HUDSON RIVER NATURAL RESOURCE DAMAGE ASSESSMENT PLAN

PREPARED BY THE HUDSON RIVER TRUSTEE COUNCIL

STATE OF NEW YORK

STATE OF NEW YORK DEPARTMENT OF ENVIRONMENTAL CONSERVATION

U.S. DEPARTMENT OF COMMERCE

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

U.S. DEPARTMENT OF THE INTERIOR

U.S. FISH AND WILDLIFE SERVICE

SEPTEMBER 2002

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This Natural Resource Damage Assessment Plan was prepared by the Hudson River Natural Resource Trustee Council, which consists of the New York State Department of Environmental Conservation, the U.S. Department of Commerce's National Oceanic and Atmospheric Administration, and the U.S. Department of the Interior's Fish and Wildlife Service. The Trustees are working cooperatively to conduct a Natural Resource Damage Assessment (NRDA) for the Hudson River. This Assessment Plan is one step in the NRDA and documents exposure of natural resources to polychlorinated biphenyls (PCBs) and identifies the anticipated procedures for evaluating the injuries caused by this exposure.

CONTACTS FOR PUBLIC INQUIRIES:

Steven Jay Sanford
Chief, Bureau of Habitat
Division of Fish, Wildlife and Marine Resources
New York State Department of Environmental Conservation
625 Broadway
Albany, NY 12233
518-402-8996
sxsanfor@gw.dec.state.ny.us

Tom Brosnan
Damage Assessment Center
National Oceanic and Atmospheric Administration
1305 East-West Highway SSMC4, Room 10219
Silver Spring, MD 20910
301-713-3038 x186
Tom.Brosnan@noaa.gov

Fred Caslick
U.S. Fish and Wildlife Service
3817 Luker Road
Cortland, NY 13045
607-753-9334 x156
fred_caslick@fws.gov

Credits:

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Line Art by Robert J. Savannah

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ACRONYMS AND ABBREVIATIONS

ATSDR	Agency for Toxic Substances and Disease Registry
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CWA	Clean Water Act
DOI	United States Department of the Interior
EPA	United States Environmental Protection Agency
FDA	United States Food and Drug Administration
GE	The General Electric Company
LC 50	Lethal Concentration 50
NOAA	National Oceanic and Atmospheric Administration
NPL	National Priorities List
NPS	National Park Service
NRDA	Natural Resource Damage Assessment
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
NYSDOS	New York State Department of State
NYSDOT	New York State Department of Transportation
PCB	Polychlorinated biphenyl
PED	Preliminary Estimate of Damages
ppb	parts per billion
ppm	parts per million
ppt	parts per thousand
PRG	Preliminary Remediation Goals
PSD	Preassessment Screen Determination
ROD	Record of Decision
SDWA	Safe Drinking Water Act
SPDES	State Pollutant Discharge Elimination System
SWDA	Solid Waste Disposal Act
TEQ	Toxic Equivalent
TSCA	Toxic Substances Control Act
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey

EXECUTIVE SUMMARY


Photo courtesy of NYSDEC

Spanning the Hudson, Bear Mountain Bridge connects Peekskill and Orange County and is the crossing point for the Appalachian Trail.

The Hudson River flows from its source in the Adirondack Mountains to its confluence with New York Harbor at the Battery in Manhattan, a distance of about 315 miles. The Hudson River has provided important natural resources and services to the residents of the Hudson River Valley since the earliest days of human settlement. The earliest European exploration was by Henry Hudson in the early seventeenth century. The Hudson River provided a travel corridor to facilitate westward exploration of New York by European settlers and was a focal point during the Revolutionary and French and Indian Wars. President Franklin Delano Roosevelt made his home along the Hudson River near Hyde Park, New York. Because of its rich resources and heritage, the Hudson River has been formally recognized as an American Heritage River and serves as the site of a National Estuarine Research Reserve.

The river has been used as a transportation corridor for commercial and recreational traffic, and has supported commercial and recreational fishing, as well as swimming and boating. Also, the river has been used in the direct generation of electricity, and as a source of cooling water for other forms of power generation. Many river communities have depended on the Hudson River as a source of potable water. Over time, ever-increasing urbanization and industrialization began to degrade the river and its natural resources.

In the early 1970s, a group of toxic compounds known as polychlorinated biphenyls, or PCBs, were discovered in the water, fish, and sediment of the Hudson River below General Electric Company's (GE's) plants at Hudson Falls and Fort Edward. As a result of PCB contamination, fishing was banned in the Upper Hudson River from Hudson Falls to Troy between 1976 and 1995, and fishing in that river reach is currently restricted to catch and release only (1). In addition, the Hudson River below the Federal Dam at Troy was closed to commercial fishing for almost all species of fish, and fish in that part of the river have been the subject of "no consumption" or restrictive consumption advisories due to PCB contamination. The discovery of PCBs in the Hudson River and other locations also prompted many scientists to study the effects of these compounds on wildlife. Years later, this research indicates that PCBs can cause serious injuries to wildlife and other natural resources.

The Trustee Role

The responsibility for restoring natural resources that have been injured by hazardous substances belongs to Federal, State, and Tribal Trustees for fish, wildlife, other living resources, water, lands, and protected areas. Trusteeship is derived from Federal and Tribal treaties, Federal and State statutes, and other laws. For the Hudson River, the Trustees are the U.S. Department of Commerce, the U.S. Department of the Interior (DOI), and the State of New York (collectively "the Trustees"). These entities have each designated representatives that are responsible for evaluating the injuries associated with hazardous substance contamination of natural resources and determining appropriate actions to restore those resources. For the Hudson River, the organizations that have been designated to perform these evaluations are the National Oceanic and Atmospheric Administration (NOAA), the U.S. Fish and Wildlife Service (USFWS), which represents the concerned DOI agencies (USFWS and the National Park Service), and the New York State Department of Environmental Conservation (NYSDEC).

The ultimate objective of a NRDA is to restore natural resources that have been injured by hazardous substance contamination to baseline, or the condition that would have existed if the hazardous substances were not released.

The process by which the Trustees evaluate the injuries associated with hazardous substance contamination in natural resources is known as a natural resource damage assessment (NRDA). The ultimate objective of a NRDA is to restore natural resources that have been injured by hazardous substance contamination to baseline, or the condition that would have existed if the hazardous substances were not released. In addition, the Trustees may obtain compensation for natural resource injuries and the loss of the services they provide between the onset of the injury and full restoration.

The U.S. Congress enacted the Superfund law to assign responsibility for the cost of cleaning up hazardous substances that threaten human health and the environment, and for restoring or replacing any public natural resources that are harmed by hazardous substance releases. It is the U.S. Environmental Protection Agency's (EPA's) responsibility to select a remedy that is intended to reduce or eliminate current and future threats to human health or the environment. It is the Trustees' responsibility to restore or replace the natural resources that are harmed. Congress determined that, rather than requiring the taxpayers to bear the costs of cleanup and restoration, it was fairer and more reasonable that entities that profited from the generation and inexpensive disposal of hazardous substances, or had other significant connections to a site containing hazardous substances, be responsible for addressing the harms caused by those substances. Natural resource damages are therefore not penalties or fines. Rather, they provide a means to restore the injured public resources to the condition they would have been in but for the release, and to compensate the public for lost services provided by those resources.

Natural Resource Damage Assessment - How it Works

General guidelines for performing a natural resource damage assessment involving hazardous substances such as PCBs are described in regulations written by the U.S. Department of the Interior and appear in the Code of Federal Regulations at Title 43 Part 11. These guidelines describe methods for (1) deciding to conduct a damage assessment, (2) establishing that hazardous substance contamination has injured natural resources, (3) determining the quantity of injured natural resources, (4) determining the amount of restoration required to fix or replace the injured natural resources and compensating the public for the lost functions, and (5) planning and conducting projects designed to restore the injured resources.

The first phase of a NRDA is the preassessment phase, during which the Trustees organize and assess available information about the area of concern and summarize their findings in a document called a Preassessment Screen Determination (PSD). The Trustees issued a PSD in October 1997, formalizing their decision to proceed with a NRDA for the Hudson River. The Preassessment Screen Determination documents the following: PCBs were released to the Hudson River; Trustee resources have been or are likely to have been adversely affected by the PCBs; the concentration of the PCBs is sufficient to potentially injure natural resources; the data necessary to conduct a NRDA are available or can be obtained at a reasonable cost; and, the completed or planned response actions would neither completely remediate the injuries to natural resources nor compensate for the public's lost use.

About the Damage Assessment Plan

Following issuance of the Preassessment Screen Determination, the Trustees determined that development of a Damage Assessment Plan was appropriate. The Trustees then issued, for public review and comment, a "Draft Scope for the Hudson River Natural Resource Damage Assessment Plan." That scoping document, which contained a preliminary outline of the potential contents of a Damage Assessment Plan for the Hudson River, formed the basis for subsequent development of this document.

This document, known as a Damage Assessment Plan, is part of the Hudson River NRDA. The purpose of this Assessment Plan is to structure the NRDA to ensure that it is performed in a planned and systematic manner and at a reasonable cost. Reasonable cost means that the anticipated cost of the assessment is expected to be less than the anticipated damage amount determined in the assessment. This Assessment Plan describes the activities that constitute the Trustees' currently proposed approach. These efforts are designed to provide more information on the nature and extent of the injuries associated with PCB contamination in the Hudson River.

This Assessment Plan documents that natural resources of the Hudson River have been exposed to contamination by PCBs. Those natural resources of the Hudson River for which exposure to PCBs has been confirmed are:

- Biota, including fish, birds, mammals, amphibians, reptiles, and invertebrates
- Surface water resources, including river sediments
- Groundwater resources
- Geologic resources, including floodplain soils, and
- Air resources

This Assessment Plan provides information regarding three major steps in the assessment: pathway and injury determination, injury quantification, and damage determination and restoration. This framework is consistent with the DOI regulations and provides an effective means of considering the impacts of PCB contamination in the Hudson River environment. Within each of these steps, the Trustees propose individual investigations (listed below) that, together, will define the nature and extent of injuries caused by PCBs in the Hudson River environment. Investigations may be added or removed as determined appropriate by the Trustees based on additional information developed by the Trustees. This is an iterative process which may take several years to complete.

During the pathway determination phase of the assessment, the Trustees will document how PCBs move through the environment. The Trustees' currently proposed approach to pathway determination entails three studies, as follows:

- PCB sources to sediment and water
- Food web pathway evaluation, and
- Floodplain evaluation

The studies listed above are preliminary investigations. Should the Trustees determine, based on such preliminary investigations, that a full pathway determination study is warranted, the Trustees will develop a study plan for that effort that will be peer reviewed and released to the public for comment.

During the injury determination and quantification phase of the assessment, the Trustees

During the injury determination and quantification phase of the assessment, the Trustees undertake investigations to determine the injuries to natural resources resulting from exposure to PCBs, and then quantify those injuries, including how long each resource has been or will be injured, and the reduction in services that has resulted from the injury.

undertake investigations to determine the injuries to natural resources resulting from exposure to PCBs, and then quantify those injuries, including how long each resource has been or will be injured, and the reduction in services that has resulted from the injury. This Assessment Plan identifies procedures that are appropriate to evaluate the injuries to natural resources associated with exposure to PCBs.

The Trustees are considering conducting injury determination and quantification for the following Hudson River resources: fish, birds, mammals, amphibians and reptiles, surface water, groundwater, geologic resources, and air. The Trustees' currently proposed approach to injury determination and quantification entails the following specific investigations:

- Fish consumption advisory
- Fish - FDA evaluation
- Preliminary fish evaluation
- Fish health reconnaissance survey
- Effects of PCBs on early life stages of fish
- Waterfowl consumption advisory
- Waterfowl - FDA evaluation
- Preliminary avian evaluation
- Breeding bird survey
- Bird egg study
- Evaluation of avian exposure from feeding on floodplain organisms
- Bald eagle monitoring
- Mink and otter health
- Bat exposure
- Snapping turtle consumption advisory
- Snapping turtle health
- Water quality evaluation
- Sediments characteristic of solid waste
- Sediments injury: pathway and biota
- Groundwater quality evaluation
- Geologic resource evaluation
- Air quality evaluation

The studies listed above can be categorized as either preliminary investigations or injury determination/quantification studies. Many of the studies listed above are preliminary investigations, designed to improve the Trustees' understanding of exposure of Hudson River resources to PCBs. Data from these preliminary investigations will then be assessed by the Trustees to determine whether injury determination/quantification studies are warranted, or whether a particular resource should not be assessed further for injury. Should the Trustees determine, based on such a preliminary investigation, that an injury determination study is warranted, the Trustees plan to develop a study plan for that effort that will be peer reviewed and released to the public for review and comment. The results of any study conducted pursuant to such a study plan will be peer reviewed upon completion of the study, and the results then released to the public.

Based on the results of the injury determination and quantification, the Trustees will establish the total quantity of injured natural resources that must be restored or replaced, or for which the equivalent must be acquired. The Trustees will also calculate the total reduction in services that has resulted from the injury. The Trustees will then determine how to restore, replace, or acquire those resources. The Trustees will also determine the compensable value of services lost to the public from the time of the release to full restoration. This can be done by establishing the value of the injured resources or by calculating the cost of the restoration projects that will compensate the public for the injuries. This is done in the damage determination and restoration phase of the assessment. The Trustees' currently proposed approach to damage determination and restoration entails four studies, as follows:

- Recreational fishing lost use study
- Habitat equivalency analysis
- Assessment of lost navigational services
- Assessment of impacts to National Park Sites and Affiliated Areas

The results of any of these, or other, studies undertaken by the Trustees will be contained within the Report of Assessment to be issued by the Trustees at the conclusion of the assessment. The Report of Assessment will be released to the public.

This Assessment Plan is a living document that the Trustees will continue to develop and refine as the NRDA progresses. As Trustee investigations proceed and as new study plans are proposed, the Trustees intend to issue updates, including fact sheets, so that all interested individuals can remain apprised of ongoing and planned NRDA activities. As additional opportunities for public involvement arise, the Trustees plan to advertise those opportunities in newspapers, direct mailings, and on the Trustees' internet sites, and to provide information on how to participate. The internet sites for NOAA, USFWS, and NYSDEC are available at:

- *http://www.darp.noaa.gov/neregion/hudsonr.htm,*
- *http://contaminants.fws.gov/restorationplans/HudsonRiver.cfm*
- *http:www.dec.state.ny.us/website/dfwmr/habitat/nrd/index.htm*

The Trustees will consider all public comments and input on the Assessment Plan, and will prepare a responsiveness summary to the comments. Based on the public's comments or other information, the Trustees may modify the Assessment Plan at any time. Any modifications will be made available for review by the public, including the party or parties responsible for the contamination. At the conclusion of this assessment, the Trustees will prepare a Report of Assessment that includes this Assessment Plan, as well as any comments and responses to comments on plan modifications and subsequently developed study plans and any additional information relevant to the assessment. The Report of Assessment will be released to the public.

How You Can Help

The Trustees are interested in receiving feedback on this Assessment Plan. To facilitate this process, the Trustees are asking the public and the party or parties responsible for the contamination to review the Assessment Plan and provide feedback on the proposed approach and studies. Comments should be submitted by November 1, 2002. These comments will help the Trustees plan and conduct an assessment that is scientifically valid, cost effective, and that incorporates a broad array of perspectives. To that end, the Trustees request that you carefully consider this Assessment Plan and provide any comments you may have to:

Contact for Public Comments

Steven Jay Sanford
Chief, Bureau of Habitat
Division of Fish, Wildlife and Marine Resources
New York State Department of Environmental Conservation
625 Broadway
Albany, NY 12233
518-402-8996
fax: 518-402-8925
sxsanfor@gw.dec.state.ny.us

THE NATURAL, CULTURAL, AND ECONOMIC SIGNIFICANCE OF THE HUDSON RIVER

Photo courtesy of the National Park Service

Photos courtesy of National Oceanic and Atmospheric Administration/Department of Commerce

The Hudson River originates in Lake Tear of the Clouds in the Adirondack Mountains and flows south for 315 miles, past many of New York State's major cities, including Troy, Albany, Poughkeepsie, and New York City (see Exhibit 1-1). In total, about 13,390 square miles of land drain to the Hudson River; this drainage basin encompasses about one-quarter of New York, as well as portions of Connecticut, Massachusetts, New Jersey, and Vermont. The river reaches a maximum depth of 216 feet, and is over three miles wide in some places.

For purposes of this assessment, the Trustees will consider the Hudson River as comprising two distinct parts that are known as the Upper and Lower Hudson River. The Upper Hudson River extends from the river's origin to the Federal Dam at Troy, a distance of approximately 160 miles. The southern portion of the Upper River has been extensively modified by dams that create a series of interconnected impoundments with relatively slow currents. The Upper Hudson River is a freshwater ecosystem. The Federal Dam is the first significant barrier to upstream fish movement in the Hudson River. Dams located upstream of the Federal Dam further impede fish passage, although all of the dams are associated with locks that allow for some fish movement both upstream and downstream. A few anadromous species such as blueback herring and gizzard shad have been collected in the Upper Hudson River. Land use along the Upper Hudson River is dominated by forests and agriculture interspersed with towns and cities.

The Lower Hudson River extends from just below the Federal Dam at Troy to the Battery in Manhattan, a length of approximately 155 miles. This portion of the river is influenced by both the freshwater that flows from the river's upper reaches as well as by seawater that moves upstream with the ocean's tide. During extreme droughts, saltwater can push as far north as Poughkeepsie, 60 miles upstream of the river's mouth. The Lower Hudson River and adjoining tributaries provide significant spawning and nursery habitat for a number of anadromous fish species. Land uses along the banks of the Lower Hudson River range from forest and agriculture to intensive residential, commercial, and industrial development.

Exhibit 1-1: Hudson River Below Corinth, New York

ECOLOGICAL COMMUNITIES OF THE HUDSON RIVER

The Hudson River supports a rich array of ecological resources that interact in complex ways. The upper reaches drain a large portion of the eastern Adirondack Mountains, where it flows through forests of first coniferous trees, such as spruces (*Picea spp.*), balsam fir (*Abies balsamea*), and white pine (*Pinus strobus*), and then northern hardwoods, such as maple (*Acer spp.*), beech (*Fagus americana*), and birches (*Betula spp.*). Between Hudson Falls and Troy, the forests give way to farmlands, where corn and hay are grown for the local dairy industry. Throughout this reach, the waters of the Hudson are fresh and unaffected by tides. Below Troy, the Hudson flows through hardwood forests and farmlands but also through increasing levels of development, urban, industrial, and residential. Ocean tides are felt as far upstream as the Federal Dam at Troy; saltwater from the Atlantic typically reaches as far upstream as Newburgh. The Hudson Valley becomes increasingly developed as the river flows to New York City. These conditions create a transitional ecosystem that provides habitat for a wide range of plants and animals.

Resource management officials have recognized the ecological significance of the Hudson River ecosystem in a variety of ways. The importance of the Hudson River's habitat has been recognized by the New York Department of State, which has designated 41 sections of the Hudson River as significant tidal habitat (2). Additionally, the U.S. Fish and Wildlife Service (USFWS) has recognized a number of regionally significant habitats along the river, including Papscanee Marsh, Vosburg Swamp, and Esopus Estuary (3). Similarly, the National Oceanic and Atmospheric Administration (NOAA) has designated four sections of the Hudson River, Piermont Marsh, Iona Island, Tivoli Bays, and Stockport Flats, as a National Estuarine Research Reserve. The National Marine Fisheries Service has designated the river an Essential Fish Habitat, in recognition of the role the river plays in maintaining 34 commercially important fish species (4).

The Hudson River plays a role in the larger global ecosystem as well. Most notably, the river provides essential habitat for anadromous fish species such as striped bass (*Morone saxatilis*) and American shad (*Alosa sapidissima*). Anadromous species are those that spawn and spend their early life stages in freshwater but spend the majority of their adult lives in salt water. The Hudson River also supports the catadromous American eel (*Anguilla rostrata*), which spends most of its life in the river before moving to the ocean to spawn. The Hudson River Valley is an important migration stop for numerous species of waterfowl, including tens of thousands of geese and ducks that spend winters on the river.

The purpose of this section of the Assessment Plan is to briefly describe representative ecological communities along the Hudson River between Hudson Falls and Manhattan. The descriptions will provide a sense of the biological diversity present in the Hudson River ecosystem. An ecological community is a "variable assemblage of interacting plant and animal populations that share a common environment"(5). Communities include the full range of organisms, from simple forms such as bacteria, fungi, and plankton, to the most complex flowering plants and vertebrate animals, whether they are permanent residents or migratory visitors. Hudson River communities are dependent on environmental features including: elevation, topographic position, geologic history, soil type, land use history, water depth, water quality, tides, and salinity.

The U.S. Fish and Wildlife Service has recognized a number of regionally significant habitats along the river, including Papscanee Marsh, Vosburg Swamp, and Esopus Estuary. NOAA has designated four sections of the Hudson River, Piermont Marsh, Iona Island, Tivoli Bays, and Stockport Flats, as a National Estuarine Research Reserve. The National Marine Fisheries Service has designated the river Essential Fish Habitat, in recognition of the role the river plays in maintaining 34 commercially important fish species.

Some of the communities described below support organisms, especially among the plants, which require very specific environmental features. For example, high salinity precludes the survival of most flowering plants and amphibians. Some fish require high salinities; others simply cannot survive them. Plants and animals with narrow requirements may have a limited distribution within the Hudson Valley. Organisms with wider tolerances use many of the communities and are distributed throughout the valley; this is especially true among the mammals and the birds. For example, semi-aquatic mammals such as mink (*Mustela vison*), river otter (*Lontra canadensis*), and muskrat (*Ondatra zibethicus*) use aquatic habitats throughout the Hudson Valley; the mink uses uplands more than the others do. Furthermore, many species of wildlife use different communities for different life functions, such as feeding, resting, reproducing, hibernating, and migrating. Several species of bats can be found foraging over both aquatic and terrestrial habitats but may roost in trees, caves, or buildings in the uplands. White-tailed deer (*Odocoileus virginianus*) and short-tailed shrews (*Blarina brevicauda*) are generally associated with uplands but will frequently venture into wetter communities. Many birds, too, exhibit a wide use of community types. Waterfowl will generally roost and rest on water but will feed in both uplands and wetlands. Tree swallows (*Tachycineta bicolor*) nest in tree cavities or artificial boxes but will feed on insects over aquatic habitats. Herons can be found throughout the river wherever the water is shallow enough to enable them to wade and hunt for their aquatic prey.

Hudson Falls to Troy

The main river channel between Hudson Falls and Troy is a wide, slow-flowing channel with a mostly sandy bottom and beds of aquatic vegetation in coves or bar areas where finer soils accumulate (6). Riffle habitat is limited and usually found adjacent to islands or man-made structures such as locks and low-head dams. Typical fish species found in the main channel include largemouth bass (*Micropterus salmoides*), smallmouth bass (*Micropterus dolomieui*), yellow perch (*Perca flavescens*), brown bullhead (*Ameiurus nebulosus*), northern pike (*Esox lucius*), white sucker (*Castostomus commersoni*), and American eel (6). Beds of wild celery (*Vallisneria americana*), Eurasian milfoil (*Myriophyllum spicatum*), and water chestnut (*Trapa natans*) are present in portions of the main channel where the bottom sediments are stable and sunlight can penetrate far enough to support plant growth. Waterfowl such as mallards (*Anas platyrhynchos*), black ducks (*Anas rubripes*), and Canada geese (*Branta canadensis*) forage in these beds. Examples of this community occur along Griffin Island in Saratoga County (7).

This section of the Hudson River also supports wetland communities such as emergent marshes, shrub swamps, hardwood swamps, and floodplain forests. These communities occur in patches along the banks of the river and are interspersed with stretches where uplands come right to the banks.

Emergent marshes occur along the edges of bays and near the mouths of some tributaries. Marshes that are usually flooded during most of the growing season support plants such as spatterdock (*Nuphar luteum*), pickerelweed (*Pontedaria cordata*), arrowhead (*Sagittaria* spp.), cattail (*Typha* spp.), and softstem bulrush (*Scirpus validus*); those flooded only during high water periods support rice cutgrass (*Leersia oryzoides*), purple loosestrife (*Lythrum salicaria*), wool grass (*Scirpus cyperinus*), and various sedges (*Carex* spp.) (5). Northern pike and carp (*Cyprinus carpio*) use these flooded areas as spawning habitat; frogs and waterbirds such as herons, bitterns, rails, and waterfowl feed and reproduce here. A good example of an emergent marsh can be seen along the west side of the river near the confluence of Snook Creek in Saratoga County (8).

