Table 8-10
Adverse Morphological, Physiological, and Behavioral Effects Observed in Green Bay and the Lower Fox River Wildlife Species

Species	Reduced Reproduction	Overt External Malformations			Chick "Wasting"	Internal Malformations	Behavioral Abnormality	
		Edema	Beak	Leg			Reduced Parental Attentiveness	Reduced Colony Tenacity
Double-Crested Cormorant	X[1]		X[1]					
Black-Crowned Night-Heron		X[2]				X[2]		
Common Tern	X[2]	X[2]		X[2]				
Forster's Tern	X[3]	X[3]	X[4]	X[4]	X[5]	X[3,4]	X[3]	
Caspian Tern								X[6]
Bald Eagle	X[7]							

1. Larson et al., 1996.
2. Hoffman et al., 1993.
3. Kubiak et al., 1989.
4. Hoffman et al., 1987.
5. Harris et al., 1993.
6. Mora et al., 1993.
7. Dykstra unpublished data.

locations in inner Green Bay and outer Green Bay (Figure 8-6). Further data analysis will be performed to quantify injuries to birds and other wildlife species.

8.6 SUMMARY OF PRESENT AND ONGOING STUDIES

The following studies have, or are soon to be, initiated by the Trustees to supplement existing data.

8.6.1 Field Collection of Walleye and Salmonids

8.6.1.1 Objectives

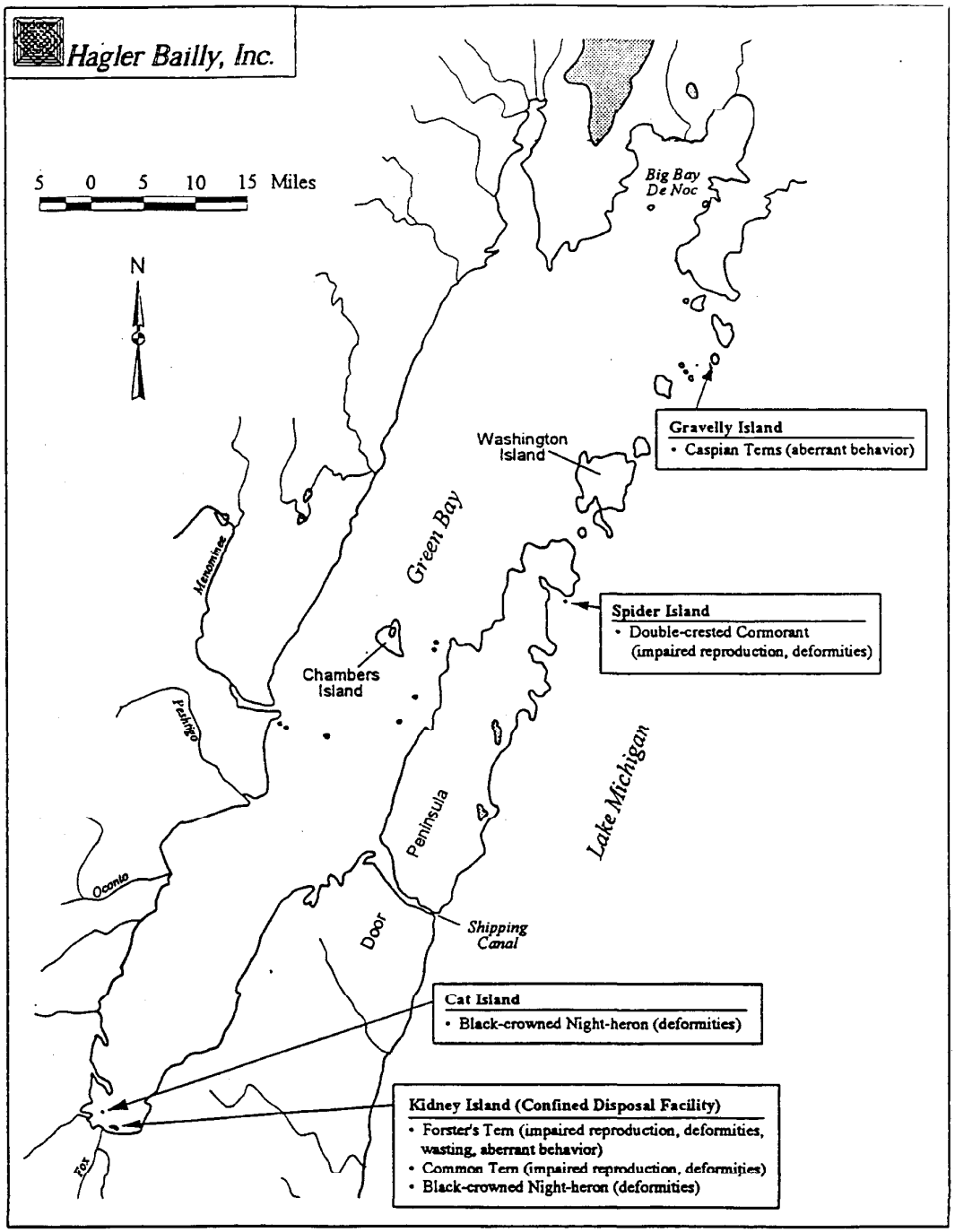
The objectives of this effort include:

