CHESAPEAKE PERSPECTIVES

INQUIRY IN A CULTURE OF CONSENSUS

Science and Management for the Chesapeake Bay

William Matuszeski

Sea Grant
A Maryland Sea Grant Publication

C H E S A P E A K E
PERSPECTIVES

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The ideas and opinions expressed in this monograph are entirely those of the author and do not necessarily represent the views of the Maryland Sea Grant College, the University of Maryland, or the National Oceanic and Atmospheric Administration.

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Preface

Each and every day natural resource managers responsible for the health of the Chesapeake Bay make difficult decisions, and they often make them in the midst of considerable uncertainty. In this monograph, former head of the joint federal-state Chesapeake Bay Program, William Matuszeski, draws on his experience to explain how scientific information, scientific uncertainty, and the search for consensus have shaped Bay policies. These observations highlight the difficulty of science-based decision-making in the face of ecological complexity.

As they work to provide policymakers with the information they need to manage coastal ecosystems, scientists must interpret complex, often non-linear patterns in the environment. It is, of course, impossible to model fully all the processes that drive ecosystem function and — more importantly — to predict the pathways that ecosystems are likely to take in response to certain changes, such as an increase or decrease in nutrient loads. Considerable uncertainty is a given in Bay policymaking, an inherent part of the dynamic interaction between scientists and decision-makers. This is particularly true when decisions cry out for specific cause-and-effect relationships — for example, the cause of reproductive failure of an important commercial species or the presence of toxic compounds in areas far from obvious sources. Complicating our attempts to understand the biological and physical aspects of ecosystems are human actions — the socio-economic and cultural drivers that define how we collectively interact with the natural world.

Experts recognize two linked approaches that can help shape — or reshape — the management of complex ecosystems like the Chesapeake Bay. These are ecosystem-based management and adaptive management. We thought it might be useful to describe them here.

Ecosystem-based management challenges managers to address an ecosystem in a holistic fashion, considering not only biological and physical factors, but human drivers as well, including land use. While this poses a tremendous challenge, progress in implementing ecosystem-based management is evident across the United States and worldwide.[1] In broad terms, ecosystem-based management develops options that balance societal objectives with ecological (biological) constraints. Leading scientists and policymakers are in consensus that this approach must focus on actions that not only protect specific resources — like crabs or oysters — but also ecosystem structure, function, and processes. In addition, there must be recognition of the inherent place-based nature of ecosystems and of their interconnectedness within and among ecosystems and with the broader environment as a whole.[2] The Chesapeake Bay, with its recognized regional identity and its well-studied estuarine ecology, should be a strong candidate for this kind of place-based ecosystem approach.

Procedurally, ecosystem-based management seeks broad engagement of stakeholders in a collaborative, transparent decision-making process based on shared learning and mutual goals. Such engagement places a high value on a mutual understanding of the motivations of all stakeholders. It also values the different types of knowledge that groups and individuals bring — from detailed scientific understanding, to the reality of how management and policy are crafted, to experiential knowledge key stakeholders have gained over long periods. An important goal is to develop mechanisms that limit unidirectional knowledge transfer and emphasize co-creation of knowledge as management strategies are crafted.[3]

Implicit in this approach is the notion that management must be a sustained process. Over the last three decades a body of ecosystem management theory has emerged that embraces this idea — adaptive management.[4] Adaptive ecosystem management is defined as the development of policy through iteration and "experimentation" linked to clear assessment of outcomes. There is in this a focus on learning by doing.[5] Such experimentation can include "trial and error" approaches that attempt to learn from previous actions, "passive" adaptive management that relies upon more detailed historical analyses designed to yield a single (hopefully best) option for decision-makers, and "active" adaptive management where experiments lead to different options and an evaluation of the expected outcomes of each scenario.[6] It is important that management actions in this regard are not one-time approaches that lock managers and ecosystems in place. Rather in all these scenarios, there is a commitment to ongoing learning and course corrections as needed. Success ultimately depends on the quality of the decisions made and implementation that includes a commitment to monitoring and evaluation of outcomes.

Does the management of Chesapeake Bay and its watershed represent a viable example of ecosystem-based management and adaptive management?

Many have considered the Chesapeake Bay Program a powerful model, given its robust structure and long-term regional commitment from government, managers, scientists, and diverse publics.[7] According to some experts, however, long-term success in achieving restoration goals will depend on greater integration of science and management in the practical dimensions of ecosystem-based management.[8] Implementing these practical outcomes may present systemic challenges to the current organizational structure.

The adaptive management approach that underlies ecosystem-based management could provide a framework to evaluate not only the outcomes of management actions but the structure of management bodies as well. Commitment to organizational and institutional evaluation is key in moving along a path of adaptive management, as is a willingness to work for more effective management structures. There is evidence that leaders of the region-wide effort to restore the Bay are willing to re-evaluate the program's organizational architecture and to adapt new, perhaps more responsive, approaches.

In the following essay, those concerned about the future of Bay management will find some very important lessons learned. These experiences will no doubt help guide us toward the goal of consensus-based decision-making in the face of inevitable uncertainties.

— Jonathan G. Kramer and
Jack Greer, editors

Inquiry in a Culture of Consensus

Science and Management for the Chesapeake Bay

Management Based on Sound Science — Compass or Label?

Probably no other estuary has been subjected to as much scientific study as the Chesapeake Bay. It was here that the natural forces at work in an estuarine system — the movement of warmer fresh water down the Bay and overtop colder saltier water flowing up, and all the associated mixing and stratifying and gathering and spreading out of the waters — were first understood.[1] And it was here that the sources of all the troubles being experienced by estuaries around the world were unquestionably tied to the excess of sediments and nutrients running off the land and (in the case of nitrogen) discharging from sewage treatment plants and settling out of the air — all moving down the rivers to the Bay.[2] Over the decades the Bay has provided a great outdoor laboratory for scientific investigation, from basic understanding of estuarine processes to the most practical applied research.[3] And there has been a large scientific support function tied to the concrete restoration efforts of the states and the federal government.

In addition to this scientific attention, few other places have had the long-term attention of politicians and government managers assigned to carry out the cleanup. For nearly thirty years, the U.S. Congress and the legislatures of the states around the Bay have provided funds to determine what is wrong with the Bay and to then fix it. And for nearly twenty-five the chief executives of each of the state and federal partners have met regularly to measure progress and to recommit to the cause of a restored Chesapeake.

