The Technical Review of The Chesapeake Bay Program's Basinwide Monitoring Program.

Conducted under the auspices of the Science and Technical Advisory Committee (STAC).

December 5, 2000

Executive Summary

Summary of major findings and recommendations in response to specific questions posed to the review panel.

Finding. The Chesapeake Bay's monitoring database is one of the most comprehensive compilations of its kind nationally and internationally. This data provide extraordinary resource for evaluating past management strategies to restore the Bay as well as predicting future conditions and trends.

Recommendation. Any changes in the monitoring strategy and collection procedures should complement the historical record as much as possible. The consequences of any changes in sampling design should be assessed by government representatives and scientists who are familiar with both sampling design and the Bay ecosystem.

Finding. Analysis and integration of existing monitoring data were not highlighted in the Basin Wide Monitoring Strategy and presumably have not been a focus of the Bay Program (or most other restoration projects). Instead, the Bay Program has relied on water quality modeling to demonstrate that management goals have been accomplished. The review panel recommends that a full-time research position be created for appropriate subcommittees to rigorously analyze the existing data and provide expertise to the subcommittees on future monitoring strategies.

Recommendation. Before new programs are developed, the existing monitoring data should be analyzed to determine its sensitivity and reliability in reflecting ecosystem changes. It is critical to determine why the empirical data collected by the monitoring program does not coincide with the predictions of the Bay model.

Finding. New remote and in situ monitoring technologies are continually developed and utilized by scientists working in the Chesapeake Bay. These technologies provide much broader spatial and temporal coverage of the Bay ecosystem than the existing field collection system.

Recommendation. The Bay Program should embrace and lead in the implementation of remote monitoring techniques and promote better coordination with existing programs around the Bay (e.g. CBOS and C-GOOS). However, the implementation of new technologies or methodologies should occur through a series of intercalibrations with historical methods thereby preserving the historical record.

Finding. Setting priorities to conduct ecosystem management of the Bay have been established in the Chesapeake 2000 Agreement, and the Agreement should drive the Basinwide Monitoring Strategy.

Recommendation. The Bay Program should evaluate the objectives of the existing monitoring program and determine which elements have been completed and if opportunity and resources exist to address new objectives and priorities identified in the Agreement.

Finding The current subcommittees of the Bay Program (e.g. Living Resources, Toxics, Air, etc.) do not coordinate their respective monitoring programs effectively.

Recommendation. The existing subcommittee structure should be linked under three major committees (Modeling, Monitoring and Management/Research). These larger committees should meet quarterly and coordinate the functions of the subcommittees. For example, the Monitoring Committee would coordinate field sampling trips for toxics, nutrients, etc. The Management/Research Committee would ensure that the Chesapeake 2000 Agreement goals are being met and advise the Bay Program on the management and research information needs to achieve these goals. Membership in these major committees would include representative(s) from the existing subcommittees (e.g. Living Resources, Toxics, Air, etc.).

Finding. Coordinating and integrating the findings of regional monitoring networks including federal, state and local programs remains one of the largest challenges for implementing restoration programs in the Chesapeake Bay.

Recommendation. The Bay Program should commit to a larger leadership role in the Bay region and work to coordinate monitoring and management/research efforts as well as ensure compatible sampling designs and methodologies among government and academic studies. The role of facilitator is one of the major strengths of the Bay Program and should be treated as a high priority activity.

Introduction

The Chesapeake Bay Basinwide Monitoring Strategy represents the culmination of a multi-year effort by the Chesapeake Bay Program (CBP) to develop and implement coordinated monitoring networks throughout the Chesapeake Bay watershed. This Strategy is a shift from the present monitoring process by which different committees independently fund and coordinate monitoring for various components of the system (e.g., nutrients, plankton, and toxic chemicals). The new Strategy establishes program-wide monitoring priorities to conduct 'ecosystem management' of the Bay and more effective utilizes the limited resources and time available for monitoring. Volume I of the Monitoring Strategy identifies the information needs of the Chesapeake Bay Program and defines frameworks for the collection and interpretation of the necessary monitoring data. Subsequent volumes of the strategy will specifically address the implementation of the revised monitoring programs.