Scrub-shrub swamps occur at slightly higher elevations than emergent marshes and are flooded less frequently. Typical shrubs include silky and red-osier dogwoods, shrub willows (*Salix* spp.), and spiraeas; herbaceous species such as cattails and sedges may also be present. Common yellowthroat (*Geothlypis trichas*), yellow warbler (*Dendroica petechia*), and song sparrow (*Melospiza melodia*) are typical songbirds. This type of swamp can be seen on Thompson Island in Saratoga County (8).

Hardwood swamps are found as elevation increases and flooding decreases. Trees such as red maple (*Acer rubrum*), silver maple (*Acer saccharinum*), eastern cottonwood (*Populus deltoides*), black willow (*Salix nigra*), and green ash (*Fraxinus pensylvanica*) dominate the canopy. Wood ducks (*Aix sponsa*) nest in cavities in large trees and red-bellied woodpeckers (*Melanerpes carolinus*) bore into dying trees. Wood frog (*Rana sylvatica*) and spotted salamander (*Ambystoma maculatum*) may be present if temporary (vernal) pools are available in the spring and early summer (9). Examples of this community occur on Thompson Island in Saratoga County and downstream of Fort Miller in Washington County (8).

Floodplain forests are closely associated with the river and are subject to a wide range of inundation. Some may be flooded after every severe storm, others only flood during exceptional runoff events. Eastern cottonwood, silver maple, red maple, black willow, and sycamore (*Platanus occidentalis*) are indicative of this community. American woodcock (*Philohela minor*) nest and forage on the ground (5).

TROY TO NEWBURGH

Below the Federal Dam at Troy the Hudson River becomes an estuary, where fresh waters meet salt waters. Tides in the Lower Hudson River occur twice each day. They rise and fall a total of about five feet at Troy (the northern extent of tidal influence) and at the mouth near the Battery on Manhattan. Tidal amplitude declines to about three feet mid-estuary. The main channel of the river courses through freshwater tidal wetlands such as subtidal shallows, intertidal mudflats and intertidal shores. Patches of tidal marshes and floodplain swamps are found along the shores. These communities occur above the salt front where the surface water salinity is generally lower than 0.5 parts per thousand.

Freshwater subtidal shallows and aquatic beds include wild celery, naiads (*Najas* spp.), and the introduced water chestnut. An example of this community occurs near Constitution Marsh in Putnam County (2, 5).

Intertidal mudflats generally occur in areas where wave energy or unstable substrates prevent stands of rooted plants from becoming established, though scattered individuals may be present, particularly along the periphery. Mudflat areas provide important foraging areas for migrating shorebirds and waterfowl. Species that use these areas year-round include black duck, mallard, Canada goose, herring gull (*Larus argentatus*), ring-billed gull (*L. delawarensis*), great blue heron (*Ardea herodias*), and fish crow (*Corvus ossifragus*) (7). Examples of this community occur in North Tivoli Bay in Dutchess County and Inbocht Bay in Greene County (2, 5).

Freshwater tidal marshes occur in shallow bays, bars, or tributary mouths and are flooded for at least a portion of the growing season. The wettest sites are flooded daily during high tides and support plant species such as spatterdock (*Nuphar luteum*), pickerelweed, three-square (*Scirpus americanus*), and common reed. Sites at higher elevations may only be inundated or saturated during spring tides and support the same plant and animal species found in the marshes found further upriver. Examples of this community occur at the Stockport Creek marshes in Columbia County and North Tivoli Bay in Dutchess County (5).

Freshwater tidal swamps occupy low-lying areas adjacent to the main stem of the Hudson River or major tributaries that are inundated seasonally or by the highest storm tides. The plants and animals found here are very similar to those which use the hardwood swamps found further upriver. Examples of freshwater tidal swamps occur along Schodack-Houghtaling Island, in Rensselaer and Greene Counties and on Roger's Island in Columbia County (2).

NEWBURGH TO MANHATTAN

Below Newburgh, the estuarine system consists of saltwater and brackish communities. The main channel of the river is flanked with patches of wetland communities or is abruptly met by uplands and even steep bluffs. The transition from upland to aquatic habitats is commonly interrupted by man-made structures such as railroad beds and bulkheads.

The tidal river itself comprises deepwater and shallow zones. Salinity varies within the deepwater zone (over 6 feet deep at mean low tide); a surface layer of lighter freshwater (salinity less than 0.5 parts per thousand (ppt)) flows above a brackish layer (salinity from 0.5 ppt to 18 ppt). Salinity in the middle reaches of the estuary fluctuates with the movement of the salt front as the tides move in and out and as seasonal fluctuations in rainfall cause variations in freshwater inputs from upstream (3). Under average runoff conditions, the salt front reaches West Point or Newburgh. Characteristic fish include resident and anadromous species such as Atlantic tomcod (*Microgadus tomcod*), hogchoker (*Trinectes maculatus*), and rainbow smelt (*Osmerus mordax*) in the deepwater zone. Shallow water species include striped bass, American shad, banded killifish (*Fundulus diaphanus*), and blue claw crab (*Callinectes sapidus*) (3, 5). Some fish species more typical of freshwater systems, such as tessellated darter (*Etheostoma olmstedi*) and pumpkinseed (*Lepomis gibbosus*), are found in the less saline portions of the estuary. Certain fish can be found in both deepwater and shallow water habitats; these include white perch (*Morone americana*) and alewife (*Alosa pseudoharengus*). An example of this habitat is Haverstraw Bay in Rockland and Westchester Counties.

Other permanently flooded habitats include tidal creeks and brackish aquatic beds. Tidal creeks are permanently flooded and drain the tidal waters of coastal saltmarshes. Water is brackish to saline (0.5 to 30.0 ppt) and water levels fluctuate with the tides. Creek banks are flooded during high tides but exposed at low tides. Tidal creeks that have not been altered by historic mosquito ditching or small navigational dredging projects tend to follow sinuous pattens through the salt marsh. Here the plant community provides food and cover for wildlife and includes widgeongrass (*Ruppia maritima*), saltmarsh cordgrass (*Spartina alterniflora*), and common reed (*Phragmites australis*). As salinity drops in the upstream portions of these creeks, plant species such as narrow leaf cattail (*Typha angustifolia*), pickerelweed, and purple loosestrife (*Lythrum salicaria*) become more abundant. Resident fish use tidal creeks and also the salt marsh when it is flooded at high tide; these include the Atlantic silversides (*Menidia menidia*), mummichog (*Fundulus heteroclitus*), striped killifish (*Fundulus majalis*), and American eel (*Anguilla rostrata*) (5). These tidal creeks are also used as nursery habitat for winter flounder (*Pseudopleuronectes americanus*), black sea bass (*Centropristis striata*), bluefish (*Pomatomus saltatrix*), and striped bass (5). Less saline reaches of these creeks may support species such as pumpkinseed, largemouth bass, and three-spined stickleback (*Gasterosteus aculeatus*). Wildlife using these habitats include black duck, Canada goose, marsh wren (*Cistothorus palustris*), raccoon (*Procyon lotor*), and muskrat. An example of this habitat includes Piermont Marsh in Rockland County (2).

Brackish subtidal aquatic beds occur in continuously-flooded areas of the river and are dominated by rooted submergent vegetation species such as waterweed (*Elodea* spp.), coontail (*Ceratophyllum demersum*), and sago pondweed (*Potamogeton pectinatus*). Introduced species, such as curlyleaf pondweed (*Potamogeton crispus*), and nuisance invasive species such as Eurasian milfoil, are also abundant. These beds provide habitat for a variety of fish species such as largemouth bass, pumpkinseed, yellow perch, and white perch. They are also important foraging areas for waterfowl. Examples of this community are also located at Piermont Marsh (2, 5).

In addition to the more common inhabitants of the Hudson River's major ecological communities, the river also is home to a number of species that the State of New York and the Federal government list as threatened and endangered or that the State considers "of special concern." Exhibit 1-2 lists the Hudson River species that fall into these categories.

Exhibit 1-2: Endangered, Threatened, Special Concern or Rare Species in or Near the Hudson River

Endangered, Threatened, Special Concern or Rare Species Identified in or Near the Hudson River By The State of New York or as Potentially Occurring in or Near the Hudson River by The U.S. Fish And Wildlife Service

Common Name	Scientific Name	Federal Status	New York State Status
Plants			
American waterwort	*Elantine americana*		Endangered
Bicknell's sedge	*Carex bicknelli*		Rare
Blunt-lobe grape fern	*Botrychium oneidense*		Endangered
Clustered sedge	*Carex cumulata*		Rare
Davis sedge	*Carex davisii*		Rare
Estuary beggar-ticks	*Bidens bidentoides*		Threatened
False hop sedge	*Carex lupiformes*		Rare
Glaucous sedge	*Carex flaccosperma var. glaucodea*		Rare
Golden seal	*Hydrastis canadensis*		Threatened
Heartleaf plantain	*Plantago cordata*		Threatened
Illinois pinweed	*Leachea racemulosa*		Rare
Marsh straw sedge	*Carex hormathodes*		Rare
Mock-pennyroyal	*Hedeoma hispidum*		Rare
Saltmarsh bulrush	*Scirpus novae-angliae*		Endangered
Schweinitz's flatsedge	*Cyperus schweinitizii*		Rare
Slender crabgrass	*Digitaria filiformis*		Threatened
Smooth bur-marigold	*Bidens laevis*		Rare
Southern yellow flax	*Linum medium var. texanum*		Threatened
Spongy arrowhead	*Sagittaria calycina var. spongiosa*		Rare
Swamp lousewort	*Pedicularis lanceolata*		Rare
Swamp cottonwood	*Populus heterophylla*		Threatened
Violet lespedeza	*Lespedeza violacea*		Rare
Water pigmyweed	*Crassula aquatica*		Endangered
Weak stellate sedge	*Carex seorsa*		Rare
Invertebrates			
Karner blue butterfly	*Lycaeides melissa samuelis*	Endangered	Endangered
Fish			
Shortnosed sturgeon	*Acipenser brevirostrum*	Endangered	Endangered
Amphibians			
Northern cricket frog	*Acris crepitans*		Endangered

Exhibit 1-2 continued: Endangered, Threatened, Special Concern or Rare Species in or Near the Hudson River

Endangered, Threatened, Special Concern or Rare Species Identified in or Near the Hudson River By The State of New York or as Potentially Occurring in or Near the Hudson River by The U.S. Fish And Wildlife Service

Common Name	Scientific Name	Federal Status	New York State Status
Reptiles			
Bog turtle	*Clemmys muhlenbergii*	Threatened	Endangered
Blanding's turtle	*Emydoidea blandingii*		Threatened
Fence lizard	*Sceloporus undulatus*		Threatened
Timber rattlesnake	*Crotalus horridus*		Threatened
Spotted turtle	*Clemmys guttata*		Special Concern
Wood turtle	*Clemmys insculpta*		Special Concern
Birds			
Peregrine falcon	*Falco peregrinus*		Endangered
Short-eared owl	*Asio flammeus*		Endangered
Least bittern	*Ixobrychus exilis*		Threatened
Bald eagle	*Haliaeetus leucocephalus*	Threatened	Threatened
Northern harrier	*Circus cyaneus*		Threatened
King rail	*Rallus elegans*		Threatened
Upland sandpiper	*Bartramia longicauda*		Threatened
Osprey	*Pandion haliaetus*		Special Concern
Cooper's hawk	*Accipiter cooperii*		Special Concern
Red-shouldered hawk	*Buteo lineatus*		Special Concern
Common nighthawk	*Chordeiles minor*		Special Concern
Vesper sparrow	*Pooecetes gramineus*		Special Concern
Grasshopper sparrow	*Ammodramus savannarum*		Special Concern
Mammals			
Indiana bat	*Myotis sodalis*	Endangered	Endangered
Allegheny woodrat	*Neotoma magister*		Endangered

Source: (10, 11)

Historical Significance of the Hudson River

The history and culture of a particular place can sometimes be traced through a prominent natural feature. Such is the case with the Hudson River. Many of the major historical events and trends of the northeastern United States — exploration, war, industrialization — are reflected in the history of and human activity within the river basin. In 1998, the Federal government recognized the Hudson River's historical and cultural significance by designating it as an American Heritage River. The Heritage Rivers program strives for natural resource protection, economic revitalization, and historic and cultural preservation in the country's most valuable river corridors.

In the centuries preceding European settlement, the Hudson Valley was home to several groups of Native Americans, including the Mohican and Haudenosaunee. As shown in Exhibit 1-3, the recorded history of the Hudson begins with its exploration by Henry Hudson in 1609. Sailing for a Dutch trading company, Hudson was searching for a passage to China when he came upon the river. Dutch colonists subsequently settled an area near the mouth of the Hudson River, which they named New Amsterdam.

The Hudson River was the site of a number of events during the Revolutionary War. The Battle of Saratoga was fought along the banks of the Hudson River in 1777 and led to a critical alliance between the Americans and the French. In 1778, the Americans recognized the strategic importance of the Hudson River and began building forts at West Point. The infamous spy Benedict Arnold commanded the area, but was foiled in his attempts to pass information about the forts to the British. Beginning in 1782, George Washington commanded the war from a post in Newburgh, along the Hudson River.

The next century in the Hudson River Valley was one of innovation and industrialization. The introduction of steamboat travel in 1807 was instrumental in getting people and supplies up and down the Hudson River. By 1850, estimates suggest that roughly 150 vessels carried as many as a million passengers each year. The new transportation corridor allowed development of industrial centers such as Cold Spring, where the West Point Foundry produced metal products ranging from pipes to railroad engines. Industrial enterprises that thrived along the Hudson River included whale processing, ice production, brick making, and brewing.

Despite rapid industrialization in parts of the Hudson River Valley, the region also became popular as a recreational retreat. New York City residents traveled to the valley to take advantage of the mountains and fresh air, believing that such conditions were therapeutic. The area's reputation as a tourist destination was enhanced with the advent of the Hudson River School of Painting, a detailed landscape style that became popular with artists and art lovers alike in the mid-19th century.

In 1998, the Federal government recognized the Hudson River's historical and cultural significance by designating it as an American Heritage River.

Finally, the Hudson River has played a major role in the history of modern environmentalism. Efforts by wealthy industrialists to protect the Palisades, the majestic cliffs of the Lower Hudson River, increased environmental awareness in the area, and led to further efforts to protect the river's habitat and ecosystems. For example, Bear Mountain-Harriman State Park, which was established in 1910, represents one of the first major conservation successes in the Nation's history. Beginning in 1963, a battle over construction of a large electric generating facility on the Hudson River led to the formation of Scenic Hudson, a river protection group that still exists to this day. Other non-governmental organizations active in the Hudson River valley include Hudson River Sloop Clearwater, Riverkeeper, the Natural Resources Defense Council, the Sierra Club, and others.

EXHIBIT 1-3: SELECTED EVENTS IN THE RECORDED HISTORY OF THE HUDSON RIVER

SELECTED EVENTS IN THE RECORDED HISTORY OF THE HUDSON RIVER

1609
Englishman Henry Hudson, sailing for the Netherlands, explores Hudson River, sailing as far north as present-day Albany.

1624
The Dutch settle permanently along the Hudson River; call their settlement New Amsterdam.

1664
British conquer Dutch Amsterdam; rename region New York in honor of the Duke of York.

1777
Revolutionary War Battle of Saratoga fought along river. Won by the Americans, it leads to the French alliance, and thus to eventual victory and independence.

1802
United States Military Academy at West Point established.

1807
Robert Fulton launches his "North River Steamboat of Clermont" on the Hudson River. The first ever successful steam-propelled vessel, it begins a new era of transportation.

1817
West Point Foundry established, which later supplies munitions to the Union during the Civil War.

1825
Completion of the Erie Canal greatly enhances the importance of the Port of New York, connecting the Hudson River to Lake Erie and later to the St. Lawrence River Seaway; Champlain Canal also completed, providing an important transportation corridor for raw materials and completed products from the Hudson River valley to markets beyond.

1828
Opening of Delaware and Hudson Canal between northeastern coal fields of Pennsylvania and ports of New York and New England.

1831
Completion of the Morris Canal; designed to bring coal from Pennsylvania to New York Harbor.

1886
Dedication of the Statue of Liberty in New York Harbor.
Poughkeepsie Railroad Bridge constructed.

1984
Hudson River is placed on the Superfund National Priority List.

1996
Hudson River Natural Resource Trustee Council formed.

1998
Hudson designated as an American Heritage River.

SOURCE: (12, with adaptation)

RECREATION AND THE MODERN ECONOMY

The Hudson River continues to be an economic cornerstone in New York State and the northeastern United States. Economic sectors such as tourism, fishing, transportation, power generation, and real estate development all benefit from the river. As part of the assessment, the Trustees may make a determination of the extent to which the transportation and recreational fishing sectors have been adversely affected by the polychlorinated biphenyl (PCB) contamination.

Foremost among the Hudson River's economic contributions is its continued role as a tourist and recreational destination. Historical sites, sweeping landscapes, boating, and other attractions draw visitors year after year. These activities support local businesses and generate revenue for the State. Examples of the Hudson River's tourist offerings include the following.

- **Historical Sites:** As noted, the Hudson River has been at the center of many historical developments in the region. The banks of the river are lined with historic homesteads, museums, and historical parks that evoke key people and events. Examples include Clermont State Historic Park, the Hudson River Maritime Museum, the Saratoga National Historical Park, the Franklin D. Roosevelt National Historic Site, the Vanderbilt Mansion National Historic Site, the U.S. Military Academy at West Point, and the Cloisters. At the mouth of the Hudson River stands the Statue of Liberty and the Ellis Island museum. The National Park Service (NPS) oversees management of a number of these sites; other areas affiliated with the NPS include the Hudson River Valley Heritage Area and Hudson River Valley Greenway.
- **Festivals and Performances:** Towns along the river host annual events that celebrate the Hudson River Valley, its history, and its people. These festivals and performances draw thousands of visitors each year. Examples include the Hudson Valley Shakespeare Festival, the Hudson Valley Film Festival, the Hudson Heritage Festival, and numerous musical performances hosted by arts and cultural organizations in towns along the Hudson River.
- **Commercial Cruises:** Several companies offer commercial cruises of the Hudson River that tour the historic towns, architecture, and natural features of the region. These excursions range from several hours to full weekend trips.
- **Parks and Campgrounds:** An extensive network of parks and campgrounds attracts visitors to the Hudson River Valley and provides outdoor recreational opportunities. Bear Mountain State Park, for example, is open year-round and offers swimming, hiking, skiing, and other activities. Other popular and scenic parks include Adirondack Park, Schaghticoke Canal Park at Lock 4, Peebles Island State Park, Rockefeller State Park Preserve, Anthony Wayne Recreation Area, Hudson Highlands State Park, James Baird State Park, Mills-Norrie State Park, and Hudson River Islands State Park.

Foremost among the Hudson River's economic contributions is its continued role as a tourist and recreational destination. Historical sites, sweeping landscapes, boating, and other attractions draw visitors year after year.

- **Recreational Boating:** Recreational boating is popular in the Hudson River Valley. The Champlain Canal is also important to such boaters. For the 1999 canal season, 14,298 pleasure craft traveled through Locks 1 (Waterford) through 6 (Fort Miller) of the Champlain Canal. Navigation of vessels, particularly larger vessels with deeper drafts, through the Champlain Canal may be impeded by the lack of dredging in the Canal due to the presence of PCB contaminated sediments. Many boat launches and marinas allow access to the Hudson River and its tributaries. Requests for space at marinas has historically outstripped availability, indicating strong demand for boating opportunities.

Further Economic Significance of the Hudson River

The economic significance of the Hudson River extends beyond just its recreational offerings. An estimated 8 million people reside in the 19 counties in New York State that border the Hudson River. As an example of the economic significance of the river, the Hudson River serves as a source of public drinking water for several communities. The cities of Waterford, Poughkeepsie, and Rhinebeck, as well as the Highland and Port Ewen Water Districts, obtain their water supplies directly from the Hudson River. In addition, a water intake near Chelsea, north of Beacon, may be used to supplement New York City's water supply during periods of drought. The towns of Stillwater and Green Island use groundwater drawn from areas adjacent to the Hudson River as their municipal water supplies. The Champlain Canal in the Upper Hudson River served as an important corridor for the transport of petroleum products and jet fuel to the Plattsburgh Air Force Base, until the Base closed in 1994. Present commercial traffic on the Champlain Canal consists primarily of tour boats. For the 1999 canal season, 1,361 commercial vessels traveled through Locks 1 (Waterford) through 6 (Fort Miller). Use of the Canal may be impeded by the accumulation of sediments which have not been removed due to PCB contamination. Hudson River water is used for manufacturing processes, cooling, and fire protection. Major industries in the Upper Hudson area include paper mills, hydroelectric plants, and manufacturing (brake linings, paper products, clothing, garden equipment). Hydroelectric dams at Hudson Falls, Fort Miller, Upper Mechanicville, Mechanicville, Stillwater, and Green Island harness the flow of the river to generate electricity. Several thermal power plants (those that use fossil and nuclear fuels) use large amounts of cooling water from the Hudson River. These include the Indian Point, Bethlehem, Bowline, Lovett, Roseton, and Danskammer power plants as well as numerous industrial facilities that generate their own power. Hudson River water is also used for domestic purposes (watering lawns and gardens) and agricultural purposes (irrigating crops). Agriculture in the Upper Hudson River includes apple orchards, dairy farms, corn and hay for forage, and cash crops such as oats and wheat.

American Shad

Illustration by: Duane Raver, U.S. Fish and Wildlife Service

In addition, the river's unique ecological features provide spawning grounds for important commercial species such as striped bass, American shad and rare species such as the endangered shortnose sturgeon and increasingly scarce Atlantic sturgeon.

In addition, the river's unique ecological features provide spawning grounds for important commercial species such as striped bass, American shad, and rare species such as the endangered shortnose sturgeon and increasingly scarce Atlantic sturgeon. Thus, the Hudson plays an important role in the maintenance of commercial fisheries throughout the Northeastern United States.

PCB CONTAMINATION IN THE HUDSON RIVER

Photo by Tom Ligamari for Scenic Hudson, Inc.

The GE Hudson Falls plant site and Allen Mills. EPA estimates that GE discharged up to 1.3 million pounds of PCBs.

HISTORY AND EFFECTS OF PCBS IN THE HUDSON RIVER

The General Electric Company (GE) is the major source of the PCBs in the Hudson River (13). At its plants at Fort Edward and Hudson Falls, GE manufactured electric capacitors containing PCBs. In the course of its manufacturing activities, GE discharged PCBs directly to the Hudson River and to the soil and groundwater beneath the two plants, which resulted in additional discharges of PCBs into the river. EPA estimates that GE discharged up to 1.3 million pounds of PCBs to the Hudson river between the 1940s and 1977 (14). Prior to 1975, GE did not have a permit authorizing any discharges of PCBs; the vast majority of the total PCBs discharged were released prior to 1975. Smaller volumes of PCBs, in contaminated groundwater, continue to be discharged, without permit, to the river through fractured bedrock and soils underlying the two manufacturing sites to this day.

Other possible, less significant sources of PCBs to the Hudson River include wastewater treatment plants, stormwater runoff, landfill leachate, dredge spoils, hazardous waste sites, and atmospheric deposition (10, 13). Some of the landfills and dredge spoils contain PCBs that originated at the GE facilities (10). EPA estimates that 50 percent of the PCB contamination in New York Harbor is attributable to releases from GE's Fort Edward and Hudson Falls plants.

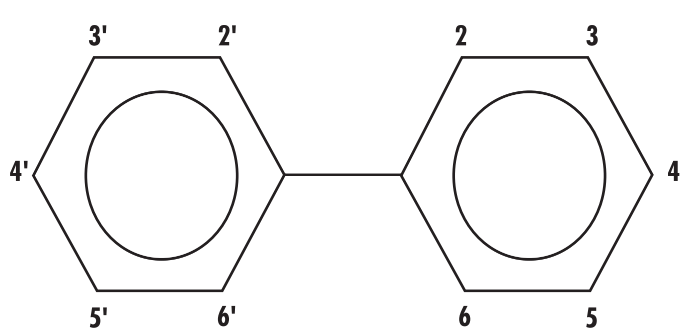
PCBs are synthetic (man-made) chemicals that form a group of 209 individual compounds that have similar chemical structures based on a biphenyl core with 1 to 10 chlorine atoms attached. PCBs have the generic formula $C_{12}H_{(10-x)}Cl_x$, where x is an integer from 1 to 10. Exhibit 2-1, below, is a figure of a biphenyl molecule. Each individual PCB compound, called a congener, is identified by the unique number and location of chlorine atoms that attach to the compound's base structure. Congeners differ both in their physical properties and in their effects on fish and wildlife. All commercial applications of PCBs consist of a mixture of different congeners. These mixtures were produced by multiple manufacturers and sold under a variety of trade names including Aroclor, Kanechlor, Clophen, and Fenchlor (15).

