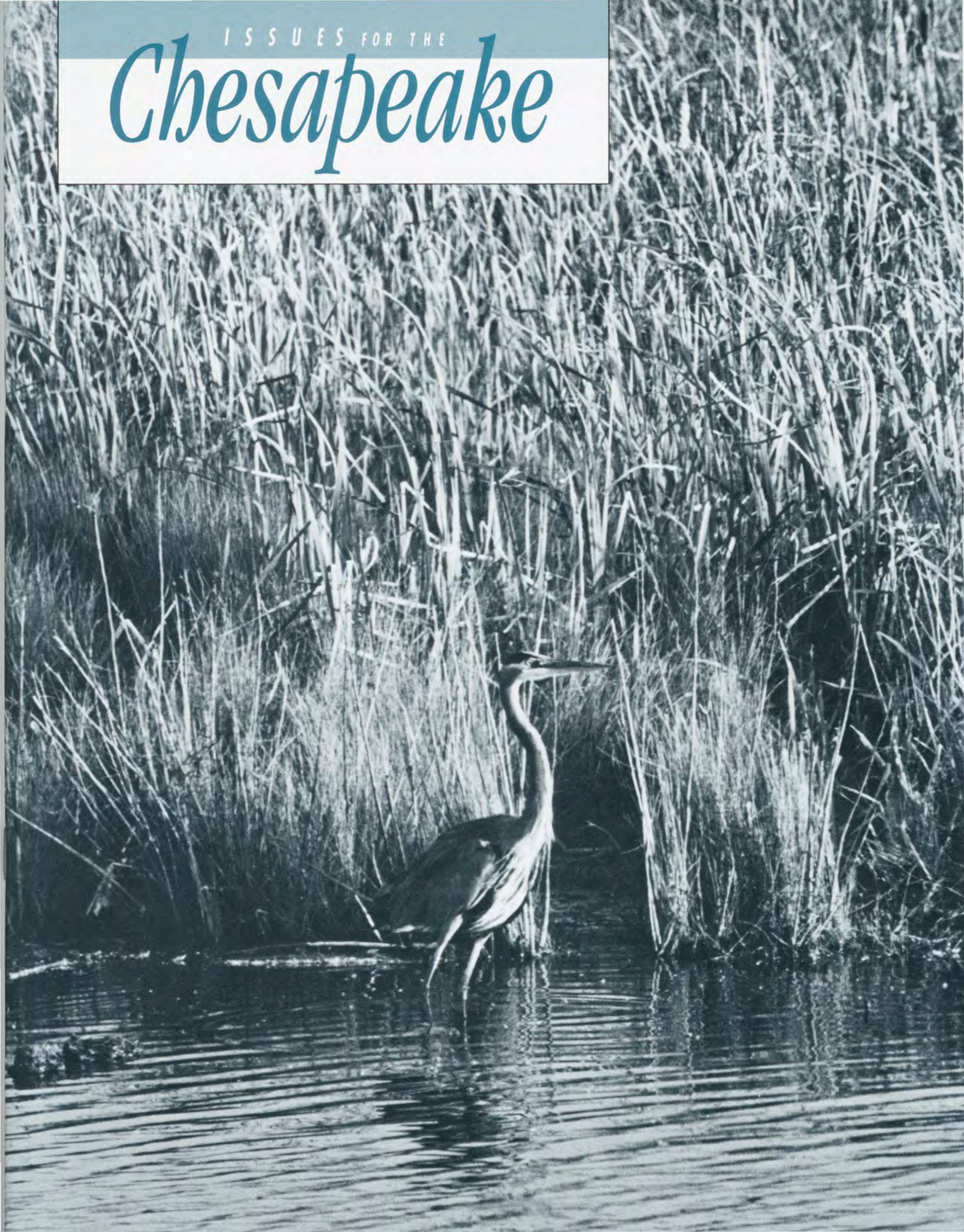
ISSUES FOR THE

Chesapeake




Susquehanna
C & D Canal
BALTIMORE
DELAWARE BAY
WASHINGTON
Choptank
Nanticoke
Patuxent
Wicomico
Potomac
CHESAPEAKE BAY
ATLANTIC OCEAN
Rappahannock
RICHMOND
York
James
NORFOLK

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Searching for Something

The early settlers who arrived on the shores of the Chesapeake Bay came looking for religious freedom. They came looking for a better life. They came to Jamestown and Williamsburg, in Virginia, to St. Marys and Londontowne, in Maryland. The Chesapeake Bay represented for them a new kind of promised land.

Life on the Shores of the CHESAPEAKE BAY

Settlers came to begin a new enterprise, and ultimately founded a new country. Even the native Americans who greeted the settlers had come from somewhere else, crossing a land bridge — where Alaska once touched Asia — many centuries before. But these native Americans had preserved a lifestyle which had not taken a great toll on the natural environment or the countryside. They took oysters but did not destroy the bars. They used logs for canoes but did not clear-cut the forests. The settlers who came from Europe, from Africa, from Asia, would have a much greater impact on the forests, streams and rivers as they created their new country.

That new country would have its beginnings in land grants from the kings of Europe, who were the great powers of their day — land grants by the kings of England to men such as Lord Baltimore. The country would have its beginnings, too, in commerce, with the backing of businesses such as the Virginia Company (the equivalent of today's large international corporations, like Exxon, perhaps, or Toyota). But the life the settlers made for themselves profited not so much from their European backing as from the riches of the land they had found.

While explorers farther south were exploiting gold from the ancient South American cultures, the colonists of the Chesapeake Bay region found another kind of wealth: teeming schools of fish, hardwood forests, fertile soil, wild game. The riches of the Chesapeake were the riches of nature, and as the centuries passed, the Bay region, with its large farms and plantations, became known as "the Land of Pleasant Living."

Of course living was not pleasant for all the people all the time. Indentured servants labored for years to gain their freedom. Slaves labored for a lifetime, and many were never free. War came to the Chesapeake more than once. Native Americans fought the settlers. Slaves revolted against their masters. But the great wars were fought between the settlers and their European forebears and then finally among the settlers themselves.

The Chesapeake watershed served as the scene for bloodshed. The Revolutionary War's final campaign took place in the Bay region, with the surrender of the British general Cornwallis at Yorktown, on the shores of the York River. The War of 1812 saw the British return to the Bay, with warships guarding the Bay's entrance and raiding parties making their way up Bay rivers to attack cities — to burn Washington and Baltimore. A Baltimore lawyer by the name of Francis Scott Key watched the attack on his city and wrote a poem which eventually became "The Star-Spangled Banner."

The Chesapeake Bay we see today is only one of many which have come and gone over long geological epochs, growing and shrinking with the rise and fall of the sea.

The bloodiest battle of this nation's bloodiest war was fought in the Chesapeake watershed, along the edges of Antietam Creek. In the Battle of Antietam, during the Civil War, more Americans died than in any other battle, in any other war.

Through all this, the Chesapeake Bay continued to provide. People took its productivity for granted, like the air or the rain. But changes were taking place in the Chesapeake, and the impacts of settlement began to be felt. The Chesapeake changed slowly at first, but it would never be the same.

A Brief Geologic History of the Chesapeake Bay

While humans were writing their history of hardship and prosperity, war and peace, the Chesapeake Bay was evolving according to a history of its own. The Bay's history is first and foremost geologic. Without the rhythms of the earth — the shifting of the continents, the spread and retreat of glaciers — the Bay would not have existed at all. Actually, as the scientist J. R. Schubel has pointed out, we should remember that the Chesapeake Bay we see today is only one of many which have come and gone over long geological epochs, growing and shrinking with the rise and fall of the sea.

The Chesapeake Bay we see today, the Bay that has provided us with so many oysters, crabs and fish, began about 10,000 years ago, when the glaciers that had advanced as far south as present-day New York City finally began to recede. They receded because the world, in a kind of planetary seasonal rhythm that we still do not fully understand, began to get warmer. The changes in temperature as the Earth swings through these mysterious long-term seasons are slight — often only a few degrees. But the change is enough to affect the entire face of the globe. When the Earth experiences one of its "winters," which we call an Ice Age, much of the planet's moisture is caught up in ice. The level of the oceans falls, both because less water is available and because molecules, including those of water, contract when cold.

For ninety percent of the recent geologic past, the sea has remained in a well-defined basin, with a sharp drop off at its edge. But when the glaciers melt, during our planetary "summers," the sea rises. The overflowing ocean covers the edge of that basin, flooding the long flat shoreline under a shallow sheet of water. That shoreline, now covered with seawater, we call the continental shelf.

If you were to sail out of the Chesapeake Bay with a depthfinder on your boat, you would find the depths fairly shallow — about forty feet or so — for twenty, thirty, forty, fifty miles out to sea. You would be sailing over the old shoreline, the flat plain that once bordered the coast, where land animals like bison, deer and panthers roamed for centuries. Then the depthfinder would drop to over a hundred feet, then it would soon stop reading altogether, because your boat would have passed over the edge of a great cliff. If the depthfinder's pulsing signal could reach that far, its numbers would rise rapidly to over a thousand feet, then two thousand, then three thousand. About a hundred and twenty miles out of the Bay, off the Virginia capes, you would be beyond the continental shelf, past the slope of the shelf and over the ancient sea bottom. The depthfinder, if it could read that far, would say nine thousand feet.

In the Chesapeake Bay, the patterns are the same, even if the depths are less — much less. Because the Chesapeake, taken as a whole, is a *very* shallow body of water. Its average depth is less than 30 feet. Many of its tidal flats may be only a few feet deep. The Chesapeake, for much of its history, was not a bay at all. It was a river, the river we now call the Susquehanna, a name given it by the native Americans.

The Susquehanna River, one of the longest in North America, begins in New York state and wends its way through Pennsylvania. Once it continued straight to the sea, emptying into the ocean basin at a point which is now well off the coast. Now the sea has come to meet it, rising and backfilling into Virginia past Norfolk, past Reedville, into Maryland past the Potomac, past the Patapsco. Tidal waters now reach all the way to Havre de Grace, where they flood a broad area only a foot or two deep called the Susquehanna Flats.

Those 10,000 years since the glaciers receded created a very special place in the Chesapeake Bay. The Bay is an estuary, where salt water from the sea mixes with fresh water from the rivers. This natural mixing bowl, fed with nutrients off the land, makes for a fertile feeding ground and nursery ground for fish and shellfish. It made a great place, for example, for oysters. It seems remarkable that a system that developed over 10,000 years could be changed in a matter of a few centuries, perhaps even a few decades, by the settlers that came to its shores. To understand how this could have happened, consider the different uses people have made of the Bay over the years and some of the problems that resulted from those uses.

Principal Uses — and Problems — of the Chesapeake Bay

• **As a waterway.** The settlers first used the Bay to get off the ocean. According to historical writer Donald Shomette, the Spanish came even before the British, and called the Chesapeake the Bahia Santa Maria. Sadly, even some of the ships that arrived in the Bay after difficult Atlantic crossings ran aground in the shallows and broke apart.

Those that arrived safely rode the relatively protected waters of the Bay north and west, founding settlements and towns. Then the Bay became for them their connection with the Old World, their supply line and their chance for trade and commerce. The Bay has continued as a major waterway to the present day, with ocean-going ships calling at Baltimore and Norfolk, which rank among the nation's busiest ports.

