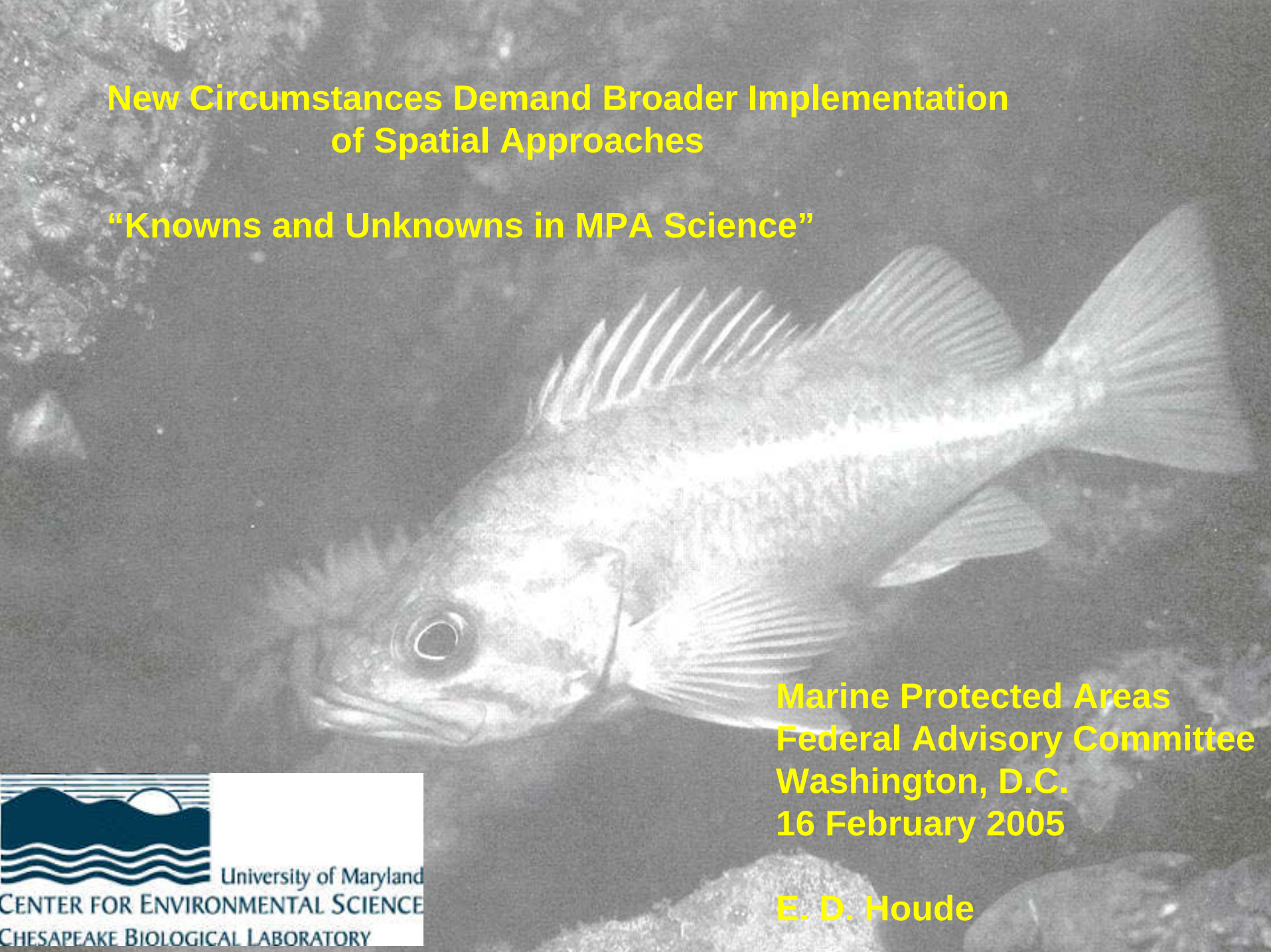


New Circumstances Demand Broader Implementation of Spatial Approaches

"Knowns and Unknowns in MPA Science"

Marine Protected Areas
Federal Advisory Committee
Washington, D.C.
16 February 2005

E. D. Houde

University of Maryland
CENTER FOR ENVIRONMENTAL SCIENCE
CHESAPEAKE BIOLOGICAL LABORATORY

Goals of Marine Reserves and Protected Areas

Augment Fishery Management

Conserve Biodiversity and Habitat

Maintain Other Ecosystem Services

Enhance Recreation and Tourism

Protect Cultural Heritage

Increase Scientific Knowledge

Provide Educational Opportunities

Marine Managed Areas, A Hierarchy of Spatial Management Approaches

- **Temporal-Spatial Closures**
(e.g., spawning areas/seasons)

- **Special Regulations by Area**
(gears, size, sex, season, effort, bycatch reduction, protect nurseries)

- **Species Protection**
(moratoria, endangered/threatened species)

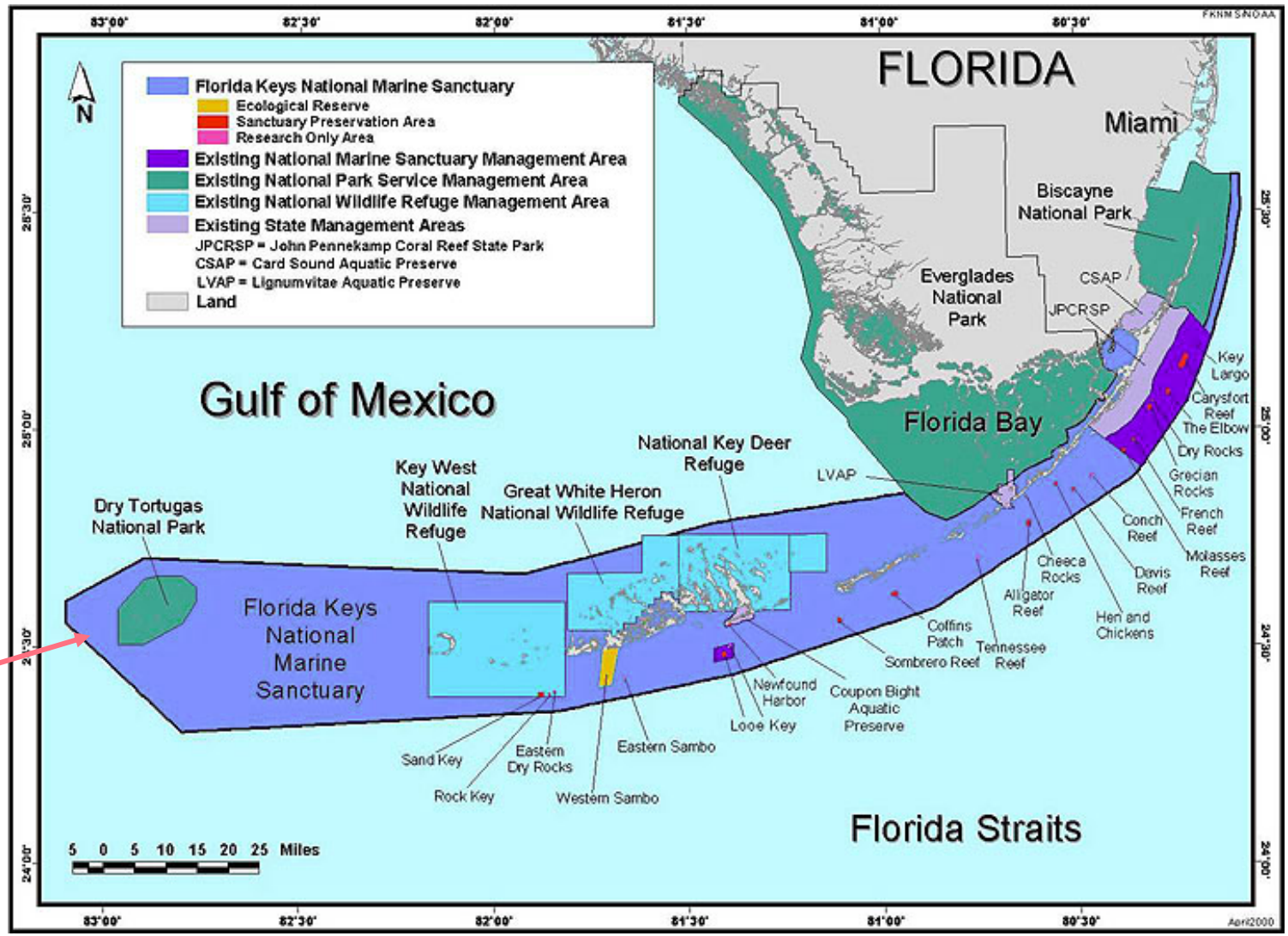
- **Marine Reserves**
(no-take areas; no removals of living organisms)

