

UNITED STATES
DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Northeast Region
State, Federal & Constituent Programs Division

COMPLETION REPORT

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Project Title: FISHERY MANAGEMENT PLAN IMPLEMENTATION INITIATIVE

Period Covered: 01/01/96 - 12/31/96

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Approved by: _____

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Statutory Funding Authority: Anadromous Fish Conservation Act
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- ☒ Chesapeake Bay Studies
- ☐ Endangered Species Act
- ☐ Interjurisdictional Fisheries
Act (Title III of P.L. 99-659)
- ☐ Magnuson Act
- ☐ Oyster Disease Research
- ☐ Saltonstall-Kennedy
- ☐ Unallied Industry Projects
- ☐ Unallied Science Projects

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ANNUAL COMPLETION REPORT
January 1, 1996 - December 31, 1996
FOURTH QUARTERLY REPORT
October 1, 1996 - December 31, 1996

Recipient: Maryland Department of Natural Resources, Fisheries Services
Award #: NA66FU0122
Accounting Code: 6FM1400/RL1AHR6F/4119
Award Period: January 1, 1996 - December 31, 1996
Project Title: Fishery Management Plan Implementation Initiative

TECHNICAL REPORT

Overview

The Department of Natural Resources maintains a Home Page on the World Wide Web. Fisheries issues dominate the interest of those accessing the Department's page. The staff contributes to the Home Page with monthly updates of commercial and recreational legislation and regulation. Plans are to place the Fisheries Habitat Linkage document on the Internet. The individual species Fact Sheets are scheduled for revision and placement on the DNR Home Page. Maryland fisheries information may be accessed via www.gacc.com/dnr/.

Public meetings were conducted for tautog, scup, black seabass, king mackerel and spanish mackerel. Staff presented information on biology, habitat, fisheries, and coastal management. Further information is provided under the specific species heading below.

A review of the blue crab stock assessment developed by the Chesapeake Bay Stock Assessment Committee (CBSAC) was completed and culminated in a day long discussion in December 1996. Concerns from stock assessment scientists remain. The Blue Crab Fishery Management Plan will be completed during the next quarter and shall include recommendations from the CBSAC assessment.

Fisheries Habitat

Work continued throughout the quarter on the Habitat Linkages Document. A meeting of the FMP Habitat Workgroup was held November 21 to report on the progress of the group and reaffirm direction. In addition to a written report, a plan for formatting the document for use on the Internet was discussed. On the Internet, it was determined that the document would be most useful as a reference tool equipped with a search engine that could access a bibliography of references via key words. A permit reviewer, land use planner, or interested citizen could tailor the search to fit their specific information needs and access literature references, addresses, and contact points quickly and easily. The annotated bibliography will be prefaced with introductory text, following the format of the original Linkage Document outline, for those who are interested in the general concepts of human activities in the watershed as they impact fisheries. The text will also be embedded with key words that the user can select for further information or a list of references and contacts. Text was received by authors; however, sections are in draft form and have not been formatted into a single, flowing document. The current listing of references collected by FMP staff and a list of cross references, which will eventually become the key words used for Internet searches is attached. Collection of references continues.

Staff participated in the Marine and Estuarine Shallow Water Conference in Atlantic City, NJ, during November to collect references and establish contacts which will enhance the habitat effort.

Atlantic Sturgeon

A time line for the Chesapeake Bay Atlantic Sturgeon Restoration Plan was developed. A copy is enclosed. The first draft of Amendment #1 to the Atlantic States Marine Fisheries Commission should be completed in January with final approval by May. The first draft of the Bay's Sturgeon Restoration Plan should be available for review by April with a finished document by the 1997 Executive Council meeting. Literature continues to be obtained and reviewed. A Sturgeon Workgroup will be organized in January and begin writing the first draft.

American Eel

Staff participated in the ASMFC meeting for the development of the ASMFC Eel FMP which is scheduled for completion during 1997.

Black Sea Bass

Copies of the Chesapeake Bay and Atlantic Coast Black Sea Bass FMP are available from this office and the Chesapeake Bay Program office. A copy is enclosed. Specific management actions include a 9 inch minimum size limit, a 4.0 inch minimum mesh size for trawlers harvesting more than 100 pounds, and escape vents, biodegradable hinges and biodegradable fasteners for black sea bass pots.

Blue Crab

On December 10, results of the CBSAC blue crab stock assessment were presented to Chesapeake Bay scientists and managers for review and comment. FMP staff attended the presentation. The Chesapeake Bay Commission Bi-state Blue Crab Advisory Committee will be providing comments on the Draft Blue Crab FMP before completion scheduled for next quarter.

Catfish

A fact sheet has been prepared for catfish and includes the five species addressed in the Technical

Report. A copy of the draft is enclosed. The more recently prepared fact sheets will be formatted for the Department's Home Page on the Internet. The catfish fact sheet will be one of the first to be offered over the Internet.

Menhaden

The biological background section has been drafted for a Maryland Atlantic Coast Menhaden FMP. The resource is currently managed under an ASMFC FMP. Several meetings have been held to discuss the impacts of opening Maryland state waters (2 to 3 miles offshore) to purse seining.

Scup

Regulations are under consideration for scup in Maryland. The current 7 inch minimum size for scup is inadequate and should be raised to 9 inches. Rather than a full FMP, Maryland regulations could be amended under the "In Need of Conservation" provision in the law. Regulations are expected to be promulgated next quarter.

Striped Bass

The first draft of the habitat section of Amendment #1 to the Chesapeake Bay Striped Bass FMP was reviewed by the FMP Workgroup. The Workgroup agreed that the early life stages (eggs, larvae, and juveniles) of striped bass are most critical. Additional literature and comments have been received pertaining to these life stages and are being incorporated into the amendment. The next step will be for the Workgroup to identify those habitat requirements that are essential for these early life stages. The present status of these habitat parameters will be examined for each major spawning tributary of the Chesapeake Bay. The results of this work and help from other Living Resources Workgroups will aid in the development of habitat management strategies. Additional literature has been received since the first draft. This information is currently being reviewed.

Summer Flounder

Amendment #1 to the 1991 Chesapeake Bay Summer Flounder FMP has been finalized by the FMP Workgroup. The amendment was developed to equitably allocate the coastwide harvest of summer flounder. Currently, the Atlantic coastal states manage the summer flounder resource under a quota system. Maryland has been allocated 2% of the total coastal harvest based on historical landings. The amendment adds language which will allow the Chesapeake Bay states to maintain the traditional commercial fishery by requiring a special landings permit. The jurisdictions will develop, define, and adopt criteria to determine eligibility for participation in the fishery. The amendment was reviewed by the Living Resources Subcommittee at the November meeting. The Amendment is out for public review and comment. Since this is considered a minor amendment to the plan, the Principal Staff Committee of the Chesapeake Bay Program can complete the amendment without the signature of the Executive Council. Regulations have been proposed for a size increase and a special summer flounder landing permit.

Tautog

Currently, there is no minimum size limit or creel limit for tautog. A minimum size limit of 13 inches by April 1997 and 14 inches by April 1998 has been recommended for this species. A draft FMP has been prepared for the Chesapeake Bay by the Virginia FMP staff. Maryland staff are expected to add more recent information and complete the final draft consistent with ASMFC compliance requirements.

Fisheries Allocation

The first meeting for Fisheries Allocation convened December 5, 1996. Participants included members from within DNR and the facilitator, Joe Farrell from the University of Delaware. The purpose, scope, and function of the Allocation Committee were determined. The primary objective of the Allocation Committee will be to develop a protocol for Maryland by which to address fishery allocation issues in the Chesapeake Bay and Atlantic coast within the State's jurisdiction. Fisheries allocation is expected to become a major issue before the Maryland legislature in 1997.

Fishery Management Plan Annual Progress Report

A draft of the 1995 Annual Progress Report for FMPs is under review by the Virginia staff. The report reviews the progress of management plans during 1995 and includes the current stock status, fishery updates and progress towards implementing management recommendations on 13 plans covering 19 species. The FMP staff has coordinated with the Chesapeake Bay Program to update environmental indicator slides for alosids, oysters and striped bass. This information is used during public forums to indicate the current state of the Bay.

cc: George Herlth



Chesapeake Bay Coastal Ecosystems Program

Atlantic Sturgeon

DEPARTMENT OF THE INTERIOR • U.S. FISH AND WILDLIFE SERVICE

Atlantic Sturgeon (*Acipenser oxirinchus*) – A Resource at Risk

Along the Atlantic Coast from Canada to Florida, a prehistoric creature still lives. With bony plates covering its head and five rows of bony shields, or scutes, covering the body, this primitive fish, the Atlantic sturgeon, has existed since dinosaurs roamed the earth 150 million years ago.

No small fry, this fish may weigh as much 800 pounds and reach lengths of 15 feet. The fish's distinguishing features include a soft toothless mouth, located on the underside of a long hard snout, and four sensory threads, called barbels, projecting from the mouth. The dorsal and anal fins are located far back on the body, and the upper lobe of the tail is much longer than the lower.

During the late 1800s and early 1900s, Atlantic sturgeon was an important commercial fish in Chesapeake Bay, as well as other bays and rivers along the Atlantic Coast. Today, less than 90 percent of the historic population of Atlantic sturgeon survives. Primary causes for the decline include overfishing, damming of rivers and degradation or loss of habitat.

Life as an Atlantic Sturgeon

The Atlantic sturgeon is an anadromous fish, meaning it spends most of its life in brackish or salt water and migrates into freshwater to spawn. They may live to 60 years of age. Atlantic sturgeon mature very slowly. Sexually mature males are at least 11 to 12 years old and weigh up to 100 pounds, while mature females are 18 to 20 years old and weigh more than 100 pounds.

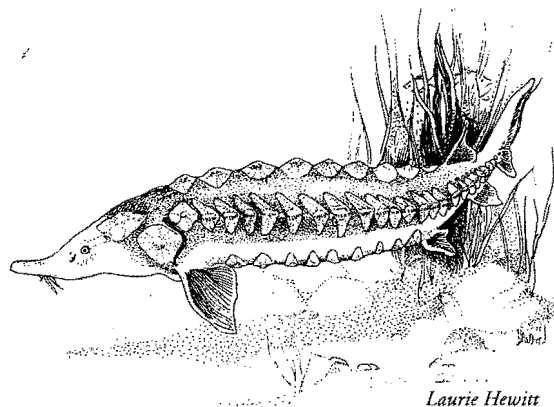
Males migrate into freshwater during March and April, one month before females. They do not school together but meander singly. Females begin spawning as soon as they reach spawning grounds. Females lay 1 million to 2½ million eggs in flowing water up to 60 feet deep. Both males and females may remain in the river until late fall before migrating back to the Atlantic. After hatching, the young tend to remain in their natal areas up to five years before beginning their journey to the ocean. Immature Atlantic sturgeon may also wander in and out of the Atlantic coastline.