From the beginning, ships on the Bay have probably caused some pollution: raw sewage, garbage dumped overboard and river bottom disturbed and sediment stirred up by anchors. But these impacts were quite small — until modern times. Garbage from an old square-rigger is one thing; flushing the oily bilges of a 500-foot freighter is something else. And while the colonial period may have seen a few watermen fishing or hunting for oysters, and perhaps a few hearty souls rowing about for recreation, today the Bay is home to hundreds of thousands of recreational boats and thousands of watermen when the catch is good. And these modern boats do not often drift silently with the wind. Many of them have powerful engines and throw substantial wakes, wakes that beat against the shoreline and further erode the banks of rivers and creeks. These modern craft also use petroleum products — gasoline, diesel fuel, oil — which may find their way into the estuary, as do chemicals for cleaning and polishing, painting and varnishing, and antifouling agents to keep marine growth off of hulls.

• **As a dumping ground.** All animals, whether humans or striped bass or blue crabs, continually cycle food, taking in nutrients and expelling wastes. When very few people lived on the shores of the Bay, human sewage did not create a large problem. Even when more people moved into the area, creating cities like Baltimore, the biggest problems from sewage were health related, since sewage can carry bacteria which cause diseases such as cholera. Once modern sewage treatment began — and modern medicine evolved — these waterborne diseases became less of a threat. Only in areas of the world where sewage treatment is not properly managed (as in underdeveloped countries) does human waste still pose a serious health problem.

But the Chesapeake Bay faces another problem from sewage, an environmental health problem: too many nutrients.

Sewage is rich in nutrients, including phosphorus and nitrogen. These nutrients can overenrich the Bay and make it too productive for its own good. Nutrients fuel the explosive growth of microscopic floating plants called algae or phytoplankton. These tiny plants grow in great numbers, like green clouds drifting through the Bay, blocking light from other more desirable plants.

When these algae finally die and drop to the bottom, they begin to decompose. As bacteria break down the fibers and minerals of the dead algae, they use up large amounts of oxygen — so much, in fact, that they can literally draw the oxygen right out of the water, especially in deeper areas, such as channels. This lack of oxygen makes it difficult for other animals that also need oxygen, such as oysters, fish and crabs. Sometimes the waters have very little oxygen (hypoxic waters) or virtually no oxygen at all (anoxic waters), and fish and other sealife unable to escape suffocate and die.

In the words of Jackie Russell, a Chesapeake Bay waterman who has pulled up many pots filled with dead crabs, this dead water is "high potency stuff."

• **As a fishing ground.** Despite the other ways in which we have used the Chesapeake Bay, its reputation and its tradition center on its value as a fishing ground. In its heyday, the Chesapeake's shallow waters provided, acre for acre, more fish and shellfish than any other body of water in the world.

For many years, for example, Maryland's oyster harvest held steady at about two million bushels a year or so — nothing compared to the fifteen-million-bushel harvests of the nineteenth century, but enough to sustain a long-standing fishery and the Bayside communities that depend on oysters to round out an annual cycle of working the water. Then, during the 1980s, oyster harvests in Maryland dropped to less than two million bushels, then less than one million, then less than a half million.

Other changes have also taken place in the Chesapeake's water trades. The blue crab has become king of the commercial fisheries, surpassing oysters as the Bay's most lucrative harvest. Because of relatively low fuel prices during the 1980s and high demand for crabmeat, watermen hauling in blue crabs saw a 250 percent rise in profits during the 1980s. In many ways, the blue crab, once an undesirable bycatch, has kept the Bay's seafood harvesting industry alive.

Equally as dramatic as the blue crab's rise has been the fall of the Bay's striped bass fishery. Generally known as rockfish in the Bay region, striped bass once traveled by the tractor truckload from ports like Rock Hall, headed for Lexington Market in Baltimore or Fulton Market in New York. Harvest figures for 1973 reached over 4 million pounds in Maryland alone. But a precipitous decline in striped bass stocks, coupled with an appreciation of the Chesapeake's importance as the Atlantic coast's major spawning ground, brought about stiff restrictions and then a total ban on fishing for (or even possession of) striped bass in Maryland, beginning in 1985.

A recent reopening of Maryland's fishery, based on promising surveys of juvenile stripers, has meant a short season for both commercial and recreational anglers, but it will be a long time, if ever, before the Chesapeake sees a return of the great harvests of twenty years ago.

It is no surprise that watermen and the communities where they live feel a sense of anger and of loss.

The real culprit, it seems, is both the rapid growth that has come to the region and the difficulty of providing adequate sewage treatment and adequate controls of damaging runoff, including herbicides, pesticides and fertilizers. The very hands and mouths that make for good seafood markets also appear to be contributing to the demise of the largest and historically the most productive estuary in the nation. And of course the watermen themselves, in their very attempts at making a living, have stressed the already weakened stocks of fish and shellfish they depend on. Being a waterman in the Chesapeake Bay has never been easy, and it is not getting any easier.

A Model Bay

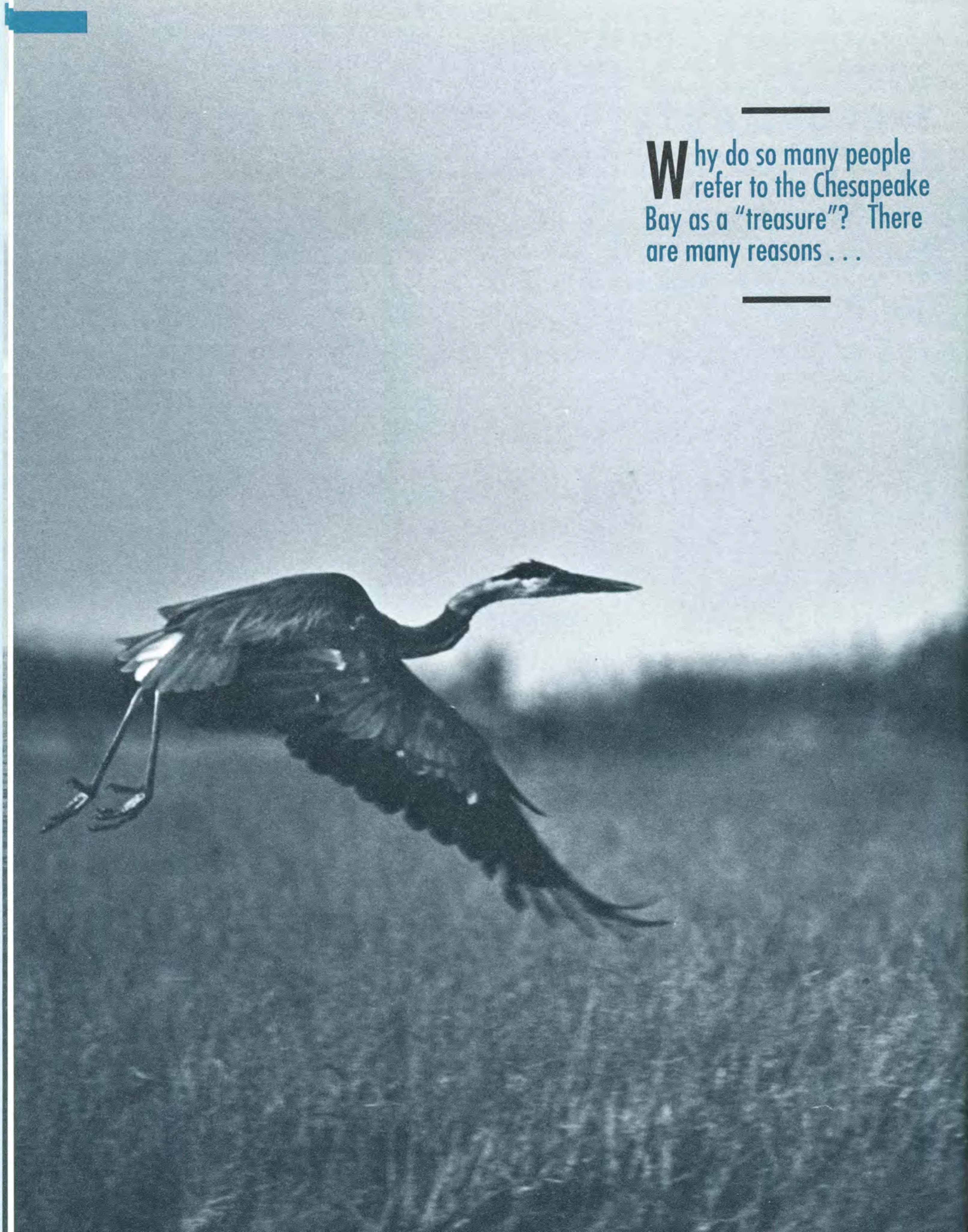
Anyone who has ever built a model house, car or airplane knows the satisfaction of creating an accurate likeness on a miniature scale. Scientists interested in learning more about how the Chesapeake Bay works also build models in miniature.

In the past, physical models — built by the Army Corps of Engineers, for example — tried to recreate the movement of bays like the Chesapeake. Now researchers use powerful computers to manipulate an imaginary Bay without having to create a physical model. Computer modelling has attracted much attention in the Bay region. There is, for example, a model not only of the Bay itself, which takes into account tides and other factors, but also a model of the Bay watershed, which is beginning to simulate runoff from farm fields and other sources.

The Bay computer model has proven very useful for scientists interested in nutrient cycling. By simulating specific amounts of nutrients, which can come from farm fields and waste treatment plants, scientists can study responses of the Bay — such as shifts in the food web. These computer programs allow the researchers to combine a number of influences, not only from rivers, but also from sources such as nutrients that lie trapped at the bottom of the Bay, in the sediments.

Some of these studies suggest that if we could suddenly stop the large influx of nutrients into the Chesapeake, the nutrients deposited in the sediments would essentially pass through the system in about a year. Scientists often refer to this as the sediment "memory." According to some models, in approximately a year the Bay would "forget" that it had ever been over-filled with nutrients.

Thanks to computer models, researchers have a better chance at predicting what changes will take place in the Chesapeake.



Why do so many people refer to the Chesapeake Bay as a "treasure"? There are many reasons . . .

The Chesapeake Bay: A REMARKABLE ECOSYSTEM

Because of the way it formed over the centuries, the Chesapeake provides a rich habitat for fish and shellfish. The Bay is an estuary, which means it opens to the sea, and because it contains water from both the ocean and the many rivers that flow into it, the Bay acts as a mixing bowl for fresh and saltwater. Add to this mixing bowl a plentiful amount of nutrients from the land, spread across the Chesapeake's shallow volume, and one begins to see why the Bay fuels an amazing productivity. Over time, the Bay has produced a remarkable quantity of fish and shellfish, more seafood than any other bay in America.

While some bays may measure their oyster production in terms of hundreds of thousands of bushels, the Chesapeake has measured its output in terms of millions. Even during the modest years of the twentieth century, Maryland alone harvested two or more million bushels of oysters every year until recently. During the great harvesting raids on the Bay's original oyster reefs, in the latter part of the nineteenth century, Maryland oystermen harvested some fifteen million bushels in a single year.

The Chesapeake also serves as a major spawning ground for fish. According to some estimates, the Bay is responsible for some sixty to ninety percent of the striped bass reproduced along the Atlantic coast. The Bay is also home to American shad and many other fish that swim in and out of the Bay at various times, including white perch, yellow perch, bluefish, croakers, spot, sea trout, flounder, catfish, menhaden — and of course the blue crab, now the Bay's most valuable seafood.

