Contaminants and the Chesapeake

CHESAPEAKE BAY PROGRAM • FACT SHEET NUMBER ONE

Toward a Contaminant-Free Bay

Whether or not they live near the Bay's shores, whether they take seafood from its waters or simply care about preserving the Chesapeake's remarkable ecosystem, citizens of the Mid-Atlantic have made it clear that they want to see a Chesapeake Bay free of toxic contaminants. In 1994, their strong concern led the governors of Maryland, Virginia and Pennsylvania, the Mayor of Washington, DC, the Chair of the Chesapeake Bay Commission, and the Administrator of the U.S. Environmental Protection Agency to sign a pact calling for a "toxics-free Bay," one with no toxic or bioaccumulative impacts on living organisms.

Although the word "toxics" does not appear in the dictionary (see "A Toxics Primer" on page 2), it has come to stand for contaminants that are harmful to aquatic life — blue crabs, oysters, rockfish and other organisms that make up the Bay's complex food web. While numbers of compounds occur naturally (and in small amounts are important to the health of these organisms), others enter Bay waters as a result of human activities — in some cases they can be detrimental to fish and shellfish and, potentially, to human health. Fortunately, the 200-mile mainstem Chesapeake Bay, as well as hundreds of miles of rivers and streams, has remained relatively free of harmful contaminants. Nevertheless, three specific Regions of Concerns have been clearly identified as having significant problems — the Patapsco River, the Anacostia River and the Elizabeth River — and other rivers throughout the region show some evidence of contaminants.

Many of these chemical contaminants — especially in the three Regions of Concern — are part of a toxic legacy. Chemicals such as DDT, PCBs and chlordane have long been banned, but because they persist — especially in sediments — they have continued to re-enter the food web in these areas and to accumulate (bio-accumulate) in the tissues of organisms. Again, these effects are found in specific, localized areas, largely because of past practices.

In addition to the Regions of Concern, the Chesapeake Bay Program has launched a study to characterize the waters of the Bay as a whole, to determine whether there are other areas where chemical contaminants may pose a threat to the Bay's health. This characterization is helping the Bay Program as it works closely with citizens, businesses and other stakeholders to prevent unwanted contaminants from entering the Bay. Taking the lead for the Bay Program is its Toxics Subcommittee, specifically charged to examine and track contaminant issues, and to work with governmental agencies, academic institutions and others to further our scientific knowledge of how contaminants affect the ecosystem and to chart the directions we must take to restore and protect the ecological health of the estuary.

A Toxics Primer

Even the terms we use to speak about "toxics" can be confusing — and confusion often leads to miscommunication and misunderstanding. Consider the important but often poorly understood differences among the following terms.

Toxics. Although "toxic" appears in the dictionary as an adjective, it does not appear as a noun. This is important, because while an adjective describes the character or attribute of, say, a chemical compound, the term as a noun suggests that a compound is by definition toxic. For example, consider that oxygen is deadly for a number of microbial life forms (anaerobes, which once dominated the earth), but no one would describe oxygen as a toxic. The same point could be made about many chemicals in and around the Bay, and one might say that toxics are simply chemicals in the wrong place. It is therefore important to remember that calling a compound a toxic may be misleading, and that toxicity will depend on several factors:

- the concentration (dose) of a specific contaminant in a form determined to be "biologically reactive" in a particular environment
- how frequently an organism is exposed (exposure frequency)
- how long an organism is exposed (exposure duration)

Organisms will tend to vary in terms of their sensitivity to these factors, and their response may well depend on environmental conditions, such as temperature and salinity. While some potential contaminants are beneficial in small amounts — zinc is an example — others can be harmful even at very low concentrations, and these are thought of as being particularly toxic. EPA's action level for dioxin (TCDD), for example, is one part per billion.

Toxin. Although some may use the word toxin to describe toxic compounds in the open environment, the term more accurately refers to biological compounds found within an organism. Some marine organisms produce toxins, as defense mechanisms, for example.

Toxicant. This is the noun form derived from "toxic." It describes a compound or chemical that has been determined to be harmful to living organisms at certain known doses.

