CHESAPEAKE BAY:

REMOVING IMPEDIMENTS TO MIGRATORY FISHES

FISH PASSAGE IN THE CHESAPEAKE BAY AGREEMENT

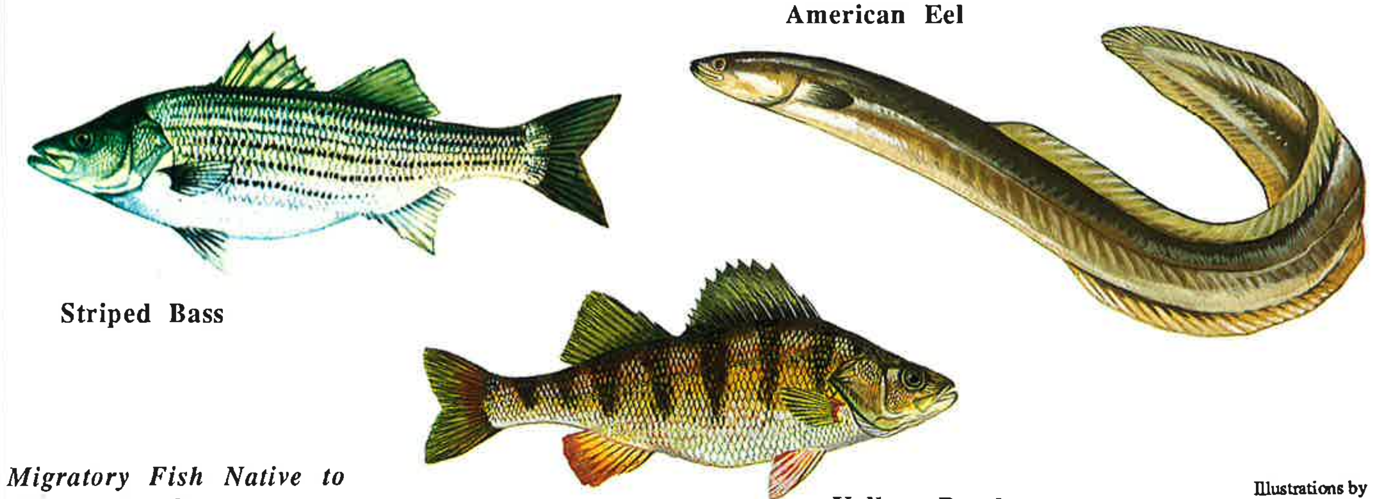
Thousands of miles of fish spawning habitat on Chesapeake Bay tributaries are currently blocked by dams, culverts and other obstructions. Restoring and protecting the Bay's vital fishery resources are integral components of the 1987 Chesapeake Bay Agreement. Working toward this restoration goal, the signatories of the Agreement have supported a commitment by the States and Federal government to:

Provide for fish passage at dams, and to remove stream blockages wherever necessary to restore passage for migratory fishes.

A workgroup of the Chesapeake Bay Program's Living Resources Subcommittee was formed in December 1987 to develop the strategy for fish passage. The membership of the Fish Passage Workgroup includes representatives of the National Marine Fisheries Service, U.S. Fish and Wildlife Service, Maryland Department of Natural Resources, Chesapeake Bay Foundation, Pennsylvania Fish Commission, Virginia Department of Game and Inland Fisheries, Virginia Council on the Environment, and the District of Columbia Fisheries Management Program.

BACKGROUND

Of the approximately 260 fish species found in Chesapeake Bay, perhaps those most revered and sought after by both sport and commercial fishermen are the migratory species. This group includes "anadromous" fishes such as striped bass, river herring and shad that spend most of their adult lives in saltier coastal waters but return each year to spawn (reproduce) in fresh water. Another class of migratory fishes are the "catadromous" species, represented in the Bay watershed by the American eel. Catadromous fish spend most of their adult lives in fresh water, returning to the ocean to spawn. Together, anadromous and catadromous species are described as diadromous, or migratory between salt and fresh water. Other species, including white and yellow perch, migrate to fresh water to spawn but spend the rest of the year in the brackish waters of Chesapeake Bay.



Migratory Fish Native to Chesapeake Bay

Illustrations by Duane Raver, Jr.

Table 1

RECENT COMMERCIAL HARVESTS OF MIGRATORY FISHES IN CHESAPEAKE BAY

(Average annual tons for each 10-year period)

		1966-1975	1976-1985	% Decline
American Eel	VA	427.1	257.0	40%
	MD	117.8	106.7	9%
American Shad	VA	1,114.0	454.0	59%
	MD	409.7	37.4*	91%
Hickory Shad	VA	18.8	0.5	97%
	MD	8.7	0.6*	93%
River Herring	VA	9,486.0	725.0	92%
(Blueback herring and alewife)	MD	1,094.7	71.0	94%
Striped Bass	VA	1,059.0	226.0	79%
	MD	1,803.3	642.4*	64%
White Perch	VA	173.8	65.0	63%
	MD	650.8	341.9	47%
Yellow Perch	VA	1.9	0.2	90%
	MD	51.8	14.9	71%
Total	VA	12,280.6	1,727.7	86%
	MD	4,136.8	1,214.6	71%
TOTAL	Bay	16,417.4	2,942.6	82%

* *Pre-moratorium*

At one time, Chesapeake Bay abounded with these migratory fishes. Striped bass, shad and river herring (the collective term for blueback herring and alewives) supported extensive recreational and commercial fisheries during their annual spawning runs. Today, however, landings of migratory fishes are at the lowest ebb in history. In Maryland, the catch of American shad has declined from over 7 million pounds a century ago to about 20,000 pounds in 1980. In Virginia waters, shad harvests now average around 900,000 pounds, compared to over 11 million pounds a hundred years ago. A once thriving shad run in the District of Columbia has similarly declined, and fishes no longer migrate up the Susquehanna River to Pennsylvania due to several dams its the lower reaches.

During the last twenty years the decline in commercial landings has been particularly steep. The majority of landings have decreased by 90% or more (see table 1). This decline is the result of an intricate complex of factors -- some natural, most man-made -- including pollution and siltation of spawning areas, overharvesting by commercial and recreational fishermen, and construction of dams and other obstructions across the Bay's streams and rivers which prevent access to formerly utilized (historic) habitat.

FISHERY VALUE

The decline of migratory fishes has had significant economic and ecological impacts on the Bay area. In 1920, American shad and river herring were number one and two in value of those finfish species landed commercially in Chesapeake Bay. Current values for these species are slight by comparison. The American shad commercial catch for Chesapeake Bay peaked at about 17 million pounds at the turn of the century. Today these landings would be worth over $6 million at the dock. The 1985 harvest of shad from the Bay had a dockside value of $170,000.

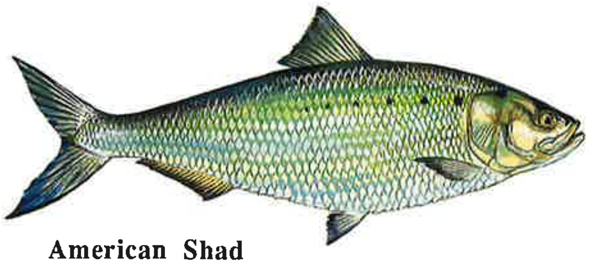
The benefits of restoring migratory fishes to their former abundance are increased greatly when the total value to the economy is considered. When taken to the retail level, commercial fisheries are worth significantly more than their dockside value. Sportfishing also has a great impact on the economy due to retail purchases by recreational fishermen. A 1981 study (1) estimated the fishery benefits of providing passage for migratory fishes past four hydropower dams on the lower Susquehanna River, opening nearly 350 mainstem river miles of historic habitat. The study considered the expectedbenefits from the commercial and recreational harvests of American shad. The value to the economy ranged from a low estimate of $42 million to a high of $185 million annually. This analysis did not include other social and aesthetic values immeasurable in dollars. It also did not include the potential benefits of restoring other migratory species. The 1981 estimated one-time cost for providing fish passage at the four dams was $60 million.

A similar analysis (2) was conducted in 1987 for the James River to estimate the value of providing fish passage around the five dams at Richmond, extending the range of migratory fishes to Lynchburg, Virginia. Approximately 140 river miles would be opened. The estimated economic benefits of restoring several anadromous species to this stretch of river ranged from $8.1 to $13.1 million annually. The cost of fish passage facilities was estimated to be a one-time expenditure of $4.5 - $6.5 million.

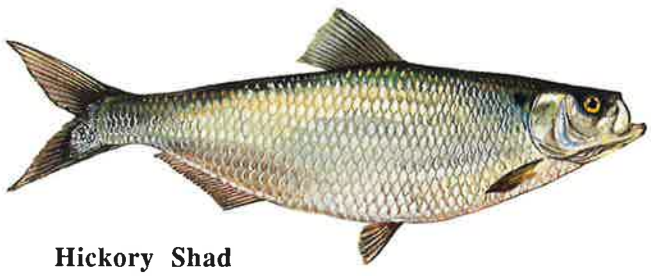
While the economic benefits of a fishery can be mathematically estimated, it is more difficult to calculate the ecological value of fish restoration. Shad, herring and other migratory fishes have

1. "Economic Benefits Associated with Shad Restoration on the Susquehanna River," McConnell and Strand, University of Maryland, 1981.
2. "Anadromous Fish Passage in Virginia," Virginia Council on the Environment, 1987.