Sturgeon use their snouts and barbels to root around in bottom sediments, vacuuming up organisms with their soft mouths. Their diet consists of worms, snails, shellfish, crustaceans and small fish, as well as large amounts of mud and debris.

Other than sharks and people, sturgeon have few predators. Today, the majority of sturgeon are taken from the Hudson River fishery or as incidental catch in other fisheries before reaching maturity. Biological characteristics of the Atlantic sturgeon, such as slow growth, advanced age at maturity, and long periods between spawning, make it particularly vulnerable to overfishing and other human-induced impacts and changes to its habitat.

Cause For Concern

Harvesting Atlantic sturgeon was an important industry from colonial times to the turn of the century. During the 17th century, sturgeon meat, eggs and oil were exported to Europe. The most valuable part of the fish was its eggs, or roe. Prepared as caviar, this delicacy was in high demand in Europe. The delicate meat, comparable to pork or swordfish, was smoked and eaten. Even sturgeon air bladders were valuable. They were used to make isinglass (a clear gelatin), jellies, clarifying agents for beverages, plasters, waterproofing agents, adhesives and lubricants. By 1850 sturgeon meat and roe became popular in this country as well. By the late 1800s, landings as high as 7 million pounds were reported for all the states, collectively.



Traditionally, Atlantic sturgeon fishermen worked the Hudson River in New York, the Susquehanna River in Pennsylvania, the Delaware River in Delaware, the Potomac and St. Mary's rivers in Maryland, and the York and James rivers in Virginia. They used large drifting gill nets, some 1,500 feet long and 21 feet deep with a mesh of 13 inches.

By the 1920s, the average annual harvest was reduced by more than 90 percent with total landings reported at only 22,000 pounds. In the Chesapeake Bay, sturgeon catch peaked in 1890s at a record level of more than 700,000 pounds. Now in the Chesapeake Bay, sturgeon are being caught at levels probably less than 2,200 pounds.

Today, sturgeon are still caught with gill nets, haul seines, pound nets and weirs. Fishing seasons generally occur during spring spawning migrations and some fall migrations. Fishing occurs in the Hudson River and along the Atlantic coast with size limits and/or pound quotas. Harvests are but a fraction, less than 10 percent, of the peak harvests a century ago.

Restoring Atlantic Sturgeon

Restoration and management of Atlantic sturgeon are underway. Because so little is known about the migration patterns of Atlantic sturgeon, the U.S. Fish and Wildlife Service, in partnerships with several states, has initiated a program to tag wild sturgeon along the Atlantic Coast and the Gulf of Mexico. People who catch a tagged fish and report tag numbers to the Service receive a reward. In this way, individuals help provide information to biologists who are tracking distribution, mortality, age, growth and coastal migration patterns of the fish.

Other restoration efforts include producing hatchery-reared fish, for further study and for possible release into the wild, and raising the minimum size limit of capture. Maryland and Delaware have placed a 7-foot size limit on their Atlantic sturgeon fisheries. The District of Columbia, Pennsylvania and Virginia have

closed their Atlantic sturgeon fisheries. In the Chesapeake Bay, no Atlantic sturgeon greater than 7 feet have been caught since 1970.

The Future of the Fish

It will take more than reducing fishing pressure and restocking fish to bring the Atlantic sturgeon back. Habitat quality is crucial to the survival of the species. For instance, increased development and deforestation has reduced the amount of forest litter (decaying organic matter found on the forest floor) entering streams and rivers. Forest litter is necessary for egg attachment and survival.

Water quality is also critical to the survival of adults and juveniles. Excessive amounts of nutrients in waterways can create sudden blooms of phytoplankton. After the phytoplankton die, decomposition uses up large amounts of oxygen. This can lead to dangerously low dissolved oxygen levels along the bottom where eggs and larvae grow and sturgeon feed.

Like all anadromous fish, Atlantic sturgeon must have access to their spawning grounds. By removing blockages or altering the design of dams to accommodate fish passage, sturgeon can reach the upstream areas critical to their reproduction.

With citizens working in cooperation with local, state and federal agencies to lower fishing mortality, reduce pollution, provide fish passage and possibly enhance stock through hatchery production, the Atlantic sturgeon may once again become a vital and familiar part of the Chesapeake Bay heritage.

For more information contact:

U.S. Fish and Wildlife Service
Chesapeake Bay Field Office
177 Admiral Cochrane Drive
Annapolis, Maryland 21401
(410) 573-4500

U.S. FISH AND WILDLIFE SERVICE

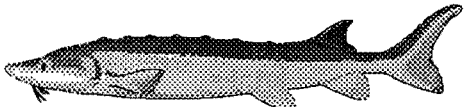
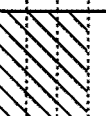
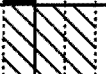
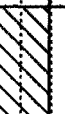
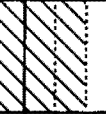
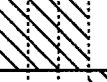
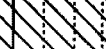
The U.S. Fish and Wildlife Service provides the federal leadership to conserve, protect and enhance fish and wildlife resources and their habitat for the continuing benefit of people.

The Service manages more than 500 national wildlife refuges, representing the most comprehensive wildlife habitat management effort in the world. The Service also manages national fish hatcheries, enforces federal wildlife laws and international treaty obligations, and provides leadership in habitat protection.

National resources entrusted to the Service for conservation and protection are: refuges, migratory birds, fishery resources, threatened and endangered species, wetland resources, and certain marine mammals.

The Service's Northeast Region encompasses 13 states from Maine to Virginia with more than 100 field offices. Headquarters for the region are located in Hadley, Massachusetts.

Chesapeake Bay Atlantic Sturgeon Restoration Plan Timeline (1/2/97)

ACTIVITY NAME	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT
MD FMP staff prepares outline and develops working group.										
ASMFC Plan Development Team prepares 1st draft of Amend. #1										
FMP Wkgrp. prepares 1st draft and distributes to LRSc.										
LRSc reviews 1st draft and sends comments to MD FMP staff.										
MD FMP staff incorporates comments and sends draft to IC & FMP Wkgrp..										
ASMFC Amend. #1 is approved.										
IC reviews draft and sends comments to MD FMP staff.										
MD FMP staff incorporates comments and gets approval by FMP Wkgrp. to send to LRSc.										
LRSc reviews revised draft and sends comments to MD FMP staff.										
MD FMP staff incorporates comments, gets approval by FMP Wkgrp., and sends to IC and PSC.										
IC and PSC reviews draft and sends comments to MD FMP staff.										
MD FMP staff makes revisions, gets approval by FMP Wkgrp., and sends to LRSc.										
LRSc approves final draft.										
Final draft distributed to IC and PSC for approval.										
Chesapeake Bay Atlantic Sturgeon Restoration Plan signed by EC										

Chesapeake Bay Program

Three species of catfish are native to the Chesapeake Bay system and include white catfish (*Ictalurus catus*), brown bullhead (*I. nebulosus*), and yellow bullhead (*I. natalis*). Two introduced species, channel catfish (*I. punctatus*) and blue catfish (*I. furcatus*), have become important economically. Channel catfish are established in the upper Bay and tributaries throughout the Bay system and blue catfish, once considered rare, are becoming increasingly abundant in several tributaries. A third introduced species, flathead catfish (*Pylodictis olivaris*), has only a limited distribution in the Potomac River.

History of Distribution

Channel catfish were first stocked in the Potomac River system during 1889-1905 and the Upper James River during 1893-1894. Stocking practices in Maryland and Pennsylvania led to the current status of channel catfish as the dominant *Ictalurid* species in the Upper Chesapeake Bay, Susquehanna Flats, and northern tributaries.

Channel Catfish



Young channel catfish are easily identified by their spotted skin, but lose their markings as they grow older. Look for a deeply forked tail. Also, compare the rounded anal fin to the sharp-edged anal fin of the blue catfish.

Blue catfish were stocked in the mid 1970s and 1980s in Virginia tributaries and numbers have been steadily increasing. In the Potomac River, sightings of blue catfish have been random to increasingly common, though documentation of their introduction is sketchy. Surveys in Virginia reveal that blue catfish are most abundant in upper, freshwater portions of tributaries, while downstream, white catfish are the dominant species. Beyond their introduced range, blue catfish are not present in Maryland, Pennsylvania or isolated tributaries of Virginia.

Flathead catfish are introduced to the Chesapeake Bay system in the Potomac, James and Roanoke Rivers.

Biology

Catfish are a warmwater species that are tolerant of cold temperatures during winter months. They become active in early spring, as water temperatures begin to warm, and spawn from late spring through early summer. Nests are often near structure such as logs or underneath banks where males clear the area of debris and guard the gelatinous egg mass until they hatch.

Catfish are opportunistic, which means they will eat whatever food is available. Common food items include aquatic plants and seeds, small fish, molluscs, insects and their larvae, and crustaceans.

While catfish have only average eyesight, their barbels, or "whiskers", are well-equipped with taste buds which help them find food at night and in muddy waters. In addition, catfish have taste buds on their skin and gills and in their mouth, and can detect even the smallest molecules, or "flavors", in the water. Catfish also use olfactory senses, much like our sense of smell, to recognize other catfish.

Channel and flathead catfish typically seek cover during the day and move from deep, sheltered areas to shallow areas at night to feed. Brown bullheads have been observed submerged in sediments, with only their face and barbels exposed, lying in wait for unwary prey.

Size Limits

Maryland

Channel catfish: 10"
White catfish: 10"
Bullheads: No limit

Washington, D.C.

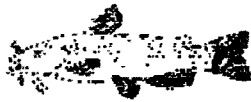
Channel catfish
Blue catfish
Brown Bullheads

* *Journal of the American Academy of Child and Adolescent Psychiatry*, 1997, 36:101-108.

Commercial Fishery

In 1929, prior to channel catfish introductions, white catfish were commercially harvested in Maryland for the food market. An estimated 90% of all present-day catfish landings in Maryland are channel catfish and their largest market is for stocking sportfishing ponds in the midwest and eastern mountain states. Catfish landings in Maryland rank second in weight of all commercial finfish species, next to menhaden, and average 1.7 million pounds per year.

Commercial catfish harvest in Virginia averages 8 million pounds per year. Species of commercial importance in Virginia mainly include channel and blue catfish. When harvested for human consumption, blue catfish are preferred by some buyers because they are easily skinned and yield white, attractive filets. However, commercial harvesters that sell to the live market do not welcome the presence of blue catfish due to their aggressive nature and high mortality when held in confinement. Yellow bullheads are not commercially targeted; however, brown bullheads have a small, specialized market in both Maryland and Virginia.



White Catfish

White catfish have a large head and grow to 24 inches.

Brown Bullhead

Brown bullheads have a square, slightly notched tail. Yellow bullheads have a rounded tail with no notch.



Recreational Fishery

Catfish are prized by anglers for both their culinary value and trophy size potential. Catfish rank third in angler preference nationally, and Virginia anglers spent an estimated 6.2 million days pursuing catfish in 1985. With the increased size and abundance of blue catfish in Virginia has also spawned a growing sport tournament industry. In Maryland, channel catfish ranks fifth for all finfish species kept by anglers statewide and Washington, D.C., supports significant angler activity for brown bullheads and channel catfish.