A word or two on the organization of the Chesapeake restoration effort for those not familiar with it. The governing board of the cleanup is the Chesapeake Executive Council, comprised of the Governors of Maryland, Pennsylvania, and Virginia, the Mayor of the District of Columbia, the

Administrator of the federal Environmental Protection Agency, and the Chair of the Chesapeake Bay Commission, a tri-state body composed primarily of state legislators. A couple of things that are special about this Council: it meets annually and the principals actually attend; and part of the meeting is a private session where the six sit alone to make decisions and issue Directives (quasi-executive orders) about actions required or goals to be achieved. In other words, they have to know what is going on and what they are committing to. All other committees, subcommittees, workgroups, and other entities in the Chesapeake Bay Program report to the Council, as do three advisory committees (comprised of scientists, citizens, and local government officials) who have their own private meetings with the Council to provide their frank opinions.

The focus of this monograph is to examine how scientists and managers have learned to work together in this incredibly complex endeavor to improve conditions in the nation's largest estuary. This is not as simple as one might think, since scientists and managers approach problems and solutions with very different mindsets. In a few words, science is based on an open opportunity for inquiry, while management is engaged in the constant need to show progress, both to obtain recognition for success and to keep political support for the funds coming in.

The issue is further complicated in the Chesapeake by a decision of the Executive Council soon after it was formed in 1985 that the states and the federal government were going to work together on commonly agreed-upon goals and solutions, rather than engage in regulatory battles. Targets would be set and decisions would be reached based on a culture of consensus. Yet if that consensus is central to managing the cleanup, how can we be sure that the latest knowledge is being used? How can the spirit of scientific inquiry survive in such a culture? Doesn't the issue of seeking common ground run counter to the way science finds solutions through innovation and individual inspiration?

The goal of supporting both science and consensus has proven hard, and over the years, some lessons have been learned. From the beginning, the restoration of the Chesapeake was seen as different; this effort would be based not on the issues of the moment, but on scientific analysis of the entire set of interconnected issues that had led to the deterioration of the Bay's water quality and the loss of diversity in its fish and shellfish.[4] The keystone was a five-year study of the Bay to identify causes of decline, carried out from 1978 to 1983.[5] This steering away from speculation was very useful in the early years. It gave the scientific community more than a seat at the table; from the outset there was an understanding that the effort would be driven by what they found. Actions based on sound science became a touchstone.[6]

Those managers in charge of government programs that would carry out the Bay's restoration were to listen to what the scientists said before deciding what to do. This concept of "management based on sound science" seemed fair enough from their point of view. But the assumption of the scientific community that managers should wait until scientists knew for sure what was going on and were able to tell them what to do about it proved more difficult for managers to accept. How, then, could they show progress and continued public support, and thus be assured public funds? As the five-year study drew to a close, managers began to wonder how much longer the public would give them before demanding action.

The transition from research to nutrient reduction programs was slow and the reputation of the Bay Program in the 1980s was not good. It seemed strangled by science, unable to make decisions and using the taxpayers' money to simply do more studies.[7] Extensive monitoring programs were carried out along the lines recommended by scientists, and computer modeling efforts became more and more complex. But actions on farms and at sewage treatment plants were slow to get organized, and politically tougher areas like air sources of nitrogen and stormwater were essentially ignored.

Meanwhile, like many concepts developed by the Bay Program, managers and politicians elsewhere dealing with estuarine improvement began to repeat the words "management based on sound science" as a mantra, without necessarily adding any understanding to their meaning. Everyone found it easy to call for sound science before taking action. In fact, it was soon learned that this mantra could be used as a convenient label for inaction — the science is not yet "sound," whatever that means. Some of this was due to the high level of litigation in so much U.S. pollution regulation — the very reason the Bay partners had chosen the road of consensus. The question became, will the scientific basis of what is being required stand up in court? Those who oppose environmental initiatives of all types, from protecting the spotted owl to dealing with global warming have alleged the absence of "sound science." The label of "sound science" actually began to get a bad name.

Where did this leave the Bay? Fortunately, the emergence of some creative tension between science and management over the issue led to a reformulation. The issue became how to set timeframes and deadlines that the public could relate to in an area of scientific uncertainty. As "sound science" began to take on an unclear meaning at best, decisions at the Bay Program began to be based on using the "best available science." This made the scientists a bit nervous, but it served notice of the intention to proceed with the best science we have — assuming there is enough scientific agreement to move forward in some direction. As the managers put it, "The boat is leaving the dock; don't be caught with only one foot on board." As the scientists responded, "We need to be on board; if you have to leave, this is the best course, but we may have to correct enroute." In this way, the use of sound science remained a compass guiding the managers.

"Management based on sound science" may have become just a label elsewhere, something you could attach to any complex issue requiring some scientific knowledge. But it remains a touchstone in the Chesapeake, precisely because the tensions between science and management were largely worked out and the understanding reached that sometimes we must move ahead without all the answers, with assurances that course corrections can and will occur as we become more scientifically informed along the way. This relationship has evolved into an important part of the "adaptive management" approach used in the Chesapeake. As discussed below, adaptive management has become a popular way to describe what is going on in the Chesapeake Bay and other complex natural systems where humans are seeking to improve conditions, and the Chesapeake is often cited as a prime example. What is not often included in such analysis is an effort to identify how the region came to this approach and how regional culture plays a role. In the case of the Chesapeake, culture gives value to consensus over either conflict or keeping quiet; this is not true in some other places. At the same time, it is the inherent tension between scientific inquiry and the value given to consensus by the "Chesapeake culture" that has inspired the on-going dialogue between scientists and mangers and kept this conversation in the open.

Bay Restoration Takes Shape — 1978-85

"When science reigned supreme."