Upon the release of a draft of the Chesapeake Bay Basinwide Monitoring Strategy Volume I, the Chesapeake Bay Program's Implementation Committee and Monitoring Subcommittee requested that the Scientific and Technical Advisory Committee (STAC) convene an external technical review of the report. The primary objective of the review was to determine the efficacy of the proposed program and to assist in improving the existing monitoring program so that it better assesses the environmental health of the Bay. The review panel was also asked to provide recommendations to conduct "ecosystem management" within the Chesapeake Bay watershed. (The complete charge is found in Appendix A). An Expert Panel of scientists from outside the Chesapeake Bay Program was selected whose expertise encompassed land use, fisheries, chemical contaminants, water quality, hydrology, ecosystem modeling, and other ecosystem processes.

Panel Members

- Dr. Fred Holland - South Carolina Department of Natural Resources
- Dr. Candace Oviatt - University of Rhode Island
- Dr. Jonathan Phinney - American Society of Limnology & Oceanography / University of Maryland CES, Horn Point Laboratory
- Dr. Steve Seagle - University of Maryland CES, Appalachian Laboratory
- Mr. Jim Sitzman - Oregon Department of Land Conservation and Development
- Dr. John Waldman - Hudson River Foundation

I. General Findings & Recommendation

The panel commends the Chesapeake Bay Program (CBP) on the scope of the past and current monitoring program, which extends over a significant time period. The present monitoring database represents an extremely important resource for tracking changes within the Bay, evaluating the effectiveness of management actions on the system, and developing predictions of future conditions. Similarly, the panel was impressed by the range of issues and management questions addressed in the Basinwide Monitoring Strategy, and the effort that was expended to develop a comprehensive, coordinated monitoring effort among the CBP committees.

One of the most valuable components of the current CBP monitoring program is the long-term and comprehensive data records. This data allows ecological changes in the Bay to be evaluated over extended time periods and helps managers make informed predictions of future trends. It is critical that CBP maintains as many of the components of the long-term monitoring data as possible. Unfortunately, without additional resources, not all components can be maintained and priorities must be set through collaborative discussions among the Bay Program, the states and research scientists familiar with the Bay ecosystem. By analyzing the existing monitoring data, the Bay Program may be able to reduce the number of sampling stations without sacrificing the value of the information collected. In addition, any new methods and technologies that the Bay Program incorporates into the monitoring program must be calibrated with the existing long-term monitoring data. Only through detailed assessment of these new technologies and their careful integration with existing data, can the potential for extending existing records in a cost effective manner be assessed.

Despite pressure to increase the number of environmental parameters monitored and to sample a greater number of stations within the watershed, it is critical that sufficient resources be allocated towards analysis and integration of existing and future data. In addition, the data must be synthesized in a manner that evaluates the effectiveness of management actions. Since its inception, the Bay Program has not funded the synthesis and integration of the monitoring data at a realistic level but has relied on water quality modeling results to evaluate management actions. The water quality model is, however, one of many syntheses and integration approaches. The review panel recommends that a full-time research position be created for appropriate subcommittees to analyze the existing data and provide expertise to the subcommittees on its data needs.