- collection of walleye, brown trout, and lake trout (as available) for determination of whole-fish contaminant concentrations
- collection of walleye, brown trout, and lake trout (as available) for determination of contaminant concentrations to be used in pathway analyses and to evaluate predictions of the Green Bay Mass Balance model
- evaluation of potential physiological and deformative injuries in fish collected from the assessment area.

8.6.1.2 Approach

Approximately 100-150 walleye may be collected from the Fox River, Lower Green Bay, Middle Green Bay, and Upper Green Bay, approximately 40-60 brown trout may be collected from Middle Green Bay and Upper Green Bay, and approximately 30-50 lake trout may be collected from Upper Green Bay and from two other locations near Green Bay in western Lake Michigan. Fish collection may be by electroshocking, gill netting, and/or trap-netting, as necessary. Whole fish will be processed and archived for contaminant analyses. Walleye will also be processed for liver histopathological analyses. Trout may be collected by electroshocking, gill netting, trap-netting, and/or angling, as necessary. Whole fish will be processed and archived for contaminant analyses. Additional live-caught fish will be processed for bioindicator analyses (e.g., immunotoxicological, histopathological, and biochemical analyses). For reference purposes, 10 brown trout and 13 lake trout will be obtained from local (Wisconsin/Michigan) fish hatcheries and processed for bioindicator analyses. Fillets of fish collected for bioindicator analyses will be analyzed for total PCB concentrations.

Figure 8-6
Location of Observed Adverse Effects on Birds: Green Bay



8.6.2 Lake Trout PCB/Thiamine Reproductive Study

8.6.2.1 Objectives

The objectives of this study include:

- evaluating potential adverse effects thresholds for Green Bay PCB effects on embryo/larval viability of lake trout
- evaluating potential interactions between thiamine deficiency and PCB effects on embryo/larval viability of lake trout.

8.6.2.2 Approach

This task will involve characterizing and quantifying the relative and interactive effects of egg thiamine deficiencies and Green Bay PCBs on the hatching success and survival of salmonid embryos and larvae. Thiamine deficient eggs may be obtained from females collected from a population known to be affected by low thiamine levels and free of contaminants. Thiamine deficient eggs may also be produced in hatchery fish by feeding adult females with chemicals that block thiamine uptake. PCBs may be obtained by extraction from walleye captured in inner Green Bay. Deficient eggs may be treated with thiamine (either injected or in an egg-soaking bath) and PCBs (by injection) in a block design.

Completion of this study may involve the following subtasks:

- field collection of thiamine deficient lake trout eggs
- hatchery production and collection of thiamine deficient lake trout eggs
- augmentation of thiamine levels by soaking or injection
- injection of PCBs extracted from Green Bay walleyes into eggs
- monitoring of embryo/larval viability from time of injection to time of first feeding
- evaluation of viability data to estimate thresholds for thiamine deficiency and PCB effects.