Blue Catfish



Blue catfish grow larger than any other catfish in Chesapeake Bay. The largest fish caught in Virginia weighed in over 60 pounds.



ANNOTATED BIBLIOGRAPHY

Able, K. And S. Kaiser. 1994. Synthesis of Summer Flounder Habitat Parameters. NOAA Coastal Ocean Program Decision Analysis Series No. 1. NOAA Coastal Ocean Office, Silver Spring, MD. Phone: (301) 713-3338.

Summer flounder distribution, life history patterns, and habitat requirements for each life history stage for the Atlantic coast and estuaries. Maps are large scale for the Atlantic Coast and smaller scale for Pamlico-Albemarle and Long Island Sounds.

Alliance for the Chesapeake Bay. 1993. Nutrients and the Chesapeake: Refining the Bay Cleanup Effort. Chesapeake White Paper. Baltimore, Richmond and Harrisburg. 1-800-662-CRIS. e-mail: cris@igc.apc.org

Written for citizens and laypersons. Describes human development of the Chesapeake Bay watershed, the resultant problems from nutrient runoff into the estuary, efforts to reduce nutrient loads by 40%, and an evaluation of what more needs to be done to meet the 40% goal. Maps: target nitrogen reductions by tributary and region.

Bohnsack, J. 1992. Reef resource habitat protection: the forgotten factor. In: Stroud, 1992; pages 117-129.

Overview of reef ecology, importance of reef habitats, and threats to reef habitat.

Bozeman, E. and J. Dean. 1980. The abundance of estuarine larval and juvenile fish in a South Carolina intertidal creek. *Estuaries*. 3(2):89-97.

Sampled the fall and winter population of larval fish in a small intertidal creek. Five species comprised 99.3% of the fish captured.

Breitburg, D. 1994. Behavioral response of fish larvae to low dissolved oxygen concentrations in a stratified water column. *Mar. Biol.* 120:615-625.

Effects of low oxygen gradients on distribution and survival of fish larvae in Chesapeake Bay; effects of exposure to low oxygen over 24 hours.

CBP (Chesapeake Bay Program). Chesapeake Bay Program Office, Annapolis, MD. 1-800-YOUR BAY. <http://www.epa.gov/r3chespk/>

1995, a. Chesapeake Bay Habitat Restoration: A Framework for Action.

Identifies four target habitat areas for restoration in Chesapeake Bay for specific living resources and provides an implementation framework for protecting and restoring the four target areas (target habitats: freshwater tributaries, tidal shallow water, tidal open water, and islands and inlands). Summarizes federal and state programs involved in habitat restoration and conservation.

1995, b. Guidance for Protecting Submerged Aquatic Vegetation in Chesapeake Bay from Physical Disruption.

Recommends protective measures for state and federal agencies to consider in their decision making process to prevent physical disruption of SAV in Chesapeake Bay. Specific issues include dredging, development, mitigation, water quality, shoreline stabilization and use of shallow water areas. Includes a list of current protective policies and guidelines and a list of existing regulations.

1993, a. Implementation Plan for Removing Impediments to Migratory Fishes in the Chesapeake Bay Watershed.

Outlines fish passage initiatives in jurisdictions of Chesapeake Bay, progress made, and future plans for implementation. Maps: Fish passage projects completed in Maryland and Virginia in 1993.

1992, a. Submerged Aquatic Vegetation Habitat Requirements and Restoration Targets: A Technical Synthesis.

SAV and water quality relationships, habitat requirements and restoration targets. Reports on regional examinations of SAV in the upper Chesapeake Bay, upper Potomac River, Choptank River and York River. Maps: Restoration target areas, historic SAV distribution, SAV monitoring stations.

CEC (Chesapeake Executive Council). Chesapeake Bay Program Office, Annapolis, MD. 1-800-YOUR BAY. <http://www.epa.gov/r3chespk/>

In preparation, a. Chesapeake Bay Blue Crab Fishery Management Plan.

Life history, habitat requirements, fishery, stock status, problems and concerns, management strategies, laws and regulations in Chesapeake Bay. Updated annually in Chesapeake Bay Program Fishery Management Plans Annual Progress Report. Maps include life history, distribution of SAV settlement and nursery habitat, and dissolved oxygen limitations.

In preparation, b. Chesapeake Bay and Atlantic Coast Tautog Fishery Management Plan.

Life history, habitat requirements, fishery, stock status, problems and concerns, management strategies, laws and regulations in Chesapeake Bay and the adjacent Atlantic coast. Updated annually in Chesapeake Bay Program Fishery Management Plans Annual Progress Report. Maps include ...

1996. Chesapeake Bay and Atlantic Coast Black Sea Bass Fishery Management Plan.

Life history, habitat requirements, fishery, stock status, problems and concerns, management strategies, laws and regulations in Chesapeake Bay and the adjacent Atlantic coast. Updated annually in Chesapeake Bay Program Fishery Management Plans Annual Progress Report. Maps include ...

1995, a. Local Government Partnership Initiative.

Signed by the Governors of Bay jurisdictions, the mayor of Washington, DC, the administrator of the US EPA, and the chair of the Chesapeake Bay Commission. The Initiative formally recognizes the importance of local governments in achieving Chesapeake Bay restoration goals and outlines initiatives for including local governments in the Chesapeake Bay Program's restoration effort.

1994, a. Chesapeake Bay and Atlantic Coast Horseshoe Crab Fishery Management Plan;

1994, b. Chesapeake Bay and Atlantic Coast Spanish and King Mackerel Fishery Management Plan;

1994, c. Chesapeake Bay Oyster Fishery Management Plan.

Life history, habitat requirements, fishery, stock status, problems and concerns, management strategies, laws and regulations in Chesapeake Bay and the adjacent Atlantic coast. Updated annually in Chesapeake Bay Program Fishery Management Plans Annual Progress Report. No maps.

1994, d. Aquatic Reef Habitat Plan.

Plan for restoration and management of oyster reef habitat and other hard substrate for enhanced reef community development in Chesapeake Bay. Includes history of reef habitat in Chesapeake Bay, framework for restoration and enhancement, technical issues of design, management issues, research and monitoring. Maps: reef sites in Chesapeake Bay, oyster bed locations, public oyster and clam grounds, oyster restoration areas, and bathymetry data.

1994, e. Chesapeake Bay Basinwide Toxics Reduction and Prevention Strategy.

Outlines Baywide strategies for reducing and controlling toxic contamination in Chesapeake Bay through directed toxics assessments, regulatory program implementation, and pollution prevention.

1993, a. Chesapeake Bay Black Drum Fishery Management Plan;

1993, b. Chesapeake Bay Red Drum Fishery Management Plan.

Life history, habitat requirements, fishery, stock status, problems and concerns, management strategies, laws and regulations in Chesapeake Bay and the adjacent Atlantic coast. Updated annually in Chesapeake Bay Program Fishery Management Plans Annual Progress Report. No maps.

1993, c. Chesapeake Bay Strategy for the Restoration and Protection of Ecologically Valuable Species.

A strategic plan to view the Bay as an ecosystem, composed of biological communities that interact with their surroundings to function as a single unit. Management recommendations address: habitat requirements and species interactions in fishery management plans, habitat goals in nutrient reduction plans, education and outreach, ecosystem indicators and their use in management, ecosystem modeling efforts, habitat restoration and management, and research priorities.

1991, a. Chesapeake Bay American Eel Fishery Management Plan;

1991, b. Chesapeake Bay Atlantic Croaker and Spot Fishery Management Plan;

1991, c. Chesapeake Bay Summer Flounder Fishery Management Plan.

Life history, habitat requirements, fishery, stock status, problems and concerns, management strategies, laws and regulations in Chesapeake Bay and the adjacent Atlantic coast. Updated annually in Chesapeake Bay Program Fishery Management Plans Annual Progress Report. No maps.

1990, a. Chesapeake Bay Bluefish Fishery Management Plan;

1990, b. Chesapeake Bay Weakfish and Spotted Seatrout Fishery Management Plan.

Life history, habitat requirements, fishery, stock status, problems and concerns, management strategies, laws and regulations in Chesapeake Bay and the adjacent Atlantic coast. Updated annually in Chesapeake Bay Program Fishery Management Plans Annual Progress Report. No maps.

1990, c. Draft Chesapeake Bay Wetlands Policy Implementation Plan.

Recommends short-term actions to protect existing wetlands and long-term actions to protect and create wetlands in the future by providing better information about the functions and locations of wetlands and increasing coordination and consistency among multiple Bay agencies.

1989, a. Chesapeake Bay Alosid Fishery Management Plan;

1989, b. Chesapeake Bay Striped Bass Fishery Management Plan.

Life history, habitat requirements, fishery, stock status, problems and concerns, management strategies, laws and regulations in Chesapeake Bay and the adjacent Atlantic coast. Updated annually in: a) Chesapeake Bay Program Fishery Management Plans Annual Progress Report; b) 1990-1994, Chesapeake Bay Striped Bass Fishery Management Plan Annual Progress Report; 1995-current, same as a. No maps.

1989, c. Chesapeake Bay Watershed Development Policy and Guidelines.

Summarizes effects of development on water quality and living resources. Provides six development policies, followed by guidelines, for developing land in a manner which reduces adverse impacts on water quality and living resources of the Bay. The six policies and guidelines address: 1) Sediments, 2) Toxics, 3) Nutrients, 4) Hydrologic Cycle, 5) Plant and Animal Protection and 6) Resource Protection.

1987, a. Chesapeake Bay Agreement.

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Chesapeake Bay Currents. Easton, MD. 1-800-446-5422.

Made up of local government employees, LGAC serves as an advisory committee to the Chesapeake Bay Program which is a partnership of state governments, federal agencies,

local governments, and business in the Chesapeake Bay watershed. LGAC's newsletter reports on activities at the local level which protect and restore the Chesapeake Bay and its aquatic resources.

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I. FIELD GUIDES AND SPECIES IDENTIFICATION GUIDES:

Guides for Chesapeake Bay and the Atlantic Coast vicinity

Dove and Nyman, 1995; Funderburk et al., 1991; Gosner, 1978; Hildebrand, 1972 reprint; Hurley, 1990; Lippson, 1973; Lippson et al.; Lippson and Lippson, 1984; Page and Burr, 1991; Robins et al., 1986; White, 1989;

II. HABITAT MANAGEMENT AND PROTECTION:

Methods, local authority, and existing federal and state laws and regulations

1. Federal laws, regulations and programs

Agriculture Conservation Program, USDA:

CBP, 1995a;

Anadromous Fish Conservation Act, 1965: preserve and reestablish salmon populations in rivers.

Haines, 1992;

Breakwaters and Bulkheads: for effects on fish and shellfish, see section III.

