Chesapeake Bay Living Resources 1995-96

Living Resources Subcommittee Biennial Report

Prepared by
Living Resources Subcommittee
Chesapeake Bay Program

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How did the Bay's animals and habitats fare in 1995 and 1996...

Many Living Resources Subcommittee projects matured during 1995 and 1996, with several stream restoration projects hitting the ground. Watershed groups in Pennsylvania, Maryland, and Virginia started planting trees and assessing natural resources. Throughout the watershed, the opening of 13 blockages that prevented migratory fish from spawning upstream moved from planning stages to implementation. Over 93 additional miles of fish habitat were opened during 1995 and 1996. Wild weather dominated 1996. Huge floods in January and September poured debris, sediment, and nutrients into Chesapeake Bay. One positive effect of the flooding was low salinity, which kept oyster diseases in check.

Submerged aquatic vegetation (SAV) showed resilience, despite extreme weather. Although high freshwater flows may have contributed to fewer SAV acres overall, submerged vegetation increased in several regions of the Bay during this reporting period. During 1996 surveys, researchers discovered new SAV beds in some Chesapeake Bay tributaries. Oyster and aquatic reef creation and restoration continued in Maryland and Virginia. New studies, initiated in 1995-96, are examining oyster ecology on the new reefs and how well these reefs are working.

Reflecting greater understanding of the linkages between fish and their environment, the *1996 Chesapeake Bay and Atlantic Coast Black Sea Bass Fishery Management Plan* was the first Bay fishery management plan to incorporate an enhanced habitat section. This represented an important step toward protecting important fish nursery, spawning, and feeding habitats such as aquatic reefs, SAV beds, and wetlands.

Past commitments to monitoring Chesapeake Bay living resources, in addition to water quality, has resulted in long-term datasets that were put to use in 1995 and 1996. The monitoring of SAV, plankton and benthos, plus acquisition of other existing fish data, contributed to the development and validation of the Chesapeake Bay ecosystem models. These models are beginning to provide a three-dimensional picture of how the Bay's living resources interact with the environment. The ecosystem models will help evaluate how nutrient reductions, which the Bay Program committed to in 1983, affect the plants and animals.

Living resources should benefit from the 1996 *Adoption Statement on Riparian Forest Buffers*. The Bay Program's commitment to restoring 2,010 miles of forest buffer along streams by the year 2010 will help improve water quality and fish habitat in the watershed. The LRSc plans to work closely with local governments over the next year to restore streams and wetlands, and protect fish and waterfowl. Biological monitoring will continue so scientists can refine the ecosystem models and examine future management strategies through model simulations.

Stream Restoration

Five major rivers run through the Chesapeake Bay watershed. The Susquehanna, Potomac, Rappahannock, York, and James rivers supply nearly 90% of the freshwater flowing into the Bay. These are large river systems, comprised of many smaller rivers and streams. A huge portion of the Bay's nutrients and sediments come from the tributaries. Stream preservation and restoration is crucial to controlling nitrogen and sediment inputs into Chesapeake Bay. Healthy streams provide essential habitat for fish and other wildlife.

Chesapeake Bay Habitat Restoration: A Framework for Action lists freshwater tributaries as one of four habitat areas targeted for restoration efforts. In addition to opening migratory fish blockages and restoring nontidal wetlands, preservation and restoration of upstream habitat is a Bay Program priority. The 1996 Chesapeake Executive Council *Adoption Statement on Riparian Forest Buffers* reinforces the Bay Program's commitment to stream restoration. The goal of this statement is to restore forest buffers on 2,010 miles of stream and shoreline in the watershed by the year 2010. Restoration projects are a good example of local, state, and federal government agencies partnering with local, nonprofit organizations.

Stream Restoration Training

The Chesapeake Bay Program supported training in basic stream processes and river assessments to bolster ongoing efforts and initiate new stream restoration projects in the watershed. Training during 1995 equipped 120 people with new, ecological skills that will immediately assist over 500 locally funded restoration projects. Trainees are working to restore nearly 250 miles of stream and riparian habitat in 18 separate river basins. Training courses in 1996 equipped another 80 people to work on streams in Pennsylvania and Maryland. Virginia will hold its stream restoration course for 40 people in March 1997.

This kind of effort is vital to ensuring both water quality and aquatic habitat for migratory fishes, especially as fish passage openings proceed. Migratory birds that rely on forested wetlands also benefit. Stream restoration training helps local governments and interested stakeholders address tough land-use issues, such as stormwater management, using ecologically sound, cost-effective techniques.

Octoraro Watershed Restoration

Funding from the Chesapeake Bay Program helped the Alliance for the Chesapeake Bay (ACB) and the State College, Pennsylvania office of US Fish and Wildlife Service (US FWS) assess the Octoraro Watershed, located along the border of Pennsylvania and northeastern Maryland. A dam located in the middle of the watershed halts fish passage and divides the watershed into two ecologically distinct zones, with forests below the dam and development and agriculture above the dam. The 1995 assessment identified sites suitable for restoring riparian integrity and biodiversity.