It is possible that the Bay Program is attempting to do too much with not enough funding. Rather than directly funding on-the-ground monitoring projects, the Bay Program should consider acting in a coordination role for monitoring efforts throughout the Bay region and ensure compatible sampling methods among jurisdictions and coverage of priority monitoring parameters. One avenue is to take a larger role as a facilitator and develop greater cohesion and coordination between the various governmental and university monitoring efforts in the Chesapeake Bay. It is not an easy role to play, but a very critical one

A citizen's monitoring program, such as that found within portions of the Chesapeake Bay watershed and in other regions around the country, can be a valuable source of monitoring data for management efforts. Volunteers, trained to take accurate, reliable samples, can greatly increase the number of active monitoring stations throughout the watershed, resulting in a much more comprehensive database for the system. There are legitimate concerns voiced by the management and scientific communities about the quality and consistency of volunteer monitoring data, and the Bay Program appears to be aware of these concerns. In the long term, however, monitoring by citizens may be the primary means used to collect data from smaller tributaries and localized sites. Citizen monitoring can also contribute to stakeholder education and involvement in management issues. The Bay Program should take an active leadership role in citizen monitoring and link citizens groups with local scientists to improve the quality of the data collected. The Bay Program should also provide modest funds for analysis and integration of the data collected by citizens into the larger monitoring database.

The changes to the Chesapeake Bay monitoring program, as proposed by the new Basinwide Monitoring Strategy, are significant. The CBP must develop a feasible timeline for the implementation of the proposed changes into their planning process. It is also critical that a realistic budget be developed for proposed program expansions.

II. Answers to specific questions addressed to the monitoring review committee.

Question 1

1a. Do the priorities outlined in the Executive Summary of the strategy provide the information necessary for the Chesapeake Bay Program to effectively conduct "ecosystem management" of the Bay watershed? The Panel should specifically prioritize the monitoring activities identified in the Executive Summary to maximize the ability of the Bay Program partners to evaluate the ecosystem.

1b. Use the objectives from the draft 2000 Chesapeake Bay Agreement to focus the evaluation of the monitoring strategy as an ecosystem management tool. Will the priorities identified for the Strategy allow the effective analysis of the progress toward the established goals and objectives?

1c. What additional activities not identified in the Strategy should be implemented to create an effective ecosystem based management program?

1a. Setting Priorities

The review panel was comprised primarily of outside experts who felt that any exercise in setting monitoring priorities in the Bay Program should be accomplished by a larger group of stakeholders including state and federal managers as well as scientists who work on the Bay. The review panel questions whether the present Basin-wide Monitoring Strategy was developed based on well-defined and scientifically testable management objectives that could be assessed by a monitoring program. The review panel strongly recommends that the Bay Program not go ahead with developing new monitoring programs without first setting monitoring priorities through a stakeholder process and second without a full evaluation of whether the existing program is adequate in its spatial coverage, frequency and parameters (among others) to detect changes in the Bay that are attributed to management actions.

Setting priorities for the location of monitoring stations is another important consideration in developing a comprehensive program, as variation in the spatial coverage can affect patterns observed in the data. Historically, many of the Bay Program monitoring stations have been located in the mainstem of the Bay, but there is an increasing awareness of the importance of measuring conditions in nearshore and tributary regions. In light of reduced resources for the monitoring program, the review panel recommends a growing reliance on remote monitoring technologies with coverage expanded from the mainstem to tributaries and Priority Living

Resources (explained in more detail in Question 3). Much work to determine the most effective placement of monitoring stations has already been completed. For example, the CBP designated Priority Living Resource Areas as monitoring locations of interest to management.

1b. Use of 2000 Chesapeake Bay Agreement to Direct the Monitoring Strategy.

The panel suggests that the Chesapeake Bay Program has already undergone an extensive priority setting exercise, as evidenced by the recently adopted 2000 Chesapeake Bay Agreement. This document clearly identifies the major goals and objectives for the Program for the next decade.

- Restore, enhance and protect living resources, their habitats and the ecological relationships required for a balanced ecosystem.
- Preserve, protect and restore habitats vital for maintaining the biodiversity and productivity of the Bay and rivers.
- Achieve and maintain water quality conditions that support aquatic living resources in the Bay and Tributaries and protect human health.
- Develop, promote and achieve land use ethics that maintain environmental quality and restore and protect living resources.
- Promote stewardship of the Bay as a valued natural resource and assist individuals, community-based organizations, local governments and schools in acting as stewards of the Bay.