CZMA: see Coastal Zone Management Act

Clean Air Act:

Alliance for the Chesapeake Bay, 1993;

Clean Water Act:

CBP, 1995a; CBP, 1995b; Davis and Robb, 1992; Vestal et al., 1995;

Coastal America Program:

CBP, 1995a;

Coastal Wetlands Planning, Protection, and Restoration Act: Louisiana wetlands protection, establishment of a National Wetlands Coastal Grant Program, and funding for the North American Wetlands Conservation Act.

Johnston et al., 1992;

Coastal Zone Management Act, 1972:

Davis and Robb, 1992; Vestal et al., 1995;

Conservation Reserve Program, USDA:

CBP, 1995a;

Dredge Disposal:

CBP, 1995a;

Dredging:

CBP, 1995a;

EEZ: see Exclusive Economic Zone

Environmental Impact Assessment: see also, National Environmental Policy Act

Vestal et al., 1995;

Exclusive Economic Zone: waters within 200 miles of the United States and its territories

Locandro, 1992;

Farm Act:

Federal Water Pollution Control Act: see also, Section 404 Program
Johnston et al., 1992;
Fishery Management Councils: see also,
Locandro
Forestry Incentives Program, USFS:
CBP, 1995a;
Forest Stewardship Program/Stewardship Incentive Program, USFS:
CBP, 1995a;
Interjurisdictional Fisheries Act:

Land Trust:
CBP, 1995a;
Magnuson Fishery Management Act, 1976:
Locandro, 1992;
Marina Development:
CBP, 1995a;
Marine Plastic Pollution Research and Control Act (MPPRCA), 1987: regulates dumping of
plastics in United States ocean territory.
O'Hara, 1992;
Marine Sanctuaries: areas where fishing activities are restricted or prohibited
Bohnsack, 1992;
Laws and Regulations
Mitigation:
CBP, 1995b;
NEPA: see National Environmental Policy Act
National Coastal Wetlands Conservation Grants Program:
CBP, 1995a;
National Environmental Policy Act, 1969:
Vestal et al., 1995;
National Estuary Program:
Davis and Robb, 1992; Vestal et al., 1995;
National Pollution Discharge Elimination Program:
CBP, 1995b;
National Sea Grant College Program:

North American Waterfowl Management Plan Joint Venture Projects:
CBP, 1995a;
Pier Construction:
CBP, 1995a;
Private Lands Assistance and Restoration Program, USFWS:
CBP, 1995a;
Rivers and Harbors Act, 1899:
CBP, 1995b; Vestal et al., 1995;

Saltonstall-Kennedy Act:

Shallow-water Wildlife Areas Program, USDA:

CBP, 1995a;

Section 404 Program: regulates discharge of dredged or fill materials into waters of the U.S. under the Clean Water Act

CBP, 1995b; Johnston et al., 1992; Vestal et al., 1995;

State Wetland Conservation Plans:

Davis and Robb, 1992;

Water Resources Development Act, 1992, 1986, 1974:

CBP, 1995a;

Wetlands: no-net-loss

Johnston et al., 1992;

Wetlands Reserve Program, USDA:

CBP, 1995a;

2. State and jurisdiction laws, regulations, and local government assistance

Maryland

Biological Nutrient Removal Cost-Share Program:

Boat Traffic: in SAV beds

CBP, 1995b;

Buffer Incentives Program:

CBP, 1995a;

Critical Areas Law:

CBP, 1995b;

Dredging:

CBP, 1995b;

Forest Stewardship Program and Stewardship Incentives Program:

CBP, 1995a;

Forestry Incentives Program:

CBP, 1995a;

Glatfelter Cost-Share Program:

CBP, 1995a;

Land Trust:

CBP, 1995a;

Marina Development:

CBP, 1995b;

Nonpoint Source Permits Program:

Non-structural Shore Erosion Act:

CBP, 1995a;

Nontidal Wetlands Program:

CBP, 1995a;
Mitigation:
CBP, 1995b;
Pier Construction:
CBP, 1995b;
Program Open Space:
CBP, 1995a;
Stormwater Pollution Control Cost-Share Program:

SAV: regulated activities in and around SAV beds
CBP, 1995b;
Shoreline Stabilization:
CBP, 1995b;
Small Streams and Estuary Restoration Cost-Share Program:
CBP, 1995a;
Surface Transportation Program:
CBP, 1995a;
Water Quality:
CBP, 1995b;
Water Quality Certification Program:
CBP, 1995b;
Water Quality Revolving Loan Fund:

Westvaco Cost-Share Program:
CBP, 1995a;
Wetland Conservation Plan:

Woodland Incentives Program:
CBP, 1995a;

Pennsylvania

Adopt-A-Stream Program:
CBP, 1995a;
Forest Stewardship Program and Stewardship Incentives Program:
CBP, 1995a;
Keystone Recreation, Park, and Conservation Fund:
CBP, 1995a;
Stream Bank Fencing Program:
CBP, 1995a;
Surface Transportation Program:
CBP, 1995a;
Water Quality:
CBP, 1995b;
Wetlands Program:

CBP, 1995a;

Potomac River

Virginia

Boat Traffic: in SAV beds

CBP, 1995b;

Chesapeake Bay Preservation Act:

CBP, 1995b;

Dredging:

CBP, 1995b;

Grass Filter Strip Program:

CBP, 1995a;

Grazing Land Protection Program:

CBP, 1995a;

Land Trust:

CBP, 1995a;

Marina Development:

CBP, 1995b;

Marine Sanctuaries: areas where fishing activities are restricted or prohibited

Bohnsack, 1992; CEC, in preparation a;

Mitigation:

CBP, 1995b;

Permanent Vegetation Cover on Critical Areas Program:

CBP, 1995a;

Pier Construction:

CBP, 1995b;

Reforestation of Erodible Crop and Pasture Land Program:

CBP, 1995a;

SAV: regulated activities in and around SAV beds

CBP, 1995b;

Sanctuaries: see Marine Sanctuaries

Shoreline Stabilization:

CBP, 1995b;

Stream Protection Program:

CBP, 1995a;

Subaqueous Guidelines: permitting activities which encroach in/on/over submerged lands

CBP, 1995b;

Surface Transportation Program:

CBP, 1995a;

VPDES Permit Program?

CBP, 1995b;

Vegetative Stabilization of Marsh Fringe Areas Program:

CBP, 1995a;

Water Protection Permit Program:
CBP, 1995b;
Water Quality:
CBP, 1995b;
Woodland Buffer Filter Strip Program:
CBP, 1995a;
Woodland Erosion Stabilization Program:
CBP, 1995a;

Washington, DC

3. Local authority

Bonus Zoning: see Incentive Zoning

Buffer Zones: area with restricted use around a protected area

U.S. EPA, 1992;

Laws and Regulations

Building Codes: describes the standards regulating new construction

U.S. EPA, 1992;

Laws and Regulations

Cluster Zoning: clustering development on a lot to create open space

U.S. EPA, 1992;

Laws and Regulations

Coastal Zone Protection

U.S. EPA, 1992; Vestal et al., 1995;

Laws and Regulations

Conservation Easements:

U.S. EPA, 1992;

Laws and Regulations

Deed Restrictions: restrictions on the use of land agreed on by the buyer and seller of property

U.S. EPA, 1992;

Laws and Regulations

Density Requirements: regulates open space, impervious surface ratio, units per acre, and floor area ratio

U.S. EPA, 1992;

Laws and Regulations

Downzoning: more restrictive zoning of previously zoned areas

U.S. EPA, 1992;

Laws and Regulations

Ecological Assessment: see Landscape Conservation

Economic Tools: using taxes, fees, etc. to finance habitat protection

U.S. EPA, 1992;

Laws and Regulations

Greenways: linear tracts managed for flood control and open space

U.S. EPA, 1992;

Laws and Regulations

Incentive Zoning: supplemental development rights in exchange for public benefits
U.S. EPA, 1992;

Laws and Regulations

Interim Development Controls: slow or temporarily halt development activities
U.S. EPA, 1992;

Laws and Regulations

Land Acquisition: see also, Takings
U.S. EPA, 1992;

Laws and Regulations

Land Banks: public agency for acquiring and protecting lands
U.S. EPA, 1992;

Laws and Regulations

Land Trust: nonprofit, private organization for acquiring and protecting lands
CBP, 1995a; U.S. EPA, 1992;

Laws and Regulations

Landscape Conservation: regulatory decisions based on an entire landscapes rather than site-specific
Vestal et al., 1995;

Large Lot Zoning: conservation areas conducive to large lots and low densities
U.S. EPA, 1992;

Laws and Regulations

Local Administration of State and Federal Regulations:
U.S. EPA, 1992;

Laws and Regulations

Local Planning
U.S. EPA, 1992;

Laws and Regulations

Mitigation: restoration or creation of new ecosystems to compensate for damaged areas
U.S. EPA, 1992;

Laws and Regulations

Overlay Zones: development must meet requirements of multiple zoning ordinances
U.S. EPA, 1992;

Laws and Regulations

Performance Regulations: regulate effects of land use activities rather than the activities themselves
U.S. EPA, 1992;

Laws and Regulations

Planned Unit Developments: planned communities which protect sensitive environments
U.S. EPA, 1992;

Laws and Regulations

Planning and Zoning
U.S. EPA, 1992;

Laws and Regulations

Post-Acquisition Disposal:

U.S. EPA, 1992;

Laws and Regulations

Restoration:

CBP, 1995 b;

Restricted Covenant: see Deed Restrictions

Sanitary Codes: standards for sanitary hookups of new construction

U.S. EPA, 1992;

Laws and Regulations

Sensitive Area Protection Ordinance: special districts where activities potentially damaging to sensitive areas are restricted

U.S. EPA, 1992;

Laws and Regulations

Set Asides: when a portion of a sensitive area may be developed and a portion left undisturbed

U.S. EPA, 1992;

Laws and Regulations

Subdivision Controls:

U.S. EPA, 1992;

Laws and Regulations

Submerged Aquatic Vegetation Restoration Targets: see SAV Restoration Targets

Takings Issue: see also, Land Acquisition

U.S. EPA, 1992;

Laws and Regulations

Transfer of Development Rights: shifting development from sensitive environments to targeted growth areas

U.S. EPA, 1992;

Laws and Regulations

Wetlands Protection

U.S. EPA, 1992; Vestal et al., 1995;

Laws and Regulations

Zoning: method of land use regulation

U.S. EPA, 1992;

Laws and Regulations

4. Regional Agreements and Initiatives

Anacostia River Restoration Program:

CEC, 1995a;

Chesapeake Bay Agreement:

CEC, 1987;

Chesapeake Bay Basinwide Toxics Reduction and Prevention Strategy:

CEC, 1994e;

Chesapeake Bay Watershed Development Policies and Guidelines:

CEC, 1989c;
Local Government Partnership Initiative
Chesapeake Bay LGAC, newsletter; CBP, 1995;
Potomac Aquatic Plant Control Program:
CBP, 1995b;
SAV Restoration Targets: Chesapeake Bay Program
CBP, 1992a; CBP, 1995b;
Wetlands Policy Implementation Plan: Chesapeake Bay
CEC, 1990c;
International
MARPOL: international treaty to regulate ocean dumping
O'Hara, 1992;

III. JOURNAL ARTICLES, MAPS AND TECHNICAL REPORTS:

Publications documenting the importance of habitats to fish and shellfish and linkages between human activities and the quantity, quality, and availability of fish and shellfish habitats.