POTENTIAL AMERICAN SHAD SPAWNING AND NURSERY HABITAT OF MAINSTEM RIVERS *

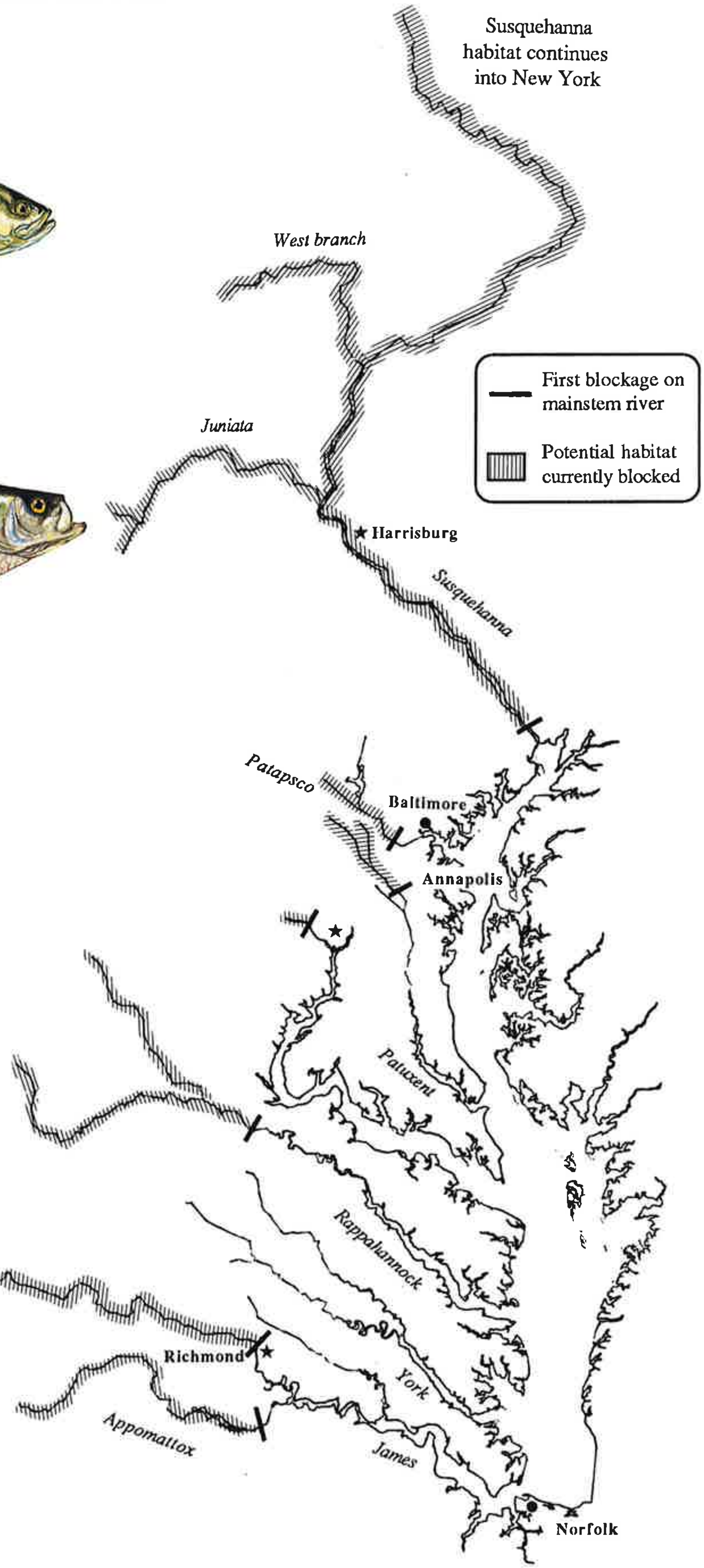


American Shad



Hickory Shad

Alewife Herring



* Potential habitat in the smaller tributaries of the mainstem rivers too detailed to include

American shad to the river as part of a cooperative restoration project. Pennsylvania law gives the Fish Commission authority to require passage at obstructions to fish migration on all waters of the state. This authority is superseded by federal regulations governing hydropower dams.

District of Columbia

Resource managers from the District of Columbia have assessed the impact of dams and blockages on local fishery resources. The municipal water supply dam at Little Falls excludes migratory fishes from 10 miles of valuable habitat. While just outside of D.C. borders, fish passage at the dam would help restore historic migratory fish runs to District waters. Other blockages on Rock Creek and tributaries of the Anacostia River also must be remedied.

SOLUTIONS

The structures which act as impediments to fish migration are diverse, ranging from large hydropower dams to small road culverts. No one solution can address all situations. The objective of fish passage is to decrease the vertical gradient and water velocity so that upstream navigation is within the fish's physical capability.

The simplest solution is to remove part or all of an obstruction. This is only possible when the structure has no useful purpose and when breaching would not adversely affect the river.

Some structures such as culverts and gauging stations can be redesigned to provide the gradient and flow necessary for fish passage. Culverts can be set below grade (partially buried in the riverbed) and gauging stations can be modified to minimize vertical rise.

A common solution is to install a fish passage facility, or fishway, to allow fish to pass over or around an obstruction. On smaller blockages, a "fish ladder" is used. This is a passive flume-like (inclined water channel) structure with a series of baffles or weirs which interrupt the flow of water (see Figure 1). The fish negotiate a ladder just as they would natural rapids.

For large dams with a vertical rise of fifty feet or more, a mechanized device known as a "fish lift" is often used. Fish are attracted by flow into a confined space and elevated in a volume of water over the dam. In some cases, fish will be transported in special tank trucks around several dams until all are fitted with passage facilities.

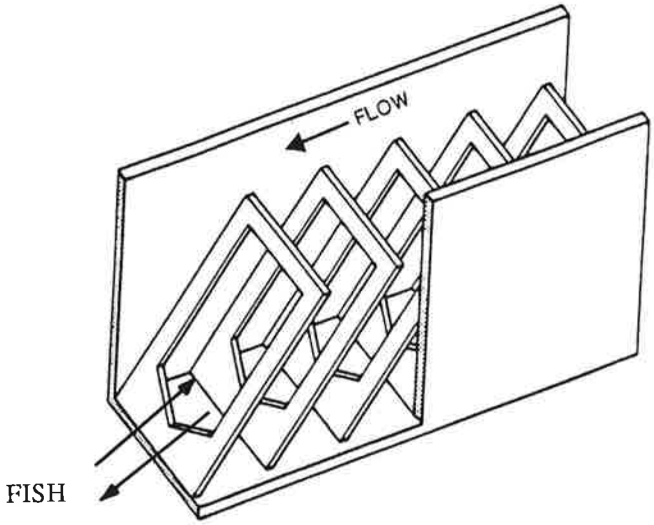


Figure 1. A common variation of the Denil Fishway concept, cut-away view.

Fish passage technology is well-developed and proven effective. Several New England states have active and successful programs providing passage for migratory fishes. In Massachusetts, nearly two hundred fishways maintain fish migrations on approximately one hundred tributaries. On the Connecticut River, migratory fishes have been restored to 174 miles of historic habitat as a result of fishway operations at 3 dams. These successes can serve as examples for Chesapeake Bay states.

A LOOK TO THE FUTURE

The Chesapeake Bay Program's Fish Passage Workgroup has analyzed existing information to determine what is known about blockages to fish migration. The findings of the Workgroup are summarized in a report entitled Removing Impediments to Migratory Fishes in the Chesapeake Watershed. Some of the recommendations contained in the report, which will be finalized in December 1988, are as follows:

1. Blockages - A multi-faceted approach is necessary to help restore migratory fishes. The states should develop programs in the following areas:

a) Culverts - All future road and highway culverts should be designed and constructed to assure the passage of migratory fish species present or potentially present in the affected stream. The highway department of each Bay state, with the assistance of other responsible agencies, should prepare an inventory of existing culverts which act as impediments to migratory fishes, and plan a strategy to remedy this problem.

historically played an important role in the Chesapeake Bay ecosystem. Along with the other Bay initiatives to reduce nutrient input, increase aquatic grass abundance and control fishing, restoration of these species will help return the Bay system to its natural productivity.

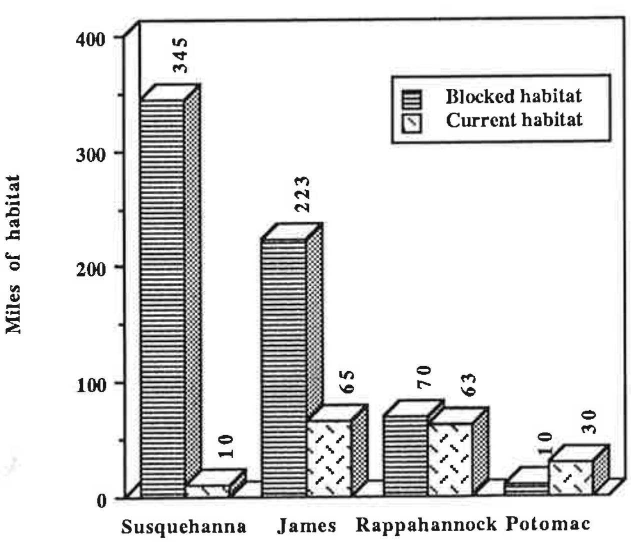
Reintroduction of anadromous fishes to their previous spawning grounds will have an ecological impact on those freshwater systems as well. Studies have shown that in freshwater areas where herring have been restored, resident fish populations were enhanced as compared to similar areas without herring. The juvenile herring produced in the spawning run serve as a forage base (food supply) for bass and other resident species.

