site is unclear.

Two federal anchorages totaling 10 acres in size are located in the harbor just to the southwest of the project site, and were created by dredging in 1962. The property to the north of Southwest Boat is a private residence with apartments and is built on filled land in an otherwise undeveloped cove. The owner received a permit to construct a pile-supported pier with a ramp and float at the site in 1994, and has already completed the project. The owner had applied for a Corps permit for a similar structure with a much longer string of floats in 1991, but his application was denied due to navigational concerns. Another pile-supported residential pier exists at the far side of the cove.

POTENTIAL FUTURE HABITAT IMPACTS

Future habitat impacts along this section of the shoreline could include additional float or wharf expansions, and perhaps fill projects similar to the proposal by Southwest Boat.

NET HABITAT LOSS/DEGRADATION OVER TIME

Based on site inspections, the quantity of filled intertidal mudflats and shallow subtidal habitat in the project vicinity may be as much as 2 acres. Most of the shoreline in the area is heavily developed and consists of riprap and bulkheads. However, the cove to the north is undeveloped except for two recreational boating piers, and consists of a broad mudflat with scattered rock outcrops.

CUMULATIVE EFFECTS

The project would contribute to cumulative environmental impacts in the area by filling an additional section of intertidal habitat, armoring additional shoreline, adding more wharf space, and increasing industrial activity. In particular, the northwestern portion of the expansion would encroach upon a largely undeveloped cove, the habitat value of which is magnified by the extent of development along the remainder of the surrounding shoreline.

RECOMMENDATIONS

NMFS commented on this project to the Corps of Engineers by letter dated August 2, 1994. NMFS' letter stated that the potential impacts of the project exceed the "minimal impact" threshold under the Maine State Program General Permit. An individual Corps permit should be required for this project, including an evaluation of less damaging alternatives. For example, NMFS recommended that the applicant consider scaling back the project by dropping from the proposal the westernmost wharf addition, the bulkhead, and the intertidal fill. Provided there is adequate justification for additional wharf area, the proposed wharf expansion between the two existing wharves could be extended over part of the area currently proposed for filling, thus providing a contiguous work area without destroying intertidal habitat. NMFS also recommended investigating removal of the black sandblasting material and restoration of the degraded intertidal area as compensation for the environmental impacts of the project.

RESULTS

The Corps has relayed NMFS' concerns to the applicant, and preliminary discussions with the applicant suggest that he may be willing to make NMFS' suggested modifications and pursue restoration of the degraded intertidal habitat on the property.

UTILITY OF THE HABITAT-BASED LANDSCAPE APPROACH

Given the heavily developed nature of the project site, the Habitat-based Landscape Approach was a helpful tool for attempting to document the incremental impacts of past development and determining the effects of the proposed boat yard expansion on remaining habitat values. Unfortunately, we were unable to obtain detailed information on the habitat conditions in the project area prior to development or the quantity of habitat affected by development over time. Also, without a harbor management plan or similar guide, is was impossible to compare development trends in the project area with desired management objectives. Despite these limitations, NMFS was able to use this approach to help illustrate that cumulative impacts of development at the site could be alleviated by reducing the project size and including intertidal habitat restoration as compensatory mitigation.

Case Study G: Indiantown Island

PROPOSED PROJECT

The applicant proposes to build a 400 foot long two lane bridge built on either 28 or 56 concrete piles (depending on design), providing access to an undeveloped island from the mainland. The island would then be subdivided into 13 lots, each greater than 4 acres in size, with one private home built on each lot. The plan also calls for utility crossings, a community wharf, and seawater intakes for fire protection.

LANDSCAPE SETTING

The project site is an undeveloped 60 acre island in Boothbay, Maine. The island is located close to the mainland in the Sheepscot River estuary and is densely forested with mostly coniferous trees. The mainland nearby and developed islands in the vicinity are rural residential areas.

TYPE/AMOUNT OF HABITAT AFFECTED

As proposed, the bridge pilings would displace less than 100 square feet of intertidal and subtidal soft bottom habitat. However, the indirect and secondary impacts associated with building the bridge include non-point source pollution from the new housing development (runoff from septic systems, lawn fertilizers, motor vehicles) and loss of wildlife habitat on the island.

The bridge alignment is dominated by intertidal mud flats and mussel beds. Resources in the proposed wharf/marina area are not known at this time, and potential impacts should be noted in the pending environmental assessment.

The impacts of the bridge on navigation have been identified by the Coast Guard as a possible concern.

HABITAT FUNCTIONS AND VALUES AT RISK

The intertidal mud flats along the east side of the island provide good quality habitat for benthic invertebrates, which are likely preyed upon by a variety of fish species at higher tidal stages and by birds at low tide. Provided bridge construction is accomplished without placing heavy equipment directly on the mud flats (as would likely be required by permit conditions), construction-related impacts to this intertidal habitat would be temporary. However, secondary impacts over time may include increased input of contaminants and elevated nutrient levels, possibly leading to algal blooms and eutrophication, degrading the overall habitat value of the area.

HISTORICAL CONTEXT OF DEVELOPMENT

The islands near the project site, including Indiantown, were used historically as fishing camps and had a Native American presence in the 17th century. One house was located on Indiantown Island historically, and two large shell piles have been noted.

POTENTIAL FUTURE HABITAT IMPACTS

Three general observations can be made regarding islands in the Boothbay area. First, most large islands have been targeted for development. Second, those islands that have light development (1 to 5 homes, usually used seasonally) have been family owned for generations. Third, those islands that have not seen development are either too small, too rocky, or too far away from the mainland for development to occur. Thus, there is limited potential for further impacts to similar coastal resources. However, Tibbet Island, an 18 acre undeveloped nearshore island with a bridge located about three miles north of Indiantown, was scheduled to be auctioned in September 1994, and was advertised as a potential site for residential development. Thus, whether on islands or the mainland, residential development will likely continue to expand in the region, along with associated water quality impacts similar to those that would be expected from the Indiantown Island development.

NET HABITAT LOSS/DEGRADATION OVER TIME

Out of the 66 island in the four townships surrounding Indiantown (Boothbay, Boothbay Harbor, Southport, and South Bristol), 26 are undeveloped (39%), 22 are lightly developed with 1-5 homes (33%), and 17 are highly developed (26%). Five out of eight large islands (41 to 84 acres in size) in the four townships have been developed. Thus, 37% of the islands in this area that are similar in size to Indiantown remain undeveloped.

CUMULATIVE EFFECTS

If Indiantown Island were developed, the proportion of undeveloped large islands in the area would decrease to 25%. Water quality impacts, although difficult to quantify, would contribute to the ambient nutrient and contaminant load. Depending on the assimilative capacity of the area the ecological effects of this change may not be apparent in the short term, but cumulative effects of similar development over time could lead to measurable water quality degradation.

RECOMMENDATIONS

At a pre-application meeting on May 3, 1994, NMFS recommended that the Environmental Assessment for the project evaluate impacts on water quality as well as direct habitat impacts at the site of the bridge and the proposed community wharf. In general, NMFS recommended that the applicant assess all reasonably foreseeable environmental impacts associated with the development (e.g., any expected additional development by individual lot owners once the development is built).

RESULTS

The permit application is pending while the applicant prepares an Environmental Assessment. Environmental review will resume once that document is complete, followed by a permitting decision.

UTILITY OF THE HABITAT-BASED LANDSCAPE APPROACH

For the Indiantown Island project, the Habitat-based Landscape Approach served to emphasize the importance of indirect environmental impacts and the scarcity of island environments similar to the project site. From a marine habitat standpoint, cumulative impacts in this case are primarily limited to effects on water quality, although for land use planners the disappearance of undeveloped islands along the Maine coast may also be a concern. Unfortunately, the Cumulative Impacts Assessment Protocol is not well suited to addressing either of these issues, since it focuses on physical (not chemical) impacts to habitat and does not account for specific human use values.