1. By Subject

Air Pollution: see Atmospheric Deposition
Acid Deposition:
Haines, 1992; Rago, 1992;
Acid Rain: see Acid Deposition
Agricultural Runoff:
Alliance for the Chesapeake Bay, 1993; Nelson and Elliot, 1994;
Anadromous Fish: see also, 3. Literature By Species: Bass, White; Perch; Shad; Lampreys;
CBP, 1995 b; Haines, 1992; Lippson et al.;
Animal Waste:
Nelson and Elliot, 1994;
Anoxia: see also, Hypoxia; Dissolved Oxygen
Nelson and Elliot, 1994; Scott et al., 1986; CEC, 1993c;
Aquatic Insect Larvae:
Dove and Nyman, 1995; Garman and Moring, 1993; Taylor and Roff, 1986;
Atmospheric Deposition: heavy metals;
Atmospheric Deposition: nutrients;
Alliance for the Chesapeake Bay, 1993; Nelson and Elliot, 1994;
Bacteria: in the food chain
CEC, 1993c;
Benthic Community:
CEC, 1993c; Dove and Nyman, 1995; Garman and Moring, 1993; Schlosser, 1982;
Schmidt and Samaritan, 1984; Taylor and Roff, 1986;
Maps Lippson et al.;

Biodiversity: see Species Diversity

Boat Traffic:

Fonesca et al., 1992;

Breakwaters and Bulkheads: see also, Rip-rap

CEC, 1989c;

Bridges: see Road Construction

Bulkheads: see Breakwaters and Bulkheads

Catadromous Fish:

CBP, 1995 b;

Channelization:

Haines, 1992; Schlosser, 1982; Scott et al., 1986;

Clearcut Logging: see Logging

Clearing: see Watershed Devegetation

Coastal Development:

CEC, 1989c; U.S. EPA, 1992; Vestal et al., 1995;

Commercial Development: see also, Industrial Development

Weaver and Garman, 1994;

Construction: environmental alternatives

Critical Habitat: see also, Essential Habitat;

Critical Life History Stage

Langton et al., 1996; Schaaf et al., 1993;

Cumulative Impacts:

Nelson and Elliot, 1994; Vestal et al., 1995;

Cumulative Impact Assessment: assessing cumulative impacts of land-use throughout a watershed

Vestal et al., 1995;

Laws and Regulations Vestal et al., 1995;

Deforestation: see Watershed Devegetation; Logging

Demographic Trends: see also, growth management

Chambers, 1992;

Development Location Guidelines:

CEC, 1989c;

Dissolved Oxygen: see also, Eutrophication; Anoxia; Hypoxia

Alliance for the Chesapeake Bay, 1993; Nelson and Elliot, 1994; Rago, 1992;

Maps Funderburk et al., 1991;

Dredging:

CBP, 1995b; CEC, 1989c; Fonesca et al., 1992;

Dredge Disposal:

Ecologically Valuable Species:

CEC, 1993c;

Economic Value: see Fisheries; see Habitat Degredation or Removal

Energy Flow: see Trophic Structure

Erodable Soil:

CEC, 1989c;

Erosion:
CEC, 1989c; Taylor and Roff, 1986;

Essential Habitat: see also, Critical Habitat
Langton et al., 1996;

Eutrophication:
Alliance for the Chesapeake Bay, 1993; Lewitus et al., 1995; Nelson and Elliot, 1994;
Rago, 1992;

Fertilizer Runoff:
CEC, 1989c;

Filling: see also, Hydrology, Wetland Loss
CEC, 1989c;

Fish Kills: see also, Toxic Dinoflagellates

Fish Migration: see also, Anadromous Fish,
CEC, 1993a; Lippson et al.; Rozengurt, 1992;

Fish Passage: see also, Stream Blockage
CEC, 1993a;

Fisheries: combined impacts of fishing exploitation and habitat degradation
Chambers, 1992; Haines, 1992; Langton et al., 1996; Rago, 1992; Schaaf et al., 1993;
Vestal et al., 1995;

Fisheries: economic value of fisheries, economic impacts of fish habitat loss
Chambers, 1992; Fedler and Crookshank, 1992; Langton et al., 1996; Moberly, 1992;
Turner, 1992; Vestal et al., 1995;

Floodplains:
CEC, 1989c;

Food Chain Structure: see Trophic Structure; Benthic Community;

Forage Fishes: see also, 3. Literature by Species: Bay anchovy, Menhaden, Gobies, Silversides
CEC, 1993c;

Freshwater Inflow: effects of alteration of freshwater input to estuarine systems
Rozengurt, 1992;

Global Warming:
Haines, 1992;

Grading: see also, Hydrology
CEC, 1989c;

Gravel Deposits: naturally occurring
CEC, 1989c;

Groundwater Contamination:
CEC, 1989c;

Habitat Degradation or Removal: effects of habitat quantity, quality, and availability on fish and shellfish populations (see also, specific habitat categories in Section 2, Literature by Habitat, and specific species in Section 3, Literature by Species)
Garman and Moring, 1993; Haines, 1992; Heck and Thoman, 1981; Heck et al., 1995;
Limburg and Schmidt, 1990; Moyle and Williams, 1990; Orth et al., 1996; Pile et al.,

1996; Schaaf et al., 1993; Schmidt and Samaritan, 1984; Scott et al., 1986; Taylor and Roff, 1986; Turner, 1992; Wahle and Steneck, 1991; Wilson et al., 1987;
 Habitat Degredation or Removal: economic effects
 Chambers, 1992; Fedler and Crookshank, 1992; Turner, 1992;
 Highway Construction: see Road Construction
 Hydrology: see also, Grading, Filling, Steep Slopes,
 CEC, 1989c;
 Hypoxia: see also, Anoxia; Dissolved Oxygen
 Scott et al., 1986; CEC, 1993c;
 Impervious Surfaces: see also, Stormwater Drainage; Urban Development; Suburban
 Development; Road Construction;
 CEC, 1989c; Scott et al., 1986;
 Impoundments: see also Stream Blockage;
 Haines, 1992;
 Indicator Species:
 CEC, 1993c; Schmidt and Samaritan, 1984;
 Industrial Development
 Inlet Stabilization:
 Landfills:
 CEC, 1989c;
 Landscaping:
 CEC, 1989c;
 Lawns:
 CEC, 1989c;
 Logging: clearcut logging;
 Garman and Moring, 1993;
 Logging Industry:
 Marina Construction:
 CBC, 1995b; CEC, 1989c;
 Marine Debris:
 O'Hara, 1992;
 Marine Sanctuaries:
 Bohnsack, 1992;
 Marsh Filling/Marsh Development: see Wetlands Loss
 Microbes:
 CEC, 1993c;
 Mineral Deposits: naturally occurring
 CEC, 1989c;
 Mining:
 CEC, 1989c;
 Non-Point Source Pollution: see also, Agricultural Runoff; Nutrient Runoff; Stormwater
 Drainage;
 Alliance for the Chesapeake Bay, 1993;

Nursery Habitat

Bozeman and Dean, 1980; Fonesca et al., 1992; Rountree and Able, 1992; Weinstein, 1979;

Nutrient Cycling:

CEC, 1993c;

Nutrient Runoff: see also, Eutrophication

Alliance for the Chesapeake Bay, 1993; CEC, 1989c; Nelson and Elliot, 1994; Taylor and Roff, 1986;

Peirs and Docks:

CEC, 1989c;

Pesticides: contamination in water and groundwater; see also, Toxic Contamination;

CEC, 1989c; Chambers, 1992; Haines, 1992; Nelson and Elliot, 1994;

Oil Spills:

Ph: see Acid Deposition

Phytoplankton:

CEC, 1993c; Lippson, 1974; Nelson and Elliot, 1994; Dove and Nyman, 1995;

Maps Lippson, 1974;

Plankton: see Toxic Dinoflagellate; Phytoplankton; Zooplankton

Point Source Pollution:

Alliance for the Chesapeake Bay, 1993;

Pollution: effects on fish and shellfish

Funderburk et al., 1991; Limburg and Schmidt, 1990; Moyle and Williams, 1990; Schaaf et al., 1993; Schmidt and Samaritan, 1984; Scott et al., 1986;

Power Plants:

Maps Lippson et al.;

Refuge Habitat

Regional Assessment: management of cumulative impacts on a regional geographic scale

Vestal et al., 1995;

Residential Development: see Urban Development; Suburban Development and Sprawl

Weaver and Garman, 1994;

Riparian Buffers:

CEC, 1989c; Garman and Moring, 1993; Schlosser, 1982; Scott et al., 1986; Weaver and Garman, 1994;

Rip-rap:

CEC, 1989c;

River Flow: see Stream/River Flow

Road Construction: see also, Impervious Surfaces

CEC, 1989c; Taylor and Roff, 1986; Weaver and Garman, 1994;

Sand Deposits: naturally occurring

CEC, 1989c;

Sand Deposition: effects on aquatic communities

Schmidt and Samaritan, 1984;
Sea Level Rise:

Sedimentation: see also, Erosion, Turbidity

CEC, 1989c; Scott et al., 1986; Taylor and Roff, 1986;

Septic Systems:

Alliance for the Chesapeake Bay, 1993; CEC, 1989c; Chambers, 1992;

Settlement Habitat:

Sewage Outfall: see Wastewater Treatment

Sewage Sludge:

Nelson and Elliot, 1994;

Sheet Flow: see Stormwater Drainage/Runoff

Shoreline Development: see Coastal Development

Shoreline Erosion:

CEC, 1989c;

Silt: see Sediment Deposition

Site Placement: see Development Location

Sludge Disposal: see Sewage Sludge

Spawning Habitat:

Limburg and Schmidt, 1990; Lippson et al; Schlosser, 1982;

Species Diversity

Moyle and Williams, 1990; Schmidt and Samaritan, 1984; Scott et al., 1986; Taylor and
Roff, 1986; Weaver and Garman, 1994;

Steep Slopes: development of

CEC, 1989c;

Storage Facilities: see also, Toxic Contaminants

CEC, 1989c;

Stormwater Drainage/Runoff:

CEC, 1989c; Scott et al., 1986;

Stormwater Retention:

CEC, 1989c;

Stream Blockage:

CEC, 1993a; Haines, 1992; Limburg and Schmidt, 1990; Moyle and Williams, 1990;
Rozengurt, 1992;

Maps CEC, 1993a; Funderburk et al., 1991;

Stream/River Flow

Rozengurt, 1992; Schlosser, 1982; Scott et al., 1986;