- **Ecological Reserve**
(no removals and no disturbance of the area)

- **No Access**
(critically sensitive area; no access)

Florida Keys National Marine Sanctuary

Tortugas Reserves added recently



The hierarchy of spatial management is well represented in the FKNMS

Marine Ecosystems are Heterogeneous

The heterogeneity should be considered in implementation of management programs

Shift emphasis from catch and effort controls to spatially-explicit management, with emphasis on zoning and networking (connectivity).

Emphasize conserving the productive capacity of the ecosystem, rather than individual stocks.

Implementing MPAs can be a step towards Ecosystem-Based Fisheries Management (EBFM)

New Circumstances
(Marine Ecosystems are Under Stress)

Conventional Management Needs Help:

- Fisheries
- Habitats
- Biodiversity

Resources are scarce, valuable, and not evenly distributed. Human effects are disproportionately concentrated in productive, unique, diverse parts of aquatic ecosystems.

Spatial management should be expanded but spatial management alone will not be sufficient to protect, conserve, and manage valuable resources.

A hierarchy of spatial measures exists to include in resource management plans.

Conserving Biodiversity

Values associated with marine biodiversity:

Market - biological products such as food, pharmaceuticals, biomaterials, biodegrading microbes

Ecosystem Services - water purification, bioremediation, nutrient recycling, carbon sequestration, and others.

Esthetic - recreational activities, tourism

Existence/Heritage - desire to maintain the natural world for current and future generations

MPAs and Biodiversity Conservation

MPAs can be a comprehensive tool for biodiversity conservation. MPAs can protect many species that are otherwise unmanaged.

Beyond protecting individual species and biological communities, MPAs can protect specific ecosystem structure (habitat) and services (nursery functions, food-web dynamics, water filtration, nutrient cycling), and thus add resilience to the ecosystem.

The public is sensitive to threatened biodiversity and the need to conserve it, which helps to gain support for policy changes necessary to institute area-based management.

Bristol Bay, AK

Salmon gillnet fishery

With permission, National Fisher-Man, August 2003

New Circumstances: Fisheries

Overcapitalization and Excessive Participation

- Effort has increased
- Effective effort has increased out of proportion
- New effort is more mobile, flexible, and adaptable
- Reducing effort is difficult

Overfished Stocks, Impacted Habitats

- Collapsed fisheries
- Damaged Habitats
- Bycatch Issues
- Threatened and Endangered Species

New Circumstances (cont.)

Shift in Management Philosophy

- Precautionary approach and risk-averse management
- Shifting the burden of proof
- The ecosystem as the ‘productive engine’
- Move towards multi-species and ecosystem-based fisheries management

Broadened Stakeholder Base

- Diverse interests now demand a share
- ‘Traditional users’ (fisheries) influence is diminished

A Range of Fisheries MPAs

Temporal Closures

- spawning areas of anadromous fishes
- 'growth enhancement' areas- -e.g., Gulf of Mexico shrimp

Nursery Areas

- Georges Bank cod and haddock
- swordfish in W. N. Atlantic

No-Take Areas (Fishery Reserves)

- Diverse goals and diverse fisheries
  - Rebuild, restore stocks
  - Spillover and recruitment enhancement
  - Protect critical habitat or biological communities

Bycatch Reduction Areas

- young, pre-recruit fish
- untargeted species
- threatened, endangered species

Area Closures Are a Traditional Management Approach, but Underutilized

Area closures including time-space closures (and "rolling closures") to protect individual stocks have been a traditional management tool for centuries.

Extending the concept to protect the ecosystem and biological communities to benefit biodiversity conservation and multispecies fisheries management is a simple idea, but a practically complex extension of the concept.

Will all species benefit? Will benefits accrue to the aggregate fisheries? What are the costs of managing MPAs vs conventional management approaches?

Clear Benefits and Broadly Supported

1. Protect Nursery Areas

2. Protect Threatened or Endangered Species

3. Protect or Restore Severely Impacted Habitats

4. Reduce Bycatch, particularly if associated with #1 above

Fishery Benefits: Marine Protected Areas

1. Protect nursery areas
2. Protect or restore critical habitats
3. Limit bycatch and discards
4. Protect threatened or endangered species
5. Rebuild age and size structure of stocks (and increase fecundity)
6. Promote spillover and dispersal from protected to open fishing zones
7. Reduce fishing mortality rates (?)
8. Reduce the need for stock assessment science (?)
9. Recognize ‘uncertainties’ in science and management and adopt MPAs as insurance.

In some cases, these benefits could be achieved by alternative management approaches.

Numbers, Sizes, Biomass, and Biodiversity Increase Within MPAs!