IMPEDIMENTS TO MIGRATION: A BAY-WIDE PROBLEM

Impediments to fish migration exist on nearly every tributary of the Chesapeake Bay. Over the years, the Bay states have conducted inventories to document the type and location of these blockages. Several thousand have been found to exist in the Bay watershed. The most well known are the large hydropower facilities such as Conowingo Dam on the Susquehanna River. Fish migration can be blocked, however, by a structure with a vertical height of only one foot. Where a road passes over a small tributary, the stream runs through a culvert which may act as a blockage. On many tributaries, state and federal agencies maintain gauging station weirs to monitor streamflow. These, too, may act as blockages. Finally, a wide variety of small to mid-sized dams are found in the Bay watershed. These dams include historic mill and municipal water supply dams, as well as wildlife or recreational impoundments.

POTENTIAL SPAWNING AND NURSERY HABITAT FOR AMERICAN SHAD

(excluding smaller tributaries of the four rivers)



Virginia

Several regional surveys of stream blockages have been done in Virginia, but the data are incomplete and not currently centralized. On the James River, five dams located in Richmond block access to nearly 140 miles of historic habitat. Providing fish passage at these blockages has become a top priority for the Commonwealth. Further upstream, a series of seven dams around Lynchburg block an additional 84 miles of habitat. The first of these dams was recently granted a license for hydropower generation which requires provision for fish passage. The Embrey Dam at Fredricksburg, which blocks 70 miles of the Rappahannock River, was recently issued a hydropower license with similar conditions. However, neither of these dams have yet been modified to allow fish passage. Virginia law requires fish passage at stream obstructions, but several key regions and all dams over twenty feet high are exempt.

Maryland

In Maryland, anadromous fish spawning streams were surveyed from 1968 to 1980. Nearly 900 man-made stream blockages were documented; this inventory, however, must be updated. The Department of Natural Resources has identified priority sites where mitigation work should begin. One of the priority sites is on the Patapsco River where four dams block access to nearly 30 miles of migratory fish habitat.

The top priority for Maryland is the Susquehanna River, historically important for American shad, hickory shad, and river herring. Construction of four hydropower dams on the lower river in the early 1900s blocked nearly 350 miles of habitat. Maryland is working with the power companies involved to have fish passage provided at these dams. Maryland has the statutory authority to require fish passage at obstructions other than hydropower dams, but this authority has not been widely applied.

Pennsylvania

Pennsylvania has also conducted an inventory of dams throughout the state. All dams are documented, but smaller blockages may not be. Emphasis has been placed on fish passage at the four dams on the lower Susquehanna River. In addition, Pennsylvania and the hydropower companies have devoted substantial resources to restocking adult and juvenile

b) Small dams / obstructions - Each Bay state should establish a priority list for future fish passage projects at all small dams and other obstructions. Projects at publicly-owned obstructions should be undertaken as a cooperative effort between the appropriate state agencies and local governments. Federal agencies should cooperate with state governments to mitigate federally-owned blockages. Private sector owners of blockages should, under state law, be responsible for providing fish passage under the direction of the appropriate state agencies.

c) Hydropower dams - Fish passage should be provided at all hydropower dams that block historic or potential migratory fish habitat. The States should evaluate the adequacy of current provisions for fish passage at such facilities within the Bay watershed. When necessary, the States should request reopening the licenses of hydropower facilities to assure that adequate provisions are made for fish passage within a reasonable time frame. In no case should any new licenses be issued without proper provisions for fish passage.

d) Reintroduction - Wherever necessary and appropriate, the States should initiate programs to reintroduce migratory fishes to habitat above present blockages. Young fish can become "imprinted" on the upstream habitat and will return to spawn there when the blockage is removed. Adult fish can be trapped below blockages and transported upstream to spawn, or young hatchery-produced fish can be stocked above the blockages.

2. Evaluation and Monitoring - Federal and state agencies should determine how effective the fish passage devices are at passing different species of fish. They also should evaluate the effects of restoration efforts on target species and other organisms in the biological community.

3. Public education and involvement - Public support and involvement must be an integral part of the fish passage program to insure its long-term success.

4. Technical expertise - In the Bay region, qualified assistance is needed to design and oversee the construction of fish passage facilities. The establishment of a technical advisory office would provide this necessary resource to Bay state and local agencies.

Historic mill dam with fish ladder. Small barrier dam directs fish toward base of ladder.

5. Blockage inventory - The responsible state and federal agencies should work together to compile an up-to-date, comprehensive inventory of dams and other obstructions to fish migration in the Bay states.

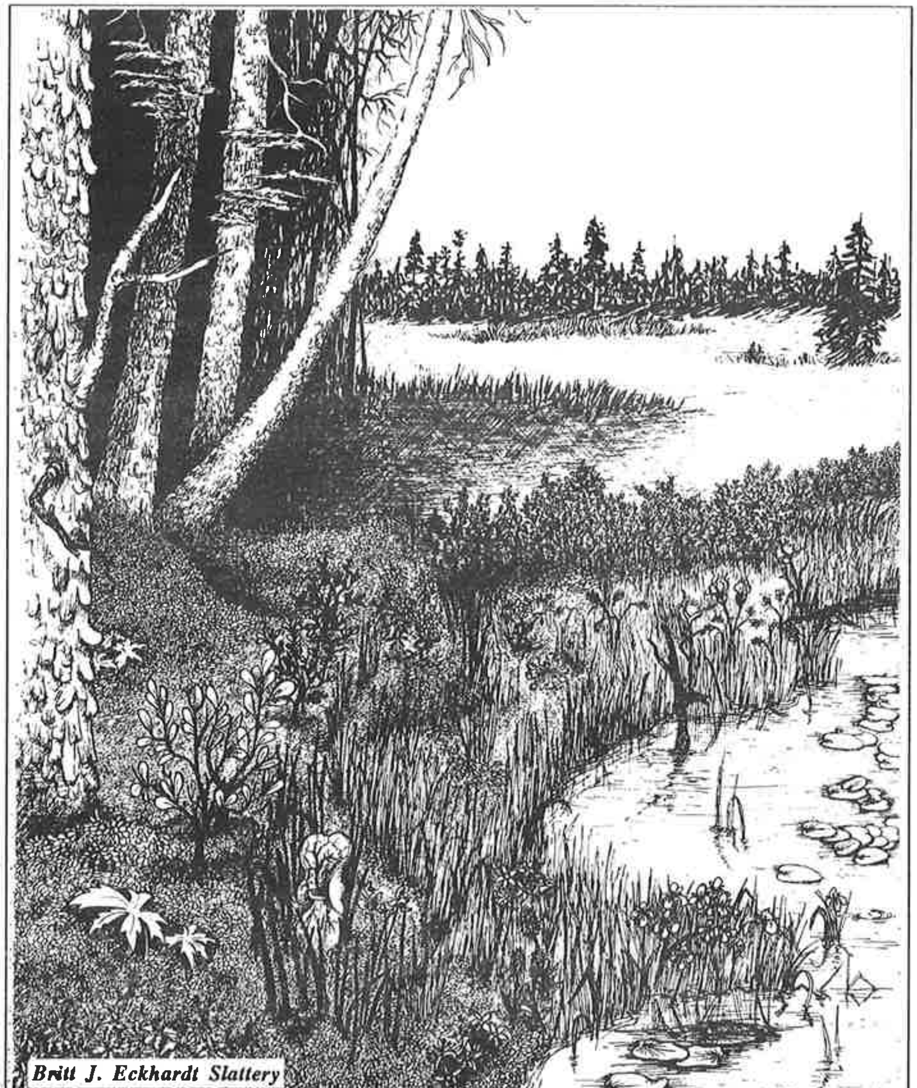
Using the Workgroup's findings, the Bay states will develop plans for removing these impediments which will require cooperation between state, federal, and local government as well as support from private citizens. With some time, money, and dedication, we can restore hundreds of miles of spawning habitat for the benefit of the Bay's fishery resources and the enjoyment of its citizens.

The Removing Impediments to Migratory Fishes in the Chesapeake Watershed report is available from the Chesapeake Bay Program, 410 Severn Avenue, Annapolis, MD 21403 (301) 266-6873.

This circular was printed by the Chesapeake Bay Foundation, with support from the Jessie B. Cox Charitable Trust and assistance from the Chesapeake Bay Program's Living Resources Subcommittee. **September 1988**

CHESAPEAKE BAY:

TIDAL AND NON-TIDAL WETLANDS POLICY



The Chesapeake Bay Program's Living Resources Subcommittee established a Tidal and Non-tidal Wetlands Workgroup in December, 1987 to develop a comprehensive Chesapeake Bay Wetlands Policy for the Bay watershed. The Workgroup, chaired by Maryland Department of Natural Resources, includes representatives from the U.S. Fish and Wildlife Service, U.S. Environmental Protection Agency, U.S. Army Corps of Engineers, National Marine Fisheries Service, Pennsylvania Department of Environmental Resources, Virginia Council on the Environment, and the District of Columbia Environmental Control Division.

BACKGROUND

Wetlands are usually semi-aquatic lands, either flooded or saturated by water for varying periods of time during the growing season. They form a transition zone between dry upland areas and deeper, permanent bodies of water. The term "wetlands" encompasses a variety of environments such as tidal marshes, shrub swamps, coastal mudflats, freshwater marshes, bottomland hardwood forests, wet meadows, and inland bogs.

At present, tidal and non-tidal wetlands constitute only three percent of the Chesapeake Bay drainage basin. Between the mid 1950s and the late 1970s, wetland destruction averaged over 2,800 acres annually. Continued wetland losses due to man-made impacts and natural causes increasingly threaten this valuable resource.