In the early years the Bay's deteriorating condition posed a real concern, with oyster and fish harvests plummeting, grasses disappearing, and increasing algae blooms killing off life in the water column and on increasingly barren bottoms.[8] Nobody seemed to know what was wrong and what was causing the decline — sewage, toxic pollutants, or what.[9] Led by Maryland's Senator Mac Mathias, Congress funded a five-year scientific study for a total of $28 million — a huge sum at the time for such an undertaking. It was these studies by top scientists within and beyond the region that pinned down the causes of the Bay's woes and set out an understanding of how complex estuarine systems actually worked. Researchers and managers established and broadened monitoring programs and applied the latest computer modeling techniques. They also offered the first estimates of the reduction in nutrient loadings would be needed to allow the Bay to recover. Looking back, those estimates were remarkable in their accuracy, despite intervening years of obfuscation and redefining by bureaucracy in an effort to avoid the implications. The estimates were not perfect; for example, they failed to calculate the importance of air as a source of nitrogen in coastal waters. But the major breakthroughs — understanding how the estuary functions as a system and understanding the role of excess nutrients — were lessons applied around the world.[10]

Enter the Politicians

It was time by 1985 to put together the strategy for restoration. At a meeting of the governors of Maryland and Virginia (Pennsylvania joined later),[11] scientists made their presentations of results. On nutrients, their best guess was that inputs needed to drop about 37 percent for the Bay to respond. In the first of many decisions over the years to pursue aggressive goals, the governors and the EPA Administrator agreed to focus on nutrient reductions and aim for a 40 percent reduction by 2000.[12] The states enacted programs to deal with agricultural and urban sources, and the federal government established the Chesapeake Bay Program Office under EPA to provide scientific and other support as well as a place for the partners and interested groups to come together.[13] The other critical decision was to proceed in partnership and to work outside and beyond the requirements of federal and state regulation, using those targets as a floor whenever necessary.

This led to the misconception that the Chesapeake Bay Program was entirely "voluntary." In a sense it was voluntary, but only in that the states and the federal government, who were the direct participants, had agreed to work together. The solutions they developed, however, were not limited to voluntary action by others, and in many cases led to new laws and regulations affecting local governments, developers, farmers, and sewage treatment plants, among others. The concept was further complicated because there was essentially no regulatory structure to deal with nutrients as pollutants, or to do much of anything with some of the most important known sources, such as agriculture. The problem was that the 1972 Clean Water Act focused on pathogens and toxics, and since nutrients and sediment had little if any apparent effects on human health, they were not considered important. Meanwhile the rivers and estuaries got sicker and sicker from sediment and nutrient overloads. Action was finally taken in the late 1990s to regulate nutrients, but the Chesapeake is one of the few places where the water quality standards were updated to make sense for nutrient loadings, as discussed below.

For state and federal partners, the decisions were to be made by consensus, not by votes or invocation of authority. And scientists did not have an absolute veto. Sometimes that consensus would prove difficult in the face of "sound science," and occasionally even the "best available science" was overlooked or "reinterpreted." As risky as that was, over time consensus-based decisions became central to the Bay culture, as well as a source of healthy tension between scientists and managers.

Scientific Method in a Culture of Consensus

The scientific method that serves as the objective basis for so many disciplines calls for constant inquiry, questioning of assumptions, and challenging accepted orthodoxy. In a complex restoration effort like that in the Chesapeake, how does one keep progress on track through consensus-based management, while maintaining and even improving the reputation of scientific work in the Bay? What happens when the accepted truth becomes subject to challenges by further research? How does one inspire young scientists when leaders set goals based on current "best available science" and focus all efforts on meeting them? What if further investigation proves the goals to be wrong? How does one get politicians and bureaucrats to admit they were wrong, even after they relied on the scientists to set the original goals? No easy answers.

Yet this conflict has not proven to be a show-stopper. Some Bay science has stayed focused in remote labs and places where observation, experimentation, modeling, and the challenge of accepted truth remain the norm. But not all science needs to be of this type. In the field of applied science there is a desire to focus on the results of science as they play out in the broader world. What is most important is that there be a recognition of the healthy value of ongoing tension between scientists and managers. In fact, part of the joy of working at the leading edge of restoration is understanding how to accommodate new information in ways that keep leaders and the public feeling that the boat is adjusting smoothly to the proper course.

The adaptive management approach, so broadly touted with the Chesapeake as an example, is what results from this interaction. Its key is in the give-and-take of science and management. If science is too remote or management too arrogant to engage the debate, it doesn't work. In other places, the system breaks down when disagreements lead to splits or to silence. Both are fatal to the adaptive approach. And it could be that the Chesapeake "culture of consensus" is part of what keeps everyone engaged.

Twenty-plus Years of Restoration Efforts

"We have to live with these other people."

What has happened in Chesapeake Bay is that scientists and managers have decided that they really need each other. So they have to stay in the room, bite their tongues, and learn to get along. What is amusing is that each group thinks they are the critical element and part of their job is to keep the other in check.

The Scientist's View

"We are managing the analysis of the Bay in order to manage the managers, so they do not screw up; this is the core of the restoration effort."

Scientists feel central to the Bay restoration effort. They have worked together over the decades and stuck together through good times and bad for the Bay. They come from academia, private institutes, and all levels of government. They play many roles: running the monitoring, modeling, data, and other programs at the Chesapeake Bay Program Office; working for state or federal agencies and playing keys roles on Bay Program subcommittees; acting as consultants, serving on the Program's Scientific and Technical Advisory Committee; carrying out research in scientific institutions in the region; and working in the Bay on behalf of institutions elsewhere.

All scientists at heart see that an important part of their role is keeping the managers and their politician bosses from making mistakes that will delay the cleanup or put it off course. To a greater or lesser degree, they seek to manage scientific information so that the managers do the right thing. They believe the key to the restoration is keeping managers from making mistakes and spending money on the wrong things.

Manager's View

"We are managing these scientists so they will finally come up with some answers we can use; this is just one important part of the overall effort."

Not all managers see scientists or even science as central to the Bay restoration effort. Some managers are themselves scientists and believe the role of science must remain paramount in assuring that the right decisions are met. But most managers rank science along with other elements such as assuring financial resources, setting understandable goals, getting the right messages out to the public to assure political support, etc. If asked, they will always say that the best available science underlies all the important decisions. But they are often occupied with other thoughts and priorities. The practical realities of running Bay-related programs in today's budget environment require managers to spend a great deal of time dealing with funding and personnel issues.

The complexity of interactions among regulatory, tax incentive, subsidy, and voluntary programs is increasing even as budgets and other constraints challenge their delivery and as people learn more about how to make them work together. And public interest and education consume large amounts of managers' time, especially as reporters begin to detect frustration and disappointment at the slow rate of progress.