Suburban Development and Sprawl:

Suspended Solids: see Sediment Deposition

Top-Down Trophic Impacts:

CEC, 1993c;

Trophic Structure: see also, Benthic Community

Garman and Moring, 1993; Schlosser, 1982; Weaver and Garman, 1994;
 Toxic Contamination: see also, Pesticides;
 CEC, 1989c; CEC, 1994e; Chambers, 1992; Funderburk et al., 1991; Rago, 1992; Scott et al., 1986; Varanasi, 1992;
 Toxic Dinoflagellates: (*Pfiesteria piscicida*)
 Lewitus et al., 1995;
 Turbidity: see also, Sedimentation
 CEC, 1989c; Fonesca et al., 1992;
 Urban Development: effects on watershed; effects on aquatic ecosystem; effects on fish and shellfish
 Vegetative Buffers: see Riparian Buffers, Watershed Devegetation, Wetland Loss,
 Alliance for the Chesapeake Bay, 1993; CEC, 1989c; Chambers, 1992; Limburg and Schmidt, 1990; Schmidt and Samaritan, 1984; Scott et al., 1986; Weaver and Garman, 1994;
 Wastewater Treatment/Discharge:
 CEC, 1989c; Chambers, 1992; O'Hara, 1992; Schmidt and Samaritan, 1984;
 Maps Lippson et al.;
 Watershed Devegetation:
 CEC, 1989c; Garman and Moring, 1993;
 Wetland Development:
 CEC, 1989c;
 Wetlands Loss: see also, Watershed Devegetation; Riparian Buffers;
 CEC, 1989c; Chambers, 1992; Johnston et al., 1992; Turner, 1992; Vestal et al., 1995;
 Wetland Mitigation/Restoration:
 CEC, 1989c;
 Zooplankton:
 CEC, 1993c; Dove and Nyman, 1995;

2. By Habitat:

Maps include distribution of habitats in Chesapeake Bay and tributaries.

Freshwater Habitats

Streams and Nontidal Portions of Rivers

CBP, 1995a; Garman and Moring, 1993; Limburg and Schmidt, 1990; Schmidt and Samaritan, 1984; Schlosser, 1982; Scott et al., 1986; Weaver and Garman, 1994; Taylor and Roff, 1986;

Maps

Tidal Portions of Freshwater Streams and Rivers

Maps Lippson et al.;

Impoundments

Maps

Shallow Water Habitats

Schlosser, 1982; Scott et al., 1986;

Maps Lippson et al.;

Aquatic Vegetation, Submerged and Emergent

CBP, 1992aa; CBP, 1995a; CEC, 1989c;

Maps Lippson et al.;

Migratory Fish Passageways

CEC, 1993a; CBP, 1995a; Haines, 1992; Limburg and Schmidt, 1990;

Maps CEC, 1993a;

Wetlands

CEC, 1989c; CEC, 1990c; CBP, 1995a; Lippson, 1974; Weaver and Garman, 1994;

Maps Lippson, 1974; Lippson et al.;

Riparian Forest

CBP, 1995 b; Garman and Moring, 1993; Schlosser, 1982; Weaver and Garman, 1994;

Maps

Estuarine and Marine Habitats

Tidal Creeks and Tributaries

Able and Kaiser, 1994; Bozeman and Dean, 1980; Hines et al., 1987; Rountree and Able, 1992; Ryer et al., 1990;

Maps Lippson et al.;

Wetlands/Marsh

Able and Kaiser, 1994; CBP, 1995b; CEC, 1990c; CEC, 1993c; Lippson, 1974; Heck et al., 1995; Rountree and Able, 1992; Ryer et al., Turner, 1992; 1990; Weinstein, 1979;

Maps Lippson, 1974; Lippson et al.;

Sand Beaches

Maps

Shallow, unvegetated habitat (sand, mud,

Able and Kaiser, 1994; CBP, 1995 b; Dittel et al., 1995; Heck et al., 1995; Olmi, 1994; Pile et al., 1996; Ruiz et al., 1993; Wahle and Steneck, 1992;

Maps Lippson et al.;

Submerged Aquatic Vegetation (SAV):

Alliance for the Chesapeake Bay, 1993; CBP, 1992a; CBP, 1995b; CEC, 1989c; Fonesca et al., 1992; Heck and Thoman, 1981; Heck and Wilson, 1987; Heck et al., 1995;

Funderburk et al., 1991; Lippson, 1974; Orth et al., 1995; Orth et al., 1996; Pile et al., 1996; Rago, 1992; Ryer et al., 1990; Tupper and Boutilier, 1995; CEC, 1993c; Wilson et al., 1987;

Maps Funderburk et al., 1991; Lippson, 1974; Lippson et al.; Orth et al., 1995;

Woody debri

Everett and Ruiz, 1993;

Reefs and Oyster Bars

Bohnsack, 1992; CBP, 1995a; CEC, 1989c; CEC, 1993c; CEC, 1994c; CEC, 1994d;

Dove and Nyman, 1995; Tupper and Boutilier, 1995;

Maps Lippson et al.;

Surface water

Clancy and Epifanio, 1989; Epifanio, 1988a; Epifanio, 1988b; Epifanio, 1995; Epifanio et al., 1984; Epifanio et al., 1989; Little and Epifanio, 1991; Metcalf et al., 1995; Olmi, 1994;

River channels, deep holes, and Bay mainstem

Breitburg, 1994; CBP, 1995a; Clancy and Epifanio, 1989; Hines et al., 1987; Little and Epifanio, 1991; Metcalf et al., 1995;

Maps see also, navigational charts for area of interest; Lippson et al.;

Open Shoals (mud, sand,

Maps

Ocean Inlets (including Bay entrance) and Nearshore Continental Shelf

Epifanio, 1988a; Epifanio, 1988b; Epifanio et al., 1984; Epifanio et al., 1989; Olmi, 1994;

3. By Species:

References pertain to habitat requirements, life histories, and documented impacts of habitat loss or degradation for each species. Maps include distribution, migrations, and life histories throughout Chesapeake Bay and tributaries.

Clams, Oysters and Other Bivalve Mollusks

Bay scallop (*Argopecten irradians*)

Fonesca et al., 1992; Heck et al., 1995;

Maps

Bent mussel (*Brachidontes recurvus*)

CEC, 1993c;

Blue mussel (*Mytilus edulis*)

Heck et al., 1995;

Maps

Brackish water clam (*Rangia cuneata*)

Maps Lippson, 1974; Lippson et al.;

Eastern Oyster: (*Crassostrea virginica*)

CEC, 1993c; CEC, 1994c; CEC, 1994d; Chambers, 1992; Dove and Nyman, 1995;

Funderburk et al., 1991; CEC, 1993c;

Maps CEC, 1994c; CEC, 1994d; Funderburk et al., 1991; Lippson, 1974; Lippson et al.;

Hard Clam: (*Mercenaria mercenaria*)

Funderburk et al., 1991;

Maps Funderburk et al., 1991; Lippson, 1974;

Macoma Clams: (*Macoma* sp.)

CEC, 1993c;

Soft Shell Clam: (*Mya arenaria*)

CEC, 1993c; Funderburk et al., 1991;

Maps Funderburk et al., 1991; Lippson, 1974; Lippson et al.;

Other:

Heck et al., 1995;

Maps Lippson et al.;

Crabs

Blue crab (*Callinectes sapidus*)

CEC, in preparation a; CEC, 1993c; Clancy and Epifanio, 1989; Dove and Nyman, 1995; Epifanio, 1988a; Epifanio, 1988b; Epifanio, 1995; Epifanio et al., 1984; Epifanio et al., 1989; Everett and Ruiz, 1993; Fonesca et al., 1992; Funderburk et al., 1991; Heck and Thoman, 1981; Heck and Wilson, 1987; Hines et al., 1987; Little and Epifanio, 1991; Metcalf et al., 1995; Olmi, 1994; Pile et al., 1996; Rountree and Able, 1992; Ruiz et al., 1993; Wilson et al., 1987; Weinstein, 1979;

Maps CEC, in preparation a; Funderburk et al., 1991; Lippson, 1974; Lippson et al.;

Lady crab (*Ovalipes ocellatus*)

Epifanio, 1988a; Heck and Wilson, 1987; Rountree and Able, 1992;

Maps

Rock crab (*Cancer irroratus*)

Clancy and Epifanio, 1989; Heck et al., 1995; Rountree and Able, 1992;

Maps

Crabs, other

Clancy and Epifanio, 1989; Dove and Nyman, 1995; Epifanio, 1988a; Epifanio, 1988b; Everett and Ruiz, 1993; Heck and Wilson, 1987; Heck et al., 1995; Little and Epifanio, 1991; Rountree and Able, 1992; Ruiz et al., 1993; Weinstein, 1979;

Maps Lippson et al.;

Horseshoe Crabs

Atlantic Horseshoe Crab (*Limulus polyphemus*)

CEC, 1994a; Dove and Nyman, 1995; Rountree and Able, 1992;

Maps

Lobster

American Lobster (*Homarus americanus*)

Langton et al., 1996; Wahle and Steneck, 1991; Wahle and Steneck, 1992;

Maps

Shrimp

Shore shrimps (*Palaemonetes* sp.)

Everett and Ruiz, 1993; Heck and Thoman, 1981; Rountree and Able, 1992; Ruiz et al., 1993;

Maps Lippson et al.;

Brown shrimp (*Penaeus aztecus*)

Fonesca et al., 1992; Rountree and Able, 1992; Turner, 1992; Weinstein, 1979;

Maps

Pink Shrimp (*Penaeus duorarum*)

Fonesca et al., 1992; Weinstein, 1979;

Maps

White Shrimp (*Penaeus setiferus*)

Turner, 1992; Weinstein, 1979;

Maps

Shrimps (*Crangon* sp.)

Heck et al., 1995; Rountree and Able, 1992; Ruiz et al., 1993;

Maps

Shrimps (*Neomysis* sp.)

Dove and Nyman, 1995;

Maps Lippson et al.;

Shrimps (*Penaeus* sp.)