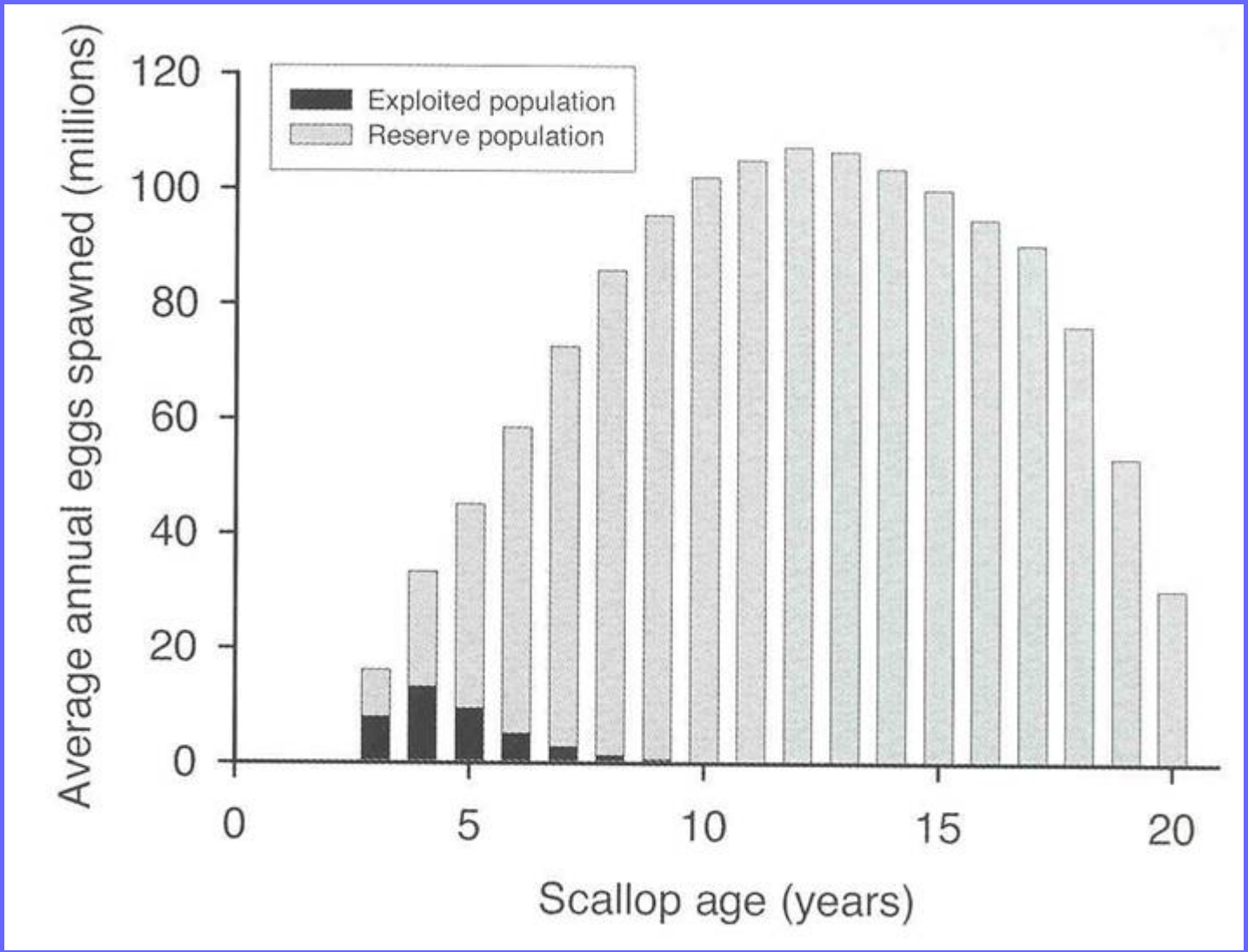
Overwhelming Evidence

Is This a Trivial Conclusion?

Implications for Fisheries Management:

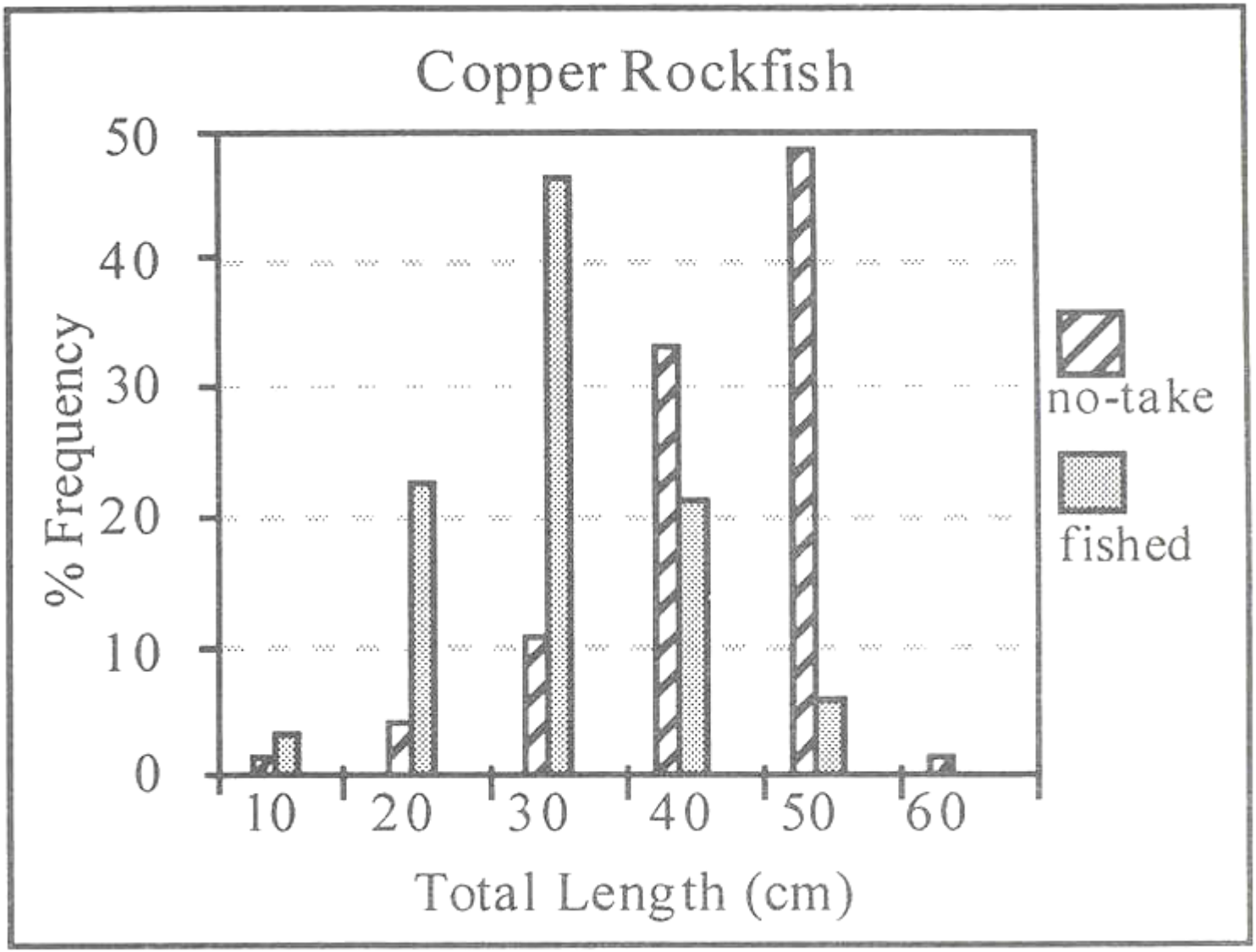
- Spawning Stock Biomass
- Fecundity
- Recruits
- Threatened/Rare Species

Sea Scallop Fecundities-at-Age



From McGarvey and Willison (1995)

Fish Sizes, in and out of an MPA



From Palsson (1998)

Successes, Benefits, Uncertainties

Most evidence of success in rebuilding stocks, restoring biodiversity, and achieving results is observed 'within' MPA boundaries.

Export of benefits to surrounding regions (a usual goal) is less certain, dependent on dispersal patterns of fish and behavior of fishers in open areas.

Economic benefits to a fishery from MPA management may not be immediate or certain and fishers may have little incentive to support MPAs unless they have potential to restore 'collapsed' stocks.

Socio-economics Issues

What happens to displaced effort?

‘Source’ areas that are presently depleted, but which have historically high productivity and profitability potential, if designated as MPAs, are most likely to increase overall stock biomass and increase profitability in a fishery.

High discount rates make it difficult for commercial fishers to accept MPAs as a management tool when performance is uncertain and benefits are displaced far into the future.

Recreational fishers may not support fishery reserves that limit their access when they believe that their fishing effort is small and not damaging to resources.

Fishers generally support MPAs proposed to address objectives other than fisheries management, e.g., biodiversity, unique habitats, historical sites.

Financial World Analogy

(from Lauck et al. 1998)

Bet Hedging → Portfolio Diversification and purchase of accident and liability insurance

Reduce the risk of loss of assets

There is a ‘premium’ cost that is accepted to achieve a reduction in risk

Bet hedging usually involves trade-offs. What ‘premium’ are we willing to accept to institute MPAs for conservation of ecosystem properties and the benefit of fisheries?

Major Conclusions from Micheli et al. (2004) Meta-analysis

1. Individual species show wide variation in response to protection. Only species that are fished and are at high trophic levels show predictable increases in abundance and biomass.