Anyone can understand this productivity when a net breaks the surface of the water teeming with life. But the Bay's productivity goes beyond a fishnet or a crabpot. It includes acres of wetlands covered with marsh grass and filled with wildlife. It includes trees filled with the giant nests of great blue herons. It includes the osprey and the eagle, wild geese and diving ducks. Stand on the shore of one of the Bay's countless quiet creeks and listen. You will hear signs of a rich web of life, an abundance of animals in, around and above the water, impressive in its scope and magnitude.

While some bays may measure their oyster production in terms of hundreds of thousands of bushels, the Chesapeake has measured its output in terms of millions.

An Ecosystem Out of Balance

Because the Chesapeake Bay has been so productive, some have called it a food factory, or compared it to a powerful engine that runs on nutrients. But the Bay is not a factory or an engine; it is an ecosystem. Instead of machinery, the Bay is composed of living parts: animals, plants and microorganisms that depend on each other. Take away or change some of these living parts, and the whole ecosystem feels the effects.

This is not simply an abstract notion. Consider, for example, one of the Bay's prized shellfish, the oyster.

For years the reputation of the Chesapeake Bay oyster has spread across the country, and in the Bay region oysters have meant money — some $20 million a year in Maryland alone during some years. As the oyster populations in the Bay fell, largely due to disease and overfishing, many watermen and natural resource managers realized that this represented a significant loss of livelihood and a shrinking economic resource for the tidewater region. What many may not have realized, however, were the ecological effects of the oyster's demise.

Like the Bay itself, the oyster bar is an ecosystem.

The oyster is a gregarious animal: it prefers to grow in groups. Scientists believe that young oyster larvae can actually detect certain chemical signals that draw them to other oysters. Because of this attraction, oyster larvae set and grow in clusters, ultimately forming large aggregations called oyster bars (or oyster rocks).

These days, after years of harvesting by oyster tongs or dredge, an oyster bar may lie low and scattered across the bottom of the Bay. But during the Colonial period, when Captain John Smith first sailed the Bay, the oyster bars were said to reach from the Bay bottom all the way to the water's surface. These bars actually formed oyster reefs, and like coral reefs in the tropics, oyster reefs undoubtedly created rich ecosystems.

Imagine, for a moment, oyster reefs stretching up both sides of the Chesapeake Bay, along the shallow margins. Fish and other marine animals would have gathered around the reefs to feed, and chances are that one could see these fish, because the water would be relatively clear.

The water during those early years would be less murky than now for two reasons. First, because prior to European settlement and the introduction of intensive agriculture, the land surrounding the Bay and its rivers was covered with forests, forests that protected the soil and prevented runoff. And second, the Bay would be more transparent because the oysters themselves were actually cleaning the water.

Oysters are filter feeders. An oyster pumps about 50 gallons of water a day in order to filter out algae (also called phytoplankton), the tiny floating plants that serve as its primary food source. As oysters feed, they act like filters in a swimming pool, drawing out algae and clearing the water. One scientist, Dr. Roger Newell, has estimated that the Bay once had so many oyster reefs that the oysters could pump through a volume of water equal to the entire Chesapeake Bay in less than a week. Because oyster populations have dwindled to such low levels, it would now take a year or more for today's oysters to filter that same amount of water.

Some have called it a food factory, or compared it to a powerful engine that runs on nutrients. But the Bay is not a factory or an engine; it is an ecosystem.

Disturb one part of the ecosystem, and the whole ecosystem changes. The Bay now has too much algae, too many phytoplankton floating through the water. Not only does the water look murky, but this lack of clarity has meant a lack of light for underwater grasses. In many areas, these grasses — which may provide food for diving ducks or shelter for molting crabs — have died off as a result of too much algae, which clouds the water and covers the submerged grasses with slime. Overwhelmed, many grasses have disappeared, leaving large stretches of Bay bottom bare.

In short, many scientists believe the Bay has changed in a number of ways because of human beings.

First, we have harvested oysters and destroyed the oyster reefs. Most of the Bay's oysters were taken during the end of the last century. During that time, watermen hauled up in a single year what it would now take more than ten years to harvest.

Second, we have increased the amount of algae in the water by adding more nutrients. These nutrients come from sewage treatment plants, from septic systems, from fertilized farm fields. These nutrients cause even larger blooms of algae, which die and decompose on the Bay floor, a process that draws life-sustaining oxygen out of the water.

Third, we have increased the amount of sediments in the water. The Bay naturally receives a heavy load of sediment, especially during heavy spring rains and storms, but human uses of the land have torn away the protective forests and left the dirt to wash away. This increased runoff began many years ago, when farmers increasingly cleared the land for agriculture. Soil erosion continues today, not only because of agriculture, but because of housing construction and other land development in the watershed. Every construction site has the potential to release tons of sediment into the Bay and its tributaries.

Fourth, we have added new chemical compounds to the Bay. Chemicals have become a part of our daily lives. Heavy metals like zinc and mercury from industrial uses, pesticides from farms and suburban lawns, cleaning solutions from households, and a host of petroleum products and other compounds, all wash off the land or down storm drains and into the streams and rivers that feed the Bay. We do not fully understand the effects of these chemicals. Scientists do know that, in significant doses, many of these compounds are toxic to fish and other marine organisms. What researchers are still trying to determine is the effect such toxic compounds have at very low levels in our waterways — levels so low that they may be difficult to measure.

Toxic compounds sometimes act together to create problems for Bay organisms. For example, when rain becomes polluted with nitrous oxides (from automobiles) and carbon dioxide (from coal-burning industries and electrical power plants), it becomes acidic. When this acidic rain falls on the Bay, it does two things. First, it adds nutrients to the Bay. Some researchers think that as much as twenty-five percent or more of the nutrients entering the Bay come from the air. Second, according to some researchers, acid rain causes elements like aluminum to leach out of the soil. If, for example, this leaching occurs in a tributary where fish are spawning, it can kill delicate larvae. Some scientists believe that this double threat from acid rain and aluminum has hurt the reproduction of striped bass.

Such problems have not gone unnoticed. The decline of striped bass, the Maryland State Fish and a popular sport and commercial fish up and down the Atlantic coast, has caused an uproar. But other effects of toxic compounds on the Bay's plants and animals — which may not be as visible to the public — may go largely unnoticed. As one researcher has said, it may be that the Bay has a giant "headache" caused by toxic compounds, and we just don't realize it.

There is one more thing to say about the Chesapeake Bay's ailing ecosystem. The Bay serves as something of an indicator for the health of the entire region.

Since the Bay lies at the base of an enormous watershed — some 64,000 square miles of mountains, foothills and coastal plain — it gathers much of what we put on the land or pour into the water throughout the area. Because it supports such a rich and productive ecosystem, the Bay provides ample opportunity for us to witness changes and trends, such as significant decreases in the populations of animals and plants.

The Bay has a story to tell about how the way we live affects the environment we live in. The Bay is not simply a pool of water where oysters and crabs grow. It is the most visible part of a vast network of plant and animal life. Human beings rely on this environment as much as any animal; and we also bear a special responsibility, since our actions have an impact on the ecosystem greater than that of any other creature that walks the Earth.

Monitoring: Taking the Pulse of the Bay

All estuaries are in constant flux — and the Chesapeake Bay, the nation's largest estuary, is no exception. With 150 rivers and streams feeding the Bay, and several thousand miles of shoreline, the Bay system continually responds to nature's changing conditions: rains, tides, drought, shoreline erosion, storm runoff. The Bay also responds to human activity — discharges of nutrients from waste treatment plants, fertilizer runoff from farmland, toxic chemicals in industrial outfalls, fish and shellfish harvesting. How do we distinguish between natural and human impacts on the Bay? And why do we need to?

The Chesapeake's vital signs — its temperature, dissolved oxygen, pH, water clarity — are indicators of the Bay's environmental health. These and other indicators, such as the presence (or absence) of underwater grasses or the numbers and diversity of fish, measured week by week, month by month and year by year, give researchers and resource managers insight into the health of the Bay by tracking changes in the Bay.

Keeping track of these changes is the job of monitoring. In order to best restore the health of the Chesapeake, we need as complete an understanding of its ecology as we can get. Bay monitoring programs, funded by the state and federal government, help chart emerging trends, enabling us to see whether the ecosystem is responding to programs designed to reverse the decline of water quality or populations of fish or shellfish.

Government agencies in the Bay region (for example, the U.S. Environmental Protection Agency, the Maryland Department of the Environment, the Maryland Department of Natural Resources, as well as the University of Maryland) are cooperating by regularly monitoring many different water quality factors, including toxic chemicals, metals and nutrients. They are also monitoring the abundance of key fish and shellfish species, the presence of diseases in fish and shellfish, underwater grasses and waterfowl. Especially important are samplings of dissolved oxygen and chlorophyll, as indicators of whether overgrowths of algae are occurring. (Since virtually all plants, including algae, contain chlorophyll, if high levels of chlorophyll emerge, then scientists can assume that high numbers of algae are present.) Interpretation of these data can help scientists and resource managers determine whether management programs to restore living resources to the Bay — such as underwater grasses, striped bass, oysters — are working, or whether they need to be revised, or new strategies attempted.

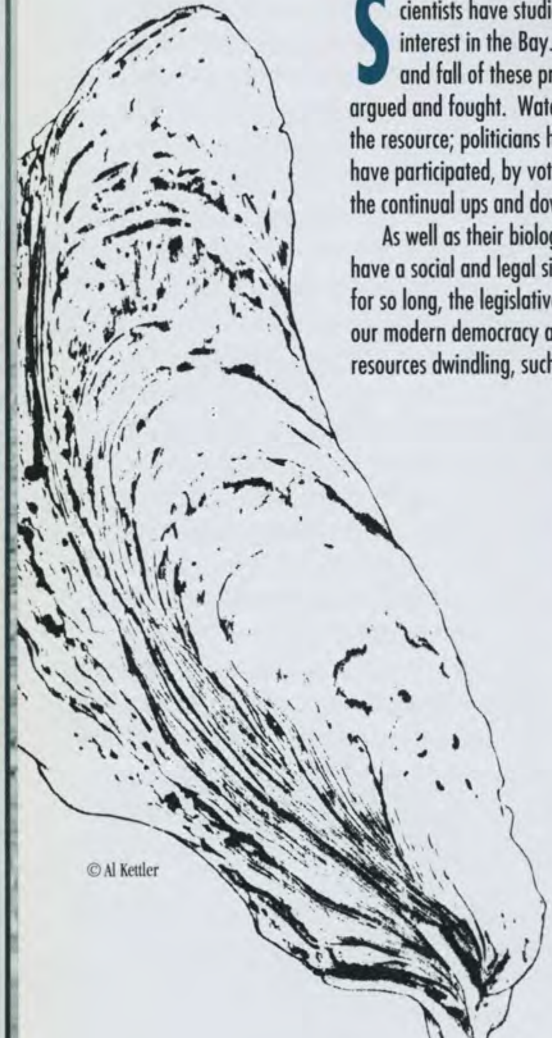
But the Bay is enormously complex, and monitoring is too costly for government agencies to take all the samples necessary for a thorough understanding of the ecosystem. For this reason, citizen monitoring programs in the Bay are becoming increasingly helpful. Students and volunteers in citizen organizations have for several years been regularly monitoring streams and rivers throughout the watershed. With assistance from organizations like the Alliance for the Chesapeake Bay and Save Our Streams, volunteer learn how to take water quality measurements and how to record the data so that it will be reliable and useful for data managers.