In fact, managers generally view scientists much like they view reporters. Each has very important things to say to a broad audience, but neither can be trusted to say them the right way. With the scientists, managers fear that the search for "sound science" has come to signal a cause for delay until more is known. We can't do anything because we aren't sure what to do yet. Managers do not like delay; they always push for the "best available science" rather than "sound science."

Second, scientists are always a little untrustworthy in the eyes of managers because of their penchant to seek out the truth even after everyone has come to consensus. After the goal is set, often as a result of a bruising process, there is a fear that some scientist somewhere will find what he or she thinks is a better or more accurate way to characterize the issue. There is always more to be learned and therefore always a chance that the current course of action might need to be altered or even reversed after all the work that went into building consensus.

Third, there is this idea that scientists don't get the "big picture," namely the political factors that are pressing on the restoration program to get measurable results and to define the present as an improved condition over the past. Good managers know that the public is fickle and likes to be part of a winning team. So to keep them interested and supportive, leaders want the public to feel like they are winning. This concept is alien to the scientific psyche. Scientists presumptively are held by their code of conduct to a higher order of truth in the face of political reality, a situation that often causes tension with managers, who are "just trying to get the damn job done." At the same time, many realize that if the job isn't being done in a way that takes scientific knowledge into account, it might take longer, cost more, or even not be doable.

Lessons from Some Critical Chesapeake Decisions

There is no single formula to deal with the interaction of science and management. Sometimes the science is clear and compelling and the managers and politicians must simply accept it and live with it. Sometimes politics overrides science and pushes it out of the way as a hindrance to the need to decide now. Sometimes managers work their way around the science in order to keep trying to show progress. A few specific examples over the years from the Chesapeake will throw some light on this interaction between science and policy.

Nutrients Are the Problem

This was the major finding from the five-year scientific study of the Bay carried out from 1978-83.[14] It surprised many, who were convinced that the sources were pathogens from sewage or toxics from industry. It shocked others, especially the managers, who realized the means to reduce nutrients were expensive and difficult to track, and that major sources lay for the most part outside the regulatory structure — agriculture and stormwater runoff. In addition, since there were no known ties of excess nutrients in water to human health effects, generating political support would be that much more difficult. After all, the lack of adverse impacts on humans underlay years of inaction by EPA to deal with nitrogen and phosphorus as pollutants.

Yet the science was convincing. Given the way an estuary functions, the loadings of nutrients into a slowly mixing body with long residence times resulted in algae blooms, loss of water clarity, and the hypoxia/anoxia that ultimately led to smothering life on the bottom. We call this process eutrophication. It was possible to clearly set out the sources; computer mod-

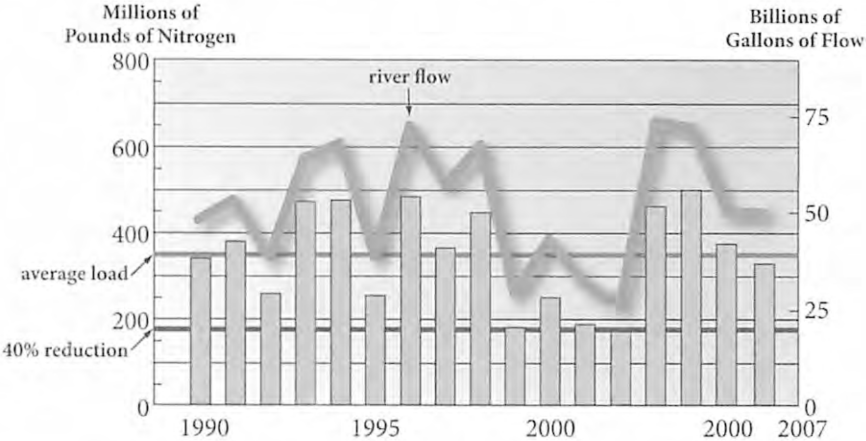

Figure 1. River flow and nitrogen loads reaching Chesapeake Bay 1990-2006. The 40 percent reduction goal shown here goes well beyond the "controllable" nitrogen load pushed by politicians. So far only low-flow years come close to this goal. Source: Chesapeake Bay Program, 2006 data provisional.

eling capability could estimate loads and effects. One could pretty much predict what the results would be from management actions.

After much work, scientists declared that improvement would require a 37 percent reduction of nutrients. As noted above, the politicians rounded it off to an even 40 percent. But no one should have counted out the managers, who were determined to reduce the extent of the task before them. Once the politicians and scientists agreed on 40 percent, the managers decided to redefine the baseline, reducing it substantially by eliminating all "uncontrollable loads" which they defined as including, among other things, all loads from air sources and upstream states not part of the Chesapeake Bay Program (New York, Delaware, and West Virginia). The resultant goal was actually closer to a 23 percent overall reduction, which when finally met did not result in substantial improvements. This was not surprising to anyone who knew what was going on. Meanwhile, the more we learn, the more the original estimate of 40 percent reduction from all sources seems to be right on. So in this case the managers trumped science and the Bay lost.

A Rockfish Moratorium Is the Only Way to Revive Stocks

Rockfish, or striped bass as it is known elsewhere, is the Bay's signature finfish species. In addition to traditional commercial and recreational rockfish fisheries, the Bay serves as the major nursery grounds for East Coast populations. Throughout the seventies and eighties, catches of rockfish dropped lower and lower. There was extended debate over the cause of decline — was it poor environmental conditions or overfishing? Generally, commercial fishermen and their friends in management fought any proposal to reduce the take, and some politicians joined them. Additional years of scientific study led to the conclusion that there was indeed overfishing. Maryland responded with a five-year moratorium on catches, joined eventually by Virginia. What followed was a remarkable response that allowed managers to declare them recovered within a few years. Some restrictions continue on season and size, but stocks remain high. While issues of disease and the effects of an expanded rockfish population — including their predation on

