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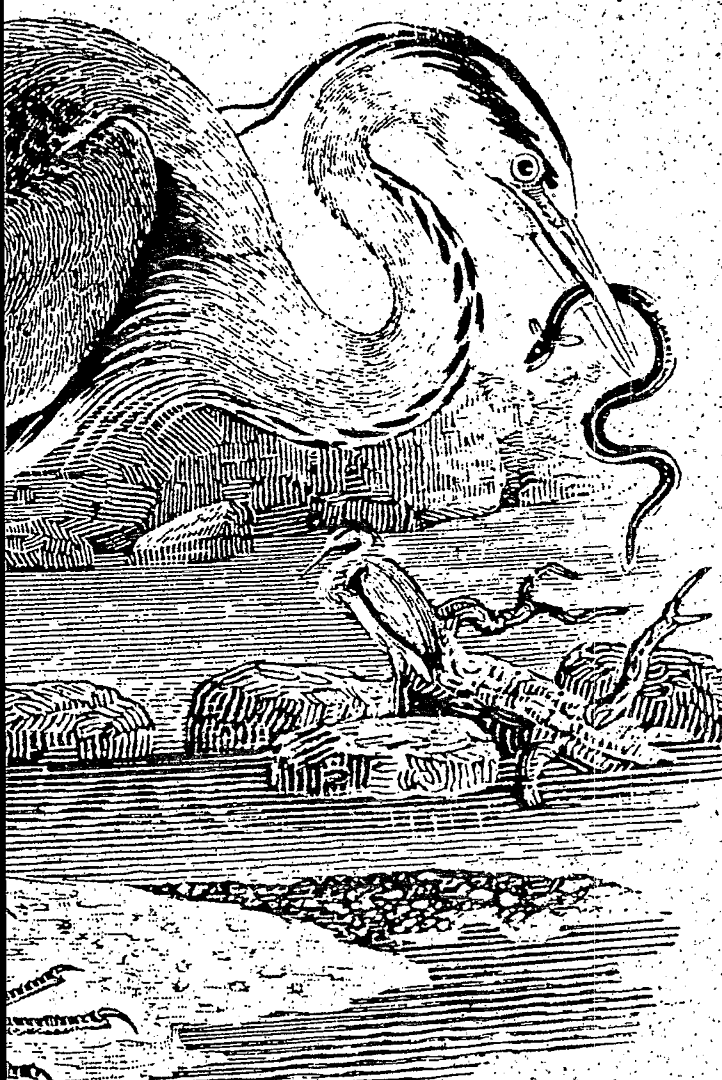
Chesapeake Bay Program

A Work *in* Progress

A retrospective on the first decade of the Chesapeake Bay Restoration



"When we try to pick out anything by itself, we find it hitched to everything else in the universe"

John Muir

Dear Fellow Citizen,

The Chesapeake Bay is a vast natural resource with significant economic, recreational, and social value to our states and our citizenry. We are beginning to see a recovery of the Chesapeake Bay as a result of a decade of hard work, determination, and commitment spearheaded by the Chesapeake Bay Program, a unique public-private endeavor comprised of governments in Pennsylvania, Maryland, Virginia, and the District of Columbia working together with the federal government, citizens, and businesses.

The Chesapeake, and its many tributaries, has suffered from the effects of more than two centuries of steady growth, from increasing pollution and run-off, and from accumulation of sediment and industrial wastes. Yet, the Bay has begun to respond due in large part to the action of local citizen groups and federal, state, and local governments.

When you get right down to it, cleaning up the Chesapeake Bay is a problem that begins at home, right in our communities. Vital citizen-action restoration efforts carried out in the Bay watershed clearly demonstrate the need to directly involve people in our restoration efforts.

This ten-year retrospective of the restoration of the Chesapeake Bay features cleanup accomplishments and highlights the results of our long-term commitment to work together. We are seeing an increase in aquatic grasses, crucial food sources and habitat for many of the Bay's living resources. The Bay Program's revolutionary 3-D model now allows scientists for the first time to predict the effects of pollution on the Bay. And the resurgence of rockfish in the Chesapeake region is a positive sign that the Bay's health is improving.

We have made significant progress in the Bay cleanup, but we must do more. We urge you to join our efforts and hope you will take the preservation of the Chesapeake Bay home to your neighborhoods and communities.

Sincerely,

William Donald Schaefer

William Donald Schaefer
Governor, State of Maryland
Chairman, Chesapeake Executive Council

Our work in the Chesapeake Bay *is a search for knowledge that will lead us to action. At the same time, we are chasing an understanding of an interconnected system of life and a clear idea of our own role within it. We are dealing with one of mankind's oldest themes -- our relation to nature -- and we have learned it is not a quiz, it is rather a dissertation. And this realization has become a major step forward in how we attack problems.*

Throughout this retrospective, the work to restore the living resources of the Chesapeake Bay is highlighted. Progress in this arena is a kind of generic "target" by which our experience improving the health of the Bay can, to some extent, be gauged. The status of the real targets -- the striped bass, the soft shell clam, and others -- is featured throughout the document.

This is not a report on the "State of the Bay." It is a collection of images that attempts to capture the vast bulk of studies, the depth of the research, and the actions and commitment of the people involved in the restoration of the Chesapeake Bay over the past ten years. For the most part, the words of managers and researchers are used to paint a picture of a decade of learning and action. It is a work in progress...

Note for the reader:
This document has two types of text and two types of sidebar material. Selected published material from managers and researchers of the Chesapeake Bay Program is set in normal type. Program commentary is set in italics. The status of the Bay's living resources is shown in illustrated sidebars. The accomplishments of the formal committees and subcommittees of the Chesapeake Bay Program are also shown in sidebars.

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EASTERN OYSTER

The eastern oyster is a resilient estuarine species that is well adapted to its fluctuating environment in the Chesapeake Bay. It tolerates wide natural variation in temperature, salinity, suspended sediments, and dissolved oxygen. To the extent that environmental regulations protect more active or more sensitive species like blue crabs and striped bass, they will also probably protect oysters. It is fecund enough to produce billions of spat in the Bay if brood stock abundance is high, suitable hard substrate is plentiful, and climatic conditions are optimal. Oysters filter water for food, improving water clarity conditions for SAV and other species.

Predation causes high mortality of the young stages. High mortality rates also have been caused by diseases in recent years. Pollution is a local problem for oysters near industrialized regions of the Bay. Overfishing has led to depressed harvests, degraded oyster grounds, and a weakened fishery. To rehabilitate the resource, it will be necessary to understand aspects of oyster biology more completely (especially diseases), to rehabilitate the oyster grounds, to manage the resource according to scientific principles, and to encourage the growth of aquaculture.

IN BRIEF

The major environmental problems of the Chesapeake Bay and its tributaries were investigated in a comprehensive study initiated by the Environmental Protection Agency (EPA) in 1975 at the direction of Congress.

Final research findings and recommended remedial strategies were published in September 1983. The study identified ten areas of environmental concern in the Bay:

- *Nutrient enrichment*
- *Toxic substances*
- *Declines in submerged aquatic vegetation (SAV)*
- *Wetlands alteration*
- *Shoreline erosion*
- *Hydrologic modification*
- *Fisheries modification*
- *Shellfish bed closures*
- *Dredging and dredged material disposal*
- *Effects of boating/shipping on water quality*

These findings and recommendations formed the foundation for the first Chesapeake Bay Agreement signed in 1983. In that agreement the EPA, in partnership with the governments of Virginia, Pennsylvania, Maryland, the District of Columbia, and the Chesapeake Bay Commission (an interstate legislative coordinating body), agreed to develop and implement coordinated plans to improve and protect the water quality and living resources of the Chesapeake Bay estuarine system. The 1983 Agreement moved the program out of the research phase and into an action phase by establishing a management and action structure to resolve Bay issues, and a water quality monitoring program to measure progress.

The second Chesapeake Bay Agreement was signed in December 1987. This Agreement expanded the scope of the 1983 Agreement with 29 commitments for action. These commitments outlined steps to be taken in six areas:

- *Living resources*
- *Water quality*
- *Population growth and development*
- *Public information, education and participation*
- *Public access*
- *Governance*

This Agreement also called for reducing the amount of nutrients reaching the Bay by 40 percent by the turn of the century. Of the many commitments in 1987, the nutrient issue was the only one of such consequence that it was assigned a numerical goal. On a broader level, the 1987 Agreement clearly established that the productivity, diversity and abundance of the estuary's plants and animals (referred to as living resources) would be used as the ultimate measurement of the Chesapeake Bay's condition. In this way, the program translated Chesapeake Bay research results into action plans.

In 1992, the 40 percent nutrient reduction goal was reexamined against new and improved information. This review confirmed the 40% goal as an achievable target that would indeed result in improved water quality. The resulting 1992 Amendments to the Chesapeake Bay Agreement reaffirmed the goal and directed that specific nutrient reduction goals be set for each of the Bay's major tributaries and that strategies be developed to achieve those goals as well as protect and improve aquatic habitats in the rivers.

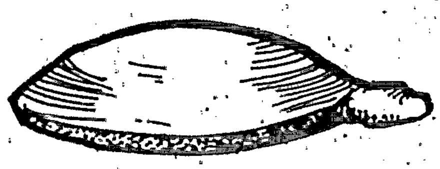
At the signing of the 1992 Amendments --
Chesapeake Bay Commission Chairman Bernard "Bernie" Fowler, District of Columbia Mayor Sharon Pratt Kelly, EPA Administrator William K. Reilly, Maryland Governor William Donald Schaefer, Virginia Governor L. Douglas Wilder and Pennsylvania Governor Robert P. Casey.

SOFT SHELL CLAM

Soft shell clams grow rapidly in the Chesapeake Bay, reaching commercial size in two years or less. They reproduce twice per year, in spring and fall, but probably only fall spawnings are important in maintaining population levels... Principal ecological roles performed by the species are filtering the water column, providing shell substrate for fouling invertebrates, and serving as prey (all life stages) for a wide assortment of animals... Major predators on juveniles include blue crabs, eels, and cownose rays. Some other species that may depend heavily on soft shell clams include ducks, geese, swans, muskrats, and raccoons.

Diseases may play an important role in regulating adult populations of soft shell clams; hydrocarbon pollution is linked to increased frequency of disease. Oil pollution does the most widespread and persistent damage to soft shell clams through toxicity, aside from its role in inducing disease. Heavy metals, pesticides, and similar pollutants can be extremely toxic, but the harmful effects to clams do not last if the pollution abates. The main concern with the latter toxicants is bioaccumulation by soft shell clams, with the potential for passing toxic contaminants on to predators or to humans.

Siltation caused by storm events, dredging operations, or erosion, can smother clam populations. Eutrophication, enhanced by nutrient inputs from sewage or agriculture, is not known to have affected soft shell clam populations.



THE CHALLENGE

A 1988 report called "The Chesapeake Bay Program: A Commitment Renewed" begins with the following sentence: "Though signs of the Bay's decline were evident long before the 1970s and some studies had been conducted, there had been no comprehensive attempts to gather and evaluate data for the watershed as a whole, to determine the cause and effect relationships underlying the Bay's problems, and to recommend remedies." A more succinct and daunting statement about the challenge of restoring the Bay would be hard to find. In dry and simple language, it asks that we discover how an arm of the Atlantic Ocean, draining 64,000 square miles of land and inhabited by 13 million people and countless plants and animals, works! It asks that we unravel a web of life with our minds and then tug on the correct threads to restore its diversity, abundance, and beauty.

It proposes that we understand the nonhuman world of ecological relations or 'nature', our inalienable part within that world, and our role in erecting an artifice atop it. This charge lets no one, urban or rural, rich or poor, young or old, disavow responsibility for the decline and the recovery of the Chesapeake Bay. We all live under a roof and we all live in the Bay and to do right by one we must do right by the other for invariably the two find in each other their own image.

Understanding nature and acting accordingly safeguards a certain set of human needs and grants immediate and familiar benefits. Farmers and foresters know which insects pollinate their crops and trees, and which devour them; dairymen know which plants can be grazed by their stock, and which ones are poisonous; fishermen know which baits are more likely to be taken at various times of the day in various seasons, and which ones will be ignored. We must know the physical requirements of the plants and animals we cultivate and depend on: how much warmth or shade they need, which side of a hill plants grow on, how big a pasture animals roam in and under what regimes of water and other nutrients they do best.

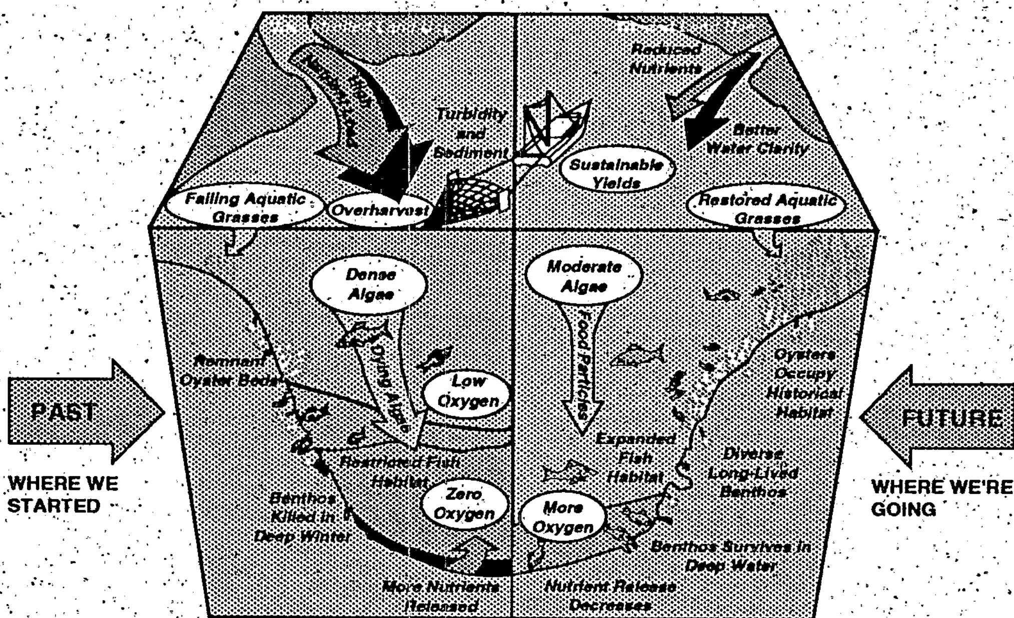
But there are other needs, less tangible and often hard to articulate, that are characteristic of us as humans. These involve the exercise of sentiment and the stimulation of our sense of order and purpose, our appreciation of beauty and freedom. These needs, immediate and future, of the flesh and of the spirit, are being severely compromised by our lack of understanding of how nature works and where we fit into its patterns. The fabric of the natural world that supports our activities and our aspirations is threatened and we have been challenged to respond.

This retrospective is about that response – how we are unraveling the threads of nature and building new ideas of care, management, and governance from them.

How the billions of organisms that live on this planet interact with each other is a constant source of amazement. Most striking are the unusual eating-and-being-eaten relationships, from giant whales that feed only on tiny sea creatures, to plants that ward off animals by their bad tasting leaves – and animals which eat them anyway, to make themselves unpalatable to their predators.

But there are other more subtle connections, ones that build a strong undercurrent of humility rather than amazement. We begin with such an observation by Kent Mountford, a Senior Scientist with the Chesapeake Bay Program. He talks about the problems we face:

Portrait of an Ecosystem



People around the Chesapeake have always seen and enjoyed the Bay's visible resources; from our marvelous beds of Bay grasses to birds of prey like the osprey and bald eagle. But these single species are connected together as parts of a complex web of interactions which make up Chesapeake Bay's ecosystem.

Do our actions, the conduct of our lives and businesses have anything to do with these species who live such different lives from our own? Of course. We wouldn't be trying to save Chesapeake Bay if we weren't part of her deeply rooted problems.

Chesapeake Bay – like virtually all natural systems – runs on energy from the sun; energy which (in concert with the moon) powers the tides, runs the great heat engine that mediates our seasons and climate, and sunlight that's captured by plantlife and turned into organic matter that feeds us all; forest to cattle fodder, plankton to poultry.

For life in Chesapeake Bay sunlight is the engine, but the Bay depends on land – the vast watershed – for its nutrition. It depends on nitrogen and phosphorus, the dissolved mineral fertilizers that have come out of the Bay's forests and rivers for thousands of years. These nutrients are necessary for both the growth of life in our waters and as fertilizer for the thousands of acres of Bay grasses.

The grasses in turn provide vast forests and fields of refuge; for the tiny larvae of crabs, for the delicate soft shelled shedding stage each crab undergoes as it grows to maturity, and to the myriad species of tiny animalcules and juvenile fish which hide there from their predators. These grass beds are the farms and pastures from which sally forth the great bounty we call Chesapeake.

HARD CLAM

The hard clam is found along the eastern coast of North America from the Gulf of St. Lawrence to Texas. In Chesapeake Bay, the hard clam is restricted to salinities above approximately 12 ppt. An extensive survey of hard clam resources is overdue. Long term trends in populations cannot be determined.

The life cycle of the hard clam includes a pelagic larval phase and a relatively sedentary benthic juvenile and adult phase...Predation on new recruits is very high; dense aggregations of hard clams have been found in the absence of predators. Aside from predation and fishing pressure, the natural mortality of larger clams appears very low.

Hard clams are important suspension-feeding infauna, thus they are important in grazing of primary production, transfer of carbon and nitrogen to benthic food chains, and through excretion, rapid recycling of particulate nitrogen as ammonia. The major food source for hard clams is planktonic microalgae. In Chesapeake Bay, growth occurs in spring and fall, when optimum water temperatures coincide with abundant food.

Clams are capable of living in a variety of sediment types, but higher abundances are found in coarse-grained sediments. Hard clam stocks are susceptible to overfishing. Recruitment rates are poorly understood, as are possible re-establishment periods if areas are depleted through commercial harvesting...Hard clam mariculture is well established and could easily be expanded into sites within the Bay.

It is this bounty, the young and growing fishes, which are the forage that supports the proud raptor birds we find so impressive; the osprey and bald eagle. Many of us think of them as symbols of a natural system at equilibrium in its processes.

When we humans add those nutrients, often together with mud and sediments, in quantities far in excess of this equilibrium, Chesapeake Bay staggers under the impact. Excess nutrients and sediments come from our construction, agriculture, and waste discharges, from the millions of us living here.

The plankton – the minute microscopic plant cells in all natural waters – have first access to these nutrients and multiply much more quickly than submerged grasses can grow. They overwhelm and overpopulate the Bay's surface waters, growing so densely that, together with the silts and mud, they shade out light reaching the bottom. Aquatic grasses suffer mightily from this onslaught and in the early 1970s nearly disappeared.

At the same time many industries in the past considered discharge and dilution the best way to dispose of toxic chemicals. These followed the way of many substances and spread throughout the Bay, and for predatory birds which ate those organisms, the chemicals stopped in their tissues, accumulating to where their health and ability to reproduce was compromised. The grasses declined, living resources declined and with them, those symbols of a vital Bay, the osprey and bald eagle declined too.

Chesapeake Bay is not the same as it was in past decades; neither is it the great, seemingly inexhaustible protein factory that H. L. Mencken once extolled.