Contaminant. A contaminant is a substance or compound that has the potential to become toxic. Contaminants are often thought of as chemicals or compounds not found naturally in an ecosystem and which have the potential to cause harm to organisms or populations of organisms. Wastes from a variety of sources (both point and nonpoint) that cause deleterious effects in plants and animals are considered to be contaminants. In general, the words toxic and contaminant are used interchangeably, though as noted above, the word toxic is more properly an adjective, and the word contaminant a noun.

Chemical. The word chemical can be used to describe any number of compounds, though it is often assumed (at times incorrectly) that these chemical compounds are man-made and are harmful. The terms chemical and contaminant are often confused. Some chemicals are very toxic, of course, while others are very beneficial. Most medicines, for example, could be described as chemicals.

Compound. A compound is simply a combination of two or more elements (for a list of basic elements, check the periodic table in an encyclopedia or similar information source). Some compounds, such as H_2O (water), are life sustaining, while others may prove toxic at certain levels of dose and exposure, e.g., H_2SO_4 (sulfuric acid).

Pollutant. The word pollutant is not particularly scientific, and actually had a more moral sense in its first usage (e.g., "a polluted [tainted] soul"). A pollutant is now deemed to be any chemical compound that degrades the environment — by killing fish, for example, or causing disease. As with toxic or contaminant the term assumes that we already know that the compound is harmful.

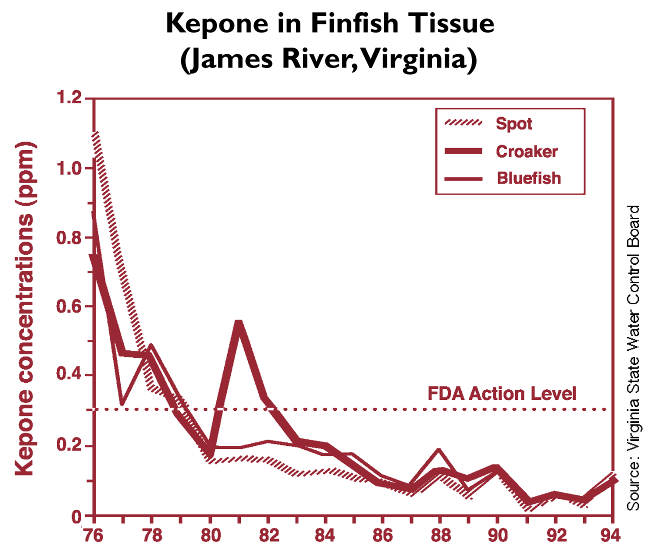
Given the complexity of terms, and the limits of our understanding of biology and chemistry, some have questioned whether the goal of a "toxics-free Bay" makes any sense. But if one understands that the word "toxics" does not stand for all chemicals but only those we know to be harmful at realistic and predictable doses and that "free" represents an objective toward which we are heading, then the term serves us as a goal. The main point here is that no one wants to put contaminants into the Chesapeake Bay. The great challenge before us is to continue to improve both our understanding of what "toxic" means and our techniques for preventing unwanted chemicals and compounds from entering the Bay or its watershed.

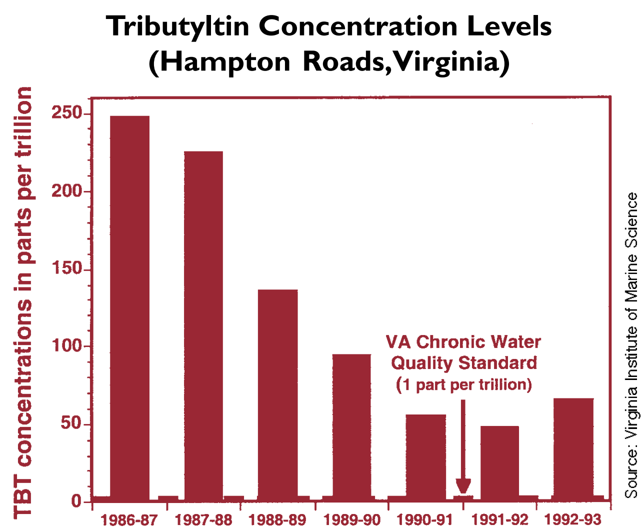
Understanding Contaminants

Understanding the behavior — not to mention the effects — of chemical contaminants in the Chesapeake Bay presents a complex challenge. Some effects are readily apparent, others are not. For example, careful monitoring and testing of fish and shellfish in areas suspected of having contaminant problems have led to fishing bans or consumption advisories in 21 areas throughout the Bay system. In 1999, for example, a PCB advisory was placed on a portion of the tidal Potomac River for channel catfish larger than 18 inches, and caution was also recommended when eating carp and eel. In 1998, Virginia designated a section of the lower tidal James River as "threatened" due to chemical contamination.