WETLANDS IN THE CHESAPEAKE BAY AGREEMENT

In recognition of the crucial function of wetlands within the Bay ecosystem, the Chesapeake Bay Agreement of 1987, signed by the Bay states and the federal government, makes the commitment:

By December 1988, to develop and begin to implement a Baywide policy for the protection of tidal and non-tidal wetlands.

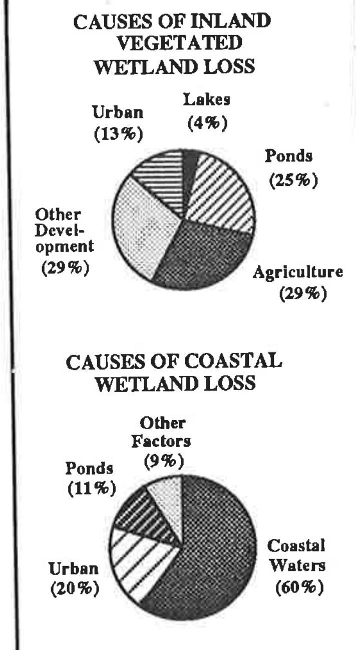
ECOLOGICAL VALUES

The health of the Chesapeake Bay ecosystem is inextricably linked to the abundance and condition of the wetlands in the Bay watershed. Some of the vital benefits wetlands provide include:

- Fish and wildlife habitat;
- Erosion control;
- Water quality improvement;
- Stormwater/flood control;
- Contribution of organic (plant) material to the Bay food web;
- Groundwater recharge;
- Habitat for rare, threatened and endangered species;
- Timber production; and,
- Recreational opportunities and scenic beauty.

Many of the Bay's living resources depend on wetlands for their survival. Large flocks of migratory ducks, geese and swans spend winters using the marshes for feeding and cover, while resident bird species rely year-round on wetland habitat.

Wetlands constitute the primary spawning and/or nursery sites for many finfish and shellfish species such as striped bass, menhaden, river herring, shad, spot and croaker, as well as blue crabs, oysters, and clams. When critical reproductive areas are filled for development or choked by pollution and excessive nutrients, the populations of these Bay species will decline.



Adapted from "Mid-Atlantic Wetlands: A Disappearing Natural Treasure," U.S. Fish and Wildlife Service and U.S. Environmental Protection Agency, 1987.

Wetland plants dampen wave action, helping to curb erosion. They are also highly effective in lessening shoreline erosion. Their roots hold soil in place, reducing sedimentation. Sedimentation is not intrinsically harmful; when it is accelerated by disturbances to the environment, however, oyster beds may be smothered and penetration of sunlight critical to the growth of submerged vegetation may be blocked.

Upland runoff and drainage water which pass through wetlands are essentially "filtered." This improvement in water quality comes from the wetland's ability to process excess nutrients such as nitrogen and phosphorus compounds, to intercept other pollutants, and to trap sediment and reduce suspended solids in the overlying water.

Controlling flood and storm waters is another important function of wetlands. Potentially damaging volumes of fast-moving storm or flood water are temporarily stored in wetland areas. The gradual release of these waters by the wetland minimizes erosion and urban/suburban property damage.

The aquatic food web is dependent upon tidal and non-tidal wetlands to provide nourishment for the many fish, shellfish, and smaller organisms that spend some period of their lives in the wetland habitat. Organic material, or food, is produced in the water by the breakdown of wetland plant leaves and stems.

The wetlands of the Bay states have an intrinsic natural beauty which provides recreational opportunities such as boating, fishing, crabbing and waterfowl hunting, as well as hiking, birdwatching, canoeing and other activities. The financial benefit of these wetland-dependent activities to the economy is significant, yet is threatened by continued wetland loss.

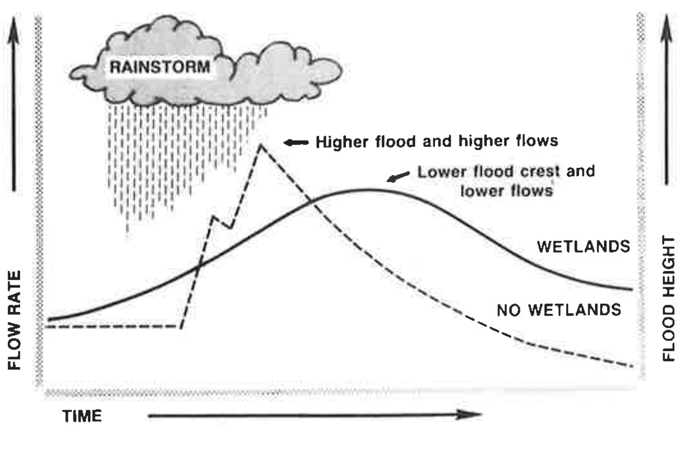


Figure 1. Wetland value in reducing flood crests and flow rates after rainstorms (adapted from Kusler, 1983.)

PROTECTION AND MANAGEMENT POLICIES

The goal of the Bay-wide strategy for the protection and management of wetlands within the Chesapeake Bay watershed is to achieve a net resource gain in wetland acreage and function over present conditions by:

- protecting existing wetlands; and,
- rehabilitating degraded wetlands, restoring former wetlands, and creating artificial wetlands.

By July 1990, implementation plans will be developed for the four following focus areas:

Defining the Resource: Inventory and Mapping Activities

To assess progress made toward the goal of net resource gain, comprehensive inventorying and monitoring of all wetland resources is needed. The National Wetlands Inventory and classification methods will be used to determine wetland distribution, acreage, and type.

Major actions include:

- Mapping of wetlands at 10-year intervals, in conjunction with status and trends analyses and cumulative impact assessments; and,
- Monitoring to quantify functions and values of various wetlands and to document changes occurring over time.

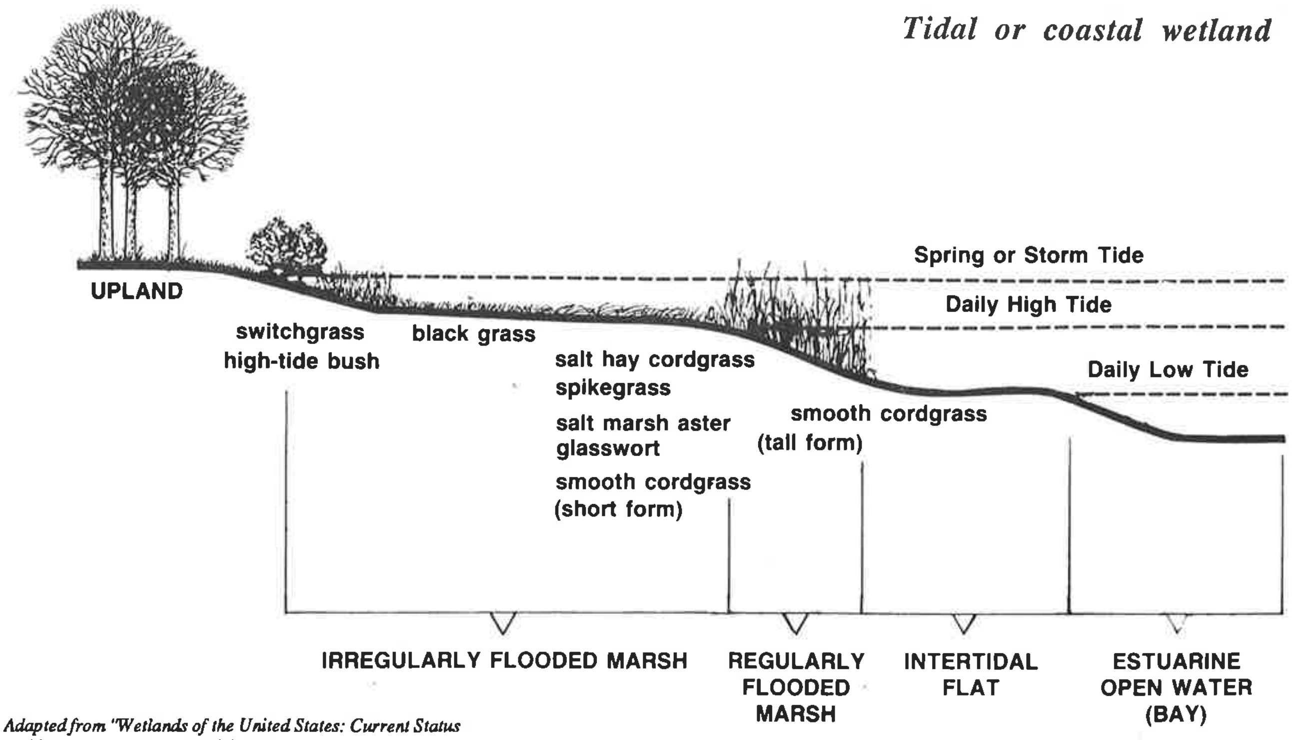
Holding the Line: Protecting Existing Wetlands

Existing regulatory standards and other programs at the federal and state level do not adequately protect wetlands. Management efforts must now be directed to control all wetland impacts--direct, indirect and cumulative.

Major actions include:

- Reviewing and evaluating existing regulatory and protection programs and initiating corrective measures;
- Identifying, in advance, wetland areas of special concern to enhance protection through the permitting process;
- Eliminating government sanctioned programs which are counterproductive to wetland protection, and establishing private sector incentive programs; and,
- Identifying priority areas for wetland preservation through land acquistion.