Each week volunteers head for an assigned site along the shore of a stream or river, where they take samples and compile a number of measurements: pH (a measure of alkalinity or acidity), dissolved oxygen level, salinity, temperature, and turbidity (a measure of how clear the water is). These data are then entered into the Chesapeake Bay data base, along with data gathered by state and federal monitoring programs. Collected over a period of years, these measurements of water quality will enable resource managers to better analyze and describe the Bay's shifting ecosystem. They will also help us to assess just how well our efforts to curb pollution are working.

Case Studies:
The American Oyster & the Striped Bass

Scientists have studied the Bay's fish and shellfish for a long time, but they are not the only ones with an interest in the Bay. Watermen, politicians, natural resource managers and others have watched the rise and fall of these profitable Bay species as well. Not only have they watched, but they have debated and argued and fought. Watermen have struggled to make a living; natural resource police have struggled to protect the resource; politicians have violently opposed some laws and rallied behind others. And through all this citizens have participated, by voting for legislators who they believe will represent their point of view and by taking part in the continual ups and downs of the democratic process.

As well as their biological and ecological importance, valuable species like the striped bass and the oyster also have a social and legal significance in the Bay region. Because so many have depended on the bounty of the Bay for so long, the legislative and regulatory history of these two species spans many decades and demonstrates how our modern democracy attempts to solve disputes over our natural resources. With population rising and natural resources dwindling, such debates may become even more important as we enter the next century.



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Case Study: The American Oyster

Debates surrounding the American oyster are not new. For a hundred years, controversy has swirled around this shellfish, arguments over who has the right to decide who can fish where. Some of those arguments resulted in bloodshed, during the so-called Oyster Wars.

In Maryland, two debates continue, with supporters on either side of the issues. The first debate pits those who believe in a public fishery against those who believe that oyster bars should be privately managed. The second debate grows out of the desire of some scientists and others to introduce a new species of oyster to the Chesapeake Bay; their opponents say we do not yet know enough about possible effects to introduce a new oyster.

Before discussing these debates, here is some background on Maryland's oyster industry.

A Brief History of the Oyster Fishery

At the end of the nineteenth century, Maryland watermen harvested great quantities of oysters, but soon it became clear that the oysters would not last forever. As the nineteenth century came to a close, those with an interest in preserving Maryland's oyster industry began to sound the alarm.

"Our method of managing the oyster industry has been a failure," said William K. Brooks in his book, *The Oyster*, published in 1891. Brooks, a Johns Hopkins University professor, was the foremost oyster biologist of his day. He warned that the way we fished the oyster bars "has led to the ruin of some of our finest beds and to the very great injury of all of them . "

Brooks blamed the coming failure of Maryland's oyster fishery on "improvidence and mismanagement and blind confidence." The coming deterioration was no different, he argued, than "in France, in Germany, in England, in Canada, and in all northern coast states." In all these places, Brooks noted, "the residents supposed that their natural beds were inexhaustible until they suddenly found that they were exhausted. The immense area covered by our own beds has enabled them to withstand the attacks of the oystermen for a much longer time."

Brooks, and the many who followed him, pushed relentlessly for leasing Bay bottom as the oyster's only hope in Maryland. The state should rent large tracts of barren or unfertile grounds, they argued, so that oyster farmers could then cultivate those plots, plant oyster seed and harvest their crop. Such beds would benefit the public bars as well, since the spawn of free-swimming oyster larvae from well-tended, privately cultivated grounds could help resupply nearby public bars.

Virginia took the lead in the Chesapeake in 1894, setting aside 110,000 acres of barren ground for leasing — another 143,000 acres remained as public oyster bars — and passed legislation to encourage private enterprise. Until Virginia beds were attacked by MSX in the 1960s, those private oyster grounds accounted for most of that state's oysters: an average of 2.8 million bushels a year in a good decade, compared with less than one-half million from Virginia's public bars.

Legislating a Leasing Act

To most Maryland watermen, the thought of Bay waters in private hands was outrageous, especially in the Tidewater counties. And they were successful in lobbying the Maryland General Assembly against repeated legislative attempts to permit leasing in the state.

But as harvests went down at the turn of the century and packing houses by the score went broke, demands for state action increased; action that would not only protect oyster beds — for example, through enforcement of cull and gear laws — but that would enhance production through leasing. The demands became so heated that even strong Tidewater opposition could not cool passage of the Haman Oyster Act in 1906, the most far-reaching attempt in Maryland to alter the oyster industry.

The Haman Act allowed private planters to lease 30 acres in the tributaries, 100 acres in Tangier Sound and 500 acres in the Bay's open waters. Haman, a Baltimore lawyer, had helped persuade Marylanders of the promise of oyster farming. Wheat, he pointed out, yielded about seven million bushels in 1890-91, while oysters, which no man had sown, yielded ten million bushels. Imagine, he argued, what those underwater farms could produce when cultivated by oyster farmers.

While amendments to the Haman Act in succeeding years would, according to an editorial in the *Baltimore Sun*, destroy its effectiveness, that act is still the basis for oyster farming in the state today.

Unfortunately, only 2,000 of Maryland's 9,000 acres of leased bottom have been cultivated for most of recent history. Poaching remains a major problem, and now oyster diseases — such as MSX and Dermo — have made investing in oyster cultivation a risky business. Scientists and others have been working on fast-growing and disease-resistant oysters, but so far disease has kept new techniques for oyster cultivation largely on hold. This has meant that incentives for more active leasing programs in the state have also remained on the back burner.

Enter a New Oyster?

Because the Bay oyster — the American oyster (*Crassostrea virginica*) — has declined so dramatically, some researchers and industry representatives have questioned whether or not we should bring in a new oyster. The oyster they often suggest is the Japanese oyster (*Crassostrea gigas*).

The Japanese oyster has come to this country already, brought in by aquaculturists in Oregon and Washington in the Pacific northwest. There oyster farmers spawn and raise this hearty oyster and ship their product across the country. Recently, they have even shipped them to the Chesapeake Bay, where oyster packers are running short of Chesapeake oysters. But in those states, where the water is cold, the Japanese oyster generally does not spawn. Hatcheries essentially control how many oysters are reproduced each year.

The Chesapeake Bay, on the other hand, becomes quite warm during the summer months, and it seems likely that the Japanese oysters could spawn. Would they displace the original

Chesapeake Bay oyster? Would their genes become mixed with those of the Bay oyster? Some early research suggests that the two oysters would not intermix, but these studies are not conclusive. Many questions remain unanswered.

The Debate

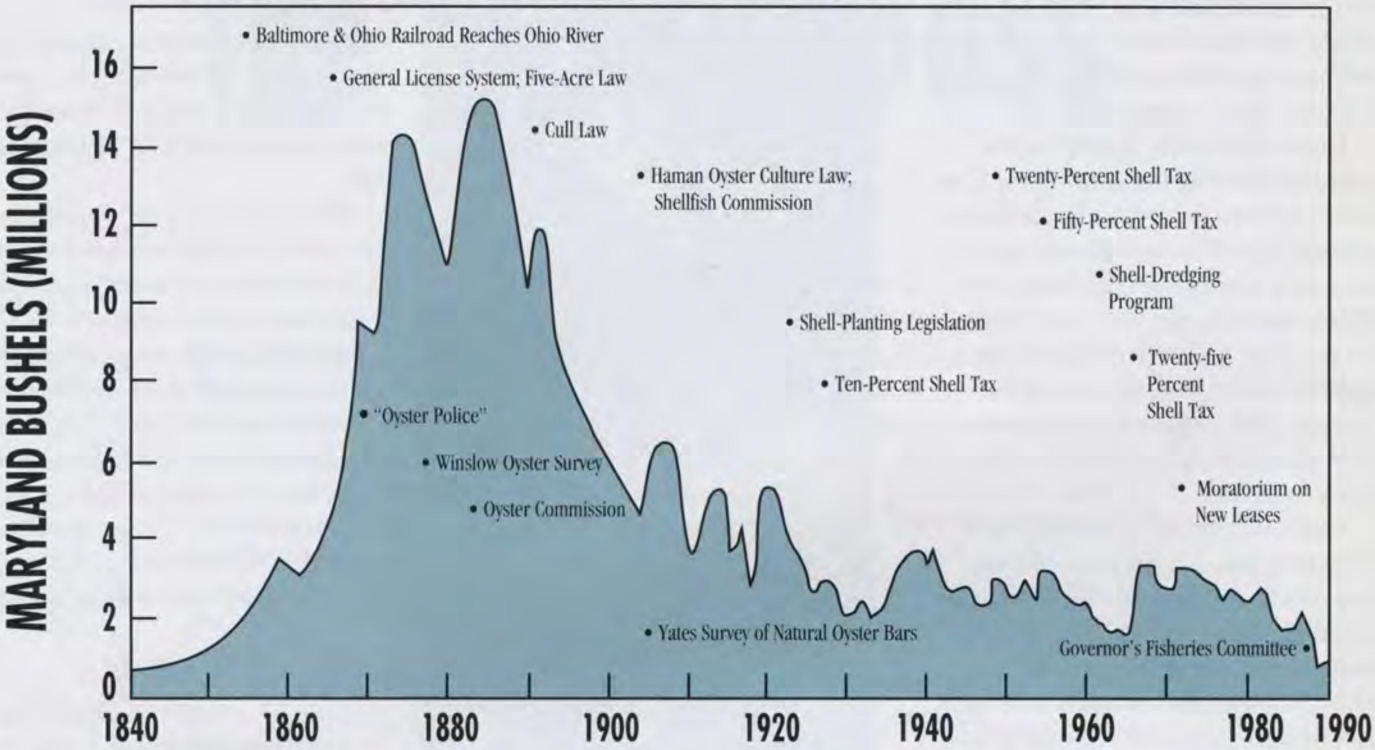
The Maryland oyster fishery and those who manage it now face these controversial issues:

- Should private leasing of bottom be encouraged, with a new emphasis on oyster hatcheries and other techniques for controlled spawning and reproduction of oysters? Or should the state focus on the wild fishery, by concentrating on improving the Bay's water quality and solving the difficult disease problem?

- Should the Bay states of Maryland and Virginia look to bring in a new oyster, such as the Japanese oyster, to replenish the Chesapeake's oyster fishery? Or do we first need more research on the impacts such an introduction might have on the Bay?

- Some have suggested calling a moratorium on the harvest of oysters to help bring them back.. What would be the benefits and the drawbacks of such a moratorium? Would a moratorium have the same effect on oysters as a ban on rockfish?

MANAGING MARYLAND'S OYSTERS: A CHRONOLOGY



c. 1852 Baltimore & Ohio Railroad reaches Ohio River. Expanded the oyster market to western communities; northern oyster packers opened plants in Baltimore.

1865 General License System; Five-Acre Law. State-wide license system regulated oystermen; leasing law allowed oyster planting on five-acre plots.

1868 "Oyster Police." Collected license fees, enforced fishing restrictions, and protected private fishing grounds.

1877-79 Winslow Oyster Survey. Documented expansion of oyster beds and decline in number of oysters in Pocomoke and Tangier Sounds.

1882 Oyster Commission. Surveyed Maryland oyster beds; recommended conservation measures and oyster farming.

1890 Cull Law. Set minimum legal size for market oysters; required return of shells with spat and young oysters to natural oyster bars.

1906 Haman Oyster Culture Law; Shellfish Commission. Increased leasing allowance, a proposed law rendered ineffectual by later legislation; commissioned Maryland Oyster Survey (Yates Survey).

1906-12 Yates Survey of Natural Oyster Bars. Conducted extensive biological and environmental surveys of Maryland's oyster bars.