In 1996, the ACB continued their support to help this community-based watershed restoration effort by installing several sites in headwater reaches of Octoraro Creek to monitor bank erosion rates. A demonstration riparian forest buffer project was created on the mainstem of the creek. In 1996, the Pennsylvania Association of Conservation Districts named the Octoraro Creek Watershed Association the "Watershed Association of the Year" for their efforts to target stream restoration projects and preserve the streamside forests.

The Octoraro Watershed assessment and restoration highlights cooperation among government agencies, nonprofit organizations, and private landowners. In addition to the CBP, the ACB and the US FWS, partners include the Natural Resources Conservation Service, Maryland's Department of Natural Resources (DNR), Pennsylvania's Departments of Environmental Protection (DEP) and Conservation and Natural Resources (DCNR), the Octoraro Watershed Association, and Nottingham Academy.

Difficult Run Urban Reforestation Project

The Difficult Run watershed, which drains into the Virginia portion of Potomac River, is 80% developed. Despite its urban location, Difficult Run hosts many wildlife species. Flooding and soil erosion are degrading water quality on this tributary. The CBP has joined forces with Virginia's Department of Forestry, local governments, and nonprofit organizations to support the Difficult Run Urban Reforestation Project. A watershed plan is being developed, including a database, map of projects, and site restoration prescriptions. In 1995, a visual and hands-on display was developed for presentations and festivals.

One hundred acres of riparian areas will be restored on Difficult Run. Volunteers are planting trees to create 40-100 foot wide riparian forest buffers along the stream. By the end of 1996, 1,250 native, water-tolerant trees had been planted by volunteers in the floodplains of Difficult Run.

Piney/Alloway Watershed

Funding from the Chesapeake Bay Program was used to match local and state dollars for a demonstration stream restoration project on Alloway Creek in Carroll County, Maryland, as part of the Maryland Targeted Watersheds Program. The Chesapeake Bay Field Office of the U.S. Fish and Wildlife Service provided design assistance. They partnered with the Maryland's Department of Natural Resources (MDNR) and Department of Agriculture (MDA), the Carroll County Public Works Department, the local Conservation District, and private landowners to initiate the first stream restoration demonstration in the Piney/Alloway Watershed, a predominantly agricultural landscape. In October 1995, approximately 500 feet of stream was restored using natural materials for bank protection and habitat enhancement. In April 1996, 1,000 feet of riparian buffer, 50-100 feet wide, was fenced and planted with native riparian species.

Fish Passage

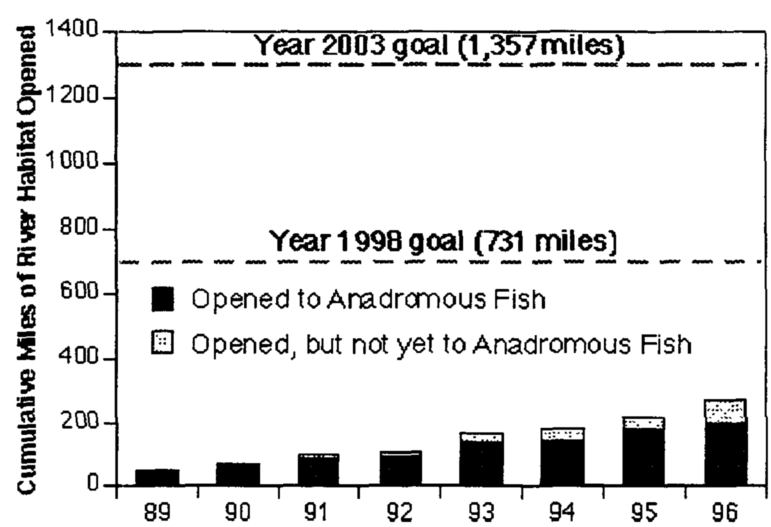
Anadromous fish, including several species of shad and herring, must migrate from saltwater environments to spawn in freshwater tributaries. Many streams and rivers in the Chesapeake Bay watershed are blocked by dams, culverts, and other structures. Over 2500 blockages in the watershed keep anadromous and other migratory fish from reaching historic spawning grounds. As a result, natural reproduction of American shad, in particular, remains low. Currently, stocking programs conducted by the states help resupply the shad population in Chesapeake Bay.

The Bay Program is committed to opening blockages in the tributaries so anadromous fish can reach freshwater spawning grounds. Fish passage goals established in 1993 direct Bay Program signatories to open 582 stream miles by 1998 and over 1,356 miles by 2003.