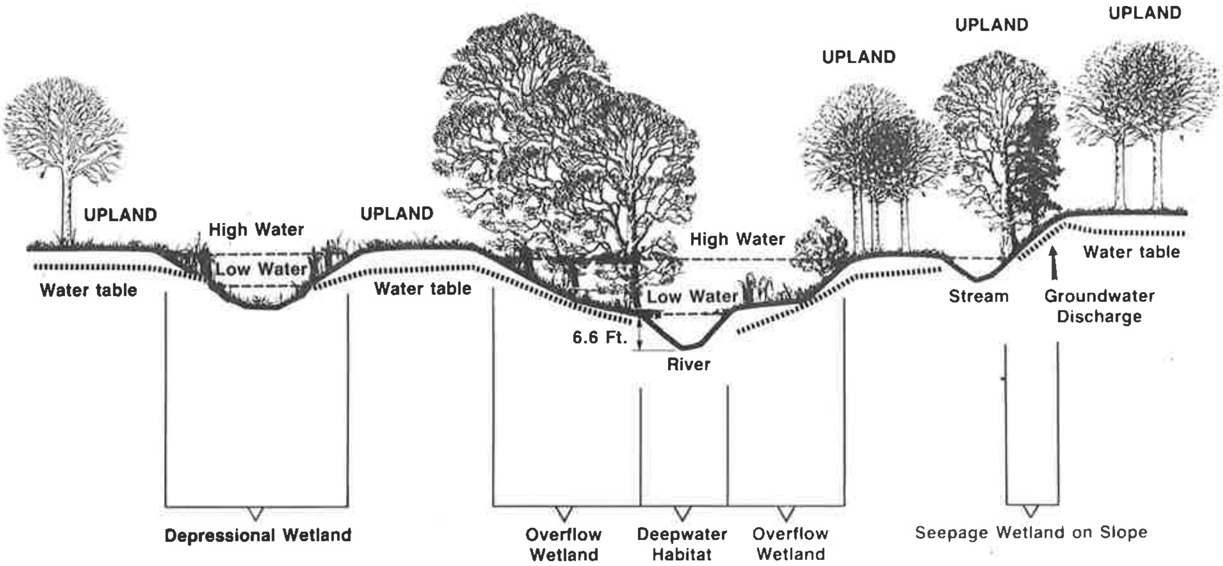
Tidal or coastal wetland



Adapted from "Wetlands of the United States: Current Status and Recent Trends," U.S. Fish and Wildlife Service, 1984.

Non-tidal or inland wetland

Adapted from "Wetlands of the United States: Current Status and Recent Trends," U.S. Fish and Wildlife Service, 1984.



Building the Base: Rehabilitating, Restoring, and Creating Wetlands

Commensurate with the goal of obtaining a net resource gain is the need to maintain the existing wetlands base, thereby reducing extensive creation and restoration projects. In those instances when unavoidable losses occur, compensatory creation, rehabilitation or restoration measures will be required. The Policy emphasizes cooperative design and evaluation of compensatory mitigation projects, along with long-term monitoring and management of these sites. Equally important tools for building the base of functioning wetlands are incentives and land acquisition.

Major actions include:

- Using private sector incentives to encourage rehabilitation, restoration, and creation of wetlands; and,
- Acquiring strategic sites to provide appropriate locations for wetland restoration, creation, and use activities.

Extending the Vision: Education and Research

Wetland protection depends upon public awareness of wetland values, management needs, and landowner support for protection policies. Appropriate technical training must be made available to resource managers and private sector interests. In addition, research is essential to refine our knowledge of wetland functions and improve our ability to sustain these resources.

Major actions include:

- Developing and disseminating information for the public and educational institutions on the values of and need to protect wetlands;
- Initiating technical assistance programs to support local government protection efforts;
- Evaluating the individual and cumulative effects on wetlands of current best management practices, shallow water dredging, structural shore erosion practices, and alteration of the land/water interface; and,
- Assessing the design and effectiveness of artificial wetlands developed for wildlife and waterfowl improvement, shore erosion control, wastewater treatment, or acid mine drainage.

The 1987 Chesapeake Bay Agreement's goal of protecting and restoring wetlands provides an important opportunity for interested citizens, resource managers and legislators to focus their commitment to the health of the Bay watershed.

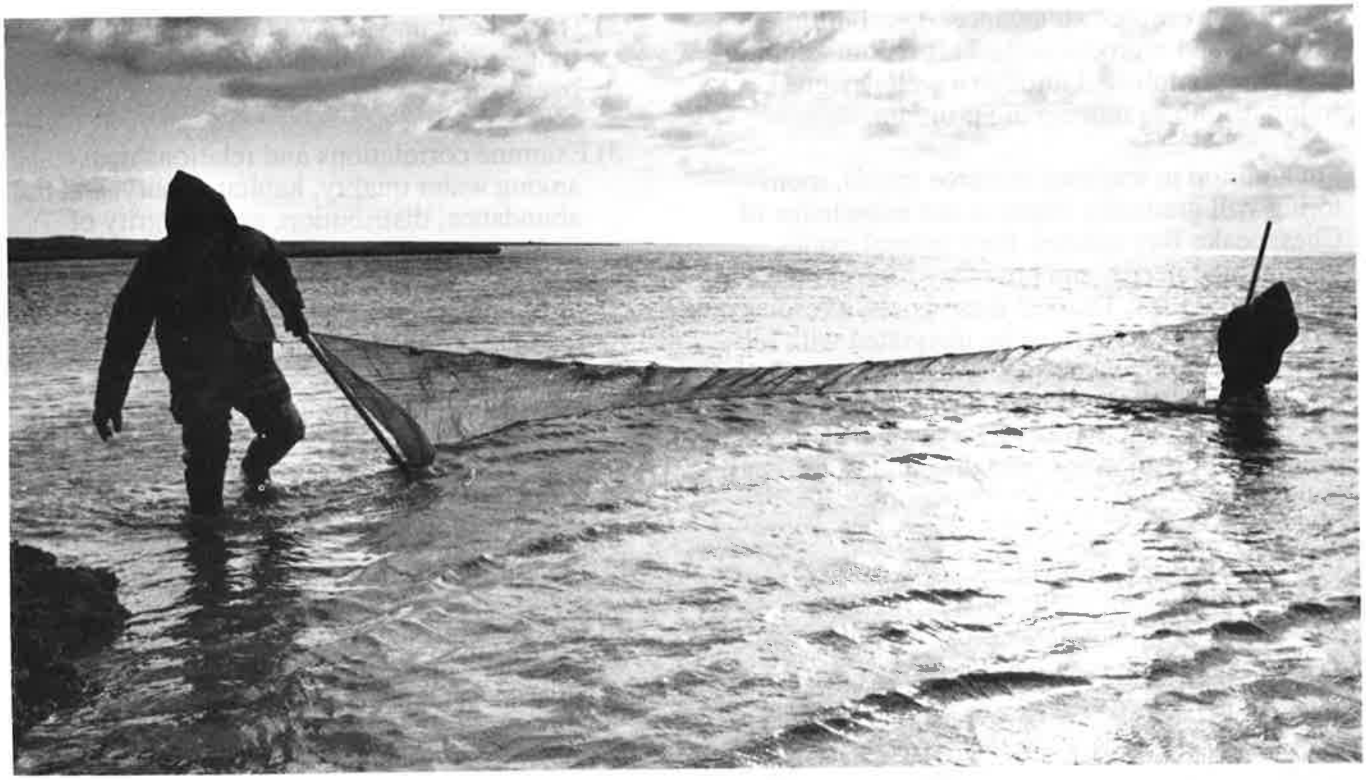
The Chesapeake Bay Wetlands Policy is available from the Chesapeake Bay Program, 410 Severn Avenue, Annapolis, MD 21403 (301) 266-6873.

This flyer was prepared by the Living Resources Subcommittee and printed by the Chesapeake Bay Program.

January 1988

CHESAPEAKE BAY:

MONITORING PLAN FOR LIVING RESOURCES



Dave Harp, Chesapeake Bay Foundation

LIVING RESOURCES MONITORING AND THE CHESAPEAKE BAY AGREEMENT

The Governance section of the Chesapeake Bay Agreement of 1987 contains a commitment by the states and the federal government:

By July 1988, to develop a Baywide monitoring plan for selected commercially, recreationally, and ecologically important species of living resources.

A joint workgroup of the Chesapeake Bay Program's Monitoring Subcommittee and Living Resources Subcommittee was formed in November 1987 to develop the living resources monitoring plan. The membership of the Living Resources Work Group includes representatives of the Chesapeake Bay Stock Assessment Committee in addition to the two Subcommittees.

Several thousand species of plants, animals and microorganisms live in the Chesapeake Bay. These thousands of species, collectively, are the Bay's living resources. Each species has its own set of habitat requirements or preferences. Some species are valuable economic resources, while others are pests to people or desirable species. Some have enormous ecological significance and some are appreciated mainly for their rarity or beauty.

WHY MONITOR?

In working toward the goal of restoring the abundance and diversity of resources in the Bay, monitoring is essential. Many of the actions necessary to improve the quality of Bay habitats have been identified and begun to be implemented. Regional fisheries management plans, presently under development, have the potential for preventing overharvest of commercial and recreational species. But plans for improving water quality will always be based on imperfect knowledge. In order to measure progress, it will be necessary to maintain the best possible records of resource abundance, distribution, diversity and reproduction. This record-keeping can be accomplished through a well designed living resources monitoring program.

In addition to tracking resource trends, monitoring will gradually improve our knowledge of Chesapeake Bay species, their natural cycles, their habitat needs, and how they respond to human activities. To meet these goals, a resource monitoring program must be integrated with biological research, water quality monitoring, ecological modeling, and fisheries management. Cooperation and coordination between agencies, programs, jurisdictions, and disciplines are essential.

photo: Kent Mountford

Fish egg and larvae survey abord the University of Maryland research vessel "Orion."