2. On average, 19% of species were affected negatively under MPA protection.

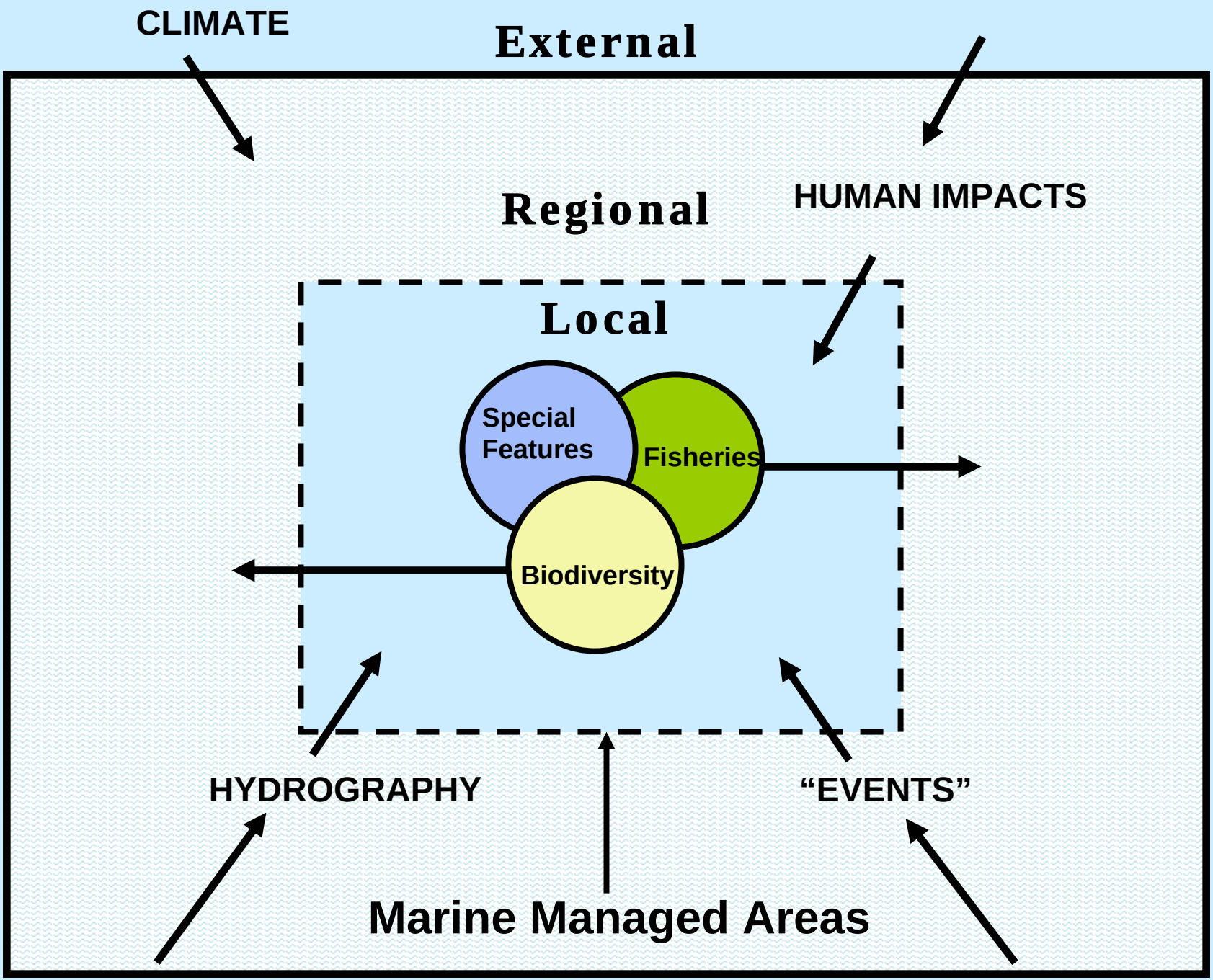
3. Fish assemblages under protection evolve over time and outcomes are variable. Evolution (recovery) may take decades. Recovery apparently only reasonably predictable in tropical ecosystems.

Terrestrial and Marine Reserves

(Marine Reserves Are More than Parks)

Benefits of terrestrial reserves usually are presumed to accrue within reserve boundaries

Benefits of marine reserves usually are presumed to accrue outside of the reserve boundaries


CLIMATE
External
HUMAN IMPACTS
Regional
Local
Special Features
Fisheries
Biodiversity
HYDROGRAPHY
"EVENTS"
Marine Managed Areas

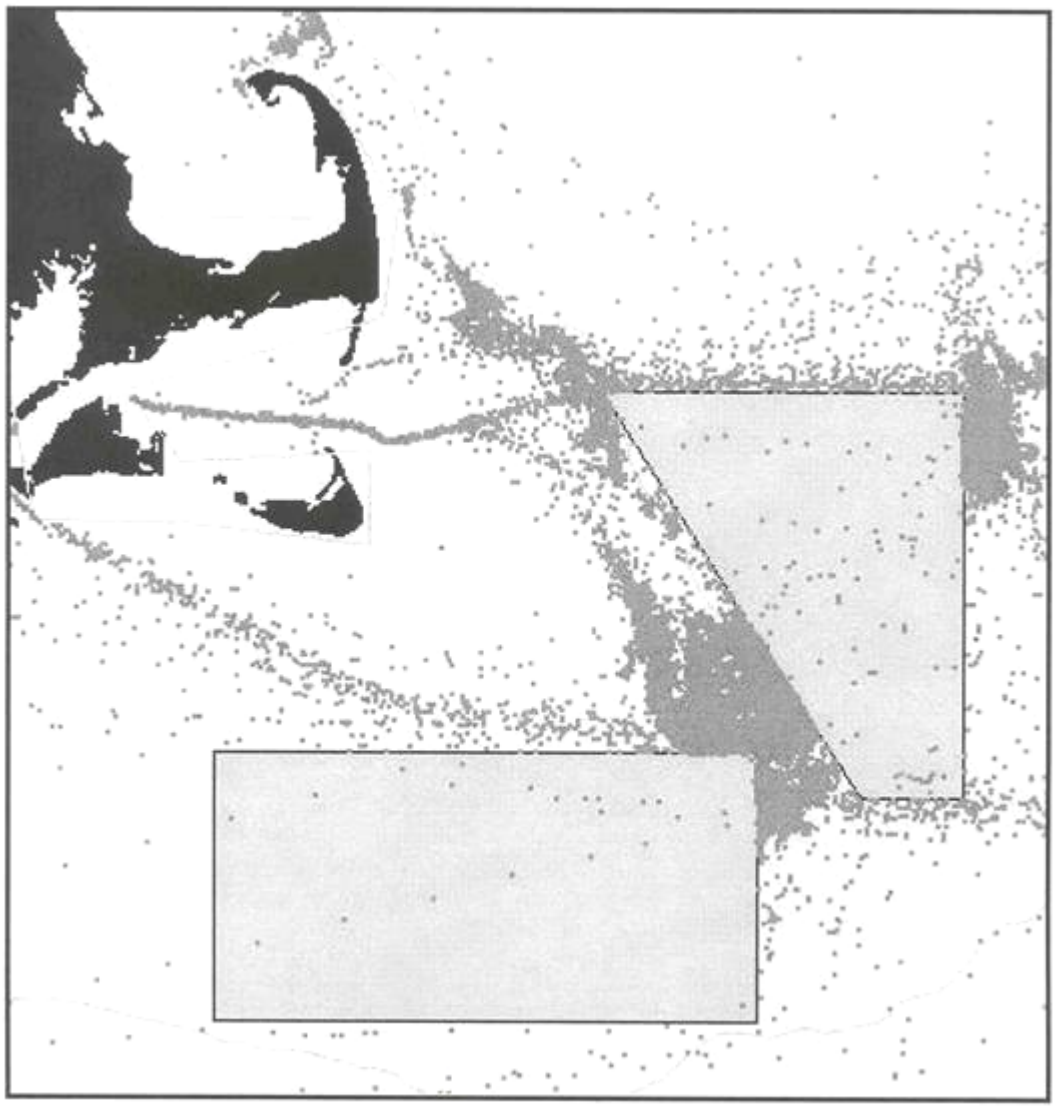
Spillover, Sources and Sinks

Can MPA spillover support fisheries in open fishing grounds?