Species intertwine, their life pathways intertwine, the welfare of one species depends on the welfare of many others. We are not exempt from that web of life and we will suffer together for its deficiencies.

HOW THE BAY PROGRAM WORKS

The Parliament of India contains the elected representatives of twenty-four political parties. The raucous complexity of defining and securing the public interest in this situation is hard for us to imagine for we seem to have a difficult time in a two-party system. But the Chesapeake Bay Program (CBP) has an even larger number of representatives. They come from federal, state, and local agencies; interstate commissions; universities; private and public interest groups; and from the house next door. In a manner of speaking, it forms its own ecosystem where the identities of the participants are subsumed and intertwined in a search for understanding and action.

THE ORGANIZING PRINCIPLES

Pre-1980: The connection between human activities and the resources of the Bay was recognized in the nineteenth century. Representatives of the oyster industry voiced concern over the decline of the fishery in the twentieth century. Both Maryland and Virginia established laboratories whose sole purpose was to study the Bay and its tributaries. A number of conferences were held (1933, 1968, 1977) and citizens groups became active pollution control advocates. Whereas in the nineteenth century concern for the Bay was voiced primarily by the oyster industry, today the chorus includes boaters, sportsmen, fishermen, and a large phalanx of concerned citizens and their elected representatives. State governments have responded with an increasingly complex and sophisticated range of pollution control and management agencies. In addition, the Federal government recognized the need for the national protection of water resources and, in the 1970's, passed a series of laws which fundamentally changed the framework for managing and protecting water resources...

The specific impetus for the EPA's Chesapeake Bay Program came from a tour of the Bay conducted by Senator Charles Mathias (R-MD) in 1973. That tour...led to conversations with Russell Train, then the EPA Administrator. In fiscal year 1976, Congress directed the EPA to conduct a five-year, 25-million-dollar study of Chesapeake Bay...[and]...required the EPA to assess water quality problems in the Bay, to establish a data collection and analysis mechanism, to coordinate all of the various activities involved in Bay research, and to make recommendations on ways to improve existing Chesapeake Bay management mechanisms...[1]

The Chesapeake Bay Program did not assume its responsibilities by default; it was created from the ground up to act as a catalyst and organizer for the solution of an extremely complex set of problems.

1983: To effectively manage the Bay, we must recognize both its variability and its unity. The Bay's water quality needs vary from region to region as do the controls necessary to support specific regional resource use objectives. The industrialized Patapsco and Elizabeth Rivers have a very different water quality problem than the Choptank or Rappahannock Rivers. Also, the desired and actual use of these areas varies significantly, industrial versus agriculture, and fishing. It is apparent that we must also target our control strategies by geographic area...we must always keep in mind that the Bay is a complex interactive ecosystem and that actions in any part of the watershed may result in water quality degradation and impacts on aquatic resources downstream. For this reason, it is essential that a Bay-wide management mechanism with appropriate representation coordinate the respective activities of the Federal and state planning and regulatory agencies. This concept is...The

BLUE CRAB

The blue crab is one of the most important species in the Chesapeake. It leads the list of economically important species and would be near the top of a list of ecologically important ones. Bivalves, crustaceans, and fish are its favored foods and blue crabs themselves are important in the diets of striped bass, eels, and numerous other species.

Hatching occurs near the mouth of the Bay in summer and larvae are exported to the continental shelf where development occurs. The number of post-larvae that return to repopulate the Bay each year is greatly influenced by weather conditions on the shelf during the planktonic larval period. Post-larvae that do make it back settle in the lower Bay to metamorphose to the juvenile crab stage. Juvenile crabs spread throughout the Bay and its tributaries during the fall and the following spring. Submerged aquatic vegetation beds and shallow nearshore areas are important nursery, molting, and foraging habitats.

Blue crabs utilize all habitats in the Bay, from the deepest to the water's edge and from the most saline to fresh water. They are most abundant in deeper portions of the Bay during winter, but prefer shallower waters during summer.

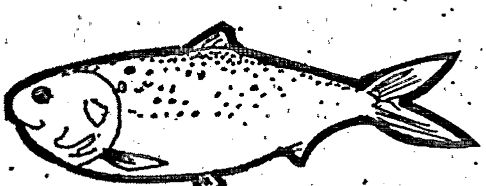
Although stock appear to be thriving, there is concern that overfishing may occur. Shoreline development and contaminant-laden runoff water could degrade important nearshore molting and foraging habitats. Areas that are currently hypoxic in summer could provide additional foraging and living space in the future if conditions improve.

ATLANTIC MENHADEN

The Atlantic menhaden is one of the most abundant species in estuarine and coastal Atlantic waters. The second most important species harvested in the United States in terms of quantity, it is processed for its oil, protein meal and solubles, and is used extensively as bait for commercial and recreational fishing. Menhaden are consumers of phytoplankton and plant detritus and, in turn, are fed upon by many predatory fish and birds.

The Atlantic menhaden is a member of the herring family, but unlike most herrings and shads, the menhaden is a coastal ocean spawner. It ranges from Nova Scotia in Canada to central Florida. The Chesapeake Bay is an important nursery ground for immature menhaden. The critical early stages are spent in coastal waters and, consequently, the eggs and larvae are not exposed to pollutants in the Bay. The Atlantic menhaden stock has remained relatively stable in recent years. Menhaden are able to tolerate sudden shifts in salinity and are found throughout the Bay from almost fresh water to high salinity.

The menhaden stock must be managed wisely if it is to withstand heavy fishing pressure and maintain its vial ecological roles as an important converter of phytoplankton and plant detritus and as an important food source for many other species.



Senator Charles Mathias, one of the key shapers of the Chesapeake Bay Program.

Management Committee [now the Implementation Committee] should be the coordinating mechanism to ensure that actions are taken to reduce the flow of pollutants into the Bay, and to restore and maintain the Bay's ecological integrity.

The Management Committee's specific responsibilities should include:

- ☐Coordinating the implementation of the Chesapeake Bay Program recommendations;
- ☐Developing a comprehensive basin-wide planning process in conjunction with ongoing planning efforts;
- ☐Investigating new regional approaches to water quality management including creative financing mechanisms;
- ☐Resolving regional conflicts regarding water quality issues; and
- ☐Reviewing ongoing Bay research efforts and recommending additional research needs.

Hopefully, the needs of the future can be met and the quality of the Bay preserved. It is apparent that we are talking about some governmental change, long-term commitments, and money. There will be no quick-fix for the Chesapeake's problems. We will need to continue to study and to monitor, but while we do that, we will also need to focus concerted remedial action on some of the most severe problems in the system. Above all, we will need to continue the dialogue among the state and among the users of the Bay. The new spirit of cooperation and awareness generated by the Chesapeake Bay Program has brought us to the point of believing that we can, after all, manage the Bay for the benefit of all.[2]

WHO IS INVOLVED AND WHAT THEY DO

The concerted effort to restore the Chesapeake Bay is relatively new. It was only ten years ago that state and federal leaders from around the Bay region met to pledge protection of the Bay. It was only six years ago in the 1987 Chesapeake Bay Agreement that a detailed and coordinated restoration effort was launched. It was only a year ago that the 1992 Amendments were approved.

The 1983 Agreement set in motion a coordinated campaign to reverse the decline of living resources in the Bay. It also established the major elements of a cooperative structure to develop and coordinate the comprehensive Bay cleanup: the Chesapeake Executive Council, its Implementation Committee, and EPA's Chesapeake Bay Liaison Office. And it established a Baywide monitoring program to gather basic data against which desired change could be measured.

1983-88: Maryland, Virginia, Pennsylvania, the District of Columbia, the Chesapeake Bay Commission and EPA were the original partners in the Chesapeake Bay Agreement. Six other federal agencies formally joined in the Bay cleanup in 1984: Soil Conservation Service, Fish and Wildlife Service, National Oceanic and Atmospheric Administration, Geological Survey, U.S. Army Corps of Engineers, and the Department of Defense.

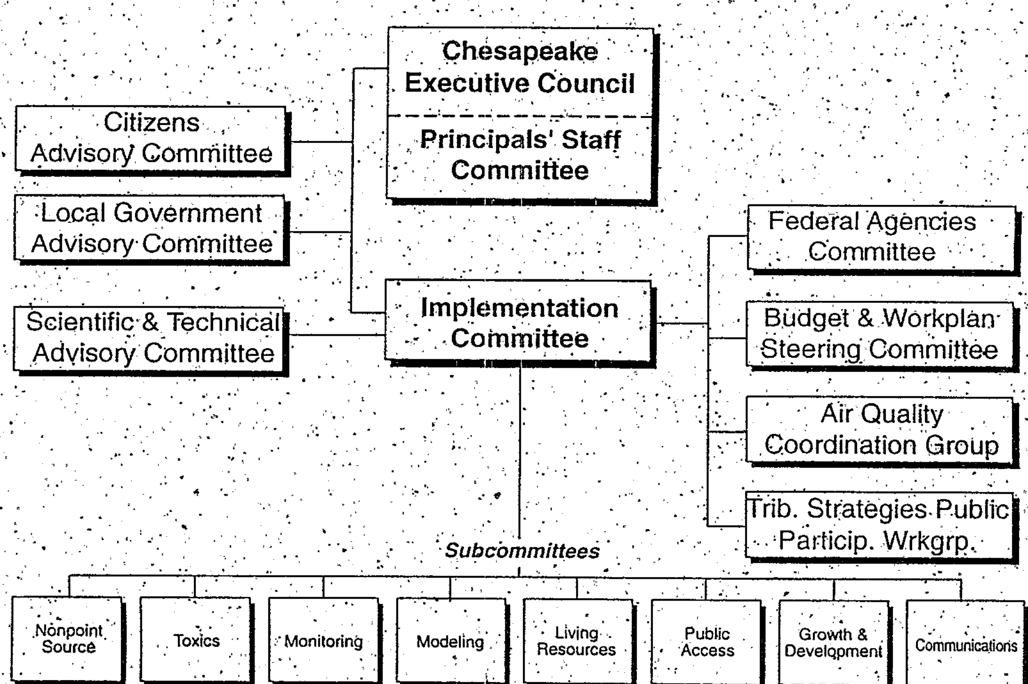
Commitment to restoring the Bay has enabled states whose institutions and political traditions differ and federal agencies with diverse missions to work together to solve common problems while retaining the independence of their programs. The Chesapeake Executive Council provides the leadership and focus that shapes their work.

IMPLEMENTATION COMMITTEE RESPONSIBILITIES

The Implementation Committee was established by the Chesapeake Bay Agreement of 1983 and is composed of representatives for the states of Maryland, Virginia and Pennsylvania, the District of Columbia, the Chesapeake Bay Commission, the EPA and other federal agencies (Defense, NOAA, Fish and Wildlife, USGS, Agriculture and Transportation). It is responsible for implementing the policy decisions and technical studies of the Chesapeake Executive Council and coordinating restoration and protection activities under the 1987 Bay Agreement.

It establishes and coordinates all of the Bay Program subcommittees and is responsible for the annual workplan and budget, preparation of the Annual Report, technical and computer support and public outreach. It is advised by the Scientific and Technical Advisory Committee, the Local Government Advisory Committee and the Citizens Advisory Committee whose Chairmen are also members.

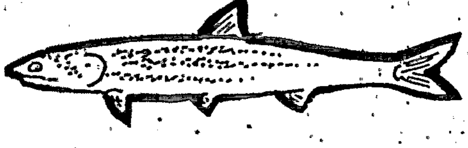
The Chesapeake Bay Program



BAY ANCHOVY

The bay anchovy, a small, schooling species, is the most abundant fish in Chesapeake Bay. It is a major consumer of plankton and is itself a major food of predatory fish, terns, and jellyfish making it a key species in the Bay's food web. The bay anchovy occurs throughout the Bay and is widely tolerant of salinity and temperature. It lives to three years of age, seldom grows longer than 90 mm, and spawns in late spring and summer when low dissolved oxygen may limit the distribution of all life stages. Oxygen levels below 3.0 mgL can be lethal to eggs and larvae and DO below 2.0 mgL is critical. Specific habitat features, structure, and shoreline development are not of particular concern for bay anchovy, but hydrographic features that affect water quality could limit its distribution and abundance. Surprisingly little is known about toxicant effects on bay anchovy. Bay anchovy losses from being entrained and impinged in power plant cooling systems may affect its abundance as well as that of fishes that consume it.

Bay anchovy populations in the Chesapeake Bay fluctuate annually, but no long-term declines have occurred. Deteriorating water quality in the future could affect its reproductive potential. Summer hypoxia already potentially limits its distribution and productivity in the Maryland portion of Chesapeake Bay. A better knowledge of toxicant effects on all life stages and better definition of the bay anchovy's key role in food webs will be important to define water quality criteria that may be critical.



The Implementation Committee, the Council's operating arm, has 26 members: delegates from the jurisdictions, and representatives of the seven federal agencies and three interstate commissions (Chesapeake Bay Commission, Interstate Commission on the Potomac River Basin, and Susquehanna River Basin Commission). Subcommittees for Planning, Nonpoint Sources, Data Management, Modeling and Research, Monitoring, and Living Resources coordinate work in those categories across agency and state lines. A Scientific and Technical Advisory Committee, whose membership includes directors of major Bay area research institutions, also assists the Implementation Committee. The Chesapeake Research Consortium, an organization of Bay research institutions, provides support...

The Council has a Citizens Advisory Committee (CAC) to provide a public perspective on policy issues. CAC has 25 members: four appointed by the chief executive in each state, and nine at-large members nominated by the Citizens Program for the Chesapeake Bay, Inc...[3] [*Another committee was formed in 1988 to represent the local government role in the restoration: the Local Government Advisory Committee. It has 20 members from Bay Program jurisdictions.*]

EVOLVING IN NEW DIRECTIONS

The organizational structure of the Chesapeake Bay Program forms the framework for looking at the Bay. Its endurance and success depends upon whether or not it allows formulation of the appropriate questions.

1990: As the Chesapeake Bay Program resolves some of the issues before it, other problems come to the forefront for consideration. The first Agreement identified a small number of critical issues to be addressed. The selection of these issues was based on a consensus among citizens, resource managers, and the scientific and technical community. These groups agreed, first, that these problems were important, and, second, that we knew enough about them to develop successful solutions.

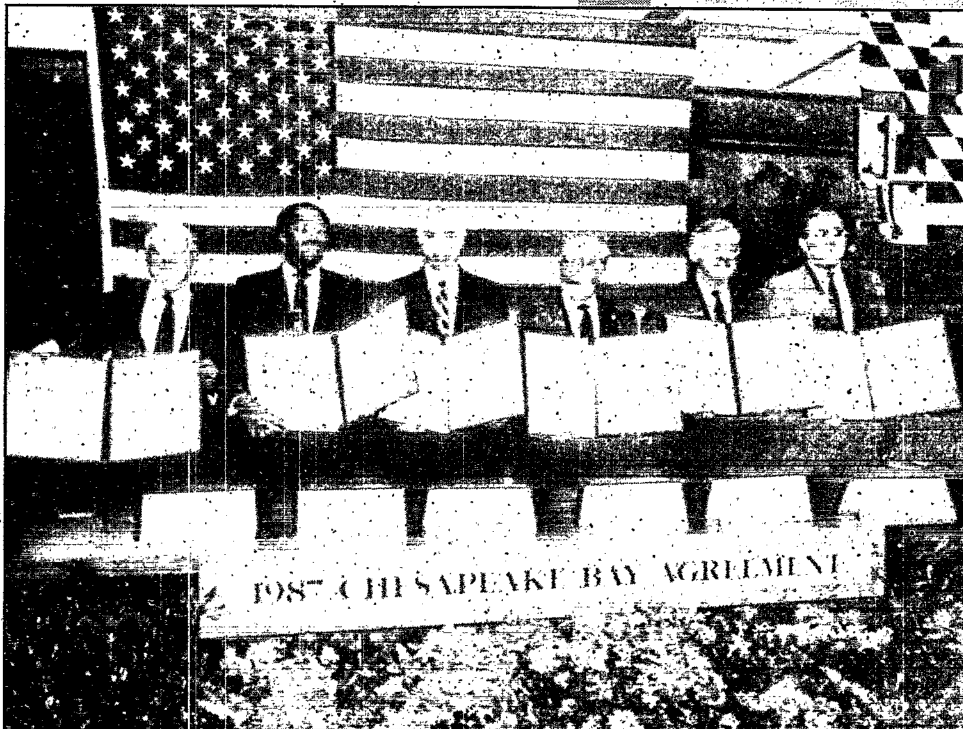
As time has passed, the different parts of the complex interstate, state-federal, state-local, public-private, and legislative-executive entities that comprise the Chesapeake Bay Program have coalesced into an increasingly effective and efficient apparatus for dealing with the various parts of the problem. It has become apparent that the solutions to many of the problems articulated in the 1983 Agreement and its successor...are not going to be as simple as was hoped in 1983. The basic consensus as to the importance of the original problems still holds, but some newly-identified problems demand solutions and require integration into the Program.

The Chesapeake Bay Program is moving in uncharted waters. No other environmental management effort on this scale has ever been attempted in a system as complex as the Chesapeake...For convenience and manageability, the day-to-day activities of the Chesapeake Bay Program are coordinated through committees and workgroups such as Living Resources, Modeling, Toxics, Stock Assessment, etc. In reality, however, these areas are not isolated from each other, and the best decisions consider and integrate the deliberations of all these groups...The management community involved in the Bay Program interacts on an almost continuous basis. This interaction is critical to the success of a program that deals across political boundaries with a natural system as complex as the Chesapeake Bay and its watershed.[4]

This idea of constant evolution is brought home in the changing thrusts of the basic Agreements and their Amendments.

1992: The unique 1987 pact set the framework for restoration with clear goals and objectives, specific commitments, and deadlines for action. Nearly all of the commitments and deadlines have been met, but this is a misleading measure of progress because the Bay and our knowledge of its problems have not remained static. New connections have been found and new challenges created. Nothing speaks better to the fundamental soundness of the Agreement than how these new challenges are incorporated.

A decade ago, scientists were unable to agree on the relative importance of phosphorus and nitrogen as nutrients in estuaries and tributaries. Continuing research, much of it conducted on the Chesapeake, revealed the importance of both. More thorough study on the chemical transformations of nutrients in Bay waters and sediments has shown how overenrichment of nutrients, algal blooms, and the development of oxygen-starved water are interrelated. This has led to a dual nutrient control strategy which recognized the spatial and temporal complexity of improving water quality.



1987 signatories -- Chesapeake Bay Commission Chairman Kenneth J. Cole, District of Columbia Mayor Marion Barry, Jr., Pennsylvania Governor Robert P. Casey, Maryland Governor William Donald Schaefer, Virginia Governor Gerald L. Baliles and EPA Administrator Lee Thomas.

This advance in knowledge is directly reflected in the 1992 Amendments to the basic 1987 Agreement with a reaffirmation of the commitment to achieve an overall 40% reduction of nitrogen and phosphorus entering the Bay from 1985 levels by the year 2000, maintain at least this level thereafter, and to place added emphasis on improving control technologies to attain this reduction.

Research has also made clear that the future success of the Chesapeake Bay Program will rely heavily on better control of nutrient inputs from the system's expansive watershed. The new Amendments therefore calls for a major shift toward pollution control in the Bay's tributaries to improve conditions in the Chesapeake mainstem.