OBJECTIVES

The Workgroup began its task by defining three major objectives of living resources monitoring:

1) Document the current status of living resources and habitats in Chesapeake Bay.

2) Track the abundance and distribution of living resources and the quality of habitats over time.

3) Examine correlations and relationships among water quality, habitat quality, and the abundance, distribution, and integrity of living resource populations.

The Living Resources Monitoring Plan has been designed to:

* Provide a framework for Bay-wide monitoring of living resources;

* Achieve coordination and data compatibility among living resources, habitat, and water quality monitoring programs;

* Establish biological data collection methods which will ensure data comparibility between jurisdictions and programs;

* Establish an efficient, coordinated system of data management responsive to the objectives of living rsources monitoring; and

* Review existing programs, identify components that should be added or modified, and develop recommendations for implementation of the plan.

A goal beyond the immediate commitment to develop a living resources monitoring plan is the full integration of living resources and water quality monitoring within Chesapeake Bay. That is, ultimately, there will be a Chesapeake Bay Monitoring Program that will include both water quality and living resources components. The Living Resources Monitoring Plan is a significant step towards that goal.

APPROACH

The Living Resources Monitoring Workgroup has given the language of the Bay Agreement ("selected ... species" and "living resources") a broad interpretation in the development of the

Monitoring Plan. For example, tidal and non-tidal wetlands, although not truly "species," have been included because of their great importance as habitats and regulators of water quality.

The Plan provides a framework for consistent, sustained monitoring of Chesapeake Bay living resources: monitoring that is responsive to the information needs of those who must manage the Bay's habitats and living resources, and to the public, who ultimately will judge the success of the Bay restoration.

COMPONENTS OF THE ECOSYSTEM

In Section II of the Plan, entitled Data Needs, Existing Programs, and Monitoring Recommendations, several broadly defined groups of organisms are considered as "ecosystem components":

FINFISH
- Freshwater Spawners
- Estuarine Spawners
- Marine Spawners
- Ichthyplankton

SHELLFISH
- Oysters
- Blue Crab
- Hard Clam
- Soft Shelled Clam

WILDLIFE
- Waterfowl
- Colonial Birds
- Shore and Seabirds
- Raptors
- Reptiles and Amphibians
- Mammals

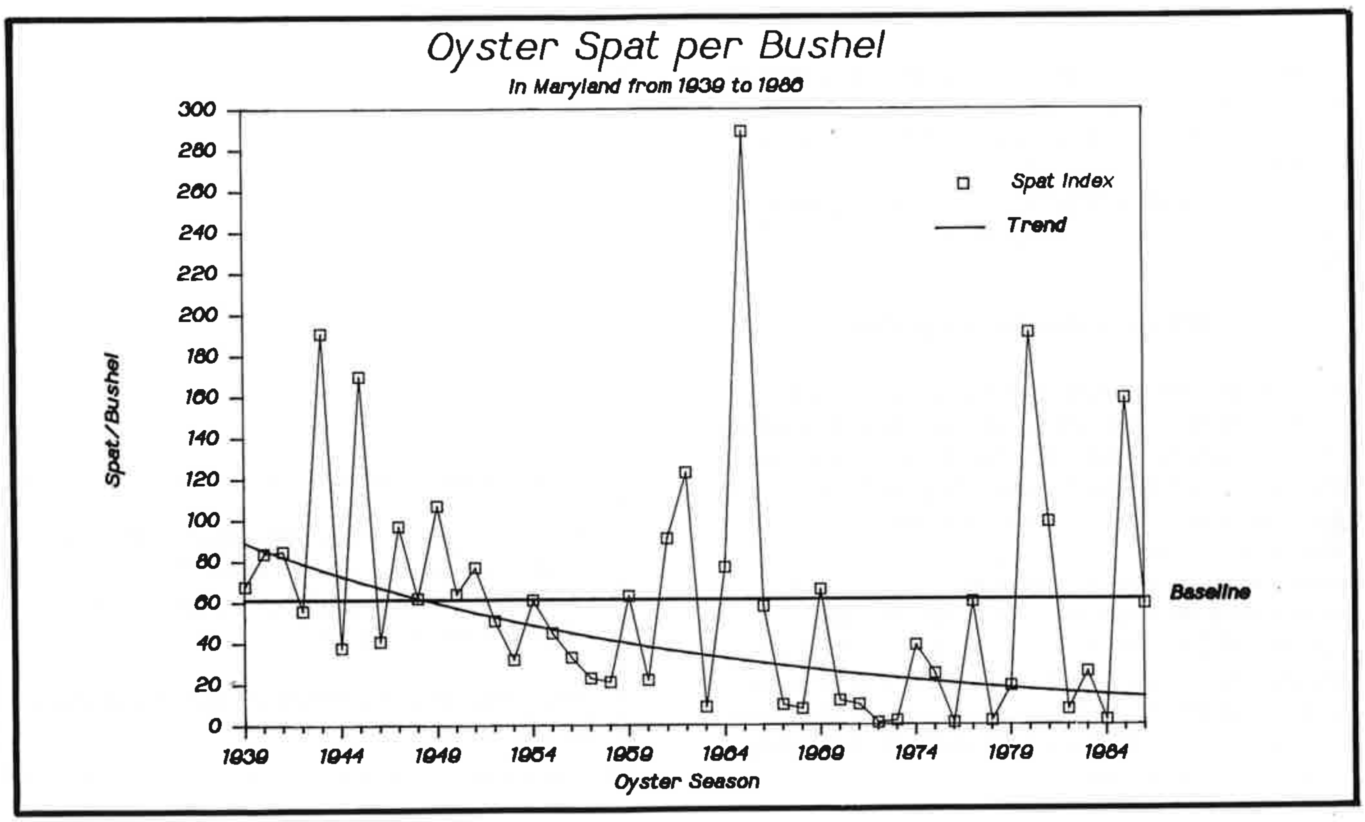
PLANT COMMUNITIES
- Submerged Aquatic Vegetation
- Benthic Algae and Macroalgae
- Tidal Wetlands
- Non-tidal Wetlands

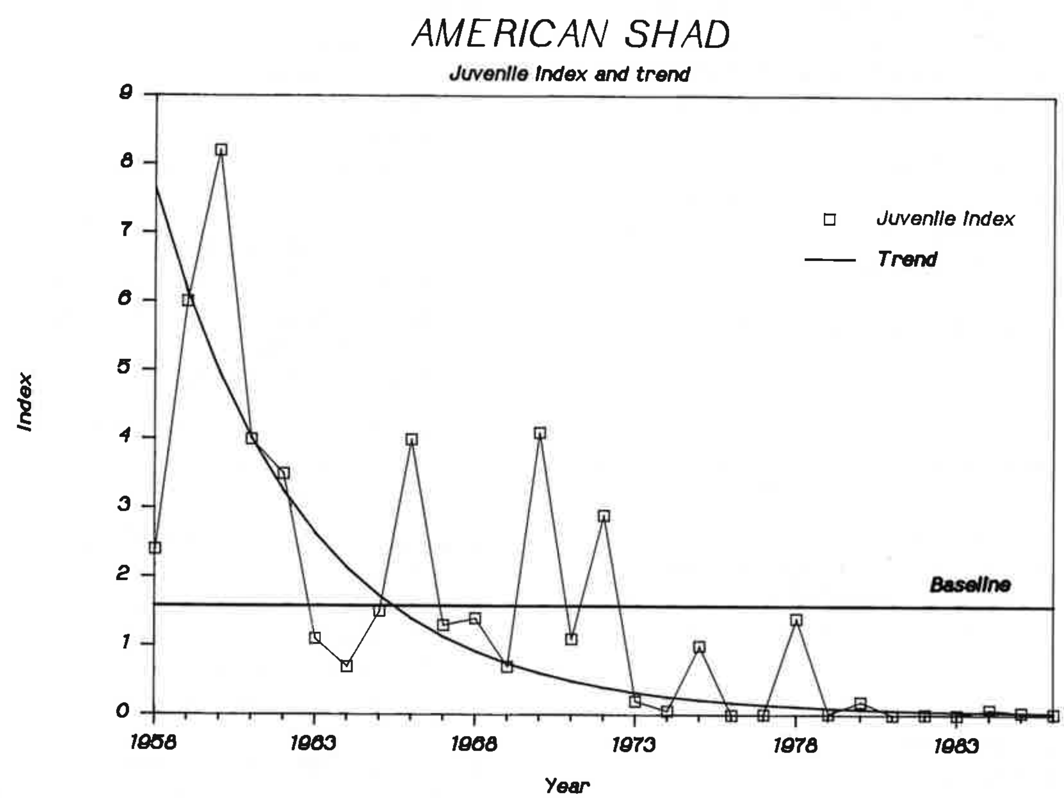
BENTHIC FAUNAL COMMUNITIES
- Benthic Infauna
- Benthic Epifauna

PLANKTONIC COMMUNITIES
- Picoplankton
- Nanoplankton and phytoplankton
- Microzooplankton
- Mesozooplankton
- Gelatinous Zooplankton

For each subgroup, data needs are identified, existing monitoring programs are reviewed, deficiencies noted, and recommendations made for future monitoring, including key areas of integration with other living resources and water quality monitoring programs.