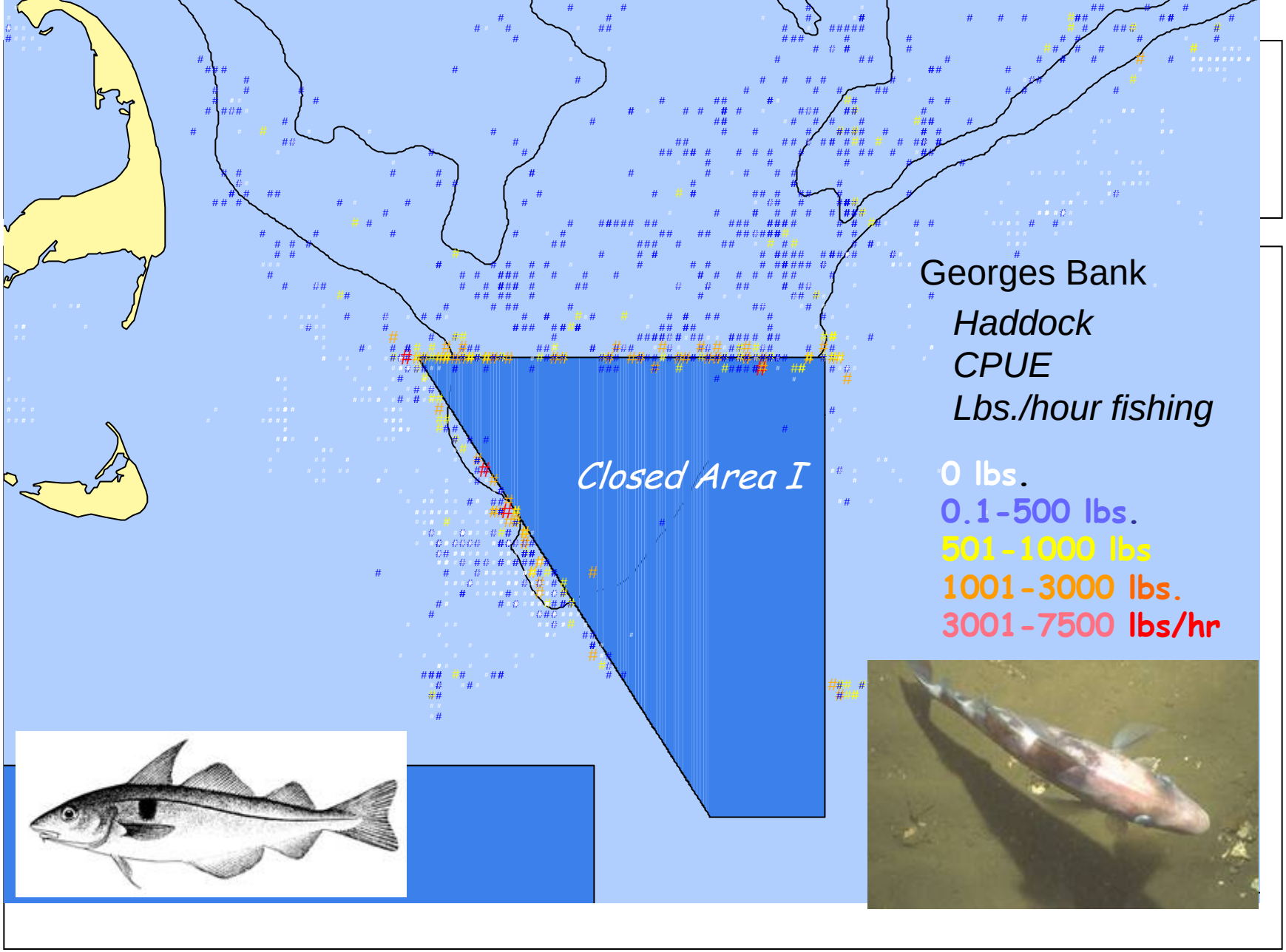
- Reserve must be located in a site that supports the productivity of the stock, i.e., a source

- Reserve may supply either early-life stages or recruited fish to areas remaining open to fishing, depending on dispersal characteristics

Georges Bank Closed Areas and VMS-tracked scallop vessels



From Fogarty et al. 2000

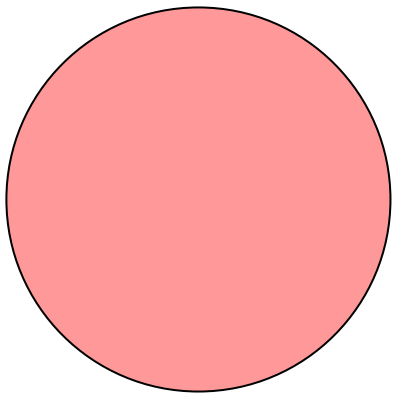


from S. Murawski, NOAA/NMFS

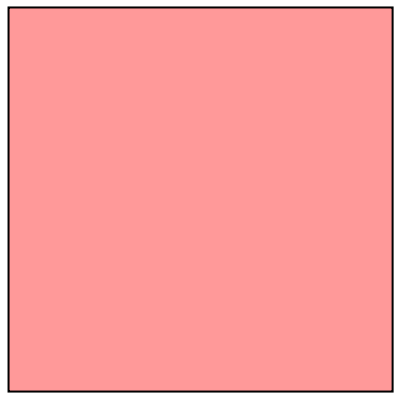
Dimensions: Size and Shape

Perimeter : Area Relationships

Controlling Probability of Dispersal Across MPA Boundaries. Shape and size are important.