Chapter 5
Conclusions

EVALUATION OF THE TWO APPROACHES AND FIELD TEST RESULTS

Environmental assessment can be a subjective process, particularly where there is incomplete information. Assessing cumulative impacts (rather than project-specific) is especially difficult because it may not be possible to document environmental effects that take place in different parts of an ecosystem and at different times. The two approaches we developed for assessing cumulative impacts both are limited by this problem. Cumulative impacts assessment is imprecise without sufficient data to prove both (a) what environmental conditions and ecological relationships existed prior to development, and (b) that development caused observable changes in environmental quality or species abundance. We attempted to account for these uncertainties by performing iterative evaluations of both approaches and seeking peer reviews of our methodologies. Nevertheless, the two approaches remain imperfect, and should be used cautiously.

Key Indicator Species Approach

We designed the Key Indicator Species Approach to emphasize incremental ecological effects to an important indicator organism. These effects can then be utilized as a guide for assessing overall environmental impacts. Using habitat requirements of an indicator species, this approach demonstrates that a specific cause/effect relationship between coastal development and impacts to living marine resources can form the basis for a cumulative impact assessment. A protocol for linking the cumulative losses of crucial habitat functions can provide sufficient information to strengthen the technical basis for NMFS' recommendations regarding proposed coastal development. In Cases Studies A through C, understanding the functional needs of a specific resource enables one to consider cumulative impacts in terms of the ecology of a large area.

To conclude that proposed development projects would not adversely affect living marine resources, resource managers must confirm that anticipated habitat impacts can either be counterbalanced by habitat values in adjacent areas or be mitigated. Case Studies A and B both possess this relationship. Once we began to assess the "needs" of the Atlantic silverside we were able to identify options that mitigated the impacts of the proposed construction activities.

In the case of Fairfield Beach (Case Study B), we found the indicator species approach extremely valuable because it prompted us to evaluate the proposed bulkheading in the context of the entire tidal portion of the Pine Creek basin. The indicator species approach helped to focus our review on resource-specific mitigating measures to alleviate environmental impacts within the river basin. Through that perspective, NMFS was able to develop a series of minor project modifications that would, individually and cumulatively, reduce the impacts associated with construction of the bulkhead.

In the case of the Milford Harbor application (Case Study A), NMFS was asked by the state regulatory agency and the applicant to explain our review process and conclusions. Through the Key Indicator Species Approach we were able to explain the positive and negative biological consequences of each component of the project, as well as specific mitigation measures to offset identifiable functional values impacted by the proposal. This degree of resource-based ecological detail appears to have influenced the state's regulatory decision.

In the case of the application for Jeffrey T. Gardner (Case Study C), our findings indicated that the proposed project would benefit the ecology of Winnapaug Pond. The Key Indicator Species Approach also suggested that habitat values could be maintained by insuring that the aquaculture structures are securely anchored within the pond (which had an added benefit of improving public safety). In addition, NMFS presently is reviewing three similar aquaculture projects in Rhode Island, and will benefit by applying the lessons learned from the Gardner project.

In view of the success that we have had with the Atlantic silverside as an indicator species, we suggest that American lobster (*Homarus americanus*), winter flounder (*Pleuro-nectes americanus*) and the bay anchovy (*Anchoa mitchilli*) be the next species investigated through the Key Indicator Species Approach. These species are important from a number of perspectives including ecological and economic. American lobster and winter flounder are heavily fished for direct consumption and their stocks are reported to be in decline. The bay anchovy is another lower trophic level species that supports many higher level predators.

Selecting indicator species that have a broad role in the environment is crucial if the organisms are to be truly indicative of overall ecological conditions. However, there is a significant data accumulation and management cost involved in the collection and review of appropriate literature as well as extrapolation of controlled research findings to field conditions. Fortunately, we found the effort beneficial since it improved our understanding of Atlantic silverside ecology. Our examination of this approach was aided by frequent consultation with researchers, who helped us link life history information (which generally focuses on the natural forces influencing survival) to anthropogenic impacts.

Habitat-based Landscape Approach

We designed the Habitat-based Landscape Approach to account for losses in habitat functions and values from all sources within a given geographic area, in addition to the specific project under review. Although regulators require site specific resource information and impacts assessments as a basis for their permit decisions, in many cases important environmental impacts only become apparent through a broader landscape perspective. This broader view allows analysis of a pending project together with other coastal development—past, present, and future—at the project site and in surrounding areas.

Based on Case Studies D through G, the Habitat-based Landscape Approach appears to be a useful tool for cumulative impacts assessment, albeit with several limitations. Particularly in cases with substantial past development, this approach provides a simple methodology for documenting the type and extent of habitat degradation and loss from coastal development over time. Once compiled, this information can increase the ability of resource managers to assess overall environmental impacts to an area, as well as the contribution of a proposed project to further declines in environmental quality. In situations where adequate information exists and can be obtained within a reasonable time frame, this technique may be extremely beneficial since it enables resource managers to trace a series of environmental impacts and then evaluate a pending proposal with a better understanding of the influence of development on localized environmental conditions.

The overall utility of the Habitat-based Landscape Approach for assessing cumulative environmental impacts is controlled by several limiting factors. First, the process of gathering relevant information on past habitat conditions and development impacts is extremely time consuming. The Habitat-based approach requires the discovery and application of far more information, from a wider variety of sources, than is typically used in project reviews. In many cases permit reviewers may not have the flexibility to devote sufficient time to a detailed investigation of issues that are not directly related to a site-specific impacts assessment. Thus, on a case-by-case basis resource managers should balance the potential benefits of applying this approach against the costs of devoting scarce staff resources to the review of a single project area. An advantage to carrying out such an investigation, however, is that once information is compiled it can later be applied to cumulative impacts assessments of other projects in the same area.

Second, we found that portions of the available information on past environmental conditions and habitat impacts were contradictory, incomplete, or inaccurate. Data from Corps of Engineers permit files, interviews with harbormasters, and historical records sometimes conflicted or left gaps. In particular, the habitat functions and values lost over time were not always well documented, forcing us to draw conclusions based on the weight of evidence available.

A third limitation is that the Habitat-based Landscape Approach does not directly address cumulative impacts to human use values, such as recreational boating, fishing, or access to the shore. As discussed above, this approach was designed to evaluate cumulative impacts to habitats that are important to living marine resources. Other public interests may be impaired by the collective effects of coastal development, but are beyond the scope of this study.

Fourth, because the Habitat-based Landscape Approach focuses on the physical loss or alteration of habitat and associated biological values, it is not well suited to assessing chemical impacts to habitat quality due to nutrient inputs, contaminant spills, or other factors. For instance, an estimate of the effects of incremental changes to water quality or sediment chemistry could be inferred through the Habitat-based approach based on changes in surrounding land use, but documenting such impacts would be difficult unless specific studies are available.

In addition to these four limiting factors, an important observation surfaced regarding the utility of the Habitat-based Landscape Approach. As expected, we found that it was not possible to confirm that the loss or degradation of habitat documented in the case studies actually caused identifiable declines in overall species richness or productivity. Even with an improved understanding of the types and quantities of habitat lost in an area over time, it remains extremely difficult to ascribe population scale resource based ecological importance to specific discrete areas of habitat.

COMPARISON OF THE TWO APPROACHES

Both the Key Indicator Species Approach and the Habitat-based Landscape Approach can be useful for resource managers who suspect that environmental conditions are being eroded by the cumulative effects of development, yet lack sufficiently detailed information about impacts to localized environmental conditions. The two approaches differ primarily in orientation. The indicator species approach takes a "bottom up" perspective by projecting broad scale effects based on the site-specific ecological requirements of a representative species. In contrast, the habitat-based approach takes a "top down" perspective, using historical records to document habitat loss, and inferring impacts to living marine resources according to the type and quantity of habitat functions lost over time.