Section III of the Plan is a discussion of how the data resulting from living resources monitoring





These graphs (above and preceding page) depict examples of long-term living resources monitoring information from Maryland's portion of the Chesapeake Bay. An annual index developed from field counts of each year's reproductive crop is shown, along with the long term average of the index (baseline), and long-term trends that can be discerned through simple statistical analysis.

should be stored, analyzed, and reported. Permanent accessibility and regular reporting of basic data on living resources status and trends were the principle concerns addressed in this section. The information gained from monitoring must be readily available to managers, scientists, and the public.

RECOMMENDATIONS

Section IV summarizes the major recommendations of the Plan, and discusses how and when these should be implemented. First, it is recommended that the Plan be used Bay-wide as a guide to uniform collection methods for biological data. Second, a core living resources monitoring program is proposed to fulfill the monitoring objectives. Additional recommendations address the need for managing monitoring data to ensure quality, security, and accessibility, and the need to develop better methods for assessing the impacts of contaminants on living resources populations.

The Living Resources Monitoring Plan is available from the Chesapeake Bay Liaison Office, 410 Severn Ave., Annapolis, MD 21403 (301) 266-6873

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CHESAPEAKE BAY:

HABITAT REQUIREMENTS FOR LIVING RESOURCES

LIVING RESOURCES IN THE CHESAPEAKE BAY AGREEMENT

The restoration and protection of the Chesapeake Bay's living resources, their habitats and their ecological relationships is a major focus of the 1987 Chesapeake Bay Agreement. The comprehensive report, "Habitat Requirements for Chesapeake Bay Living Resources", compiled over the past two years by the Chesapeake Bay Program's Living Resources Task Force, is an important first step toward meeting the goals of the Bay Agreement. The following brief summary from the Living Resources Task Force report contains an example of habitat requirements for one of the selected target species.

BACKGROUND

Declines in the abundance of living resources have been the most tangible warning signs of widespread environmental problems in the Bay. Attempts to protect and restore the Bay ecosystem's health and integrity must go beyond water quality issues to address biological and physical factors as well.

Many variables influence the abundance and distribution of species within the Bay : climate, natural population cycles, reproductive potential, disease, predation, and the abundance and quality of food and habitat. Human activities, including land and water use, contaminant discharges, and physical habitat alterations, also directly affect important species. Indirectly, results of these activities can disrupt food chains and upset the ecological balance of the estuary.

HABITAT REQUIREMENTS DEVELOPMENT

The Living Resources Task Force identified representative species from all levels of the Chesapeake Bay food web, including plankton, benthos (bottom dwellers), submerged aquatic vegetation, shellfish, finfish, waterfowl, and wildlife. A smaller group of 26 species was targeted for immediate attention in the development of habitat requirements. This selection was based upon their commercial, recreational or ecological significance and the potential threat to sustained production if populations of those species decline further or experience serious habitat problems.

Once the target species were chosen, the Task Force had two areas to investigate. The first objective was to gather data on the physical, biological, and chemical factors affecting the selected living resources. Secondly, they needed to determine where the species live and reproduce, and when, in the life cycle, survival is threatened or critical. The "Habitat Requirements" report merges this knowledge of influential environmental factors with specific habitat locations and critical stages in the species' lives so that protection and restoration efforts and spending can be effectively focused.

APPLICATIONS

The "Habitat Requirements" report is intended to give planners, managers, researchers, and modelers of the Bay information on the habitat quality required for the target species. These habitat conditions will be part of the information used to protect and enhance the Bay's living resources. The Implementation Committee of the Chesapeake Bay Program has set up a Living Resources Subcommittee concerned with the health and abundance of water and wildlife species that depend on Chesapeake Bay habitats. The Subcommittee will help guide agencies in using the report in their own programs.

The "Habitat Requirements" report does not establish regulatory standards; rather, it identifies necessary habitat conditions to guide management decisions for modifying existing regulatory programs. The report will be useful for guiding programs that regulate or influence :

- agricultural runoff
- urban runoff
- shoreline erosion
- contaminant discharges
- municipal and industrial wastewater treatment
- shoreline deforestation
- wetland dredge and fill
- stormwater management
- urban development
- highway development

Spawning areas require careful protection measures.

TARGET SPECIES : OYSTER

An example of one of the 26 selected target species presented in the "Habitat Requirements" report is the American oyster. The oyster's economic importance and its ecological significance in the benthic (bottom dwelling) community make it a highly valued living resource. Drastic reductions in oyster distribution and abundance in recent years, primarily due to deteriorating habitat quality, overfishing, and disease, are cause for great concern.

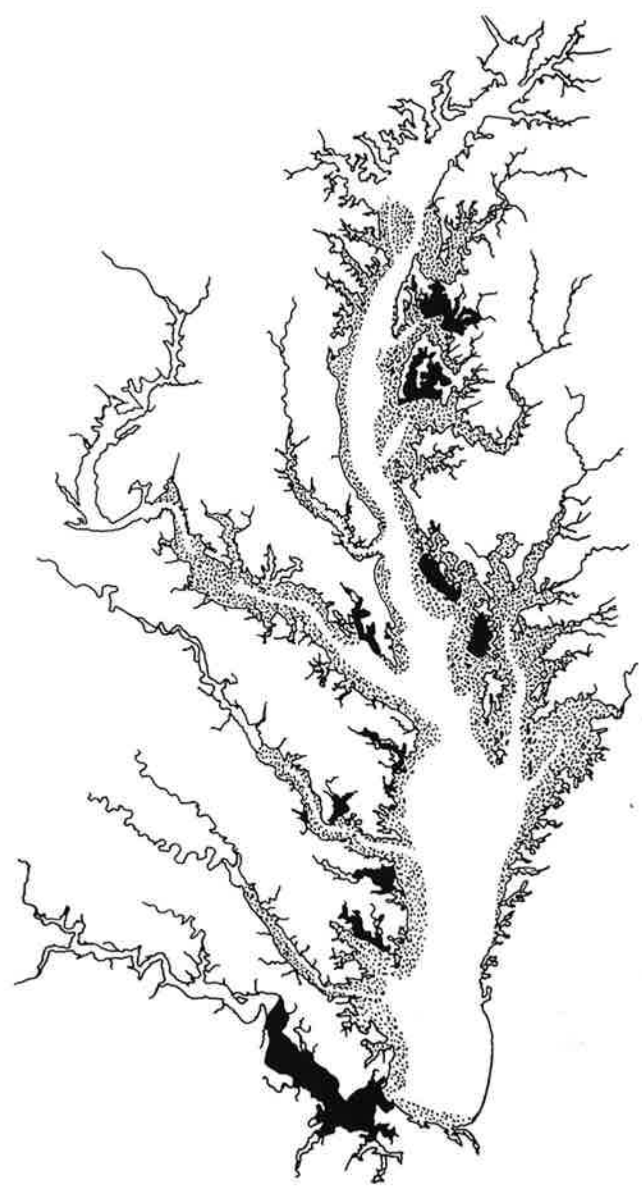
Oyster distribution in the Bay is presently determined largely by salinity, salinity related diseases, substrate, and depth. Although oysters are tolerant of a wide range of salinities (3-35 ppt salinity), they cannot survive in tidal freshwater or low salinity regions of the Bay. A strong correlation has been found between high salinity and good oyster reproduction. Dry years may increase the salinity of the water up the Bay to promote favorable growing conditions. Under the same saline conditions, however, potentially fatal oyster diseases caused by MSX and Dermo pathogens can flourish.

Oysters spawn (reproduce) in the summer when water temperatures are over 15°C, with the highest rates occurring between 22°- 23°C. Free-swimming oyster larvae permanently attach their newly formed shell to a firm substrate and become young oysters or "spat". This attachment process is known as spat setting. Critical for their survival is the availability of firm foundations, such as pilings, hard rock bottoms, and particularly old shells, called cultch, left naturally on oyster bars or "planted" by resource management agencies and watermen.

Oysters are also sensitive to sedimentation and total suspended solids in the water. Excessive sedimentation smothers adults and prevents setting of spat on clean cultch. When surrounding waters are highly turbid, or cloudy, adult oysters will slow their intake of suspended materials and may cease feeding entirely.

The depths at which oysters can survive are limited by dissolved oxygen concentrations, the amount of available oxygen in the water. Natural episodes of hypoxia, low oxygen concentrations [< 2mg O_2/L], in bottom waters are believed to have limited oyster distribution in the past to the shallower, more oxygenated areas of the Bay. In recent years, an increased duration and distribution of hypoxia has been responsible for local areas of oyster mortality at depths less than the historical 10 meter limit.

As a filter feeder, the oyster ingests a variety of phytoplankton, bacteria, and small particles of decaying plants and animals mostly from 3 to 35 microns in size. The availability of food within this critical size range may be a key factor in the long-term survival of oysters and other shellfish. Scientific evidence suggests that excess phosphorus and nitrogen in the Bay can cause detrimental changes in the food chain. Nutrients may be shifting the underlying support of the entire chain, the plankton communities, to smaller species which are less desirable food.



Habitat Distribution of Seed Areas and Suitable Substrate for the American Oyster.

■ Seed areas
▨ Suitable substrate

Overall restoration of oyster habitat is a prerequisite for increasing the abundance and distribution of oysters. Several steps toward habitat restoration are now being undertaken. Re-establishing

Summary of Habitat Requirements for the American Oyster

Critical Life Stages : larval, spat, adult
Critical Life Period : entire life cycle

Target Species	Habitat Zone	Salinity (ppt)	pH	Dissolved Oxygen (mg/l)	Suspended Solids (mg/l)	Prey Species
American oyster	Firm substrate, cultch	5 - 35	6.8-8.5	> 2.4	< 35	Phytoplankton (size range of 3-35 microns)

shoreline submerged aquatic vegetation in key regions would benefit these bottom dwellers by controlling the resuspension of sediments; moreover, the vegetation minimizes sediment from other sources such as eroding farmland, construction sites, and shorelines. Many of these sediment sources also add nutrients to the Bay ecosystem.