The physical and chemical properties of PCBs that made them useful to industry also contribute to environmental problems. PCBs generally degrade slowly once in the environment and their lipophilicity (tendency or affinity to partition to fats) allows them to bioaccumulate in higher levels of the food chain .

The properties that make PCBs useful for commercial applications include chemical stability, heat resistance, miscibility with organic compounds (lipophilicity), and electrical insulating capabilities (15, 16, 17). Since they were first manufactured in the United States in the late 1920s, PCBs have been used for a wide range of applications, including electrical insulators, plasticizers, lubricants, hydraulic fluids, and sealers (18, 19, 20, 21). The physical and chemical properties of PCBs that made them useful to industry also contribute to environmental problems. PCBs generally degrade slowly once in the environment and their lipophilicity (tendency or affinity to partition to fats) allows them to bioaccumulate in higher levels of the food chain (15). Due to increasing concern about the compounds' impacts on human health and the environment, Congress passed PCB legislation under the Toxic Substances Control Act (TSCA), effective January 1977, which required EPA to establish labeling and disposal requirements for PCBs, and mandated an eventual ban on the manufacture and processing of PCBs. As a result of the TSCA legislation, virtually all uses of PCBs and their manufacture have been prohibited in the United States since 1979.

EXHIBIT 2-1: BASIC CHEMICAL STRUCTURE OF PCBS

BASIC CHEMICAL STRUCTURE OF PCBS



Because of their chemical stability, PCBs released to the Hudson River may reside in the environment for decades or longer. PCBs are hydrophobic compounds with low water solubilities. PCBs also display an affinity for adsorbing to particulate materials such as sediment and organic matter (22). The hydrophobic nature of PCBs, in combination with their lipophilicity and their tendency to adsorb to particulate matter, results in their partitioning into the sediment and biotic components of an aquatic system like the Hudson River. PCBs in the water column may be absorbed directly into the fats of plankton or benthic invertebrates; PCBs may also be taken into the roots or stomata of aquatic plants in the Hudson River and terrestrial plants growing in the floodplain of the Hudson River (23, 24, 25). Higher level organisms, such as fish and birds, may accumulate PCBs directly from the water column or through the ingestion of contaminated food (26, 27). The degree to which PCBs accumulate in animals is dependent on a number of factors, including their position within the food chain, feeding strategy, longevity, fat content, sex, and reproductive status.

Scientific research indicates that PCBs can be harmful to fish and wildlife. The exact nature of these effects depends on the level and duration of exposure, the specific PCB congener mixture to which the organism is exposed, and the specific organism. Although acute PCB toxicity is rare, exposure to very high levels of PCBs can result in death. For example, a PCB concentration of approximately 310 parts per million (ppm) in the brain has been associated with a high probability of death in a number of bird species (28). Lower concentrations of PCBs may cause a number of harmful biological responses such as reproductive failure, birth defects, impaired growth, behavioral changes, lesions, immune system dysfunction, or hormone imbalances. Studies of fish exposed to PCBs have found liver lesions, poor bone development, higher than normal egg mortality, reduced larvae survival, and abnormal cell growth (29, 30, 31, 32, 33, 34). Birds exposed to PCBs may exhibit reduced hatching rates, embryo mortality, physical deformations, and changes in brain chemistry (35, 36, 37, 38). Laboratory studies have shown that the North American mink (*Mustela vison*) is sensitive to PCBs. In controlled feeding studies of mink on diets containing PCBs, mink experienced reduced or inhibited reproduction, disrupted molting, reduction in thyroid hormones, increased incidence of fetal resorption, and in some instances, mortality (39, 40). Exhibit 2-2 summarizes PCB concentration data for Hudson River natural resources and identifies regulatory criteria and guidelines, as well as threshold concentrations that may be associated with adverse biological effects.

CLEANING UP PCBs IN THE HUDSON RIVER

Since the magnitude of the PCB problem in the Hudson River became known in the early 1970s, many State and Federal authorities and non-governmental organizations have worked to characterize the contamination in the Hudson River and reduce PCB discharges from GE's Hudson Falls and Fort Edward plant sites. In order to facilitate navigation and to respond to the emergency created by the removal of a dam in 1973, the New York State Department of Transportation (NYSDOT) has removed thousands of cubic yards of PCB-contaminated sediments from the river since the 1950s (41, 42). In recent years, navigational dredging in most of the Upper Hudson River has not occurred due to the high concentrations of PCBs in sediments. No dredging in the Upper Hudson River has occurred since 1979, except for the removal of coarse, uncontaminated sediments that periodically accumulate at the mouth of the Hoosic River, a tributary that empties into the Hudson River near Stillwater. Since the early 1990s, the State has also taken action to require GE to remediate PCB sources to the Hudson River at GE's Hudson Falls and Fort Edward plant sites (13). In 1984, EPA designated 200 miles of the Hudson River as a Superfund site, providing a mechanism for evaluation and cleanup. A chronology of selected events related to the discharge, discovery, and removal of PCBs in the Hudson River is provided in Exhibit 2-3.

In 2002, EPA adopted a plan for the cleanup of the Hudson River Superfund site. The remedial program is designed to remove an estimated 150,000 pounds of PCBs from some of the most contaminated portions of the river's bed.

In 2002, EPA adopted a plan for the cleanup of the Hudson River Superfund site. The remedial program is designed to remove an estimated 150,000 pounds of PCBs from some of the most contaminated portions of the river's bed. However, the plan does not address many areas of sediment contamination that contribute to natural resource injury. Current estimates indicate that the remedy will leave behind approximately 80,000 pounds of PCBs in the Upper Hudson River between Hudson Falls and the Federal Dam at Troy. PCB-contaminated sediments in the Lower Hudson River will also remain. As a result, even if this plan is fully implemented, natural resources will continue to be exposed to PCBs and may continue to be adversely affected as a result of that exposure.

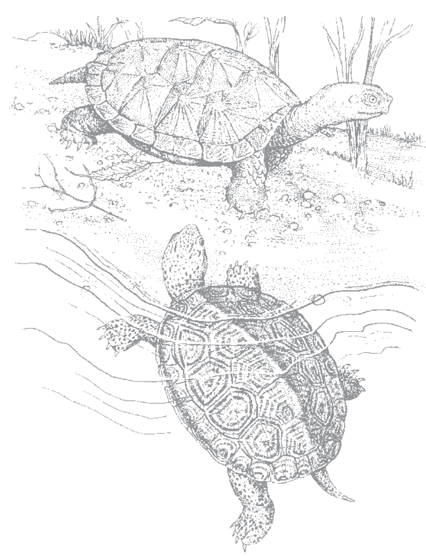


Exhibit 2-2: PCB Concentrations in Selected Hudson River Natural Resources

PCB Concentrations in Selected Hudson River Natural Resources, Regulatory Criteria and Guidelines, and Threshold/Effects Identified in the Literature

Resource	PCB Concentration in Hudson River	Regulatory Criteria or Guidelines	Selected Threshold/Effects Identified in the Literature	
Sediment				
Upper River	Non-detected (ND) - 4,747 ppm, 1976-2001 (43)		0.035 ppm	Threshold Effect Concentration (TEC) for freshwater sediment (44)
Lower River	ND - >1,700 ppm, 1976-2001 (43)		0.048 ppm	TEC for marine/estuarine sediment (44)
			0.34 ppm	Moderate Effect Concentration (MEC) for freshwater sediment (44)
			0.47 ppm	MEC for marine/estuarine sediment (44)
			1.6 ppm	Extreme Effect Concentration (EEC) for freshwater sediment (44)
			1.7 ppm	EEC for marine/estuarine sediment (44)
			>0.4 - 1.7 ppm	42.5% incidence of toxicity to bottom-dwelling freshwater biota (44)
			> 1.7 ppm	82.5% incidence of toxicity to bottom-dwelling freshwater biota (44)
Water				
Upper River	0.006 - 5.1 ppb, 1975-2001 (45)	0.000001 ppb to protect human consumers of fish; 6 NYCRR 703.5 (46)	1 - >10 ppb	Lethal to zooplankton and large invertebrates such as shrimp and oysters (47)
Lower River	0.006 - 0.46 ppb, 1975-2001 (45)	0.00012 ppb to protect fish-eating wildlife; 6 NYCRR 703.5 (46)	> 1 - 10 ppb	Lethal to certain fish (48)
		0.001 ppb - general exposure of humans and wildlife; 40 CFR 129.105		
		0.09 ppb for sources of human drinking water; 6 NYCRR 703.5 (46)		

EXHIBIT 2-2 CONTINUED: PCB CONCENTRATIONS IN SELECTED HUDSON RIVER NATURAL RESOURCES

PCB CONCENTRATIONS IN SELECTED HUDSON RIVER NATURAL RESOURCES, REGULATORY CRITERIA AND GUIDELINES, AND THRESHOLD/EFFECTS IDENTIFIED IN THE LITERATURE

RESOURCE	PCB CONCENTRATION IN HUDSON RIVER	REGULATORY CRITERIA OR GUIDELINES	SELECTED THRESHOLD/EFFECTS IDENTIFIED IN THE LITERATURE	
SNAPPING TURTLE				
	2.94 - 4,319 ppm in fat (49, 50, 51) 0.54 to 196 ppm in liver (49, 50, 51) ND - 3.92 ppm in muscle tissue (50, 51)		15 ppm in eggs	Reduced hatching success of snapping turtles (52)
FISH				
	ND - 250 ppm in brown bullhead fillets, from 1975-1999 (43) ND - 300 ppm in largemouth bass fillets, 1975-1999 (43) <0.02 -1,836 ppm in fillets of fish species from the Upper Hudson River, 1977-1998 (43, 51) <0.02 - 686 ppm in fillets of fish species from the Lower Hudson River, 1977-1998 (43, 51) 0.252 - 444.78 ppm in fillets of 21 fish species from the Upper Hudson River, 1998-1999 (43, 51) 0.032 - 24.8 ppm in fillets of 22 fish species from the Lower Hudson River, 1998-1999 (43, 51)	2 ppm - FDA tolerance in edible portions of fish (21 CFR 109.30 (a)(7))	High ppb - low ppm range in fish tissue	Biochemical changes (31)
			50 ppm in fish tissue	Altered growth (31)
			> 100 ppm in fish tissue	Altered reproduction and lethality (31)

Exhibit 2-2 continued: PCB Concentrations in Selected Hudson River Natural Resources

PCB Concentrations in Selected Hudson River Natural Resources, Regulatory Criteria and Guidelines, and Threshold/Effects Identified in the Literature

Resource	PCB Concentration in Hudson River	Regulatory Criteria or Guidelines	Selected Threshold/Effects Identified in the Literature	
Birds				
	<0.01 - 1.1 ppm in breast muscle of adult mallards; <0.1 - 26 ppm in fat of adult mallards (53, 54, 55) 0.005 - 77.3 ppm in tree swallow eggs (56) 20 - 62 ppm in non-viable bald eagle eggs (57)	0.3 ppm - FDA tolerance in eggs (21 CFR 109.30(a)(4)) 3 ppm - FDA tolerance in poultry fat (21 CFR 109.30(a)(3))	1 - 5 ppm in eggs	Decreased hatching success for chickens (27)
			8 - 25 ppm in eggs	Decreased hatching success for terns, cormorants, doves, eagles (27)
Mammals				
	1.31 - 431 ppm in otter liver fat (50, 51) 0.13 - 139 ppm in mink liver fat (50, 51)		21 ppm in fat	Critical level for health impairment (58)
			50 ppm in fat	Critical level for reproductive impairment (59, 60)
Floodplain Soils				
	ND - 360 ppm in soils collected in 2000 (61)		0.371 ppm in soil	Adverse effects on floodplain-associated small mammals (62)
			0.655 ppm in soil	Adverse effects on floodplain-associated birds (62)
			2.5 ppm in soil	Acute LC50 for earthworms (63)

EXHIBIT 2-3: SELECTED CHRONOLOGY OF EVENTS RELATED TO THE DISCHARGE, DISCOVERY, AND REMOVAL OF PCBS IN THE HUDSON RIVER

SELECTED CHRONOLOGY OF EVENTS RELATED TO THE DISCHARGE, DISCOVERY, AND REMOVAL OF PCBS IN THE HUDSON RIVER

YEAR	DESCRIPTION OF ACTIVITY OR ACTION
1947	• GE begins discharging wastewater containing PCBs from the facility in Hudson Falls.
1952	• GE begins discharging wastewater containing PCBs from the facility in Fort Edward.
1969	• PCBs are detected in fish collected from the river.
1973	• Fort Edward Dam is removed, accelerating the movement of PCB-contaminated sediment down river.
1974-1975	• NYS removes 380,000 cubic yards of PCB-contaminated sediment from Fort Edward waterfront.
1974-1978	• NYS stabilizes the Remnant Deposits.
1976	• NYS determines that PCB concentrations in fish from the Hudson River are a human health risk, and advises public to limit consumption; all Upper River, and most commercial fishing, is closed. • NYS begins extensive sediment sampling and analysis. • Administrative Law Judge issues interim order finding GE's PCB discharges illegal. • GE and NYSDEC sign Consent Order to address direct PCB discharges from GE's Hudson Falls and Fort Edward facilities.
1977	• GE discontinues use of PCBs at Hudson Falls and Fort Edward facilities.
1977-1978	• NYS removes 180,000 cubic yards of PCB-contaminated sediment at Fort Edward.
1978	• NYS removes 14,000 cubic yards of sediment from the remnant area.
1983	• EPA proposes listing the Hudson River on the National Priorities List.
1984	• EPA lists the Hudson River (200 river miles) on the Superfund National Priorities List. • EPA issues Record of Decision (ROD) for the Hudson River calling for interim "no-action" decision for river sediment, in-place capping, containment and monitoring of remnant deposit sediments, and treatability study for the Waterford Treatment Plant.
1989	• EPA commences a Reassessment of the 1984 "no-action" decision.
1991	• GE completes interim capping of remnant deposits. • GE signs Consent Agreement with NYS to remediate Bakers Falls area and Hudson Falls plant site. • EPA issues Phase I of the Reassessment Report, which summarizes and evaluates all available data for the Hudson River from Hudson Falls to the Battery. • Allen Mill raceway breaks, releases PCB-contaminated sludge to river.
1993-2000	• EPA conducts Phase 2 of the Reassessment.
2000	• NYSDEC issues ROD for the GE Fort Edward plant site directing the removal of PCB-contaminated soils and sediments. • EPA issues results of the Reassessment, completes the Feasibility Study, and issues proposed plan for the removal of approximately 75 tons of PCBs from the Upper Hudson River.
2002	• EPA issues decision to remediate the Upper Hudson River in two phases. NYS concurs in selection of remedy.

THE ROLE OF THE TRUSTEES

Photos by Al Poelzl for Scenic Hudson, Inc.

Overlooking the Hudson River, Storm King mountain was the focal point of a historical environmental battle in 1963 over a proposed power plant.

The responsibility for restoring natural resources that have been injured by hazardous substances lies with several government agencies and Indian tribes that are known as Trustees.[1] Trustees include the heads of State agencies, Indian tribes, and Federal government agencies such as the U.S. Department of the Interior and the U.S. Department of Commerce. These entities act as stewards of our natural resources and are responsible for holding these resources in trust for the public and future generations.

The Trustees for natural resources of the Hudson River ecosystem have formed a Natural Resource Trustee Council for the purpose of conducting an assessment for the river's natural resources. These Trustee agencies include the U.S. Department of Commerce, the U.S. Department of the Interior, and the State of New York. These entities have each designated representatives that possess the technical knowledge and authority to perform natural resource damage assessments. For the Hudson River, the designees are the National Oceanic and Atmospheric Administration, the U.S. Fish and Wildlife Service, which represents the concerned DOI agencies (USFWS and NPS), and the New York State Department of Environmental Conservation (NYSDEC).

The process by which Trustees evaluate the impacts of hazardous substance contamination to natural resources is known as a natural resource damage assessment. The objective of NRDA is to restore natural resources that have been injured by hazardous substance contamination to baseline, or the condition that would have existed if the hazardous substances were not released. In addition, the Trustees may obtain compensation for natural resource injuries between the onset of the injury and full restoration.

[1] The authority of the Hudson River Trustees is derived from Federal law which authorizes the President and the representatives of any State to act on behalf of the public as trustees for natural resources (Section 107(f)(1) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and Section 311(f)(5) of the Federal Water Pollution Control Act (the Clean Water Act (CWA)). Pursuant to CERCLA and the National Contingency Plan, the President has designated the Secretary of Commerce and the Secretary of the Interior to act as trustees for particular natural resources managed or controlled by their agencies (CERCLA § 107(f)(2) and 40 CFR § 300.600). On November 30, 1987, the Governor of New York appointed the Commissioner of Environmental Conservation as the trustee for State natural resources. The Commissioner's natural resource damage responsibility under Federal law complements long-standing authority under State common law and Articles 1 and 3 of the New York State Environmental Conservation Law to conserve, improve, and protect New York's natural resources.

General guidelines for performing a natural resource damage assessment involving hazardous substances such as PCBs are described in regulations that were written by the U.S. Department of the Interior and appear in the Code of Federal Regulations at Title 43 Part 11. These guidelines describe methods for (1) making the decision to conduct a damage assessment, (2) establishing that hazardous substance contamination has injured natural resources, (3) determining the quantity of injured natural resources, (4) determining the amount of restoration required to fix or replace the injured natural resources and compensating the public for the lost functions, and (5) planning and conducting projects designed to restore the injured resources. These assessment procedures are not mandatory, nor do they preclude the Trustees' use of alternate methods of assessing damages or arriving at a negotiated settlement with a responsible party. These assessment procedures do, however, provide a framework to assess injury and plan and implement restoration of injured natural resources. The Trustees have been, and will continue to be, guided by these regulations as they carry out the NRDA.

Below, we briefly summarize the major steps in the damage assessment process.

The Assessment Plan documents exposure of natural resources to hazardous substances and identifies the anticipated procedures for evaluating the injuries caused by this exposure.

Preassessment Phase

During the preassessment phase the Trustees organize and assess available information about the area of concern and decide whether to proceed with a damage assessment. The findings of this evaluation are summarized in a document called a Preassessment Screen Determination. The Hudson River Trustees performed an evaluation of the available information regarding the river and issued a Preassessment Screen Determination in October of 1997 (64). The Trustees determined to proceed with a NRDA in the Hudson River because (1) PCBs were released to the river, (2) Trustee resources have been or are likely to have been adversely affected by the PCBs, (3) the concentration of the PCBs is sufficient to potentially injure natural resources, (4) data necessary to conduct a NRDA are available or can be obtained at a reasonable cost, and (5) completed or planned response actions would not completely remedy the injuries to natural resources. Subsequently, the Trustees sent GE a Notice of Intent to perform an assessment, dated September 22, 1998.

Preliminary Estimate of Damages

As part of the planning process for a damage assessment, the Trustees develop a Preliminary Estimate of Damages (PED). This PED is used to evaluate whether the costs of the anticipated assessment methods are reasonable in relation to estimated damages. To do this, the Trustees use readily available information to estimate damages and/or the cost of restoring injured natural resources. This includes reviewing different restoration and compensation scenarios, including an option that allows the environment to recover naturally without intervention from the Trustees. The PED also considers whether cleanups performed by non-Trustee agencies (e.g., EPA or the responsible party) affect the scope of the required restoration. The Trustees completed a PED for the Hudson River and concluded that the costs of the expected damage assessment methodologies are reasonable. Further, the Trustees are confident that the assessment can be conducted at a reasonable cost, i.e., the anticipated damages that the NRDA will establish will exceed the estimated assessment costs. The Trustees will review, and revise as appropriate, the PED at the end of the injury determination and quantification phases. At the conclusion of the assessment, the PED and any significant modification of the PED will be reported in the Report of Assessment that will be prepared by the Trustees.

Assessment Plan Phase

Once the decision to conduct a NRDA has been made, the Trustees may develop an Assessment

Plan. The purpose of this effort is to ensure that the assessment is performed in a planned and systematic manner and that the proposed studies can be conducted for a reasonable cost. To do this, the Assessment Plan documents exposure of natural resources to hazardous substances and identifies the anticipated procedures for evaluating the injuries caused by this exposure. The Trustees may then circulate the Assessment Plan for review and comment by the public and responsible party or parties. The Assessment Plan may be modified by the Trustees at any stage of the assessment as new information becomes available.

The Trustees have determined that development of an Assessment Plan for the Hudson River is appropriate and, accordingly, prepared this document as the Hudson River Assessment Plan. Within this Assessment Plan, the Trustees confirm that natural resources have been exposed to PCBs, make a preliminary determination of the recovery period, and outline the currently proposed approach for the NRDA. This approach includes studies which have been completed, are in progress, or are proposed.

Injury Determination and Quantification Phase

During this phase of the assessment, the Trustees undertake investigations to determine and quantify injuries to natural resources resulting from exposure to hazardous substances. The first step in this process, called injury determination, determines whether an injury to one or more of the natural resources has occurred, and determines whether the injury resulted from the release of a hazardous substance based upon the exposure pathway and the nature of the injury. Natural resources may be injured in a number of ways. Some of these include physical deformities, reproductive impairment, increased incidence of cancer, or death. Other injuries may include exceedances of regulatory standards or the presence of fish consumption advisories or regulatory closures in the assessment area. Injury determination also establishes the pathway by which injured natural resources come into contact with the hazardous substances. For example, these investigations may establish that fish are exposed through contact with contaminated water or that birds are exposed through the consumption of contaminated fish.

Within this Assessment Plan, the Trustees confirm exposure to natural resources, make a preliminary determination of the recovery period, and outline the Trustees' currently proposed approach for the NRDA.

After injury determination is complete and before injury quantification begins, the Trustees will review the Assessment Plan to ensure that the methodologies selected for the injury quantification and damage determination are consistent with the results of the injury determination, and that the use of such methodologies remains consistent with the requirements of reasonable cost.

Once the injuries and routes of exposure have been identified, and having made the determination noted above, the Trustees perform the next step, which is called injury quantification. During this stage of the process, the Trustees determine the quantity of each resource that has been injured, including how long each resource has been or will be injured. The Trustees then combine the information from both steps (injury determination and quantification) to establish the total quantity of injured natural resources that must be restored or replaced. The Trustees' currently proposed approach to the injury determination and quantification phase is described in Chapter 4. Where possible, this approach relies on existing information and data. Where existing information is insufficient to establish the extent of a particular injury, the Trustees may undertake new data collection and analysis. New data collection — primarily to confirm exposure of Hudson River resources to PCBs — is both ongoing and proposed for the future (see Chapter 4). Injury determination studies are either completed, in progress, or proposed.

Damage Determination and Restoration Phase

Once the quantity of injured natural resources has been established, the Trustees must determine how to restore or replace those resources, and the services those resources provide. This can be done by establishing the value of the injured resources and of the services they provide, or by calculating the cost of the projects that will restore or replace the injured resources and their lost services. In some cases, it may be necessary for the Trustees to use elements of both approaches (while ensuring that there is no double-counting) to provide the most accurate account of the injuries and ensure adequate restoration. For example, to address reproductive impairments in fish, the Trustees may design projects that provide fish access to new breeding habitat that is free of contamination. The damage determination for such a project would involve calculating the costs of making the required ecological improvements. Alternatively, the Trustees may undertake a study to calculate the value of the injuries in dollars. The Trustees will document the evaluation of restoration options in a Restoration and Compensation Determination Plan, which will evaluate several restoration alternatives, summarize the rationale behind the preferred alternative, and establish the cost of the restoration activities. The existing data are not sufficient for the Trustees to develop the Restoration and Compensation Determination Plan at this time. For that reason, the Restoration and Compensation Determination Plan will be developed later, after the completion of the injury determination or quantification phases. The Restoration and Compensation Determination Plan will be distributed to the public and responsible party or parties for review and comment. This input facilitates the Trustees' selection of restoration projects that are focused on the natural resources that have been injured and provide the greatest benefits while also considering cost.

At the conclusion of an assessment, the Trustees will prepare a Report of Assessment that includes the Preassessment Screen Determination, the Preliminary Estimate of Damages, the Assessment Plan, any comments concerning the Assessment Plan with responses to those comments, any comments on the individual study plans, with responses to those comments, all documentation supporting the determinations required in the injury determination phase, the quantification phase, and the damage determination phase, and the Restoration and Compensation Determination Plan, along with comments received during the public review of that plan and responses to those comments. The Report of Assessment will be released to the public.