8.6.3 Determination of Contaminant Concentrations in Tern Eggs

8.6.3.1 Objectives

The objective of this study is to:

- collect common and Forster's tern eggs from colonies in vicinity of the Lower Fox River/Green Bay for PCB residue analysis.

8.6.3.2 Approach

Eggs from approximately 10 nests will be collected for each species. The total number of nests containing eggs in the study colonies will be determined and this figure used to ensure that the study nests are spread throughout the colony. If, for example, the colony contains 60 nests with eggs, the colony will be walked through and an egg will be collected from every 6th (60/10) nest.

8.7 OBTAINING AND SHARING DATA

Under 43 CFR § 11.31(a)(2) and § 11.31(c)(3) of the NRDA regulations, a type B assessment plan is required to include objectives for any testing and sampling, sampling locations, sample and survey design, numbers and types of samples to be collected, and analyses to be performed on assessment studies. At this time, it is not feasible to provide this information because it is still under development by the trustees. However, the trustees intend to make this information available for public review and comment once it has been developed. Similarly, procedures for sharing data pursuant to 43 CFR § 11.31(a)(4) will be made available for public review and comment as soon as they have been developed.

CHAPTER 9
DAMAGE DETERMINATION

9.1 INTRODUCTION

This chapter provides an overview of the restoration planning and economic valuation approaches to be used in the damage determination assessment phase. These approaches are explained in the context of the DOI regulations promulgated under CERCLA (43 Part 11, as amended).

The purpose of the damage determination phase is to establish the amount of money to be sought in compensation for injuries to natural resources resulting from a discharge of oil or release of a hazardous substance. The measure of damages is the *cost of restoration*, rehabilitation, replacement, and/or acquisition of the equivalent of the injured natural resources and the services those resources provide.[1] (Hereafter, for brevity, the terms restore and restoration are used to refer to all actions that restore, rehabilitate, replace, and/or acquire equivalent natural resources and natural resource service flows.) Damages may also include, at the discretion of the authorized official, the *compensable value* of all or a portion of the services lost to the public for the time period from the discharge or release until the resources and their services are returned to baseline conditions [43 CFR § 11.80(a)(2)(b)]. In short, damages include restoration costs and may include compensable values.

Baseline is defined as the condition of the injured resource had the release of hazardous substances not occurred [43 CFR § 11.14(e)]. Restoration actions are undertaken to return injured natural resources to their baseline conditions. Actions that achieve baseline at an earlier date will restore the ability of natural resources to provide services sooner than if baseline were achieved at a later date. In this way, the restoration actions that achieve baseline at the earlier date reduce total interim compensable values. Therefore, restoration actions and compensable values are jointly determined.

The term *interim damages* refers to all damages from the time of release to when resources are returned to baseline and encompasses past damages up to the present, ongoing damages during restoration actions, and future residual damages after restoration actions have ceased if the restoration actions do not fully restore natural resources to baseline levels.

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1. The exact requirements in terms of restoration of resources and/or services is subject to review and revision based on *U.S. DOI v. Kennecott Utah Copper Corporation* [93-1700 (D.C. Cir. 1996)]. This review and revisions, if any, will be reflected in the Restoration Compensation and Determination Plan.

The remainder of this chapter is divided into two sections that discuss approaches to restoration planning and costing (Section 9.2) and compensable value determination (Section 9.3). This discussion will guide the trustees in developing a Restoration and Compensation Determination Plan (RCDP) that will list a reasonable number of possible restoration alternatives [43 CFR § 11.81]. The RCDP is intended to provide sufficient information to enable the trustees to select the appropriate restoration alternative to be used to determine restoration costs and compensable values.

At the time that this assessment plan is being made available for public comment and review, the existing information is insufficient to develop the RCDP. Consistent with the DOI regulations, the RCDP will be developed and issued after the completion of the Injury Determination and Quantification phases and will be made available for public review and comment [43 CFR § 11.81(d)(1-2)].