1922 Shell-Planting Legislation. Initiated annual placement of shell as cultch for depleted oyster bars.

1927 Ten-Percent Shell Tax. Required oyster processors to make 10 percent of their shucked shell available for state use in planting.

1947 Twenty-Percent Shell Tax. Increased shell tax on processors.

1953 Fifty-Percent Shell Tax. Increased shell tax again, but the supply still proved insufficient.

1961 Shell-Dredging Program. Initiated new oyster repletion program using old shells dredged from nonproducing areas.

1965 Twenty-five Percent Shell Tax. Reduced shell tax; allowed processors the option of cash payment, in place of shell.

1972 Moratorium on New Leases. Suspended awards of new leases of oyster grounds pending completion of new survey of state oyster grounds.

1990 Governor's Fisheries Committee makes recommendations for major restructuring of Maryland's public oyster fishery and enhancement of private aquaculture.

Case Study: The Striped Bass

Steadfast, even though threatened by overfishing and pollution, the striped bass still swims the coastal waters of the eastern United States from Maine to the Carolinas. The vast majority of these stripers sooner or later enter the Chesapeake Bay, where they swim into shallow tributaries to lay their eggs.

Long sought after because of their taste and their grit at the end of a line, the striped bass — *Morone saxatilis*, also known in the region as the rockfish — have lured sports fishermen by the thousands. Commercial fishermen, no less intent on catching the popular seafood, have combed the waters with their nets and, at times, made a good profit. During the 1970s and 1980s so many fishermen, both commercial and recreational, caught so many striped bass that resource managers up and down the Atlantic coast began to worry about declining populations and threatened reproduction.

It became clear that solutions to the striped bass decline would have to be both biological and political.

One of the most important biological facts about the striped bass is that it is, like the salmon, an anadromous fish. It spends much of its life in the ocean, but it returns to rivers to spawn. This biological fact also has a political significance: it means that the fish will spend its most vulnerable stages in the rivers and inshore waters which are most affected by humans.

In order to protect the striped bass, those living on land would have to pass a series of laws and regulations.

Laws governing the catching of striped bass go back at least as far as the 17th century. In 1639, to stop what they saw as the misuse of this valuable food fish, New England leaders banned the use of striped bass and cod as fertilizer. This act has been called the first conservation statute enacted in the United States. In the first year of the American Revolution, the legislatures of New York and Massachusetts took time out from raising armies for George Washington to ban wintertime commercial fishing for striped bass — one of the nation's first fisheries management efforts. Other regulations (including taxation) followed, often surrounded by intense debate.

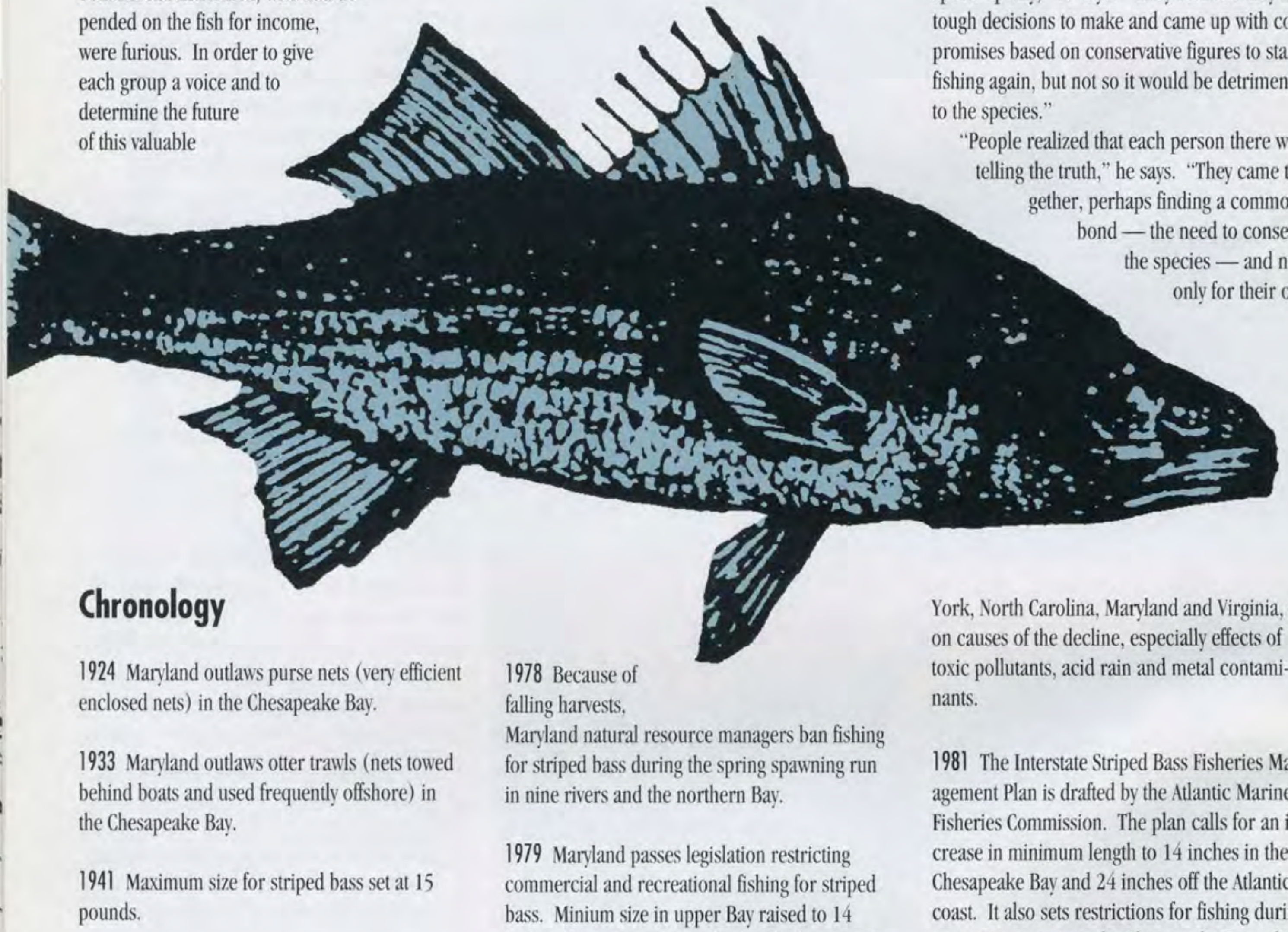
But seldom in our history has this popular fish caused as many controversies as it has in the past decade. After very large catches during the 1970s, a series of low harvests led authorities to ban fishing in a number of Maryland rivers during the spring spawning run. Stricter size limits followed. By 1985, low harvests and declining reproduction prompted the Maryland Department of Natural Resources to designate the striped bass a threatened species. A full moratorium then went into effect, prohibiting the catching of — or even the possession of — striped bass in Maryland.

Controversy flared. Environmentalists largely applauded the move, but many commercial fishermen, who had depended on the fish for income, were furious. In order to give each group a voice and to determine the future of this valuable fish in the most democratic way, the governor of Maryland appointed a Striped Bass Committee. The Committee had representatives from commercial and recreational fishermen, from university researchers, from environmental groups, from state legislators and regulators. They set about to reach a compromise.

Delegate Ron Gunns, a representative in the Maryland General Assembly from the Eastern Shore, has served on the state's Striped Bass Committee. He notes that the situation can be very political, but that in the end he feels that politics should not regulate fishing quotas. Instead, he says, scientific information should play a greater role in determining management strategies.

According to Delegate Gunns, the striped bass moratorium served an important function. Officials accumulated a lot of information during that time (1985-1990) on monitoring processes, size limits and best times to allow fishing. The moratorium, he says, also allowed different user groups time to come to an understanding. In one sense, he says, it "took the heat off" and put everyone on the same level. "During meetings of the state's Striped Bass Committee, everyone spoke openly," he says. "They realized they had tough decisions to make and came up with compromises based on conservative figures to start fishing again, but not so it would be detrimental to the species."

"People realized that each person there was telling the truth," he says. "They came together, perhaps finding a common bond — the need to conserve the species — and not only for their own



Chronology

1924 Maryland outlaws purse nets (very efficient enclosed nets) in the Chesapeake Bay.

1933 Maryland outlaws otter trawls (nets towed behind boats and used frequently offshore) in the Chesapeake Bay.

1941 Maximum size for striped bass set at 15 pounds.

1957 Size limit for striped bass increases from 11 to 12 inches.

1975 Striped bass plentiful. Restrictions are removed on number of yards of gill net that can be licensed.

1978 Because of falling harvests, Maryland natural resource managers ban fishing for striped bass during the spring spawning run in nine rivers and the northern Bay.

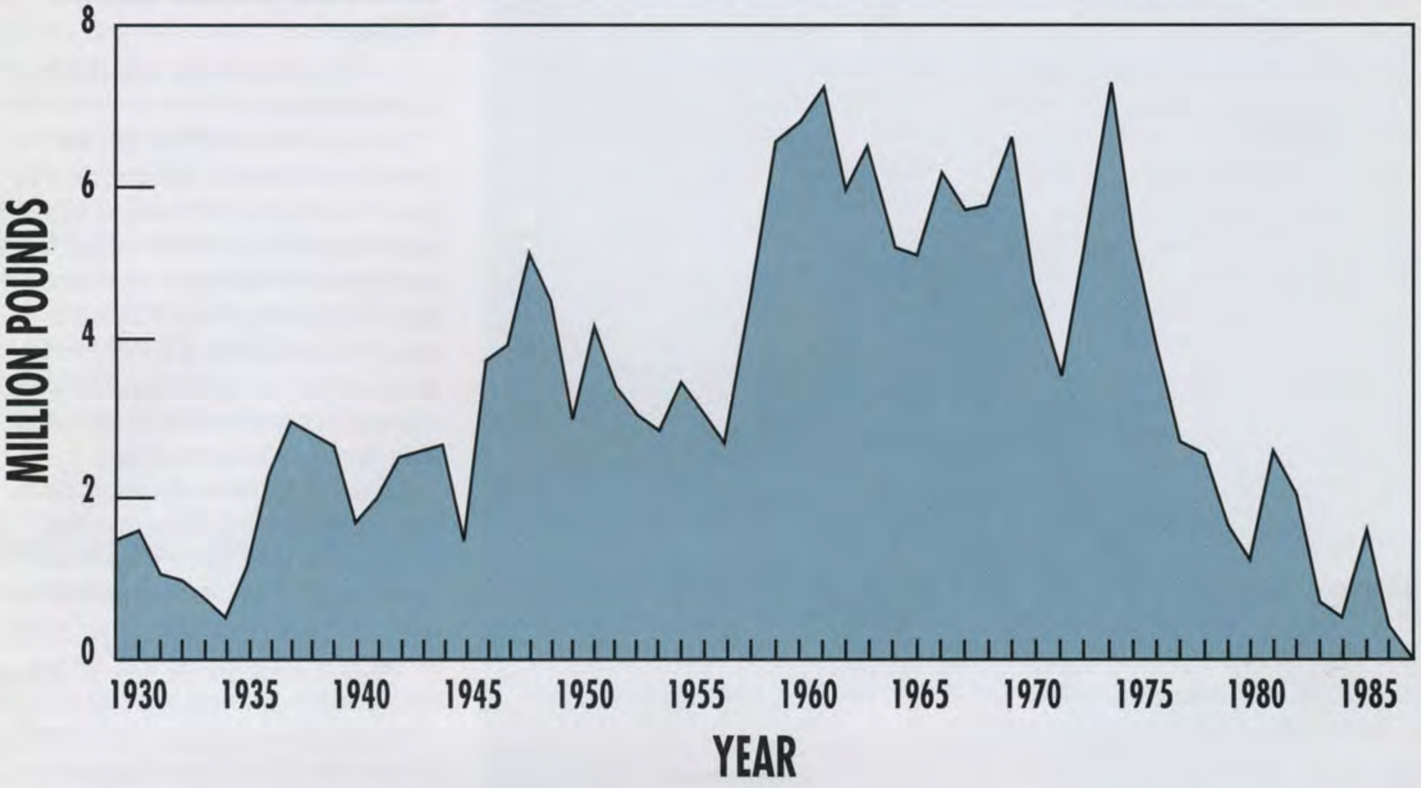
1979 Maryland passes legislation restricting commercial and recreational fishing for striped bass. Minium size in upper Bay raised to 14 inches (June through October). The law permits recreational fishing for striped bass between May and February. A group of New England anglers raises $3,500 to support continued research at the University of Maryland on young striped bass.