PRELIMINARY DETERMINATION OF THE RECOVERY PERIOD

As part of the assessment, the Trustees make a preliminary estimate of the time needed for the injured resources to recover. The recovery period that must be estimated is defined by the NRDA regulations as the longest length of time required to return the services provided by the injured resources to the condition in which they would have been had the release not occurred (this is the "baseline" condition), or any lesser period of time selected and documented in the Assessment Plan. These estimates must be based on the best available knowledge. Where appropriate, the estimates may be based on cost-effective models. Information gathered may come from one or more of the following sources, as applicable: published studies on the same or similar resources, the experience of resource specialists with the injured resource or with restoration for similar discharges elsewhere, and field and laboratory data from the assessment and control areas. A number of factors are considered in estimating recovery times, including the ecological succession patterns in the area; the growth or reproductive patterns, life cycles, and ecological requirements of biological species involved, including their reaction or tolerance to the hazardous substance involved; the bioaccumulation and extent of hazardous substances in the food web; and the chemical, physical, and biological removal rates of the hazardous substance from the media involved.

As shown in Chapters 2 and 4, natural resources of the Hudson River, including biological resources, surface water resources, groundwater resources, geologic resources, and air resources, have been and continue to be exposed to PCBs. These natural resources will remain exposed as long as environmental media such as soils, sediments, groundwater, and surface water remain contaminated and continue to operate as pathways for exposure. Based on an evaluation of the existing literature documenting the limited natural degradation rates of PCBs, their resulting persistence in the environment, the evidence of continued bioaccumulation of PCBs in Hudson River biota provided by data that have been and are being gathered, and the estimates of relatively long recovery periods for other PCB-contaminated sites, the Trustees' preliminary determination of the recovery period is that it will be decades before natural recovery will occur, although dredging of PCB-contaminated sediments (the remedial action selected by EPA) will expedite recovery compared to not removing such contaminated sediments.

Shortnose Sturgeon

Illustration by: Duane Raver, U.S. Fish and Wildlife Service

Coordination with Other Government Agencies

Since the 1970s, a wide variety of State and Federal programs have targeted the Hudson River for various levels of cleanup and monitoring. Numerous efforts have focused on eliminating PCB releases to the river, assessing the impacts of PCB-contaminated sediment, and implementing fishing restrictions and fish consumption advisories along the entire length of the river. In 1984, EPA placed 200 miles of the Hudson River on the National Priorities List (NPL), thereby designating the river as a Superfund site. This action established a framework through which PCB contamination in the river would be evaluated and potential problems would be resolved. This framework consists of two equally important but distinct activities. The first of these efforts is site cleanup, which is designed to reduce or eliminate risks to human health and the environment. In some cases, these cleanup actions may also address all or a portion of the injuries to natural resources. The second element is NRDA, which is specifically designed to restore injured natural resources that were not addressed by EPA's cleanup. This includes returning injured resources to baseline and addressing losses that occur from the onset of the injury to the time at which the resources are restored. Cleanup is performed by EPA while NRDA is performed by the Trustees.

EPA's cleanup activities are often referred to as removal, remedial, or response actions. These actions are specifically undertaken to reduce or eliminate possible threats to human health or the environment. EPA's activities are often directed at the hazardous substance itself — its physical removal from the environment or the creation of barriers between the hazardous substance and humans or animals. Although cleanups attempt to eliminate or reduce the risks associated with the hazardous substance, they do not directly address natural resource injuries caused by exposure to that substance.

NRDA is designed to address these injuries. When natural resources such as fish, birds, and mammals are exposed to hazardous substances, there may be a reduction in the health or viability of those resources. For example, a fish that consumes prey containing hazardous substances may become ill or be unable to produce healthy offspring. Alternatively, exposure to a hazardous substance may inhibit a resource's ability to support recreational fishing, provide wildlife habitat, or provide uncontaminated groundwater. A NRDA addresses these injuries in two ways. First, the objective of a NRDA is to restore natural resources to the condition that would have existed if the hazardous substance were never released. Second, a NRDA seeks to recover damages for the period of time that the natural resources are injured. In this way, a NRDA is intended to compensate the public for its losses throughout the period from the initial injury to full recovery.

Although the cleanup and the NRDA process are separate and distinct, a clear nexus exists between the two. For example, EPA, in its cleanup capacity, may decide to physically remove contaminated sediment from a waterway to reduce the human health threat associated with consumption of contaminated fish. In such a case, the sediments are a source of contamination to such fish. The Trustees may determine that such action is also necessary to reduce the incidence of mortality within the fish population. In this example, different paths were followed that reached the same outcome. Because of the high potential for such occurrences, it is important that cleanup and the NRDA are closely and carefully coordinated. By doing so, the Trustees can select appropriate restoration options, avoid duplication, reduce the time required to restore natural resources, and save money. Additionally, the remedy selected and the implementation method used are likely to significantly affect the time period until recovery occurs. The duration of the recovery period is a key factor that determines the amount of interim losses associated with injuries caused by released contaminants.

The Hudson River Trustees consider coordination with EPA and other organizations involved in the river's cleanup and assessment to be an important priority.

The Hudson River Trustees consider coordination with EPA and other organizations involved in the river's cleanup and assessment to be an important priority. As a result, the Trustees provide recommendations to EPA for investigation activities and cleanup proposals. As part of this process, the Trustees attend public meetings held by EPA, the State of New York, and other organizations to obtain information, provide technical input, and educate participants about the role of the Hudson River NRDA. The Trustees also provide EPA with comments on technical documents and administrative decisions. When EPA or the State of New York collect and analyze data as part of the remedial investigation and cleanup, the Trustees also use those data for NRDA. Finally, the Trustees integrate EPA's cleanup plans into the damage assessment to ensure that restoration efforts do not overlap and to assist the Trustees in identifying areas where EPA's cleanup will not fully address natural resource injuries. This coordination promotes timely, integrated, and cost-effective solutions for addressing hazardous substances in the Hudson River and its resources.

Importance of Public Participation

We are all stewards of the Hudson River, and have an opportunity to preserve and protect the river for future generations. When natural resources are injured by hazardous substances, the Trustees, representing the interests of the public, are responsible for restoring those resources. Restoration is based on the need to restore, replace, or acquire the equivalent of the injured resources and the services they provide. It is based on both scientific principles and input from individuals interested in and affected by Trustee efforts.

The Hudson River natural resource Trustees have developed an overall public involvement program to ensure effective and informed public input throughout the damage assessment. The Trustees have implemented and propose to implement a number of outreach efforts that may include the following activities:

- meeting with affected interest groups and organizations;
- periodic newsletter mailings to the public;
- posting new reports, data, and other information on Trustee internet sites;
- working with the local media; and,
- holding public availability sessions.

As opportunities for public involvement arise, the Trustees plan to advertise those opportunities in newspapers, direct mailings, and on the Trustees' internet sites, and provide information on how to participate in a productive and meaningful manner.

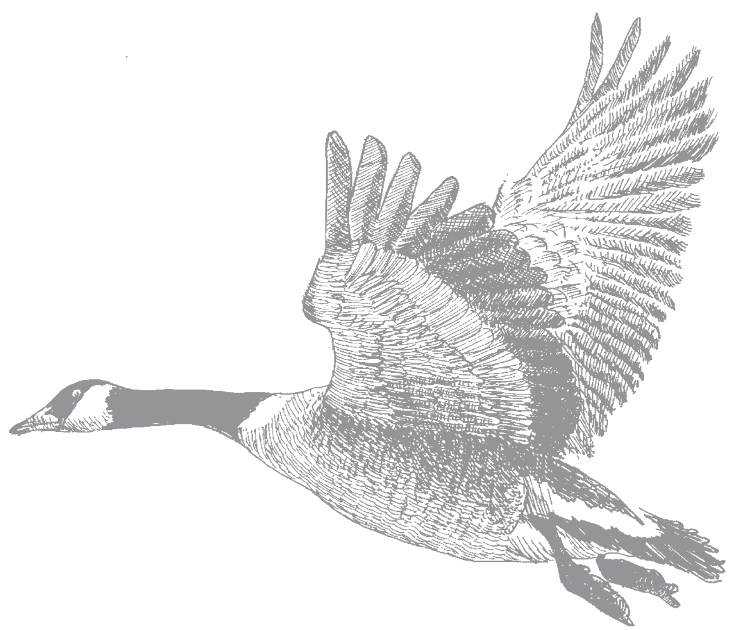
Although public participation is ongoing, several specific points in the damage assessment process provide unique opportunities for public involvement. Among the most important of these are (1) commenting on this Assessment Plan, including forthcoming study plans for injury determination/quantification studies that the Trustees currently plan to make available for public review and comment, and (2) participation in restoration planning. Because this Assessment Plan provides a roadmap for the Trustees' planned activities, interested individuals have the opportunity to comment on the Assessment Plan. This Assessment Plan is a living document that the Trustees will continue to develop and refine as the NRDA progresses. During restoration planning, restoration objectives and criteria are discussed and specific restoration projects are identified. In support of this effort, the Trustees have issued an open letter seeking input on restoration ideas. Individuals interested in participating in this process may obtain a copy of the letter through any of the Trustees' internet sites for the Hudson River, or through the contact for public inquiries noted at the end of the Executive Summary.

Invitation for Cooperative Assessment

The Trustees have also invited, and will continue to encourage, the active participation of the party or parties that are responsible for the contamination. Such interactions may serve to open a dialog, and identify common perspectives, enhancing the quality and acceptability of scientific studies, reducing costs, and expediting restoration. These interactions also provide responsible parties with the benefit of early involvement, the opportunity to participate in assessment and restoration, and an appreciation of the public's interest in restoring the resource.

This Assessment Plan is a living document that the Trustees will continue to develop and refine as the NRDA progresses. During restoration planning, restoration objectives and criteria are discussed and specific restoration projects are identified. In support of this effort, the Trustees have issued an open letter seeking input on restoration ideas.

At the option of the Trustees, and if agreed to by the potentially responsible party or parties, the potentially responsible party or parties, under the direction, guidance, and monitoring of the Trustees, may implement all or any part of the Assessment Plan. The Trustees also intend to develop procedures and schedules for sharing data, split samples, and results of analyses, when requested, with any identified potentially responsible party. Information on any such decisions and procedures will be shared with the public.



THE HUDSON RIVER NRDA: ASSESSMENT AND RESTORATION

Photo courtesy of NYSDEC

The Hudson River at Bear Mountain Bridge.

The Trustees are conducting a damage assessment to evaluate injuries to natural resources exposed to PCBs in and around the Hudson River. In developing this Assessment Plan, the Trustees have been guided by the Department of the Interior's regulations for performing damage assessments provided at Title 43, Part 11 of the Code of Federal Regulations. These regulations establish guidelines and procedures for performing NRDAs and define the criteria for determining whether natural resources have been injured. The Trustees will continue to be guided by these regulations as they carry out this NRDA.

The actual job of conducting a NRDA and restoring the Hudson River is a significant undertaking. The size and complexity of the effort are directly related to the complex nature of the river and the role of PCBs within the ecosystem. For example, PCB concentrations vary significantly depending on location and whether samples are collected from sediment, soil, water, or animal tissues. Similarly, some animals may be exposed to large quantities of PCBs due to their feeding habits, while others may be exposed only on occasion. Also, different species exhibit a wide range of effects following exposure to PCBs. Where one animal may exhibit abnormalities that are plainly visible, others may exhibit responses that can be observed only at the cellular level. Finally, some biological effects can be observed only at certain stages of development. Special consideration must be given to species that exhibit injuries in juvenile life stages.

As part of the assessment planning process, the Trustees decide whether to conduct a simplified assessment or a comprehensive assessment. In light of the complexities noted above and other considerations, the Trustees have determined that the simplified procedures of the "type A" assessment provided for in the NRDA regulations are inappropriate for this NRDA and that a "type B" assessment should be conducted. The "type A" procedures, which use minimal field observations and computer models to generate a damage claim, are limited by the regulations to the assessment of relatively minor, short duration discharges or releases in coastal or marine environments or in the Great Lakes. Based on the

Trustees' determination (1) that the nature of the releases and exposures to PCBs in the Hudson River assessment area are long-term and spatially and temporally complex, (2) that substantial site-specific data already exist to support the assessment, and (3) that additional site-specific data can be collected at reasonable cost, the Trustees have concluded that the use of "type B" procedures is justified.

The NRDA regulations require that before including any "type B" methodologies in the Assessment Plan, it must be confirmed that at least one of the natural resources identified as potentially injured in the Preassessment Screen Determination has in fact been exposed to the released hazardous substance. The Preassessment Screen Determination identified sediment, water, and biota of the Hudson River as potentially injured natural resources. Confirmation of the exposure of those resources is provided by Exhibit 2-2 in Chapter 2, and by the additional information provided in Chapter 4 regarding levels of PCBs in natural resources of the Hudson River. Those natural resources of the Hudson River that have been exposed to contamination by PCBs and for which such confirmation of exposure to PCBs has been made are biological resources, including fish, birds, mammals, amphibians, reptiles, and invertebrates, surface water resources, including river sediments, groundwater resources, geologic resources, including floodplain soils, and air resources.

As required for "type B" assessments, a Quality Assurance Plan has been prepared and is attached to this Plan as Appendix A.

Scientific research indicates that PCBs can be harmful to fish and wildlife. The exact nature of these effects depends on the level and duration of exposure, the specific PCB congener mixture to which the organism is exposed, and the specific organism.

The Trustees plan to conduct the remaining components of the Hudson River NRDA in three major phases. These include pathway determination, injury determination and quantification, and damage determination and restoration. This framework is consistent with the Department of the Interior's regulations and provides an effective means of considering PCB contamination in the Hudson River.

The Trustees' general approach to the assessment is and has been to review the existing data, analyze gaps, and then undertake additional testing and sampling as needed. This minimizes the cost of the assessment and maximizes the use of existing information. Within each of the three phases noted above, the Trustees will, based on that initial review and additional preliminary investigations where necessary, develop individual investigations that, together, will define the nature and extent of injuries caused by PCBs in the Hudson River. The remaining sections of this chapter provide overviews of each phase of the assessment and summarize the Trustees' approach within each category of natural resource.

PATHWAY DETERMINATION

During the pathway determination phase of the assessment, the Trustees will document how PCBs move through the environment. During this phase, the movement of PCBs from their source into the environment and into the food web is determined. Once in the food web, the pathway evaluation establishes how the PCBs move from one species to another. Pathway studies are frequently very technical, focusing on the chemical composition of the PCBs and how PCBs interact with the physical environment and biological processes they encounter. The pathway evaluation often relies on a combination of empirical and modeling data as well as model assumptions. The interpretation of these data helps the Trustees determine whether a link exists between the release of the PCBs and the injured natural resource.

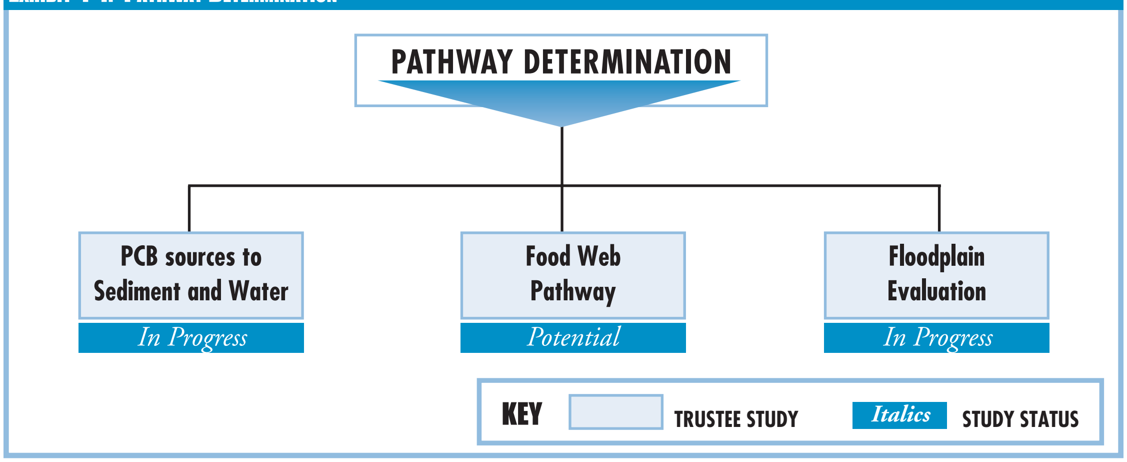
The PCB pathway for the Hudson River includes contaminated soil, sediment, and water, which are important habitats for components of the base of the food web. For example, the sediment in the Hudson River provides habitat for a wide range of shellfish, worms, and insects. These organisms are key components of the ecosystem, providing food for other animals, cycling nutrients, and constantly modifying the river bottom. Because sediment may contain large quantities of organic matter, PCBs readily bind to the sediment and are available to enter the food web. Organisms that live in direct contact with the sediment may accumulate substantial amounts of PCBs and pass these contaminants on to other organisms.

Exhibit 4-1 illustrates the status of each study the Trustees are currently considering within the pathway determination stage of the damage assessment. The specific studies that the Trustees currently plan to implement to define the PCB pathway are described below. Studies may be added or removed based on considerations such as public comment and additional information developed by the Trustees.

Hudson River ranged from undetected to 4,747 ppm (43). In the Lower Hudson River, PCB concentrations in sediment ranged from undetected to over 1,700 ppm (43). Existing data further demonstrate that PCBs are present in other natural resources of the Hudson River, including the surface water and biota (43, 50, 51, 61).

EPA has concluded that the vast majority of this PCB contamination is due to past releases from GE's plants at Hudson Falls and Fort Edward. The Trustees are conducting a screening-level analysis of the PCB pathway using existing information. This analysis entails an evaluation of available data on sediment chemistry, sediment deposition and transport, fish tissue chemistry, and PCB loadings to the Hudson River. This analysis will allow the Trustees to make preliminary determinations regarding the relative contribution of those upriver sources to the PCB contamination in the Hudson River. This preliminary investigation may inform the Trustees regarding the need for future assessment studies.

EXHIBIT 4-1: PATHWAY DETERMINATION



The pathway determination studies listed below are preliminary investigations. Should the Trustees determine, based on such preliminary investigations, that a pathway determination study is warranted, the Trustees plan to develop a study plan for that effort. Such a study plan would be released for public review and comment and subject to peer review.

PCB Sources to Sediment and Water

Existing data demonstrate that PCBs are present in the sediment of the Hudson River. From 1976 to 1994, the State of New York, EPA, GE, and others (e.g., Bopp et al. 1998 (65)) collected thousands of sediment samples from the Hudson River. Analytical results show that concentrations of PCBs in sediment collected from the Upper

Food Web Pathway Evaluation

PCBs have chemical properties that cause them to accumulate in biota. Because some PCB congeners are very stable, many animals that are exposed to PCBs will accumulate them faster than their bodies can depurate them. PCBs tend to accumulate to the highest levels in long-lived, upper trophic level organisms, such as fish and wildlife that feed on fish.

The Trustees have studied the PCB concentrations in the organisms living in or on Hudson River sediment. These organisms provide one of the primary means of PCB transfer from the sediment into the food web. From 1977 to 1997, the State of New York and EPA conducted a series of studies that indicate that these sediment-dwelling organisms have been exposed to PCBs and that the compounds remain in their tissues. Concentrations in certain sediment-dwelling organisms collected from the Upper Hudson River were over 26 ppm in 1993 (45).

The Trustees could develop studies to explore how PCBs move through the Hudson River food web. This effort could explore how the food web operates based on principles of ecology, biology, and chemistry. This effort could assist the Trustees in better understanding exposure through the food web and may provide insight into restoration options for those resources that have been injured by PCBs. This preliminary investigation may inform the Trustees regarding the need for future assessment studies.

Floodplain Evaluation

The Hudson River floodplain provides habitat to a wide range of wildlife, including amphibians, reptiles, birds, and mammals. These organisms often are important parts of the diet for predators such as mink, eagles, falcons, and owls. If floodplain soils contain PCBs, they may provide a PCB source for floodplain biota. The floodplain may become contaminated when heavy rains and snowmelt cause the Hudson River to overtop its banks. These flood waters bring with them sediment that has been churned up from the river's bed. Eventually, the flood waters subside and deposit sediment on the floodplain. Since these floodplains provide habitat for a number of species, the Trustees are working to better understand to what extent floodplain PCBs should be considered an exposure pathway within the damage assessment.

In 1990, 1992, and 1998, the State of New York and EPA collected soil samples from the floodplain around Rogers Island. The results of this investigation show concentrations of PCBs in floodplain soils ranging from undetected to 384 ppm (66). In 2000, the Trustees conducted a screening-level investigation from Fort Edward to Stillwater and identified PCB contamination in floodplain soils and in small mammals. Data collected during this investigation indicate that PCB concentrations in floodplain soils in the 20 miles downstream of Fort Edward ranged from undetected to 360 ppm (61). The Trustees expanded this investigation in 2001 to refine the areas and species that may be exposed to floodplain PCBs. Based on the results of this preliminary investigation, the Trustees will determine whether the floodplain should be considered for a more comprehensive assessment.

Injury Determination and Quantification

Injuries generally fall into two categories. The first category establishes injury based on the exceedance of regulatory criteria. This may include violation of established standards or the existence of state health advisories warning against the consumption of contaminated biota and closures or restricted use of resources. The second category establishes injury based on physical, chemical, or biological changes in the resource resulting from contaminant exposure. Examples of these injuries include changes in an organism's physical development, health, reproductive success, or behavior. The injury to the resource can be quantified in terms of the loss of services that the injured resource would have provided had the contaminant release not occurred. Loss of services may include impairment of the habitat that a resource provides or diminished human use of a resource. Injury determination and quantification studies typically are performed by scientists who compare their observations regarding samples collected from the contaminated area to samples collected from appropriate reference locations. These studies may be performed in a laboratory, in the field, or a combination of the two settings.

The Trustees are considering conducting injury assessments for the following Hudson River resources: fish, birds, mammals, amphibians and reptiles, surface water, groundwater, geologic resources, and air. The Trustees plan to evaluate whether each resource should be included within the damage assessment. The Trustees presently expect that several specific injuries identified from this larger group will form the basis of the final claim for damages.

To assess whether an injury should be included in the final claim for damages, the Trustees are generally using a phased approach to injury determination and quantification. The studies in this approach can be categorized as either preliminary investigations or injury determination/quantification studies. For each resource, the Trustees will gather existing information about past, present, and predicted future concentrations of PCBs and compare these data to known criteria, standards, guidance values, or other threshold values that, if exceeded, indicate that injury to that resource exists or is likely to exist. The Trustees will assess whether there are sufficient data to adequately characterize the degree of contamination. Although substantial exposure information has been collected on some resources (e.g., fish, sediments, and water), for many other resources the available data are much more limited. Where data are limited, but an injury appears likely, the Trustees may decide to conduct further preliminary exposure assessment studies.

Data from these preliminary investigations will then be assessed by the Trustees to determine whether injury determination/quantification studies are warranted, or whether a particular resource should not be assessed further for injury. When the Trustees determine, based on a preliminary investigation, that an injury determination/quantification study is warranted, the Trustees will develop a study plan for that study. Study plans will include detailed information, including but not necessarily limited to the following: objectives to be achieved by testing and sampling, the sampling locations, sample and survey design, numbers and types of samples to be collected, analyses to be performed, and other such information required to perform the selected methodologies. The Trustees expect that study plans for injury determination/quantification studies to be initiated by the Trustees will be peer reviewed and released to the public for review and comment. The results of Trustees' studies will be peer reviewed and released upon completion of the studies. The final study report will include a description of the methods used.

Exhibit 4-2 illustrates the injury assessment status of each resource that the Trustees are currently considering within the injury determination and quantification stage of the damage assessment. The specific studies that the Trustees have completed, currently have in progress, or plan to implement as preliminary investigations, such as to better understand exposure of Hudson River resources to PCBs, or to determine injuries to Hudson River natural resources from PCBs, are described below.

BIOLOGICAL RESOURCES

FISH

Over 200 species of fish, including American shad, striped bass, and Atlantic sturgeon, live in the Hudson River. Other important species include smallmouth bass, largemouth bass, bullhead, and pumpkinseed. Fish are both predators and prey in the Hudson River food web; they eat plants, insects, and other fish, and in turn, may be eaten by amphibians, reptiles, birds, and mammals. The Hudson River fishery also is used by recreational anglers and historically supported a vibrant commercial catch.