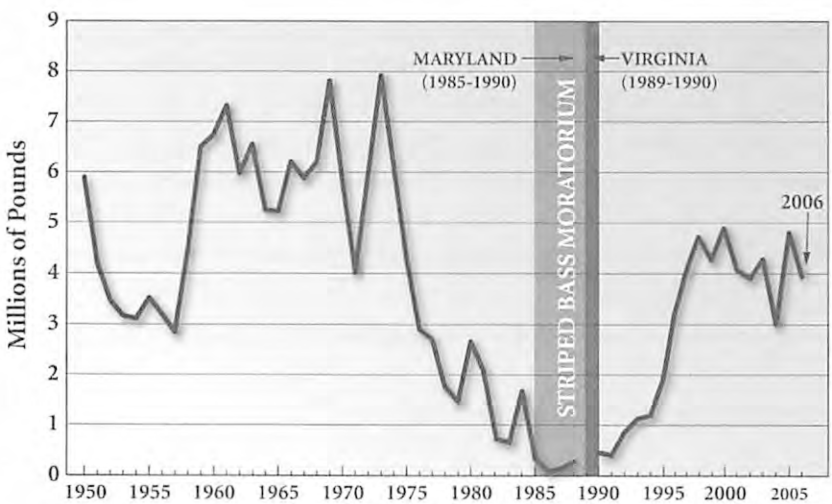

Figure 2. Commercial landings of striped bass in Chesapeake Bay, 1950-2006. Intense fishing pressure led to a steep decline of the Chesapeake's most popular commercial and sport fish. A moratorium and careful management are credited with bringing the "rockfish" back. Source: National Oceanic and Atmospheric Administration.

blue crabs — continue, there is no doubt that the moratorium worked. Scientists trumped the skeptical managers, politicians went along, and the Bay won.

Pfiesteria Is Tied to Excess Nutrients in the Water

In the summer of 1997, a series of outbreaks of a toxic dinoflagellate occurred in small embayments in North Carolina and Chesapeake Bay tidal waters. What made the blooms noteworthy were their apparent effects on the short-term memory of those handling affected fish or even breathing the air above a fish kill. While the scientific community engaged in an extensive debate over sources and triggering conditions for the outbreaks, the public outcry for action grew acute. Excess nutrients were a likely contributing factor, but more important was that for the first time human health effects were tied — however tenuously — to nutrient overload in the Bay. As far as the public was concerned the health effects were scary. There were stories of fishermen who once ashore could not remember where they lived or how to call home. The debates in the scientific community went on, and became quite nasty, with jobs, careers, and reputations on the line. But managers and politicians were not willing to wait. They sorted through the scientific evidence, decided nutrients were the culprit, and passed laws to control them from farms and other sources, laws that until then no one ever thought possible. The public, led by the fishing community, demanded a response and they got it. Meanwhile, ten years later, scientists are still issuing reports and trying to pin down causes and effects of the outbreaks, which have not recurred. In this case, politics trumped science and the Bay won.

Impervious Surface Kills Streams

With progress on nutrient removal from sewage treatment plants and programs in place to begin to deal with agricultural sources, attention in the Bay restoration effort has turned to urban stormwater. Stormwater has long been recognized as a major source of nutrient and sediment loadings, but it is now the only increasing source, with treatment plants, agriculture, and even air sources showing reductions. Stormwater is also troublesome because of its tendency for flashiness, where a rush of runoff enters streams and causes extensive damage to their natural form and function. Stormwater is difficult to address — it is diffuse, not well regulated under the Clean Water Act, under the jurisdiction of myriad local governments, and it's very expensive, especially if retrofits to existing developed areas are required. These high costs and the political price of getting locals to act have prevented managers from doing much about stormwater sources.

Scientists have been more and more successful at quantifying the causes of stormwater damage to streams and detailing conditions to be treated. Studies at the Center for Watershed Protection show that 10 percent impermeable cover represents the limit for stream health, although the precise number depends on how the impermeable surfaces are arrayed in the watershed. Once a damaging level is reached, the streams receiving the stormwater are eroded and degraded, hampering natural functions that allow them to absorb loadings and maintain healthy habitats. Loadings of both toxics and nutrients tend to be concentrated in the "first flush" of stormwater from areas with high levels of impermeable surface, and they tend to be moved quickly downstream to the Bay. The baselines and loading factors and the effects of impermeability are largely all known by science. But there is little action by managers, who in this case are local governments. There were the first stirrings of action in the 2007 session of the Maryland General Assembly, which passed a Stormwater Management Act that requires the use of environmental site design (ESD) to slow down the flow of stormwater from developed lands. There was also active consideration of a bill for a "driveway tax" on impermeable surfaces from new development. Offsets would be allowed for low impact development measures that would reduce runoff. Up until now, the scientists on this issue have been trumped by the managers (both those unwilling to take on local government and the local government officials) and the Bay is losing. But if the scientists and the politicians join up and take on the managers, the Bay could still win.

Water Quality Standards Can Be Made to Make Sense

Implementation of the Clean Water Act began soon after passage in 1972 and one of the first efforts was to establish water quality standards on water bodies nationwide. Since not much was understood about how pollutants interacted and no one wanted to chance setting the limits too low, we ended up a nation with generally unrealistic and unachievable standards, and with no ability to get popular consensus to do anything. Environmental groups fought every attempt to lower standards out of rightful fear that relaxed standards would allow even more pollution. Managers generally didn't care about the unreasonably stringent standards, so long as permit limits could be flexible in taking them into account.

This state of affairs remained until a successful series of nationwide lawsuits by environmental groups. These lawsuits targeted an obscure section of the Clean Water Act calling for Total Maximum Daily Load (TMDL) allocations for every pollutant in every impaired waterbody, including the Bay. For the first time, the standards had to reflect what was possible, and they didn't. For the rest of the country, this impasse pretty much continues and there is no match-up of standards and reality.

Beginning in 2000, Chesapeake Bay Program managers decided to act, since the Bay was covered by unrealistic and in some cases misguided standards. There were no standards for nutrients or sediment, for example; in fact, EPA was just getting around to issuing national guidance on how to set such standards. Even more, no one had ever downgraded to realistic standards anything larger than a pond, let alone the largest estuary in the nation. Led by the managers, the scientists got to work and reset the standards to match recovery of key water quality parameters — clarity, oxygen, and chlorophyll. New water quality criteria and designated uses based on living resources were developed and applied judiciously to different areas of the tidal waters, and the resulting standards were geared to meet Bay agreement goals.[15-16]

The entire job was completed, adopted, and accepted by all including the environmental community — a remarkable achievement that has received far too little recognition. Unique in America, modern, relevant and achievable standards are in place throughout the Chesapeake Bay and its tidal tributaries, and the necessary reduction levels to meet them have been assigned to each major tributary system. Managers and scientists worked together and the Bay won big-time. The politicians probably still don't know it happened.