1980 An amendment to the Anadromous Fish Act passes, making nearly $5 million available for the next three years to study striped bass. Research focuses on stock assessments in New York, North Carolina, Maryland and Virginia, and on causes of the decline, especially effects of toxic pollutants, acid rain and metal contaminants.

1981 The Interstate Striped Bass Fisheries Management Plan is drafted by the Atlantic Marine Fisheries Commission. The plan calls for an increase in minimum length to 14 inches in the Chesapeake Bay and 24 inches off the Atlantic coast. It also sets restrictions for fishing during spawning seasons in the Chesapeake Bay, where 60 to 90 percent of striped bass spawn.

1982 A large number of rockfish spawn in the Bay. In the coming years the Atlantic Marine Fisheries Commission will take steps to protect this important group, in the hopes that this class will spawn and help bring back the entire population to more normal levels.

STRIPED BASS COMMERCIAL LANDINGS FROM THE CHESAPEAKE BAY



1983 Despite the healthy spawn of rockfish in the previous year, commercial landings remain low, only 397,000 pounds, down from several million pounds a few years before.

1984 With concern increasing, plans call for a 55-percent reduction in the fishing rate of striped bass from Maine to South Carolina and restrictions for catch size to allow young stripers to survive and replenish the stock.

1985 In Maryland, striped bass is declared a threatened species. Commercial and recreational fishing is completely banned. All Atlantic Coast states put in place a management plan that meets or exceeds the 55-percent reduction in striped bass fishing, as recommenced by the Atlantic States Marine Fisheries Commission. Research on reproduction of striped bass continues.

1988 Governor William Donald Schaefer tells members of a U.S. Senate Committee that he would like to make rockfish a game fish available only to sports fishermen, in order to conserve the remaining fish. (He will later change his position.)

1989 Surveys of the number of young striped bass in the Bay are very high. The juvenile index reaches a key level set by the management plan put in place in 1985. Officials see this as a strong sign that the population is healthy and that management and pollution controls are succeeding. Lifting the moratorium on fishing in 1990 is discussed.

1990 Maryland Department of Natural Resources announces in August the opening of a 1990-1991 striped bass fishing season, with restraints on size and number of fish caught. A strict quota system is used. This is the first time a fishery in Maryland has been regulated by a quota system. The season runs from October 5 through January 30, 1991. DNR mounts an expensive monitoring and enforcement blitz to control how many fish are caught. Sports fishermen continue to lobby to make striped bass a game fish. Designation of striped bass changed from "threatened" to "species in need of conservation."

Fall, 1990 The recreational season for rockfish is shut down. Tens of thousands of anglers deplete the 318,750-pound quota allocated to them after only nine days into the first season in five years. Charter boats reach their quota in 15 days. Governor Schaefer reverses his position, claiming that everyone, not just sports fishermen, should be allowed to fish for striped bass.

1991 Commercial fishermen begin their season in January. They are assigned individual quotas — a certain number of pounds per person. At about $3.00 per pound, officials estimate the catch will be worth about $1 million.

benefit and pleasure, but also for the fish. The striped bass is, after all, a fellow species on this earth."

What Lies Ahead?

What's in store for striped bass in the next decade? Different regulations? More research?

Peter Jensen of the Maryland Department of Natural Resources, the agency that regulates striped bass stocks, says fishermen can probably look forward to bigger quotas in the coming years. Other states have initiated restrictions on catch size, but Maryland is the only one so far to establish quotas. He says they will be the way of the future. According to Jensen, we have shown that quotas are an effective tool in managing striped bass.

Equally effective and most likely essential, he says, will be strong cooperation by citizens, who sometimes have conflicting goals. Whatever their goal — to catch the rockfish, to study it, or simply to know it's there — people need to be involved in making policy. "They were involved in setting quotas for the 1990-1991 season, and discussions were long, emotional, and ultimately full of give-and-take," says Jensen. "But this is the democratic process, and it needs to continue."

The Role of Science

In the future, a major problem facing resource managers will be how to predict the size and survival of stocks from year to year. Reproductive rates change quickly. How can managers adjust to rapid changes in stocks in order to make the right decisions? How might scientists and managers work together to approach these uncertainties?

To track the rise and fall of striped bass reproduction, the Maryland Department of Natural Resources conducts an annual survey of juvenile stripers. This survey of small stripers helps to determine the reproductive success of the stocks.

According to Dr. Ed Houde at the University of Maryland's Chesapeake Biological Laboratory, research over the past few decades has shown that most probably overfishing, not pollution, caused the collapse of the striped bass fishery. Given this, what should science focus on in the next decade? For one thing, according to Houde, research will continue to focus on the biology of striper populations. For example, studies in the 1980s showed that older females generally produce more, and higher quality, eggs. According to Houde, these older females in particular need to be protected.

Resource managers point out that they will want to assure that a certain number of young fish are also protected, or else there will not be enough young females around to grow into mature females.

Houde believes that in the next decade research will continue to look at populations of striped bass and how the environment affects these stocks. Studies have shown, for example, that weather plays an important role in the survival of eggs and young bass. Sudden drops in temperature after a bad storm, says Houde, will kill eggs and larvae, though not necessarily at catastrophic levels. Houde and other scientists also hope to improve their understanding of how fish populations and fishing pressures along the Atlantic seacoast relate to fisheries in the Chesapeake Bay.

There will be no going back to the old ways, when a waterman could haul in as much as his boat could hold.

Another area of interest will be the contribution of fish hatcheries to restoring and maintaining striped bass in the Chesapeake. Raising striped bass could help keep fishing quotas up, or even increase them. But raising fish in hatcheries is expensive. Will the cost of raising striped bass in hatcheries be offset by the money the fishing industry brings to the area? Just how much are anglers willing to pay to hook a fish? These are complicated economic questions.

In order to make decisions about the future of the striped bass in the Chesapeake Bay, we will need reliable information from the biological sciences and the social sciences, from the fisheries biologists and the economists. Research and management are closely linked, says Dr. Houde. "Striped bass studies are no longer done just to learn more about how the bass lives. Studies are done to answer specific management questions. It's really an evolution of science."

Commercial and Recreational Fishing

How do those who fish for striped bass feel about the next decade?

Bob Eurice, Treasurer of the Maryland Watermen's Association, is optimistic about the future. He says he feels that putting in place a good management system for striped bass, which took long hours of talking and compromising, was a learning process for all of the factions involved. He says that more of this will have to be done, more working together to improve not only stocks of striped bass, but the quality of the whole Bay.

Eurice feels that the first few years under the new quota system will be a learning process, learning how to check quotas in, how to label catches and so on. In 1991, watermen had a quota of 100 pounds of striped bass per person per day, up to 650 pounds per boat, and then they had to stop. Watermen are feeling positive, Eurice says, because there are "a lot of rockfish out there now, and they'll get at least $3.00 per pound." To make farming of striped bass (or their hybrids) economical, the fish must bring $4.50 to $6.00 per pound, he says. So he feels the watermen "can't lose."

Some have questioned whether or not quotas can be enforced well enough to be effective. But according to Eurice, watermen "can't cheat" because catches are so carefully monitored, from the docks to the fish markets. "If you're caught," he says, "the fine is $1,500 per fish!" And, he says, cheaters can have their gear and equipment confiscated. At $50,000 to $100,000 a boat, says Eurice, cheating hardly seems worth the risk.

Still, it is with some regret that Eurice admits that there will no going back to the old ways, when a waterman could haul in as much as his boat could hold. He now believes that there will always be a quota system, and that everyone who fishes for striped bass will have to get used to the idea.

Captain Ed O'Brien, who runs a charter boat business on the Bay, says that the charter boat captains are also generally optimistic about the future of the striped bass and their business. He says it will be frustrating for a few years, because the quotas are, in his view, so conservative, even over-regulated. He's been fishing the Bay for thirty years, and he says there are more striped bass out there than ever. "It's difficult for my customers to throw the tasty fish back when there are so many. They lose respect for the tight laws when there's such an abundance of fish." But he believes that if stocks remain stable, quotas will increase in a couple of years.

Despite some complaints from his customers, O'Brien agrees with the watermen that a quota system is good and practical. He feels that the State of Maryland has been very creative in its approach to bringing back and managing striped bass. "And with intelligent conservation and intelligent use of the fish, we will always have striped bass."

Food for Thought

Consider these questions:

- If you were given $10,000 of the state's money for research, what sort of striped bass studies would you fund over the next few years? How should decisions about spending the taxpayer's money be made?

- Why would a group of sports fishermen spend time and energy to raise money to study striped bass (rockfish)? Do you have a sport or other interest that you would fight to preserve if it were threatened?

- Different groups have different goals and interests. How would you expect the following groups to respond to a ban on fishing: Watermen? Environmentalists? Researchers? Resource managers? Do you think the general citizen cares about striped bass? Why or why not?

- Do you think the quota system will work? Will people sign in their fish as they catch them? After so much waiting, will they cheat?

- In the accompanying chronology, notice that the Governor changed his mind about making striped bass a game fish. What types of information might make him change his mind in the future?

- How do you think watermen will feel about regulations that may change their centuries-old way of life?

As striped bass and other species have faltered, watermen have increasingly turned to the blue crab, now their major harvest.

What Do We Mean By **Environmental Health?**

We may not think of it often, but human beings are as much a part of life in the Chesapeake Bay and its watershed as striped bass and oysters. What we do and how we live affects the Bay; and if the Bay is in decline, what does that say about how we are using the land and the water? What does it suggest about the health of the ecosystem we depend on for food and for a worthwhile quality of life?

First of all, what do we mean by a healthy or unhealthy Bay? To answer this question try thinking about your own health. What makes you healthy? Certainly the absence of disease — and the fact that your body's arteries, veins, heart, lungs and other organs are working together. The most important factor in determining your health, however, is the proper flow of energy throughout your body: the transfer of oxygen from the air you breath to your blood and the conversion of the food you eat into carbon to fuel cell metabolism. A flu virus, for example, makes you weak and unhealthy because it diverts a great deal of energy away from the normal pathways in your body to an attack against the virus. Also, the quality of the food, water and air you ingest has a great deal to do with how healthy you are.