Progress Opening Blockages

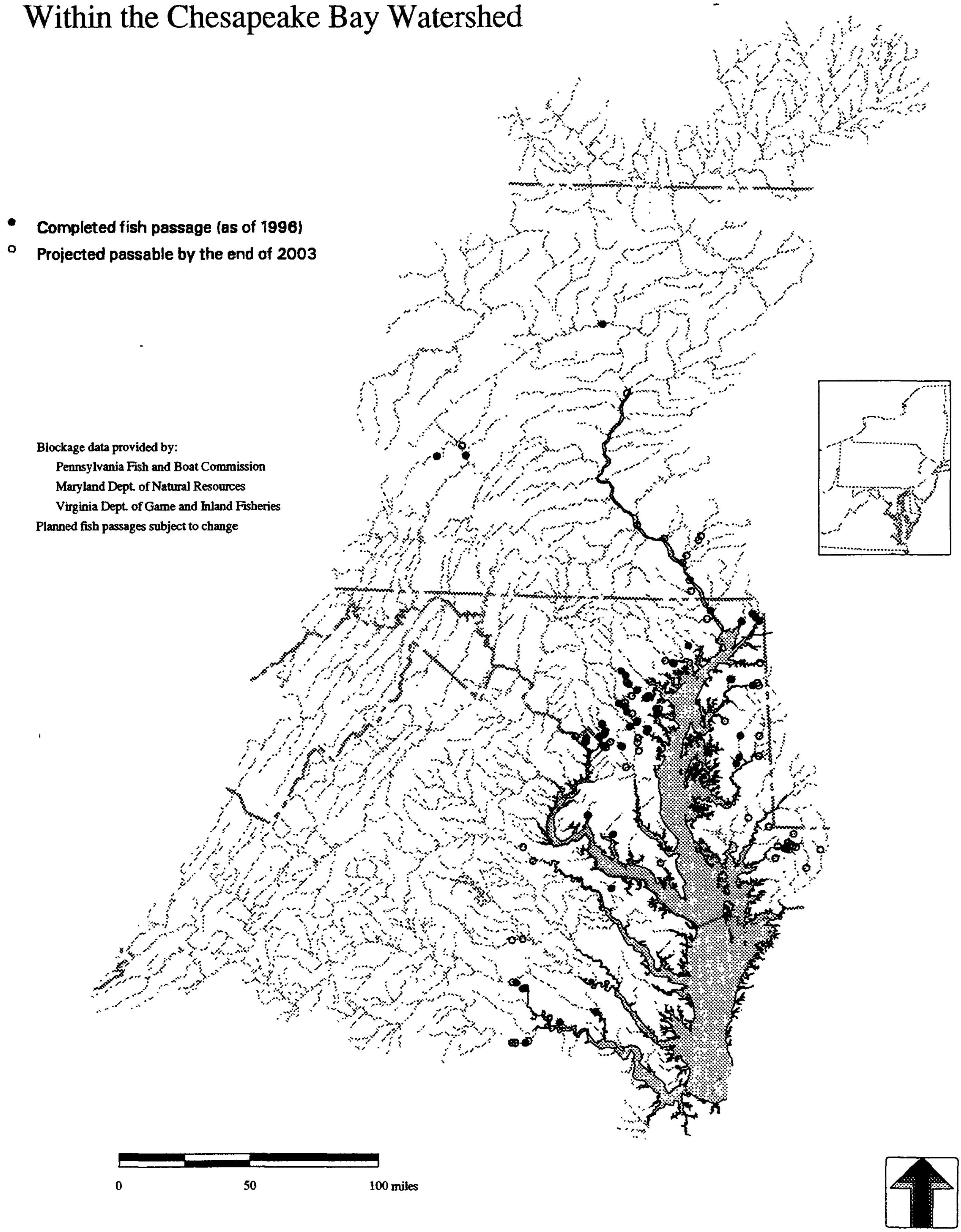
In 1995, 37.6 miles of tributary waters in the Chesapeake Bay watershed were reopened to anadromous fish migration through breaching, notching and development of fish passage facilities at dams; 55.8 miles were opened in 1996. By the end of 1996, Bay jurisdictions had completed nearly 50 fish passage projects, opening a total of 271.8 miles of stream habitat. This includes 149 miles opened prior to the 1993 Directive. Of the total miles, 195.6 miles are opened to anadromous fish; 76.2 are opened only to non-anadromous fish. Major projects on the Susquehanna and James Rivers, to be completed in 1997-98, will substantially add to this total. Before the turn of the century, another 1,061 miles will be opened for migratory fish, when the 30 projects currently under design or construction in the watershed are completed.

Stream Miles Opened for Migratory Fish



Removal of blockages, combined with harvest restrictions and larval fish stocking, resulted in substantial increases in shad. The CBP Bay states, the Pamunkey Tribal Government in Virginia, and the U.S. Fish and Wildlife Service all contributed to American shad and river herring stock rebuilding efforts through trap and transfer of adult spawners and/or culture and release of marked larvae. During 1995-96, almost 90,000 adult shad and over 30,000 adult herring were stocked into spawning waters above dams in

Completed and Projected Fish Passages Within the Chesapeake Bay Watershed



Pennsylvania and Virginia. Throughout the watershed, hatchery production and stocking during this reporting period amounted to 46 million American shad and 900,000 hickory shad. During the past 15 years, the shad population estimate in the upper Chesapeake Bay improved from fewer than 10,000 fish to over 300,000, largely in response to hatchery releases. The percentage of wild shad at Conowingo Dam soared to 45% in 1996. This shows that hatchery-reared shad are successfully reproducing and their offspring are making their runs back up into these tributaries Prior to this, only between 11 and 31% of the adult shad captured were wild. Other migratory fish, including herring and striped bass, are also benefitting from the opened stream miles.