The goals and objectives of the 2000 Chesapeake Bay Agreement provide a basis for establishing monitoring priorities for the next decade and should be used for this purpose by the Bay Program. Status and trends information about many aspects of the Bay ecosystem will be required (e.g. water and sediment quality, living resource, land use changes etc.) to determine if the goals of the Agreement are being met. The Committee recommends that the Bay Program evaluate the objectives of the existing monitoring program and determine which elements are not contributing pertinent information and which have information that can be better utilized.

For example, the Agreement states that by 2007, the Bay Program will "revise and implement existing fisheries management plans to incorporate ecological, social and economic considerations, multi-species fisheries management and ecosystem approaches." Multi-species fisheries management necessitates the understanding and monitoring of key ecosystem components related to the target fish species. Therefore, the targeted species could function as endpoints for the monitoring system and key indicators that are linked to the health of targeted fish species could be used to define the monitoring parameters. A model monitoring system for striped bass is included for illustrative purposes only (Appendix B). Monitoring needs include stock and recruitment for striped bass, but also available food resources, habitat availability, water quality effects, potential human health impacts from accumulated toxins, etc. By focusing on endpoint species such as striped bass, a web of related ecosystem monitoring parameters becomes apparent and can be directed to a specific management objective.

The development of a conceptual model[1] of the Chesapeake Bay ecosystem is another critical activity for identifying key monitoring activities. A conceptual model should reflect how the system functions and identify the linkages among stressors, and key resource responses. The

model must be detailed enough to provide the scientific basis for the identification of specific indicators to be measured by the monitoring program. The model should also identify the "key" ecological responses that should be the focus of management. Changes in these indicators and ecological responses would then serve as a trigger to focus expanded efforts on identifying the causes behind the observed changes.

1c. Additional activities in the existing monitoring program

Following a preliminary evaluation of the current monitoring efforts, the Panel identified several general areas which would benefit from increased emphasis including (1) measurement of atmospheric loadings to the watershed and surface waters, (2) measurement of groundwater inputs, and (3) filling gaps in the toxics databases. In addition, information about land use / land cover throughout the watershed will become of increasing importance as efforts are made to link the impact of human activities on the land, to conditions in the Bay ecosystem.

Traditionally, the Bay monitoring program has focused on collecting information about the aquatic system – water quality, stock assessments, habitat quality – and has not effectively linked watershed development (including humans) to the health of the Bay. However, humans are an inextricable part of the functioning of the larger ecosystem, and have substantial effects on the Bay ecosystem. Any revisions to the monitoring program should therefore integrate a mechanism for tracking changes in human activities including land use, pollution abatement, and population changes.

For example, information about the specific sites where best management practices (BMP's) are implemented and how long they are maintained is critical information for calculating changes to nutrient loads from agricultural lands. Accurate data on driving patterns in specific regions of the watershed would provide information about the amount of chemical contaminants from roadways that potentially enter the Bay, as well as predictive capabilities for future highways construction and subsequent increase in impervious surfaces. State agencies know years in advance the likely site of major road construction and upgrades. Because road development corresponds with housing sprawl and development, monitoring transportation developments provides advance warning about future impacts on the Bay

Frankly, the Chesapeake Bay Program may not have sufficient resources to directly conduct such monitoring effectively. However, given their unique collaborative role in the region, the Bay Program is in an excellent position to foster partnerships between agencies such as NASA, EPA (EMAP Program), the states, and other remote sensing operations which are already collecting water and land use/land cover data through missions like SEAWIFS and LANDSAT.

The products of the Chesapeake Bay monitoring efforts must be used to evaluate the effectiveness of management actions. Products might take the form of effective syntheses of data compilations and analyses for use by resource managers. Publication in peer reviewed journals and meeting proceedings would broaden national recognition and partnership in the monitoring efforts. Graduate students and fellows throughout the Chesapeake Bay region provide a multitude of opportunities for mutually beneficial partnerships for the analysis of the extensive monitoring database and the publication of its results. Biannual conferences of Bay

researchers and managers would provide a forum for monitoring data to be presented and analyzed.