Your body is, in effect, a mini-ecosystem, just as the Chesapeake Bay is an ecosystem. An ecosystem is a collection of living members and nonliving parts which are interconnected in a dynamic balance — altering one part of the system will likely disturb the whole. Your health and the Bay's health depend on many of the same factors: the proper functioning of members or parts within the system, whether they be red cells carrying oxygen through your bloodstream or underwater plants releasing oxygen into the Bay; the quality and quantity of the inputs coming into the system (for instance, sunlight, air, water and food); and the proper flow of energy throughout the system.

Although comparing the Bay to a human body provides us with a helpful analogy, there are significant differences. The Chesapeake Bay is a complicated ecosystem — whether it is more complicated than your body may be a subject for debate. Clearly, there are many more components involved in the Bay ecosystem than are involved in your body. Not only are there oysters and striped bass but also underwater grasses, sediments, bacteria, birds, viruses, chemicals and, of course, humans, to name but a few.

There are many factors and variables that affect the functioning of the Bay, largely because it encompasses such an immense area. The Chesapeake Bay ecosystem includes the main part of the Bay (usually called the mainstem), more than twenty major rivers or tributaries, and all of the land which drains into thousands of creeks and streams feeding those tributaries. We call this vast drainage area a watershed. A look at a watershed map reveals what a huge area this is — some 64,000 square miles in six states: Maryland, Virginia, Pennsylvania, New York, Delaware and West Virginia, plus the District of Columbia.

A Timeline for the Clean up of the Chesapeake Bay:

1965 U.S. Army Corps of Engineers conducts major study of the Bay.

1966 Chesapeake Bay Foundation established as a nonprofit conservation organization committed to help "Save the Bay" through public education and advocacy.

1970 3.9 million people living in Maryland, 12.4 million in watershed.

1975 Senator Mathias tours the Bay and requests that EPA start a study of the Bay's problems.

1976 Six-year, 26-million-dollar EPA study begun.

1978 Chesapeake Bay Legislative Advisory Commission (CBLAC) — intergovernmental coordinating committee created to develop a method for managing the Bay's resources.

1980 Chesapeake Bay Commission created as an outgrowth of the CBLAC. Commission composed of ten state legislators from Maryland and Virginia who were responsible for developing a cooperative arrangement between the two states to clean up the Bay.

1980 4.2 million people living in Maryland, 13.4 million in watershed.

1983 EPA study completed.

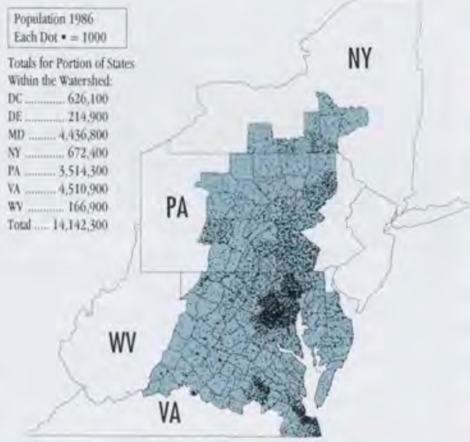
Making Connections

The Bay is an estuary, with a narrow connection to the open ocean. The entire volume of the water in the Bay is replaced about twice a year, not a very fast flushing rate considering the amount of materials that flood into the estuary from the land, the rivers and the air. In other words, the Bay often becomes a trap for most everything that enters it. Look once again at the watershed map and notice population density. It may be difficult to imagine the quantities of pollution produced by the more than 15 million people who live in this watershed. Try picturing how much waste comes from a single family, for example, and then imagine multiplying that by 4 million — each and every day. While more than 400 waste treatment plants in Maryland attempt to clean wastewater before it returns to the Bay, it remains difficult to halt the flow of nitrogen, phosphorus and chemicals into the estuary.

In a sense, we are altering the bloodstream of the ecosystem with nutrients and toxic chemicals and often overwhelming the natural ability of the Bay to deal with this imbalance. Toxic chemicals, such as petroleum products and pesticides, can poison the Bay in different ways. These chemicals may, for example, create a very thin microlayer on the water's surface. If larval fish ingest too much of a toxic substance as they feed and breathe in this microlayer, they will die.

Chemicals can also poison the Bay indirectly through a process called bioaccumulation. Bioaccumulation occurs when organisms low in the food chain — such as algae — ingest a toxic chemical and are then eaten by other organisms higher on the food chain, such as striped bass larvae. Because these larvae will eat a large number of the algae, they will accumulate the chemical in their tissues, thus magnifying the toxicity of the chemical. At some critical level, the chemical will become deadly or significantly impair the functioning of the fish.

Even in the absence of humans, estuaries are subject to a very slow, natural process, analogous to our aging process, called eutrophication. Natural eutrophication occurs over thousands of years and is characterized by increasing growth of algae and the gradual filling in of the estuary by sediments. With increasing human populations, enormous quantities of nutrients are released into the rivers from sewage treatment plants and from developed lands. Greater nutrient loading leads to greater numbers of algae that cloud the waters and fall to the Bay bottom. This process, a kind of rapid environmental aging, is called cultural eutrophication.



CHESAPEAKE BAY WATERSHED
Map compiled by S. Tennenbaum and R. Costanza
Chesapeake Biological Laboratory, University of Maryland, Solomons, MD

When cultural eutrophication occurs, algal growth is no longer in balance with the nutrients entering the estuary. More algae are produced than the estuary can absorb, so the excess algae falls to the bottom; there they are broken down by bacteria. This process of decay uses up valuable oxygen, robbing it from other organisms, such as oysters and fish. The Bay's bottom waters may then suffer from hypoxia, a lack of oxygen, or even anoxia, the complete absence of oxygen. The reduction or absence of oxygen is one major symptom of ill health in the Chesapeake Bay.

In the words of Senator Gerald Winegrad, a Maryland legislator long concerned with the environment, "The heart and lungs of the Chesapeake Bay are the wetlands and forests." Think about the basic functions of our circulatory system, heart, lungs and liver, and then consider how different parts of the watershed may serve particular functions in the Bay ecosystem.

The Search for Environmental Health

In the 1970s and early 1980s, many citizens in the Chesapeake region began to realize the toll human activity had taken on the Bay, and many argued that something had to be done immediately to improve the Bay's health. Scientific studies helped confirm the fact that what we were doing on the land was affecting the health of the Bay's ecosystem. In addition to increased nutrients, greater numbers of people in the watershed also meant the development of land for homes and businesses and shopping malls. This led to the destruction of forest lands, which help to absorb rainfall and runoff, and to an increase in the erosion of soil from construction sites.

Maryland joined the other states in the Bay region to launch far-reaching initiatives to address these problems. One primary Maryland initiative, the Critical Area Program, addresses an important cause of the Bay's problems: the unplanned use of land near the water's edge. The Critical Area Law works by closely managing development in the sensitive 1000-foot-wide strip of land surrounding the Bay. This strip is critical because it is the interface between land and water — it acts to filter pollution running off the

1983 December, first Chesapeake Bay Agreement signed by Maryland, Virginia, Pennsylvania, Washington, D.C. and the EPA. The agreement is considered a compact between all the parties.

1984 Critical Area Law enacted and several other clean-up initiatives launched.

1985 State of Maryland releases its Restoration Plan, aimed at "restoring and maintaining the Bay's ecological integrity, productivity, and beneficial uses and to protect public health."

1987 New Chesapeake Bay Agreement signed by Maryland, Virginia, Pennsylvania, Washington, D.C., the EPA and the Chesapeake Bay Commission. This agreement extends and expands the 1983 compact and calls for more specific goals to be reached by specific times. For example, a 40-percent reduction of nitrogen and phosphorus is to be achieved by the year 2000.

1988 The Year 2020 panel releases its findings on the effects of increased population growth within the watershed on the Chesapeake Bay and makes recommendations to avert further adverse impact on the Bay's water quality.

1990 4.7 million people living in Maryland, 13.8 million living in watershed.

1991 Chesapeake Bay Growth and Preservation Act presented before legislature. This is the first bill to address statewide growth management and to focus on growth as the Bay's number one problem. The bill was not passed but was deferred for further study.

land, and provides habitat for many important species in the Bay. To protect the health of the Bay, it was argued, we must protect its most vulnerable parts.

Another important step toward improving the health of the Bay was the commitment to reduce nutrients (especially nitrogen and phosphorus) pouring into the estuary. Initial plans called for a 40-percent reduction of nutrients, and the strategy for achieving this goal was, first, to reduce point-source pollution — that is, pollution coming from specific points, such as sewage treatment plants — by improving and building more treatment facilities, and, second, to reduce nonpoint-source pollution. Nonpoint-source pollution comes from widespread sources such as fertilizers on suburban lawns and farm fields, animal wastes on farm lands, and even acid rain. The Bay states agreed to work toward reducing these kinds of nutrient overloads in the Chesapeake.

Restoring the health of the Bay will mean cutting down the amount of nutrients and toxics entering the system. It will also mean the restoration of species such as the oyster, which can help clean the water and play an important role in the Bay's ecological balance. Any final definition of environmental health will have to include the word "balance." When the Bay is healthy, the activities of plants and animals fit together in a web of beneficial interrelationships which have evolved over geologic time. When these relationships are disturbed, the ecosystem goes out of balance — and that is when the Bay's health problems begin.

How Does an Environmental Bill Become a Law?

Environmental laws take a very long time to become enacted by the state or federal government. This is because lawmaking is a political process, where legislators have to be convinced by the general public that a problem exists and that some remedial action should be taken. What often takes a long time is convincing the public that there is a problem with the environment. One of the major roles of science in society is first to identify ecological problems and then to help communicate these problems to the public.

Once legislators are convinced of the value of a bill, the bill must pass through both the House and the Senate. In Maryland, environmental bills will generally be handled by the Environmental Matters Committee in the House and by the Environmental Affairs Committee in the Senate. Once passed by the committees, the bills are voted on in the full House and Senate. If passed, the bill is then signed into law by the governor.

The Critical Area Law is an example of an innovative environmental law passed by the Maryland General Assembly. This law was the result of a process which took approximately ten years, from the time scientists and others realized there was a eutrophication problem in the Bay to the enactment of the legislation. The process started during the early 1970s, when people began to recognize the Bay's poor health and realized that something had to be done. Around this time, Charles Mathias, a concerned U.S. Senator from Maryland, toured the Bay with his family and several other legislators. The senator was so upset by the deteriorating condition of the Bay that he began work immediately to seek funds for the Environmental Protection Agency (EPA) to study the Bay's problems.

In 1976, the EPA started a six-year, 26-million-dollar study to determine the major problems facing the Bay's health. Nutrient overenrichment or eutrophication turned out to be the major cause of the Bay's deterioration, and scientists concluded that many of the nutrients were coming from nonpoint sources (such as farm fields) and from wastewater treatment plants. The study pointed out that many of the Bay's problems, particularly the nutrient problem, resulted from the large number of people living in the watershed.

In 1983, the governors of Maryland, Virginia, and Pennsylvania and the mayor of the District of Columbia signed an agreement aimed at cleaning up the Bay. Maryland's governor at that time, Harry Hughes, decided that the most important step the state could take would be to protect the fragile coastal zone along the Bay and its tributaries. This margin is important because it acts as a filter for nutrients and chemicals running off the land. Shallow waters along this coastal border also serve as home and nursery ground for fish, crabs, birds and many plants. While people like to build homes on waterfront lands to have access to the water, enjoy the view and experience the diversity of wildlife by the Bay, too many people living along the water can destroy the very environment they came to enjoy.