Fish Passage Workshop

Forty water resource managers, engineers, consultants, land use planners, biologists, and government agency representatives gathered in Williamsburg, VA on March 21-23, 1995 for a Fish Passage Workshop, sponsored by the CBP. The workshop emphasized the basic needs of anadromous fish during migration and techniques for design and implementation of fishways. Class-room style instruction was supplemented with field trips to three Virginia fishways, including a double-Denil fish passage at Walker's Dam, a Denil fish passage at Harrison Lake, and a notch fishway at William Island Dam. Other dams and culverts blocking the migration of fish were visited to discuss site-specific designs for fish passage.

Submerged Aquatic Vegetation (SAV)

SAV grow in shallow water regions of the estuary and are ecologically important to the Bay's living resources. SAV provides food for waterfowl and habitat for fish, crabs, and invertebrates; removes suspended sediments from the water; and adds oxygen to water and sediments. Growth is dependent on sufficient levels of light reaching the underwater leaves. Sedimentation and algae that grow on SAV leaves and thrive in high-nutrient situations reduce the amount of light reaching plants. Thirteen species of SAV once covered over 400,000 acres of the Bay.

The Chesapeake Bay Program is working to restore SAV to historical levels of acreage, abundance and species diversity. In 1993, the Executive Council agreed to an interim goal of restoring 114,000 acres of SAV Baywide by 2005.

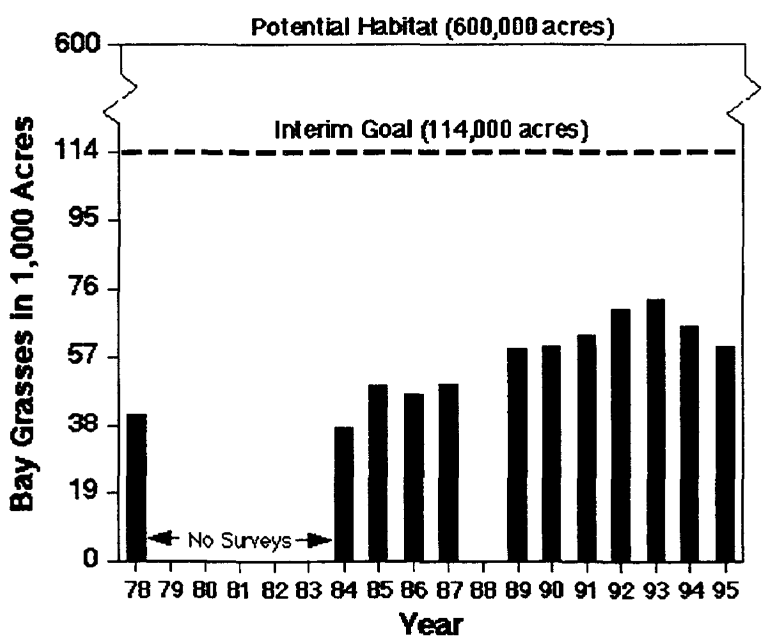
Progress Report

The amount of SAV observed in the Bay during 1995 increased 61% over its low-point in the mid-1980s. However, SAV coverage in the Bay declined by 8%, or 5,500 acres, between 1994 and 1995. This was the second consecutive year SAV declined in Chesapeake Bay. A total of 59,894 acres were documented during the 1995 aerial survey. Scientists attribute the decline to natural fluctuations, but speculate that spring floods in 1993 and 1994, which carried increased sediments and nutrients, may have contributed to the loss. Most of the losses occurred in three areas of the Bay: around the mid-Bay islands; in the lower mainstem of the Bay; and in the upper and middle Potomac River in Maryland. Several areas experienced increases in SAV abundance, including Eastern Bay and the lower Potomac River. The Chester, Magothy, Manokin, Sassafras, and Severn Rivers also gained SAV acreage in 1995.

Several initiatives to plant SAV in Chesapeake Bay continued or were started by SAV Workgroup members in 1996. These initiatives demonstrate the many partnerships working to improve Chesapeake Bay habitat. The Virginia Institute of Marine Science (VIMS) expanded a 15-year effort to plant eelgrass in Virginia portions of the Bay by increasing the number of areas and testing new techniques. The U.S. Geological Survey (USGS) continued research on the natural spread of SAV in the Potomac and piloted several planting projects. The National Oceanic and Atmospheric Administration (NOAA) supported an Alliance for the Chesapeake Bay (ACB) pilot project to plant eelgrass in St. Mary's River, done in cooperation with local partners. The ACB also worked with the Maryland Department of Natural Resources (DNR) to conduct pilot SAV planting projects in the Middle River, using seeds collected by watermen. The Department of Defense (DOD) started programs to monitor and, ultimately, restore SAV populations near Chesapeake Bay military bases in 1996. The Army's Aberdeen Proving Ground (APG) initiated SAV and water quality monitoring around their lands in the upper Bay and the Navy monitored SAV near the Patuxent Naval Air Station.