Studies have also demonstrated the link between water quality and the survival and health of submerged aquatic vegetation (SAV). Consequently, the new Amendments call for the use of the distribution of SAV in the Bay and its tidal tributaries as an initial bellwether of progress in improving water quality and restoring living resources...

At a time when "gridlock" is a popular phrase, the 1992 Amendments offer a refreshing reprieve. The research observations were made, the required actions were agreed upon, and the Chesapeake Executive Council responded with performance. We will always quibble over the modesty or majesty of particular actions, but on the

LIVING RESOURCE SUBCOMMITTEE MILESTONES

1987

- ***Subcommitee formed***

1988

- ***Prepared Baywide Resource Management Strategy, Removing Fish Passage Impediments Strategy, an ecosystem Monitoring Plan, and a Fisheries Stock Assessment Plan***
- ***Published "Habitat Requirements For Chesapeake Bay Living Resources"***
- ***Adopted Wetlands Policy***

1989

- ***Management Plans prepared for alosids, blue crabs, oysters, and striped bass***
- ***Adopted Submerged Aquatic Vegetation Policy***
- ***Prepared Implementation Plans for fish passages and oysters***

1990

- ***Adopted a Waterfowl Policy and Management Plan and fishery Management Plans for bluefish, weakfish, and spotted seatrout***
- ***Prepared Implementation Plans for alosids, blue crabs, striped bass, submerged aquatic vegetation, and wetlands***

1991

- ***Prepared fishery Management Plans for summer flounder, spot, croaker, and American eel***
- ***Published "Habitat Requirements For Chesapeake Bay Living resources: 2nd Edition"***

1992

- ***Published "Anadromous Fish Habitat Restoration: A Resource Assessment"***

1993

- ***Prepared a fishery Management Plan for black drum and red drum, a Technical Synthesis for submerged aquatic vegetation, and strategies for wetlands mapping and the restoration and protection of ecologically valuable species***
- ***Published "Dissolved Oxygen Goals"***

1983: Governors Harry Hughes of Maryland, Dick Thornburgh of Pennsylvania and Charles S. Robb of Virginia -- three of the signatories of the historic 1983 Chesapeake Bay Agreement.

bottom line we find that the special partnership responsible for the continuity of management and commitment necessary to ensure long-term results is in place and working.

The idea of cooperative, multi-jurisdictional governance is key to restoring the Bay. The Amendments call for an expansion of the partnership by exploring possible working relationships with the three remaining basin states - New York, West Virginia, and Delaware - in the development of strategies for nutrient reduction in tributaries.[5]

THE GOAL FOR GOVERNANCE

"Cooperative Governance" is another way of saying that all the players should be brought into the game. The same may be said of the evolving approach to restoring the life of the Bay--treat the whole patient. The discrete programs involving fish ladders or grasses or assessing blue crab stocks are linked by the search for a better understanding of the complex relationships which bind the overall Chesapeake ecosystem. This understanding is maturing and becoming more comprehensive. We are better able to track the unwinding consequences of specific actions and gather clues about the best levers to pull and which signals are reliable.

1987: ...the Chesapeake Bay Program Implementation Committee formed the Living Resources Task Force directing it to "provide for the restoration and protection of the living resources, their habitats and ecological relationships." Its mandate developed from the growing recognition that "the productivity, diversity and abundance of living resources are the best ultimate measures of the Chesapeake Bay's condition."

With time, the committee realized the need for a permanent body of scientists and managers to guide living resource restoration; the task force transformed into the current Living Resources Subcommittee.

The 1987 Chesapeake Bay Agreement sets the broad agenda which the subcommittee must carry out. More detailed than the 1983 Agreement, the 1987 Agreement specifies the portions of the Bay ecosystem requiring protection and rejuvenation and set timetables for the creation of management plans to achieve these goals. The schedule is demanding by any standard. Yet, the production of detailed plans remains on track.

Under the framework of the Resource Management Strategy adopted in 1988, twelve living resource management plans have been written, reviewed by the Bay Program and the public and adopted by the Executive Council to guide the coordinated management of the Chesapeake Bay's fish and waterfowl. While people respect political boundaries and road signs, species do not and effective, cooperative management is essential for the fish and waterfowl to survive and prosper.

1992: Until the signing of the 1987 Agreement, much of the restoration effort hinged on saving the Bay's plants and animals one species at a time. Implicit in the Living Resources Subcommittee's charge is to manage the Bay from an ecosystem approach. For example, we seek to restore not only the oyster, but also its habitat. The oyster reef hosts a variety of dependent species. By restoring the reef and its oysters, we will not only bolster populations of other reef species but ultimately help clean the Bay as more and more oyster filter her water.

Each species has a niche which is integrally related to all other niches in the complex workings of the Bay ecosystem. By nursing the ecosystem back to health, we necessarily promote the well-being of each component species.[6]

The Chesapeake Bay Program has two audiences: A public that asks, "Is the Bay getting any better?" and a large group of scientists, managers, and policymakers that asks, "How can we make the Bay better?" The mysteries of the Bay are revealed to researchers through such tools as a three-dimensional water quality computer model and are translated into measures of progress and targets such as threshold amounts of dissolved nitrogen and phosphorus that interfere with the growth of Bay grasses. The quantification of key aspects of the life of the Bay is an essential ingredient to discover how we are doing and how we can do better. But there is another measure, and that is how the mysteries are realized in the spirit of the people who live with the Bay. This is the translation of the Chesapeake Bay Program from a government and industry effort to a way of life whose stewards are individual men, women, and children.

Maryland's Governor William Donald Schaefer attends a cleanup.

COMMUNICATIONS SUBCOMMITTEE MILESTONES

1987

- *Established as the Public Information and Education Subcommittee*
- *Sponsored public outreach and education conference for Bay region*
- *Reprinted "Baybook," an easy to understand guide for reducing water pollution at home*
- *Reprinted the EPA's document "Introduction to an Ecosystem," a primer on the Bay*

1988

- *Created "Bay Activity Cards" -- student activity cards to assist in teaching about all aspects of the Bay*

1990

- *Developed "Wetland Education Resource Inventory"*

1991

- *Changed name to Communications Subcommittee and broadened mission to include developing more effective communications about the restoration and the Chesapeake Bay Program*
- *Established the Chesapeake Bay Communications Office*

1992

- *Created "A Citizen's Guide" to the Chesapeake Bay Program," a public education oriented pamphlet about Chesapeake Bay Program activities*
- *Established Urban Teacher Training Workshops in each of the Bay jurisdictions to provide teachers with Bay-related education material*
- *Introduced "Bay Starts Here" program to promote stewardship of the Bay and its tributaries*

1993

- *Undertook a Bay "Attitudes and Behavior" survey, a watershed-wide research project to determine citizen attitudes toward the restoration of the Bay*

1993: A growing number of business people, developers, and political leaders understand that what is good for the environment is ultimately good for the economy and the public welfare. Many private citizens have become involved in helping the Bay and its living resources through interest groups, advisory committees, donations, and individual volunteer work...

But how do we help the public at large to better understand the connections among the water, land, air, people, and, of course, the living resources, when many of the specialists are just beginning to grasp this idea? We will only conquer the problems of non-point source pollution, as a prime example, when the majority of decisions that are made locally by developers, local officials, engineers, homeowners, and farmers are made with a sense of the whole system, the water, the land, the air, the people, living resources – the Chesapeake Bay ecosystem. It would be foolish to think that we can regulate all of these decisions at State and Federal levels. But we can work hard to educate, to offer alternatives, to coordinate our environmental programs at all levels of government, and to urge that the lessons we are learning from the Chesapeake experience are shared and applied throughout the watershed.[7]

SEE ALSO:

- The Chesapeake Bay Program: A Commitment Renewed; February 1988
- Chesapeake Bay: A Framework For Action; September 1983.

LEARNING TO ASK THE RIGHT QUESTIONS/FINDING THE RIGHT ANSWERS

At a most fundamental level, the phrase 'cleaning up the Chesapeake' means to increase the amount of "good water" available in the Bay. "Good water" contains enough dissolved oxygen to support the Bay's tremendous variety of aquatic life. Oxygen is constantly entering the Bay from the atmosphere and by photosynthesis from aquatic plants but significant portions of the Bay contain little or no dissolved oxygen at all during summer months and water without enough oxygen threatens life. The eggs and larvae of fish may die, the growth and reproduction of oysters and clams is impaired, and adult fish find their habitat reduced and their feeding affected. The very reason to restore the Bay--its living inhabitants--is under direct assault.

THE FIRST QUESTION

Pre-1983: In choosing problems upon which to focus research, the EPA looked to the scientific community, the Bay area governments, and the public. A list of ten candidate issues was drawn up. From this list, three topics were chosen as targets for the 25 million dollar research program. Nutrient enrichment, toxic substances, and the disappearance of submerged grasses were major concerns upon which little previous research money had been spent. Shortly after the priority objectives were established, the Chesapeake Bay Program's managers developed and implemented a unique approach to managing a water quality research program. To the greatest extent possible they involved all components of the Bay community in the decision process. This included scientists, state officials, citizens, recreational interests, watermen, business, and industry.

...In addition to coordinating and staffing principal research efforts, the CBP also developed a computerized data management system to compile and evaluate the data collected by individual CBP projects and by other research efforts...The information assembled in the CBP data base is considered to be the most extensive body of scientific knowledge on any single estuary in the world. More important, the data base provides a common set of knowledge about the Bay's ecological problems – a prerequisite necessary to carry out individually and collectively the most urgent task of establishing common goals for action to improve the Bay.[8]

ESTABLISHING THE DATA BASE

One branch of this "common set of knowledge" has grown into a coordinated Baywide water quality monitoring system that develops baseline data and records subsequent environmental changes. Beginning in the outer reaches of the watershed, researchers track and measure the sources of nutrients and other pollutants. On the Bay itself, they monitor a variety of factors to give a comprehensive diagnosis of the Bay's health. As data builds, scientists unravel the technical details and translate the information into terms meaningful to managers and legislators who design and implement specific actions to remedy the Bay's ills.

1984: Like analysts diligently tracking the daily fluctuations and long-term trends of the stock market, Bay scientists monitor the Chesapeake Bay. Routine collection and analysis of water samples provide information on short and long-term changes in water quality while the status of the supporting members of the estuarine food web-plankton, benthic organisms and aquatic grasses – are [checked]...Building on

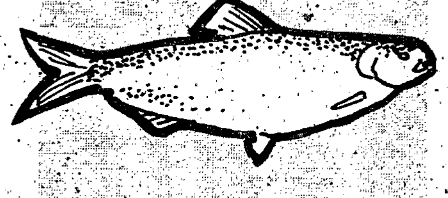
AMERICAN SHAD & HICKORY SHAD

Natural shad spawning habitats include non-tidal reaches of virtually all Chesapeake Bay tributaries. American shad juveniles leave the estuary in late fall, mature in the ocean, and return to the tributaries to spawn after two to five years. The life history of hickory shad is similar, but poorly known.

American shad historically supported important recreational and commercial fisheries in Chesapeake Bay tributaries, whereas hickory shad, because of their naturally lower abundance in the region, were a much less important fishery species. Severe stock declines of both species in the latter half of the 20th century led to drastically lower harvests, and a fishing moratorium in the Maryland portion of Chesapeake Bay which has been in effect since 1980. The causes of the declines apparently include overfishing in earlier decades, blockage of spawning rivers by dams and other impediments, and degradation of water quality and physical habitat in spawning reaches.

The critical life stages of shad are the eggs, larvae, and early juveniles...American shad and hickory shad are principally zooplankton feeders and, in turn, are preyed upon by other predatory fish, thus serving as a trophic link between plankton and piscivores in coastal and estuarine waters...

Although American shad have shown some signs of recovery in recent years, stocks must continue to be protected, both from excessive harvest and from degradation of their spawning and nursery habitats.



a data base reaching back to the 1950s, monitoring of the Bay's finfish and shellfish populations provides the information needed to ensure wise management of existing living resources...Monitoring serves not only to assess the current "state of the Bay" and long-term trends, but also to help better understand its dynamics in response to pollution reduction.

In 1984, state and federal agencies initiated a coordinated monitoring program in the Chesapeake Bay mainstem and its tidal tributaries. Integrated with this water quality network are plankton, benthos and sediment sampling...The Chesapeake Bay Monitoring Program has since expanded to include monitoring activities in the District of Columbia, other living resource monitoring programs, and monitoring of non-tidal Bay tributaries...

...the Bay Program's Monitoring Subcommittee published the "Chesapeake Bay Basin Monitoring Program Atlas," a document containing summary descriptions of ongoing, long-term environmental monitoring programs within the watershed. The number and diversity of monitoring programs described in the atlas attest to the wealth of information being generated for management purposes. Yet, the sheer number of programs emphasizes the need to integrate across jurisdictional boundaries – in essence, to treat the Chesapeake as a whole.[9]

Monitoring the Bay is not accomplished with words. It involves people, weather, and sensitive equipment. The Chesapeake Bay Program funds the routine monitoring of 19 water quality parameters at 49 stations in the mainstem of Chesapeake Bay. At each station, measurements are taken for dissolved oxygen, water temperature, conductivity, salinity, and pH. These measurements are sampled from surface to bottom at 1 to 2 meter intervals. One use of this data is to feed another sensitive device--a collection of computer software that patterns the connections between events in the watershed and water quality in the main Bay.

MONITORING SUBCOMMITTEE MILESTONES

1984
- ***Subcommittee established***
- ***Published "Monitoring 1984: A First Report from the Chesapeake Bay Program Monitoring Subcommittee"***

1985
- ***Published "The State of the Chesapeake Bay: A Second Annual Monitoring Report"***

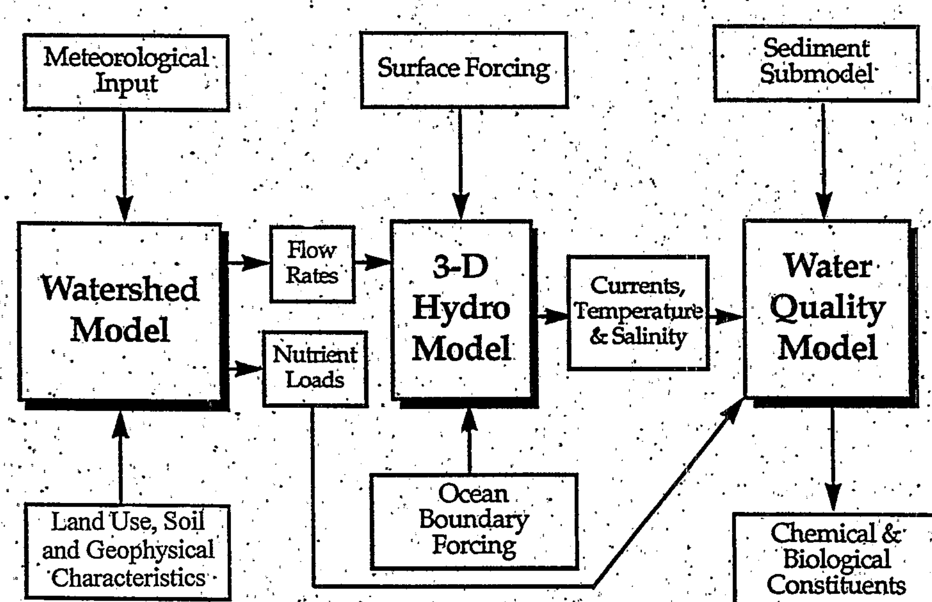
1988
- ***Established the Coordinated Split Sample Program to assess the comparability of water quality data***

1989
- ***Published "Chesapeake Bay Basin Monitoring Program Atlas Volume I: Water Quality and Other Physiochemical Monitoring Programs"***
- ***Published "Chesapeake Bay Basin Monitoring Program Atlas Volume II: Biological and Living Resource Monitoring Programs"***
- ***Published "The State of the Chesapeake Bay: Third Biennial Monitoring Report"***

1990
- ***Established Data Analysis Issues Trading System, an issues resolution system***

1992
- ***Published "Progress Report to the Implementation Committee on Refinement to the Monitoring Program," a review of the Chesapeake Bay mainstem and tributary water quality monitoring program assessing its effectiveness to provide the data needed to guide management decisions***

Key Elements of Chesapeake Bay Modeling



USING THE DATA

The Chesapeake Bay Program has relied heavily on water quality modeling to guide program strategies. This comprehensive modeling approach consists of two models, each with a specific role, that interact and ultimately predict the effects of nutrient loadings in the watershed on water quality in the mainstem. The two models used by the Bay Program are the Watershed Model and the Time Variable Bay Model. The Watershed Model simulates runoff, groundwater flow, and river flow to estimate nutrient loadings from nonpoint and point sources to the tidal Chesapeake Bay. These loading estimates are used as input to the Time Variable Model, a continuous hydrodynamic and water quality model of the tidal estuary.

Water quality modeling efforts in the Bay began with the Watershed Model in the late 1970s. The first generation Watershed Model was completed in 1983 and was used to support the subsequent development of a two-dimensional, steady-state water quality model of the mainstem. The mainstem model, which was developed during 1985 through 1987, was used to test a number of potential nutrient control scenarios. This modeling effort became the basis for the nutrient load reduction goal of 40 percent by the year 2000 established in the 1987 Bay Agreement.

Another upgrade to the Model began in 1988 and was completed in 1991. The Three Dimensional Time Variable Model (3-D Model) was also completed in 1991. It estimates the water quality response of the Bay to nutrient inputs estimated by the Watershed Model. The 3-D Model simulates sediment nutrient flux, plankton growth, and other water quality processes. The 3-D Model is capable of profiling an entire year and is able to evaluate in detail the needed phosphorus and nitrogen reductions in the mainstem of the Chesapeake Bay to achieve the desired restoration goals. It can also address the extent of nutrient reductions that are necessary to protect living resources in specific sensitive areas of the Bay and can estimate how long it will take before measurable improvement occurs once nutrient controls are in place.

The coupled Watershed and 3-D Models do not provide absolute predictions of watershed nutrient loads and resulting Bay water quality. However, the models do provide an excellent tool for studying cause-effect relationships between activities in the Bay watershed and water quality in the main Bay.

1993: The major purpose of the Watershed Model is to enable Chesapeake Bay Program managers to look beyond the measured data and establish cause-effect relationships that explain water quality levels at various locations in the system. By subjecting the current land use pattern and wastewater treatment plant loadings to a full range of potential hydrological conditions, the Watershed Model is used to extend short-term water quality records and to examine the most important processes responsible for water quality levels in various sections of the Bay.

Since all major processes responsible for pollutant discharges and transport are represented by the Watershed Model, the model is used to evaluate the water quality impacts of alternate land use patterns and wastewater treatment plant discharges under the same long-term hydrologic conditions.