From 1969 to 2000, the State of New York, NOAA, and GE collected more than 17,000 fish samples from the Hudson River. Based on the results of its sampling program, the State of New York, beginning in 1976, issued fishing bans and advisories from Hudson Falls to the Battery in Manhattan (67). Between 1977 and 1998, PCB concentrations in fish from the Upper Hudson River ranged from less than 0.02 to 1,836 ppm. More recently (1998-1999), the PCB concentrations in fillets from 21 fish species in the Upper Hudson River ranged from 0.252 to 444.78 ppm. PCB concentrations in fish from the Lower Hudson River during the years 1977 through 1998 ranged from less than 0.02 to 686 ppm. In

EXHIBIT 4-2: INJURY DETERMINATION AND QUANTIFICATION

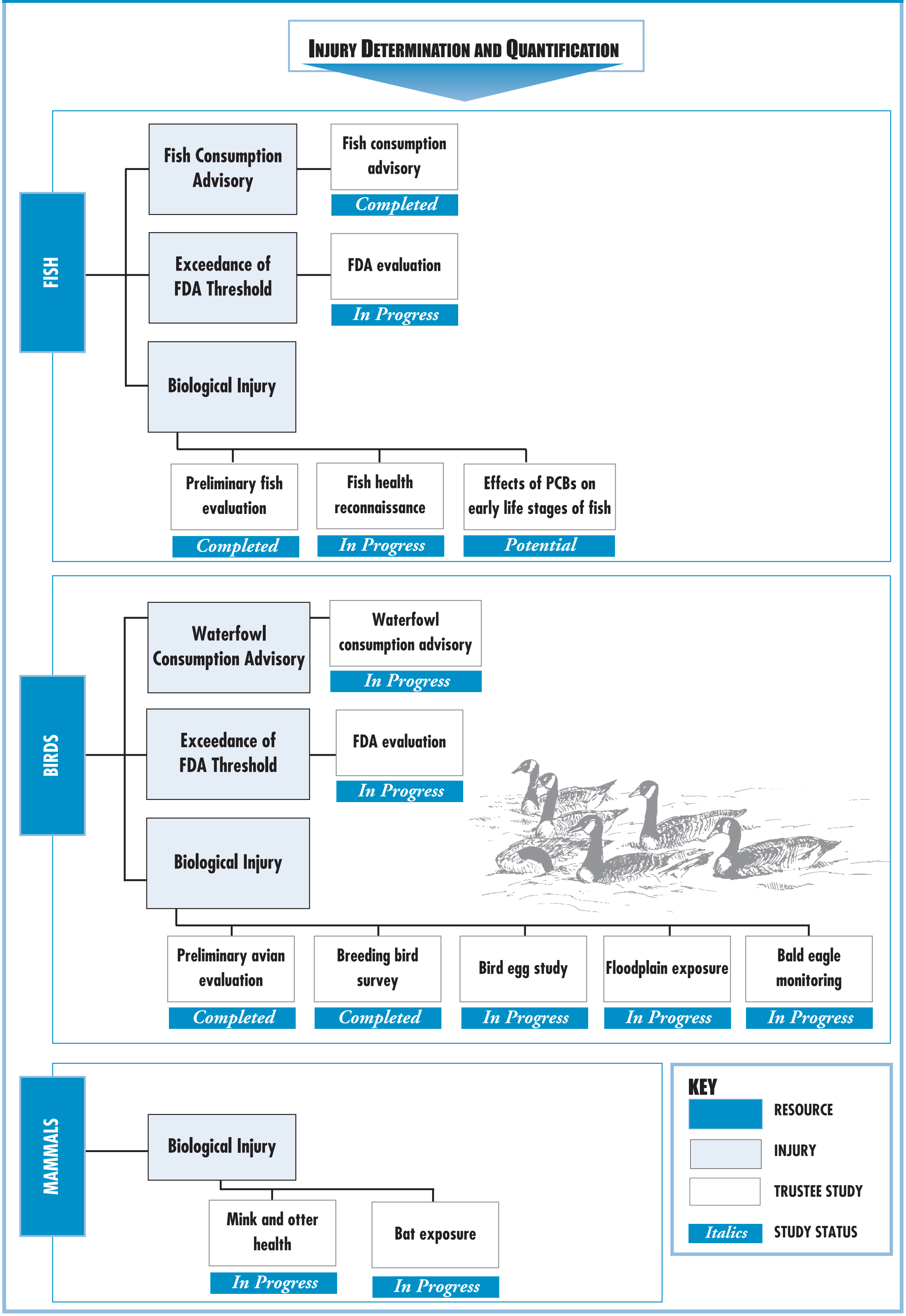
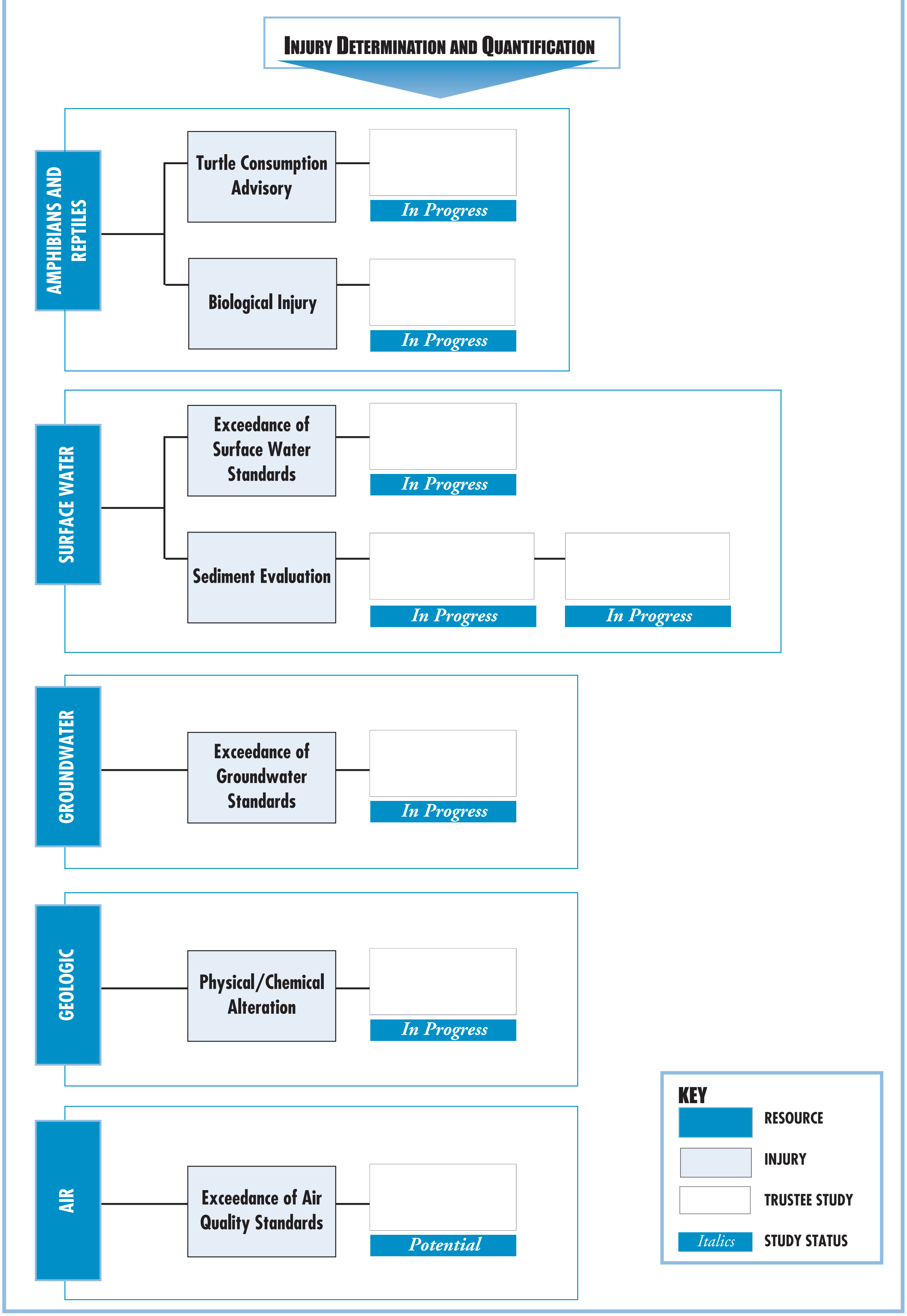


EXHIBIT 4-2 CONTINUED: INJURY DETERMINATION AND QUANTIFICATION



the Lower Hudson River, recent (1998-1999) PCB concentrations in fillets from 22 fish species ranged from 0.032 to 24.8 ppm (43).

The specific studies the Trustees have conducted, have in progress, or currently plan to conduct to determine if injuries to Hudson River fish are occurring are described below.

Fish Consumption Advisory

The Hudson River is an important resource for recreational anglers. Since 1976, high levels of PCBs in fish have led officials in the State of New York to close various recreational and commercial fisheries and to issue advisories restricting the consumption of fish taken from the Hudson River (67).

In February 1976, NYSDEC closed all fishing in the 40-mile reach of the Upper Hudson River between Hudson Falls and the Federal Dam at Troy. This regulatory prohibition applied to both recreational and commercial fishing. This ban remained in place until 1995, when NYSDEC modified the regulations to permit "catch-and-release" recreational fishing within this reach; possession of fish remains illegal. Commercial fishing is still prohibited in this 40-mile reach of the Upper Hudson River. Additionally, from February 24, 1976 to the present, the New York State Department of Health (NYSDOH) has warned against consumption of any species within the 40-mile reach of the Hudson River from Hudson Falls to the Federal Dam at Troy. This consistent "no consumption" advisory for all fish caught within this section of the river is based on the excessive levels of PCBs found in all species of fish from this reach. This "no consumption" advice remains in effect despite the lifting of the regulatory ban on recreational fishing from Hudson Falls to the Federal Dam at Troy in 1995. NYSDOH's concurrence in re-opening a "catch and release" fishery in the Upper River was predicated on a continued "eat none" advisory (67).

Beginning on February 25, 1976, all commercial fishing, with exceptions for baitfish, Atlantic sturgeon greater than four feet, American shad, and goldfish used for ornamental purposes, was banned in the Hudson River between the Federal Dam at Troy and the Battery in New York City. The commercial fishing ban, with periodic adjustments, has remained in effect to the present. For example, in 1982 NYSDEC re-opened this reach for certain species, but continued the ban on commercial fishing for striped bass, American eel, common carp, goldfish, white catfish, and white perch. In 1985, the commercial fishing closure below Troy was again expanded to include black crappie, brown bullhead, and pumpkinseed. These closures have remained unchanged since 1985 (67).

In general, the NYSDEC has not prohibited recreational fishing in the Hudson River between the Federal Dam at Troy and the Battery in New York City. However, the State banned recreational striped bass fishing from May 6, 1986 until April 27, 1987, based in large part on the elevated PCB levels found in Hudson River striped bass. The NYSDEC has also banned the taking of American eel from 1976 until the present. During this period, the NYSDOH has issued fish consumption advisories warning the public to either avoid or limit consumption of Hudson River fish taken from this reach because of the excessive levels of PCB contamination found in them. These advisories are discussed below (67).

For the Hudson River below the Federal Dam at Troy, consumption advisories have been issued to address separately the section of the river between the Federal Dam at Troy and Catskill, and the section of the river south of Catskill.

For the section of the Hudson River from the Federal Dam at Troy to Catskill, the NYSDOH issued a general, limited consumption advisory in 1976, with American eel being the only species subject to a "no consumption" advisory. Between 1983 and 1994, more restrictive advisories for specific fish species were added. Beginning in 1994, the advisories were shifted to "no consumption" for all species with the exception of American shad. This advisory continues to the present 2002-2003 advisory, with the exception of four species, alewife, blueback herring, rock bass, and yellow perch, which were upgraded in 1999 to a recommendation that no more than one meal per month be eaten. For white catfish, carp, and goldfish, a "no consumption" advisory has been in effect from November of 1984 to the present day. For striped bass and white perch, the "no consumption" advisory began with the 1982-1983 advisory, resulting in a "no consumption" advisory for these two fish species for 18 years. For the American eel, a "no consumption" advisory has been in effect continuously since 1976, a total of 25 years (67).

In the Hudson River reach south of Catskill, a "no consumption" advisory was in place for 10 different fish species for periods ranging from five years to 10 years between the mid 1980s and the mid 1990s. These fish species include the American eel, brown bullhead, carp, goldfish, largemouth bass, pumpkinseed, striped bass, walleye, white catfish, and white perch. In the spring of 1994, in an attempt to make the Hudson River fish consumption advisories more easily understood, NYSDOH abandoned the species-by-species approach and issued a blanket advisory for Catskill downstream to New York City to eat no more than one meal per month for all species, except American shad, Atlantic sturgeon, blueback herring, bluegill, pumpkinseed, and yellow perch. This changed the advisory status of many fish, imposing consumption advisories on many unintended freshwater and marine species. Consequently, NYSDOH switched back to a species and reach specific format in the Lower River south of Catskill in May of 1995. In the most recent health advisory for 2002-2003, a recommendation that no more than one meal per month be eaten is still in effect for 13 fish species (1).

The NYSDOH sets more stringent consumption protocols for "persons at special risk." In 1976, state health officials specifically advised infants, young children, and pregnant women to avoid eating any fish from the Hudson River because of PCB contamination. In 1982, the "persons at special risk" group was redefined as women of childbearing age, infants, and children under the age of 15, a definition that has remained unchanged to the present. The reason for this specific advice is the concern that environmental contaminants such as PCBs can accumulate in a mother's body and be passed on to a fetus or to a nursing infant through the mother's milk, or can accumulate in a young child, with the potential to cause adverse effects to developing systems of the fetus or young child. The "no consumption" advisory for this group remains in effect, with the exception of special advice for American shad (67).

The Department of the Interior's NRDA regulations define the fish consumption advisories issued by the State of New York as an injury. To document this injury, the Trustees evaluated the history, dates, and geographic ranges of the advisories, including the relevant species. The Trustees' report documenting the extent of the injury is available at *http://www.dec.state.ny.us/website/dfwmr/habitat/nrd/index.htm* (67).

FDA Evaluation

To protect human health, the Food and Drug Administration (FDA) requires that fish containing PCB concentrations in excess of safe levels be removed from commerce. For PCBs, this level, or tolerance as it is formally called, is currently 2 ppm in edible fish tissue. Natural resources are injured when concentrations of PCBs in fish exceed the FDA's tolerance. To document this injury, the Trustees will compare the fish tissue data available from the State of New York and other sources with the FDA tolerance. This effort will allow the Trustees to establish the geographic scope and dates for which Hudson River fish exceed the threshold. This injury determination study is in progress.

Blueback Herring

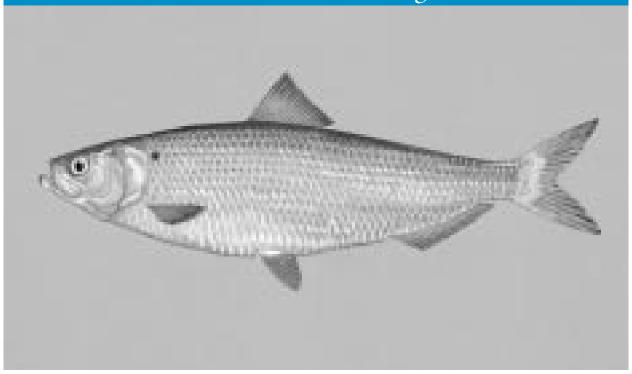


Illustration by: Duane Raver, U.S. Fish and Wildlife Service

Fish Health

Many of the more than 200 species of fish that reside in the Hudson River are in direct contact with contaminated sediment, water, and prey. These fish also are critical links in the Hudson River food web. The Department of the Interior's NRDA regulations establish that a biological injury exists when the concentration of PCBs is sufficient to cause death, disease, behavioral abnormalities, cancer, genetic mutations, physiological malfunctions, or physical deformations in fish.

To evaluate whether PCBs are affecting the health and viability of fish in the Hudson River, the Trustees are conducting a multi-phase study. In the first phase of the study, the Trustees conducted screening-level research to evaluate the effects of exposure to PCBs on fish in the Hudson River. This work included gathering and synthesizing existing field and laboratory studies that assess the effects of PCBs in fish, and determining PCB concentrations that may be associated with harmful effects in Hudson River fish. The first report developed by the Trustees concluded that PCB concentrations (Aroclor 1254) of 5 to 70 ppm in liver may result in reproductive and developmental effects including reduced gonad growth and survival (68) This work also concluded that PCB concentrations (congener 77) at lower levels (0.3 to 5 ppm in liver) have the potential to cause reduced egg deposition, alter hormone levels, and reduce larval survival (68). The Trustees also reviewed the results of several existing studies which reported that Hudson River fish exposed to PCBs may develop cancer and liver lesions, suffer from poor bone development, experience abnormal cell and organ growth, exhibit impaired reproduction, and have increased incidence of parasitic infection (32, 33, 34).

In 2000, the Trustees assembled an expert panel to review the exposure and effects information compiled by the efforts above and to provide guidance to the Trustees on appropriate next steps for determining whether PCBs are causing adverse biological effects in Hudson River fish. The panel discussed several adverse effects known to be associated with PCB exposure including early life stage mortality, developmental abnormalities, histopathological deformations, immune system effects, and endocrine system effects. The panel recommended that the following approaches to evaluating fish biological injuries be pursued:

- **Fish Health Reconnaissance Survey:** Exposure to PCBs has been associated with several types of histopathological deformations, including deformations of the liver, gonads, fins, and skeleton. However, very little information is available regarding these adverse effects in Hudson River fish. Therefore, the panel suggested that the Trustees conduct a reconnaissance survey to determine whether histological injuries are occurring. The panel also recommended that limited laboratory testing be performed to assess immune function status.

  Based on this recommendation, the Trustees conducted a field study in 2001 that assessed the prevalence of abnormalities to fish tissues such as liver, kidney, gonads, and spleen, as well as the presence of gross abnormalities to internal organs and external features of fish sampled from the river. The incidence of disease and parasitic infection was also assessed. To conduct this study, the Trustees collected three species of fish (brown bullhead, yellow perch, and smallmouth bass) from the Upper Hudson River downstream of Fort Edward, and from appropriate reference locations, which are less impacted by PCBs. Fish collected for the investigation were selected for their abundance, position in the food web, and sensitivity to PCBs. Conclusions regarding the injuries associated with PCB exposure can be drawn by comparing the incidence of these effects in fish from both locations. The Trustees also collected various fish tissues for future chemical analysis. These tissues may be analyzed for PCB levels if the results of the fish health study suggest that Hudson River fish are exhibiting injuries that are consistent with PCB exposure. The Trustees may also assess the levels of other potential contaminants in these tissues. The purpose of the chemical evaluation is to document the hazardous substance concentrations that are associated with the effects identified in the study. Blood was also collected and archived by the U.S. Geological Survey for potential analysis of endocrine disruption biomarkers. The Fact Sheet for this study, "Assessing Fish Health," is in Appendix B.

This injury determination study is in progress. Fieldwork, conducted in Fall 2001, has been completed. Histopathological analysis of microscopic and gross lesions, fish aging, and analysis of disease screen samples are in progress. The various fish tissues collected for future chemical analysis have been archived.

- **Effects of PCBs on Early Life Stages of Fish:** The expert panel indicated that adverse effects on early life stage mortality and development are sensitive endpoints of PCB exposure. However, the sensitivity of fish varies significantly by species. Therefore, the panel recommended early life stage laboratory testing to evaluate the relative sensitivity of early life stages of different Hudson River fish species to PCBs. The Trustees are considering this recommendation, and will then decide whether to initiate this injury determination study.

BIRDS

The Hudson River and surrounding area support more than 150 species of birds, including waterfowl, wading birds, shorebirds, songbirds, and rare species such as the bald eagle, peregrine falcon, and osprey (69). These birds are an integral part of the ecosystem and provide a number of important ecosystem services such as seed distribution, plant pollination, and insect control. Birds are also an important source of prey to other species. Birds may be exposed to PCBs through direct ingestion of contaminated water, sediment, and soil. A more important exposure pathway is likely their consumption of food items that contain PCBs derived from the Hudson River and its floodplain. PCB contaminated food items linked to the river may include fish, amphibians, benthic invertebrates, adult insects that develop from aquatic larvae, plants growing in or near the river, and mammals that forage in the floodplain. Birds are valued by the public through participation in activities such as bird-watching, nature study, and bird-feeding.

A limited number of scientific studies have documented the presence of PCBs in Hudson River birds. Mean concentrations of PCBs in tree swallow eggs and nestlings collected along the Upper River ranged from 0.7 to 62.2 ppm (56). PCB concentrations in the breast muscle and fat of Hudson River mallards ranged from less than 0.01 to 1.1 ppm and from less than 0.1 to 26 ppm, respectively (53, 54, 55). Non-viable bald eagle eggs collected along the Lower Hudson River contained between 20 and 62 ppm PCBs and the plasma of nestling and adult bald eagles contained between 0.2 and 14.0 ppm PCBs) (57).

PCBs have been shown to cause a range of adverse impacts in birds, including disease, behavioral abnormalities, genetic mutations, physical deformities, changes in brain chemistry, reduced hatching rates, embryo mortality, and death (35, 36, 37, 38). The levels of PCBs found in birds in the Hudson River watershed are greater than PCB concentrations known to initiate these responses in birds. For example, levels of 8 to 25 ppm PCB in eggs are associated with decreased hatching success for terns, cormorants, doves, and eagles (27).

The specific studies the Trustees have in progress, as preliminary investigations, to confirm exposure of Hudson River birds to PCBs or to determine if injuries to Hudson River birds are occurring are described below.

Scientific research indicates that PCBs can be harmful to fish and wildlife. The exact nature of these effects depends on the level and duration of exposure, the specific PCB congener mixture to which the organism is exposed, and the specific organism.

Waterfowl Consumption Advisory

The State of New York has issued a statewide advisory recommending limited consumption of wild waterfowl such as ducks and geese due to the levels of contamination from PCBs and pesticides found in waterfowl (1). Specifically, the State advises that mergansers - diving ducks that feed on fish, frogs, and aquatic invertebrates - should not be eaten. The State also advises that other wild waterfowl should have the skin and fat removed before cooking, and that any stuffing should be discarded after cooking. The State also advises that individuals should limit their consumption of these other wild waterfowl to no more than two meals per month.

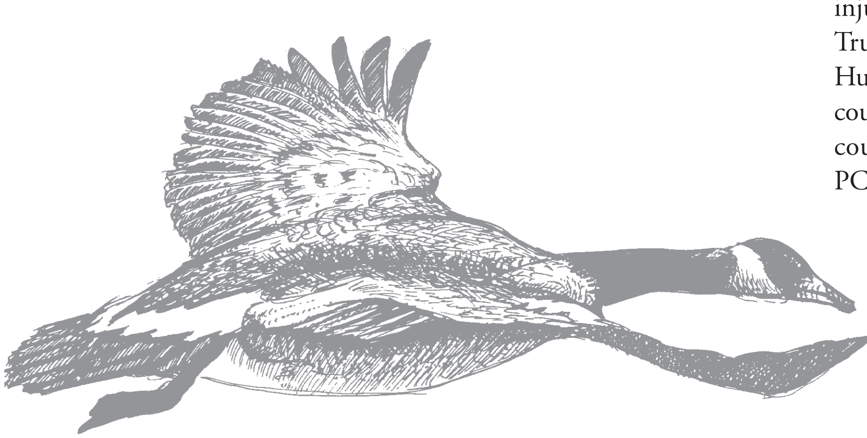
The Department of the Interior's NRDA regulations define the wild waterfowl consumption advisory issued by the State of New York as an injury. The Trustees currently plan to evaluate what part of the contamination that led to the statewide advisory is attributable to PCBs from the Hudson River.

FDA Evaluation

To protect human health, the FDA requires that poultry containing PCB concentrations in excess of safe levels be removed from commerce. For PCBs, this level, or tolerance as it is formally called, is currently 3 ppm in the fat tissue of poultry. Natural resources are injured when concentrations of PCBs in wild waterfowl exceed the FDA's tolerance for poultry. To evaluate this injury, the Trustees may compare available waterfowl tissue data with the FDA tolerance. The Trustees also may elect to collect additional samples to support this analysis.

Preliminary Avian Evaluation

Many species of birds depend on the Hudson River for food, shelter, and breeding. Some species live in and around the river throughout the year, while others use the river only for breeding, as an over-wintering area, or a stopover during long migrations.



The Trustees conducted a screening-level evaluation of the effects of PCBs on birds and gathered information on contamination and effects on Hudson River birds. This work included reviewing existing scientific studies, evaluating exposure and tissue concentrations that are associated with avian injury, and summarizing exposure data and injury studies for Hudson River birds. An expert panel was convened to evaluate the information collected and to provide guidance on additional studies to determine whether avian resources have been injured by PCBs. Based on the results of this work, the Trustees may undertake additional studies to provide a better understanding of exposure and potential injury of Hudson River avian resources.

Breeding Bird Survey

Each of the more than 150 species of birds found in the Hudson River Valley uses specific types of habitats for feeding, breeding, and nesting. To perform injury studies involving birds, it is important that the Trustees understand the relationship between the river and each species' particular habitat preferences. Such relationships help define the likelihood that a given species is at risk for adverse impacts from PCBs, and guide decisions regarding which species should be studied. To confirm the presence and relative abundance of bird species along the Hudson River, the Trustees identified the breeding birds that are present in the Upper Hudson River and the northern portion of the Lower Hudson River. This study included a review of the available literature on bird abundance in the Hudson River. The results of this preliminary investigation could inform the Trustees regarding the design of future avian injury determination studies, as well as help the Trustees decide which species to include in the Hudson River damage assessment. The study also could assist the Trustees in designing studies that could be useful in characterizing the effects of PCBs in these species.