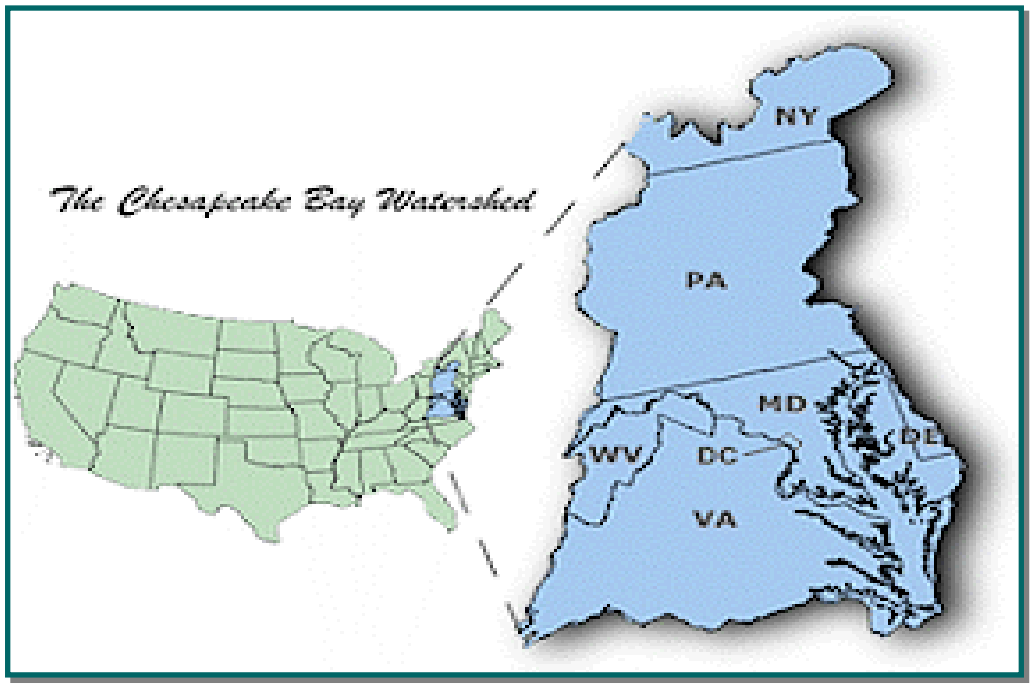
Minimal



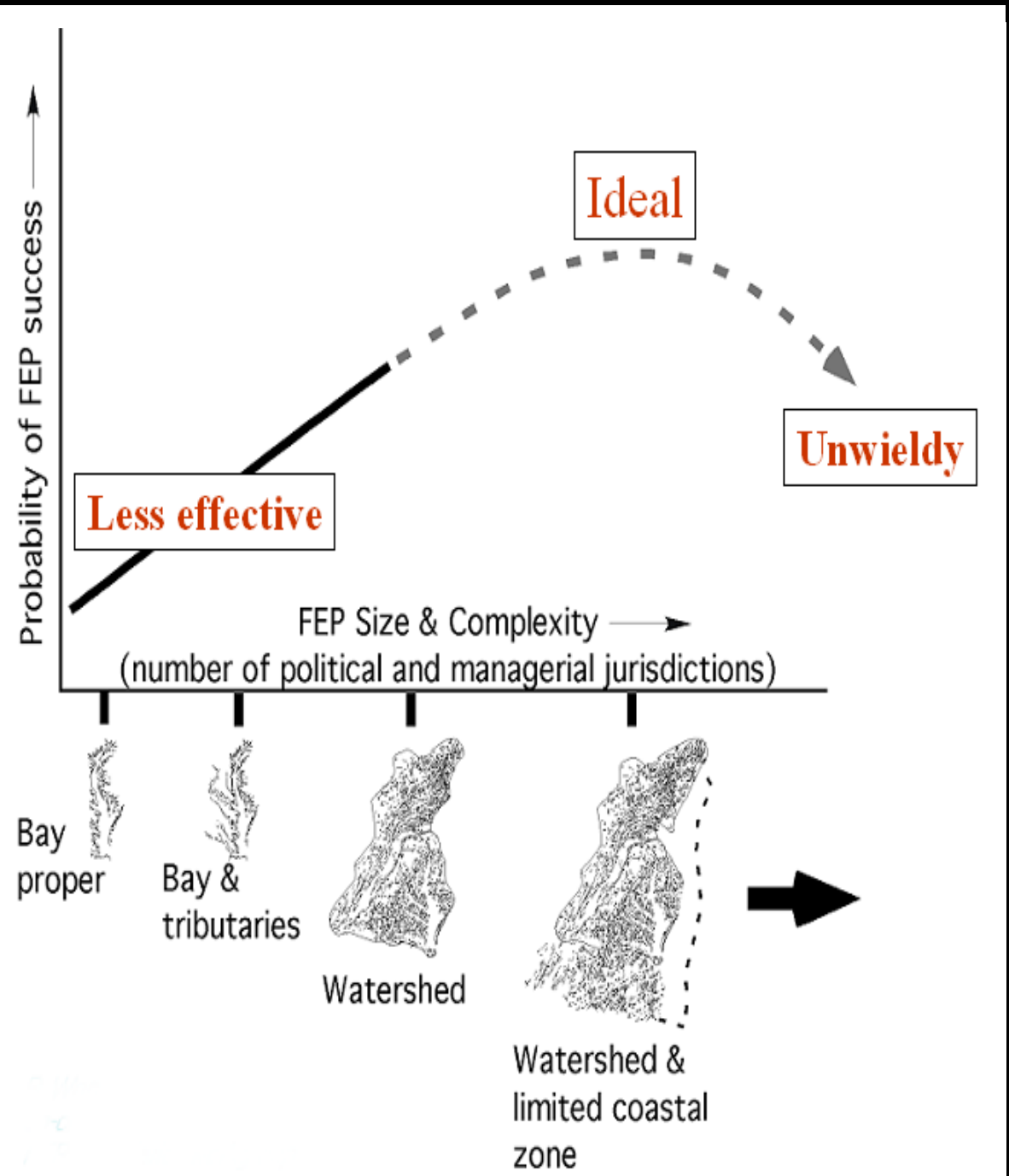
Intermediate

Maximal

The Chesapeake Estuary is a Reflection of its Watershed And Terrestrial Management Practices



Much (most?) of terrestrial resources management is spatially explicit and often zoned for specific uses. This is less true in the estuary itself.



Boundary Issues

Geographical

Jurisdictional

Institutional

Practicalities

from FEP

Key Habitats for Spatial Management and Protected Areas in Chesapeake Bay

1. Submerged Aquatic Vegetation (SAV) beds (nursery value for fish and crabs, food for bird species, wave and turbidity control)

2. Oyster reefs (both ecosystem and fishery value)

3. Spawning, migration, and overwintering habitats (blue crab 'migration corridor' and overwinter areas; anadromous fish migration, spawning and nursery areas)

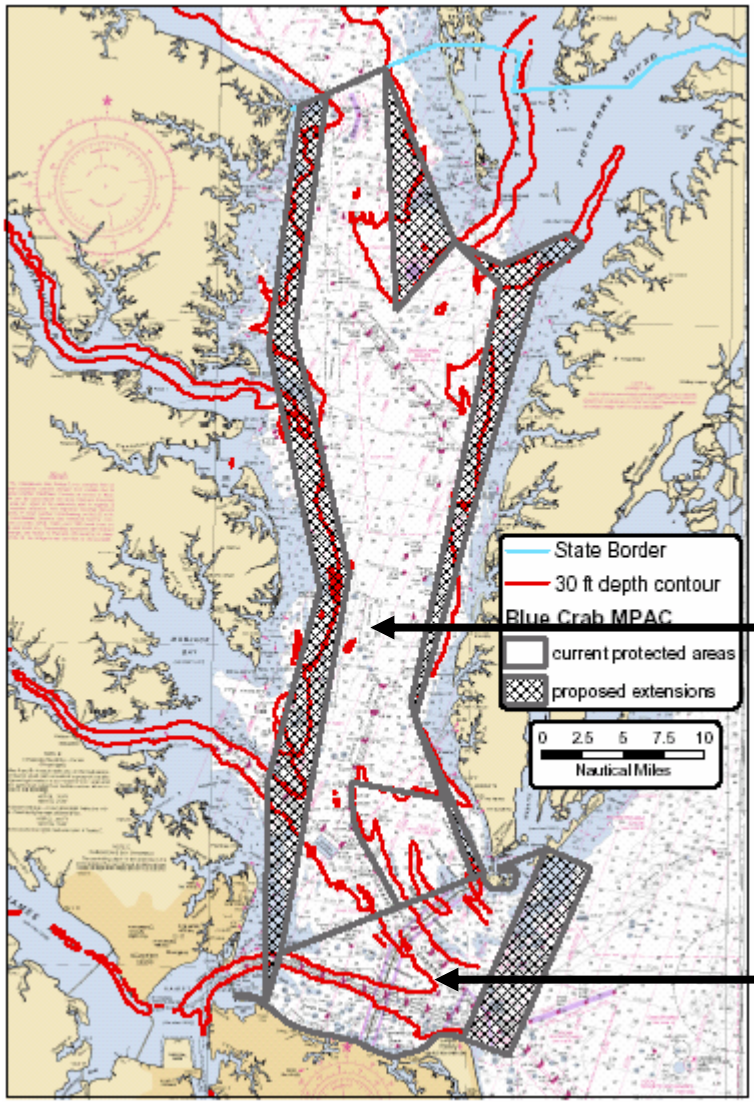
4. Intertidal/extreme shallow areas (juvenile fish and crab refuges from predation, and shorebird foraging habitat)

5. Saltmarshes (nursery and water quality value)

6. Habitats that serve as critical links between terrestrial and aquatic ecosystems (e.g., wetlands, nesting beaches for birds, turtles or horseshoe crabs);

from Lipcius et al. 2003

The Blue Crab MPAC



Closed to crabbing
June 1 to Sept. 15

VA Bay-wide
Spawning Sanctuary
(Deepwater Corridor)

Lower Bay
Spawning Sanctuary

30' depth contour

MPAs: Stakeholders' Concerns

These three issues were raised repeatedly by stakeholder participants in a workshop on proposed expansion of spatial management approaches in Chesapeake Bay.