A major advantage to the Key Indicator Species Approach is that once life history and habitat utilization data is compiled, the approach to assessing impacts can readily be transferred to other areas that support the same species and similar environmental conditions. Although information gathered through the Habitat-based Landscape Approach is area-specific and cannot be used in other settings, the habitat-based technique provides greater documentation of the aggregate effects to important habitats due to a series of incremental impacts.

Although both approaches have their strengths, it is important to note that neither of the two approaches yields enough information about proposed coastal development projects to make a sufficiently persuasive case for permit denial based on cumulative impacts alone. Under the Corps of Engineers regulatory program (and most other regulatory systems for coastal development), environmental impact assessments focus primarily on the specific ecological consequences of proposed projects, rather than the collective impacts of a series of individual projects over time. The cumulative effects of development must be considered in the Corps' regulatory decisions, but in order for environmental factors to influence permit decisions, site-specific resource impacts must be documented. Thus, the principal advantage to cumulative impacts assessments using either of the two approaches we developed is that these techniques can help resource managers to understand better the contribution of site-specific environmental impacts to declines in habitat quality and/or quantity within larger ecological systems.

ADDITIONAL INFORMATION NEEDS

More work is needed to refine the two approaches we developed and to improve the prospects for making cumulative impacts analysis a routine step in environmental decision making. In general, a prerequisite to determining how individual development projects contribute to incremental declines in overall environmental quality is an improved understanding of how specific components of ecological systems influence the system as a whole. Thus, both the Key Indicator Species Approach and the Habitat-based Landscape Approach could be strengthened by continued research into the physical, chemical, and biological interrelationships within coastal ecosystems.

In the shorter term, a couple of steps can be taken to make cumulative impacts analysis (using our approaches or others) more practicable. To facilitate the evaluation of future development, local or regional planners could inventory existing development and research pre-development conditions to determine the quantity of habitat that has been lost or altered over time. When additional development is proposed, anticipated impacts could then be evaluated using this pool of information, viewing proposed actions in the context of a series of related habitat impacts. The result would be an improved ability to assess pending development proposals together with the cumulative effects of past losses.

Another valuable step toward improved cumulative impacts assessment would be for coastal permitting and zoning processes to become more oriented toward watershed-based environmental planning and regulation, as opposed to evaluating development on a project-by-project basis. The clearest way for decision makers to account for cumulative impacts is to try to avoid regulating development through a series of incremental decisions, since the collective effects of such actions cannot easily be evaluated. To bring about this type of shift, coastal communities would need to undertake comprehensive local and regional planning, establishing measurable goals and benchmarks against which to evaluate the individual and cumulative environmental impacts of coastal development.

Appendix A
Reference List for the Key Indicator Species Approach

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Appendix B

Habitat Documentation for the Key Indicator Species Approach

ORGANISM: ATLANTIC SILVERSIDE

FACTOR: WATER TEMPERATURE PRIMARY IMPORTANCE: SIZE AND FITNESS

Importance of the Factor to the Organism	Ref#	Page	Impact Activity
Water temperature influences sex determination during larval development of the species by influencing the body size, and hence, the fitness for survival of the individual.	2	514	Discharge
	2	518	Discharge
Low water temperatures produce significantly higher proportions of females than do the higher temperatures which produce predominantly males.	2	514	
	5	577	
Environmental sex determination that occurs in varying water temperatures may be an adaptive development.	4		
Temperatures characteristic of the early breeding season (11-19° C in April and May) produce females, and temperatures of the late season (17-25° C in June and July) produce males.	4	298	
	5	577	
	5	578	
Females of the species are larger in size although they grow at a similar rate, because the females are produced earier in the season and have a longer growing season than the males.	4	298	

ORGANISM: ATLANTIC SILVERSIDE

FACTOR: WATER TEMPERATURE PRIMARY IMPORTANCE: SIZE AND FITNESS

Importance of the Factor to the Organism	Ref#	Page	Impact Activity
In order for the organism to survive and produce both sexes in adequate numbers, the environment must be patchy, or slightly favor one sex over the other.	4	298	
Winter mortality was size selective, and fish returning to the shore zone in the spring displayed an obvious shift in the length/frequency distribution toward larger individuals that could not be explained by winter growth.	4	302	
Increased size resulting from temperature dependent sex determination results in an increase in gamete production which raises the level of reproductive success. This relationship seems to best benefit females of the species	4	306	

ORGANISM: ATLANTIC SILVERSIDE

FACTOR: WATER VELOCITY PRIMARY IMPORTANCE: REPRODUCTIVE SUCCESS/CUES

Importance of the Factor to the Organism	Ref#	Page	Impact Activity
Spawning runs began when daytime flood vel. ranged from 3 to 16 cm sec^{-1} (mean = 11). The runs ended when ebb velocities ranged from 5 to 22 cm sec^{-1} (mean = 17).	7	97	Culvert
			Dredge
			Fill
Spawning runs occurred in response to decreased current velocities at high tide. As such sperm entering the water during diminished tidal currents would be less susceptible to dispersion.	7	99	Culvert
	7	102	Dredge
	3	275	
The onset of spawning occurs as a result of decreasing water velocities at high tide in combination with photo-period. The availability of spawn habitat at this time also plays a part in whether spawning activity commences.	7	100	Culvert
			Dredge
			Fill

ORGANISM: ATLANTIC SILVERSIDE

FACTOR: WATER QUALITY IMPORTANCE TO ORGANISM: SUCCESS OF VARIOUS LIFE STAGES

Importance of the Factor to the Organism	Ref#	Page	Impact Activity
Large numbers of silversides will often spawn in very small patches of cordgrass. This activity deletes the DO concentrations in the local area, stressing the reproducing fish. DO was reduced from 6.1 to <1 mg/l.	3	273	Dredge
			Culture
			Fill
Silversides behaved as if in a spawning stupor, especially during the period immediately after spawning when they formed non-schooling aggregations in nearshore zone. This behavior could result from low DO and increase predation in the nearshore area.	3	274	Dredge
			Culture
			Fill

ORGANISM: ATLANTIC SILVERSIDE

FACTOR: WATER QUALITY   IMPORTANCE TO ORGANISM: SUCCESS OF VARIOUS LIFE STAGES

Importance of the Factor to the Organism	Ref#	Page	Impact Activity
Large numbers of silversides will often spawn in very small patches of cordgrass. This activity deletes the DO concentrations in the local area, stressing the reproducing fish. DO was reduced from 6.1 to <1 mg/l.	3	273	Dredge
			Culture
			Fill
Silversides behaved as if in a spawning stupor, especially during the period immediately after spawning when they formed non-schooling aggregations in nearshore zone. This behavior could result from low DO and increase predation in the nearshore area.	3	274	Dredge
			Culture
			Fill

ORGANISM: ATLANTIC SILVERSIDE

FACTOR: TIDAL PRISM PRIMARY IMPORTANCE: REPRODUCTIVE SUCCESS/CUES

Importance of the Factor to the Organism	Ref#	Page	Impact Activity
Spawning runs began when daytime flood vel. ranged from 3 to 16 cm sec^{-1} (mean = 11). The runs ended when ebb velocities ranged from 5 to 22 cm sec^{-1} (mean = 17).	7	97	Culvert
			Dredge
			Fill
The onset of spawning occurs as a result of decreasing water velocities at high tide in combination with photo- period. The availability of spawn habitat at this time also plays a part in whether spawning activity commences.	7	100	Culvert
			Dredge
			Fill