Science at Work on the Bay from Day to Day

Some further thoughts from a long-time Bay manager

Goal-setting

"Please don't tell me to change the numbers."

Setting clear and measurable goals for the Bay has a long history. Beginning with the 1987 nutrient reduction goal of 40 percent by 2000, over the years the Program has been driven and measured through a series of targets or indicators of progress. This has become almost a trademark of the Chesapeake cleanup, and has been copied by other efforts throughout the world. Goal-setting has been further encouraged by a system of Directives, essentially executive orders signed by the governors and other members of the Executive Council at their annual meetings. Many of these goals are set in response to the results of scientific investigation; others are the result of the judgments of managers. Most represent a consensus of the best thinking of both.

When it comes to setting goals, managers tend to be conservative so they can be assured of success. Scientists like to shoot holes in the underlying assumptions about goals, and they feel no constraints on calling for change in response to new knowledge. This can lead to a lot of squabbling. Often politicians are the ones who have to step in and make the final goal decisions. They tend to set aggressive goals, in part to please the public and get good press, and in part because they are unlikely to be in office when the date for the goal to be met arrives.

There is nothing wrong with this dynamic, so long as the managers fall into line and the scientists endorse the result. The problems arise when managers try to redefine the goal to make it easier to achieve, as they did the 40 percent reduction goal. There are two other examples: the first forest buffer goal, where managers decided to define progress by counting plantings on both sides of the river as double the actual river mileage, which had been the basis for the goal; and the sprawl reduction goal, where the managers rejected the clear and intended USDA measurement system under the Agriculture Census and replaced it with nothing. Sometimes it is the scientists who step in, deciding to continue the inquiry and to determine whether the goal was based on inaccurate information. The spirit of inquiry lives, but it is not normally welcome by politicians, who value clarity of objectives and clear messages to the public. What would really help things would be if the scientists would direct themselves to measuring whether the recovery is making actual progress, thus keeping the managers honest. There is not enough of that.

Monitoring

"Hell hath no fury...."

Monitoring the water quality of the Bay and its supporting natural systems is critical to measuring progress, and it also provides important data for modeling. Managers want the monitoring data to show trends, but scientists want to be sure above all that the information is accurate and that any trends are in fact true. There is a tendency among scientists to deny a trend if there is any question of accuracy or the possible impact of other variables. Being correct is the measure of their job. For managers, the key is having something to tell the public. Even if bad news, reports at least show that they are on top of the problem. The absence of trends reported by scientists year after year or the use of caveats to play down the significance of any evident trends drives managers mad — they are left with nothing to say, nothing to justify continued support, financial or political. A lot of tension results when scientists do not seem sympathetic to their plight.

Another issue that creates dissension is the scientists' desire for consistent data sets. Scientists want to measure the same things year after year; an 18-year set is just that much more accurate than a 15-year set. Managers want to look for positive signs. They want to seek out the good news wherever it is, new things to measure and new ways to measure the old things that will provide the public with a sense of progress being made. This creates constant rancor in a world of limited resources. Scientists tend to dominate the monitoring committees and thus fight any efforts to change the way data is being collected. Why should we continue to collect data in the center of the Bay, managers would ask, when we now know the recovery signals will appear first in the shallows? Give us more money and we'll do it, answer the scientists, but don't ask us to do it at the expense of our multi-year datasets in the center of the Bay. To paraphrase William Congreve's comment about a woman scorned, "Hell hath no fury like a scientist told his dataset will no longer be funded."

Another peeve of managers is the low opinion scientists have of citizen monitoring programs. At the Bay Program in the 1990s, year after year those programs had to be added back into the budget by the managers after the science-dominated Monitoring Subcommittee cut them out to fund more favored projects. Granted, part of the problem is quality assurance, but others have found ways to deal with this. There are no points given by scientists for the value of engaging an interested public who would willingly take all those needed measurements close to shore. The sad result is that the Chesapeake Bay, which literally wrote the Bible used nationwide for citizen monitoring, has fallen far behind in its support for such efforts. Blame the scientists and their iron grip on monitoring projects.

Modeling

"If we just have some more time, we will pierce into the alternate universe and all will be solved."

Modelers are among the most optimistic and misunderstood of scientists. They seek to replicate reality in order to test assumptions and measure the results of proposed actions. Problems arise when managers try to step in. Time is a different dimension for modelers; the next iteration is always behind schedule. The managers want the answers; the modelers want accuracy and better input data. For the manager, the model is a way to tell the public we are on the right track and if we only continue we will get results, so having some model output is of the essence. For scientists, the outputs are only as good as the inputs, so time must be taken to assure accuracy.

Model results are used for different purposes. For managers they justify steps being taken or course corrections needed or policy issues that need resolution. For scientists, they identify the weak parts of the data input and they signal what has to be done to improve the accuracy of results. Both are valuable but they are often conflicting. Managers need to show some sympathy for identifying what more we need to know for better modeling. Modelers need to realize that this is not some sort of giant computer game, but a tool to justify continued political support for, among other things, more modeling.

Another area of conflict lies in the priorities given for model improvements. For scientists, what tends to get priority for correction and upgrade are the things that can be done most easily. For managers, priority goes to the things that are causing the biggest credibility problem with model results, some of which will require a lot of work. One example involves groundwater lag time. It has long been known that many agricultural "best management practices" (BMP's) benefit the Bay only when reduced nutrient levels work their way through groundwater to the edge of streams. This can take a few years or much longer. For the past twenty years, Bay models have lacked the capacity to estimate that lag time and have therefore assumed immediate benefits of the BMP's. As a result, no one is able to estimate the actual delivered reductions of nutrients to the Bay as a result of the thousands of BMP's placed on the land, or to predict when we will see the results. The operational ability to makes these estimates is still "on the horizon," but the horizon seems to recede with each step taken toward it.