1. Access
2. Permanency
3. Need for Science-Based Recommendations

Permanency, Access, and ‘Freedom to Fish’

Fishers are concerned that spatial management based on insufficient science may limit access to fishing areas and that closed areas may be implemented permanently, rather than subject to evaluation of effectiveness as a requirement for continued use.

Recently, legislation in the USA known popularly as ‘Freedom to Fish’ Acts are being proposed (enacted in Maryland) that provide restrictive guidelines for MPAs, and require public notice, open debate, and strong scientific justification before a Marine Reserve could be designated.

The timeframe for spatial restrictions should be appropriate to the management goal

Many protected areas should be long-term to insure desired benefits. However, permanent closure may be undesirable if it prevents the possibility of responsive, adaptive management.

In some cases temporary closures or restrictions on access will be sufficient to protect habitat or re-establish species targeted for restoration.

Spatial management alone is insufficient to restore and protect habitats

Planning : an Hierarchical, Incremental, and Inclusive Process

1. **Evaluate management needs at local and regional levels**
2. **Clearly define objectives and goals for an MPA**
3. **Describe key biological and oceanographic features of a region**
4. **Identify and choose sites that have highest potential for implementation**
5. **Engage all stakeholders in the planning process (‘bottom-up strategy’)**
6. **Insure that there is effective agency/institutional guidance and direction (‘top-down strategy’)**
7. **Combined, steps 5 and 6 will provide the ‘middle-ground’ recommended by Jones (2002)**

Location

MPA site selection should be guided by the overall management objective. Criteria for selection of sites should be developed during the planning stage.

Fisheries: The success of an MPA depends on the characteristics of the site but also, and importantly, the behavior of fishers.

The success of MPAs depends on the quality of management in the surrounding waters and coastal areas.

Ultimately, choice of sites for MPAs should be integrated into an overall plan for marine area management that optimizes conservation of the marine ecosystem (Zoning and Networking).

How Much is Enough?

(Size and Number)

The question of "How much is enough?" is an important consideration that, in part, is determined by goals and desired outcomes (e.g., preserving a single stand of eelgrass *Zostera marina* in a critical habitat vs. preserving the capacity for production of submerged aquatic vegetation in general).

Size

The optimal size of marine reserves and protected areas should be determined for each site by evaluating:

- the management needs and goals,
- quality and amount of critical habitat,
- levels of resource use,
- efficacy of other management tools, and
- characteristics of the species or biological communities requiring protection.

Comparing Conventional Fisheries Management and Spatial Approaches

Conventional Single-Species Management

Regulate Catch

Regulate Effort

Reference Points

Spawning Stock Biomass (or numbers)

Fishing Mortality Rates

Spatial Management

- Conserves communities of organisms, not just the target species.

- Conserves habitats.

- Requires knowledge of life history of species targeted for conservation - dispersal, food, and habitat requirements.

- Facilitates adaptive management by providing reference sites to assess human-induced versus environmental changes.

- A step towards ‘ecosystem-based management.’

Do MPAs Enhance Fisheries Performance?

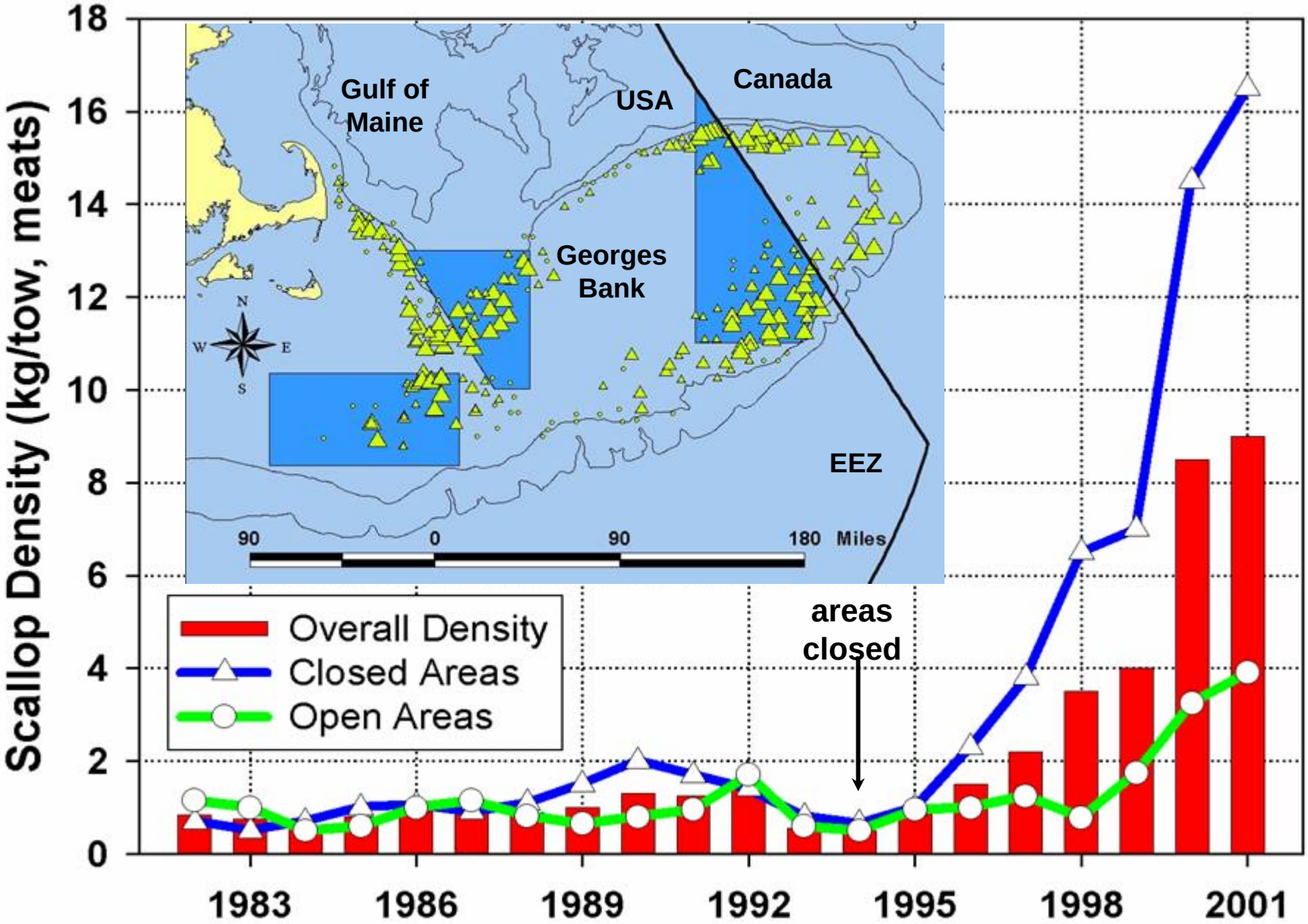
Enhancements Can Come in Many Forms, in Addition to Increases in Yield, or Yield per Recruit

Insuring sustainability in the face of uncertainty should be a goal. Some benefits may not be attained until years after implementation of MPAs.