Other biological effects, however, are not so discernible. Researchers know that contaminants can affect organisms at cellular and molecular levels with possible impacts on the reproductive or immune systems of fish and shellfish. Contaminants can also affect fish and shellfish indirectly, by altering organisms lower down the food chain. For example, studies have shown that toxic metals such as arsenic, chromium and copper can alter the structure of phytoplankton communities. Recent experiments in the Patuxent River, for instance, have examined the effects of chronic exposure of phytoplankton to arsenic. Those studies found that while the total phytoplankton abundance remained essentially constant, a smaller arsenic-resistant species was better able to survive. This subtle shift in phytoplankton populations subsequently led to a decline in copepod survival and reproductions, thus potentially affecting the food web as a whole.

Although researchers are making impressive progress in uncovering these and other effects of toxic substances, it is clear that the array of chemicals entering our waterways can stress the fabric of the ecosystem in countless, often unpredictable, ways. Thanks to federal legislation and the region-wide restoration effort now underway, considerable progress has been made in controlling chemical contaminants, but effective control and prevention depend on the best understanding possible of where these contaminants originate and how to reduce them — preferably at the source.



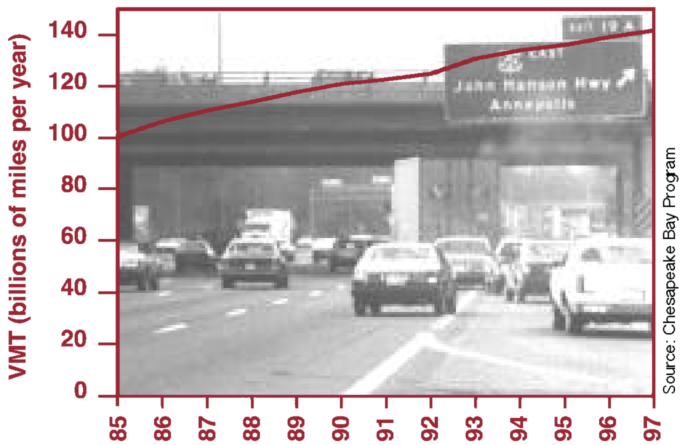


Concentrations of Kepone in the James River and tributyltin in Hampton Roads have dropped significantly since actions were taken to restrict their use. Fishing bans in the James were lifted, though a fish consumption advisory remains because a few fish still show concentrations above the FDA action level. While tributyltin concentrations are below EPA's acute water quality criteria, they still register far above Virginia's chronic water quality criteria of 1 part per trillion.

Contaminants and Their Sources

Whenever we mow our lawns, drive our cars or throw away unused household chemicals, we face the potential of adding airborne or waterborne contaminants to the Bay. Multiply such compounds by millions of citizens in the watershed,

Estimated Vehicle Miles Traveled



and the resulting flows can become considerable. For a long time, the impacts of diffuse or (non-point) flows seemed relatively small compared with those released by industry, whether through factory discharge pipes, smoke stacks or stormwater runoff. Even now, discharges from a single industry account for the highest source of metals to the Patapsco River, while nearly 90 percent of the metals in the Elizabeth River derive from industrial urban runoff.

Large industries and waste treatment plants represent activity on a concentrated scale. Though reducing contaminant discharges from these sources may sometimes be costly, they can generally be undertaken with more efficiency than reducing flows from diffuse sources such as farms, highways and suburban developments. Specifically, these "point sources" are required to monitor their discharges to water and are prohibited from discharging chemicals that they add in concentrations known to be toxic.

Because of the *Clean Water Act*, the *Clean Air Act* and other targeted efforts to curb industrial pollution, contaminated effluent has in fact dropped dramatically. Such reductions do not imply that industrial effluent is "toxics-free" by any means, but impressive headway continues. Between 1988 and 1997, for example, industries in the Bay region reduced releases and transfers of chemical contaminants by some 67 percent. The goal is to emphasize long-term voluntary pollution prevention by industry in the effort to reduce contaminant releases to zero.