Water quality models of the Bay suggest that substantial reductions in nutrients are necessary to achieve acceptable dissolved oxygen levels. Higher oxygen levels will increase the acreage of suitable habitat, and lower nutrient levels could increase the abundance of the preferred food species of plankton. In addition, Baywide oyster repletion and fisheries management programs are essential for maintaining a viable oyster industry.

Glenn D. Chambers

The American oyster is just one of the target species whose habitat requirements are detailed in the Living Resources Task Force report. Through a focused and concentrated effort to restore and protect the habitats of our living resources, the Chesapeake Bay will continue to be an economic and ecological treasure for future generations.

MARYLAND DEPARTMENT OF NATURAL RESOURCES
TIDEWATER ADMINISTRATION

Copies of the "Habitat Requirements for Chesapeake Bay Living Resources" report are available from the Chesapeake Bay Liaison Office, 410 Severn Ave., Annapolis, MD 21403 (301) 266-6873.

This circular printed by the Maryland Department of Natural Resources, Tidewater Division.

CHESAPEAKE BAY:

SUBMERGED AQUATIC VEGETATION POLICY

SUBMERGED AQUATIC VEGETATION IN THE CHESAPEAKE BAY AGREEMENT

Providing for the protection and restoration of Chesapeake Bay's living resources is a hallmark of the 1987 Chesapeake Bay Agreement. A "Schedule for Developing Baywide Resource Management Strategies" was developed in response to the Living Resources commitment:

By July 1988, to adopt a schedule for the development of Bay-wide resource management strategies for commercially, recreationally, and selected ecologically valuable species.

Submerged aquatic vegetation, an important indicator of Bay health, is one of the five major catagories of Bay living resources for which management strategies are being developed.

The Submerged Aquatic Vegetation Workgroup of the Chesapeake Bay Program's Living Resources Subcommittee developed the strategy for the protection and restoration of submerged aquatic vegetation. The workgroup includes representatives from the U.S. Fish and Wildlife Service, U.S. Geological Survey, U.S. Environmental Protection Agency, U.S. Army Corps of Engineers, National Marine Fisheries Service, Maryland Department of Natural Resources, Virginia Marine Resources Commission, Interstate Commission on the Potomac River Basin, Chesapeake Bay Foundation, University of Maryland, Virginia Institute of Marine Science, and Harford Community College.

This Policy's intent is to guide the protection and restoration of all submerged aquatic vegetation within the Chesapeake Bay and its tidal tributaries.

BACKGROUND

Submerged aquatic vegetation (SAV) are vascular plants that live and grow below the water surface. Because of their need for sufficient sunlight, they are found in the shallow water areas of the Chesapeake Bay and its tributaries. There are 13 principal species distributed according to their individual salinity requirements.

ECOLOGICAL VALUES

SAV provides a number of important ecological benefits:

a) Fish and wildlife habitat

b) Food for waterfowl

c) Nutrient uptake

d) Removing suspended sediments and holding substrates

e) Producing oxygen for the water column and upper sediment layer

f) Contibuting organic matter to the Bay food web

SAV beds provide shelter and nursery areas for many species of fish and wildlife. Small fish such as killifish, silversides, and minnows and juveniles of larger species such as white perch, striped bass and yellow perch find protection and cover from predators in SAV beds. The plants are a substrate in the water column for algae, snails and worms which are food for fish and larger invertebrates. Molting blue crabs also find shelter in SAV until their shells harden.

SAV is an important source of food for many species of ducks, geese and swans. Migrating and over-wintering populations of waterfowl rely on the nutritious seeds, rootstocks and starchy tubers of SAV for their diet.

Excessive nutrients in the Bay can cause algae blooms; SAV helps to prevent this by removing nutrients from the water and sediment. SAV also helps to remove suspended sediments from the water column by trapping sediment particles on the plant leaves and stems. The roots act to bind the substrate and prevent resuspension of particles, while dense beds of SAV slow water currents and dampen wave energy to protect shorelines from erosion.

Another valuable function of SAV is its ability to provide oxygen to the surrounding waters. In the absence of SAV, low dissolved oxygen levels can be harmful or lethal to many aquatic organisms.

As SAV beds die back at the end of the growing season, they provide a valuable source of organic material (detritus) for the Bay ecosystem's food web.

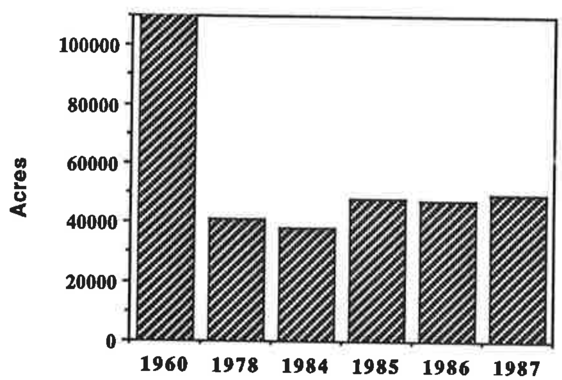
MONITORING VALUES

Because the growth and survival of SAV are directly connected to the water quality of Chesapeake Bay, SAV can serve as a valuable indicator of whether an area's water quality is sufficient to support living resources. Attempts to improve Bay water quality can be evaluated by SAV response. Thus, changes in SAV distribution and abundance can serve as a measure of the success of the Bay-wide restoration program. In addition, the annual SAV monitoring reports are used in the regulatory review process.

Decline of SAV

Former levels of SAV distribution were well over 100,000 acres. Today, less than 50,000 acres remain. Most of this decline has occurred within the last two decades and has affected all species in most areas of the Bay.

Acres of SAV in Chesapeake Bay



Causes for the loss of SAV are attributed to a decline in the water quality of Chesapeake Bay mainly from excessive loadings of nutrients and sediments. Resultant algae blooms and high sediment levels increase turbidity blocking vital sunlight to SAV.

POLICY ISSUES

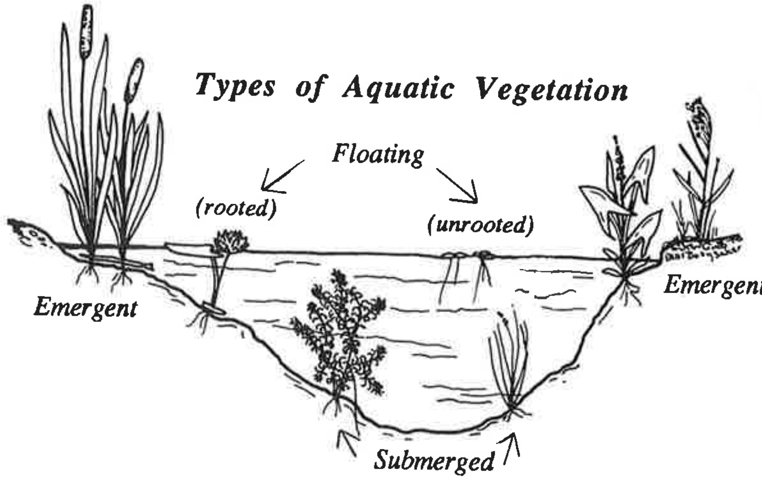
The goal of the Bay Program's Policy for the protection and restoration of submerged aquatic vegetation is to achieve a **net gain** in SAV distribution and abundance in the Chesapeake Bay and its tidal tributaries by:

* protecting existing SAV beds from further losses;

* setting and achieving regional water and habitat quality objectives that will result in Bay-wide restoration of SAV; and,

* setting regional SAV restoration goals considering historical distribution records and estimates of potential habitat.

Four key components are included in the Policy: assessing the resource, protection of existing SAV, restoration of SAV, and education and scientific research. Within each component,



specific policy statements and action items to implement the policy have been developed.

I. Assessing the Resource

Only through an established, consistent and regular survey of populations over time can progress toward thegoal of net SAV gain be measured. An effective assessment and monitoring strategy is essential to evaluate SAV distribution and abundance, and the quality of their supporting habitats.

II. Protection of Existing SAV

Current regulatory and resource management programs need to be evaluated for their effectiveness in protecting existing SAV and their habitats from further losses.

III. Restoration of SAV

Efforts must be made to restore SAV by improving the habitat conditions necessary for natural revegetation. The water quality and habitat quality requirements of SAV should be established as regional goals for strategies to reduce influx of nutrients, toxics and conventional pollutants to the Chesapeake Bay.

IV. Education and Scientific Research

Education is important to increase public awareness of this valuable resource and to provide sufficient information to resource managers responsible for implementing SAV protection and restoration practices. Scientific research will improve our knowledge of SAV to refine and enhance protection activities.

Greater detail on specific SAV policy statements and action items may be found in the Chesapeake Bay Submerged Aquatic Vegetation Policy. Meeting the 1987 Chesapeake Bay Agreement's goals for protecting and restoring SAV provides an important opportunity for interested citizens, resource managers and legislators to focus their commitment to the health of the Bay ecosystem.

The Chesapeake Bay Submerged Aquatic Vegetation Policy is available from the Chesapeake Bay Liaison Office, 410 Severn Ave., Annapolis, MD 21403 (301) 266-6873.

This circular was prepared by the Living Resources Subcommittee and printed by the Chesapeake Bay Program. August, 1989