Alone, MPAs may not always achieve dramatic success, but when implemented along with conventional tools, potential for success is enhanced.

In this Context, the Answer is likely to be ‘Yes.’

From S. Murawski,NOAA/NMFS



Performance

Expectations: Enhance the stock within MPA boundaries, and promote spillover that replenishes stock outside of boundaries.

Criteria: Increases in yield or profits in the fishery, restoration of the spawning stock biomass, increased recruitment, benefits to habitat, conservation of ecosystem services.

Evaluations: Pre-implementation design is important. Pre-implementation and post-implementation evaluations of MPAs should be planned. Design considerations are critical to successfully evaluate performance.

Performance (cont.)

Monitoring: It is essential- -on a regular basis; should include target species and associated species; also habitat. It should be conducted within the MPA and in the surrounding area open to the fishery.

Enforcement: Yes. It is essential. Costs of enforcement need to be considered in the design phase.

Non-Performance

Failure to Meet Objectives Requires Adaptive and Timely Actions

Set Timelines for Amendment of MPA policy

- Management decisions required at designated timelines

Possible Actions

- Modify objectives of the MPA
- Modify the design (size, number, location)
- Abandon the MPA in favor of other management measures
- Maintain adaptive flexibility

Benchmarks

Performance Indicators (To be defined at the outset, during MPA planning and design)

Timelines
Single-species, multi-species, and broader reference points (compound indicators)
Ecological Indicators: within the MPA and for the fishery
Economic and social indicators

Examples of benchmarks and indicators:
species of concern- -abundance, SSB, age structure, recruitment indices, dispersal rates or outcomes for relevant life stages;

fishery-dependent measures for the fishery- - landings, effort, disposition of effort, costs and profits;

habitat and biodiversity measures, or other measures specific to the particular MPA- -e.g., bycatch, threatened or endangered species.

Examples of Benchmarks

(Measured against prescribed levels and timelines)

Species Indicators (Target Species)	Community Indicators (Aggregate Ecosystem)	Habitat Indicators
Number of species	Species diversity	Structure
Abundances	Number of trophic levels	Complexity
Biomasses	Biomass of trophic levels	Damage indices
Predator species	Trends in biomass and production at trophic levels	Trends
Forage species	Bycatch indices	EFH / HAPC
Vital rate Indicators	Threatened and endangered species	
Recruitment indices	Community stability indices	
Age structure	Energetics indicators	
Fecundity		

Combining Conventional and MPA-Based Fisheries Management

Conventional single-species management will not disappear. Its role is secure in fisheries management. It needs help.

Conventional management of landings and fishing effort (F) are legitimate and effective methods (when applied properly), but in some cases can benefit from MPAs that recognize heterogeneity of the ecosystem.

Marine Ecosystems and Essential Fish Habitat

Broader Implementation of MPAs would:

1. Recognize explicitly the importance of marine habitats
2. Act to protect essential fish habitats
3. Address the need to preserve the structure of marine ecosystems

Fisheries Ecosystem Plans, Ecosystem-Based Fisheries Management, and MPAs

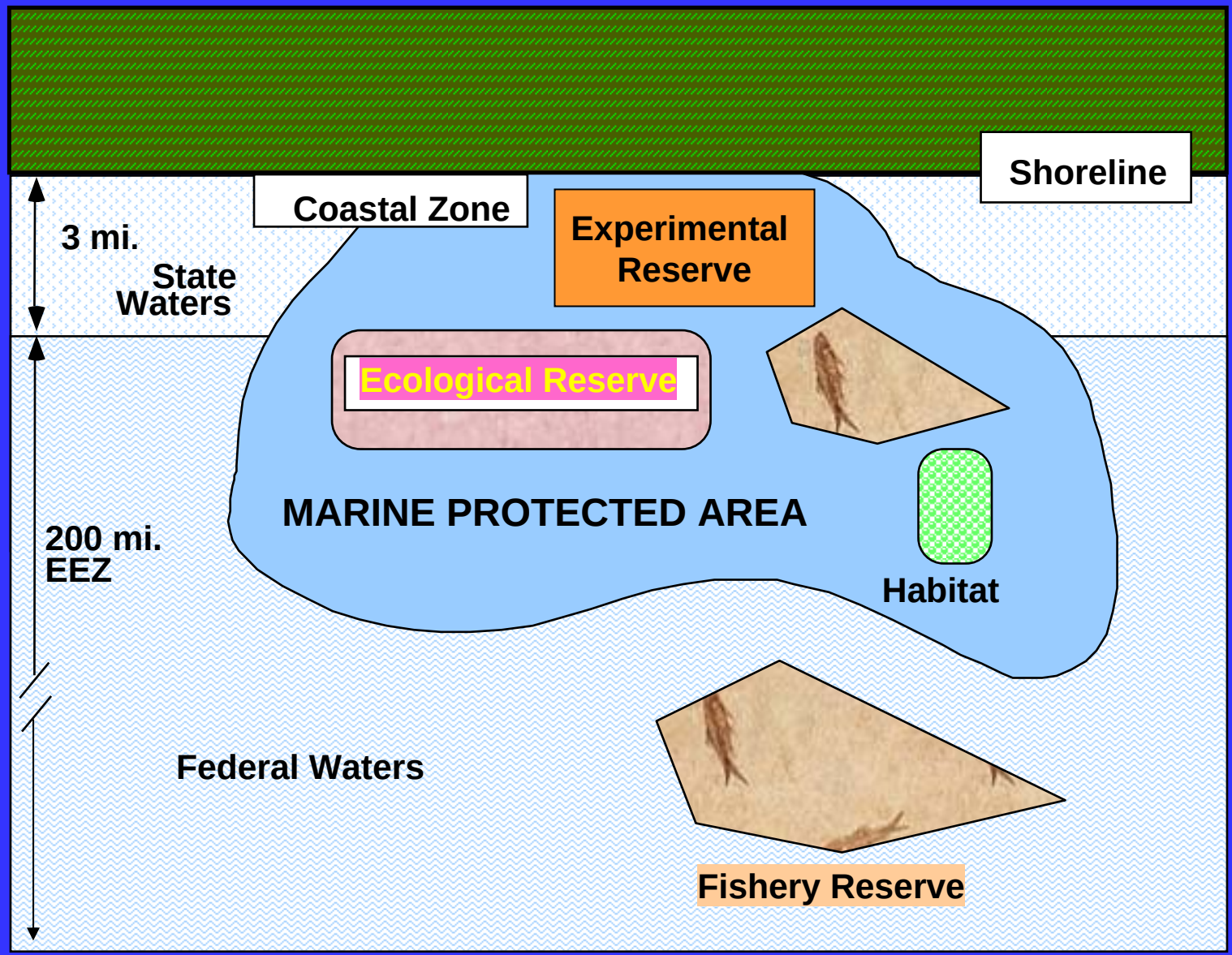
NMFS Ecosystems Advisory Panel, 1999		Strong Support
NRC 1999, 2001		Strong Support
Magnuson-Stevens	1996	Presently allows MPAs
Reauthorization of M-S	??	
Pew Commission Report	2003	Strong Support
U.S. Commission on Ocean Policy	2004	Relatively Silent

Institutional Structures

Overlapping jurisdictions among state and federal agencies potentially can impede designation and implementation of marine protected areas.

Integration of resource management by U.S. federal and state agencies is needed to develop a national system of MPAs that effectively and efficiently conserves marine resources and provide equitable opportunities for diverse stakeholder groups.

Zoning and Marine Protected Areas



Conclusion

MPAs are contributing to a shift in focus from single-species and single-issue management to ecosystem-based policies. Such policies recognize the spatial heterogeneity of marine habitats and utilize it to develop management plans for marine resources that preserve the structure and function of marine ecosystems while continuing to allow sustainable stakeholder uses.