At the same time that large industrial sites have decreased both production levels and outputs of potentially toxic compounds, diffuse sources of chemical contaminants have continued to increase, especially as population grows in the Chesapeake Bay watershed (now more than 15 million people). These nonpoint sources are much more difficult to control, since there are few permits or other regulatory limits on many of these activities, some of which are simply part of daily life.

Cars and trucks, for example, release significant amounts of contaminants that enter the Bay's ecosystem, whether in the form of gasoline or oil on the roadway, nitrogen oxides and hydrocarbons from exhaust fumes, or particulate matter from tires and brake linings. While tightening automotive emissions standards has significantly decreased pollution from individual vehicles, increasing numbers of cars on our highways have kept overall emissions nearly constant nationwide, and escalated pollution in many population centers.

The pressing question that jurisdictions in the Bay region continue to face is how to effectively check this rising input from nonpoint sources of contaminants when they enter the Bay system in so many ways — by land, by groundwater and from airborne deposition. At the same time, how can we be certain which contaminants and which sources are causing the biggest problems? The answers to these questions are crucial for developing a set of priorities that will enable government agencies, communities and citizens to manage and curtail major pollutants.

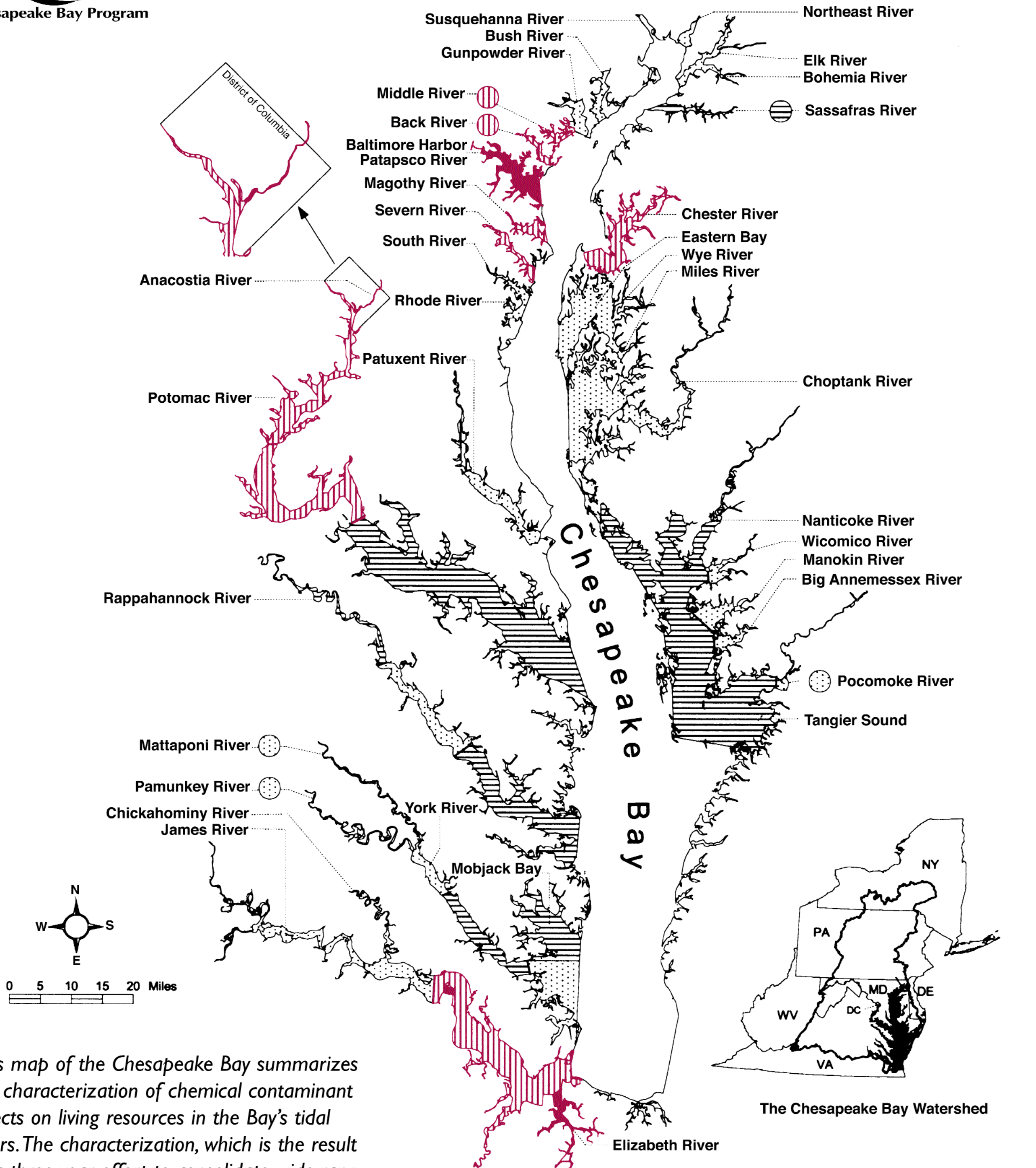
Assessing Our Rivers for Contaminants

Eliminating the biological impact of chemical contaminants resulting from human activities forms a major goal of the Chesapeake Bay Program. To provide a clearer picture of contaminants throughout the Bay, the Bay Program has published *Targeting Toxics: A Characterization Report*. This toxics characterization consolidates data previously collected by various groups, including federal and state agencies, research institutions, and Bay Program-funded monitoring activities. The information it provides is vital not only for highlighting troubled and threatened waterways, but also for identifying the areas that, so far, have received scant attention.

Included in the study are 27 tidal rivers — each divided into geographical segments that share general attributes. While the smaller western shore

Status of Chemical Contaminant Effects on Living Resources in the Chesapeake Bay's Tidal Rivers

Chesapeake Bay Program