ORGANISM: ATLANTIC SILVERSIDE

FACTOR: SUBSTRATE PRIMARY IMPORTANCE: AVAILABILITY OF SPAWNING HABITAT

Importance of the Factor to the Organism	Ref#	Page	Impact Activity
The position of spawning runs at each site are related to the location of suitable spawning substrates including cordgrass, detrital mats, and erosional scarps.	3	273	Dredge
			Fill

ORGANISM: ATLANTIC SILVERSIDE

FACTOR: SALTMARSH VEGETATION PRIMARY IMPORTANCE: SPAWNING HABITAT

Importance of the Factor to the Organism	Ref#	Page	Impact Activity
The fish deposit their eggs on the lower stems of cord- grass plants, and exposed roots systems found in the uppermost portion of the intertidal zone.	3	271	Dredge
			Fill
			Bulkhead
Individuals that utilized cordgrass as substrate preferred areas where free swimming movement of a school over the vegetation at high tide was possible.	3	271	Fill
			Culvert
			Bulkhead
The silverside appeared to spawn in cordgrass that was near the water's edge and was covered to a depth of 0 to 30 cm.	3	271	Dredge
			Fill
			Bulkhead
The females release their eggs between the stems of the plants, and the males (sometimes multiple) follow the females and release their sperm as they cross the area of cordgrass where the eggs had been deposited.	3	271	Dredge
			Fill
The threads that form prior to release of the ova adhere to the base of the stem, anchoring the eggs in a position above the substrate that is low enough on the plant to be partially shaded from direct sunlight.	3	271	Dredge
			Fill

ORGANISM: ATLANTIC SILVERSIDE

FACTOR: SALTMARSH VEGETATION PRIMARY IMPORTANCE: SPAWNING HABITAT

Importance of the Factor to the Organism	Ref#	Page	Impact Activity
The silverside used detrital mats with a surface area of .5 to 5.0 mm^2 found located in the upper intertidal zone over or within cordgrass plants as spawn substrate. These mats consisted of decomposing cordgrass. Spawning in these areas was indiscriminate.	3	271	Dredge
			Fill
Large numbers of silversides were documented as spawning in a very limited area of cordgrass from $1m^2$ to $10m^2$. This behavior depleted DO in the area.	3	273	Dredge
			Culture
The position or location of spawning runs is related to the location of suitable spawning substrates, including cordgrass, and detrital mats.	3	273	Dredge
	7	100	Fill
The presence of tall cordgrass appeared to affect the potential for multiple spawns to occur in an area. Tall cordgrass is used more extensively as spawn habitat.	3	274	Fill
It was concluded with the help of other data that the use of cordgrass substrate for spawning helps to reduce the potential for mortality associated with temperature and desiccation stress.	3	275	

ORGANISM: ATLANTIC SILVERSIDE

FACTOR: COVER/PREDATION PRIMARY IMPORTANCE: SURVIVAL AND ENERGY TRANSFER

Importance of the Factor to the Organism	Ref#	Page	Impact Activity
Schools of sub-adult bluefish that had been preying on silversides prior to spawning, did not penetrate further than the 4 mg/l DO isopleth, while C. nebulosis moved in as far as 2.5 to 3 mg/l.	3	273	Dredge
			Fill
			Discharge
Depostion of eggs from 1.2 to 2.4 m above MLW appeared to reduce the amount of time in each tidal cycle that eggs were exposed to aquatic predators. Only the blue crab consumed eggs at high tides.	3	275	Fill
High mortalilty in offshore water suggests that the silverside serves as an exporter of biomass from the estuary to the open water. The species is used by many commercially valuable offshore fish.	6	21	
Mortalities of unprotected eggs in the subtidal zone were much higher than the mortality of unprotected eggs in the intertidal zone. The larger mortality in the subtidal zone can be partially attributed to predation.	8	81	Fill
			Dredge

ORGANISM: ATLANTIC SILVERSIDE

FACTOR: FOOD PRIMARY IMPORTANCE: GROWTH AND SURVIVAL

Importance of the Factor to the Organism	Ref#	Page	Activity
The three major food items found in the guts of adults were copepods, shrimp, and plant material. The smaller fish fed more on the zooplankton and copepods, and the larger fish on shrimp and small fish.	6	23	Fill
			Dredge
			Culture
The plant material found in the stomachs of the fish consisted of 80% grass (most S. alterniflora). The rest included diatoms, and filamentous blue-greens. However, the nutritional value of the plant material is questioned	6	23	Fill
			Dredge
			Culture
In the upper estuary plant material, fish and copepods dominated the diet. In the lower estuary, shrimp, copepods, and eggs were the staple.	6	23	Fill
			Dredge
			Culture

ORGANISM: ATLANTIC SILVERSIDE

FACTOR: AREA   PRIMARY IMPORTANCE: SUCCESS OF CRITICAL LIFE FUNCTIONS

Importance of the Factor to the Organism	Ref#	Page	Impact Activity
Individuals that utilized cordgrass as substrate preferred areas where free swimming movement of a school over the vegetation at high tide was possible.	3	271	Fill
			Culvert
			Bulkhead
The silverside appeared to spawn in cordgrass that was near the water's edge and was covered to a depth of 0 to 30 cm.	3	271	Fill
			Culvert
			Bulkhead
The fish deposit their eggs on the lower stems of cord-grass plants, and exposed roots systems found in the uppermost portion of the intertidal zone.	3	271	Dredge
			Fill
The silverside used detrital mats with a surface area of .5 to 5.0 mm^2 found located in the upper intertidal zone over or within cordgrass plants as spawn substrate. These mats consisted of decomposing cordgrass. Spawning in these areas was indiscriminate.	3	271	Dredge
			Fill
Large numbers of silversides were documented as spawning in a very limited area of cordgrass from $1m^2$ to $10m^2$. This behavior depleted DO in the area.	3	273	Dredge
			Fill
			Culture

ORGANISM: ATLANTIC SILVERSIDE

FACTOR: ACCESS PRIMARY IMPORTANCE: ACCESSIBILITY TO SPAWNING HABITAT

Importance of the Factor to the Organism	Ref#	Page	Activity
Individuals that utilized cordgrass as substrate preferred areas where free swimming movement of a school over the vegetation at high tide was possible.	3	271	Fill
			Culvert
			Bulkhead

Appendix C

Example Field Investigation Form

Example Field Investigation Form for the Key Indicator Species Approach

Project: Jeffrey T. Gardner **Location:** Winnapaug Pond, Rhode Island

Date: 9/13/94 **Time:** 1230 **Pic:** Roll 1 (15, 16, 17)

Description: Clam culture operation for E. oyster, hard clam, and bay scallop. Winnapaug Pond is a coastal pond on the south shore of RI. Project is adjacent to Misquamicut Beach. The pond is isolated by barrier beach and Atlantic Avenue. Residential and commercial development is present. Weekapaug Breachway provides tidal influence from Block Island Sound. Cordgrass is the vegetative border, and expansive high marsh is also present. Coarse sand is the dominant substrate, and nutrient input appears to be high. Eelgrass is present in sparse quantities in deeper parts of the pond. Some of the southern wetlands are protected as state park property.