Epifanio, 1988b;

Maps

Heck and Thoman, 1981;

Squid

Boreal Squid (*Illex illecebrosus*)

Rountree and Able, 1992;

Maps

Fish

Alosids: see Shad

Anchovies:

Bay (*Anchoa mitchilli*)

CEC, 1993c; Dove and Nyman, 1995; Breitburg, 1994; Funderburk et al., 1991;

Rountree and Able, 1992; Ruiz et al., 1993; Weinstein, 1979;

Maps Funderburk et al., 1991; Lippson, 1974; Lippson et al.;

(*Anchoa hepsetus*)

Rountree and Able, 1992; Weinstein, 1979;

Maps

Bass, Largemouth and Smallmouth: see Sunfish

Bass, Sea: (Family Serranidae)

Black sea bass (*Centropistes striatus*)

CEC, 1996a; CEC, 1993c; Dove and Nyman, 1995; Rountree and Able, 1992;

Maps CEC, 1996a;

Bass, White: (Family Moronidae, includes white perch, striped bass)

White perch (*Morone americanus*)

CEC, 1993c; Dove and Nyman, 1995; Funderburk et al., 1991; Limburg and

Schmidt, 1990; Rountree and Able, 1992; Varanasi, 1992;

Maps Funderburk et al., 1991; Lippson, 1974; Lippson et al.;

- Striped Bass (*Morone saxatilis*)
 CEC, 1989b; CEC, 1993c; Chambers, 1992; Dove and Nyman, 1995; Fedler and Crookshank, 1992; Funderburk et al., 1991; Rago, 1992; Rountree and Able, 1992; Schaaf et al., 1993;
Maps Funderburk et al., 1991; Lippson, 1974; Lippson et al.;
- Black Sea Bass: see Bass, Sea
- Blennies: (Family Blenniidae)
 (*Chasmodes* sp.; *Hypsoblennius* sp.)
 CEC, 1993c;
Maps Lippson et al.;
- Bluefish: (Family Pomatomidae)
 Bluefish (*Pomatomus saltatrix*)
 CEC, 1990a; CEC, 1993c; Dove and Nyman, 1995; Rountree and Able, 1992; Schaaf et al., 1993;
Maps Lippson, 1974;
- Bonita: see Cobia
- Bullheads: see Catfish
- Butterfishes: (Family Stromateidae)
 Harvestfish (*Peprilus alepidotus*)
 CEC, 1993c;
- Carp: see Minnows
- Catfish and Bullheads: (Family Ictaluridae)
 Channel catfish (*Ictalurus punctatus*)
 CEC, 1993c; Dove and Nyman, 1995;
Maps Lippson, 1974; Lippson et al.;
- Brown bullhead (*Ameiurus nebulosus*)
 CEC, 1993c; Dove and Nyman, 1995; Weaver and Garman, 1994;
Maps Lippson, 1974; Lippson et al.;
- Madtoms (*Noturus* sp.)
 Schlosser, 1982; Weaver and Garman, 1994;
Maps
- White Catfish (*Ictalurus catus*)
 CEC, 1993c; Dove and Nyman, 1995;
Maps Lippson, 1974; Lippson et al.;
- Yellow bullhead (*Ameiurus natalis*)
 Schlosser, 1982; Weaver and Garman, 1994;
Maps
- Clingfishes: (Family Xenopterygii)
 Skilletfish (*Gobiesox* sp.)
 CEC, 1993c; Everett and Ruiz, 1993; Ruiz et al., 1993;
Maps Lippson et al.;
- Cobia: (Family Rachycentridae)
 Cobia, bonita (*Rachycentron canadum*)

- Rountree and Able, 1992;
Maps
- Codfishes: (Family Gadidae)
 Atlantic Cod (*Gadus morhua*)
 Langton et al., 1996; Tupper and Boutilier, 1995;
Maps
- Pollocks (*Pollachius* sp.)
 Rountree and Able, 1992;
Maps
- Croakers and Drums: (Family Scianidae, includes croaker, drum, spot, whittings)
 Atlantic croaker (*Micropogonias undulatus*)
 Bozeman and Dean, 1980; CEC, 1991b; CEC, 1993c; Dove and Nyman, 1995;
 Schaaf et al., 1993; Ruiz et al., 1993; Varanasi, 1992; Weinstein, 1979;
Maps Lippson, 1974;
- Black drum (*Pogonias cromis*)
 CEC, 1993a; CEC, 1993c; Dove and Nyman, 1995;
Maps
- Red drum (*Sciaenops ocellatus*)
 CEC, 1993b; CEC, 1993c;
- Silver Perch (*Bairdiella chrysaura*)
 CEC, 1993c;
- Spot (*Leiostomus xanthurus*)
 Bozeman and Dean, 1980; CEC, 1991b; CEC, 1993c; Dove and Nyman, 1995;
 Fonesca et al., 1992; Funderburk et al., 1991; Rountree and Able, 1992; Ruiz et al., 1993; Weinstein, 1979;
Maps Funderburk et al., 1991; Lippson, 1974;
- Spotted sea trout (*Cynoscion nebulosus*)
 CEC, 1990b; CEC, 1993c; Dove and Nyman, 1995; Fonesca et al., 1992; Schaaf et al., 1993;
Maps
- Weakfish (Grey sea trout, *Cynoscion regalis*)
 CEC, 1990b; CEC, 1993c; Dove and Nyman, 1995; Rountree and Able, 1992;
 Schaaf et al., 1993;
Maps Lippson, 1974;
- Whiting (*Menticirrhus saxatilis*)
 Rountree and Able, 1992;
Maps
- Other
 Dove and Nyman, 1995; Rountree and Able, 1992; Weinstein, 1979;
Maps
- Dace: see Minnows
 Darters: see Perch
 Drum: see Croakers

Eel:

American (*Anguilla rostrata*)

CEC, 1991a; CEC, 1993c; Dove and Nyman, 1995; Rountree and Able, 1992;
Schmidt and Samaritan, 1984; Weaver and Garman, 1994;

Maps Lippson, 1974;

Filefish: (Family Monacanthidae)

(*Monacanthus* sp.)

Rountree and Able, 1992;

Maps

Flounders: (Family Pleuronectidae)

Summer Flounder (*Paralichthys dentatus*)

Able and Kaiser, 1994; CEC, 1991c; CEC, 1993c; Dove and Nyman, 1995;
Fonesca et al., 1992; Rountree and Able, 1992; Schaaf et al., 1993; Varanasi,
1992;

Maps

Winter Flounder (*Psuedopleuronectes americanus*)

CEC, 1993c; Rountree and Able, 1992; Varanasi, 1992;

Maps Lippson, 1974; Lippson et al.;

(*Paralichthys* sp.)

Weinstein, 1979;

Maps

Groundfish: see Codfishes; see Flounders

Grunts: (Family Haemulida)

(*Haemulon* sp.)

Fonesca et al., 1992;

Pigfish (*Orthopristis chrysoptera*)

Fonesca et al., 1992;

Gobies: (Family Gobiidae)

(*Gobiosoma* sp.)

Breitburg, 1994; CEC, 1993c; Everett and Ruiz, 1993; Rountree and Able, 1992;
Ruiz et al., 1993; Weinstein, 1979;

Maps Lippson et al.;

Hakes: (Family Merlucciidae)

(*Merluccius* sp.)

Rountree and Able, 1992;

Maps

Herring: see Shad; see Herring, Sea

Herring, Sea:

(*Clupea harengus*)

Rountree and Able, 1992;

Maps

Jack: see Pompano

Killifish: (Family Cyprinodontidae, includes mummichog, sheepshead minnow, killifishes,

rainwater fish)

(*Cyprinidon* sp.)

CEC, 1993c; Dove and Nyman, 1995; Rountree and Able, 1992;

Maps

(*Fundulus* sp.)

CEC, 1993c; Dove and Nyman, 1995; Everett and Ruiz, 1993; Heck and Thoman, 1981; Ruiz et al., 1993; Ruiz et al., 1993; Schlosser, 1982; Schmidt and Samaritan, 1984; Ruiz et al., 1993; Weinstein, 1979;

Maps Lippson et al.;

(*Lucania* sp.)

Dove and Nyman, 1995; Rountree and Able, 1992;

Heck and Thoman, 1981;

Maps Lippson et al.;

Lampreys: (Family Petromyzontidae)

(*Lampetra* sp.)

Scott et al., 1986;

Maps

Lizardfish: (Family Synodontidae)

(*Synodus* sp.)

Rountree and Able, 1992;

Maps

Mackerel: (Family Scombridae)

King mackerel (*Scomberomorus cavalla*)

CEC, 1994b; Schaaf et al., 1993;

Maps

Spanish mackerel (*Scomberomorus maculatus*)

CEC, 1994b;

Maps

(*Scomberomorus* sp.) Rountree and Able, 1992;

Menhaden:

Atlantic (*Brevoortia tyrannus*)

Bozeman and Dean, 1980; CEC, 1993c; Dove and Nyman, 1995; Fonesca et al., 1992; Funderburk et al., 1991; Rountree and Able, 1992; Schaaf et al., 1993; Weinstein, 1979;

Maps Funderburk et al., 1991;

Minnows: (Family Cyprinidae; includes carp, goldfish, stonerollers, dace, chubs, minnows, and shiners)

Carp (*Cyprinus carpio*)

CEC, 1993c; Dove and Nyman, 1995; Schlosser, 1982; Schmidt and Samaritan, 1984;

Maps Lippson et al.;

Chubs (*Nocomis* sp.)

Schlosser, 1982; Weaver and Garman, 1994;

Maps

Chubs (*Semotilus* sp.)

Garman and Moring, 1993; Schlosser, 1982; Schmidt and Samaritan, 1984; Taylor and Roff, 1986;

Maps

Dace (*Clinostomus* sp.)

Weaver and Garman, 1994;

Maps

Dace (*Phonixus* sp.)

Weaver and Garman, 1994;

Maps

Dace (*Rhinichthys* sp.)

Garman and Moring, 1993; Schmidt and Samaritan, 1984; Scott et al., 1986; Taylor and Roff, 1986; Weaver and Garman, 1994;

Maps

Fallfish (*Semotilus corporalis*)

Schmidt and Samaritan, 1984; Weaver and Garman, 1994;

Maps

Goldfish (*Carassius auratus*)

Schmidt and Samaritan, 1984;

Maps

Minnows (*Cyprinodon* sp.)

Maps Lippson et al.;

Minnows (*Ecoglossum* sp.)

Schmidt and Samaritan, 1984;

Maps

Minnows (*Hybognathus* sp.)

CEC, 1993c; Dove and Nyman, 1995; Taylor and Roff, 1986; Weaver and Garman, 1984;

Maps Lippson et al.;

Minnows (*Pimephales* sp.)

Schlosser, 1982; Taylor and Roff, 1986;

Maps

Shiners (*Cyprinella* sp.)

Weaver and Garman, 1994;

Maps Lippson et al.;

Shiners (*Luxilus* sp.)

Weaver and Garman, 1994;

Maps

Shiners (*Notropis* sp.)