This map of the Chesapeake Bay summarizes the characterization of chemical contaminant effects on living resources in the Bay's tidal rivers. The characterization, which is the result of a three-year effort to consolidate wide-ranging information, identifies tidal river areas (not including the mainstem Bay) where contaminant effects on living resources occur or have the potential to occur. Human health impacts from contaminated air, soil and drinking water are not addressed here. (See Targeting Toxics: A Characterization Report *from the Chesapeake Bay Program.)*

- Region of Concern — area with probable adverse effects
- Area of Emphasis — area with potential adverse effects
- Area with Low Probability for Adverse Effects
- Area with Insufficient or Inconclusive Data
- Not characterized due to historically low levels of chemical contamination

rivers and most of the eastern shore rivers were considered as single segments, a number of the larger western shore rivers — like the Potomac and James — were divided into multiple segments, bringing the total number of segments in the report to 38. After weighing the chemical concentration and biological effects data available for each, researchers working with the Toxics Subcommittee assigned each segment to one of the following four categories, indicating the potential for impact on living resources:

1. ***Regions of Concern*** are river segments that have a an apparent chemical contaminant-related problem, including concentrations above thresholds associated with adverse effects and a high likelihood of negative impacts on living resources. The three Regions of Concern first identified in 1993 still remain: the Patapsco River, the Anacostia River and the Elizabeth River.

2. ***Areas of Emphasis*** are river segments that show signs of elevated chemical concentrations and/or adverse effects on living resources, but lack a clear link between chemical levels and observed biological impacts. Ten areas show significant potential for chemical contaminant-related problems.

3. ***Areas of Low Probability for Adverse Effects*** are those segments where contaminant levels fall below the thresholds associated with adverse effects and give no signs of contaminant-related effects on aquatic plants and animals. Eight areas appear unlikely to have chemical contaminant-related problems.

4. ***Areas of Insufficient or Inconclusive Data*** are river segments that have either not yet been studied, or where existing data are too old to reliably reflect current conditions. Twenty areas fall into this category.

A clear picture of the current status of all these tidal rivers is critical to understanding the scope of chemical contamination in the Bay system. The identification of *Areas of Emphasis* can highlight targets for monitoring and management, while *Areas of Insufficient or Inconclusive Data* can help focus monitoring goals for agencies and volunteer tracking efforts.