Bird Egg Study

At the present time, there is limited information on exposure of Hudson River bird species to PCBs, especially at sensitive early life stages. Exposure can be confirmed by analyzing bird eggs to see whether PCBs are present. To provide additional insight into this issue, the Trustees are implementing a study that evaluates PCB concentrations in eggs from a number of species of Hudson River birds from several sections of the river. Based on the results of this exposure confirmation study, the Trustees will determine whether injury determination and quantification studies are warranted. This preliminary investigation is in progress.

Evaluation of Avian Exposure from Feeding on Floodplain Organisms

Some bird species use the floodplain heavily for feeding. One such species is the American robin. Robins forage on the ground and in low growing vegetation by probing with their beaks and by gleaning. They may forage along the edge of streams. Robins feed heavily on ground-dwelling invertebrates, particularly during the months preceding and during the breeding season. Their breeding habitats include moist forests, swamps, and open woodlands. Very young robins feed almost entirely on insects and other invertebrates. Another such species that uses the floodplain heavily for feeding is the American woodcock. The American woodcock is a shorebird that feeds almost exclusively on earthworms and insects. The woodcock has a long bill that enables it to probe into the soil to capture its prey. Preferred habitats include fields, hardwood forests near water, moist bottomlands, shrub thickets, and young evergreen forests. Because of their feeding habits and locations, the woodcock, American robin, or similar species, provide an opportunity to evaluate one pathway through which birds might be exposed to PCBs from floodplain soils.

The U.S. Department of Energy (DOE) has developed Preliminary Remediation Goals (PRGs) that reflect the adverse effects of PCBs as they bioaccumulate from soil to terrestrial organisms. For example, PCB concentrations in soil greater than 0.655 ppm may cause toxicity to birds such as American woodcock (62). PCB levels in Hudson River floodplain soils exceed this level, suggesting potential adverse impacts to organisms such as woodcock and American robin (61).

The Trustees collected and archived earthworms from floodplain soils in 2000. In 2002, these worms could be analyzed for PCBs. These results could then be modeled to estimate likely exposure of woodcock, robin, or similar species. The modeled values could then be compared to effects levels from the literature. To perform this assessment, the Trustees plan to survey the Hudson River floodplain to determine which areas woodcock, robins, or other similar species are using for nesting and feeding. During this survey, the Trustees could also attempt to collect eggs from the nests for analysis of PCBs. The Trustees could return to the nesting sites prior to the fall migration and sample young birds for further PCB analysis. The results of these preliminary analyses could help the Trustees determine whether species that live and feed in the Hudson River floodplain have been exposed to PCBs and determine the need for future studies of floodplain-dependent bird species. This preliminary investigation is in progress.

Bald Eagle Monitoring

Bald eagles are at risk of accumulating PCBs because they are at the top of the food web. Eagles prey on fish and scavenge carcasses of birds, mink, otter, and other organisms that may contain PCBs. Because much of the eagles' diet may contain PCBs, they are at risk of accumulating concentrations that are associated with adverse health impacts. To assess whether PCBs may be injuring Hudson River bald eagles, the Trustees plan to build upon studies that have been conducted by the USFWS and NYSDEC to monitor bald eagle nests in the Hudson River for reproductive success. In addition, the Trustees currently intend to collect blood samples from the eagles. Using these samples, the Trustees currently intend to determine the level of PCBs or other contaminants in the eagles' blood and plasma and could further evaluate the eagles' physiological functioning. Non-viable eggs may also be collected. The results of these investigations could allow the Trustees to evaluate the possible effects these PCBs may have on eagle health, and inform the Trustees regarding the need for future injury determination studies of bald eagle. This preliminary investigation is in progress.

Mammals

Many species of mammals rely on the Hudson River, including its floodplain, for habitat, food, and as a breeding ground. Mammals that depend heavily on the river for food and habitat include otter, mink, muskrat, raccoon, and beaver. Other small mammals include bats, mice, shrews, squirrels, and rabbits. Large mammals include white-tailed deer, bobcat, and black bear. Mammals may accumulate PCBs by consuming fish, insects, and other river-dependent species. They also may be directly exposed to PCB-contaminated water, sediment, soil, and plants as they physically manipulate their environment by building dens, foraging for food, and marking territory.

Beginning in 1982, the State of New York, the NPS, and the Trustees have collected information regarding PCB concentrations in Hudson River mammals. Data are available from two studies performed by the Trustees that analyzed PCB concentrations in small mammals collected from the Hudson River floodplain. These studies found PCB concentrations ranging from 0.05 to 38 ppm in 43 short-tailed shrews (61), and 0.024 to 0.22 ppm in 10 meadow voles (70). Other studies assessed PCB concentrations in mink, muskrat, and otters from the Hudson River. These data show PCB concentrations in liver (normalized for the amount of fat in each sample) ranging from 0.13 to 139 ppm in mink, 1.31 to 431 ppm PCBs in otter, and undetected to 2.18 ppm PCBs in muskrat (50, 51). PCB concentrations in liver on a wet weight basis range from 0.038 to 22.5 ppm in otter, and from 0.0082 to 3.34 ppm in mink (50, 51).

Several studies have investigated the potential effects of PCB exposure to mammals. Existing data suggest that mink are more sensitive to PCB exposure than most other mammals; otter may be at least as sensitive as mink to PCBs (59, 60). In controlled feeding studies of mink, diets with PCB levels between 0.64 and 5 ppm completely inhibited reproduction (71, 72). Moore et al. (1999) predict, based on a dose-response curve, a greater than 99 percent reduction in fecundity (litter size) of ranch mink fed a 5 ppm PCBs fish diet (73). Adverse effects on mink reproduction are expected when PCB concentrations in mink tissues exceed about 0.01 ppm Toxic Equivalents lipid weight (60, 74, 75). Based on Smit et al. (1996), 21 ppm PCBs (lipid normalized) or more is a critical level for health impairment in mink and otter; this is based on the effects of PCBs on hepatic retinol levels in European otter (58). Further, 50 ppm or more PCBs (lipid normalized) is a critical level for reproductive impairment in mink and otters; this is based on reduction in litter size in mink (59, 60).

Based on the PRGs developed by DOE that reflect the adverse effects of PCBs as they bioaccumulate from soil to terrestrial organisms, PCB concentrations in soil greater than 0.371 ppm may cause toxicity to small mammals such as short-tail shrews (62). PCB levels in Hudson River floodplain soils exceed this level (61).

The preliminary investigations the Trustees have in progress are described below.

Mink and Otter Health

The Trustees currently plan to build upon NYSDEC's existing mink and otter studies, conducting further studies to determine PCB effects in mink and otter from the Hudson River. The Trustees will review the results of the NYSDEC studies as they become available. This information could help inform the Trustees regarding the need for future mink and otter injury determination studies. Additionally, in January 2002, the Trustees assembled an expert panel to review the exposure and effects information compiled by the NYSDEC for mink and otter, and to provide guidance to the Trustees on appropriate next steps for determining whether PCBs are causing adverse biological effects in Hudson River mammals, particularly mink and otter.

Bat Exposure

Bats that reside in the Hudson River Valley may be highly exposed to PCBs through the food web. To assess the extent and severity of PCB exposure in bats, the Trustees collected several dozen bats from the Hudson River in the summer of 2001 and 2002. The Trustees currently plan to analyze several of these bats for PCBs. The Trustees also currently plan to analyze additional bats from reference areas. This preliminary investigation is in progress. The results of this preliminary investigation will allow the Trustees to determine whether bats have been exposed to PCBs and evaluate the possible effects these PCBs may have on bat health, and inform the Trustees regarding the need for future injury determination studies of bats.

AMPHIBIANS AND REPTILES

The Hudson River and its surrounding habitat support many species of amphibians and reptiles. These species spend a large part of their lives in contact with potentially contaminated substances - water, sediment, and soil - and consume potentially contaminated prey. As essential components of the food web, amphibians and reptiles prey on insects and worms, and are in turn consumed by larger animals such as hawks, owls, and raccoons. In addition to providing nutrients for their predators, amphibians and reptiles also pass on to their predators the hazardous substances they have accumulated.

In 1978, the NYSDEC collected snapping turtles from along the Hudson River. PCB concentrations in fatty tissue ranged from 330 to 4,319 ppm, and from 0.54 to 683 ppm in liver (49). In 1998, both snapping turtles and bullfrogs were collected from three locations along the Hudson River. PCB concentrations in these snapping turtles ranged from 9.8 to 610 ppm in fatty tissue, and 0.54 to 8.8 ppm in liver tissue. Only leg muscle tissue of bullfrogs was analyzed. One out of 27 of those samples had a measurable concentration of PCBs in leg muscle tissue of 0.023 ppm. In 2000, the NYSDEC collected additional snapping turtle data, with PCB concentrations ranging from 2.94 to 3,091 ppm in fat, 0.63 to 196 ppm in liver, and undetected to 3.92 ppm in muscle tissue (50, 51).

The specific studies the Trustees currently have in progress as preliminary investigations, to confirm exposure of Hudson River reptiles to PCBs, or to determine if injuries to Hudson River reptiles are occurring, are described below. The Trustees may undertake additional investigations, such as contaminants analysis of whole bodies of bullfrogs.

Snapping Turtle Consumption Advisory

The State of New York has issued a statewide advisory recommending limited consumption of snapping turtles due to the levels of PCB contamination found in snapping turtles (1). Specifically, the State advises that women of childbearing age, infants, and children under the age of 15 should avoid eating snapping turtles or soups that contain their meat. The State also advises individuals to discard the fat, liver, and eggs of snapping turtles prior to cooking.

The Department of the Interior's NRDA regulations define the snapping turtle consumption advisory issued by the State of New York as an injury. The Trustees currently plan to evaluate this injury to determine what part of the contamination that led to the statewide advisory is attributable to PCBs from the Hudson River.

Snapping Turtle Health

Snapping turtles are an important component of the Hudson River food web. Snapping turtles are consumers of fish and aquatic invertebrates, while young snapping turtles and snapping turtle eggs are prey for skunks, snakes, birds, and other wildlife.

Female snapping turtles lay a single clutch of eggs each year, and those eggs reflect annual changes in chlorinated hydrocarbon exposure in the female turtle (76). In snapping turtles, sex determination is temperature-dependent; males are produced when the eggs are incubated between 22 and 28 degrees Celsius and females are produced at incubation temperatures outside this range (77). Some PCBs have been shown to affect sex differentiation in snapping turtles (77, 78). Patnode et al. (1998) collected, and then artificially incubated, snapping turtle eggs from the Sheboygan River, Wisconsin, in 1996 and 1997 (52). Hatching success was reduced in clutches containing PCB concentrations greater than 15 ppm when eggs were incubated at male-producing temperatures, but not at female-producing temperatures. Further, Patnode et al.

(1998) found that righting responsiveness was inversely related to PCB exposure; when the hatchlings were placed on their "backs" (carapace), more than 35 percent of the highly contaminated hatchlings were unresponsive (52). External sexual development in snapping turtles may be sensitive to exposure to environmental contaminants, such as PCBs (77).

To assess potential impacts to snapping turtles, the Trustees are currently evaluating existing data from Hudson River snapping turtles with regard to the literature on PCB effects on reptiles. The Trustees currently plan to collect snapping turtle eggs from the Hudson River for analysis of contamination, including PCBs. This preliminary investigation is in progress. The Trustees are also considering incubating in the laboratory a subset of the snapping turtle eggs collected; hatchlings could then be analyzed for adverse effects. The results of such an injury determination investigation could allow the Trustees to begin to evaluate the possible effects these PCBs may have on snapping turtle health. These data could also be useful for understanding potential pathways to other animals that eat turtle eggs, for example, skunks that may then be preyed upon by great horned owls or other predators.

SURFACE WATER

The Hudson River provides habitat for a wide range of plants and animals. The river provides food and shelter for these organisms, as well as essential nursery habitat for many species that nurture their offspring in the open waters, shoals, and eddies. The Hudson River also serves as a source of drinking water for several communities and provides opportunities to boat, swim, fish, and view wildlife.

The specific studies that the Trustees have in progress to determine PCB injuries to Hudson River surface water resources are described below.

WATER QUALITY EVALUATION

The NRDA regulations provide that when chemical contamination is present in waterways at levels that exceed the standards set by the State or Federal government, the surface water resource is injured, if the surface water met the standards before the release and is a "committed use" as a habitat for aquatic life, water supply, or recreation. Various investigators have measured PCB concentrations in the Hudson River since the mid-1970s.

Water quality standards have been established by EPA and the State of New York to protect humans and wildlife from the effects of exposure to hazardous substances. For PCBs, the most protective standard of 0.000001 ppb is designed to protect humans who consume fish (46). Other standards include 0.00012 ppb for the protection of fish-eating wildlife, 0.001 ppb for the protection of humans and wildlife from exposures such as swimming and wading, and 0.09 ppb for protection of drinking water sources (46).

From 1975 to 2001, the United States Geological Survey, EPA, NYSDEC, GE, and others collected more than 6,600 water samples from the Hudson River. Data for the Upper Hudson River show PCB concentrations ranging from 0.006 to 5.1 ppb. Data for the Lower Hudson River show PCB concentrations ranging from 0.006 to 0.46 ppb (45). PCB concentrations were consistently elevated downstream of the two GE plants.

The Trustees currently are comparing these existing water quality data with established water quality standards to document where and when the surface waters of the Hudson River exceeded these standards, thus documenting the injury to surface water resources. A preliminary review of data indicates that water column concentrations of PCBs in the Hudson River consistently

Atlantic Sturgeon

Illustration by: Duane Raver, U.S. Fish and Wildlife Service exceeded applicable water quality standards. This injury determination study is in progress.

Sediment Evaluation

River sediments are included within the regulatory definition of surface waters for NRDA purposes. The Trustees are evaluating whether PCB contamination of river sediments constitutes a natural resource injury. Two injury determination investigations are suggested by the NRDA regulations. These two investigations are discussed below.

Sediments Characteristic of Solid Waste

When concentrations of hazardous substances on bed, bank, or shoreline sediments are sufficient to cause the sediment to exhibit characteristics identified under or listed pursuant to section 3001 of the Solid Waste Disposal Act (SWDA), 42 U.S.C. 6921, the resource is injured. The Trustees may perform an investigation to determine whether the sediments of the Hudson River are contaminated with PCBs such that they exhibit characteristics identified under or listed pursuant to section 3001 of the SWDA. To perform such an evaluation, the Trustees could compare existing Hudson River sediment data with the regulations noted above to document where and when the sediments of the Hudson River exhibit the characteristics identified under or listed pursuant to section 3001 of the SWDA, thus documenting injury to surface water resources. Available data indicate that some areas of the Hudson River sediments are contaminated to the degree that they would exhibit such characteristics. This condition would constitute a surface water injury under the DOI NRDA regulations. This injury determination study is in progress.

Sediments Injury: Pathway and Biota

Sediments are also injured when they contain hazardous substances of sufficient concentration and duration to cause injury to other natural resources (groundwater, air, geologic, or biological resources) when exposed to surface water, suspended sediments, or bed, bank, or shoreline sediments.

The Trustees may perform an investigation to determine whether the concentrations of PCBs in Hudson River sediments are sufficient to cause injury to other natural resources, such as biota, that are exposed to those sediments. This evaluation could be primarily focused on evaluating injury to sediment-dwelling biota due to exposure to PCB-contaminated sediments and associated water in the Hudson River. To perform such an evaluation, the Trustees could compare existing Hudson River sediment data with the thresholds and effect levels identified in the literature to document where and when the sediments of the Hudson River exceed such thresholds and effect levels.

Researchers have conducted several studies to determine how PCB contamination in sediment and soil affect fish and wildlife. This research focuses on establishing concentrations that will protect species that come into contact with PCBs in sediment.

Researchers have conducted several studies to determine how PCB contamination in sediment and soil affect fish and wildlife. This research focuses on establishing concentrations that will protect species that come into contact with PCBs in sediment. For example, EPA has used a cleanup level of 1 ppm for PCB-contaminated sediment at several sites across the United States (e.g., Housatonic River, MA; General Motors Foundry at the St. Lawrence and Raquette Rivers, NY; Paoli Railyard, PA; Fox River, WI; Kalamazoo River, MI: Niagara Mohawk Power Corp., NY; Cosden Chemical, NJ; and Chemsol, NJ). At some other sites, EPA recently selected cleanup levels that were less than 1 ppm PCBs (e.g. Commencement Bay, WA; Sheyboygan River, MI). These levels were derived to protect not only the organisms that live in sediment, but also those animals that may eat contaminated prey.

Other researchers have developed sediment quality guidelines for the protection of aquatic bottom-dwelling organisms based on the expected effects associated with PCB exposure. For example, MacDonald et al. (2000) report a 15.6 percent incidence of toxicity to sediment-dwelling organisms occupying freshwater sediments with PCB concentrations of less than 0.04 ppm (44). The incidence of adverse biological effects remained relatively low (7 percent) when total PCB concentrations were greater than 0.04 ppm but less than 0.40 ppm. At sediment PCB concentrations greater than 0.40 ppm the incidence of toxicity to freshwater biota was much higher (68.3 percent) (44). At sediment PCB concentrations greater than 1.7 ppm, the incidence of toxicity to freshwater biota was still higher (82.5 percent) (44).

Available data indicate that some areas of Hudson River sediments are contaminated to the degree that they would exceed such thresholds and effects levels, i.e., the concentrations of PCBs may be sufficient to cause injury to other natural resources, particularly sediment-dwelling biota.

Available data indicate that some areas of Hudson River sediments are contaminated to the degree that they would exceed such thresholds and effects levels, i.e., the concentrations of PCBs may be sufficient to cause injury to other natural resources, particularly sediment-dwelling biota. This condition, if found in the river's sediments, would constitute a surface water injury under the DOI NRDA regulations. This injury determination study is in progress.

GROUNDWATER

Groundwater is the water beneath the Earth's surface (in the saturated zone) and that may flow naturally to the Earth's surface through seeps or springs.

Groundwater resources may be injured in several ways. First, injury occurs if concentrations of hazardous substances in the groundwater exceed standards established under Sections 1401(1)(d) or 1411-1416 of the Safe Drinking Water Act (SDWA), as long as the groundwater satisfied certain requirements prior to the discharge or release. Those requirements include either evidence of potability at the time of discharge or evidence that the groundwater met applicable standards at the time of discharge and is a "committed use" as a public water supply. Second, injury occurs if concentrations of hazardous substances in the groundwater exceed criteria established in Section 304(a)(1) of the Clean Water Act, as long as the groundwater satisfied certain requirements prior to the discharge or release. Those requirements include that the groundwater met the criteria for a domestic water supply before the discharge or release, and is a committed use as a domestic water supply. Third, injury may occur when violations occur for certain other State or Federal standards or criteria for groundwater designated as a drinking water supply, public water supply, or domestic water supply prior to the discharge or release. Contaminated groundwater resources can also be injured, and can injure, other resources by serving as a source and pathway for PCBs. For example, seepage of PCB-contaminated groundwater into a river may be an exposure pathway for fish; in such an example, both the groundwater and fish may be injured.

Regulations promulgated under the SDWA establish a Maximum Contaminant Level for total PCBs of 0.5 ppb for finished water provided to consumers. The state groundwater standard for protection of drinking water sources is 0.09 ppb (46).

In 1992 and 1993, NYSDEC determined that PCBs in the form of dense non-aqueous phase liquid underlie the Hudson Falls and Fort Edward plant sites. The NYSDEC further discovered that PCBs from the Hudson Falls plant site were entering the Hudson River as part of the groundwater discharge to the river and contributing significantly to PCB loading to the sediment and water column (80, 81).

The Trustees currently are compiling existing information regarding the presence of PCBs in groundwater resources in and around the Hudson River, and comparing that information to the standards and criteria noted above. This injury determination study is in progress.

GEOLOGIC RESOURCES

Geologic resources include elements of the Earth's crust, including soils, sediments, rocks, and minerals.

A geologic resource may be injured by the release of a hazardous substance when, among other things, one or more of the following changes in the physical or chemical quality of the resource is measured: (a) concentrations of substances sufficient for the materials in the geologic resource to exhibit characteristics identified under or listed pursuant to section 3001 of the SWDA, 42 U.S.C. 6921; (b) concentrations of substances sufficient to have caused injury to groundwater from physical or chemical changes in gases or water from the unsaturated zone; (c) concentrations in the soil of substances sufficient to cause a toxic response to soil invertebrates; or, (d) concentrations in the soil of substances sufficient to cause a phytotoxic response such as retardation of plant growth.

PCB concentrations in floodplain soils of the Hudson River have been detected at levels equal to or greater than 50 ppm (61). This concentration is sufficient to cause a toxic response to soil invertebrates, as the acute LC50 for earthworms is 2.5 ppm PCBs (63). Further, as a result of the PCB contamination, these soils would be subject to regulations pursuant to the TSCA. The TSCA regulations specify three options for the disposal of contaminated sediments or soils: incineration, disposal in a licensed chemical waste landfill, or an alternative accepted by the EPA Regional Administrator (81).

Contaminated geologic resources can also be injured, and can injure, other resources by serving as a source and pathway for PCBs.

The Trustees currently are compiling existing information regarding the presence of PCBs in geologic resources, such as floodplains, in and around the Hudson River, and comparing it to the injuries noted above. Such injuries would be in addition to the injuries to the biological resources of the floodplains, including birds, mammals, amphibians, and reptiles. This injury determination study is in progress.

AIR

Air may be injured when a hazardous substance is present at concentrations that exceed air quality standards established by Section 112 of the Clean Air Act or other standards issued by the State or Federal government to protect public welfare or natural resources. Contaminated air resources can also be injured, and can injure, other resources by serving as a source and pathway for PCBs.

PCBs that are present in water may volatilize and enter the atmosphere. Additionally, under certain conditions the volatile loss of PCBs from wet soils and sediments may be rapid and substantial (82). PCBs have been detected in the atmosphere in the Hudson River environment. Air sampling performed by GE in the Fort Edward area in 1989 detected a maximum PCB concentration of 2.3×10^{-7} ppm (83).

The Trustees currently plan to investigate existing information regarding the presence of PCBs in the air in and around the Hudson River, and compare that information to injuries noted above. Following this review, the Trustees may undertake additional investigations, potentially including an injury determination study, prepare a report documenting the extent of the injury, or make a determination that provides the basis for removing this resource from the assessment.

PCB concentrations in floodplain soils of the Hudson River have been detected at levels equal to or greater than 50 ppm. This concentration is sufficient to cause a toxic response to soil invertebrates.

DAMAGE DETERMINATION AND RESTORATION

The Trustees consider the issue of restoration throughout the damage assessment. Restoration is designed to return injured resources to their baseline condition and to compensate for the resources that were lost during the period of injury. To accomplish this objective, the Trustees may use one or both of the following approaches depending on the circumstances of the case: (1) calculate the cost of restoring, replacing, or acquiring the equivalent of the injured resources and the services they provide, and (2) determine the value of the losses due to the resource injuries and apply that amount to resource restoration. The Trustees will develop a Restoration and Compensation Determination Plan that establishes the procedures for determining the appropriate restoration.

Restoration is the goal of a NRDA. It is an active component of damage assessment that can be seen and felt for generations. For example, restoration projects may improve or create aquatic habitats, thereby providing fish with clean spawning habitat and anglers with opportunities to catch fish with reduced PCB levels. Similarly, restoration may involve creating conservation areas and nesting sites that are attractive to waterfowl, eagles, owls, or other birds. Restoration also may include increasing the viability and abundance of threatened, endangered, special concern, or rare species.

Restoration is the goal of a NRDA. It is an active component of damage assessment that can be seen and felt for generations.

The restoration planning process is initiated and managed by the Trustees. The Trustees identify: (1) restoration goals, (2) restoration projects, and (3) the type and amount of restoration that is necessary to effectively compensate the public for the injured natural resources and the loss of the services those resources provide. The Trustees will consider a number of restoration alternatives, including taking no action and estimating the time required for natural recovery. The Trustees will then select the most appropriate alternative. Ultimately, the Trustees will develop and issue a Restoration and Compensation Determination Plan that memorializes the restoration process. This plan will be distributed to the public and potentially responsible party or parties for review and comment.