9.2 RESTORATION PLANNING APPROACHES

The restoration planning will develop and evaluate restoration alternatives necessary to restore injured natural resources to baseline conditions and to address additional restoration of natural resources and services at the site or at other sites to which compensable damages may be applied. Because no response actions are currently planned for implementation at any portion of the entire assessment area, the restoration analysis will be based on the assumption that no response will be undertaken.

The information reviewed for the restoration cost analysis will be used to:

- characterize the current natural resource injuries and their relationship to alternative restoration actions [43 CFR § 11.81(a)(1)]
- identify and evaluate restoration actions required to partially or fully restore resources and services to baseline conditions [43 CFR § 11.82(a)]
- identify and evaluate additional resource restoration or enhancement actions to which compensable damages may be applied [43 CFR § 11.93(a)].

The trustees will identify a range of possible restoration actions that will include [43 CFR § 11.73, 11.82(b) and (e)]:

- intensive efforts to achieve complete restoration, or, if complete restoration is infeasible to achieve intermediate levels of restoration

- replacement or acquisition of equivalent resources that provide the same or substantially similar services

- "no-action" natural recovery with minimal management actions, including an evaluation of how long such natural recovery can be expected to occur, if ever.

When selecting the appropriate restoration alternative to be used to determine restoration costs and compensable values, the trustees will evaluate each proposed actions using all relevant considerations, including the following factors identified by DOI [43 CFR § 11.82(d)]:

- technical feasibility
- the relationship between the expected restoration costs and expected restoration benefits
- cost-effectiveness
- results of any actual or planned response actions
- potential for additional natural resource injury resulting from the proposed alternative
- natural recovery time period
- ability of resource to recover with or without alternative actions
- potential effects of the proposed action on human health and safety
- consistency with relevant Federal, State, and tribal policies
- compliance with applicable Federal, State, and tribal laws.

For the application of compensable values to additional resource restoration and enhancement actions, other factors also may be considered such as trustee objectives for regional resource management, timing of restoration, the types and location of restoration.

The application of a strict cost-benefit test to each proposed alternative is not required under the DOI regulations and is therefore not envisioned by the trustees. The trustees will, however, consider the likely costs and benefits of each proposed action in light of the other relevant considerations. A detailed economic study of the proposed alternatives is not considered.

The methodologies to be used to establish the cost of restoration alternatives will be consistent with the DOI regulations [43 CFR § 11.83], with emphasis on comparison and unit cost methods [43 CFR § 11.83(b)(2)(i) and (ii)]. Other methods may also include probability methodologies, factor methodology, standard time data methodology, cost- and time-estimating relationships, and other cost estimating methodologies where they are consistent with the regulations [43 CFR § 11.83(b)(2)].

The trustees will consider all potential restoration costs when evaluating proposed alternatives. These costs typically include many of the following components:

- planning costs
  - restoration plan development
  - public review, public meetings, response to comments, and community relations
  - human health and safety, and quality assurance plans
  - chemical, physical, and biological surveys
  - feasibility and pilot studies
  - National Environmental Policy Act (NEPA) [42 U.S.C.A. § 4321 et al.] compliance, and other regulatory compliance requirements
- implementation costs
  - physical, chemical, and biological containment removal, treatment, and containment
  - habitat creation and enhancement
  - wildlife restocking and protection
  - land and water rights acquisition
  - contributions to existing mitigation banking programs or regional response plans
  - trustee oversight of actions undertaken by responsible parties
  - community relations
  - contracting costs
- program evaluation and monitoring costs
  - monitoring progress of restoration actions
  - evaluating restoration results
  - follow-up studies or actions, as required
  - on-going management.