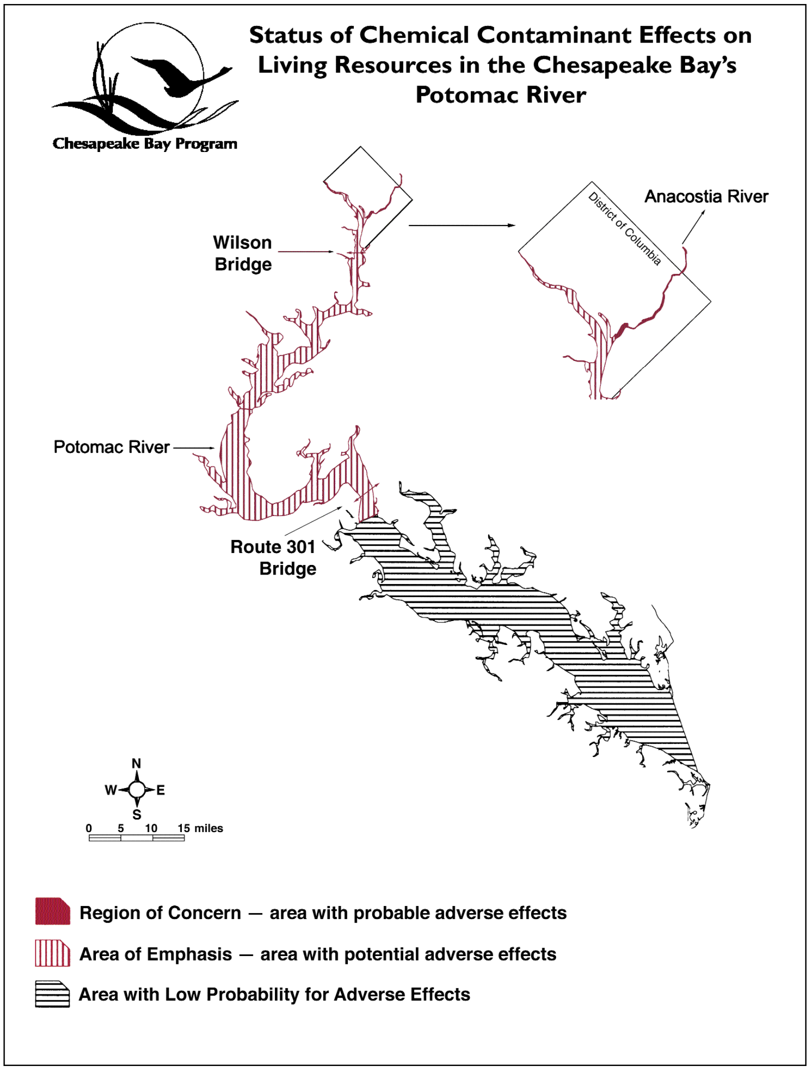
Looking Ahead

How are we to meet the goal of a Chesapeake Bay with no toxic impacts on the Bay's living resources? Government regulation is one means — in numbers of cases, regulatory actions have met with evident success. For example, the U.S. EPA's mandated phase-out of leaded gasoline has led to demonstrable declines in emissions, which are evident in Chesapeake Bay sediments, while the ban on Kepone in 1975 resulted in steep declines of the contaminant in fish tissue.

On the other hand, while restrictions on tributyltin (used in antifouling paints) have led to its reduction in the Bay, levels remain high enough to pose a risk to organisms such as plankton and shellfish. The issue is more complicated for compounds such as PCBs and DDT, chemical contaminants that do not break down easily in the aquatic environment. Recycled through the food web, they persist in some regions of the Bay system, presenting difficult challenges on how best to remediate their impacts.

Continued research and monitoring are critical for a clearer understanding of how chemical compounds move through food webs and how that movement is influenced by shifting environmental conditions such as seasonal changes in temperature, salinity and oxygen levels. Armed with the understanding that such research provides, management agencies can better identify specific contaminants that have the most significant impacts on living resources and thus prioritize monitoring and restoration efforts.

Anatomy of a River: The Potomac



Winding down from the Appalachians, and draining waters from four states and the District of Columbia, the Potomac River — now named an American Heritage River — helps to define the region. The tidal Potomac, from the fall line to the Bay, provides a prime example of the range of water quality conditions found in a single river. From the troubled waters that flow through the densely populated portions of Maryland, Virginia, and Washington, D.C. to the healthier waters of the lower Potomac, a trip down this historic river reveals the kinds of impacts we have had on the rivers that flow to the Chesapeake.