FACTOR	FIELD NOTES	SCORE	REF #
H_2O Temp	Water temperature, because of the shallow nature of the pond, is higher than expected. Because spawning of the shellfish is not an element of the proposal we do not expect water temperature to be affected. Therefore silverside spawning activities will not be impacted by fluctuating water temperatures.	Neutral	
Water Quality	Because shellfish are being cultured, it does not appear that water quality will be adversely impacted by the project. Waste products are expected to be minimal. However, elevated water temperatures in combination with the import of seed may increase incidences of communicable shellfish disease. Filtration is a plus. Susp sediments associated with harvest may be possible.	Neutral + and - cancel	
DO	DO in the ponds can get to low levels during the summer months, but it is unlikely that the operation will cause any additional impacts to DO in the pond. Therefore low DO levels will not affect silverside post-spawn survival.	Neutral	
H_2O Vel	The placement of the cages on the bottom may alter water velocities in the general vicinity, but these slight alterations are not expected to affect velocities around silverside spawn habitat. Impeding circulation may increase already heavy levels of shoaling in this portion of the pond, howerver, this will not impact the silverside.	Neutral	
T Prism	Tidal prism will not be altered by the proposed project and will not affect the inundation of habitat necessary for the spawing of the species.	Neutral	

Example Field Investigation Form

Project: Jeffrey T. Gardner **Location:** Winnapaug Pond, Rhode Island

Date: 9/13/94 **Time:** 1230 **Pic:** Roll 1 (15, 16, 17)

Description: Clam culture operation for E. oyster, hard clam, and bay scallop. Winnapaug Pond is a coastal pond on the south shore of RI. Project is adjacent to Misquamicut Beach. The pond is isolated by barrier beach and Atlantic Avenue. Residential and commercial development is present. Weekapaug Breachway provides tidal influence from Block Island Sound. Cordgrass is the vegetative border, and expansive high marsh is also present. Coarse sand is the dominant substrate, and nutrient imput appears to be high. Eelgrass is present in sparse quantities in deeper parts of the pond. Some of the southern wetlands are protected as state park property.

FACTOR	FIELD NOTES	SCORE	REF #
Prey	The creation of stable bottom by the placement of the cages will allow area for the attachment of a variety of fouling organisms. This result will increase potential food sources for the silverside, and perhaps increase rate of survival to spawn adults. Large numbers of silversides were observed foraging off of another culture project in RI. Competition may increase	Positive	
Light	The project should have no noticeable affect on the amount of sunlight penetration or photoperiod.	Neutral	
Substrate	The culture operation may indirectly alter the substrate characteristics of the area by increasing the incidence of shoaling. Beneath the cages, sediments are likely to take on a finer quality. In the area of harvest, discarded shells may contribute to the establishment of a more stable environment for the natural setting of shellfish. No affect on silverside.	Positive	
Area	Placement of cages in the subtidal zone of the pond should not affect the amount and type of habitat available for spawning and egg attachment of silverside. However, the cages will provide additional substrate by an increase in surface area.	Positive	
Predators	The increased biological productivity in the vicinity of the cages may attract additional predatory species. This could increase the predatory pressure on the silverside.	Negative	

Project: Jeffrey T. Gardner **Location:** Winnapaug Pond, Rhode Island

Date: 9/13/94 **Time:** 1230 **Pic:** Roll 1 (15, 16, 17)

Description: Clam culture of E. oyster, hard clam, and bay scallop. Winnapaug Pond is a coastal pond on the south shore of RI. Project is adjacent to Misquamicut Beach. The pond is isolated by barrier beach and Atlantic Avenue. Residential and commercial development is present. Weekapaug Breachway provides tidal influence from Block Island Sound. Cordgrass is the vegetative border, and expansive high marsh is also present. Coarse sand is the dominant substrate, and nutrient imput appears to be high. Eelgrass is present in sparse quantities in deeper parts of the pond. Some of the southern wetlands are protected as state park property.

FACTOR	FIELD NOTES	SCORE	REF #
Access	The location of the cages(~100 feet offshore) will not impede access of the silverside to the marsh vegetation used for spawning. However, the cages should be adequately anchored to prevent the structures from breaking loose and becoming lodged on the intertidal vegetated habitat. This would impede access of the fish.	Neutral	
Veg	If adequately anchored the structures will not affect growth of the intertidal marsh vegetation, and the silverside will not experience a decrease in the amount of forage or spawning habitat.	Neutral	
Cover	The additional stabilized structures will provided an increased number of crevices for the silverside to hide from predators. Survival of the juveniles may be enhanced.	Positive	

CONCLUSIONS

NEGATIVE	POSITIVE		
Predators	Prey Substrate Cover Area	Negative=1 Positive=2 Neutral=10	

Appendix D

Matrix of Habitat Factors vs. Anthropogenic Activities

APPENDIX D: Matrix of Habitat Factors vs. Anthropogenic Activities

	Dredge	Fill	Pier	Float	Culvrt	Dischrg	Blkhd	Culture
H_2O Tmp	L	M	L	L	L	H	L	L
H_2O Vel	M	M	L	L	H	L	L	M
H_2O Qua	H	L	L	L	M	H	L	H
D.O.	H	L	N	N	M	M	L	H
Prism	M	M	N	N	H	L	M	L
Substr	H	H	L	L	M	M	M	H
Vegetat	H	H	M	M	M	H	M	L
Cover	M	H	L	M	L	N	M	L
Food	M	H	L	M	L	M	L	H
Area	H	H	M	M	M	M	L	L
Access	L	H	L	L	H	L	H	L

THE ACTIVITY'S POTENTIAL TO IMPACT THESE FACTORS IS:

L = Low M = Moderate H = High N = Does not exist

Appendix E
Explanation of How Matrix Ratings Were Developed

DREDGING/NEARSHORE DISPOSAL

Water Temperature—Dredging resuspends sediments in the water column and degrades an area within 500 to 1500 meters of the site. The persistence of the degradation is related to sediment sizes, volume involved, type of removal equipment and operational window. The increased turbidity, vertical mixing and potential translocation can have a localized effect on water temperature. The depths created by dredging may raise or lower water temperature in the immediate locality for some unspecified period of time. However, the cumulative impact is probably low if the project is short-lived, the sediments are coarse grained, and the area of impact is relatively small in scale.

Water Velocity—Removal of sediment, such as the creation of a channel in the nearshore zone, can alter water velocities by (1) increasing the cross-sectional area of the flow access and reducing frictional impacts, (2) channelizing flows and increasing water velocities along the surface, or (3) increasing water velocities along the bottom of the channel. The alteration of water velocities/currents by the creation of a depression or channel in an inter-connected wetland complex has a moderate potential to occur, and can be either positive or negative.

Water Quality—Dredging resuspends benthic sediments and associated contaminants, which can degrade water quality near the dredging and disposal site. The physical removal of sediments may allow toxic compounds such as PCB's to become more available to aquatic organisms, and increase the potential for bioaccumulation within aquatic organisms. Dredging has a high probability of affecting water quality on a short-term basis, and can be a postive or negative impact.

Dissolved Oxygen—Dredging can result in the aeration of dissolved oxygen by mixing water masses which causes the entrapment of surface waters. Estuaries that possess elevated organic material loads in their sediments, when disturbed, will induce an increase in the biological and chemical oxygen demands, often resulting in D.O. depression. How the activity in question will affect oxygen levels depends on the organic composition of the sediments, salinity levels, water depth, temperature, and the amount resuspended material. Fluctuations in D.O. are of a relatively short duration, and do not linger after the activity has been completed, however, they may induce fish kills. Dredging and/or disposal activities have a high probability of altering dissolved oxygen levels in the water column. This is predominantly a negative impact.

Tidal Prism—Where tidal flow is restricted, the alteration of water depth or volume moving into an area in the nearshore zone is likely to increase the volume of water that enters or passes through an estuarine environment. Alteration of tidal prisms can degrade habitat suitability for wetlands and SAV and induce a profound effect on overall habitat value. The tidal increase may not be of considerable importance for some projects, but merits consideration where tidal flow is restricted. Dredging activities have a moderate probability of altering the volume of water in an estuary, and may be considered both a positive and negative impact.