Modeling remains an extremely useful tool; it can measure the long-term effects and the costs of many alternative actions. The Bay model recently got into trouble when reporters started asking questions. Scientists with a focus on monitoring were too ready to criticize the model and point out its shortcomings. The model is one tool, but too often appears as a competitive use of funds by other scientists. As a manager, it is important to recognize the limits of the model, to try to balance the use of monitoring and model results. But in the absence of any messages or trends from the interpretations of monitoring data by scientists, the manager is forced to be more dependent on model results. Rather than use the model as it was intended to identify areas for further study or better data, model results too often become the primary basis for management decisions — which they were never intended to be.

Science and Management — Synthesis under Tension

No one has ever undertaken the recovery of a natural system as diverse and jurisdictionally fractured as the Chesapeake Bay. It has proven difficult. But there is little doubt among the players that the right formula is in place — to use the best available science to drive a culture of consensus. The results outlined above show tensions and conflicts, but the mix of scientists, managers, and politicians working together — sometimes winning, sometimes losing, always willing to put pressure on each other and always staying in the game — seems to be working.

No single formula has emerged to deal with the interaction of science and management. It is probably just as well that each thinks of itself as the zookeeper, and of the other as the animals. Lord knows what they think of the politicians — at best VIP visitors. But a number of lessons can be drawn:

Scientific inquiry will always play a key role in the Bay, if for no other reason than that there are few other places to learn from. Even the most recent technical standards for stormwater and low impact development are being developed and applied here first. Keeping the scientific edge and respecting the power and role of science must remain central to the effort.

When scientists and managers can work together, as they did in developing the new water quality standards for the Bay, they can achieve remarkable and innovative results. It takes a lot of talent to get these kinds of results, but there is no shortage of that in the region.

Scientists in the Bay must never give up the task of keeping the managers honest. We have seen what happens when managers are left to redefine terms and adjust goals to make them easier to achieve. The Bay is not deceived and the public sees it as lack of progress.

Managers can't always wait for science to tell them what to do. Sometimes they must strike in the absence of full assurance, but with the use of the best science available. If we had waited for science to pin down *Pfiesteria*, we would still be wondering what happened. More important, we would not have the laws on the books today that are getting results.

When I served as Director of the Chesapeake Bay Program from 1991-2001, we would occasionally get wrapped up in incredibly complex issues of science and management. After a while I learned the technique of stopping the debate and saying, "OK this is so complicated that we need to back off and get ourselves untangled. What would happen if we tried the truth?" That inevitably got us back to basics about what we knew and didn't know, and it gave the scientists a chance to construct a logic model with the managers on how to proceed. The bottom line that would result is a pretty good guide for how science and managers should work together. The scientists keep it honest, but the managers keep it moving.

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Appendices

Chesapeake Bay Program
1983 Chesapeake Bay Agreement

We recognize that the findings of the Chesapeake Bay Program have shown an historical decline in the living resources of the Chesapeake Bay and that a cooperative approach is needed among the Environmental Protection Agency (EPA), the State of Maryland, the Commonwealths of Pennsylvania and Virginia, and the District of Columbia (the States) to fully address the extent, complexity, and sources of pollutants entering the Bay. We further recognize that EPA and the States share the responsibility for management decisions and resources regarding the high priority issues of the Chesapeake Bay.

Accordingly, the States and EPA agree to the following actions:

1. A Chesapeake Executive Council will be established which will meet at least twice yearly to assess and oversee the implementation of coordinated plans to improve and protect the water quality and living resources of the Chesapeake Bay estuarine systems. The Council will consist of the appropriate Cabinet designees of the Governors and the Mayor of the District of Columbia and the Regional Administrator of EPA. The Council will be initially chaired by EPA and will report annually to signatories of this Agreement.

2. The Chesapeake Executive Council will establish an implementation committee of agency representatives who will meet as needed to coordinate technical matters and to coordinate the development and evaluation of management plans. The Council may appoint such ex officio nonvoting members as deemed appropriate.

3. A liaison office for Chesapeake Bay activities will be established at EPA's Central Regional Laboratory in Annapolis, Maryland, to advise and support the Council and committee.

DATE: December 9, 1983

SIGNERS:
For the Commonwealth of Virginia — Charles S. Robb, Governor
For the State of Maryland — Harry Hughes, Governor
For the Commonwealth of Pennsylvania — Richard Thornburgh, Governor
For the District of Columbia — Marion Barry, Mayor
For the United States of America — William Ruckleshaus, Administrator, Environmental Protection Agency

Chesapeake Bay Program
1987 Chesapeake Bay Agreement
(Excerpted)

The Chesapeake Bay is a national treasure and a resource of worldwide significance. Its ecological, economic, and cultural importance are felt far beyond its waters and the communities that line its shores. Man's use and abuse of its bounty, however, together with the continued growth and development of population in its watershed, have taken a toll on the Bay system. In recent decades, the Bay has suffered serious declines in quality and productivity.

Representing the Federal government and the States which surround the Chesapeake Bay, we acknowledge our stake in the resources of the Bay and accept our share of responsibility for its current condition. We are determined that this decline will be reversed. In response, all of our jurisdictions have embarked on ambitious programs to protect our shared resource and restore it to a more productive state.

In 1980, the legislatures of Virginia and Maryland established the Chesapeake Bay Commission to coordinate interstate planning and programs from a legislative perspective. In 1985, Pennsylvania joined the Commission. And, in 1983, Virginia, Maryland, Pennslyvania, the District of Columbia, the U.S. Environmental Protection Agency and the Chesapeake Bay Commission formally agreed to a cooperative approach to this undertaking and established specific mechanisms for its coordination. Since 1983, our joint commitment has carried us to new levels of governmental cooperation and scientific understanding. It has formed a firm base for the future success of this long-term program. The extent and complexity of our task now call for an expanded and refined agreement to guide our efforts toward the twenty-first century.

Recognizing that the Chesapeake Bay's importance transcends regional boundaries, we commit to managing the Chesapeake Bay as an integrated ecosystem and pledge our best efforts to achieve the goals in this Agreement. We propose a series of objectives that will establish a policy and institutional framework for continued cooperative efforts to restore and protect Chesapeake Bay. We further commit to specific actions to achieve those objectives. The implementation of those commitments will be reviewed annually and additional commitments developed as needed.

Goals

- *Living Resources* — Provide for the restoration and protection of the living resources, their habitats and ecological relationships.

- *Water Quality* – Reduce and control point and nonpoint sources of pollution to attain the water quality condition necessary to support the living resources of the Bay.