Question 2

How can monitoring and modeling be better integrated within the Chesapeake Bay Program to make both programs operate more effectively and accurately?

As STAC's recent review of the water quality model concludes, the monitoring and modeling efforts within the CBP need better integration. A collaborative effort of monitoring and modeling should be to distinguish trends from established baseline conditions within the ecosystem. Modeling requires accurate, reliable data in order to reproduce ecosystem functions and make projections about changes within the watershed under changing conditions. Simultaneously the models should provide feedback information to the monitoring program including spatial and temporal guidelines for obtaining the most effective monitoring data. The type of collaboration necessary to achieve such synergism has not occurred in the Bay Program to date. (However, there is evidence that the Bay Program is actively working towards this goal). The review panel recommends significant restructuring of modeling and monitoring activities to ensure the priorities of the monitoring and modeling efforts and indeed the priorities of the entire management program, coincide. Specifically, both the monitoring and modeling programs should be oriented toward evaluating progress of specific goals identified in the Chesapeake 2000 Agreement.

Presently the monitoring and modeling committees function independently and their actions are not integrated in a manner that advances common objectives. The current committee structure of the Chesapeake Bay Program causes unnecessary "turf" issues and harmful competition for limited resources. It does not facilitate the coordination and integration of monitoring and modeling activities. Furthermore, many of the other Chesapeake Bay Program subcommittees implement a significant portion of the monitoring activities (e.g. Living Resources, Toxics, Air). The Panel makes a strong recommendation that the monitoring and modeling subcommittees be required to more effectively integrate their activities by coordinating their individual efforts under an umbrella Monitoring Committee.

Approaches for accomplishing this objective include joint meetings to exchange information, simultaneous peer reviews and assignments of shared objectives. The organizational structures of the National Science Foundation's Long Term Environmental Research (LTER) network might be used as a model for integrating monitoring and modeling. A goal of the LTER network is to develop models and gather data for on-site monitoring, cross-site comparison and testing of hypotheses within ecosystems. In the case of the Bay Program, management objectives should be included as the end point for a similar effort. The existing committee structure could be modified to include three major committees: Monitoring, Modeling and Management/Research that are supported by the existing subcommittees (e.g. Living Resources, Toxics, Nutrients, etc.) that meet quarterly and coordinate the monitoring, modeling and information needs of the subcommittees. Under this structure, the Toxics Subcommittee, for example, would have representative(s) on the Monitoring, Modeling, and Management/Research committees. Their

role would be to ensure that the Monitoring, Modeling and Management/Research Committees collect the information required to make assessments of the status and trends for the Toxics Subcommittee and develop tools for predicting future conditions. The Management/Research subcommittee would ensure that the Chesapeake 2000 Agreement goals are being met and advise the Bay Program on the management and research information needs to achieve these goals.

Question 3

What new technologies are available to increase the spatial and temporal coverage of monitoring data? Could they realistically be applied on a large-scale basis?

Existing and emerging technologies would certainly enhance and improve the spatial and temporal coverage of the monitoring program. Broader spatial and temporal coverage would provide a better characterization and understanding of the ecological processes within the Bay as well as the effectiveness of management actions. The review panel anticipates that improved spatial and temporal monitoring coverage throughout the watershed will result in more accurate detection of short-term fluctuations in key ecosystem parameters such as nitrogen and phosphorus. In turn, improved coverage will provide a more realistic analysis of ecosystem change than the current use of mean and median values.