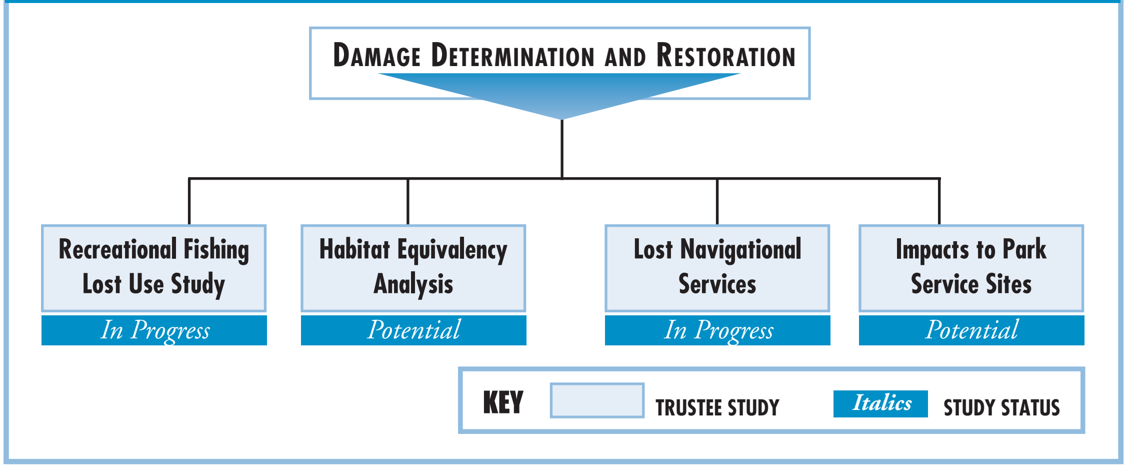
Throughout this process, the Trustees seek assistance and input from individuals who are interested in the future of the Hudson River. Periodically, the Trustees will develop fact sheets or information packets that explain the restoration process and avenues for public participation, advertise opportunities for public involvement, hold public meetings, and seek comments on potential restoration goals and projects. For example, the Trustees are currently soliciting ideas for restoration projects in the Hudson River. To contribute to this effort, interested individuals may obtain information about submitting restoration proposals through any of the Trustees' internet sites for the Hudson River, or through the contact for public inquiries noted at the end of the Executive Summary. Through all of these forums and opportunities, the Trustees intend to keep the public apprised of the ongoing restoration program and facilitate the exchange of information among all interested parties. By actively involving people with different perspectives, it is hoped the Hudson River will be restored with a richer range of projects that builds a stronger sense of community.

Exhibit 4-3 illustrates the status of each study the Trustees are currently considering within the damage determination and restoration phase of the assessment. The specific studies are described below. Some of the studies are underway to guide the Trustees in development of the Restoration and Compensation Determination Plan. The results of all studies undertaken by the Trustees will be contained within the Report of Assessment.

RECREATIONAL FISHING LOST USE STUDY

The Trustees are assessing the value of the lost use of the recreational fishery as part of the damage

EXHIBIT 4-3: DAMAGE DETERMINATION AND RESTORATION



determination. The Hudson River is a popular fishing destination for recreational anglers. In some locations, the river is so diverse that it provides opportunities to catch sought after species of both freshwater and saltwater fish. However, PCB contamination has likely changed the way that anglers view the river and its fishery. In particular, the fishing bans and restrictions issued by the State of New York in response to the PCB contamination may alter angler behavior and reduce the enjoyment that each angler receives from a fishing trip. Common responses that anglers have when faced with chemical contamination and any associated advisories at their preferred fishing location include fishing less frequently or not at all, fishing in less desirable locations, traveling further to fish, converting to catch-and-release angling, or pursuing a different activity altogether. In order to assess these impacts, the Trustees are evaluating how fishing restrictions in the Hudson River affect angler behavior.

HABITAT EQUIVALENCY ANALYSIS

As noted above, the Trustees are engaged in a process of assessing exposure of natural resources to PCBs and determining whether injuries from PCBs are occurring to a variety of natural resources, including surface water, sediment, and various biota, as a result of that exposure. As part of the damage assessment, the Trustees may determine the amount of restoration that is necessary to compensate the public for identified injuries to these resources for the period between the onset of injury and the resource's return to baseline. One way to do this is to use a method called Habitat Equivalency Analysis (HEA). The HEA method is founded on the principle that the public can be compensated for past and future losses of natural resources by providing additional resources of the same type and quality (84, 85, 86). The HEA method provides compensation by establishing equivalency between the quantity of injured resources or services and the quantity of restoration. The Trustees will determine the appropriateness of using this or other methods after it is determined which resources are injured.

ASSESSMENT OF LOST NAVIGATIONAL SERVICES

The Hudson River, in particular the Champlain Canal portion of the Upper Hudson, is an important waterway for recreational and commercial boat traffic. Completed in 1825, the Champlain Canal linked the Upper Hudson River to Lake Champlain and provided a vital transportation route for the movement of raw materials and finished goods, linking the farmers and merchants of the Hudson Valley with the rest of the world. Portions of the Champlain Canal are coincident with portions of the Hudson River, extending from Waterford, New York, at River Mile 158 on the Hudson River, to Whitehall, New York, at the southern end of Lake Champlain. The Champlain Canal is 60 miles long, including 37 miles of canalized Hudson River from Waterford to Fort Edward. The Canal diverges from the Hudson River at Fort Edward just downstream of Lock 7 and proceeds in a northeasterly direction to Lake Champlain, with 23 miles of land-cut sections from Fort Edward to Whitehall.

The Champlain Canal is operated and maintained by the New York State Canal Corporation, a subsidiary corporation of the New York State Thruway Authority. Before 1979, the Canal Corporation (the New York State Department of Transportation prior to 1992) routinely dredged the Champlain Canal to maintain a water depth of 12 feet. However, due to the incremental costs associated with PCB contamination, no dredging in the Upper Hudson River has occurred since that date, except in the area where the Hoosic River discharges into the Champlain Canal below Lock C-4. Since 1992, the Canal Corporation has conducted annual depth surveys of the canal to determine areas of increased sedimentation and decreased water depth in the navigation channel. Areas of decreased depth are marked with additional buoys to prevent Canal boaters from grounding their vessels. The inability to dredge the Champlain Canal due to the presence of PCB contamination has caused a number of locations to have less than the required 12 foot depth. This suggests that the navigation of vessels through these areas, particularly larger vessels with deeper drafts, may be impeded by the current conditions.

As part of this assessment, the Trustees will determine whether injuries to surface water resources have led to any loss or impairment of the services the Champlain Canal is capable of providing. If the Trustees find that there has been injury and an associated loss of this kind, the Trustees will evaluate whether the proposed remedial dredging to be carried out by EPA will adequately restore this waterway to its full uses. Should it appear that EPA's remedy will not achieve full restoration, the Trustees will consider and evaluate further restoration options and their costs. The Trustees may also institute a study of potential loss of navigational services in the Lower Hudson attributable to PCB contamination.

Assessment of Impacts to National Park Sites and Affiliated Areas

The NPS oversees several parks and historic sites in the Hudson River Valley that contain important natural resources that have been exposed to PCBs. Among these are the Saratoga National Historical Park, the Franklin D. Roosevelt National Historic Site, and the Vanderbilt Mansion National Historic Site. The presence of PCBs in and around these and other properties has likely changed how park visitors view these sites. In addition, PCB contamination affects how the NPS plans and manages these properties. To evaluate the damages associated with contamination at these sites, the Trustees currently plan to use existing data to define the scope of the impacts. If the results of this preliminary investigation warrant further action, the Trustees could develop one or more additional studies that fully characterize the damages at these sites associated with PCB contamination in the Hudson River Valley.

Photo courtesy of the National Park Service

The Great Redoubt at Saratoga National Historic Park.

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GLOSSARY

Advisory - State-generated health warning regarding the consumption of contaminated animals (e.g., fish, waterfowl). These advisories include advice on how to reduce exposures to chemical contaminants in fish and game by avoiding or reducing consumption and by the use of filleting/trimming and cooking techniques to further reduce contaminant levels. In New York State, these advisories are issued by the New York State Department of Health.

Air resources - those naturally occurring constituents of the atmosphere, including those gases essential for human, plant, and animal life.

Algae - marine and freshwater plants (including most seaweeds) that are single-celled, colonial, or multicelled, with chlorophyll but without true roots, stems, or leaves and with no flowers or seeds.

Anadromous - reproducing in freshwater and then living as adults in marine waters; generally the term is used to describe fish species that ascend rivers and streams from saltwater habitat for the purpose of spawning.

Aroclor - commercially prepared PCB mixture, consisting of individual PCB compounds (congeners) differing in position and degrees of chlorination, that was manufactured by the Monsanto Chemical Company.

Assessment Plan - see Damage Assessment Plan

Baseline - the condition or conditions that would have existed at the assessment area had the discharge of oil or release of the hazardous substance under investigation not occurred.

Bioaccumulation - the accumulation of substances from the environment in the tissues of exposed organisms.

Biological resources - plants and animals; those natural resources referred to in section 101(16) of CERCLA as fish and wildlife and other biota. Fish and wildlife include marine and freshwater aquatic and terrestrial species; game, non-game, and commercial species; and threatened, endangered, and State sensitive species. Other biota include shellfish, terrestrial and aquatic plants, and other living organisms not otherwise listed in this definition.

Brackish - water that has some salt content but is less saline than ocean water.

Catadromous - reproducing in marine waters and then migrating as adults to freshwater.

Clean Water Act - Public Law 95-217 as amended, 33 USC 1251 et seq.; restores and maintains the chemical, physical, and biological integrity of the nation's waters by achieving a level of water quality which provides for the protection and propagation of fish, shellfish, and wildlife and for recreation on the water; elimination of the discharge of pollutants into surface waters; and promotion of a policy that the discharge of toxic pollutants in toxic amounts be prohibited.

Code of Federal Regulations - the general and permanent rules published in the Federal Register by the Executive departments and agencies of the Federal Government.

CERCLA (Comprehensive Environmental Response, Compensation and Liability Act) - Public Law 95-510 as amended, 42 USC Sec. 9601 et seq.; designed to respond to situations involving the past disposal of hazardous substances; regulates the cleanup of sites where hazardous substances are located and the distribution of cleanup costs among the parties who generated and handled hazardous substances at these sites.

Committed use - either a current public use; or a planned public use of a natural resource for which there is a documented legal, administrative, budgetary, or financial commitment established before the discharge of oil or release of a hazardous substance is detected.

Confluence - the point where two or more streams come together.

Congener - viz. PCBs, a compound with a specific number and position of chlorine atoms attached to a biphenyl; a member of the group of compounds known as PCBs (polychlorinated biphenyls).

Criterion - the level of a compound or material set by a governmental agency to be protective of human health, wildlife health, and/or the environment.

Damage Assessment Plan - a plan created by the Trustees and reviewed by the public that serves as a means of evaluating whether the approach used for assessing damages is likely to be cost-effective and meets the definition of reasonable cost; includes descriptions of the natural resources and geographical areas involved, the methodologies proposed for injury assessment, and a statement of trusteeship.

Damages - the amount of money sought by the natural resource Trustee as compensation for injury, destruction, or loss of natural resources as set forth in section 107(a) or 111(b) of CERCLA.

Degradation - decomposition of a compound or material.

Deposition - setting down of particles on a surface.

Dredge spoils - material removed from a water body by dredging for subsequent storage and/or disposal.

Drinking water supply - any raw or unfinished water source that is or may be used by a public water system, as defined by the Safe Water Drinking Act, or as drinking water by one or more individuals.

Ecosystem - the complex of a community and its environment functioning as an ecological unit in nature.

Emergent vegetation - herbaceous wetland vegetation that is erect and rooted.

Endangered species - any species that is in danger of extinction throughout all or a significant portion of its range.

Erosion - the process of wearing away by the action of water, wind, or ice.

Floodplain - low-lying lands near a river that are submerged when the river overflows its banks.

Food web - complex of interacting organisms, accounting for feeding relations, production, consumption, decomposition, and energy flow.

Geologic resources - those elements of the earth's crust such as soils, sediments, rocks, and minerals, including petroleum and natural gas, that are not included in the definitions of ground and surface water resources.

Groundwater resources - water in a saturated zone or stratum beneath the surface of land or water and the rocks or sediments through which groundwater moves. It includes groundwater resources that meet the definition of drinking water supplies.

Habitat - place where a plant or animal species naturally exists.

Hazardous substance - substances designated in sections 311(b)(2)(A) or 307 (a) of the Federal Water Pollution Control Act; any element, compound, mixture, solution or substance as defined in section 102 of CERCLA; any hazardous waste having the characteristics identified under or listed pursuant to section 3001 of the Solid Waste Disposal Act; any hazardous air pollutant listed under section 112 of the Clean Air Act; and any imminently hazardous chemical substance or mixture with respect to which the Administrator has taken action pursuant to section 7 of the Toxic Substances Control Act (does not include petroleum, natural gas, or synthetic gas).

Herbivore - animal that feeds primarily on plants.

Injury - a measurable adverse change, either long- or short-term, in the chemical or physical quality of the viability of a natural resource resulting either directly or indirectly from exposure to a discharge of oil or release of a hazardous substance, or exposure to a product of reactions resulting from the discharge of oil or release of a hazardous substance.

Intertidal - area of the shore between mean high water and mean low water.

LC 50 - the concentration of a substance that is expected to cause death in 50 percent of an experimental test population when administered over a specified period of time.

Lesion - abnormal change in the structure of an organ or tissue due to injury or disease.

Lipophilic - having an affinity for lipid (fats); easily miscible in organic substances, literally "fat-loving".

Lower Hudson River - the stretch of the Hudson River between the Federal Dam at Troy (River Mile 154) and the Battery in Manhattan (River Mile 0).

Migrate - to move (usually periodically) from one area to another for feeding or breeding.

National Priorities List (NPL) - a list of sites prepared according to the statutory criteria of the hazard ranking system that evaluates the known releases or threatened releases of hazardous substances, pollutants, or contaminants throughout the United States; Appendix B of the National Contingency Plan.

Natural resources - land, fish, wildlife, biota, air, water, groundwater, drinking water supplies, and other such resources belonging to, managed by, held in trust by, appertaining to, or otherwise controlled by the United States (including the resources of the fishery conservation zone established by the Magnuson Fishery Conservation and Management Act of 1976), any State or local government, any foreign government, any Indian tribe, or, if such resources are subject to a trust restriction or alienation, any member of an Indian tribe. These natural resources have been categorized into the following five groups: surface water resources, groundwater resources, air resources, geologic resources, and biological resources.

Natural resource damage assessment - the process of collecting, compiling, and analyzing information, statistics, or data to determine damages for injuries to natural resources.

No-action - when a resource is allowed to recover from injury naturally, without any remedial intervention.

Organic matter - material of, relating to, or derived from living organisms.

Pathway - the route or medium through which oil or a hazardous substance is or was transported from the source of the discharge or release to the injured resource.

Phytoplankton - microscopic aquatic plant forms of passively drifting organisms.

Polychlorinated biphenyls (PCBs) - a group of 209 congeners consisting of a biphenyl ring with between 1 and 10 chlorine atoms attached, known to be persistent in the environment and to cause adverse effects in organisms.

Predator - an animal with a mode of life in which food is primarily obtained by the killing and consuming of animals.

Prey - an animal taken by a predator as food.

Quality Assurance Project Plan - a document outlining procedures that those who conduct a monitoring project will take to ensure that the data they collect and analyze meets project requirements.

Reasonable cost - the amount that may be recovered for the cost of performing a damage assessment. Costs are reasonable when: the Injury Determination, Quantification, and Damage Determination phases have a well-defined relationship to one another and are coordinated; the anticipated increment of extra benefits in terms of the precision or accuracy of estimates obtained by using a more costly injury, quantification or damage determination methodology are greater than the anticipated increment of extra costs of that methodology; and the anticipated cost of the assessment is expected to be less than the anticipated damage amount determined in the Injury, Quantification, and Damage Determination phases.

Remediation - an action that alleviates contamination or injury.

Remnant Deposit - PCB-contaminated sediment deposits which were exposed as a result of the removal of the Fort Edward Dam and the subsequent drop in the water level of the Hudson River.

Restoration - actions undertaken to return an injured resource to its baseline condition, as measured in terms of the injured resource's physical, chemical, or biological properties, or the services it previously provided, when such actions are in addition to response actions completed or anticipated, and when such actions exceed the level of response actions determined appropriate to the site pursuant to the National Contingency Plan.

Safe Drinking Water Act - Public Law 93-523 as amended, 42 USC 300f et seq.; ensures that the water that comes from the tap in the United States is fit to drink (according to EPA national drinking water standards), and prevents contamination of groundwater.

Services - the physical and biological functions performed by the resource including the human uses of those functions. These services are the result of the physical, chemical, or biological quality of the resource.

Spawning - the production of eggs in large numbers, usually in reference to aquatic animals (e.g., fish and frogs).

Species of special concern - species of fish and wildlife found to be at risk of becoming either endangered or threatened.

Standard - see criterion.

Superfund - see CERCLA.

Surface water resources - the waters of the United States, including the sediments suspended in water or lying on the bank, bed, or shoreline and sediments in or transported through coastal and marine areas. This term does not include groundwater or water or sediments in ponds, lakes, or reservoirs designated for water treatment under the Resource Conservation and Recovery Act of 1976 or the Clean Water Act and applicable regulations.

Threatened species - any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

Toxic - poisonous.

Toxic Equivalent - the potency or toxicity of one substance in comparison to another.

Trophic level - position of an organism in a food web.

Trustee - any Federal natural resources management agency designated in the NCP [National Contingency Plan] and any State agency designated by the Governor of each State, pursuant to section 107(f)(2)(B) of CERCLA, that may prosecute claims for damages under section 107(f) or 111(b) of CERCLA; or an Indian tribe, that may commence an action under section 126(d) of CERCLA.

Trustee Council - a council composed of one representative from each natural resource Trustee. For the Hudson River, the Trustee Council includes a representative from the U.S. Fish and Wildlife Service (representing the Department of the Interior), the National Oceanic and Atmospheric Administration (representing the Department of Commerce), and the New York State Department of Environmental Conservation (representing the State of New York).

Upper Hudson River - the stretch of the Hudson River between the river's origin in Lake Tear of the Clouds and the Federal Dam at Troy (River Mile 154).

APPENDIX A

QUALITY ASSURANCE MANAGEMENT

The Hudson River Natural Resource Trustees will collect and analyze chemical, biological, and physical data as part of the Hudson River Natural Resource Damage Assessment. In order for the Trustees to have confidence in the data developed through the damage assessment, a structured process for ensuring quality must exist. Therefore, beginning in 2001, project-specific Quality Assurance (QA) plans will be developed for each data collection effort that is part of the Hudson River Natural Resource Damage Assessment and is identified in the Damage Assessment Plan. The QA Plan may be an independent document or be incorporated into the project work plan.

The purpose of each project-specific QA Plan will be to assist the Trustees in developing defensible data that will provide a solid foundation for their decisions. The QA plans developed for this NRDA will be based on EPA requirements for Quality Assurance Project Plans (EPA QA/R-5, March, 2001) and EPA Guidance for Quality Assurance Project Plans (EPA QA/G-5, February 1998). In general, each project-specific QA Plan should provide sufficient detail to demonstrate that:

- The project's technical and quality objectives (i.e., data quality objectives) are identified and agreed upon;
- The intended measurements or data acquisition methods are appropriate for achieving project objectives;
- Assessment procedures are sufficient for confirming that data of the type and quality needed and expected are obtained; and
- Any limitations on the use of the data can be identified and documented.

Accordingly, the plans developed for this assessment will address the four general elements identified by EPA guidance as described below:

Project Management - documents that the project has a defined goal(s), that the participants understand the goal(s) and the approach to be used, and that the planning outputs have been documented;

Data Generation and Acquisition - ensures that all aspects of project design and implementation including methods for sampling, measurement and analysis, data collection or generation, data handling, and quality control (QC) activities are identified and documented;

Assessment and Oversight - assesses the effectiveness of the implementation of the project and associated QA and QC activities; and

Data Validation and Usability - addresses the QA activities that occur after the data collection or generation phase of the project is completed.

Each of these elements is discussed briefly below.

Project Management

Project organization, roles, and responsibilities help ensure that individuals are aware of specific areas of responsibility for quality assurance, as well as internal lines of communication and authority. Organizational roles and responsibilities may vary by study or task, depending on the lead agency and project team performing the investigation, and should be described in the Quality Assurance Project Plan.

The overall Quality Assurance organization for the damage assessment is shown in Exhibit A-1 below.

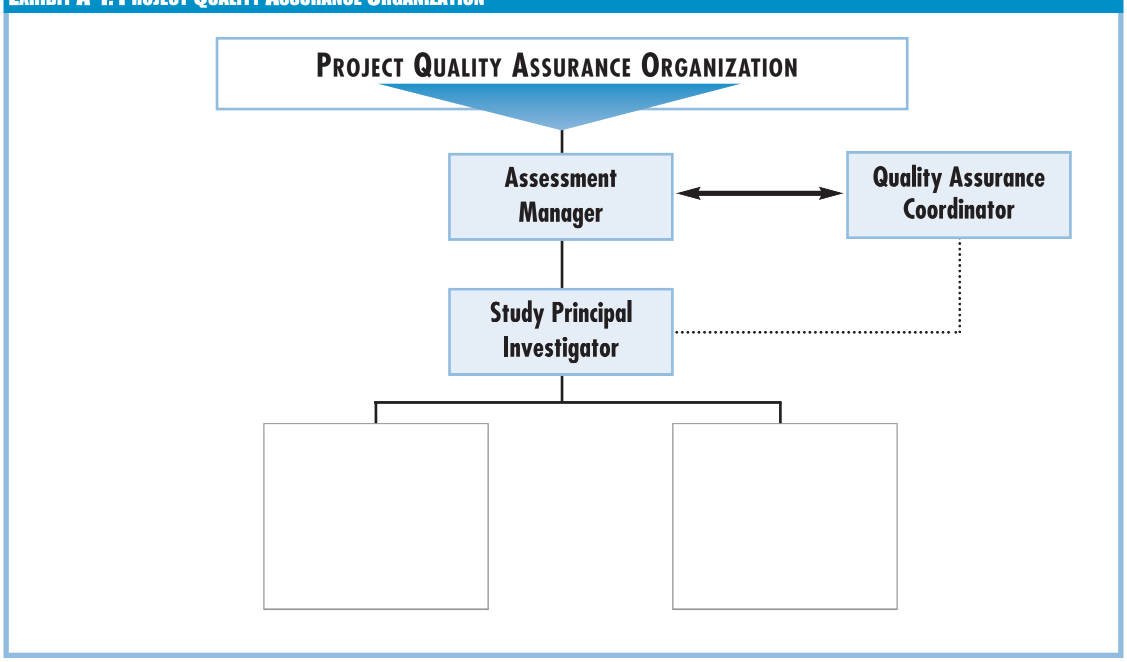
The Assessment Manager is the designated Trustee representative (from NOAA, NYSDEC, or DOI) who is responsible for the review and acceptance of the project-specific QA plan and ensuring that various Trustee agency efforts are in accordance with requirements of the Hudson River NRDA.

The overall conduct of the quality system for the damage assessment is the responsibility of the QA Coordinator appointed by the Trustee Council. The responsibilities of this individual include, but are not limited to: development of an Analytical QA Plan; reviewing/assisting project leaders with the development of project-specific QA plans; conducting audits and ensuring implementation of both project and overall QA plans; archiving samples, data, and all documentation supporting the data in a secure and accessible form; and reporting to the Trustee Council.

Study-specific Principal Investigators (PIs) ensure that QA guidance and requirements are followed. The PI or the designee will note significant deviations from the QA plan for the study, and report the deviations to the Assessment Manager and the QA Coordinator.

The Field Team Leader (FTL) supervises day-to-day field investigations, including sample collection, field observations, and field measurements. The FTL generally is responsible for all field quality assurance procedures defined in the Quality Assurance Project Plan. The Laboratory Project Manager is responsible for monitoring and documenting the quality of laboratory work.

Exhibit A-1: Project Quality Assurance Organization



Data Generation and Acquisition

Beginning in 2001, studies that are identified in the Damage Assessment Plan that either generate or acquire data to be used in the Hudson River NRDA will have a prepared study plan to be submitted to and approved by the QA Coordinator or designee. Each study plan should include, at a minimum:

- Rationale for generating or acquiring the data;
- Proposed method(s) for generating or acquiring the data;
- Data quality requirements for the study or project and the types of quality control materials and procedures to be used in determining if the data meet these requirements;
- In-house quality assessment procedures to be used in evaluating the outcome; and
- Description of the interpretation, including statistical analyses, of the data.

Project-specific QA plans for each study may be based on EPA guidance, such as EPA Guidance for Quality Assurance Project Plans (EPA QA/G-5) or some other model, but will describe the experimental data generation or data collection design for the project including the types and number of samples required, the design of the sampling network, sampling locations and frequencies, and the rationale for the design.