9.3 COMPENSABLE VALUES

9.3.1 Damage Assessment Concepts and Measures

Compensable values include "the value of lost public use of the services provided by the injured resources, plus lost nonuse values such as existence and bequest values" [43 CFR § 11.83(c)(1)]. These terms are defined in the regulations as follows:

- *use value* is the value of the resources to the public attribution to the direct use of the resources provided by the natural resources [43 CFR 11.83(c)(1)(I)]

- *nonuse value* is the difference between compensable value and use value [43 CFR 11.83(c)(1)(ii)].

We also use the following terms and definitions of the concepts, which are consistent with DOI regulations:[2]

- *Direct use values* are generally associated with well-identified active, and often on-site, resource uses such as recreational and commercial activities.

- *Nonuse values (or passive use values)* arise from the values individuals place on resources apart from their own readily identified and measured direct use. Nonuse values may include bequest values for the availability of resources for use by others now and in the future, and existence values for the protection of the resources even if they are never used [56 FR 19760].

Additionally, option values to preserve the site for one's own *potential* future use and casual or indirect uses of natural resources, such as enjoying the site while driving or walking by or working near the site; and enjoying hearing about, reading about, or seeing photographs of the site may also be included in direct uses or passive uses depending on the study design.

Damage assessments may place dollar values on direct use and passive use impacts that result from natural resource and service flow injuries. The primary measure of value is based on *Willingness to pay (WTP)*, which is how much an individual would be willing to pay to have no injuries, or to clean up the injuries in the assessment area. WTP is also a measure of damages from having incurred the injuries, or an estimate of what individuals would pay to clean up the injuries in the assessment area. WTP measures are consistent with choices made everyday in purchasing goods and services and through voting choices that entail costs to support changes in environmental quality and other public goods.

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2. Some authors use different terms to refer to these concepts, or define the terms slightly differently. These differences generally have little substantive impact on the computation of total compensable damages.

9.3.2 Service Flow Losses and Selection of Economic Assessment Methods

Economic methods are used to identify, characterize, quantify, and value human use service flow losses. Identified in Table 9-1 are examples of potential services flow losses in the assessment area for which economic assessment methods may be required. The economic assessment methods, and the final detailed specification of study designs, are contingent upon further progress on the injury assessment activities so that the economic assessments are consistent with the injury determination. Based on the potential service flow losses at the site, at least three groups of methods are anticipated in the compensable value assessment, including:

Table 9-1
Potentially Affected Service Flows
Associated with Potential Injuries to Natural Resources
in the Lower Fox River/Green Bay/Lake Michigan Assessment Area

Potentially Injured Resource	Examples of Service Flows
Fish	▸ Recreational fishing use ▸ Subsistence fishing use ▸ Commercial fishing (e.g., carp) use ▸ Ecological services nonuse ▸ Tribal values use and/or nonuse
Wildlife	▸ Recreational and subsistence hunting use ▸ Nonconsumptive recreation use (e.g., bird watching: bald eagles, cormorants, herons) ▸ Ecological services nonuse ▸ Tribal values use and/or nonuse
Surface water	▸ Swimming use ▸ Boating use ▸ Aquatic habitat use and/or nonuse ▸ Assimilative capacity use and/or nonuse[1] ▸ Ecological services use and/or nonuse (e.g., habitat) ▸ Tribal values use and/or nonuse
Sediments	▸ Habitat use and/or nonuse ▸ Recreation use (hiking, picnicking) ▸ Assimilative capacity use and or nonuse[1] ▸ Tribal values use and/or nonuse

1. The ability of a resource to "absorb low levels of [contaminants] without exceeding standards or without effects" [51 FR 27716 Aug. 1, 1986].

1. **Valuation methodologies for recreational uses.** Assessments of recreational use values will be used to assess direct use impacts and values for interim injuries, and for evaluating restoration alternatives, for recreational fishing, wildlife hunting and viewing, and other recreational activities.

2. **Market price methods.** Market prices, including factor pricing and other market based methods, can be used to estimate damages related to commercial fishing, and potentially for damages related to subsistence fishing and other resource impacts still to be addressed.

3. **Total compensable value methods.** Methods such as contingent valuation and revealed preference methods can be used to establish use values, nonuse values, or total compensable values in WTP measures.