Annual surveys of SAV in the Bay continue and the results are being made available sooner than in past years. The latest results in map and tabular formats are now available on the VIMS World Wide Web site at: http://www.vims.edu/bio/sav/

At the time of publication, 1996 SAV acreage numbers were still undergoing analysis.



Aquatic Reef

Aquatic reefs have an important ecological role in Chesapeake Bay. Aquatic reefs provide essential habitat for the Bay's oysters, as well as finfish and crabs. Historically, reefs of densely packed individual oysters grew upward and outward, creating hard surface over many acres of Bay bottom and three-dimensional habitat for bay creatures. Reef acreage has been lost to harvest pressure, oyster diseases, and pollution. Harvesting techniques have reduced many three-dimensional reefs to flat surfaces.

The *Aquatic Reef Habitat Plan* establishes specific goals to rebuild and restore reefs as habitat for the oyster and other reef community species. The plan commits Bay Program signatories "to enhancing, protecting, and restoring benthic reefs as ecological systems to benefit the oyster resource and the diverse ecological community associated with Chesapeake Bay structured reefs." Approximately 5,000 acres each in Maryland and Virginia, and 1,000 acres in Potomac River, must be designated as oyster reef habitat by the year 2000. Oyster reef habitat will be created within these designated areas.

Designation of Oyster Reef Habitat

Maryland, Virginia, and the Potomac River Fisheries Commission (PRFC) have different approaches to fulfilling the *Aquatic Reef Habitat Plan* goals of designating and creating aquatic reefs. Maryland is designating specific geographic areas that will be set aside as aquatic reef areas. Their goal is to enhance and/or create aquatic reefs on approximately 10% of the bottom within these areas. The designation process should be completed by the end of 1998.

Virginia is creating reef habitat and then monitoring the "field of effect" of the constructed reef. The field of effect is considered the area that is positively impacted for oysters per square foot of created reef habitat. Defining how much effect a new oyster reef has on an area is essential to determining the areas designated.

The PRFC is primarily following the designation and creation methods used in Maryland, but field of effect is monitored as well.

Aquatic Reef Creation Progress

Aquatic reefs are being created using designed structures, oyster shells, rock, fly ash, and recycled materials. Virginia completed three oyster reefs in 1995 and two in 1996, for a cumulative eight reefs built. Maryland reef construction began in 1996, with seven reefs created. Success of reef restoration has been demonstrated by the colonization of natural oysters within a mile radius of one of Virginia's first reef projects. Maryland's structures are developing a representative oyster reef community.

Virginia is using historical records of reefs as a "footprint" for potential reef projects. Four oyster reefs were constructed in Piankatank River and two in James River during 1993-1995. Several reef-creation technologies were used. One technique involved washing shells off a barge to create intertidal structure. With another method, earthen mounds were constructed underwater and capped with shells. Both designs created three-dimensional structures that stand 5-6 feet off the bottom. Virginia built an intertidal reef in

Chesapeake Bay Program Reef Restoration Sites

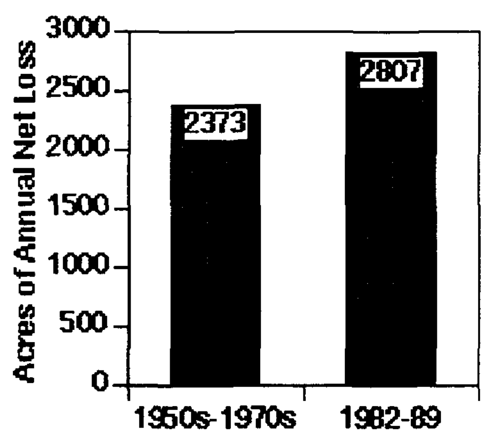
Data updated August 1996

the Great Wicomico River in 1996 and evaluated three types of reef-building materials, including coal ash, on a large reef constructed near Fisherman's Island.

Maryland used strategically placed oyster shell piles and designed concrete structures to create aquatic reefs. The constructed piles were 50 feet in diameter and 8-10 feet off the bottom. Two-foot concrete cubes with open sides were spread between the piles to increase structure diversity. Seven reefs, covering 373 acres were built in 1996: one each in the Magothy and Severn Rivers, and Eastern Bay; two in Patuxent River; and two in the main Bay.