The objectives of the 3-D Model are to determine the relationship between nutrient load reductions and reductions of eutrophication and anoxia in the Bay. The 3-D Model uses flow rate and nutrient load output from the Watershed Model to simulate the Bay's response to these variables. The model was used to reevaluate

MODELING SUBCOMMITTEE MILESTONES

1979

- ***Development begins on the first Bay basin Watershed Model***

1982

- ***Model indicates that nonpoint sources are the dominant supplier of nutrients to the Bay***

1984

- ***Development begins on the 2-D Steady State Model that will determine what nutrient loadings mean in terms of water quality***
- ***Updating of the Watershed Model to Phase I to include nonpoint source loadings begins***

1987

- ***Findings from the 2-D Model and the updated Watershed Model are used in determining the 40% nutrient reduction goal***
- ***Development of the Phase II Watershed Model and the 3-D Time Variable Model begins with animal waste and air deposition added as nutrient sources and the ability to express nutrient loadings over time expanded to three years***

1991

- ***First scenario run through the model***

1993

- ***Published "Watershed Model Application to Chesapeake Bay Nutrient Loadings"***
- ***Published "Application of the 3-D Eutrophication Model to Chesapeake Bay"***
- ***Published "Technical Analysis of Response of Chesapeake Bay Water Quality Model to Loading Scenarios"***

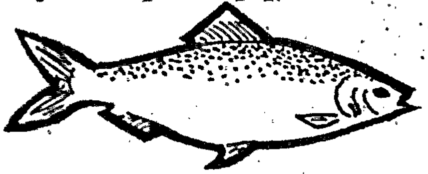
ALEWIFE & BLUEBACK HERRING

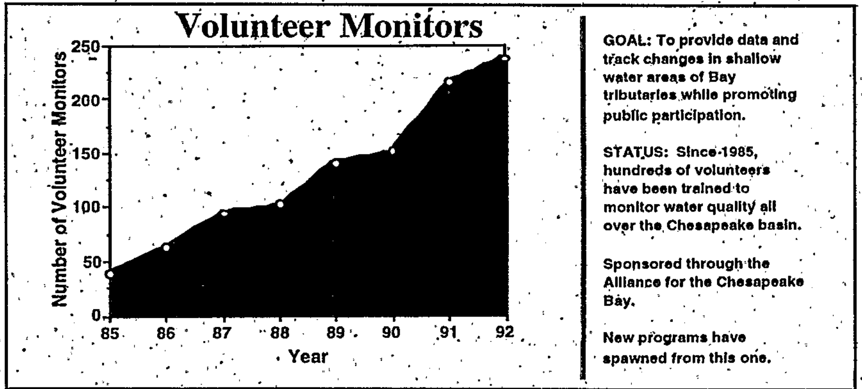
Spawning habitats of these "river herring," include freshwater, non-tidal areas of smaller tributaries of Chesapeake Bay. River herring juveniles leave their nursery areas in fall, mature in the Atlantic Ocean, and return after two to five years to Bay tributaries for spring spawning.

River herring supported relatively important commercial fisheries in Chesapeake Bay until the early 1970s when stock began to decline dramatically. Current landings are the lowest on record. Probable causes of stock declines include loss of spawning and nursery habitat quantity and quality, over-exploitation of primarily immature individuals in the offshore foreign fishery between 1967 and 1977, and decimation of the 1972 year classes and alteration of spawning habitats by tropical storm Agnes.

The critical life history stages of alewife and blueback herring are the eggs, larvae, and early juveniles... Both species feed principally on zooplankton, small insects, fish eggs, and the like, serving as an important trophic link to estuarine and coastal piscivores, and to some mammals, amphibians and aquatic birds. Larval forms and eggs of these species also serve as prey for small fish and invertebrates...

Chesapeake Bay stocks of river herring have continued to decline. Mitigation of stream acidification, removal of spawning stream blockages, implementation of effective stormwater management practices, and Baywide harvest restrictions are positive steps that should be taken to encourage recovery of these depressed populations.





the 1987 Bay Agreement nutrient reduction goal and forecast the time required for water quality to respond to nutrient controls.

By operating the Watershed and 3-D models in a series to simulate the entire Bay system, management agencies can evaluate the Baywide impacts of regional water quality management strategies in terms of the frequency of violations of water quality criteria/standards for different beneficial uses (e.g. fisheries habitat, recreation). Locational differences in seasonal pollutant delivery by point and nonpoint sources can be examined with models to identify sections of the tributary river basins where pollution controls promise the greatest benefit in terms of Chesapeake Bay water quality. Since it represents the hydrologic cycle in the tributary area of approximately 64,000 square miles, the package of models also can be used to quantify Baywide water quality impacts of various water management strategies.

In short, the Bay Watershed/3-D models package is a state-of-the-art planning tool that allows state and regional management agencies to relate upstream water resources management decisions to Chesapeake Bay water quality.

A very important product of this monitoring and modeling is the securing of a point of view—and that point of view is the ecosystem. It's very much like the nursery rhyme:

This is the house that Jack built.
This is the malt
That lay in the house that Jack built.

This is the rat,
That ate the malt
That lay in the house that Jack built.

This is the cat,
That killed the rat,
That ate the malt
That lay in the house that Jack built.

This is the dog,
That worried the cat,
That killed the rat,
That ate the malt
That lay in the house that Jack built...

You may substitute phytoplankton for "malt", oyster for "rat", and so on to create your own play on the Bay's ecosystem. The point is that you will always find another complexity, another dog, another cat, another relationship to unravel and understand.

NUTRIENTS AND DISSOLVED OXYGEN

Over time, changes in the way we use land have caused a tremendous increase in the amounts of nutrients reaching the Bay. Their impact is counterintuitive. We have overfertilized the garden and, instead of spurring luxuriant growth among beneficial Bay residents, we have triggered an insidious process: Excess phosphorus and nitrogen feed an abundant growth of algae which clouds the water and blocks the sunlight needed by Bay grasses. Without sun, the grasses die and the essential habitat and food supply they provide vanishes. As the algae themselves die, they sink and decompose. The bacteria that cause decomposition use up dissolved oxygen. In an oxygen-poor habitat, those species that can move must leave and compete for food and space in still satisfactory areas. Those that can't leave may die.

In many ways, what follows is what the Bay Program is about—serious science, hard words, an intellectual quest designed to produce tangible goals and actions.

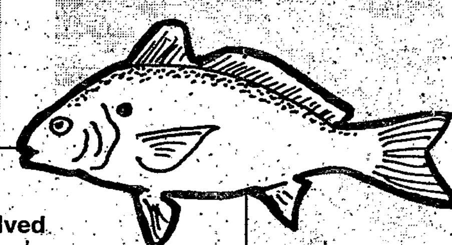
1992: Dissolved oxygen is a major factor affecting the survival, distribution, and productivity of living resources in Chesapeake Bay. Dissolved oxygen in natural waters has two major sources: 1) atmospheric oxygen which diffuses into the water at the surface, and 2) oxygen which is produced by plants (chiefly free-floating microscopic plants, or phytoplankton) during photosynthesis. Animals, plants and bacteria consume DO by respiration. Oxygen is also consumed by chemical processes (e.g. sulfide oxidation, nitrification). Depletion of DO has harmful effects on animals, and can stimulate production of hydrogen sulfide and ammonia and the release of heavy metals and phosphate from bottom sediments.

The amount of oxygen dissolved in water changes as a function of temperature, salinity, atmospheric pressure, and biological and chemical processes. The equilibrium (or saturated) concentration of DO in natural waters ranges from about 6 to 14 parts per million (or mg/L). The higher the temperature and salinity, the lower the equilibrium DO concentration. Biological processes such as respiration and photosynthesis can affect the concentration of DO faster than new equilibrium can be reached with the atmosphere. As a result, for relatively short periods of time, or under conditions of reduced mixing, DO concentrations can be driven far above or reduced well below saturation. Dissolved oxygen can decrease to near zero (anoxia), especially in deep or stratified bodies of water, or increase as high as about 20 mg/L (supersaturation) in dense algal blooms.

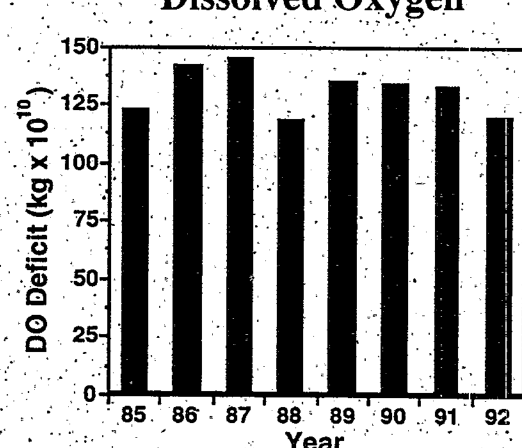
SPOT

Spot is an abundant marine and estuarine bottom foraging species. They occupy all areas of the Bay except in winter when they migrate to coastal waters or concentrate in deep-water refuges in the Bay. Spot are tolerant of a range of environmental conditions, generally preferring brackish to saline waters above mud substrate in the Bay, although they occur ubiquitously throughout all Bay depths. They are short-lived coastal spawners with excellent reproductive capacity; major predators of shallow benthic invertebrate communities in the Bay; and important prey to a host of predatory fish. The larvae consume zooplankton. Spot support a modest commercial fishery and are frequently (often incidentally) taken by sport fishermen in summer and fall.

Although spot is an extremely abundant and wide-ranging species, little is known of factors contributing to its stock-recruitment dynamics. Given its ecological importance, more effort should be made to understand what contributes to spot's success and what may be done to assure its continued high level of abundance.



Dissolved Oxygen



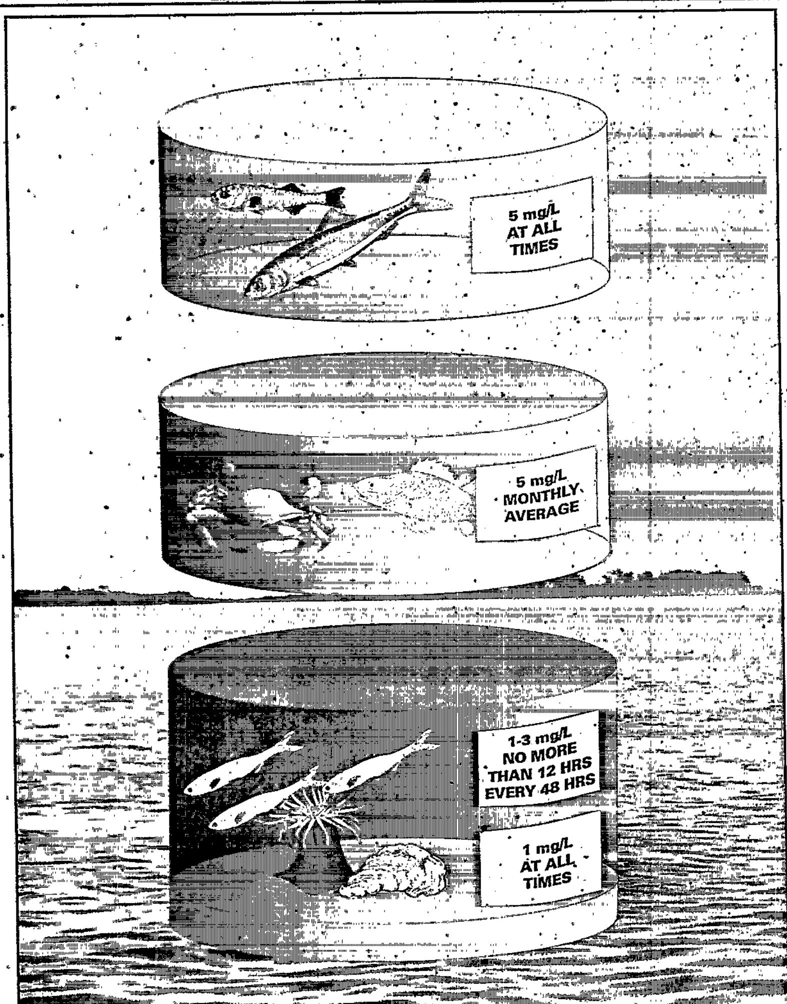
GOAL: Improve the dissolved oxygen (DO) concentrations to levels that will support the aquatic life of the Bay.

The 3D water quality model predicts a 20-25% improvement in bottom DO levels with the attainment of the 40% Nutrient Reduction Goal.

STATUS: DO has not yet responded to management actions.

There are seasonal considerations, as well. Low DO in Chesapeake Bay is mostly associated with deep water during the warm months (May-September), when the water column is stratified into density layers with cool salty water at the bottom, and warm, fresher water near the surface. The bottom layer becomes oxygen-depleted because the oxygen consumed by respiration and chemical oxidation cannot be replaced through diffusion of atmospheric oxygen and there is insufficient light to support photosynthetic production of oxygen. Some parts of the Bay can become anoxic for periods of days or weeks during midsummer.

In summer, very low DO can also occur for shorter periods of time (a few hours to a few days) in shallow water. In these cases, DO is depleted by the decay of large amounts of organic matter (perhaps due to respiring or dying algae blooms or from wastewater discharges). Deep water low in oxygen can also be moved into shallow areas by winds. Episodes of strong winds can transport (literally "slosh") water with extremely low oxygen content across the Bay bottom, up and into the habitat of shallow-water dwelling living resources. While strong winds persist, low oxygen waters may remain in the shallows for 40 hours or more. During these times inshore species are continuously exposed to stressful or life-threatening conditions. This sloshing of deep water is sometimes so extreme that anoxic waters move almost to the shoreline. During the resulting "jubilees" or "crab wars," blue crabs and fish congregate at the water's edge attempting to find sufficient oxygen to stay alive.



The Chesapeake Bay Dissolved Oxygen Goal for Restoration of Living Resource Habitats is: to provide sufficient dissolved oxygen to support survival, growth and reproduction of anadromous estuarine and marine fish and invertebrates in Chesapeake Bay and its tidal tributaries by achieving certain target concentrations of dissolved oxygen in milligrams per liter (mg/l).

In the spring, striped bass, white perch, shad, herring, and yellow perch spawn far up the Bay's tributaries. The eggs and larvae of these species are quite sensitive to low DO, and could be threatened by even moderate DO depletion associated with algal blooms or wastewater discharges. In the fall and winter, DO depletion is uncommon, and the most sensitive life stages of the target species generally are not present...[10]

The nutrients connected with the low dissolved oxygen problem--phosphorus and nitrogen are both natural fertilizers found in human wastes, animal wastes, and plant material. Like the seasonal freshwater flow, these nutrients have always been in the Bay; the problem lies in the amounts that are found. When the Bay was surrounded by undisturbed forest very little phosphorus and nitrogen ran off the land into the water; most of it was absorbed by the natural forest cover. Since the 1600s, the forest has been replaced by farms using large amounts of fertilizers, cities covered with asphalt and concrete, and sprawling suburbs rich in pampered lawns and automobile use.

Reducing the profound impact of excess nutrients on the inhabitants of Bay waters was a centerpiece of the 1987 Bay Agreement. The signers agreed to cut the "controllable" amounts of phosphorus and nitrogen reaching the Bay by 40% by the year 2000. The 40% reduction was chosen because at that level enough oxygen would be available for the Bay's living resources. Controllable amounts included discharges from dispersed or "nonpoint" sources such as runoff or erosion from agricultural, urban, suburban, and shoreline locations as well as end-of-the-pipe or "point" sources such as wastewater treatment plants and industry. The 1987 Agreement also called for a reevaluation of the 40% goal as continuing research produced new understanding.

NONPOINT SOURCE SUBCOMMITTEE MILESTONES

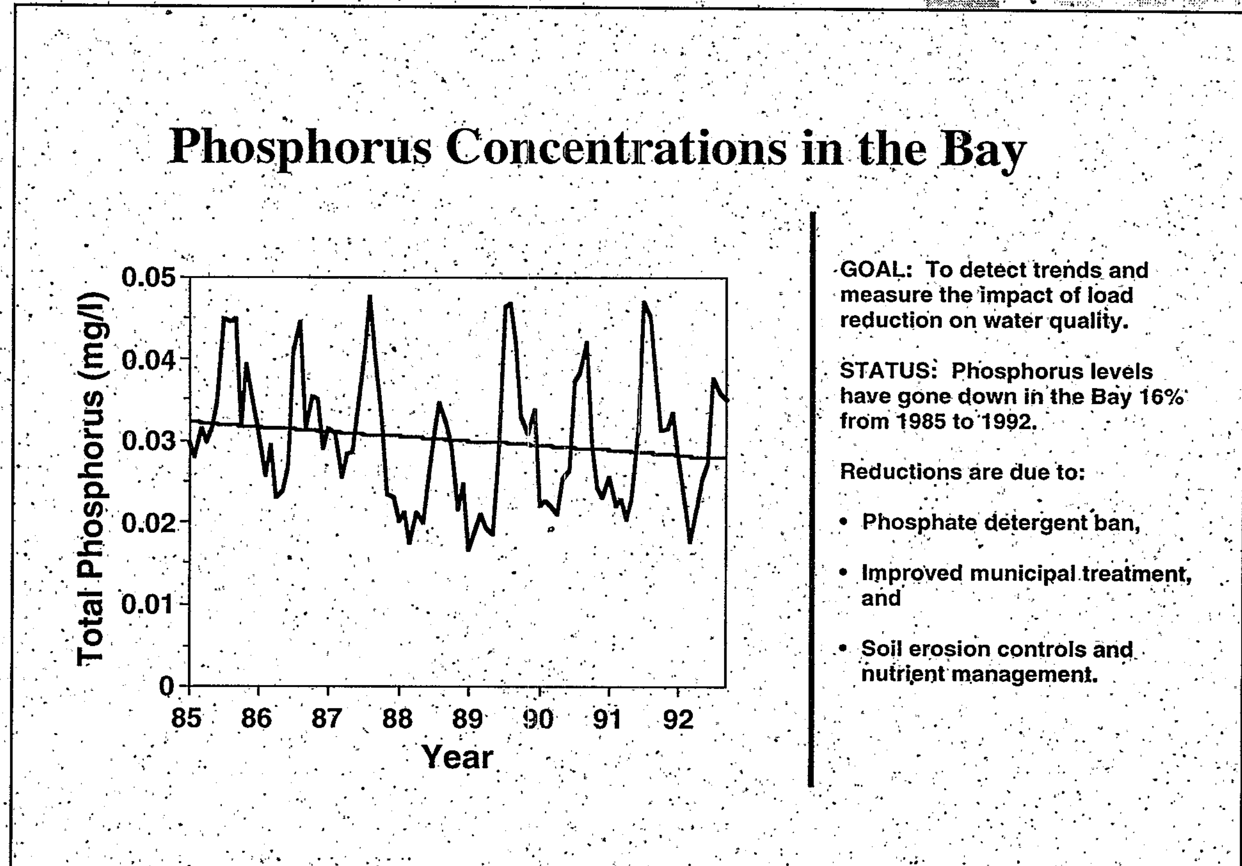
1985
- ***Subcommittee formed***

1986
- ***Began annual technical information exchange among Bay Program managers, Bay jurisdictions, government agencies, universities, and citizens***