9.3.3 Assessments of Recreational Uses

Recreational use of natural resources in the assessment area may be among the most important direct uses affected by PCB contamination at the site. The following categories of recreational use services may be addressed:

- recreational fishing
- recreational hunting
- other recreation, including nonconsumptive recreational use such as wildlife viewing, boating, swimming, hiking, and picnicking.

Recreational Fishing

Recreational fishery service flow losses may be associated with (1) changes in the quantity, quality, and location of fishery stocks for species such as lake trout, and (2) fish consumption advisories. The accumulation of PCBs in sportfish in the assessment area has resulted in the establishment of fish consumption advisories (FCAs). These FCAs have varied through time and by location (Table 9-2). FCAs for fish caught in Lake Michigan have been established by all the states surrounding Lake Michigan and by Wisconsin tribes. Discovery of PCBs and other contaminants in sportfish species led to the establishment of an FCA in 1976 for the Wisconsin waters of Green Bay and Lake Michigan, and for the Fox River below Lake Winnebago. The initial FCAs were relatively general. As more information about the contamination of sportfish species became available, FCAs were increasingly refined to focus on location, species, and size.

Generally, the FCAs reflect two levels of consumption restrictions. At the more restrictive level, the FCAs advise that some fish, primarily larger fish, as well as fish from locations with higher levels of PCBs, should not be eaten at all. At the less restrictive level, the FCAs advise that women of childbearing years and children should not eat the fish and all others should restrict

Table 9-2
Fish Consumption Advisories for the Wisconsin Waters of Lower Fox River, Green Bay, and Lake Michigan, 1990-1995

Species	Location		
	Lower Fox River, Green Bay to De Pere	Green Bay	Lake Michigan[1] (for PCBs and pesticides)
Carp	●	●	●
Catfish	●		●
Drum	●		
Lake Trout 20-23"			○
Lake Trout > 23"			●
Walleye < 18"	○		
Walleye > 18"[2]	●	●	
Northern Pike	○		
White Sucker	○		
White Bass	●	●	
Coho Salmon > 26"			○
Chinook Salmon 21-32"			○
Chinook Salmon > 32"			●
Splake < 16"		○	
Splake > 16"		●	
Rainbow > 22"		●	
Chinook > 25"		●	●
Brown Trout > 12"		●	
Brook Trout > 15"		●	
Brown Trout < 23"			○
Brown Trout > 23"			●
Northern Pike > 28"		●	
Sturgeon[3]		●	

○ = Limit consumption to 1 meal per week for general population, no consumption by children or women of childbearing years.

● = No consumption.

1. Based on State of Wisconsin advisories. Lake Michigan advisories for other states are the same or similar.
2. Greater than 20" in Green Bay.
3. 1993-1995 only.

Sources: WDNR Division of Health, 1990-1995.

consumption of these fish to one meal a week. The Wisconsin fish consumption advisories for fish contaminated with PCBs and pesticides are accompanied by advice regarding the preparation of these fish. The preparation advice includes removal of skin and fat, cooking by baking or broiling, and discarding any drippings.

The current Lake Michigan FCAs for Illinois and Indiana are identical to those issued by Wisconsin. The State of Michigan FCAs for Lake Michigan differ slightly from Wisconsin's for larger lake trout and chinook salmon: these larger fish from northern Lake Michigan are subject only to a restricted consumption advisory. Furthermore, in Michigan waters of Lake Michigan, walleye over 22" are subject to a restricted consumption advisory, and larger whitefish from southern Lake Michigan should not be consumed at all.

The presence of FCAs and potential presence of PCB-related injuries could affect the quality of recreational fishing in many ways. Evidence regarding the magnitude of the behavioral responses of anglers to FCAs can be found in several recent studies (e.g., Fiore et al., 1989; Knuth and Connelly, 1992; Knuth et al., 1993; Silverman, 1990; Vena, 1992; West et al., 1993). These studies consistently report that the public respond to advisories by reducing trips to the affected site, targeting alternative species, changing fish consumption behavior, and changing fish consumption preparation methods. Each of these behavioral responses results in injuries and damages to the public. Others who are active at the injured sites but who make no behavioral change, may also be damaged because they simply enjoy the experience less than if there were no advisories.