Wetlands

Losses of Freshwater Wetlands

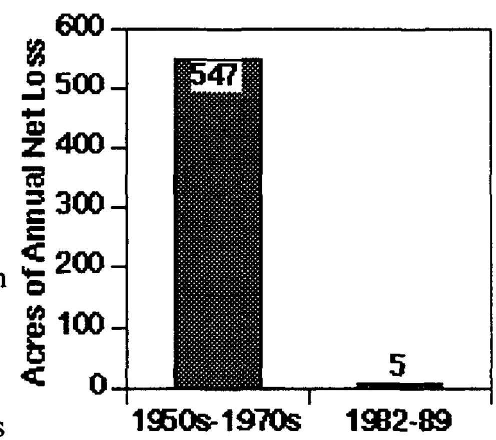


Wetlands are a vital link between the land and water of Chesapeake Bay. Wetlands help maintain water quality, contribute to flood and erosion control, and provide wildlife habitat. Nearly 1.5 million acres of wetlands occupy the Bay's watershed. Population and development pressures, however, are threatening both tidal and nontidal wetlands in all the Bay states. The Bay Program established a "no net loss" goal in 1988. The *Chesapeake Bay Wetlands Policy Implementation Plan* fosters protection of wetlands through four strategies: inventory and mapping of wetlands; protection of existing wetlands; rehabilitation and restoration of degraded wetlands; and education and research.

Wetlands Workshop

A Wetlands Workshop, held October 30-31, 1995, addressed wetlands mapping, functional assessment of wetlands, and mitigation banking. The workshop was sponsored by the LRSc Wetlands Workgroup and the Center for Coastal Management and Policy, Virginia Institute of Marine Science (VIMS), at the College of William and Mary. Participants ranked research priorities for the upcoming years. Assessment of wetland function in a watershed context and the effectiveness of restoration efforts were considered highest priority. Efforts will be undertaken to improve the understanding of linkages among wetlands, upland, water quality, and living resources. Impacts of development on wetlands continue to remain a concern among scientists and resource managers.

Losses of Estuarine Wetlands



Fisheries Management

Bay fisheries were traditionally managed separately by Pennsylvania, Maryland, Virginia, and the District of Columbia, with guidance from several fisheries management councils. Chesapeake Bay Fish Management Plans (FMPs) are developed to provide compatible, coordinated management for the conservation and wise use of the Bay's fishery resources. To be effective, Chesapeake Bay FMPs must consider biological, economic and sociological factors of each resource.

The *1987 Chesapeake Bay Agreement* mandated the development of FMPs for commercially, recreational and ecologically valuable aquatic species. Fourteen FMPs now provide guidance to Bay states for coordinated, Baywide management of fisheries. The *Strategy for the Restoration and Protection of Ecologically Valuable Species* goes a step further, requiring the incorporation of habitat requirements for species as part of FMPs.

Fishery Management Plans

Alosids (Shad and herring)
American Eel
Atlantic Croaker and Spot
Black Drum
Black Sea Bass
Blue Crab**
Bluefish
Horseshoe Crab
Oysters
Red Drum
Spanish and King Mackerel
Striped Bass
Summer Flounder
Weakfish and Spotted Seatrout

** available Summer 1997

Fisheries Habitat

The Chesapeake Bay Program is increasing emphasis on fish habitat through two different mechanisms. New Chesapeake Bay FMPs will include Chesapeake Bay-specific habitat requirements for each fish species. Habitat protection and restoration recommendations are being made, based on the expanded habitat information. The *1996 Chesapeake Bay and Atlantic Coast Black Sea Bass FMP* is the first to comprehensively address habitat requirements. This new FMP, adopted by the Chesapeake Executive Council in 1996, recommends the development and implementation of regional programs to rebuild and restore aquatic reefs, protection of SAV, protection and restoration of Chesapeake Bay wetlands, and continued implementation of nutrient reduction and toxics prevention programs.

Habitat sections were created for the Blue Crab FMP, to be published in summer 1997. Another upcoming document, to be published in late 1997, will link the importance of habitats in the Chesapeake Bay watershed with fisheries. This new habitat-fisheries linkage document and the enhanced habitat information in FMPs will provide additional tools for resource managers working to protect and restore Bay fisheries.

Biological Monitoring

Over 2,700 species of plants and animals inhabit the Chesapeake Bay region. To better assess the state of Bay resources, the Chesapeake Bay Program has enhanced and assisted state biological monitoring programs since 1984. Datasets for the Bay's mainstem and major tributaries are available from the states and are being acquired and used by the CBP. Aerial surveys track SAV coverage Baywide. Plankton programs are piggy-backed onto the CBP water quality monitoring program. States have kept track of benthos, bacteria, shellfish and finfish commercial landings, and juvenile finfish for decades. Summer and winter trawl and seine surveys supplement this information. Other state surveys also monitor habitat coverages, such as oyster bars and wetlands. Numerous waterfowl and songbird surveys are conducted throughout the United States; the Bay Program utilizes some of these data.

The *Living Resources Monitoring Plan* directs development of a Baywide monitoring program for commercially, recreationally and ecologically important species. The Monitoring Plan recommends the establishment of long-term, Baywide monitoring of the Bay's plant and animal resources. Analysis of these datasets is essential for a full understanding of how humans are impacting the Chesapeake Bay ecosystem, as well as the progress of Bay Program protection and restoration efforts.