Substrate—The removal of sediments during dredging permanently changes the substrate characteristics and the habitat value of the site. For example, fines suspended by the dredging activity routinely settle into the excavated depression creating a highly hydrated substrate in place of the original bottom, and establishing an environment that may not be suitable for habitat by infauna such as shellfish. Disposal of dredged material can also permanently alter the benthic characteristics of a site (e.g., placing mud on a sand bottom alters the community structure). Dredging and disposal have a high probability of altering substrate characteristics. This can be either a positive or a negative impact.

Vegetation—The removal or disturbance of emergent or submerged aquatic vegetation during dredging/disposal alters habitat values. These impacts generally have long-term consequences. Permanent alteration of vegetated habitat may decrease the value of a particular area by reducing wetland functions such as pollution control, export of detrital material, and nearshore productivity. Such changes may also alter the ability of the habitat to serve as a nursery or spawning area for aquatic and terrestrial species. The probability that dredging or disposal in the nearshore vegetated zone will permanently impact the quality and/or quantity of habitat is high, and generally negative.

Cover—Dredging may change the availability or accessibility of protective space. Removal of course substrates (rock, rubble) and emergent or submerged aquatic vegetation decreases the quality and quantity of hiding places available for aquatic organisms to seek protection from predation, and decreases access to biofouling organisms that are food sources. However, these protective sanctuaries, may be replaced by other types of objects offering some cover from predators such as boats, floats, or riprap. The probability that the quantity and quality of cover will be impacted by dredging or nearshore disposal operations is high/moderate, and can be either positive or negative.

Food—Dredging of shallow intertidal or nearshore areas alters water depths, potentially decreasing sunlight penetration and hence the phytoplankton production of the locality on a short-term basis. Dredging of intertidal emergents can affect nearshore productivity by reducing the amount of plant material in the form of detritus that will enter the food web. Dredging and disposal activities may also smother benthic invertebrates causing at least a temporary decline in food sources. Finally, dredging can alter the bottom suitability for colonizing species typical of the adjacent substrate. The probability that dredging or nearshore disposal activities will affect the forage available for aquatic species is high, but the impacts are moderate.

Area—Dredging activities in intertidal or nearshore habitats reduces the amount of suitable substrate type that is available for direct use by a species. Dredging also contributes to the fragmentation of the habitat, by disturbing the continuity of a large parcel. Areas which have been bisected by deepened areas may not support the same use levels as a single area. Dredging in intertidal or nearshore habitats has a high probability of altering habitat area that is suitable for spawning, nursery, and forage functions of aquatic species. The alteration of a reach of available habitat can be both positive and negative.

Access—The removal of sediments during dredging suspends material within the water column. In the short term, this suspended sediment load may physically impede, or behaviorally discourage, fish from attempting to obtain access to regular feeding, spawning, or nursery grounds. However, this impact is temporary and is not likely to remain for more than a short period of time after the dredging has been completed. The potential for dredging to affect the ability of aquatic species to travel to, or utilize necessary aquatic habitat is low, but negative.

FILLING ACTIVITIES

Water Temperature—Filling of aquatic habitat may increase water temperatures above an optimum level if an area's depth is significantly reduced. An elevation in water temperature could alter the suitability of the habitat for spawning finfish and shellfish, or could cause a change in the species composition of the area by exceeding the threshold values of the organisms that presently reside within the zone of influence. The potential for filling to modify the water temperature of an area is low, but it can influence aquatic organisms or habitat in either a postive or negative fashion.

Water Velocity—Filling activities within a waterbody such as a river or estuary can alter the natural flow patterns of a system. Filling a portion of a river channel may increase frictional forces, or increase the amount of exposed surface area in relation to the depth of the channel. This could result in a change in water velocity. Filling within a waterbody may also create localized areas of altered circulation, such as eddies, that could impact benthic habitat by scouring, or flushing juveniles or other weak swimmers from a nursery area. Filling activities have a moderate potential to affect localized water velocities or currents within an estuary. These impacts can be both positive and negative.

Water Quality—Impacts on water quality resulting from the filling of aquatic habitats can include 1) an increase in the level of suspended materials in the water column, 2) an elevation of water born contaminants (depending on the source of the fill material and the level of contaminants in the exposed surfaces of the fill), and 3) a decrease in the chemical retention abilities of substrates. The loss of chemical retention by vegetation and sediments is influenced by their organic content, and burial of such areas is permanent. However, the other impacts, elevation of sediments and contaminants, is temporary and localized. Because these impacts will occur regularly with filling, and because they are primarily temporary, there is a moderate probability that water quality will be altered at the project site. The impact of filling on water quality is negative.

Dissolved Oxygen—During the mechanical operations of filling, fine grained and organic enriched sediments may be suspended, temporarily increasing the biological oxygen demand. However, most filling activities are not drawn out over a long period of time like dredging. Therefore, the impacts on D.O. from filling are expected to be less severe than the impacts that are associated with dredging. Filling activities have a low probability of altering the D.O. levels in the water column for an extended period of time. The lowering of D.O. is predominantly a negative impact.

Tidal Prism—Filling activities that occur in the aquatic environment may affect the tidal prism chiefly by altering water depths within a tidally influenced corridor. Generally, smaller fill projects will not have a significant effect on the volume of water entering the receiving estuary or river system. However, projects with a larger scope of impact (vast acreage) will alter the tidal prism significantly, which in turn can affect the amount and type of aquatic vegetation, productivity of the estuarine or riverine habitat, and the diversity of the aquatic communities. Larger scale filling associated with residential, commercial, or industrial development will have a moderate probability of altering the tidal prism within the system. Alteration of the tidal prism can have both detrimental and beneficial results.

Substrate—Beyond outright loss of substrate by the filling activity there exists the potential for erosion induced or incomplete filling of aquatic habitat. These incomplete filling activities on intertidal or nearshore habitats can alter the size and type of substrate, making it difficult for organisms to colonize or attain community stability. Filling aquatic habitat has a high probability of changing the substrates of the impact area. Such alterations can be either positive or negative (e.g., benefits can be derived from capping polluted sediments).

Vegetation—Filling of intertidal or nearshore habitats dominated by either emergent or submerged aquatic vegetation will change the quality and/or quantity of the vegetation in the impacted area. Placing material in these vegetated zones can change the physical characteristics of the site (elevation, sediment type and size), which may affect the ability of the area to support the vegetation. Loss of this valuable aquatic habitat affects the aquatic organisms that depend on the vegetated characteristics of the site for reproduction, food, or protection. The filling of aquatic habitat has a high probability of impacting the vegetated characteristics of a site, and can have both positive and negative consequences.

Cover—Many species of aquatic invertebrates and fish depend on the presence of intertidal habitat (eg. vegetation, erosional scarps, and rocky habitat) to provide a safe haven from predation during vulnerable life stages. The filling of this habitat affects the amount and type of cover available, and adversely impacts the survival of the aquatic organisms and potentially the stability of the population. Filling shallow water habitat has a high probabilty of adversely impacting cover that these aquatic resources require. The impacts can be of both a postive and a negative nature.

Food—Shallow intertidal or nearshore habitats provide a large quantity of the food sources that are regularly available within an esturine system. Vegetated habitats contribute organic plant material. They also provide microhabitat where small aquatic organisms such as protozoans, bacteria, and algae can colonize the vegetative leaves, stems, and roots. By doing so, these organisms make themselves available for consumption by many other species of aquatic invertebrates and fish. Unvegetated tidal flats provide productive habitat dominated by microalgae (diatoms, dinoflagellates, etc.) that contribute to primary production in an estuary. Filling this habitat smothers the benthic invertebrates, decreases the flow of organic material available for transfer up the food chain, and changes the suitability of the habitat to support food producing organisms. Filling of these intertidal/shallow water habitats has a high probabilty of altering the availability of food for a variety of aquatic resources.