Supplemental evidence is also found in a Wisconsin study. Anglers who were fishing inland waters only were asked about the relative importance of various factors that played a part in choosing not to fish in the Great Lakes (Bishop et al., 1994). "PCB and other contamination in the fish" was identified as a "somewhat important" or "very important" factor by 55% of the respondents. No other single factor was cited by a higher proportion of respondents. Many of the FCAs apply to large fish, and the possibility of catching large fish is often a primary reason why anglers fish (Bishop et al., 1990; Morey et al., 1995).

The objectives of the recreational fishery damage assessment are three-fold. The first objective is to quantify the impacts of fish injuries on recreational anglers. Potential impacts to be examined include changes in the rates of participation in fishing; number of trips and location of trips; the species and size of fish targeted on a fishing trip; impacts on decisions regarding keeping, preparing, and consuming fish; and impacts on the quality of the experience. The second objective is to quantify economic values associated with the recreational fishing impacts, which when combined with quantification of use impacts can be used to compute compensable use value damages. The third objective is to obtain information useful to evaluate potential restoration actions to which compensable damage awards may be applied.

Recreational Hunting and Other Recreational Impacts

Since 1987 the State of Wisconsin has issued a waterfowl consumption advisory for waterfowl taken from the Lower Fox River/Green Bay (WDNR, 1987), and there is no evidence that this advisory will be lifted in the near future. This advisory suggests that all skin and visible fat be removed before cooking mallard ducks using these waters and that drippings or stuffing should be discarded because they may retain fat that contains PCBs. Just as FCAs result in recreational fishing service flow losses, so too do waterfowl consumption advisories. Other recreation service flow losses may also occur because of the fish and waterfowl advisories and because of other contamination at the site. Waterfowl and wildlife observation, shoreline use, and boating are examples of recreational activities that may be directly or indirectly affected.

9.3.4 Commercial Fishing

Releases of PCBs may have caused impacts to commercial fisheries in the assessment area, which results in damages to the commercial operators and to the public. The assessment will address public losses.

The carp fishery may be of particular relevance because carp tend to accumulate PCBs and because nearly all of the commercially harvested Lake Michigan carp were caught in Green Bay. Annual harvest exceeded 3 million pounds in 1973 and 1974 [data provided by Eva Moore, National Biological Survey, Great Lakes Science Center (NBS-GLSC)], and dropped to 700,000 pounds in 1975. This drop coincided with concerns expressed by the U.S. FDA and the Wisconsin Department of Agriculture regarding the safety of carp caught in Green Bay (Kleinert, 1976). A summary of the 1974 commercial fishery in Wisconsin (WDNR, 1976) noted, "With PCB contamination a serious problem in larger and older carp, the future harvest, which takes place primarily in the winter months, is not very bright." In 1984, the carp fishery in Green Bay was closed entirely because of PCB contamination, and thus, the carp fishery on Lake Michigan was effectively ended. After 1984, the entire annual Lake Michigan commercial harvest of carp was typically less than 1,000 pounds.

The alewife fishery is also relevant because these fish also accumulate PCBs. Alewife harvest in Lake Michigan began in the late 1950s (WDNR, 1974). By the 1970s, commercial alewife harvest ranged from 30 million to 40 million pounds annually. During the 1980s, the annual commercial harvest ranged from about 10 million pounds to 23 million pounds [data provided by Randy Eshenroder, Great Lakes Fishery Commission (GLFC), 1995]. Substantial decreases in Lake Michigan alewife populations led to dramatic reductions in alewife harvest beginning in 1991. In that year, harvest dropped to about one million pounds (Eva Moore, NBS-GLSC, 1995). By 1993, the Lake Michigan commercial alewife fishery had nearly disappeared.