Many new monitoring technologies are already in place and functioning within the Chesapeake Bay region . For example, the Chesapeake Bay Observing System (CBOS)[2], operated by the University of Maryland Center for Environmental Science (UMCES), Virginia Institute of Marine Sciences (VIMS) and Old Dominion University (ODU) consists of four permanent monitoring stations along the mainstem of the Bay as well as a collection of Rover Buoys deployed in targeted sites in the tributaries. This system, one of five in operation around the country, collects real time observations (updated every 6 minutes) of water levels, currents, water temperature and salinity, wind speed and direction and atmospheric pressure. The Trophic Interactions in Estuarine Systems (TIES) program at the University of Maryland conducts towed arrays in the Bay and collects data on temperature, salinity, chlorophyll, dissolved oxygen, and zooplankton abundance thereby providing a three-dimensional view of water quality[3]. Research at the University of Maryland and NOAA also includes regular aerial surveys of the Bay to track phytoplankton abundances and blooms. At the Federal level, NASA and NOAA currently deploy multiple air and space-based sensors of varying temporal and spatial resolution that are underutilized by the CBP for tracking changes in terrestrial and aquatic ecosystems.

The problem with this large array of remote sensing options is investment in analysis and updating of equipment. The Bay Program should partner closely with NASA and NOAA and the scientific research community to remain abreast of opportunities to address these problems. Partnerships are one of the greatest strengths of the Chesapeake Bay Program, and stronger partnerships could be developed with these and other on going state-of-the-art monitoring efforts in the region (e.g. Coastal Ocean Observing System[4]) in order to analyze and track the status and trends of the Chesapeake Bay ecosystem.

The implementation of any new technologies or methodologies should occur through a series of intercalibrations with historical methodologies, thus preserving the long-term data record. The existing data set developed by the Bay Program remains one of its greatest assets and should be complimented by new technologies. The review panel does not recommend that remote monitoring replace field sampling; the current technology will not allow such replacement. Nonetheless the efficiency and completeness of remote monitoring are very promising and the Bay Program should embrace the concept and lead in its application.

In short, the review committee strongly recommends the Bay Program coordinate directly with existing monitoring programs that utilize in situ and remote sensing technologies. It is very likely that redundancies exist between the existing field and remote monitoring programs- although the review committee did not explore these redundancies. Annual or biannual workshops and forums drawing together the research and management community would be one means to develop collaborations between researchers on the Bay and the Bay Program. The committee acknowledges there already exists several close collaboration between the Bay Program and some prominent researchers on the Bay. However, the collaborations should be a larger priority for the Bay Program.

Question 4

How can the Chesapeake Bay Program overcome institutional and jurisdictional obstacles to attain regionally integrated monitoring networks? How have other programs successfully implemented ecosystem management principles? Can we apply lessons or experience from other regions to our efforts in the Chesapeake Bay?

The coordination and implementation of a monitoring program in the Chesapeake Bay watershed is a challenge, due to the physical size, ecological complexity of the system and the competing jurisdictional, social, and economic considerations within the region. The Chesapeake Bay Program predates the other National Estuary Programs, and is often called upon to provide leadership and example to other restoration efforts around the country and the world. As such, it is difficult to identify another program that might act as a model for the Chesapeake Bay Program.

That said, the Panel offers three examples for overcoming institutional and jurisdictional obstacles to attain regionally integrated monitoring networks.

1. The Southern California Coastal Water Research Project Authority (SCCWRP) is joint arrangement of federal and state government agencies that coordinate monitoring and modeling of the Southern California Bight. An important part of their mission is to ensure that the data is collected and synthesized effectively and reaches decision-makers, scientists and the public. Staff scientists provide technical review and advice of the data. Some hold joint appointments with local research institutes thereby publicizing the efforts of SCCWRP as well as obtaining current technical information that can be applied to the monitoring effort. Contact SCCWRP for more information (http://www.sccwrp.org).