Data Management

The Living Resources Subcommittee data management program has acquired numerous datasets -- some gathered through CBP monitoring programs and some acquired from other organizations. Living resources data is used to create indices of environmental health and progress of Bay Program activities. Modelers incorporate data to enhance model performance or verify model predictions. Other researchers may use the data to correlate animal abundance with water quality factors or other living resources.

During 1995 and 1996, many datasets became available to researchers on the Chesapeake Bay homepage (http://www.epa.gov/chesapeake/). Other datasets can be acquired by request through the homepage or by contacting the Chesapeake Bay Program's data manager. Plankton and benthos monitoring data now exist in a relational database structure. This structure is compatible with the CBP water quality and toxics databases. Species are coded with the National Oceanographic Data Center (NODC) species codes. Historic benthic data and marine mammal strandings data are also available.

Habitat and Living Resources Monitoring Workshop

The Bay Program's Scientific and Technical Advisory Committee (STAC), the Monitoring Subcommittee, and the LRSc gathered in September 1995 to discuss existing monitoring programs and formulate future needs for the program. Cooperation and coordination between the Monitoring and Living Resources Subcommittees ensures a monitoring program plan that will aid the modeling process and answer specific questions about the fate of living resources in Chesapeake Bay.

Primary recommendations focused on the need for a conceptual framework for living resource monitoring so that benthos, fish and other living resources can be linked to water quality over time. These linkages will demonstrate the far-reaching consequences of management policies. The group decided to form a new ecosystem indicator workgroup, assigned to develop ecosystem-level indicators of the Bay's health. Participants hope to see creation of a Benthic Restoration Goal Index in the near future. Monitoring to determine nonpoint source nutrient loads further up the tributaries and the impacts of nutrient reductions in nontidal waters on living resources is needed. Improved data management, increased spatial and temporal coverage, and integration of databases completes the list of recommendations from the workshop.

Zooplankton Monitoring

A zooplankton monitoring program for Chesapeake Bay has existed since 1984. Technical indicators for phytoplankton and zooplankton were completed in 1996; these will eventually reside on the Program's homepage. Although many of these indicators are highly technical, a "Food Availability Index for Striped Bass and White Perch Larvae" may provide a good indication of fish larvae habitat quality. Zooplankton and phytoplankton data are incorporated into the Tributary Water Quality Model, as the first step toward linking water quality with higher plants and animals. Evaluation of the program this year resulted in two important changes in the monitoring program. Beginning January 1996: (1) the frequency of sampling was decreased; and (2) spatial coverage of the Bay was increased with the addition of new monitoring stations. Greater spatial coverage will help delineate zooplankton and phytoplankton changes in the tributaries.

Stream Surveys

Stream surveys conducted in Pennsylvania during 1995-96 assessed the physical and chemical characteristics of selected tributaries in the lower Susquehanna River basin. Stream assessments determined characteristics associated with anadromous fish habitat. Blockages that prevented migratory fish passage along these streams (and a few others) were also inventoried. In 1996, Phase III of the Pennsylvania fish blockage inventory was completed. This was the final phase of the Pennsylvania effort, funded by the CBP, which inventoried most of the major stream systems below the confluence of the Susquehanna and Juniata Rivers in Pennsylvania.

During this reporting period, blockages were also identified along selected tributaries of the Rappahannock River in Virginia. Data from habitat and fish surveys on those streams will be used to test a new model for assessing habitat suitability. Virginia Commonwealth University, who conducted the surveys, completed preliminary data compilation in 1996.

Modeling

The Chesapeake Bay Ecosystem Modeling Program explores how water quality, the growth of plants and animals, and the physical and chemical forces of Chesapeake Bay affect each other. Model simulations help predict how things may change over time or under different conditions. The Bay Program's ecosystem models help clarify how the Bay's plant and animal life interact with the environment. Ecosystem models emphasize nutrient and organic matter sources and cycles, interactions among food web connections, and habitat structures. These state-of-the-art models help explain how and why the things we observe in Chesapeake Bay happen.

The *Strategy for the Restoration and Protection of Ecologically Valuable Species* directs Bay Program partners to pursue development of simulation models of the Chesapeake Bay ecosystem. Simulation models are part of a bigger package designed to restore and protect Bay species, at all trophic levels. Meeting the *1987 Chesapeake Bay Agreement* goal to "provide for the restoration and protection of the living resources, their habitats and ecological relationships" requires understanding the physical, chemical, and biological processes at work in the Bay. The Ecosystem Modeling effort is developing a series of interlinked models that address relationships in the Bay by simulating critical habitats of Chesapeake Bay. These simulations will be used for management decisions concerning land use, nutrient loadings, and fish production.