In addition, project-specific QA plans will describe or reference (and include as appendices) standard operating procedures (SOPs) for all sampling or data generating methods and analytical methods, including sample handling and custody in the field, in the laboratory, and during transport. Documentation to be included with the final report(s) from each study will include: field logs for the collection or generation of the samples, chain of custody records, and QA/QC documentation. Documentation will be specific for each study but each project-specific plan will identify the appropriate documentation and provide for retention. All studies are required to comply with Good Laboratory Practice Standards for facilities, apparatus, and physical/chemical and biological test systems. This includes descriptions of maintenance, inspections of instruments, and acceptance testing of instruments, equipment, and their components, as well as the calibration of such equipment and the maintenance of all records relating to these exercises.

Assessment and Oversight

All studies that include the generation or acquisition of data will be audited by the QA Coordinator or designee. These audits will include both technical system audits (*i.e.*, qualitative evaluations of operational details) and data and report audits (*i.e.*, evaluations of data quality, adequacy of documentation, and technical performance characteristics). The purpose of these audits is to ensure that the project-specific plan is being implemented as described.

If, in the professional opinion of the QA Coordinator, the results of an audit indicate a compromise in the quality of the data, the QA Coordinator has the authority to stop work by oral direction. Within two working days of this direction, the QA Coordinator will submit to the Trustee Council a written report describing the necessity for this direction.

Data Validation and Usability

All study plans, work plans, and final reports will be reviewed for adequacy of design and appropriateness of methodology. Analytical data will be validated by an independent third party. Prompt validation of analytical data will assist the analyst or analytical facility in developing data that meet the requirements for precision and accuracy. It is expected that data validation will use the project-specific QA plans and EPA Guidance on Environmental Verification and Validation (EPA QA/G-8).

APPENDIX B

FACT SHEETS:

ASSESSING FISH HEALTH

PRELIMINARY INVESTIGATIONS OF BIRD INJURIES

PRELIMINARY INVESTIGATION OF SNAPPING TURTLES

HUDSON RIVER NATURAL RESOURCE DAMAGE ASSESSMENT: SUMMARY OF THE NRDA PLAN

Winter 2001 status report on the
Hudson River Natural Resource Damage Assessment

Assessing Fish Health

Background

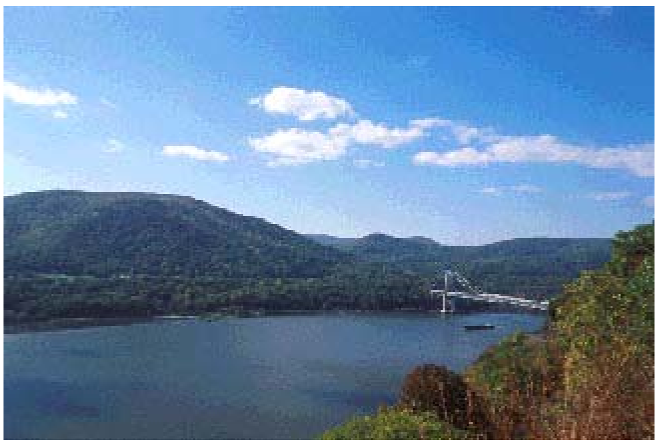
Past and continuing discharges of PCBs have contaminated natural resources of the Hudson River for at least 200 miles. Federal and state trustee agencies are conducting a natural resource damage assessment (NRDA) to assess and restore Hudson River natural resources that may have been injured by PCB contamination. PCBs are a major concern because they persist in the environment for many decades, can be harmful at low concentrations, and accumulate in living creatures.

PCBs pose health hazards to Hudson River fish, mammals, birds, and other wildlife and are found at concentrations up to 1,000 times greater than those considered protective of human health or the environment. For example, agency scientists recently found PCB concentrations in fish from the upper Hudson ranging from 1.9 to 287 parts per million (ppm). In comparison, New York has established a PCB guidance value of no more than 0.11 ppm of PCBs to protect wildlife that eat fish.

This factsheet provides summary information about one of the studies being implemented under the NRDA, the "Hudson River Fish Health Assessment."

PCB Effects

Many laboratory and field studies done in other parts of the country have shown the potentially harmful effects of PCBs on fish, birds, mammals, and other wildlife. Some effects on fish include impaired reproductive, endocrine, and immune system function, increased lesions and tumors, and death. Several other studies have documented the contamination of Hudson River wildlife by PCBs. However, very few studies have assessed whether this long-term PCB contamination is harming Hudson River wildlife.



A view of the Hudson River and Bear Mountain Bridge.

Study Objectives

This study will investigate whether fish in areas highly contaminated with PCBs show more indicators of injury than fish from reference areas that are less contaminated with PCBs. Fish will be examined for evidence of internal and external lesions, tumors, or other abnormalities and diseases, parasites, and other immune system indicators.

Methodology

Fish were collected from four sites in the Fall of 2001. Two sites were located in the most contaminated reach of the Hudson River, downstream of the industrial sources of PCBs at Hudson Falls and Fort Edward. The other two sites were reference sites, with one located upstream of Hudson Falls and one located in a waterbody known to have very low levels of contamination. Fish species targeted for this study include brown bullhead, smallmouth bass, and yellow perch. Tissue samples were collected to investigate a variety of biological impacts that can be caused by PCB contamination.

Investigators

The study was implemented by the following trustee agencies: the U.S. Fish and Wildlife Service, the New York State Department of Environmental Conservation, and the National Oceanic and Atmospheric Administration. The U.S. Geological Service also provided assistance.

For more information, contact
Lisa Pelstring
NOAA Damage Assessment Center
301.713.3038 x195; fax 301.713.4387
Lisa.Pelstring@noaa.gov

Larry Gumaer
NYS Department of Environmental Conservation
518.402.8971; fax 518.402.9027
lwgumaer@gw.dec.state.ny.us

www.darp.noaa.gov/neregion/hudsonr.htm
www.dec.state.ny.us/website/hudson/index.html

Spring 2002 status report on he
Hudson River Natural Resource Damage Assessment

Preliminary nvestigations of Bird njuries

Past and continuing discharges)of PCBs)ave) contaminated natural resources)of the) Hudson River for at least 200 miles. Federal) and state trustee agencies are conducting a natural) resource damage assessment (NRDA) to assess and) restore Hudson River natural resources that may) have been)njured by polychlorinated biphenyls) (PCB) contamination.)

PCBs are a major concern because they persist) in the environment for many decades, can be) harmful at low concentrations, and accumulate)n) living creatures. PCBs pose)ealth)hazards to) Hudson River fish, mammals, birds, and)ther) wildlife and are found at concentrations)up to 1,000) times)greater than those considered protective)f) man) ealth)or the environment.)

This factsheet provides summary)nformation) about preliminary)nvestigations)on PCB)mpacts to) birds being)mplemented)under the NRDA.)

PCB Exposure and Effects

Many laboratory and (field studies (one (in other(parts of (the country have shown (the potentially(harmful effects of PCBs on (fish, birds, mammals,(and other wildlife. In birds, PCBs have been shown(to cause a (range of adverse (mpacts, (ncluding(disease, behavioral abnormalities, genetic muta-(tions, physical (deformities, changes (in brain(chemistry, (reduced hatching (rates, embryo mortal-(ity, and (eath.(

Purpose

There are (four preliminary (nvestigations (n(progress (that will (nform (he (trustees about (he(need (for and (design of (future avian (bird) (njury(studies (or (the Hudson River.((

1. Breeding Bird   rvey   Trustees will reviewP e P literature on P rd P undance Pin theP Hudson River. This study will help with selectingP bird species for possible Pinjury studies Pin theP future.P

2. A ian Egg Exposure tudy   Trustees will collectP eggs from Pa number of species of Hudson RiverP rds P nd Panalyze the eggs for contaminants. ThisP study Pincludes Pinstalling nest Pboxes. The study willP provide Pn Pindication of the exposure of thoseP species Pto PHudson PRiver Pcontaminants, PndP facilitate potential design of P   n P injury studies.P

3. A ian Exposure from Floodplains   Trustees willP survey the Hudson River floodplain to determineP where woodcock, robins, or other species PreP nesting Pand feeding. Trustees will Palso collect PndP analyze eggs, Pand possibly monitor nests PndP collect samples of young Pbirds. This study will helpP determine PCB exposure to P rds P   ng PndP feeding Pin the Hudson River floodplain, Pand theP need for future studies of floodplain-dependentP bird Pspecies.P

4. Bald Eagle Monitoring   Trustees will PmonitorP bald eagle nests Pin the Hudson River Parea forP reproductive success Pand potentially collect PndP nalyze Pblood samples. This study Ps Pa continuationP of work done previously Pby the USFWS PndP NYSDEC. It will help evaluate the possible effectsP contaminants have on eagle health, Pnd P d PnP determining the need for future PinjuryP determination Pstudies.P

Trustees will conduct preliminary   vestigations on bald eagles and other birds.

Investigators

The study (is being (mplemented by (he (ollowing(trustee agencies: (the U.S. Fish and Wildlife(Service, (the New York State Department of Envi-(ronmental Conservation, and (the National Oceanic(and Atmospheric Administration.(

For more information

www.darp.noaa.gov/neregion/hudsonr.htm
www.dec.state.ny.us/website/hudson/index.html

Kathryn Jahn - USFWS(
607-753-9334 x156(
kathryn_jahn@fws.gov(

Larry Gumaer - NYSDEC(
518.402.8971; (fax 518.402.9027(
lwgumaer@gw.dec.state.ny.us(

Lisa Pelstring - NOAA(
301.713.3038 x195; (fax 301.713.4387(
Lisa.Pelstring@noaa.gov(

Summer 2002w
Hudson River Natural Resource Damage Assessmentw

Preliminary Investigation of Snapping Turtles

The Hudson River Trustee Agencies—
assessing and restoring your natural resources

Past and continuing discharges of polychlorinated biphenyls (PCBs) aveS contaminated Hudson River naturalS resources. While the USEPA is continuingS with cleanup plans, federal and stateS trustee agencies are conducting a naturalS resource damage assessment (NRDA) toS assess and restore natural resourcesS injured by PCBs.S

This factsheet provides information aboutS a preliminary investigation of PCB impactsS to reptiles being implemented under theS NRDA.S

The Hudson River and its surroundingS abitat support many species of reptiles.S These animals spend a large part of theirS lives in contact with potentiallyS contaminated substances—water,S sediment, and soil—and consumeS potentially contaminated prey.S

Trustee agencies act on behalf of the public to restore natural resources jured by hazardous substances. To 4earn 4ore,4 lease 4ontact—4

Fred Caslick - USFWS4
607.753.9334
fred_caslick@fws.gov4

Lisa Pelstring - NOAA4
301.713.3038 x1954
Lisa.Pelstring@noaa.gov4

Larry Gumaer - NYSDEC4
518.402.89714
lwgumaer@gw.dec.state.ny.u4

www.darp.noaa.gov/neregion/hudsonr.htm

www.dec.state.ny.us/website/hudson/dex.html

http://contaminants.fws.gov/restorationplans/HudsonRiver.cfm

Snapping turtles (*Chelydra erpentina erpentina*), a particular reptile species,S are an important part of the HudsonS River food web. Snapping turtlesS consume vegetation and a wide varietyS of animal matter including insects,S crustaceans, clams, earthworms, fish,S frogs, snakes, small turtles, birds, andS small mammals. Young snapping turtlesS and turtle eggs are also prey for skunks,S snakes, birds, and other wildlife.S

w Exposure and ffectsw

Many laboratory and field studies done inS other parts of the country have shown theS potentially harmful effects of PCBs inS fish, birds, mammals, and other wildlife.S However, toxicological data on PCBS mpacts on reptiles are limited. omeS past turtle studies indicate that PCBsS may cause behavioral abnormalities,S biochemical alterations, and reducedS atching of eggs.S

urposew

Trustees are investigating the extent toS which snapping turtles in the HudsonS are exposed to PCB contamination.S Trustees collected eggs from snappingS turtles in June 2002 and are nowS analyzing these eggs for contamination.S These data will inform the trustees aboutS the need for future reptile studies.S

Five eggs per nest were collected.S Turtles generally produce large clutchesS of eggs yearly (averaging 15-50 eggs perS clutch). Females may lay more than oneS clutch per year. When the trusteesS collected the eggs, care was taken toS minimize disturbance to the turtles andS their nests.S

How can you help?w

The trustees would like to hear your ideasS for possible restoration projects in theS Hudson River valley. Please tell us aboutS habitats (wetlands, streams, etc.),S resources (fish, birds, or other wildlife), orS specific sites that could be restored orS enhanced. Contact one of the individualsS in the blue box if you have restorationS deas or for more information.S

Investigatorsw

The study is being implemented by theS trustee agencies—

- The U.S. Department of Interior,S
- New York State Department ofS Environmental Conservation, andS
- National Oceanic and AtmosphericS Administration.S

2002

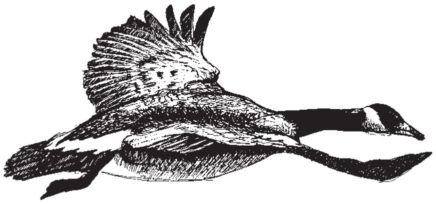
HUDSON RIVER NATURAL RESOURCE DAMAGE ASSESSMENT

SUMMARY OF THE DAMAGE ASSESSMENT PLAN

Polychlorinated biphenyls (PCBs) have polluted the Hudson River environment since the late 1940s. Two General Electric manufacturing facilities located in Fort Edward and Hudson Falls, New York, discharged up to 1.3 million pounds of PCBs into the river.

PCBs are a major concern because they last in the environment for many decades, low concentrations pose health hazards to humans, birds, fish, and mammals, and they accumulate in living creatures over time. The Hudson River is a Federal Superfund Site, and the U.S. Environmental Protection Agency has issued a Record of Decision calling for the removal of an estimated 150,000 pounds of PCBs from selected areas along a 40-mile stretch of the river between Hudson Falls and the Federal Dam at Troy, NY.

One State agency and two Federal agencies share responsibility for restoring the Hudson River's natural resources injured by PCBs. They are the New York State Department of Environmental Conservation, the National Oceanic and Atmospheric Administration, and the U.S. Department of the Interior. Collectively, these agencies are called "Trustees" and act on the public's behalf to assess and restore injured natural resources. This effort is called a Natural Resource Damage Assessment (NRDA).



CLEANUP AND RESTORATION

NRDA is different from EPA Superfund cleanup. EPA focuses on cleaning up or containing the PCBs to reduce present and future risks to human health and the environment. In a Natural Resource Damage Assessment, Trustees assess the past, current, and future PCB injuries to the resources. Trustees identify and plan restoration actions to address these injuries and the public's lost use of the resources.

NATURAL RESOURCES EXPOSED TO PCBS

The Trustees have determined that the following natural resources have been exposed to PCB contamination:

- Living resources, including fish, birds, mammals, amphibians, reptiles, invertebrates (insects, crabs), and plants,
- Surface water resources, including river sediments,
- Groundwater resources,
- Geologic resources, including floodplain soils, and
- Air resources.

THE NATURAL RESOURCE DAMAGE ASSESSMENT PLAN

As part of Hudson River damage assessment, the Trustees have completed a Damage Assessment Plan that provides information on the planned, current, or completed Trustee-sponsored studies of natural resources exposed to PCBs. Studies outlined in the Damage Assessment Plan may be considered as one of three types:

1>>> *Injury Determination*

Injury determination studies identify the natural resource injured from PCB exposure, how much of the resource has been injured, and the length of time the resource has been and will be injured.

2>>> *Pathway Determination*

Pathway determination studies document how PCBs move through the environment to the injured resource.

3>>> *Damage Determination and Restoration*

The Trustees analyze information gathered from studies and identify the best methods to restore the injured resources and lost human services provided by these resources.

Natural Resource Damage Assessment Studies

Below is a list of the planned, current, or completed studies being conducted by the Trustees for the Natural Resource Damage Assessment or NRDA.

Injury Determination Studies

Fish Injury Studies

1> *Fish Consumption Advisory*
NRDA regulations under which the Trustees operate define the existence of fish consumption advisories as an injury to the resource. The Hudson River has had advisories in place since 1976. To document this injury the Trustees have evaluated the history, dates, and geographic ranges of the advisories, including relevant species. This study is completed and can be viewed at www.dec.state.ny.us/website/dfwmr/habitat/nrd/index.htm

2> *Fish FDA Tolerance* To protect human health, the Food and Drug Administration (FDA) requires that fish containing PCB concentrations in excess of designated levels be removed from commerce. For PCBs, the current tolerance is 2 ppm in edible fish tissue. Fish are injured when PCB concentrations exceed this tolerance level. The Trustees will compare the fish tissue data available from previous New York State studies and other sources with the FDA tolerance to determine the extent of this injury.

3> *Fish Health Survey* To evaluate whether PCBs are affecting the health and viability of fish in the Hudson River, the Trustees are conducting a multi-phase study.

- ***Fish Health Reconnaissance Survey***
In 2001, the Trustees began assessing the prevalence of abnormalities in fish tissue and gross abnormalities to internal organs and external features of fish sampled from the river. The Trustees also collected fish tissue for future chemical analysis that may be carried out if the survey results suggest that fish are exhibiting these injuries.

- ***Effects of PCBs on Early Life Stages of Fish*** The Trustees are considering whether to examine any adverse effects of PCBs on early life stages and development of fish.

Bird Injury Studies

1> *Waterfowl Consumption Advisory*
New York State has issued a statewide advisory recommending limited consumption of wild waterfowl such as ducks and geese due to PCBs and pesticide contamination. The Trustees plan to evaluate what part of the contamination that led to the statewide advisory is attributable to PCBs from the Hudson River.

2> *Waterfowl FDA Tolerance* To protect human health, the FDA requires that poultry containing PCB concentrations in excess of safe levels be removed from commerce. For PCBs, this tolerance is 3 ppm. Waterfowl are injured when PCB concentrations exceed this tolerance level. The Trustees plan to compare available waterfowl tissue data with the FDA tolerance.

3> *Breeding Bird Survey* The Trustees have completed a preliminary investigation of the presence and relative abundance of the bird species found in the Hudson River Valley. This study will help the Trustees determine whether particular bird species are at risk from PCB contamination and whether future studies should be conducted.

4> *Bird Egg Survey* There is limited information on exposure of Hudson River bird species to PCBs, especially at sensitive early life stages. The Trustees are conducting a preliminary investigation of PCB concentrations in eggs from a number of species of Hudson River birds.

5> *Evaluation of Avian Exposure From Feeding on Floodplain* The Trustees plan to survey the Hudson River floodplain to identify areas being used by certain bird species for nesting and feeding. This preliminary analysis could help determine whether species that live and feed in the floodplain have been exposed to PCBs and determine the need for future studies of floodplain-dependent bird species.

6> *Bald Eagle Monitoring* The Trustees are monitoring bald eagle nests for reproductive success and potentially collecting and analyzing blood samples to evaluate possible adverse effects from PCBs.

Mammal Injury Studies

1> *Mink and Otter Health* The Trustees plan to build upon existing NYSDEC mink and otter studies to determine PCB effects in these organisms.

2> *Bat Exposure* The Trustees plan to analyze PCB concentrations in bats that have been collected to assess the extent and severity of PCB exposure.

Reptile Injury Studies

1> *Snapping Turtle Consumption Advisory* New York State has issued a statewide advisory recommending limited consumption of snapping turtles due to PCB contamination. NRDA regulations under which the Trustees operate define the advisory as an injury to the resource. The Trustees plan to evaluate what part of the contamination that led to the statewide advisory is attributable to PCBs from the Hudson River.

2> *Snapping Turtle Health* The Trustees plan to collect and analyze snapping turtle eggs to assess potential PCB impacts and whether the eggs are a pathway for PCB contamination to other reptiles, birds, etc.

Water Quality and Sediment Injury Studies

1> *Water Quality Evaluation* Previous studies showed that PCBs in the Hudson River consistently exceeded water quality standards. NRDA regulations define exceedances of such State or Federal standards as an injury to the surface water. To document the injury to surface water resources, the Trustees are comparing existing water quality data with established water quality standards. The Trustees are also making a determination of the extent to which living resources have been injured by exposure to the surface water.

The Hudson River Trustee agencies — assessing and restoring your natural resources

2> *Sediments Characteristic of Solid Waste* The Trustees plan to evaluate existing Hudson River sediment data to determine if they exceed criteria for PCB levels specified under the Solid Waste Disposal Act. If the sediment exceeds SWDA criteria, this would also constitute an injury to surface water.

3> *Sediments Injury: Pathway and Biota* The Trustees may investigate whether PCB concentrations in sediments are sufficient to cause injury to other natural resources that are exposed to the sediments. The Trustees may compare Hudson River sediment data with existing scientific studies that examine PCB thresholds and effect levels to document where and when the sediments exceed these thresholds and effect levels.

Groundwater Injury Study

The Trustees plan to compile existing information regarding the presence of PCBs in groundwater resources in and around the Hudson River and compare that information to Federal and State water quality standards established for PCBs.

Geologic Resource Injury Study

The Trustees plan to compile existing information regarding the presence of PCBs in geologic resources, such as floodplains, in and around the Hudson River to determine if they exceed PCB criteria and standards specified in the Solid Waste Disposal Act and the Toxic Substance and Control Act. Geologic resources are injured when concentrations of PCBs exceed these standards.

Air Resource Injury Study

The Trustees may investigate existing information regarding the presence of PCBs in the air around the Hudson River to determine whether there are exceedances of air quality standards under the Clean Air Act or other Federal or State air standards.

Pathway Determination Studies

1> *PCB Source Evaluation* The Trustees are conducting a screening-level analysis of available data on sediment chemistry, sediment transport and deposition, fish tissue chemistry, and PCB loadings to the Hudson River. This analysis will allow the Trustees to make preliminary determinations regarding the relative PCB contribution from upriver sources.

2> *Foodweb Pathway Evaluation* The Trustees may develop studies to explore how PCBs move through the Hudson River foodweb from sediment-dwelling organisms to fish and wildlife.

3> *Floodplain Evaluation* In 2000, the Trustees conducted a preliminary investigation from Fort Edward to Stillwater and identified PCB contamination in floodplain soils and in small mammals. Floodplains are land areas next to rivers and streams that are periodically inundated by water. Preliminary results indicate that PCB concentrations in floodplain soils in the 20 miles downstream of Fort Edward ranged from undetected to 360 parts per million (ppm). The Trustees expanded this investigation in 2001 to refine the areas and species that may be exposed to PCBs in floodplains.

Damage Determination and Restoration Studies

1> *Recreational Fishing Lost Use Study* The Trustees are assessing the value of the lost use of the recreational fishery, specifically examining how fishing restrictions and consumption bans in the Hudson River affect angler behavior.

2> *Habitat Equivalency Analysis* The Trustees may conduct a Habitat Equivalency Analysis, which will help determine how much restoration is needed to address the injured resources from the date of the PCB release until recovery.

3> *Lost Navigational Services* The Trustees will determine the extent to which PCB-contaminated sediments have caused reduced navigational dredging resulting in decreased recreational and commercial boat traffic on the river, and the increases in costs of such dredging attributable to the PCB contamination.

4> *Assessment of Impacts to National Park Sites and Affiliated Areas* The Trustees plan to investigate whether the presence of PCBs has adversely impacted visitor use and perceptions and agency management plans for parks and historic sites in the Hudson River Valley.

Hudson River Damage Assessment Plan

How can I help?

You can obtain a copy of the Damage Assessment Plan and provide Trustees with your comments about our proposed approach to assess natural resource injuries. The plan is also located at information repositories throughout the state. Call Steven Sanford at 518.402.8996 for a location near you.

To receive a copy of the Damage Assessment Plan, please contact one of the individuals listed here or download a copy from one of the following websites:

www.darp.noaa.gov/neregion/hudsonr.htm
www.dec.state.ny.us/website/hudson/index.html
http://contaminants.fws.gov/restorationplans/HudsonRiver.cfm

The Trustees would also like to hear your ideas for possible restoration projects in the Hudson River Valley. Please tell us about habitats (wetlands, streams, etc.), resources (fish, birds, or other wildlife), or specific sites that could be restored or enhanced. Contact one of the individuals listed below to submit restoration project ideas.

How do I find out more?

Steven Jay Sanford
NYS Department of Environmental Conservation
625 Broadway, 5th Floor
Albany, NY 12224
518.402.8996
fax 518.402.8925
sxsanfor@gw.dec.state.ny.us

Lisa Pelstring
National Oceanic and Atmospheric Administration
1305 East West Highway SSMC4
Silver Spring, MD 20910
301.713.3038 x195
fax 301.713.4387
Lisa.Pelstring@noaa.gov

Fred Caslick
US Fish and Wildlife Service
3817 Luker Road
Cortland, NY 13045
607.753.9334
fax 607.753.9699
fred_caslick@fws.gov

Hudson River Natural Resource Trustees
NYSDEC
652 Broadway, 5th Floor
Albany, NY 12224

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