2. The Puget Sound Water Quality Action Team, commissioned by the state of Washington's Office of the Governor, develops and carries out work plans that guide the protection of water quality and biological resources in Puget Sound[5]. The monitoring activities of this organization are structured around a set of biological indicators that are of direct interest to the state legislators and the public. There is direct accountability by the Team on a clearly defined set of issues. The status and trends of the biological indicators are reported annually to address the following questions:

    - Are areas where shellfish can be safely harvested increasing or decreasing?
    - Is the quality of water for recreation improving or declining?
    - Is the area of contaminated sediments increasing or decreasing?
    - Are aquatic nuisance species increasing or decreasing in Puget Sound?
    - Is toxic contamination of the marine environment increasing or decreasing?
    - Is the size and frequency of oil spills increasing or decreasing?
    - Is fish and wildlife habitat increasing or decreasing?
    - Are fish and wildlife populations increasing or decreasing?

3. Oregon, under the auspices of Governor Kitzhaber and the state legislature, has developed a statewide recovery strategy for native fish and watershed health. The Oregon Plan for Salmon and Watersheds[6] coordinates activities at the local, state, and federal level, but "the Plan is implemented primarily at the local level by landowners, watershed councils, soil and water conservation districts, and local governments." The organizational structure centers on the local committees, surrounded by a hierarchical series of regional and state oversight and coordination teams. Of particular importance to the Chesapeake Bay Program is the State Monitoring Team, whose mission is "to provide a forum for development and coordination of public and private monitoring activities, assist in establishing priorities for monitoring activities, coordinate resource monitoring activities, and provide for timely and effective distribution of information for adaptive management." The Oregon Plan differs from the CBP in that it is largely a local effort, with the Plan's monitoring program focused on monitoring coordination rather than on-the-ground monitoring projects.

The three examples are programs conducted within a single state and would need to be modified to accommodate the multi-state jurisdiction of the Chesapeake Bay. Nonetheless their focus (and likely their success) is on local implementation of management goals. The Review Committee recommends that the Bay Program become a leader in developing collaborations with state and local politicians and citizens through educational programs and funding of local citizen monitoring programs among other outreach efforts. It is through collaborative efforts of government agencies, academic institutions and citizen groups that a successful holistic approach be achieved to advance management goals.

These examples reiterate the need for a holistic approach towards achieving management objectives. The review committee was not asked to review collaborations between the Bay Program and local entities. Nonetheless, the committee stresses that management programs require local implementation and it acknowledges that the Bay Program has many local

partnerships. Not surprising there are few, if any, state-wide management efforts are holistic enough to link local and state political units. The committee recommends the Bay Program become a leader in changing this deficiency through educational programs for state and local politicians and environmental leaders. This task will likely be arduous, but necessary to be successful and to achieve the new management goals in the Chesapeake 2000 agreement.

References

[1] Boesch, D. F., J.S. Schubel, B.B. Bernstein, W.M. Eichbaum, W. Garber, A. Hirsch, A.F. Holland, K.S. Johnson, D.J. O'Connor, L. Speer, G. B. Wiersma 1990. Managing Troubled Waters: The Role of Marine Environmental Monitoring. National Academy Press. Washington, DC.

[2] Glenn, S.M., W. Boicourt, B. Parker, T.D. Dickey. 2000. Operational Observation Networks for Ports, a Large Estuary and an Open Shelf. *Oceanography* 13 (1):12-23.

[3] Trophic Interactions in Estuarine Systems (TIES) website: www.cbl.umces.edu/TIES

[4]Malone, T.C. and M. Cole 2000. Toward a Global Scale Coastal Ocean observing System. *Oceanography* 13(1): 7-11.

[5] Puget Sound's Health 2000: Status and Trends of Key Indicators of Puget Sound's Health. Puget Sound Water Quality Action Team / Office of the Governor. Olympia, WA.

[6] The Oregon Plan for Salmon and Watersheds: A Guide to State Teams, Oversight Bodies and Funding Agency. Oregon Governor's Natural Resource Office / Legislative Administration Committee

APPENDIX A: CHARGE FOR THE EXTERNAL PEER REVIEW OF THE CHESAPEAKE BAY BASIN-WIDE MONITORING STRATEGY

Objectives:

1. Obtain external peer review of the Draft Basin-wide Monitoring Strategy for the Chesapeake Bay Program and the priorities the Executive Summary identifies for future monitoring.