CEC, 1993c; Dove and Nyman, 1995; Schlosser, 1982; Schmidt and Samaritan, 1984; Weaver and Garman, 1994;

Maps Lippson et al.;
 Shiners (*Notemigonus* sp.)
 Dove and Nyman, 1995; Weaver and Garman, 1994;
 Maps Lippson et al.;
 Stonerollers (*Campostoma* sp.)
 Schlosser, 1982;
 Maps
 Moonfish: see Pomapano
 Mosquitofish: (Family Poeciliidae)
 (*Gambusia* sp.)
 Weaver and Garman, 1994;
 Maps Lippson et al.;
 Mudminnows: (Family Umbridae)
 (*Umbra* sp.)
 Weaver and Garman, 1994;
 Maps Lippson et al.;
 Mulletts: (Family Mugilidae)
 (*Mugil* sp.)
 Fonesca et al., 1992; Rountree and Able, 1992; Weinstein, 1979;
 Maps
 Mummichog: see Killifish
 Muskellunge: see Pike
 Needlefishes: (Family Belonidae)
 Atlantic needlefish (*Strongylura marina*)
 CEC, 1993c;
 Maps Lippson et al.;
 Perch: (Family Percidae; includes yellow perch, darters, and walleye)
 Darters (*Etheostoma* sp.)
 CEC, 1993c; Schlosser, 1982; Schmidt and Samaritan, 1984; Weaver and Garman, 1994;
 Maps Lippson et al.;
 Darters (*Percina* sp.)
 Weaver and Garman, 1994;
 Maps
 Yellow perch (*Perca flavescens*)
 CEC, 1993c; Dove and Nyman, 1995; Funderburk et al., 1991;
 Maps Funderburk et al., 1991; Lippson, 1974; Lippson et al.;
 Perch, Silver: see Croaker and Drum
 Perch, White: see Bass, White
 Pickerel: see Pike
 Pike, Pickerel and Muskellunge:
 Chain pickerel (*Esox niger*)
 Dove and Nyman, 1995; Weaver and Garman, 1994;

Maps Lippson et al.;
 Grass or redfin pickerel (*Esox americanus*)
 Schlosser, 1982; Schmidt and Samaritan, 1984;
Maps
 Pipefishes: (Family Syngnathus, includes pipefish, seahorse)
 (*Syngnathus* sp., *Hypocampus* sp.)
 CEC, 1993c; Rountree and Able, 1992;
Maps Lippson et al.;
 Pirate Perch: (Family Aphredoderidae)
 Pirate perch (*Aphredoderus sayanus*)
 Weaver and Garman, 1994;
Maps
 Pollock: see Codfishes
 Pompano, Jack, Moonfish: (Family Carangidae)
 (*Caranx* sp., *Selene* sp., *Trachinotus* sp.)
 Rountree and Able, 1992;
Maps
 Porcupine Fish: (Family Diodontidae)
 (*Chilomycterus* sp.)
 Rountree and Able, 1992;
Maps
 Porgies: (Family Sparidae, includes porgies, scups, pinfish, sheepshead)
 Porgies (*Lagodon rhomboides*,
 Bozeman and Dean, 1980; Weinstein, 1979;
Maps
 Scup (*Stenotomus chrysops*)
 Rountree and Able, 1992;
Maps
 Puffers: (Family Tetraodontidae)
 Northern puffer (*Sphoeroides maculatus*)

Maps Lippson, 1974; Lippson et al.;
 Rays: (Family Dasyatidae)
 Cownose Ray (*Rhinoptera bonasus*)
 CEC, 1993c;
 Salmon and Trout: (Family Salmonidae)
 Atlantic salmon (*Salmo salar*)
 Haines, 1992;
 Brook trout (*Salvelinus fontinalis*)
 Taylor and Roff, 1986;
Maps
 Brown trout (*Salmo trutta*)
 Schmidt and Samaritan, 1984; Taylor and Roff, 1986;

- Maps
 Chinook Salmon (*Oncorhynchus tshawytscha*)
 Scott et al., 1986; Varanasi, 1992;
- Maps
 Coho Salmon (*Oncorhynchus kisutch*)
 Scott et al., 1986;
- Maps
 Cutthroat trout (*Oncorhynchus clarki*)
 Scott et al., 1986;
- Maps
 Rainbow trout (*Oncorhynchus mykiss*)
 Scott et al., 1986;
- Maps
 Sea Robins: (Family Triglidae)
 (*Prinotus* sp.)
 Rountree and Able, 1992;
- Maps
 Seahorse: see Pipefish
- Sculpins: (Family Cottidae)
 (*Cottus* sp.)
 Scott et al., 1986; Taylor and Roff, 1986;
- Maps
 Scup: see Porgies
- Shad: (Family Clupeidae)
 Alewife (*Alosa pseudoharengus*)
 CEC, 1989a; CEC, 1993c; Chambers, 1992; Funderburk et al., 1991; Limburg and Schmidt, 1990; Rountree and Able, 1992;
Maps Funderburk et al., 1991; Lippson, 1974; Lippson et al.;
- American shad (*Alosa sapidissima*)
 CEC, 1989a; CEC, 1993c; Chambers, 1992; Dove and Nyman, 1995; Funderburk et al., 1991; Rountree and Able, 1992;
Maps Funderburk et al., 1991; Lippson, 1974; Lippson et al.;
- Blueback herring (*Alosa aestivalis*)
 CEC, 1989a; CEC, 1993c; Chambers, 1992; Dove and Nyman, 1995; Funderburk et al., 1991; Limburg and Schmidt, 1990; Rountree and Able, 1992;
Maps Funderburk et al., 1991; Lippson, 1974; Lippson et al.;
- Gizzard shad (*Dorosoma cepedianum*)
 CEC, 1993c; Schlosser, 1982;
Maps Lippson et al.;
- Hickory shad (*Alosa mediocris*)
 CEC, 1989a; CEC, 1993c; Chambers, 1992; Funderburk et al., 1991; Rountree and Able, 1992;
Maps Funderburk et al., 1991; Lippson et al.;

Sharks and dogfish:

Sharks

Dove and Nyman, 1995;

Maps

Smooth dogfish (*Mustelus canis*)

Dove and Nyman, 1995; Rountree and Able, 1992;

Maps

Shiners: see Minnows

Silversides: (Family Atherinidae)

(*Membras* sp., *Menidia* sp.)

CEC, 1993c; Dove and Nyman, 1995; Rountree and Able, 1992; Ruiz et al., 1993;

Weinstein, 1979;

Maps Lippson, 1974; Lippson et al.;

Skates: (Family Rajidae)

(*Raja* sp.)

Dove and Nyman, 1995; Rountree and Able, 1992;

Maps

Snappers: (Family Lutjanidae)

(*Lutjanus* sp.)

Rountree and Able, 1992;

Maps

Soles (Family Solidae, includes soles, hogchokers)

Hogchoker (*Trinectes maculatus*)

CEC, 1993c;

Maps Lippson, 1974; Lippson et al.;

Sticklebacks: (Family Gasterosteidae)

(*Apeltes* sp., *Gasterosteus* sp.)

Rountree and Able, 1992; Ruiz et al., 1993; Scott et al., 1986;

Maps Lippson et al.;

Striped bass: see Bass, White

Sturgeons: (Family Acipenseridae)

Atlantic (*Acipenser oxyrinchus*)

Dove and Nyman, 1995;

Maps

Shortnose (*Acipenser brevirostrum*)

Dove and Nyman, 1995;

Maps

Suckers:

(*Catostomus* sp., *Erimyson* sp., *Moxostoma* sp.)

Schlosser, 1982; Schmidt and Samaritan, 1984; Scott et al., 1986; Weaver and

Garman, 1994; Taylor and Roff, 1986;

Maps Lippson et al.;

(*Hypentelium* sp.)

- Schlosser, 1982;
Maps
- Sunfish: (Family Centrarchidae, includes sunfish, bass, crappie, bluegill, pumpkinseed)
 Black Crappie (*Pomoxis nigromaculatus*)
 Dove and Nyman, 1995;
Maps
- Bluegill (*Lepomis macrochirus*)
 CEC, 1993c; Dove and Nyman, 1995; Schlosser, 1982; Weaver and Garman, 1994;
Maps Lippson et al.;
- Largemouth bass (*Micropterus salmoides*)
 CEC, 1993c; Dove and Nyman, 1995; Schlosser, 1982; Schmidt and Samaritan, 1984; Weaver and Garman, 1994;
Maps
- Pumpkinseed (*Lepomis gibbosus*)
 CEC, 1993c; Dove and Nyman, 1995; Schmidt and Samaritan, 1984; Weaver and Garman, 1994;
Maps Lippson et al.;
- Redbreast sunfish (*Lepomis auritus*)
 Dove and Nyman, 1995; Schmidt and Samaritan, 1984; Weaver and Garman, 1994;
Maps
- Rock bass (*Ambloplites rupestris*)
 Schlosser, 1982;
Maps
- Smallmouth bass (*Micropterus dolomieu*)
 Dove and Nyman, 1995;
Maps
- Other (*Centrarchus* sp.)
 Weaver and Garman, 1994;
Maps
- Other (*Lepomis* sp.)
 Schlosser, 1982; Weaver and Garman, 1994;
Maps
- Tautog: (Family Labridae, the lipped fishes)
 Tautog (*Tautoga onitis*)
 CEC, in preparation b; Dove and Nyman, 1995; Rountree and Able, 1992;
Maps CEC, in preparation b;
- Toadfishes: (Family Batrachoididae)
 Oyster toadfish (*Opsanus tau*)
 CEC, 1993c; Rountree and Able, 1992; Varanasi, 1992;
Maps Lippson et al.;
- Tongue Fishes: (Family Cynoglossidae)

(*Symphurus* sp.)

Weinstein, 1979;

Maps

Trout, Freshwater: see Salmon and Trout

Trout, Sea: see Croaker and Drum

Walleye: see Perch

White Perch: see Bass, White

Turtles

Diamondback terrapin (*Malaclemys terrapin*)

Dove and Nyman, 1995; Rountree and Able, 1992;

Maps

Aquatic Insect Larvae

Cadisflies: (Order Trichoptera, all species have aquatic larvae)

Garman and Moring, 1993; Taylor and Roff, 1986;

Dragonflies and Damselflies: (Order Odonata, all species have aquatic "nymph" larvae)

Dove and Nyman, 1995; Garman and Moring, 1993;

Flies: (Order Diptera, species with aquatic larvae include crane flies, midges, mosquitos)

Dove and Nyman, 1995; Garman and Moring, 1993; Taylor and Roff, 1986;

Mayflies: (Order Ephemeroptera, all species have aquatic larvae)

Garman and Moring, 1993; Taylor and Roff, 1986;

Stoneflies: (Order Plecoptera, all species have aquatic "nymph" larvae)

Garman and Moring, 1993; Taylor and Roff, 1986;

Other Aquatic Larvae:

Taylor and Roff, 1986;

Amphipods and Copepods

Amphipods (*Caprella* sp.)

Heck et al., 1995;

Amphipods (*Mysis* sp.)

Sly, 1991;

Amphipods (*Pontoporeia* sp.)

Sly, 1991;

Amphipods (*Ampelisca* sp., *Gammarus* sp., *Haustorius* sp.)

Heck et al., 1995;

Copepods

Dove and Nyman, 1995;

Maps Lippson, 1974;

Nettles and Other Jelly Creatures

Sea nettle (*Chrysaora quinquecirrha*)

Breitburg, 1994;

Maps Lippson, 1974;
Other
CEC, 1993c;
Maps Lippson, 1974;

Polychaetes

Polychaetes (*Capitella* sp., *Leitoscolopos* sp., *Pygospio* sp., *Streblospio* sp.)
Heck et al., 1995;