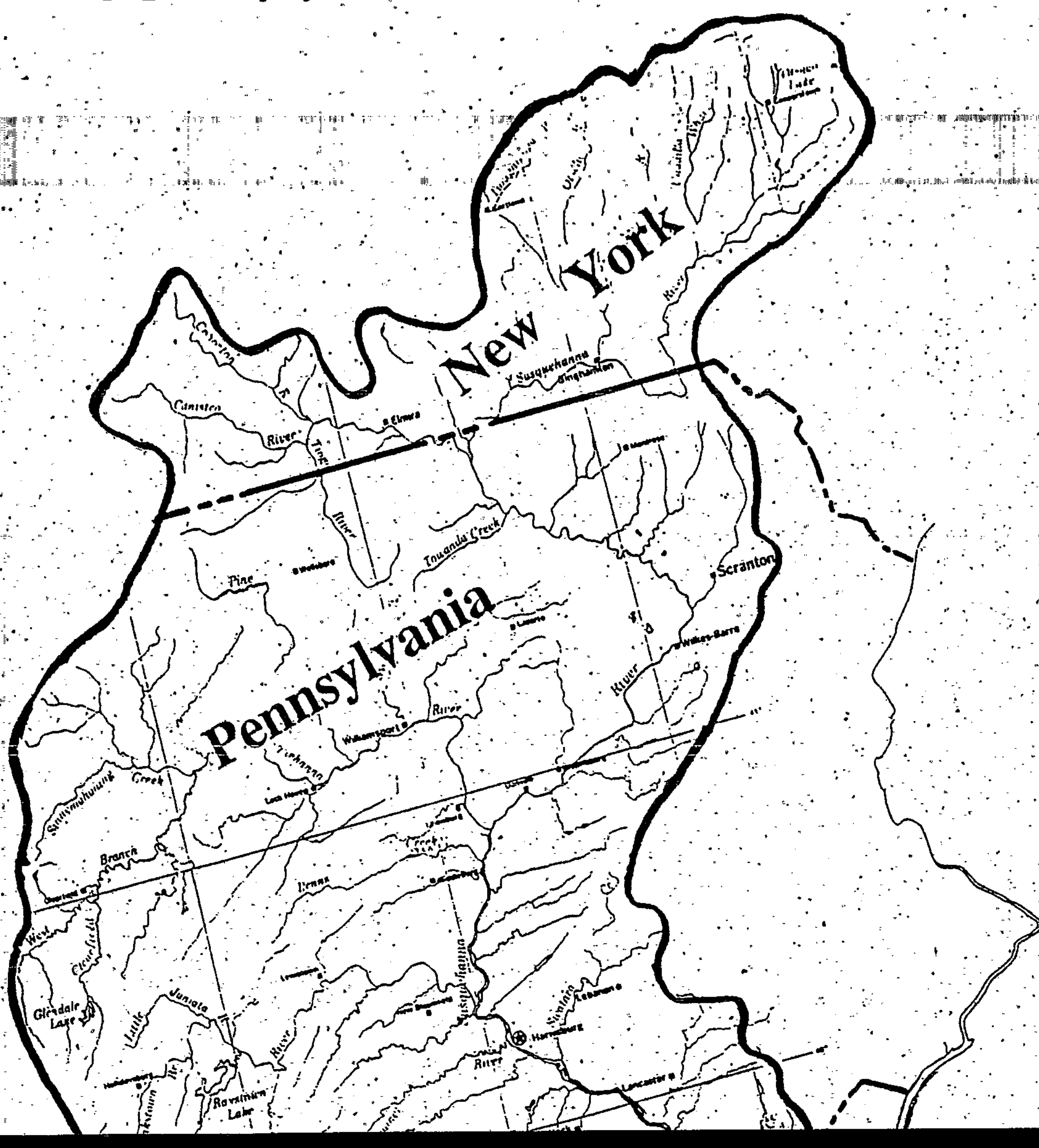
1988
- ***Published "Chesapeake Bay Nonpoint Source Program"***

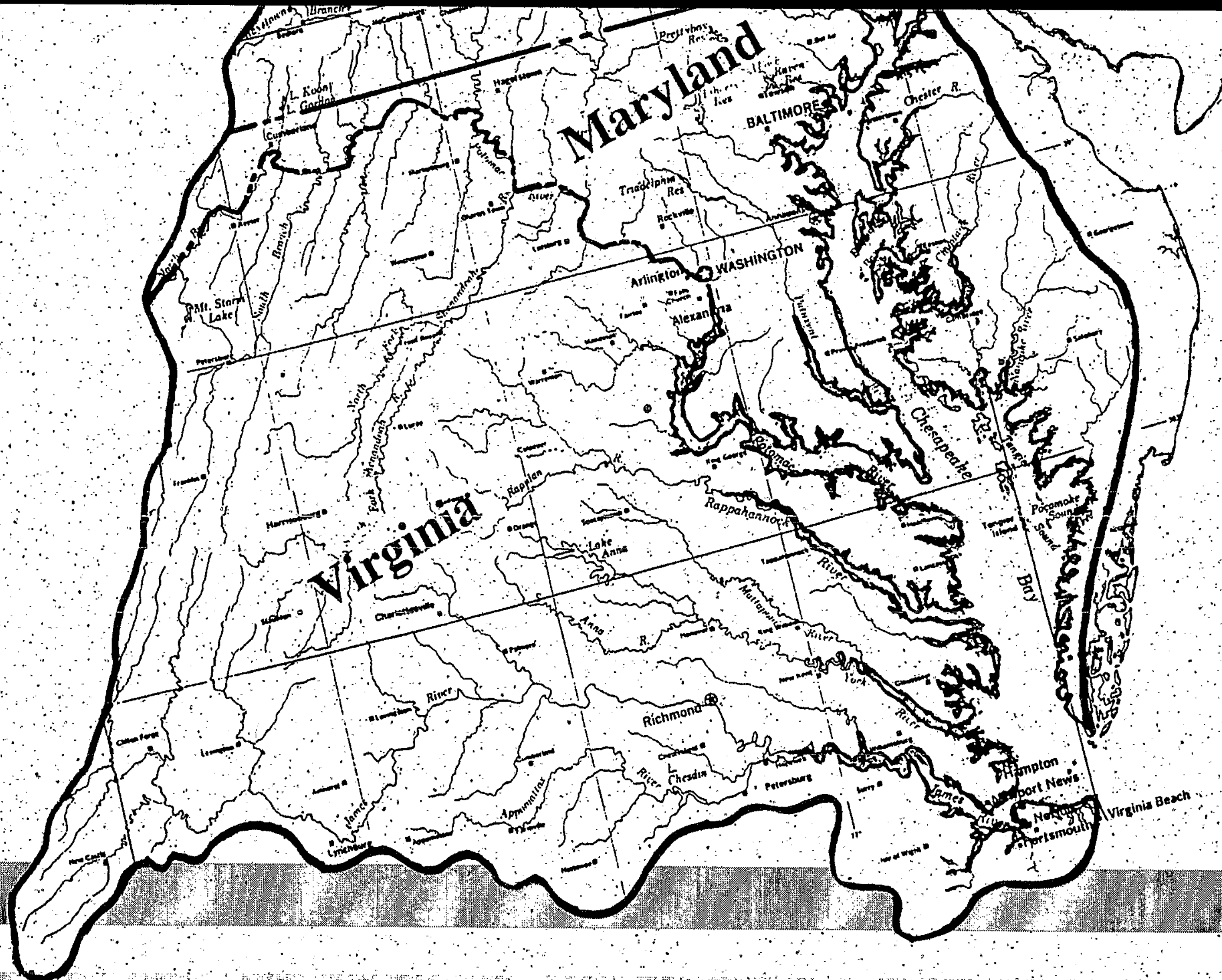
1989
- ***Conducted and published "Baywide Nutrient Reduction Progress Report"***

1990
- ***Published "Report and Recommendations of the Nonpoint Source Evaluation Panel"***
- ***Conducted a national, nonpoint source conference and published "Reducing Pollution from Nonpoint Sources: The Chesapeake Experience"***



The Chesapeake Bay & its Watershed





The Chesapeake Bay is 10,000 years old and was created by rising seawater when the glaciers melted. The Chesapeake Bay's watershed includes 64,000 square miles and extends from New York through Pennsylvania, Delaware, West Virginia, Maryland, Virginia and the District of Columbia.

More than 13.6 million people live in the Chesapeake Bay's watershed, over 200 people per square mile.

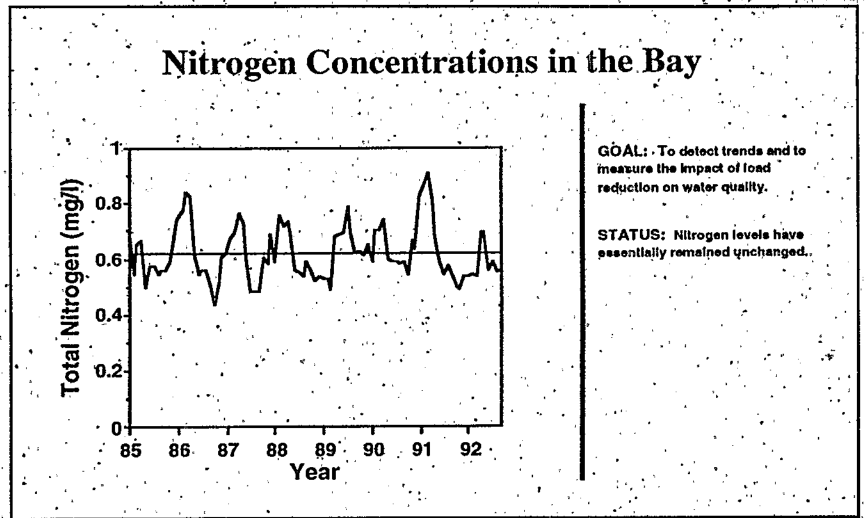
There are more than 100,000 miles of streams and rivers in the watershed. Virtually everyone in the watershed lives within 1/2 mile of a stream or river that flows into the Bay.

WHITE PERCH

White perch, a semi-anadromous species and one of the most abundant fish in Chesapeake Bay, spends its entire life in the Bay and its tidal tributaries. White perch migrate to tidal fresh and slightly brackish waters each spring to spawn. After spawning, adults move downstream to more brackish areas; summer movements are local and random. White perch overwinter in the downstream portions of the tributaries and deeper saline waters throughout the Bay, usually at depths greater than 6-12 meters, in areas with salinities in the 'teens. White perch support commercial and recreational fisheries in Maryland and Virginia. From 1980-85, Maryland commercial catches ranked from second to fourth both in pounds landed and in dollar value. Recreational catches exceed commercial catches in some years.

Juvenile white perch feed largely on zooplankton, larvae, insects and amphipods; adults are piscivores but also prey on bottom dwellers. The species occupies an important trophic link between small invertebrates and higher predators, primarily piscivorous predators.

White perch concentrate in areas with dissolved oxygen concentrations of at least 6 mgL. Increasing bottom dissolved oxygen in summer months to at least 5 mgL...will increase suitable habitat for white perch. Growth rates and longevity of white perch stocks within Chesapeake Bay may vary widely.



1992: The review began in 1990 and ended in 1992. Data collected from 1984 to 1991 showed that:

- ☐ Phosphorus levels dropped by about 16%. Phosphate detergent bans, upgraded wastewater treatment plants, and improved compliance with discharge permits are largely responsible.
- ☐ Nitrogen levels remained almost constant. Maintaining this level in the face of rising population and increasing wastewater discharges indicate that control efforts are having a positive effect.

The overall findings confirmed that the 40% reduction goal can be achieved, that it will improve water quality and habitat, and that it is an appropriate strategy for the recovery of the Bay's living resources.

The Reevaluation also outlined a refined approach to achieve the 40% goal. The refinement was added to the basic Bay Agreement in the 1992 Amendments and calls for the states to "develop and begin implementation of tributary-specific strategies by August 1993." In addition, and for the first time, numerical nutrient reductions measured in pounds of phosphorus and nitrogen were spelled out for regions and individual tributaries. The Baywide phosphorus reduction target is 8.43 million pounds per year. The nitrogen target is 74.1 million pounds per year.

Strategy development is now underway in each state. For each major tributary, the strategies will explain the amount of nutrient reduction that is to be made, the amount of that reduction which has been made since 1985, and how the remaining reductions will be achieved. The goal of the tributary strategies is to set in motion additional actions by all basin residents to reduce the amount of nitrogen and phosphorus entering our waterways.

WATER QUALITY AND LIVING RESOURCES

The 1987 Chesapeake Bay Agreement set as a major priority the "need to determine the essential elements of habitat quality and environmental quality necessary to support living resources and to see that these conditions are attained and maintained." The Chesapeake Bay Program's Implementation Committee subsequently called for guidelines to determine habitat requirements for the Bay's living resources. The first synthesis of these needs was published in 1988—"Habitat Requirements for Chesapeake Bay Living Resources." It was revised in 1991 to provide more detailed living resource habitat requirements. [The status descriptions of *individual species found in this Retrospective are drawn from the updated Habitat Requirements document.] Because submerged aquatic vegetation (SAV) was determined to be critical to the Bay's food chain, serving as food source, nursery, and potential indicator of the Bay's health due to its sensitivity to water quality, it was included in both these documents as a target community of species.*

1988: The sharp decline of SAV throughout the Bay (especially in its upper reaches) created concern over the loss of habitat and indicated that the Bay was in trouble. More than any other single group of organisms, SAV can provide a biological index of the "health" of the Bay's shallow waters. SAV functions as a critical link among the different levels of the Bay food web and the physical environment. It provides both food and habitat for species occupying the higher levels of the Bay's food web. SAV abundance is limited by turbidity and the amount of phytoplankton in the water. The distribution of various SAV species is dependent mostly on salinity and bottom sediment types.

The Bay study concluded that nutrient enrichment was the primary factor in the decline of SAV beds. Nutrients, by fueling the growth of excess phytoplankton, cause a decrease in water clarity and an increase in the number of organisms that grow on the leaves of the SAV. Both of these responses, in turn, cause a decrease in available light for the SAV. Suspended sediments also block light, contributing to the decline.[11]

1992: SAV has received considerable attention in Chesapeake Bay over the last 20 years because of an unprecedented Baywide decline of all species beginning in the late 1960s. This decline was caused by increasing amounts of nutrients and suspended sediments in the Bay resulting from continued, uncontrolled development of the Bay's shoreline and watershed and poor land use practices associated with development and agriculture.

The adoption of a Chesapeake Bay Submerged Aquatic Vegetation Policy [in 1989] followed by an Implementation Plan for the Chesapeake Bay Submerged Aquatic Vegetation Policy [in 1990] highlighted not only the need to develop SAV habitat requirements but also Baywide restoration goals for SAV distribution, abundance, and species diversity...

Chesapeake Bay SAV distribution targets and their relationships to the 1990 SAV aerial survey distribution data.

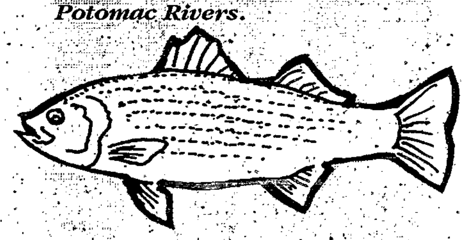
RESTORATION TARGET	DESCRIPTION	AREA (hectares)	1990 SAV DISTRIBUTION AND PERCENT OF RESTORATION TARGET
Tier I–composite beds	Restoration of SAV to areas currently or previously inhabited by SAV as mapped through regional and baywide aerial surveys from 1971 to 1990.	46,025	24,393 (53%)
Tier II–one meter	Restoration of SAV to all shallow water areas delineated as existing or potential SAV habitat down to the one meter depth, excluding areas identified as unlikely to support SAV based on historical observations, recent survey information, and exposure regimes.	In Progress	—
Tier III–two meter	Restoration of SAV to all shallow water areas delineated as existing or potential SAV habitat down to the two meter contour, excluding areas identified under the Tier II target as unlikely to support SAV as well as several additional areas between 1 and 2 meters.	247,658	24,393 (10%)

STRIPED BASS

The striped bass is a large anadromous fish found along the entire East Coast of North America. Most of the coastal migratory stock originates in Chesapeake Bay. Striped bass spawn in spring in tidal freshwater areas just above the salt wedge. Most juvenile striped bass remain in their natal areas for the first two years of life. Older fish migrate from the Bay into the coastal Atlantic Ocean. Striped bass are voracious predators... and grow rapidly. Larvae feed on a variety of zooplankton and juveniles feed on fish larvae, insects, worms, mysids, and amphipods. Adults are piscivorous, consuming bay anchovy, spot, menhaden, herring, shad, white perch, and yellow perch. Striped bass eggs, larvae, and juveniles serve as important prey for higher predators...

Striped bass have been one of the most sought-after commercial and recreational finfish in Chesapeake Bay. A long-term decline in striped bass stocks began in the mid-1970s, primarily because of overfishing. Sustained poor recruitment and low stock abundance led to a complete closure of Maryland and Virginia fisheries by the mid-to late-1980s. In response to increased stocks and stronger recruitment, limited commercial and recreational fisheries were reopened in 1990.

There is increasing concern that low dissolved oxygen in the deeper water of the upper Chesapeake Bay and in other areas has eliminated much of the summer habitat of adult and subadult striped bass. Acidity and contaminants in spawning habitats have been associated with mortality of striped bass larvae in the Choptank, Nanticoke and Potomac Rivers.

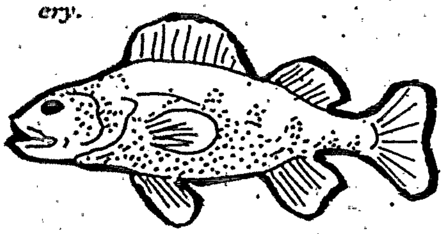


YELLOW PERCH

Yellow perch stocks in Chesapeake Bay have declined since the mid-1960s. The cause for the decline has not been identified precisely, but several environmental factors undoubtedly hinder stock recovery. They include sedimentation from improper land use, decreased spawning habitat caused by stream blockages, and the interaction of metals and acid rain. Eutrophication caused by excessive nutrient loading may adversely affect yellow perch by decreasing dissolved oxygen, which reduces the forage base for yellow perch.

Suitable habitat for yellow perch includes dissolved oxygen greater than 5.0 mgL; summer water temperatures below 30 C, and gradually warming water temperatures during egg and larval development (March through May). Yellow perch populations appear able to sustain reproducing populations at pH 5.0, but pH 4.0 has been documented after rain events. Salinities above 2.0 ppt reduce hatchability of yellow perch eggs. Adults and juveniles tolerate salinities of 13.0 ppt.

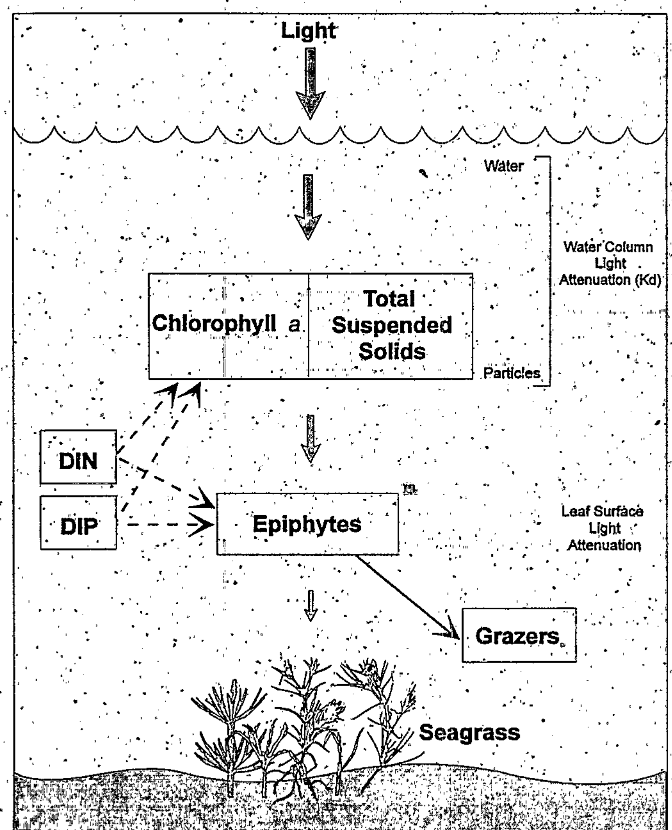
Restoration of yellow perch to historic abundance levels may be accomplished by reducing sedimentation and eutrophication in the Bay. Toxic inputs also must be reduced, and suitable yellow perch spawning habitat must be restored by reducing stream blockage. Stock recovery also will require reduced mortality which can be accomplished primarily by proper management of the yellow perch fishery.