2. Provide a forum to exchange new ideas and perspectives for monitoring the Chesapeake Bay and its watershed.

Approach:

Identify a panel of 5-6 experts on ecosystem management who will convene twice. The first meeting will cover the charge of the panel, presentations on and review of the Chesapeake Bay Program's current monitoring components, goals and objectives for managing the ecosystem, and proposed monitoring priorities. At the second meeting, panelists will present preliminary comments on the document and/or ecosystem monitoring and lead a discussion with Bay program managers, subcommittee chairs and coordinators. One or more panelists will be asked to present the group's final set of findings and recommendations to the Chesapeake Bay Program's Implementation Committee in July, 2000.

Background:

The goal of the Basin-wide Monitoring Strategy is to create a comprehensive monitoring program that will respond to the information needs of environmental managers. Chesapeake Bay Program managers initially focused monitoring on detecting changes from nutrient reduction efforts, assuming that fewer nutrients would result in better habitat for living resources. Bay Program managers and scientists are now recommending a whole ecosystem management approach, which considers individual species, their habitats, trophic relationships and their response to anthropogenic and natural changes. The shift towards ecosystem management places additional demands on monitoring programs throughout the Bay basin. At the same time, the focus of the water quality improvement effort on clarity, oxygen, and chlorophyll a as endpoints may provide opportunities to reduce traditional water quality monitoring.

Although focused on environmental monitoring, the basin-wide strategy provides a comprehensive view of an environmental management system in which modeling, information management, data analysis, and data interpretation functions are integrated subject-by-subject. The first volume identifies information needs based on the management questions raised in Bay agreements, policies, and strategies. It establishes frameworks to guide the identification of the specific, more detailed data collection, information management, and interpretation activities required to answer the stated management questions. Because the list of information needs

and identified gaps in existing monitoring programs far exceeds available resources, priorities for new monitoring networks and assessment criteria are identified in the Executive Summary.

Priorities will be used to make future funding decisions, as well as to direct the collective resources of individual Bay Program partners towards creating efficient, integrated monitoring networks. Thus, it is important that these are critically evaluated. A second volume of the strategy will provide the details for the new monitoring networks such as parameters, sampling design, frequency and methods comparability issues.

Charge:

The Expert Panel will review the strategies and priorities outlined in the draft Chesapeake Bay Basin-wide Monitoring Strategy, through two meetings and a series of conference calls. The results of the review will address the following:

1. Do the priorities outlined in the Executive Summary of the strategy provide the information necessary for the Chesapeake Bay Program to effectively conduct "ecosystem management" of the Bay watershed? The Panel should specifically prioritize the monitoring activities identified in the Executive Summary to maximize the ability of the Bay Program partners to evaluate the status of the ecosystem.

   Use the *Objectives* from the draft 2000 Chesapeake Bay Agreement to focus the evaluation of the monitoring strategy as an ecosystem management tool. Will the priorities identified for the Strategy allow the effective analysis of the progress toward the established goals and objectives?

   What additional activities not identified in the Strategy should be implemented to create an effective ecosystem based management program?

2. How can monitoring and modeling be better integrated within the Chesapeake Program to make both programs operate more efficiently and accurately?
3. What new technologies are available to increase the spatial and temporal coverage of monitoring data? Could they be realistically applied on a large scale basis?

4. How can the Chesapeake Bay Program overcome institutional and jurisdictional obstacles to attain regionally integrated monitoring networks? How have other programs successfully implemented ecosystem management principles? Can we apply lessons or experience from other regions to our efforts in the Chesapeake Bay?

APPENDIX A

Figure 1: Indicator Species Approach to Ecosystem Management