- *Population Growth and Development* – Plan for and manage the adverse environmental effects of human population growth and land development in the Chesapeake Bay watershed.

- *Public Information, Education and Participation* – Promote greater understanding among citizens about the Chesapeake Bay system, the problems it faces and the policies and programs designed to help it, as well as to foster individual responsibility and stewardship of the Bay's resources. Provide increased opportunities for citizens to participate in decisions and programs affecting the Bay.

- *Public Access* – Promote increased opportunities for public appreciation and enjoyment of the Bay and its tributaries.

- *Governance* – Support and enhance the present comprehensive, cooperative and coordinated approach toward management of the Chesapeake Bay system. Provide for the continuity of management efforts and the perpetuation of commitments necessary to ensure long-term results.

NOTE: To read detailed objectives, commitments, and timetables for achieving each goal, see a copy of the original 1987 Chesapeake Bay Agreement on the Chesapeake Bay Program web site, www.chesapeakebay.net. Search for each agreement under the site's publications.

Chesapeake Bay Program
Chesapeake 2000 Agreement
(Excerpted)

Preamble

The Chesapeake Bay is North America's largest and most biologically diverse estuary, home to more than 3,600 species of plants, fish and animals. For more than 300 years, the Bay and its tributaries have sustained the region's economy and defined its traditions and culture. It is a resource of extraordinary productivity, worthy of the highest levels of protection and restoration.

Accordingly, in 1983 and 1987, the states of Virginia, Maryland, Pennsylvania, the District of Columbia, the Chesapeake Bay Commission and the U.S. Environmental Protection Agency, representing the federal government, signed historic agreements that established the Chesapeake Bay Program partnership to protect and restore the Chesapeake Bay's ecosystem.

For almost two decades, we, the signatories to these agreements, have worked together as stewards to ensure the public's right to clean water and a healthy and productive resource. We have sought to protect the health of the public that uses the Bay and consumes its bounty. The initiatives we have pursued have been deliberate and have produced significant results in the health and productivity of the Bay's main stem, the tributaries, and the natural land and water ecosystems that compose the Chesapeake Bay watershed.

While the individual and collective accomplishments of our efforts have been significant, even greater effort will be required to address the enormous challenges that lie ahead. Increased population and development within the watershed have created ever-greater challenges for us in the Bay's restoration.

These challenges are further complicated by the dynamic nature of the Bay and the ever-changing global ecosystem with which it interacts.

In order to achieve our existing goals and meet the challenges that lie ahead, we must reaffirm our partnership and recommit to fulfilling the public responsibility we undertook almost two decades ago. We must manage for the future. We must have a vision for our desired destiny and put programs into place that will secure it.

To do this, there can be no greater goal in this recommitment than to engage everyone — individuals, businesses, schools and universities, communities and governments — in our effort. We must encourage all citizens of the Chesapeake Bay watershed to work toward a shared vision — a system with abundant, diverse populations of living resources, fed by healthy streams and rivers, sustaining strong local and regional economies, and our unique quality of life.

In affirming our recommitment through this new *Chesapeake 2000*, we recognize the importance of viewing this document in its entirety with no single part taken in isolation of the others. This Agreement reflects the Bay's complexity in that each action we take, like the elements of the Bay itself, is connected to all the others. This Agreement responds to the problems facing this magnificent ecosystem in a comprehensive, multifaceted way.

*B*Y THIS AGREEMENT, we commit ourselves to nurture and sustain a Chesapeake Bay Watershed Partnership and to achieve the goals set forth in the subsequent sections. Without such a partnership, future challenges will not be met. With it, the restoration and protection of the Chesapeake Bay will be ensured for generations to come.

Goals

- *Living Resource Protection and Restoration* – Restore, enhance and protect the finfish, shellfish and other living resources, their habitats and ecological relationships to sustain all fisheries and provide for a balanced ecosystem.

- *Vital Habitat Protection and Restoration* – Preserve, protect and restore those habitats and natural areas that are vital to the survival and diversity of the living resources of the Bay and its rivers.

- *Water Quality Protection and Restoration* – Achieve and maintain the water quality necessary to support the aquatic living resources of the Bay and its tributaries and to protect human health.

- *Sound Land Use* – Develop, promote and achieve sound land use practices which protect and restore watershed resources and water quality, maintain reduced pollutant loadings for the Bay and its tributaries, and restore and preserve aquatic living resources.

- *Stewardship and Community Engagement* – Promote individual stewardship and assist individuals, community-based organizations, businesses, local governments and schools to undertake initiatives to achieve the goals and commitments of this agreement.

NOTE: To read detailed objectives, commitments, and timetables for achieving each goal, see a copy of the original Chesapeake 2000 Agreement on the Chesapeake Bay Program web site, www.chesapeakebay.net. Search for each agreement under the site's publications.

About This Monograph Series

This monograph is part of a series entitled *Chesapeake Perspectives*, produced by the University of Maryland Sea Grant College to encourage researchers, scholars, and other thinkers to share their insights into the unique culture and ecology of the Chesapeake Bay. Its audience includes environmental scientists and scholars, from marine biologists to cultural anthropologists, and a broad interested public that encompasses resource managers, watershed organizations, and citizen advocates. For more about books in the series and related topics, visit the web at www.mdsg.umd.edu.

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About the Author

William Matuszeski was Director of the EPA Chesapeake Bay Program Office from 1991 to 2001. He served in a variety of Federal positions at the Council on Environmental Quality, the National Oceanic and Atmospheric Administration, and the Environmental Protection Agency, including Director of Coastal Zone Management Programs, Deputy of the National Ocean Service, and Executive Director of the National Marine Fisheries Service. A native of Delaware and a resident of the District of Columbia, he holds an undergraduate degree with honors in government from the University of Wisconsin and a law degree from Harvard. He is currently Chairman of the Board of the Alliance for the Chesapeake Bay and recently served as project leader for a report of the Chesapeake Bay Commission on *Biofuels and the Bay*.

Chesapeake Perspectives, a monograph series produced by the Maryland Sea Grant College, provides a forum for researchers, scholars, and other thinkers to share their insights into the unique culture and ecology of the Chesapeake Bay.

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INQUIRY IN A CULTURE OF CONSENSUS

WILLIAM MATUSZESKI