Water Quality and Living Resources Modeling Workshop

The ability of the current ecosystem models to respond to specific environmental conditions requires information on the entire Bay ecosystem, including the tributaries. A workshop, held July 11, 1995, assessed the current tributary modeling efforts. The primary objective was the technical transfer of modeling capabilities from ecosystem process models to the larger Chesapeake Bay water quality model. As a result, the workshop focused on the delineation of the shallow water zone and the incorporation of ecosystem process models such as SAV, benthos, and zooplankton. A multi-disciplinary team of modelers have begun incorporating ecosystem process models into the Bay Program's Tributary Water Quality Model. Expanded water quality modeling efforts include adding two zooplankton size-groups and dividing benthos into suspension feeders and deposit feeders. This allows linkages between primary producers, like SAV, with primary consumers like herbivorous fish. These fish are part of the middle trophic level in the complex Bay food chain and a crucial link needed to understand how nutrients ultimately affect fish.

What Can the Ecosystem Models Tell Us?

Top-down and bottom-up ecological controls, named for their direction of influence, can be examined using ecosystem models. It is well documented that nutrients, like nitrogen, affect the growth of algae. What is less known, is that living resources, such as SAV and fish, impact water quality as well. Top-down ecological controls start with a predator fish like striped bass, which eats menhaden and Bay anchovy. Because menhaden and anchovy consume plankton, striped bass ultimately affect plankton populations. Plankton affect dissolved oxygen (DO) levels in several ways, so through a chain of events, striped bass may eventually affect DO levels in the Bay. The activities of striped bass trickling down to DO is considered top-down controls. Bottom-up controls start with nitrogen and phosphorus entering the Bay via runoff from land and air pollution. High levels of these nutrients can trigger algal blooms which cloud water, blocking light to SAV. As a result, SAV may die. Bottom-up ecological controls start at the lowest level, like nutrients, and build up to higher trophic levels, like SAV and fish.

The Fish Bioenergetics Models offer bottom-up and top-down linkages among Chesapeake Bay's water quality, plants, and animals. From a bottom-up perspective, the models show how phytoplankton affect the growth and production of fish such as menhaden, anchovy, and striped bass. Top-down controls simulated by the ecosystem models include the impacts of predator fish on smaller fish, like menhaden and Bay anchovy. Those impacts eventually filter down to plankton populations.

The Zooplankton Indicators Development Project used monitoring data to describe linkages between plankton-eating fish and zooplankton, as well as between zooplankton and algae. Recent evidence from this project supports evidence simulated in the Fish Bioenergetics models. Results suggest that top-down controls from predator fish -- or the lack of these controls -- may significantly affect the number of plankton-eating fish, like menhaden and anchovy, living in Chesapeake Bay. These effects trickle down through zooplankton, phytoplankton, and benthos. DO may ultimately be affected. Another model, the Planktonic-Benthic Interactions Model, simulates potential impacts that suspension feeders, like clams and oysters, have on DO.

Currently, ecosystem model results are applicable only to the mainstem, mid-Bay regions. With completion of the Chesapeake Bay Tributary Water Quality Model at the end of 1997, predictions should extend into the James, York, and Rappahannock Rivers.

Communications

The Living Resources Subcommittee provides outreach through printed materials, free provision of datasets, and new for 1996, via the World Wide Web. The Chesapeake Bay Homepage now offers researchers, students, and other online users general information on the Bay, technical information and datasets, publications, and document descriptions. Production of technical documents, policy papers, implementation plans, and presentations are supplemented with GIS-based maps. Whenever possible, public outreach includes newspaper and television coverage of the Bay's living resources, especially SAV, crabs, and fish.

Chesapeake Bay homepage address:
http://www.epa.gov/chesapeake/
VIMS SAV homepage address:
http://www.vims.edu/bio/sav/

Homepage

The Chesapeake Bay Program homepage includes a Living Resources page, which is in the early stages of development. The homepage includes general information on the Bay's living resources, indicators of the Bay's health, and technical information and data. New publications are announced and can be ordered with an online request form. Living resources datasets can be found on the Biological Monitoring Data directory. In addition, a link to the Virginia Institute of Marine Sciences (VIMS) homepage provides the latest SAV aerial survey data. SAV data is put online as it's analyzed.

1995-96 Publications

Chesapeake Bay Habitat Restoration: A Framework for Action
Chesapeake Bay Ecosystem Modeling Program: Technical Synthesis Report 1993-94
Guidance for Protection Submerged Aquatic Vegetation in Chesapeake Bay from Physical Disruption
Introduction of Non-Indigenous Aquatic Species Implementation Plan
1994 and *1995 Distribution of Submerged Aquatic Vegetation In the Chesapeake Bay*
1996 Chesapeake Bay and Atlantic Coast Black Sea Bass Fishery Management Plan
The 1996 Users Guide to Chesapeake Bay Program Biological and Living Resources Monitoring Data
Removing Impediments to Migratory Fishes in the Chesapeake Bay Watershed: 1995 Annual Progress Report
Wetlands and the Chesapeake Bay (fact sheet)

Living Resources Subcommittee

Chair: Carolyn Watson, Maryland Department of Natural Resources (MDNR)
Coordinator: Carin Bisland, U.S. Environmental Protection Agency (US EPA)

Workgroup Chairs
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