The idea behind Maryland's Critical Area Law was to protect the shoreline's important "filtering strip" and to preserve sensitive habitat. Many concerned citizens lobbied for the law, helping to convince their state senators and delegates to support it in the legislature. Like all state laws, the Critical Area Law had to pass a rigorous round of debate in the Maryland House of Delegates and Senate. In 1984, the Maryland General Assembly passed this progressive bill, and the Critical Area Act became law, giving Maryland an important regulatory tool in the effort to protect the Chesapeake Bay.

Vocabulary

Bioaccumulation — the accumulation of a toxic pollutant in a higher-level organism, such as a fish, due to the magnifying effects of the food chain.

Ecosystem — an ecological unit consisting of a community of plants and animals and their interactions with the surrounding environment, including the climate.

Eutrophication — the nutrient overenrichment of an estuary due to human influences causing a lack of oxygen in the bottom waters of the estuary.

Hypoxia — a lack of oxygen. (Anoxia is the complete absence of oxygen.)

Watershed — the land and waters which drain into a river or estuary.

Do You Know?

- What is a healthy ecosystem?
- What do striped bass and oysters have to do with a healthy ecosystem?
- What are some examples of actions we are taking to lessen our impacts on the environment?
- How might our own health be dependent on the health of the Chesapeake Bay?
- What do you want the environment to be like in 30 years?
- How are humans affecting the Chesapeake Bay ecosystem?

"The Future of the Chesapeake Bay"

What will the Bay look like in the future?

Will it be a "live" body of water, with oysters and crabs, striped bass and shad?

Will it be "healthy"?

In one sense, the Chesapeake's future looks bright. Never before have so many programs focused on the restoration of the Bay. Citizens are planting trees and taking water quality measurements. Farmers are using careful management to keep excess fertilizer out of the Bay. A range of state and federal laws aim at reducing pollution from industry and waste treatment plants.

But the Chesapeake faces some very large challenges as well, including acid rain and overfishing. Of all these challenges, population growth may prove the most difficult to address.

Growth in the Bay Region

During the Revolutionary War, when George Washington travelled through Annapolis, about 500,000 people lived in Maryland. In the two centuries that have passed since, Maryland's population has grown almost ten times. Now 4.7 million people live in the state, and according to predictions by the Maryland Office of Planning, another 800,000 or more will settle in Maryland by the year 2020. Maryland's growth illustrates change throughout the Chesapeake region. Today, nearly 14 million people live in the Bay's watershed; that number is expected to top 16 million by the year 2020.

As population has risen in the watershed, both land and water have felt the effects. Forest and farm lands have been lost to development, and the Chesapeake Bay's underwater meadows of aquatic vegetation have died off, largely due to too many nutrients entering the estuary. As the underwater grasses have dwindled, widgeons and other diving ducks that grazed on the grasses have also gone. Rising population has also meant heavy harvesting of the Chesapeake's fisheries, such as oysters, which already feel the strain of turbidity and disease.

Unfortunately many other changes have happened at rates even greater than population growth. In 1970, for example, Marylanders owned 1.4 million cars, enough to stretch end-to-end across the entire continent. By 1988, that number had risen to 3.4 million. Our highways have felt this congestion. On the Washington beltway, for example, average speeds dropped from 47 mph in 1981 to 23 mph in 1990, according to some estimates.

Washington is becoming a big town. It is the nation's eighth largest urban area — if merged with Baltimore, it would become the fourth largest. During the 1980s, D.C. experienced a 20 percent growth spurt, and grew faster than all but two of the nation's 10 largest cities (Los Angeles and Miami). This growth rate was more than twice the overall national rate of 9.8 percent.

All those people need places to live. And many people in the region want to live away from the city, on their own piece of land. When land is used for houses, it is no longer available for farming or for forests. Between 1954 and 1990, the number of farms in Maryland declined by 50 percent. During that same time, some 39 percent of the state's farm land acreage was converted away from agriculture, largely into development. Across the nation, over 3 million acres of agricultural land are permanently converted to other uses every year.

The Challenge

Here is the challenge. What is the best way to accommodate this population growth, so it has the least effect on the state's environmental health?

Planners like Randall Arendt at the University of Massachusetts have some suggestions. The biggest problem, according to Arendt and others, is the way we divide the land. "Conventional zoning," he says, "leads to three things: development, development, and development." Arendt feels that we suffer from a lack of imagination. Developers divide rural lands into squares or rectangles, completely changing the landscape and consuming large amounts of land, especially agricultural land.

Using an approach he calls "creative development" or "open space development," Arendt and his colleagues leave many farm fields in place. He does this by tucking houses along the treeline, sometimes clustering them fairly close together. The fields remain largely intact, often protected through agreements which guarantee that they will be permanently preserved as open space.

The State of Maryland, understanding that rural lands are disappearing at an alarming rate, has suggested a number of growth controls. The main goal of these controls is to guide development toward areas which already have some development and away from farmlands and other natural areas. But not everyone favors this ap-

The region's population at a glance:

	1990	2020 (projected)
Maryland	4,666,200	5,496,600 (18% increase)
Virginia	4,726,000	6,229,800 (32% increase)
Pennsylvania	3,570,700	3,854,500 (8% increase)

Source: Maryland Office of Planning

proach. Some landowners are afraid that these controls will take away their ability to exercise their freedom of choice — to sell agricultural land for development, for example, if they choose to.

Some states, such as Florida, Georgia and Oregon, have already passed growth control laws. No one is certain yet exactly how Maryland or Virginia will deal with the growth issue. At present regulations which encourage, discourage, or guide growth are largely formed at the county level. Some counties have passed strict rules about development; other counties have not focused their attention on the growth issue.

Beyond the loss of oysters and other Bay species lies another threat, and that is the loss of the way of life we have come to associate with the Chesapeake Bay.

The Future

What the Chesapeake Bay looks like in the future will be determined by two processes, one natural and one man-induced.

Natural processes will eventually change the Bay, as they have in the past. The Bay will not be "sick"; it will just be different. Sediment will gradually fill in tidal flats and tributaries. If the world's sea level continues to rise, more marginal lands will be flooded. If the world's sea level begins to drop, the Bay will gradually become a river again (the Susquehanna River), flowing seaward just as it has for most of the recent geologic past — for about ninety percent of the time, over the last several million years.

In fact, it is likely that the earth would slowly cool, heading toward its next "winter," its next ice age, except for one thing: human beings. Who would have thought that a creature much smaller than the elephant and much slower and weaker than the lion would have such a large effect on the planet? But we have. Because of our use of fuels — especially fossil fuels — we have, according to many scientists, added large amounts of carbon dioxide to the atmosphere. The carbon dioxide comes from every fire we make, whether in our fireplaces or in the engines of our cars and trucks. It comes from industry smoke stacks and from coal-burning power plants.

Because carbon dioxide holds the radiant heat of sunlight, it acts like a large blanket — or, as commonly said, like a greenhouse. If this greenhouse effect warms our climate, then sea level will likely rise, as some of the earth's ice melts, and as the molecules of the warming oceans expand.

These changes could have definite long-term effects on the Chesapeake Bay, but the Bay faces other problems in the short term. Nutrients — from farm fields, from sewage, and even from polluted rain — have already overenriched the Bay. Without better control of these nutrients, declining water quality will undoubtedly have a harmful effect on oysters, on underwater grasses, and on other bottom-dwelling species, including certain fish.

At the same time, all the chemicals we allow to wash into the Bay — from engine oil to household cleaners to industrial effluents — threaten to harm the health of the estuary. Scientists are still studying the effects of this seemingly endless list of chemical compounds, and they are still trying to understand precisely how these potentially toxic substances affect life in the Bay.

And beyond the loss of oysters and other Bay species lies another threat, and that is the loss of the way of life we have come to associate with the Chesapeake Bay. As the health of the Bay declines, we lose the seafood it has provided for centuries. We lose the watermen that make their living from the Bay, and the Bayside towns and communities where they make their homes. We lose the character of the landscape, of the slit-sided tobacco barns and the quiet creeks surrounded by farm land. In some sense, we lose the Chesapeake Bay itself.

What Can I Do?

The Bay's problems are the result of all of the combined activities of everyone in the watershed and beyond. Each one of us has to make a concerted effort to respect the Bay as a living system and to be aware of how we can improve the Bay's health. Someone has to defend the Bay, since it can't defend itself. In defending the Bay, you may have to be courageous. You may have to pick up trash you did not create, or ask one of your friends not to do something stupid — like dumping car oil in the gutter. You can help solve the major problems of the Bay through your everyday actions. There is something you can do to help alleviate each one of the Bay's major problems that have been identified in this booklet.

Eutrophication— To help keep nutrients and sediments out of the Bay, plant trees, shrubs and grass around your house or school. These plants help the Bay by filtering out nutrients and toxic substances running off the land. They also hold the soil in place and prevent sediment from eroding off the land and running into the Bay. Do not overfertilize the lawn or garden. Water your garden or lawn in the evening to reduce evaporation. Conserve water, especially in the bathroom and kitchen, and (if you have one) make sure your septic tank is working properly.

Land Use— Help keep the land vegetated. Avoid needlessly cutting down trees, especially along streams, ponds or the Bay, where trees serve as useful filters and help prevent erosion. Avoid riding dirt bikes and mountain bikes off the trails, which can destroy vegetation. Remember, recycling helps keep paper, aluminum and other materials out of landfills, while conserving natural resources.

Overfishing— If you fish or crab in the Bay, don't waste your catch. If you're not going to eat them, release fish and crabs back into the Bay. (This is especially important during the spawning season.) If you have crabpots, tend them regularly, so crabs don't die in the pots. Be sure to remove the pots if you are not fishing them regularly.

Toxics— Dispose of household toxic waste properly—not down the drain. Avoid using herbicides and pesticides on the lawn and garden. Recycle your car oil and antifreeze fluid.

For more information write:

The Maryland Department of
Natural Resources
Tidewater Administration
580 Taylor Avenue
Annapolis, Maryland 21401

The University of Maryland Sea Grant Program
H. J. Patterson Hall
University of Maryland
College Park, Maryland 20742

The Maryland Watermen's Association
1805-A Virginia Street
Annapolis, Maryland 21401

The Chesapeake Bay Foundation
162 Prince George Street
Annapolis, Maryland 21401

The Alliance for the Chesapeake Bay
6600 York Road
Baltimore, Maryland 21212

Or call:

The Chesapeake Regional
Information Service
1-800-662-CRIS

Or contact your local representative to the General Assembly.

For Further Reading

There are, of course, many books and reports about the Chesapeake Bay. A few selected ones are listed here, but your local librarian will be able to tell you of many others.

Ecology and Geologic History

EPA. *Chesapeake Bay: An Introduction to an Ecosystem.* Washington, D.C., 1982.

Tom Horton. *Bay Country.* New York: Tickner and Fields, 1989.

Tom Horton and William Eichbaum. *Turning the Tide.* Washington, D.C.: Island Press, 1991.

J.R. Schubel. *The Living Chesapeake.* Baltimore: Johns Hopkins University Press, 1981.

Christopher P. White. *Chesapeake Bay: A Field Guide.* Centreville: Tidewater Publishers, 1989.

Fisheries and Watermen

Mick Blackistone. *Sunup to Sundown: Watermen of the Chesapeake.* Washington, D.C.: Acropolis Books, 1988.

Mark E. Jacoby. *Working the Chesapeake: Watermen on the Bay.* College Park: Maryland Sea Grant, 1990.

William Warner. *Beautiful Swimmers.* New York: Little, Brown and Company, 1976.

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