A wealth of scientific studies [assembled from around the world by a team of Bay scientists and managers] have established the importance of light availability as the major environmental factor controlling SAV distribution, growth, and survival. The primary environmental factors contributing to light attenuation are used to formulate SAV habitat requirements: light attenuation coefficient, chlorophyll a, total suspended solids, dissolved inorganic nitrogen, and dissolved inorganic phosphorus...

Light attenuation, through the water column and at the leaf surface, is the principal factor influencing SAV. The light attenuation coefficient habitat requirement reflects the minimum water column light attenuation level at which SAV survive and grow. Total suspended solids and chlorophyll a directly influence and, therefore, can be

Conceptual Model of SAV Habitat Interactions



used to explain sources of water column light attenuation. Dissolved inorganic nitrogen and dissolved inorganic phosphorus also directly affect the potential for leaf surface light attenuation through epiphytic growth. Although the light attenuation coefficient habitat requirement should be applied as the primary SAV habitat requirement, application of the remaining SAV habitat requirements will help explain regional or site specific causes of water and leaf surface light attenuation which can be directly managed through nutrient reductions and shoreline erosion controls...

SAV distribution restoration targets, approached from a Baywide and regional perspective, were produced through a series of geographical overlays delineating actual and potential SAV habitat. This technical synthesis led to the concept of monitoring SAV restoration through a tiered set of SAV distribution restoration targets for areas previously vegetated between 1971 and 1990 (Tier I), one meter (Tier II), and two meter (Tier III). These water depth targets were to provide management agencies with quantitative measures of progress in SAV distribution in response to the implementation of Chesapeake Bay restoration strategies. Each successive target represents expansions in SAV distribution in response to improvements in water quality over time, measured as achievement of the SAV habitat requirements for one and two meter restoration... *[The Tier I target is being presented for adoption by the Executive Committee as a quantifiable goal to enable citizens and the Bay Program to follow restoration progress.]* The [SAV] technical synthesis represents a first comprehensive effort to link habitat requirements for a living resource with water quality restoration targets for an estuarine system...[12]

TOXICS

Along with excess nutrients, low dissolved oxygen levels, loss of habitat and other stresses, toxic substances contribute to the deterioration of the Bay. Their adverse effects, however, are not always immediately apparent. Unlike the massive "kills" that leave thousands of fish belly up in the water or decaying on shore, toxic pollutants also may overwhelm organisms in sensitive early life. Many do not survive to become adult breeders, accelerating declines in stocks and continuing a downward spiral in the living resources of the Bay.

1985: During the seven-year study that initiated the Chesapeake Bay Program, researchers found toxic metal and organic concentrations significantly higher than natural background levels in many parts of the Bay. In highly industrial areas, such as the Elizabeth and Patapsco rivers, sediment metal concentrations were 100 times and more above natural levels. High levels of metal contamination were found in the Upper Potomac, Upper James, small sections of the Rappahannock and York rivers, and the upper mid-Bay. Organic compounds were found in sediments in mean concentrations of hundreds of parts per million, particularly in urban and industrial areas.[13]

1987: The research findings and current sampling indicate that toxic substances are accumulating primarily in urbanized areas such as the Baltimore Harbor and the Elizabeth River. With the exception of these "hot spots," Baywide concentrations of toxic substances are low, and it is difficult to determine their significance in declines in living resources. However, in highly contaminated areas, species diversity has decreased and the species mix has tilted toward pollution-tolerant organisms such as worms, indicating that living resources are stressed by the elevated levels of toxic substances. Because some toxicants bioaccumulate in the tissues of fish and shellfish, contamination also can endanger human and animal health.[14]

The research recommended that EPA and Bay jurisdictions develop a basinwide plan to control toxicity from point and nonpoint sources. The 1987 Bay Agreement expanded upon that objective and established December 1988 as the target date for beginning implementation of a control strategy.

1988: Unlike the commitment in the Bay Agreement to reduce the level of nutrients by 40%, the commitment in the Agreement to toxics reduction does not contain any short, simple to understand target...

"The long term goal of this Strategy is to work towards a toxics free Bay by eliminating the discharge of toxic substances from all controllable sources. By the year 2000 the input of toxic substances from all controllable sources to the Chesapeake Bay will be reduced to levels that result in no toxic or bioaccumulative impacts on the living resources that inhabit the Bay or on human health."

TOXICS SUBCOMMITTEE MILESTONES

1983
- ***Toxics identified as one of the three key areas of the Bay Program***

1987
- ***The 1987 Agreement commits to the development of a Baywide Toxic Reduction Strategy***

1988
- ***Baywide Toxics Reduction Strategy developed***

1989
- ***Panel formed to set priorities for the Toxics Reduction Strategy***
- ***Toxics Subcommittee formed as a result of Panel recommendations***

1991
- ***Published "Toxics of Concern"***

1992
- ***Began Baywide Toxics Reduction Strategy reevaluation***

1993
- ***Reevaluation completed***
- ***Published "Toxics Loading Inventory"***

The signatories have developed a series of milestones in order to work towards the goal of the strategy. Some of these milestones call for specific tasks to be completed by a specific date. Some are less specific. Some of the milestones deal with actual reductions in the amount of toxics being discharged from point or nonpoint sources. Others deal with gathering additional data to support future control efforts. The milestones also reflect the intention to address the highest priority toxic problems first.[15]

The 1988 Strategy included a commitment to complete a reevaluation of the Strategy. The objectives were to define what is known, what should be done now to reduce existing and prevent future impacts, and what still needs to be understood. Some tentative answers are forthcoming...

1993: Based on the findings from the Strategy Reevaluation, there is no question that, in some locations, toxics problems exist in Chesapeake Bay. The nature, extent, and severity of the problems range widely from location to location. The extent and magnitude of toxic problems over the whole Bay system, however, remains unclear. We do know that the Bay has documented toxic "hot spots" (i.e., Elizabeth, Patapsco, and Anacostia rivers). We also now know that some locations believed to be relatively free from contaminant impacts have demonstreated varying degrees of ambient toxicity in the bottom sediment or overlying water column when tested. What we don't know is how representative this information is in characterizing the extent and magnitude of toxicity throughout Bay living resource habitats.

There is no evidence to date of a severe systemwide response to toxics similar to the widespread effects of eutorphication–disappearance of Bay grasses, low dissolved oxygen conditions–attributed to excessive amounts of nitrogen and phosphorus. Toxics have not been linked to large scale population declines, widespread fish kills, or loss of significant amounts of habitat. However, elevated levels of toxic substances in the water column, fish and shellfish tissue, and bottom sediments relative to background or "pristine" conditions are found in many Bay habitats. What is not known is whether these levels are biologically available at high enough concentrations to cause longer term adverse impacts on the Bay's resources.[16]

THE BOTTOM LINE

The Chesapeake Bay's living resources–its fish, shellfish, waterfowl, underwater vegetation, and the many other plants and animals whose survival is linked to the Bay system–are the major concern of the Bay Program. It was their declining numbers that first called attention to the degradation of the Bay. And it is the re-birth of their abundance that signals the success of the restoration effort.

The measurement of our success is not an easy one. A comprehensive monitoring system tracks changes in the Bay, but short-term fluctuations are not readily related to specific pollution control activities. The unpredictable weather–wet years, dry years, and the subtle climatic changes that take place over a span of many years–has a tremendous impact on all forms of life in the Bay. Diseases, such as the oyster-devastating MSX and Dermo, may or may not be related to changes in habitat and other conditions altered by human activity.

It is now recognized by scientists and managers that to reach the overall goal of a clean, "healthy" Bay, establishment of goals for habitat restoration, which are built upon habitat requirements of critical species living in Chesapeake Bay, are required. If the many threads of the Bay Program wrap together at one point, it is probably where the plants and animals of the Bay feed, find shelter, and reproduce.

1990: The growth, distribution, abundance, and survival of any one species in a habitat is regulated by a set of requirements unique to that species (e.g. dissolved oxygen, light, and nutrients). For each particular parameter, a species survives within a range of values, above or below which that species experiences stress that may cause reduced growth and productivity or lead to death. Species survival depends on the integration of responses to all parameters that are important for its growth. Tolerances to one parameter (e.g. dissolved oxygen) may either be increased or decreased by its interaction with one or more additional parameters (e.g. temperature, salinity). Therefore, a complete understanding of the species' overall habitat requirements is critical for evaluating its response to environmental perturbations.[17]

Habitat research has blended the physical, chemical, and biological needs of several species that characterize the many habitat types and food chain levels of the Bay. These so-called "target species" are surrogates for the larger ecosystem and open windows that give us a look at how to inclusively and scientifically manage the living resources of the Chesapeake. And new questions always arise...

1991: In compiling comprehensive information on the habitat requirements of 31 target species representing all major trophic levels, and accounting for the most important interactions among the species, their predators, prey, and habitats, we have begun to assemble a descriptive model of the Chesapeake Bay ecosystem. This model is both too simplistic for predictive purposes and too detailed for the regional management planning that it should serve, however. The model needs to be extended in two directions. First, we can achieve greater predictive power by specifying and quantifying the processes that couple species to each other and to their habitats in space and time. Second, we can provide managers and planners with tools for setting goals, evaluating options, and measuring progress by sythesizing the habitat requirements across the spectrum of species and integrating them over regions, depths, and seasons. Both of thse directions have been recognized by the Chesapeake Bay Program, and the next logical steps are being taken.

In the first instance, a team of managers, scientists, and reviewers has been assembled to advance and coordinate the development of simulation models of Chesapeake Bay ecosystem processes. These models, directed ultimately towards an integrated ecosystem model, eventually will provide quanitative answers to difficult habitat questions...for example, what are the indirect effects of excess nutrients on animals at the top of the aquatic food chain?

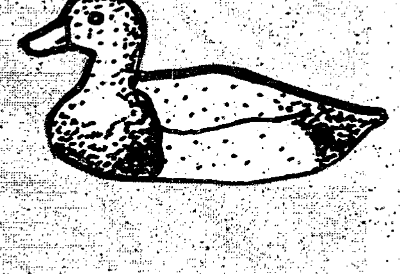
In the second instance, significant progress has been made in synthesizing the information compiled in [Habitat Requirements For Chesapeake Bay Living Resources]. Two reports have been drafted and are under review that provide the multi-species synthesis and integration necessary for regional planning purposes: (1) Chesapeake Bay Dissolved Oxygen Restoration Goals; and (2) Chesapeake Bay Submerged Aquatic Vegetation Habitat and Restoration Goals: A Technical Synthesis. These documents embody the additional steps, beyond defining individual species habitat needs, required to [build] water quality and habitat restoration programs...

Further synthesis needs can be identified. More complete syntheses of contaminants concerns for living resources should be developed, with reference to the large body of exposure and effects data that is becoming available for Chesapeake Bay species and habitats. This will be no small task, because of the enormous complexity of the field and the wide variety of data sources and sometimes questionable data quality. A synthesis of physical habitat requirements and problems would benefit greatly the

REDHEAD DUCK

The redhead duck historically was one of the most popular game ducks in the Chesapeake Bay region, second only among diving ducks to the larger, more abundant canvasback. An almost exclusive consumer of submerged aquatic vegetation (SAV), the redhead never equaled the prominence of the canvasback as a Bay winter resident, but rather favored more southern winter quarters where plant foods remained available. The redhead was thus an abundant, although sporadic fall and spring migrant, and wintering birds displayed exclusive dependence on SAV.

With similar habitat requirements and life histories, redhead and canvasback populations both have declined with the encroachment of man on breeding, migration, and wintering areas. Both species have been sensitive to ecological changes such as loss and degradation of habitats throughout their range. As SAV has declined in the Chesapeake Bay, redheads essentially have abandoned the region, while canvasbacks have switched to shellfish as alternate food resources. In the mid-1950's about 70,000 redheads wintered on the bay, representing 40% of the Atlantic Flyway population. They have dwindled over the last decade to 2,000 birds, (annual average estimate), representing only 2% of the Flyway total. Among diving ducks, the redhead is the best indicator species of the health of Bay SAV. Clearly, the return of the redhead to Bay waters will mark a major milestone in restoration of the Bay.



growing efforts to restore and protect physical habitats (wetlands, vegetated shorelines, migration routes, salinity regimes, benthic substrates, etc.) by helping to establish priorities and to assure that these actions are not undertaken in isolation from each other.[18]

1992: After all the meetings, reports, research conferences, and news briefs, it boils down to this single question: "Is the Bay getting any better?" It's what everybody, from concerned citizens to upper level managers, wants to know. Hovering in the background is the caveat–the second question that always accompanies the first and makes even the most confident scientist waver: "How do we tell if the Bay is getting better?"

These two questions form the heart and soul of the mission to reclaim the Chesapeake. The sole aim is to nurse the Bay back to health with the hope that one day we can answer with a resounding "Yes!" to that first question. And, to accomplish the task, we need a set of carefully crafted measuring sticks to gauge our progress.

The Living Resources Subcommittee holds one critical set of measuring sticks. These sticks measure the progress towards restoration of the Bay's most precious resource: its plants and animals. The abundance of the Chesapeake's plants and animals is, ultimately, the true indicator of her health. Over the past few years, the subcommittee has begun in earnest to notch new and biologically significant increments on the living resources measuring sticks. These refined calibrations offer scientists and managers more accurate tools with which to assess the Bay's status...

In a sense, restoring the Bay is a never-ending responsibility. And, the measuring sticks, unlike rulers, are not etched in stone. As scientists discover new information on the life histories of the Bay's species, the historical abundance of these species, the interworkings of the ecosystem, and human impact on the Bay, the set of notches may be added to, shifted, or refined. And finally, as we learn more about the way the Bay once was and the condition to which we would like her restored, we must mesh these hopes with the realities of revitalizing her in an age in which human activities dominate the scene...[19]

PAST DEVELOPMENT, FUTURE GROWTH

Not all is nutrients, metazoans, and the benthos. There are other concerns and they attach to a key source of the Bay's decline–people. Although it is difficult to separate natural changes from those brought about by the growing numbers of people in the basin, we know enough to speculate that human impact is the thunderbolt on the horizon. One of the great challenges we face is to maintain the balance between the inevitable growth and development of the watershed and the health of the Bay. The questions here aren't about life in the water column, they are about life in our backyard...

1983: Assessing the impact of land usage and related environmental changes on living resources is difficult, primarily because accurate records depicting Bay conditions reflect only a small portion of the Chesapeake' history. The period of scientific research in the Bay is brief, and many aspects of the Bay's environment were radically altered by man by the time research was initiated. One must recognize that the Chesapeake of today is a reflection of time, constantly changing in response to nature, and reacting, often unpredictably, in response to human activities. Use-related conflicts and water quality alterations caused primarily by nutrients and resource diversity shifts during the past 15 years are unprecedented.

POPULATION GROWTH AND DEVELOPMENT SUBCOMMITTEE MILESTONES

1988

- ☐ *Year 2020 Panel publishes "Population Growth and Development in the Chesapeake Bay Watershed to the Year 2020"*

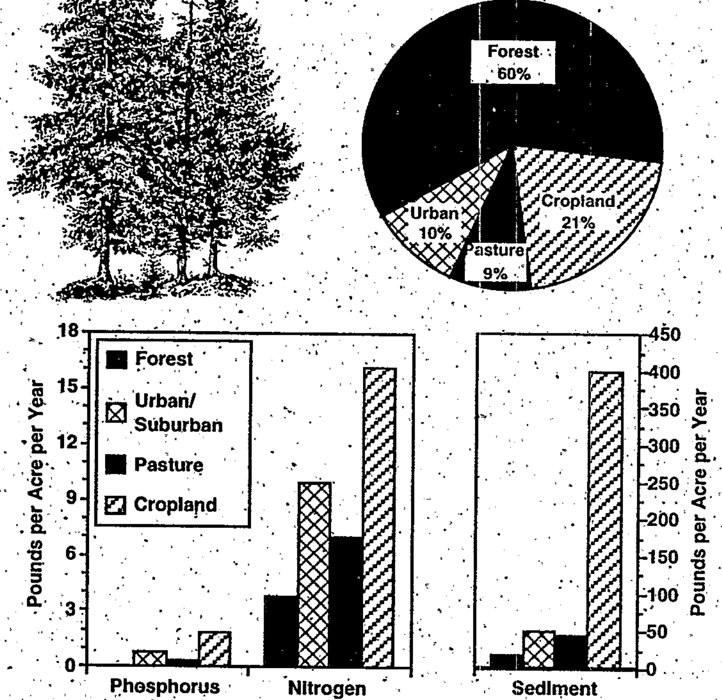
1993

- ☐ *Published "Cost of Providing Government Services to Alternative Residential Patterns"*

The...[accompanying]...Figure summarizes a number of salient historical features that reflect the changes in the Bay. These features remind us that many Bay changes caused by human activity are not of recent origin, but began at the time of European settlement and continue today. Another important aspect of the Bay's historical ecology is that this continuous human activity has been operating against a background of natural climatic cycles and an occasional extreme event such as a hurricane. The Bay ecosystem is dynamic, and our view of its current "quality" and assimilative capacity can benefit from examining the past as we attempt to manage its future...

The Bay is...showing changes clearly related to human activity which began to impact the Bay by the mid-1700s. The most significant changes began in the mid-1800s and reached high levels around WWII. The past 40 years have been a time of new events for the Bay--many possibly not coded into the genetic memory of the Bay species, including humans. Discharges of chlorinated hydrocarbons, heavy metals, and other toxicants are all relatively new problems confronting the Bay and challenging the capabilities of scientists and Bay managers. Nutrients and sediment, discharged in ever increasing amounts since colonial days, have become major problems as urbanization and centralized wastewater treatment elevated the rate at which these conventional pollutants reach the Bay...

Chesapeake Basin Land Use



GOAL: Land use goals may be tributary specific.

STATUS: 40% of the basin's forest have been lost.

Forests provide a natural filtering system that prevents pollutants and soil from reaching the Chesapeake.