Area—All nearshore activities of aquatic organisms are limited in some way by the availability of suitable habitat. Filling an area may change the suitability of the habitat for a particular use, or limit the size of a particular parcel redering it unsuitable. Filling in nearshore or intertidal habitat has a high probability of altering the amount and type of habitat that is available for spawning, nursery, and forage functions of aquatic species. Habitat area can be affected both positively and negatively by such changes.

Access—Many activities that are often associated with filling such as the construction of bulkheads, groins, or fast land for development restricts movement of aquatic resources to and from available habitat if these activities are undertaken in intertidal or nearshore habitat. The activities may alter the physical characteristics of a site making it unsuitable for its previous uses, or fragment an existing habitat so it is no longer preferable by a species. Filling has a high probability of affecting the access of aquatic resources to numerous types of habitat.

PIERS

Water Temperature—The construction of an open-pile structure over inundated nearshore or intertidal habitat blocks some portion of the daily sunlight from reaching the habitat below. However, this shading effect is unlikely to affect water temperatures in the vicinty of the structure. The impact of pier placement in this habitat zone is likely to be low.

Water Velocity—The installation of the structure will affect water velocities in the aquatic environment to some extent. These impacts are likely to be isolated to minor increases, or may result in the alteration of flow direction creating small pools or eddies. Such impacts are not likely to be considered significant to most organsims or to the overall habitat value of an area. Therefore, the construction of open-pile piers in an intertidal or nearshore habitat has a low probability of affecting the water velocities of a given area.

Water Quality—Placement of recreational pile piers in the nearshore aquatic environment is likely to result in some impacts to water quality in the vicinity of the structure. These impacts may be the result of elevated sediment levels due to construction activities (pile driving, etc.) or from the use of pre-treated construction materials such as wood pile treated with CCA or creosote. However, these impacts are very local in nature, and are not likely to cumulatively impact water quality of a waterbody. Therefore, the potential is low.

Dissolved Oxygen—Directly, open-pile piers are unlikely to impact dissolved oxygen levels in the water column. Although communities of sessile invertebrates often attach themselves to the structures, they will not appreciably change the DO levels in the vicinity of the pier. Therefore, a pier is unlikely to significantly affect the levels of dissolved oxygen.

Tidal Prism—An open-pile pier is unlikely to impact the tidal prism of an area. However, a concrete or stone pier may impede flushing characteristics in a small embayment. (To alleviate confusion between these two impacts, for the purposes of this exercise solid piers will be considered fill.) Open-pile piers do not significantly affect tidal prism on a cumulative level.

Substrate—During the construction of a pier, routine activities such as pile driving and the movement of machinery may change the local substrate characteristics of an area by resuspending sediments. However, once the structure is constructed the sediment characteristics of an area are unlikely to change significantly, although minor distrubances associated with deflection or scour may occur. The construction of a pier has a low potential to impact the substrate characteristics of an area on any cumulative level.

Vegetation—Placement of an elevated structure over intertidal emergent vegetation may significantly affect the quantity and quality of vegetation within its footprint. Impacts associated with the pier include shading and the distubance of intertidal sediments and root systems from the deflection of water off of the piles. Because of the number of structures that are routinely sited within the intertidal emergent vegetated zone, open-pile piers have a moderate potential to impact nearshore vegetated habitat cumulatively.

Cover—The placement of open-pile piers in soft bottom habitat can provide hard vertical substrate for the attachment of epibenthic organisms. However, in many instances, piers are located in areas with hard or moderately hard substrates to minimize the need for maintenance. In an existing rocky community characterized by stable substrates a pier does not contibute significantly to cover. Additionally, piers may provide some minor protection from predators to small forage fishes. Therefore, the potential for piers to impact the amount of available cover is low.

Food—Piers can provide stable substrates for the attachment of fouling organisms that may include algae, sponges, and tunicates. However, the amount of surface area is small. In addition, the constuction of piers over vegetated habitat may affect the amount of organic material available for consumption. Because this impact is very local in nature, the construction of a pier carries only a low potential to impact food availability.

Area—Individually, piers actually encompass a very small area and are unlikely to have a significant effect on the existing amount of aquatic habitat. However, when evaluated on a collective basis, piers can impact a large amount of the available aquatic habitat. Piers have a moderate potential to affect the amount of aquatic habitat in a cumulative manner.

Access—When properly maintained, open-pile pier structures do not impede the access of aquatic organisms to habitat necessary for feeding, reproduction, and growth. However, when allowed to deteriorate, the structures may have a low potential to impact the access of fish to aquatic habitat.

FLOATS

Water Temperature—Benthic productivity in the aquatic environment often depends on photosynthesis of green plants, including emergent and submerged aquatic vegetation. Floating structures placed over aquatic habitat, especially vegetated aquatic habitats, may affect water temperature slightly by altering the normal metabolic processes. Heat energy is a by-product of respiration. If an increase in this biological process occurs, water temperatures may exhibit a locally defined increase. However, because the impact is of such a small magnitude, the cumulative impact of floating structures on water temperature will be low.

Water Velocity—The installation of any structure, floating or submerged, will alter water velocities in the aquatic environment. However, the proficiency of this design to absorb energy and decrease water velocity is probably minimal and highly localized. The potential for floating structures to cumulatively impact water velocities in the aquatic environment is low.

Water Quality—Generally the placement of floats in an estuarine or freshwater environment does not have any impact on water quality. However, floating docks may be constructed with wood planks or stabilized by wood piles that are pre-treated with chromated copper arsenate (CCA) or creosote. When placed in the aquatic environment the metal constituents of CCA may leach from the structure, collecting in nearby sediments, or bioaccumulating in aquatic organisms that live in close proximity to the structure. This impact is very localized in nature (usually within 3 meters), and the liklihood that floating structures will significantly impact water quality on a cumulative scale is very low.

Dissolved Oxygen—Epi-benthic communities flourish on hard surfaces that are situated in the aquatic environment. However, these organisms do not contribute to any significant fluctuation in the levels of dissolved oxygen in the water column. The presence of a float will not significantly affect the levels of dissolved oxygen.

Tidal Prism—A float will not significantly impact tidal prism on any cumulative level.

Substrate—Floating structures are often placed in shallow water habitats where they can be used for recreational or commercial purposes. As such, these structures are sometimes sited where limited access to the water is available, so that the float pounds and abrades the bottom with the daily ebb and flood of tides. This activity alters the substrate beneath and directly adjacent to the float, while rendering the bottom poor for epi-benthic attachment. Floats may also enhance the quality of the existing substrate, by providing additional area for attachment of aquatic sessile organisms. Because the level of impact a float may exhibit is based primarily on the siting of the structure, these impacts can be controlled through design modifications and are likely to exhibit a low impact to substrate characteristics on a cumulative level.

Vegetation—Depending on their design and location, floats may shade and/or physically abrade both submergent and emergent vegetation. However, sever impacts can often be avoided during the normal regulatory review. Because this is the case, floats have a moderate probability of adversely impacting vegetation on a cumulative basis.

Cover—The buoyancy devices that support the floating docks create a stable substrate for the colonzation of many aquatic organisms, and provide protection from predators for smaller finfish species. Although this aspect is beneficial, the addition of a floating structure will only make a significant difference to the addition of hard substrate habitat in areas dominated by soft-bottom communitities. Most proposals for floats are located in areas dominated by soft-bottom habitat because the installation of pile-supported structures in these areas will not be mechanically or economically feasible. As such, the probabililty the float installation will affect the availability of cover at a cumulative level is moderate.

Food—Floating structures in the aquatic environment provide stable substrates for a variety of fouling organisms including algae, sponges, ascidians, and tunicates. As such, the structure may enhance the available food source for aquatic organisms including finfish and crustaceans. The potential impact is moderate.