Targeting Toxics: A Characterization Report lists the upper tidal Potomac above the Wilson Bridge as an impaired stretch of river, with elevated levels of PCBs, a variety of metals, and other contaminants that likely derive from diffuse sources such as stormwater runoff. Problems persist in the middle Potomac, the river segment that stretches from the Wilson bridge to just beyond Route 301, near Morgantown, Maryland and Dalgren, Virginia. Both the upper and middle segments of the river are designated as *Areas of Emphasis* because of the significant potential for contaminant-related problems. In the lower Potomac, the river begins to improve. With the exception of a few localized regions along the southern Virginia shore, there are no indications of elevated levels of contaminants that adversely affect aquatic life. For this reason, the lower Potomac, the largest of the river's three segments, is classified as *An Area of Low Probability of Adverse Effects* — though some point out that additional data is needed to develop a more detailed and confident characterization. Not every river has been as well studied as the Potomac, and many segments have been designated as *Areas with Inconclusive or Insufficient Data.*

Management agencies and the public can use the characterization of these rivers as a starting point to identify areas that need monitoring in order to evaluate the effects of contaminants on living resources. *Targeting Toxics* can also help citizens focus actions on specific goals, such as developing watershed groups to call for better management of chemical contaminants and defining specific pollution prevention goals in local areas.

Still, government regulation alone will never be sufficient to meet the goals of the Chesapeake Bay Program, goals that continue to have wide public support. Success will depend on considerable citizen efforts to prevent controllable contaminants from entering our creeks and streams and rivers in the first place — stopping potential pollutants at their sources offers the best chance for restoring the Bay's healthy waters and sustaining the kind of aquatic life that most citizens identify with the Chesapeake.

Already a number of successful efforts are underway, including:

- *Businesses for the Bay* and various "green" actions taken by some industries,
- Superfund and military base cleanups,
- Best management practices by many in the agricultural community,
- Pretreatment of municipal wastes in some areas,
- Grassroots actions by local watershed groups.

To actively undertake voluntary actions and to continue supporting policies aimed at protecting the ecological health of the Chesapeake, citizens will have to better understand the real costs of a degraded Bay system — not only the loss of aquatic resources, but the more intangible effects on quality of life. There is ample evidence in recent years that the public will support new approaches to environmental cleanup that may have previously seemed unlikely — the acceptance of unleaded gasoline, the banning of environmentally damaging pesticides and the receptivity to recycling are only a few examples. While research and monitoring are critical for improving our knowledge, the ability to communicate these findings in ways that all citizens can appreciate and respond to may prove one of the most complex challenges ahead.

For Further Information

Citizen participation remains the key to the cleanup of the Chesapeake. For specific suggestions about what you can do to keep contaminants out of the Bay, visit the web sites listed below, or call 1-800-662-CRIS.

This fact sheet on contaminants and other Bay-related issues is available from all the Chesapeake Bay Program's state and federal partners: Pennsylvania, Maryland, Virginia, Washington, D.C., the Chesapeake Bay Commission and the U.S. Environmental Protection Agency, the lead agency for federal Bay Program participation. Through the Bay Program homepage you will find links to numerous local, state and federal agencies, as well as nongovernmental groups, *Businesses for the Bay* and other pollution prevention programs. Or write the Chesapeake Bay Program, 410 Severn Avenue, Suite 109, Annapolis, Maryland 21403.

Selected Web Sites

Chesapeake Bay Program
http://www.chesapeakebay.net

Maryland Sea Grant
http://www.mdsg.umd.edu

Alliance for the Chesapeake Bay
http://www.acb-online.org

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Chesapeake Bay Basin Toxics Loading and Release Inventory. 1999. Chesapeake Bay Program CBP/TRS 222-100 (EPA 903-R-99-006). Annapolis, Maryland.

Credits

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Contaminants and the Chesapeake Bay is a joint effort of the Maryland Sea Grant College and the Alliance for the Chesapeake Bay, supported by the Chesapeake Bay Program's Toxics Subcommittee.

Maryland Sea Grant College Program
Publication UM-ES-2000-05
April 2000

Sea Grant

A Maryland Sea Grant Publication
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