Basin-wide, the population grew by 4.2 million between 1950 and 1980 and is expected to grow an additional 1.9 million, to a total of 14.6 million by 2000...More people living in the drainage basin would place additional stress on the Chesapeake because of increasing freshwater withdrawal and larger amounts of wastes (sewage, urban runoff, construction activity, intensified agricultural activities, additional industrial activity, etc.) which the Bay will have to assimilate unless necessary actions are taken...[20]

PUBLIC ACCESS SUBCOMMITTEE MILESTONES

1988

- ***Published "Public Access Strategy"***

1989

- ***Published the "Chesapeake Bay and Susquehanna River Public Access Guide"***

1990

- ***Published the "Chesapeake Bay Area Public Access Plan"***
- ***Published the "Chesapeake Bay Area Public Access Technical Assistance Report"***

1988: The EPA Bay Study recognized that land use and population growth are major factors shaping environmental conditions in the Chesapeake Bay watershed. Ultimately, the number of people living in the Bay basin determines how much water, energy and land are used, as well as how much and what types of wastes are generated. The wastes then adversely affect long-term biological and economic productivity in the watershed. Population size dictates the demands placed on the Chesapeake Bay ecosystem, and those demands are growing.

In the Bay watershed, population increased 50 percent overall from 1950 to 1980...The states of the Chesapeake watershed anticipate continued growth in the years ahead. Based on their estimates, population will increase about 11 percent basinwide between 1985 and the year 2000...Population growth brings parallel increases in industry, commercial development, transportation and housing. These increases create conflicts over land use as development competes for farm acreage and wildlife habitat. Changes in land use lead to increased loadings of nutrients and toxic substances, and can modify or even destroy critical living resources habitats (e.g. wetlands)...An increasing population generates additional waste which must be collected, treated, discharged and assimilated...These additional wastes stress existing solid and hazardous waste and municipal wastewater facilities, as well as the assimilative capacity of air, land and water...

The 1987 Chesapeake Bay Agreement recognizes the need to mitigate the potential adverse effects of continued growth and development. It calls for "development policies and guidelines" to be adopted by January 1989; assistance to local governments in evaluating land use and development decisions; incentives, technical assistance and guidance to encourage wetlands protection; and steps to ensure that state and federal development projects serves as models for the private sector...[21]

1988: The 2020 Panel is dismayed by the lack of growth management and planning, particularly on a state and regional level. It became readily apparent that the lack of comprehensive state and regional planning, uncoordinated public investment strategies, and undirected problem solving contribute greatly to the current problems of the watershed. Unless changed, this lack of clear policy and direction will compound future problems...

The 2020 Panel assembled a vision of what should come to pass in the region by the year 2020. It is meant to be a framework within which recommendations are made and is worth quoting in its entirety as a call for bold action. The vision is presented in the present tense to emphasize this is what will have happened if appropriate actions are undertaken today. The vision is an essential part of this Retrospective for it offers a fresh sense of discovery based on our own missteps.

Well before the year 2020, state Comprehensive Development and Infrastructure Plans have been developed and implemented. State and federal agencies, counties, and municipalities encourage diverse and efficient land development patterns–ones that concentrate growth and development in urban, suburban, and already developed rural centers. All growing areas have existing or planned facilities. Densities in most of these areas support mass transportation, van pooling, or other forms of ride sharing to reduce traffic.

These thriving urban centers and suburban areas are supported with funding adequate to maintain or enhance existing services. Cities and towns are vitalized by prudent public and private investment. Developers are offered incentives to provide greater community services and mitigate environmental impacts.

New mixed use growth centers are planned to take advantage of existing or projected infrastructure. Large open space areas are located within walking, bicycling, or short-drive distances of most people. Open space amenities are given the same priority as infrastructure.

Sensitive areas are protected from encroachment and damage. These areas have been defined and mapped by state and local authorities, and effective programs are in place to protect these natural assets. Very sensitive areas are in public ownership or under easement. Wetlands and lakes, rivers, and other waterbodies are protected from upland impacts by undisturbed vegetated buffers. In both urban and rural areas the shoreline of the Bay and its tributaries forms a series of vegetated corridors. These connect to large forested areas and allow for enhanced water quality, ecological balance, and biological diversity. Water supply has become a statewide issue, and safe and adequate supplies are available from protected groundwater and surface water sources.

Areas with resource-based industries such as agriculture, forestry, mining, and seafood harvesting are protected from encroachment of incompatible land uses. These industries remain important parts of the local and state economy. They have brought their environmental problems under control. Protection of these areas through effective land use controls, reasonable incentives, and innovative funding mechanisms insures a lasting, diverse economy and resource use options for the future.

Transfer of development rights from one land parcel to another better suited for development is commonplace and is proving to be an effective growth and resource management tool.

Growth in rural areas takes place in existing centers. Rural towns and highway intersections are defined by service boundaries and development space is provided for an appropriate mix of uses. These centers, with the assistance of state and federal governments, provide adequate sewer and water utilities. Use of on-site waste water treatment is limited so as to protect effectively surface and groundwater from pollution.

Outside these rural centers, residential development is limited so as to retain the economic, ecological, and scenic values of the countryside. Large woodlots and forests are retained and are selectively used for managed forestry, if they are not in preserves or parks. Quarries and other mining activities occur but are screened from neighboring uses by well developed wooded buffers. Municipal, County, and State roads are planned to allow for adequate capacity for rural traffic.

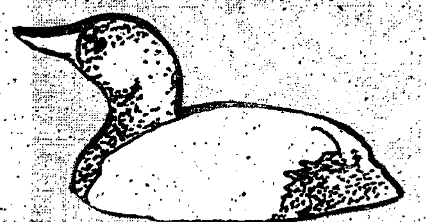
The volumes of waste produced in the region have been greatly reduced and are being effectively handled. Energy and water use per capita has been reduced as conservation programs have been put in place.

The public and government agencies are sensitive to their responsibilities not to damage the environment and to conserve resources.

Stewardship of the land and Bay is practiced by ordinary citizens who have been made aware of how they affect the land and water. The quality of the Bay is improved, tourism is strong, resource-based industry, manufacturing, and service businesses desire to locate in the basin because of its resource base, amenities, diverse economy, and the quality of life it provides residents...[22]

CANVASBACK DUCK

The Chesapeake Bay historically was the single most important wintering ground for the premier game duck in North America, the canvasback. As recently as the 1950s, Chesapeake Bay harbored over a quarter of a million canvasbacks, or about half of the estimated winter continental population. Today, canvasbacks on the Bay have declined to about 50,000, representing only one-fifth of the continental winter population. Among many factors contributing to the general decline of continental canvasbacks -- loss of prairie nesting habitat, loss and degradation of important migratory areas, and vulnerability of females to hunting -- degradation of Chesapeake Bay, the species' primary wintering area, probably also has played a significant role.



BALD EAGLE

The Chesapeake Bay may once have provided habitat for as many as three thousand pairs of breeding bald eagles and for thousands of subadult and migrant birds. The population has declined dramatically over the past three centuries due to habitat destruction, persecution, and contamination by DDT and other chemicals, reaching a low of 80-90 breeding pairs in 1970. After DDT was banned in 1972, the population began to increase. In 1989, 185 pairs of eagles nested in Maryland and Virginia.

Eagles require large trees for nesting, roosting, and perching. These trees must be in areas with limited human activity. Bald eagles are opportunistic predator-scavengers, consuming many different prey species. They take fish when they are available, but shift to waterfowl and mammals when fish are scarce.

The long-term survival of the bald eagle on Chesapeake Bay will be determined by the management of shoreline habitat. The very rapid rate of shoreline development, if unchecked, will eliminate most large undisturbed forest blocks in the next 50-100 years and will lead to a decline and perhaps extirpation of the species from the Chesapeake Bay area. This can be avoided if a series of shoreline refuges is created. Adequate fish and waterfowl populations also will be required to sustain the species in the future.

SEE ALSO:

LIVING RESOURCES

- ☐ Any of the Fishery and Waterfowl Management and Implementation Plans
- Distribution of Submerged Aquatic Vegetation in the Chesapeake Bay and Tributaries; 1987
- ☐ Implementation Plan for Removing Impediments to Migratory Fishes in the Chesapeake Bay Watershed; 1991
- ☐ Dissolved Oxygen Trends in the Chesapeake Bay (1984-1990); 1991
- ☐ Chesapeake Bay Species List; 1992
- ☐ Submerged Aquatic Vegetation Technical Synthesis; 1992
- ☐ Chesapeake Bay Submerged Aquatic Vegetation Habitat Requirements & Technical Synthesis; 1992
- ☐ Chesapeake Bay Dissolved Oxygen Goal for Restoration of Living Resources Habitat; 1993
- ☐ Chesapeake Bay Wetland Resource Directory; 1993

MONITORING

- ☐ Chesapeake Bay Basin Monitoring Program Atlas, Volume I & II; 1989

TOXICS

- ☐ Pesticide Use in the Chesapeake Bay Basin; 1988
- ☐ Chesapeake Bay Basinwide Toxics Analytical Capability Survey & Assessment; 1991
- ☐ Annual Loading Estimates of Urban Toxic Pollutant in the Chesapeake Bay Basin; 1991
- ☐ The Comprehensive List of Chesapeake Bay Basin Toxic Substances; 1992
- ☐ Status & Assessment of Chesapeake Bay Wildlife Contamination; 1992

WATER QUALITY

- ☐ Point Source Atlas; 1988
- ☐ A Comparison of Existing Water Quality Criteria and Standards with Living Resources Habitat Requirements; 1989
- ☐ Reducing Pollution from Nonpoint Sources: The Chesapeake Experience; 1990
- ☐ Trends in Phosphorus in the Chesapeake Bay (1984-1990); 1991
- ☐ Trends in Nitrogen in the Chesapeake Bay (1984-1990); 1991
- ☐ Nonpoint Source Baseline Nutrient Loading Inventory; 1992
- ☐ The Role and Function of Forest Buffers in the Chesapeake Bay Basin for Nonpoint Source Management; 1993

MODELING

- ☐ Land Use for the Chesapeake Bay Watershed Model; 1990
- ☐ Estimation of Nonpoint Source Loading Factors in the Chesapeake Bay Watershed Model; 1990

POPULATION AND GROWTH

- ☐ Chesapeake Bay Watershed Development Policies and Guidelines; 1989
- ☐ The Growth Dilemma: The Chesapeake in the 21st Century; 1989

ANSWERS INTO ACTIONS

The aim of the Chesapeake Bay Program's governing partnership and its groundbreaking research program is to produce actions that restore the Bay. Installing fish ladders, planting trees, enacting growth management legislation, improving sewage treatment plants, and building oyster reefs are all activities that connect under the Bay Program. They are actual tugs on the threads of the Bay's web of life. The child who plants grasses in the waters of the Anacostia is directly addressing the loss of SAV, the creation of habitat, and the contribution of nutrients...but a strong message is also being planted and it will echo throughout the Bay to be heard not only by the natural inhabitants of the water but by their helpers, the 13,000,000 of us on the land.

The Chesapeake Bay Program guides and coordinates the restoration actions of literally hundreds of federal, state, and local government agencies, and works with dozens of business, civic, agricultural, scientific and technical, and environmental organizations to create or place their endeavors in an effective pattern. A listing of the thousands of activities undertaken to restore the Bay is not feasible here. What does follow attempts to capture their range and flavor. What is important to take away from the brief descriptions is the reality of the new ethic of action and stewardship on the part of the residents of the Bay. We are beginning to understand the house that we have built and how the planning and the research of the Chesapeake Bay Program can be translated into important and exciting actions....

HABITAT RESTORATION

Baywide, approximately 70,000 acres of underwater bay grasses are now growing. This represents a 75% increase in acreage since 1984, significantly reversing the declining trends of the 1970s. Artificial oyster reefs are being created in areas where oyster diseases have less impact and oyster survival is likely. Watermen are being employed in the off-season to construct these beds and reseed existing oyster bars. The Pennsylvania Fish Commission's Van Dyke Fish Cultural Station in central Pennsylvania – the only shad hatchery in the world – produced nearly 22 million shad fry in 1989. About 400,000 shad are estimated to make it past the river's dams and into the Chesapeake Bay.

A record 15,964 shad were caught in 1990 at the Conowingo Dam fish lift and transported up river for spawning, many of which originated from the Van Dyke fish hatchery. Since 1989, the creation of fish passages has opened approximately 175 miles of river to anadromous fish, which migrate to freshwater spawning areas in the spring and then return to the saltier areas of the Bay and the Atlantic Ocean. Passages include fish elevators, denil fishways – step or ladder-like structures – dam breeches, and the removal of blockages. By 1994, migratory fish will have access to more than 140 river miles of historic spawning areas within Virginia's James River with the construction of new fish passages. This will be the first time in more than a century that anadramous fish will have access to the upper reaches of the James River. Since 1987, the construction of fish passages, the removal of obstacles, and restocking have restored over 173 miles of habitat around the Bay.

In 1990-1992, the Virginia Marine Resources Commission adopted a record number of conservation measures designed to protect fish stocks from overfishing. Size and catch limits were adopted for spotted seatrout, weakfish, black drum, red drum, amberjack, cobia and Spanish and king mackerel. In addition, fisheries

CITIZENS ADVISORY COMMITTEE MILESTONES

1987

- ***Held public meetings around the Bay region to solicit public comment on the proposed 1987 Bay Agreement***

1988

- ***Encouraged the formation of the Toxics Subcommittee as a way to deal with toxics issues***

1989

- ***Participated in the development of several Fisheries Management Plans***

1990

- ***Participated in the development of the Public Access Plan, the Boat Pollution Task Force Report, and the Compliance Monitoring and Enforcement Strategy***

1991

- ***Initiated a process for working with Bay region businesses to promote pollution prevention programs***

1992

- ***Participated in the Toxics Strategy Reevaluation, the Environmental Indicators program, the development of criteria for Nutrient Management Plans, and the Tributary Strategy Public Participation Workgroup*** management plans, designed to summarize the status of fish stocks and make recommendations for future management, were adopted for bluefish, spot, croaker, American eel, and summer flounder. These fisheries management plans are being formulated in cooperation with the State of Maryland.

EPA Administrator Carol M. Browner, and U.S. Senators Paul Sarbanes and Barbara Mikulski discuss progress.

The Army Corps of Engineers, EPA, the National Oceanic and Atmospheric Administration (NOAA), the U.S. Fish & Wildlife Service, the Port of Baltimore and Maryland Environmental Service are working together to rebuild the eroding Poplar Island chain and create valuable habitat for a variety of waterfowl, shorebirds and small fish. The islands are being restored using dredged material from the outer channel approaches to Baltimore Harbor.

The Department of Defense has 66 installations in the Bay watershed totalling approximately 350,000 acres. Army installations comprise a total of approximately 218,000 of these acres. Nearly 82% of the land the Army manages is undeveloped and approximately 20,838 acres is wetlands. As stewards of this land and active participants in the 1990 Department of Defense/Environmental Protection Agency Cooperative Agreement concerning Chesapeake Bay activities, the Army is helping preserve the natural environment of the Bay. The Marine Corps, in its role as stewards of the Bay, has initiated habitat restoration projects such as a 171-acre reforestation program at Quantico, Virginia.

WATER QUALITY

The 1987 goal of reducing nitrogen and phosphorus flow into the Bay by 40% has produced significant reductions from both point and nonpoint sources. The PENNVEST Program in Pennsylvania, for example, has provided $109 million in loan funding to finance 82 sewerage projects in the Bay basin. Thirty-two percent of all PENNVEST funds have been committed to sewage treatment projects within the Chesapeake Bay basin.

A ban on phosphate detergents was implemented within the jurisdictions of the Chesapeake Bay Program beginning in the 1980s to reduce phosphorus entering the Bay. This action, coupled with municipal upgrades to remove phosphorus in sewage treatment plants, has led to a 41% reduction in the amount of phosphorus entering the Bay from point sources since 1985. The phosphate ban reduced sewage treatment plant operation and maintenance costs for chemicals and sludge handling where phosphorus removal is required. For example, costs at Blue Plains Treatment Plant in Washington, D.C. were reduced by $6.5 million per year, a 10% reduction of the plant's operating budget. The phosphorus ban, sewage treatment plant upgrades, plus other methods of reducing phosphorus including nonpoint source reductions, has led to an approximately 16% reduction in the Bay since 1985. Greater reductions have been achieved in several river basins.

In Maryland, municipal wastewater treatment plants discharge 390 million gallons of treated sewage each day into the Bay and its tributaries. In 1992, all major municipal sewage treatment plants met their permit conditions – a record compliance rate.

Biological Nutrient Removal (BNR) technology is being instituted in sewage treatment systems throughout the watershed. BNR is leading-edge, cost-effective technology in point source nutrient removal. Currently eight of the eleven sewage treatment plants removing nitrogen in the Bay states use BNR technology and most planned upgrades to meet the 40% reduction goals will implement BNR technology to reduce nitrogen.

In June 1993, the Pennsylvania General Assembly enacted a mandatory nutrient management law to reduce nutrient pollution from dairy, poultry and other livestock operations. The law requires the state's largest farms to develop, and implement nutrient management plans.

More than 300,000 acres of agricultural land in 15,000 different programs are now farmed under Chesapeake Bay Program nutrient reduction initiatives, and erosion and runoff control measures. In addition to the Chesapeake Bay Program initiatives, farmers are implementing similar control measures under U.S. Department of Agriculture, state, and other guidelines and programs, as well as their own voluntary measures. The measures include such farming practices as no-till farming, contour plowing, the construction of manure storage facilities, and other agricultural Best Management Practices (BMP). The Soil Conservation Service estimates that it assists an average of 47,000 landowner/operators annually throughout the basin with technical assistance to plan, design, or install conservation practices that protect and restore the Bay.

A total of 1,059 farmers in Pennsylvania participate in the Chesapeake Bay Program. This means 41,952 acres with nutrient management plans and 2.1 million pounds of nitrogen, 2.1 million pounds of phosphorus, and 73,634 tons of sediment prevented from reaching the Susquehanna River. These savings translate into approximately a 3% reduction in nitrogen and an 8% reduction in phosphorus delivered to the Bay from the Susquehanna River. Virginia's Department of Conservation and Recreation enlisted a total of 1,017 farmers in its croplands Best Management Practices program between 1990 and 1992. The croplands program prevented approximately 314,500 tons of soil from eroding from Virginia farmlands. The Animal Wastes BMP enlisted 108 farmers, resulting in 150,053 tons of wastes treated. In Maryland in 1992 alone, over 1,100 nutrient management plans for nearly 100,000 acres were written. On average, these plans are reducing nitrogen applications by 32 pounds per acre and phosphorus applications by 39 pounds per acre.

AMERICAN BLACK DUCK

The American black duck is a species of concern both in Chesapeake Bay and continentally because of a long term decline in population numbers since the 1950s. The Chesapeake Bay is an important area to black ducks because they breed, migrate through, and winter there. It is probable that at one time, a significant proportion of the continental population of black ducks were produced in the Chesapeake Bay region. Habitat degradation, through erosion, development, and eutrophication, is a primary cause for the reduction in numbers of black ducks produced on the Bay. Another problem for the remaining black ducks may be the release of hand-reared mallards into the wild. The production and wintering conditions for black ducks on the bay can be improved with a more active habitat management program aimed at increasing the abundance of submerged aquatic vegetation, protecting existing breeding and sanctuary wetlands, and continuing conservative hunting regulations.