Area—On an individual basis floats are likely to have only a minimal impact on the existing amount of aquatic habitat. However, when viewed collectively, the amount of aqautic habitat that can be impacted increases significantly. Floats have a moderate potential to affect aquatic habitat in a cumulative manner.

Access—If properly planned and constructed, floats have minimal 3impact on the access of fish or invertebrates to habitats necessary for reproduction, feeding, and nursery activities. However, in some situations, the structures are not properly maintained (they fail) and are left to destruct on the intertidal shallows or exisiting aquatic vegetation. The potential for these scattered individual structures to cumulatively impact the access of fish to aquatic habitat is low.

DISCHARGES

Water Temperature—Discharges can have a high degree of impact due to thermal entrapment and cold shock in both the coastal and riverine environments. There is some evidence that thermal plumes can promote algal blooms and may hasten hatching and early life-stage metabolism.

Water Velocity—Discharge volumes have generally been managed to reduce their impact on water velocity. While the individual impact potential is high the cumulative impact potential is low.

Water Quality—As wastes are collected at more and more central processing facilities and population increases overload of the existing infrastructure, the impact of point source discharges of partially treated or untreated wastes has become a growing concern. Because of the perceived economies of size the use of large volume processing systems for modest discharge proposals can carry the potential for high degrees of impact.

Dissolved Oxygen—Discharges routinely increase oxygen demands and can reduce the suitability of an area for use by aquatic organisms. Summer hypoxia and anoxia events are reported from inner harbors and coastal embayments as large as the Chesapeake and Long Island Sound. Although discharges are regulated their cumulative impact remains moderate to high.

Tidal Prism—Discharges have a low impact on tidal prisms.

Substrate—Discharges routinely carry a suspended sediment load. Depending on the nature of the discharge the load is usually a mix of organic and inorganic materials. Those materials ultimately will be deposited in areas of reduced water velocity. Although dependent on the nature and volume of material involved, the impact on substrates is usually moderate.

Vegetation—Eutrophication adversely impacts the health and well being of submerged aquatic vegetation. In areas where highly organic or nutrient rich discharges occur fish and shellfish appear to suffer increased incidence of fin and shell deterioration diseases. The impacts of discharges are rated as high.

Cover—Although there can be a localized impact from discharges, those impacts should be minor in nature.

Food—Point discharges of pollution continue to be a major source of environmental contamination. Eutrophication of nearshore waters appears to be affecting the nature of the phytoplankton community and plankton density. These impacts appear to be moderate to high in a cumulative assessment.

Area—Discharges do not normally have direct impacts to habitat availability. However, their nutrient loading impacts are cumulative and can cover significant amounts of area. Because the direct impact is minor, but the secondary impacts can be significant the impacts are rated as moderate.

Access—With the passage of the Clean Water Act there are few toxic discharges that, by their presence preclude access or use of an aquatic area. For that reason the impacts are considered to be low.

BULKHEADS

Water Temperature—Bulkheads have a low impact on water temperature.

Water Velocity—Bulkheads can usually be designed to minimize their influence on currents. Thus, the impact should be low.

Water Quality—Unless circulation is altered there is little chance that a bulkhead could have a significant impact on water quality. The potential is rated low.

Dissolved Oxygen—Bulkheads should not directly impact Dissolved Oxygen. It is rated as low.

Tidal Prism—Restricting water movement by occupying significant portions of the cross sectional area of the water body can influence the size of the tidal prism. Altering the tidal prism can induce or influence several other habitat aspects. However, through careful design, in-place impacts should be moderate at worst.

Substrate—After the initial loss associated with installation there are few further adverse impacts. However, the structure provides vertical relief of varying degrees. The variability is dependent on the bulkheading material, preservatives used and the water quality/energy of the environment in which is placed. Bulkheading has an offsite erosion impact that is detrimental. Wave reflection and refraction from a bulkhead face creates adverse impacts that are moderate but persistent.

Vegetation—Wave reflection and refraction off bulkheads can alter substrate type and suitability. Although there is a potential for high impacts the norm is in the moderate range.

Cover—Although cover can be enhanced by bulkheading which provides vertical substrate, the energy problems noted above can have moderately adverse impacts in the area surrounding the bulkhead site. Altered energy fields can alter deposition and sediment accumulation zones burying or exposing habitats as the wave forces vary.

Food—Bulkheading has a minimal impact on the availability of food. However, if the bulkhead is truly intrusive and a distinct alteration of the shoreline occurs, the habitat and food available can be diminished.

Area—The passage of the Clean Water Act has reined in the use of bulkheading to create fast land. As a result there are relatively few occasions in which such a structure has anything but a minor (low) impact on habitat.

Access—Bulkheading permanently (for the life of the project) denies access or use of a piece of habitat. In that sense bulkheading has a high impact on habitat.

CULTURE IMPACTS

Water Temperature—Culture activities should not have significant impacts once hatchery/early grow out has occurred. However, hatchery operations can be a point source of heated water as a result of induced spawning and early life stage development. The impacts are identified as low.

Water Velocity—Structures placed in a waterway that contain large concentrations of fish reduce current velocities. The impacts are localized but, in confined areas, the result is alteration of sediment deposition and flushing. Both impacts influence habitat suitability and water quality which, in-turn, can influence dissolved oxygen levels. Off bottom and benthic culture facilities have moderate, localized impacts on water velocity.

Water Quality—Concentrating organisms requires an increase in food availability and creates increased concentrations of waste products. Concentrations also increase the likelihood of disease incidence in and adjacent to the site. Reduced water quality reduces site suitability for other fishery resources. Degraded water quality can be avoided, however, the "cost" is denied use of habitat. These impacts can be high.

Dissolved Oxygen—Resources consume oxygen. Their wastes also require oxygen during decomposition. The larger the concentration of resources the higher the consumption of oxygen. Depending on the hydrodynamics of the area in which the concentration occurs, the impacts can vary from minor to significant. Because of the certainty associated with this impact it is rated as high.

Tidal Prism—Culturing of organisms should not normally influence tidal prisms. However, there are practices that manipulate localized prisms for farming purposes. Lobster pounds are routinely designed to impound water to maximize available bottom habitat area. Water quality within the impoundment is critical to the well being of the resources so it is maintained at a high level. Intertidal resources can be adversely impacted by prolonged submersion. Because of their size and number and the ability of the operator to manage the impacts their rating is low.

Substrate—Farming aquatic substrate requires its alteration. While there is some evidence that habitat suitability can be enhanced, there is more likelihood that concentrating resources will diminish productivity of resources not being managed. These impacts are high. Increased waste deposition and disease incidence can degrade habitat for prolonged periods. These impacts are high.

Vegetation—As with upland farming, aquatic bottom culture routinely requires the manipulation of the substrate to maximize productivity. Because of the value of vegetated habitats it is undesirable to allow the initial placement of culture facilities in aquatic vegetation areas. However, the probability of post authorization impact is low.

Cover—Waste accumulation or substrate modification to "enhance" an area's productivity can alter cover value. Again, as with farming, a level and unobstructed bottom is preferred to facilitate placement and recovery of planted resources and retention systems. Operational needs and regulatory review should minimize the likelihood of creating situations in which cover is significantly impacted. The impact potential is low.

Food—The presence of concentrated amounts of aquatic resources and the activities associated with sustaining them, in conjunction with the manipulation of the habitat, acts to modify the availability of food for natural populations.

Area—Although individual culture activities are presently restrained in the amount of area they may occupy there is the potential for these efforts to cumulatively impact significant portions of the aquatic environment. Thus, while the individual projects are ranked as low in impact, provided all appropriate precautions are in place, there is a potential for these impacts to rise as the industry develops.

Access—Depending on the nature of the resource under cultivation, the extent of impacts to access will vary. This situation is rated as low but can, as with area, reach levels of concern as the industry expands.

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