SCIENTIFIC AND TECHNICAL ADVISORY COMMITTEE MILESTONES

1984

- ***Formed as Committee with representatives from major universities, research institutions, and federal agencies in the Bay watershed to integrate the latest scientific findings and technologies into Bay Program policy decisions***

1984-86

- ***Helped unravel the nitrogen and phosphorus issue, pioneered BNR technology, and integrated these new ideas into the Bay Program***
- ***Named Conservationist of the Year by the Chesapeake Bay Foundation***

1988-93

- ***Offered the Bay Program consensus recommendations on such issues as toxicology, modeling estuarine ecosystem processes, oyster science and management, and submerged aquatic vegetation research priorities***
- ***Helped steer restoration efforts by focusing the knowledge and expertise of the scientific community of Bay Program scientific and technical issues by serving on Program committees, by conducting reviews of Program reports, and by sponsoring workshops, research conferences, and papers synthesizing pertinent scientific literature.***

A ban on the use of tributyltin (TBT) boat paints was implemented to eliminate TBT as a toxin entering the Bay. The efforts of the Chesapeake Bay Program led to federal legislation and a nationwide ban. Voluntary Integrated Pest Management practices to decrease the use of pesticides and pesticide runoff have been increasingly put to use. The Chesapeake Bay Program has developed a "Toxics of Concern List" of the chemicals most harmful to the Bay. Strategies are now being developed to remove or reduce the impact of these chemicals. Some important small bottom-dwelling animals such as worms and other creatures which serve as fish food and indicators of cleaner water conditions have returned to Baltimore Harbor. Toxic loadings in the Harbor decreased dramatically between 1975 and 1985 through regulatory and voluntary efforts, and the benthic community present is measurably improving.

Maryland conducts regular monitoring of levels of toxic substances in its shellfish and crabs. Information from this program indicates that mercury levels in Maryland oysters have dropped by 60% since 1974. Monitoring of Maryland crabs shows that chlordane -- a termite insecticide removed from the market in 1987 -- is no longer detected in crabs.

POPULATION AND LAND USE

Landmark growth and land use legislation has been enacted with the passage of Maryland's Economic Growth, Resource Protection, and Planning Act of 1992. Legislation to protect, buffer, and stabilize environmentally sensitive Bay shoreline areas, such as Maryland's Critical Areas Program and Virginia's Chesapeake Bay Preservation Act, has been passed. The Chesapeake Bay Preservation Act requires Tidewater communities to identify and inventory environmentally sensitive lands, designate preservation areas based upon this inventory, then amend local zoning, subdivision, and comprehensive plans to protect those lands. By mid-1992, all 17 cities within Tidewater Virginia had adopted Preservation Areas and criteria for protecting those lands. In addition, 28 of the 29 counties and 19 of the 38 towns had adopted local ordinances.

In Pennsylvania, over 411,000 feet of streambank have been protected by contract with 229 landowners through Chesapeake Bay Program initiatives. In Washington, D.C., projects to stop erosion of polluting sediments, such as the Watts Branch Streambank Stabilization Project have begun. Also in Pennsylvania, the General Assembly enacted legislation re-establishing the State Planning Board as an advisory board within the Governor's Office to provide support to population growth and development initiatives. The Board is charged with developing strategic plans and making recommendations to the Governor on broad public policy initiatives.

U.S. Forest Service professionals in the Bay states have completed Forest Stewardship Plans and enhancement projects on thousands of acres of the watershed, restored over 50 miles of riparian forest, planted millions of trees, given tens of thousands of hours of volunteer time, and initiated hundreds of individual local projects to involve and educate the public about the valuable role of forests as a Bay watershed land use.

SCIENCE AND TECHNOLOGY

The Chesapeake Bay Program has remained on the cutting edge of knowledge concerning the Bay and estuarine science. The actions of colleges, universities, and research laboratories within the watershed have been invaluable to the restoration process.

Computer modeling to predict the outcome of influences and management decisions is a valuable tool in the restoration effort. The Chesapeake Bay Program has incorporated data from the most sophisticated 3-D computer modeling in the world to determine the impact of nutrient loadings on the Bay. The 3-D computer model is being used in conjunction with basinwide watershed modeling to determine loadings in the individual tributary watershed. Information developed through modeling has been instrumental in determining the nutrient reduction targets for each of the tributaries. The Chesapeake Bay Program's extensive use of watershed modeling is the first time watershed models have been used in so large an application.

Government and citizen water monitoring programs determine trends in the Bay. The Chesapeake Bay Program's monitoring effort has been used as a model for the National Estuary Program -- an estuarine restoration endeavor that now includes 21 estuaries nationwide. The Bay Program's Citizen Monitoring Program, developed through the Alliance for the Chesapeake Bay, has fostered similar volunteer water quality citizen monitoring efforts throughout the country, and has been a leader in maintaining quality data for various applications in restoration efforts.

The Chesapeake Bay Program is pioneering a multi-media, coordinated approach (water, land, air) to finding solutions to the Bay. Traditionally, experts within the different fields and sciences would investigate ecological problems separately. The Bay Program takes an all-inclusive look at the sources of pollutants affecting the Bay.

PARTNERSHIP

The Chesapeake Bay Program is a model for inter-governmental cooperation at three levels. Representatives from federal, state, and local governments and agencies are directly engaged in a consensus-based approach to policy setting and problem resolution. The Program operates through 12 major committees and more than 50 workgroups and task forces to promote direct involvement in framing solutions for pollution control, prevention, and living resources management. Through this committee structure, some 250 key decision-makers from throughout the region -- government officials, and members of the scientific and technical communities, environmental groups, agriculture, business and industry, and the public at large participate.

The Chief Executives of Virginia, Maryland, Pennsylvania, the District of Columbia, the U.S. EPA, and the Chesapeake Bay Commission are directly engaged in reviewing progress and adopting policies and commitments for future restoration initiatives. This high level of commitment from the members of the Chesapeake Executive Council exemplifies the significant institutional support that guides all Chesapeake Bay Program efforts.

A public-private partnership -- Chesapeake Bay Foundation President William C. Baker (left) and Virginia legislator Tayloe Murphy

LOCAL GOVERNMENT ADVISORY COMMITTEE MILESTONES

1987

- ***Committee formed***

1988

- ***Conducted Saving the Chesapeake: A Conference for Local Officials***

1989

- ***Prepared whitepaper "Nonpoint Source Control Needs for Protection of the Chesapeake Bay and its Tributaries"***
- ***Conducted Investing in the Chesapeake Bay: A Conference for Local Officials***

1990

- ***Published "Chesapeake Bay Restoration: Innovations at the Local Level"***
- ***Prepared whitepaper "Financing the Future of the Chesapeake Bay"***

1991

- ***Co-sponsored workshops on wetlands and environmental stewardship***

1992

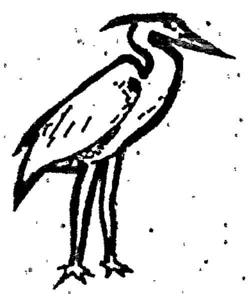
- ***Published "Local Solutions: A Guide to Household Hazardous Waste Management in the Chesapeake Bay Region"***

1993

- ***Published "Greenspace: A Local Government Guide to Developing Greenways Through Open Space and Buffers;" "Greenways Around the Bay;" and "Tributary Strategies"***

COLONIAL WADING BIRDS

Six species of colonial nesting wading birds, the great blue heron, great egret, snowy egret, little blue heron, green-backed heron, and black-crowned night heron, are prominent avian residents of the Chesapeake Bay region. They are top carnivores in a complex food web and, thus may be useful as indicators of change in wetland quality. Except for little blue herons, there is little evidence to suggest that populations in the bay may be declining; in fact, it seems likely that great blue herons are increasing. Although populations may not currently be declining, several factors are of concern: (1) loss of water quality necessary to support submerged aquatic vegetation beds (hence good nursery areas for fish and crabs); (2) loss of wetlands due to siltation, agriculture, and the sea level rise; (3) disturbance at islands or other colony sites by boaters and other types of human activity. We recommend that water quality conditions be improved so that a large prey base is maintained; that colony sites, especially large ones, receive special status for protection; that riparian zone buffers be strongly protected; and that feeding areas surrounding colonies receive protection.



A tri-state legislative body known as the Chesapeake Bay Commission was established in 1980 to coordinate approaches to state legislation having restoration and protection consequences for the Bay. This group is a unique legislative forum that directly links the legislative branches to the restoration effort.

The partnership yields substantial leveraged support for Bay restoration strategies. The governments of the three states and District of Columbia have matched Chesapeake Bay Program funds, contributing estimated funds in excess of $100 million annually towards the restoration. In addition, state tax check-off programs, automobile license plate programs, and other quasi-government and publicly funded programs help support specific Bay Program initiatives.

SEE ALSO:
Any of the numerous restoration progress reports from the Bay Program jurisdictions and federal and state agency participants.

CONTINUING ON...

The body of water and land we call the Chesapeake is a powerful symbol. It is the Everglades, it is the Great Lakes, and it is the grass in our backyards-it is the subject of great science, it is an object of contemplation and wonder, it holds mysteries and secrets. But the Chesapeake Bay doesn't hesitate to give up its secrets; it doesn't even know it has them. It exists as an elemental piece of the natural world in total majesty and total indifference. When we call her "she" or "Chesapeake," we are reaching for attributes we can understand and those attributes are the functioning and fecundity of the resource in measures of our own devising–measures that talk about numbers of crabs, levels of dissolved oxygen, and suitability of habitat. But this watery domain, like the atom in the Nineteenth Century, has yet to be quantified and apportioned. It holds dreams for science; it holds realities for politics.

We decided in the 1970s that something was wrong. Something was not as we anticipated from our understanding of the way things used to be. Granted that we are the ones that give value to its current forms of life and its current "condition" and granted that the Bay's web of life continues with or without our interference--what is good and what is not good remains the object of intense human effort, for in the Chesapeake Bay we find a reflection of the best we have to give.

We will continue to marvel and we will continue to work for losing the Bay is not a temporary setback, it would be losing a part of ourselves for generations to come.

1990; The Chesapeake Bay is an extremely complex and variable estuarine ecosystem, influenced by diverse factors. Within the Bay's natural boundaries, a spectrum of aquatic environments – ranging from freshwater to nearly full-strength seawater–supports diverse organisms and allows many chemical reactions to take place. Characterized by complexities in circulation patterns, nutrient cycles, and food webs, the Chesapeake Bay is a unique and highly productive natural system.

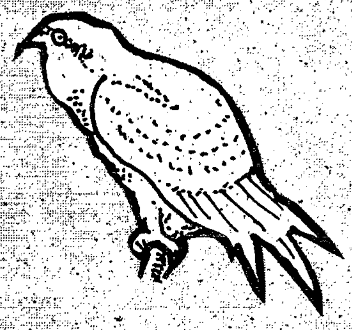
Historically, the Chesapeake Bay has demonstrated a remarkable resilience to many natural or man-made perturbations. Unusual events such as hurricanes, droughts, and seasonal temperature extremes have caused imbalances, but the Bay has gradually recovered its former state of dynamic equilibrium. Similarly, the Bay remained relatively unchanged over several centuries of urbanization, shipping, and fishing.

Yet today the Chesapeake Bay appears to be a fragile ecosystem increasingly vulnerable to the relentless encroachment of man. In fact, most of the problems currently perceived as causing declines in the health of the Bay have a common denominator – people. Man has directly influenced the estuary by adding his wastes and by withdrawing resources from the Bay and its tributaries. In addition, people have acted indirectly by changing the character of the land, water, and air that surround and interact with the Bay. In short, man is altering the hydrological and ecological continuum of the Chesapeake Bay watershed. Today we recognize ecosystem thresholds beyond which resilience or assimilative capacity can be exceeded resulting in such perceptible changes as low dissolved oxygen concentrations; increasingly turbid water, or lowered abundances of fish, shellfish, and other organisms.

OSPREY

Ospreys feed almost exclusively on live fish. Their position as consumer at the top of an aquatic food-chain proved hazardous from the 1950s through the early 1970s when organochlorine pesticides (DDT) adversely affected their reproductive success leading to a population decline. The banning of some persistent pesticides during the 1970s enabled Chesapeake Bay osprey populations to increase to an estimated 2,000 pairs by the 1980s. Pesticides are still used in South American wintering areas, however, the effects on Chesapeake Bay osprey populations are unknown.

Osprey foraging efficiency and energy budgets and the prey type, abundance, and nutritional value are poorly understood and need research. This is especially important in view of reported deteriorating water quality and decreasing fish populations. Management of ospreys in the bay should include enhanced public awareness of osprey ecology, creation and maintenance of artificial nest structures, monitoring of foraging and nesting success, and analysis of eggs and body tissue for presence and effects of toxic chemicals and metals.

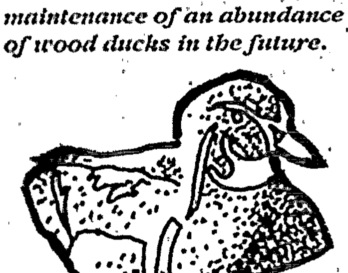


WOOD DUCK

Threatened with extinction by habitat loss and unregulated hunting near the turn of the century, the wood duck has recovered to become one of our most abundant game ducks. A widely distributed species of forested wetland habitats, the wood duck is an abundant fall and spring migrant -- the most abundant breeding anatid in the Chesapeake Bay drainage. The species' primary habitats are interior bottomland hardwood forests and adjoining river and bay marshes. Wood ducks also occupy habitats extending from tidal-brackish bay marshes to the very tops of watersheds, including the smallest of watercourses and temporary and seasonal pools within flood plain forests. Wood ducks are well-known for their beautiful plumage, dependence on tree cavities for nesting, and colonial roosting habit, especially in fall.

Although protection of large contiguous bottomland hardwoods and large riverine marshes is crucial to maintenance of wood duck populations within the Bay region, conservation of wetlands and riparian forest (along even the smallest of watercourses) will protect the diversity of habitats beneficial to wood ducks. Emphasis should be placed on managing riparian timber for mature and old growth and especially to produce mast-bearing and cavity-producing species.

Channelization and other actions that alter natural hydrology or habitats along watercourses are detrimental to wood ducks. Prudent management also includes conservative harvest limitations for maintenance of an abundance of wood ducks in the future.



On a more subtle level, many researchers point to changes in the pathways of carbon and energy through the Bay food web. Although increased amounts of nutrients such as phosphorus and nitrogen have stimulated greater production of phytoplankton, it appears that the carbon energy resulting from photosynthesis is not yielding greater quantities of useful metazoans such as finfish and shellfish. Indeed, it appears that the collective effects of water quality changes, habitat losses, recruitment failure, and fishing mortalities have shifted carbon energy away from the economically productive metazoan food web and into the trophic "dead end" of microbial production. By remineralizing excess carbon production in the microbial food web, the ecosystem consumes precious oxygen and subsequently loses habitat for the more useful metazoan species.

These kinds of Bay-wide impacts result from massive inputs of nutrients and other chemicals coming from sewage treatment plants or industrial operations (referred to as point sources) or from the stormwater runoff of rural or urban land (called nonpoint sources). These natural materials normally recycle in the environment among plants and animals, or among land, air, and water. But the large human population in the Bay watershed has disrupted the balance of the recycling process and has led to severe problems in some regions of the Chesapeake Bay.

Another type of problem confronting the Bay comes from toxic compounds-manmade products created by industrial activity, or naturally-occurring chemicals that are concentrated to levels far exceeding the trace quantities normally found in the environment. Toxic materials tend to be concentrated in regions of the Bay close to manufacturing industries or waste disposal sites. Problems caused by toxic compounds are difficult to predict or understand because of their extremely complex chemical properties. However, these compounds can cause serious human and environmental health hazards when they enter the Bay.

The complex iterations between pollutants from point and nonpoint sources, toxic compounds, and ecosystem change are further exacerbated by the diverse cause-and-effect sequences occurring throughout the Bay watershed. For example, land use changes in Pennsylvania could begin a sequence of physical, chemical, and biological events that much later produce oxygen deficiencies in Maryland deep water. Thus, the observed impact is separated from its cause in both time and space.

These complexities underscore not only the need for research, but also the importance of presenting research findings to environmental decision-makers. Management options can be complex and can require years of sustained effort before yielding significant improvements. Clearly, the Bay system does not necessarily respond to instant management fixes, nor does it hold to boldly declared target dates for restoration milestones. Why? Because we simply don't know all the answers.[23]

But we will keep on trying and we will keep on making progress...

Writing in the July, 1993, Bay Journal, Bill Matuszeski, Director of EPA's Chesapeake Bay Program Office offers these thoughts after a visit by representatives from Congress, the new Administration, and several environmental groups to the Bay Program Office:

1993: First, there seemed to be agreement that we have, perhaps even in the last year, reached a point of equilibrium in the Bay, that the patient has been stabilized. Certainly the picture is mixed – some systems are still measured in decline, while others are looking healthier and showing trackable improvements. And clearly, what we do to encourage the natural recovery potential of the healthier systems will play a key role in overall restoration...perhaps we have completed the period of containment, and entered the period of true restoration of the Bay...

Second, there was a feeling that the Chesapeake Bay will always be a natural system under stress, if nothing else due to the simple fact that 13 to 16 million people will be living in the watershed. Furthermore, the demands and lifestyles of these people can be expected to undergo change, change that will not always reduce and may often increase their impacts on the Bay ecosystem. In short, over the long term we must learn how to manage a populated watershed in a changing world...

Third,...the job of "Saving the Bay" will never end. Assuming that the work of these decades leads to stabilization and restoration, the years beyond will require us to hold onto that renewed Chesapeake. This will require as much knowledge, vigilance, and commitment as the restoration effort itself...

Finally, there was agreement that it was important to spread the sense that "we're all in this together."

ENDNOTES

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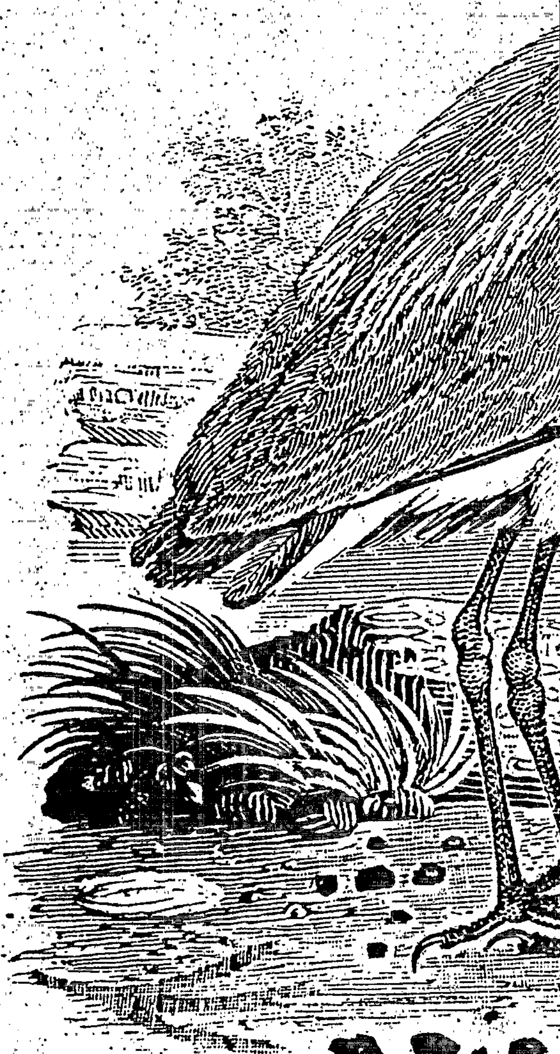

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