Review of an Environmental Monitoring Strategy for Rhode Island's Bays, Rivers and Watersheds

July 1, 2005

Report by: Scientific Advisory Committee

To: Coordination Team and
Environmental Monitoring Collaborative

Charge

The Scientific Advisory Committee (SAC) was established pursuant to RIGL 46-31-9 "to advise the coordination team on research priorities, technical matters, and best management practices". The committee is specifically charged in statute with "ensuring that peer review is employed in the development of an environmental monitoring strategy". Consistent with that responsibility, on March 16, 2005, the Coordination Team (CT) requested the SAC to review the "Strategy to Begin Development of an Environmental Monitoring Framework to Support Systems-Level Planning for Rhode Island's Bays, Rivers, and Watersheds" ("monitoring strategy") developed by the Environmental Monitoring Collaborative (EMC). Attachment 1 is the charge from the CT. The committee was asked to consider the Rhode Island Department of Environmental Management (DEM) Water Monitoring Strategy to be an element of the overall monitoring strategy and to review it as such. The committee subsequently received and was asked to direct its attention to a revised version of the DEM Water Monitoring Strategy, dated April 18, 2005.

Response

This report conveys the findings of the SAC review of the proposed monitoring strategy. Improving monitoring of Narragansett Bay and its rivers and watershed has been a prime concern of the Coordination Team and that concern reflects the direction of the executive and legislative actions which caused it to be established. The status of monitoring programs is rapidly evolving. In order to meet requests and to provide the most useful review, the committee has worked at an accelerated pace. As requested, initial findings from our review were conveyed to the CT and the EMC on May 16, 2005 (attachment 2).

- The proposed strategy is a very significant step forward for the state. For the first time, it provides a detailed, integrated picture of major monitoring programs. The Environmental Monitoring Collaborative as a whole and DEM, in particular, deserve a great deal of credit for developing this strategy in a very short time.

- The committee believes that the monitoring programs that have been recommended by the EMC and DEM and incorporated in the state's budget proposal for FY2006 will significantly improve the state of knowledge of Rhode Island's bays, rivers, and lakes.

The committee strongly supports those proposals. Those proposals are closely connected to management needs, a characteristic which the committee believes should be a hallmark of the state's monitoring programs.

- However, the SAC is very concerned that its expectations of the state for support of these monitoring programs have not been realized. Recent appropriations action by the RI general assembly with the approval of the governor zeroed out the request that was included in the budget submitted in February. Many considerations other than scientific merit and scientific judgments about need undoubtedly factored into this decision. The SAC feels that it is very important for the CT to gain a full understanding of the action taken on the monitoring request and provide appropriate guidance to the EMC so that progress can be made in implementing the strategy.

- The committee recognizes that the monitoring strategy is still developing and, even when mature, will be dynamic. The CT should support its continued development as a high priority. Further improvements can be made in the coordination of present monitoring efforts and the synthesis of their results for maximum usefulness. Over the longer term, the committee believes additional effort and integration will be needed to meet the goals of ecosystem-based management. While achieving that goal may be a decade or more in the future, we believe that methodical and practical steps must be taken at every opportunity to move in that direction. There should be a close linkage between the evolution of the monitoring program and new research results. Synergy should benefit both monitoring and research and should not cause confusion between the two.

- We note that there may be additional monitoring activities that are not specifically described in the strategy. We encourage the CT to actively engage with the EMC and SAC in providing information on the monitoring programs, plans, and requirements of their respective agencies. These include the Coastal Resources Management Council, the Water Resources Board, the Rivers Council and the Narragansett Bay Commission. It is only through a coordinated effort of all participants that the goal of developing a complete systems level plan can be reached.

The SAC has organized its comments below into three "tiers". The first tier includes general comments about the strategy as a whole. The second tier addresses more specific issues about approaches or "tactics". The third tier addresses specific monitoring needs, particularly the supplemental proposals that have been made by the EMC.

We hope that these comments are useful, constructive, and will serve to improve monitoring programs in Rhode Island.

Tier I – General Strategy

1. Framework

The basic framework for environmental monitoring of the state's bays, rivers, and watersheds is still developing. Attachment 3, provided by the Environmental Monitoring Collaborative (EMC), compares proposed and statutory frameworks with the "Strategy to Begin Development of an Environmental Monitoring Framework to Support Systems-Level Planning for Rhode Island's Bays, Rivers, and Watersheds" ("monitoring strategy"). Actual use may be the best test, as well as the best means of development, of an overall framework. RIGL 46-31-6(k) calls for the Coordination Team (CT) to prepare a report on the "current condition of the environmental health of Rhode Island's bays, rivers, and watersheds" within six months after completion of the systems-level plan (due by June 30, 2006). The SAC encourages attention to, and support for, the task of completing such a report. The monitoring strategy, according to the statute, should be updated within four years. Production and evaluation of a condition report should be viewed as an integral part of the process of revising the monitoring strategy.

2. Connection to Management Needs

The SAC reiterates its view that monitoring programs and, particularly, new proposals should be tightly coupled to management needs. Specific agency needs and the management actions that will be affected should be identified and considered strongly in the design or redesign of monitoring programs. Tracking of management actions should be linked to monitoring so that the effectiveness of those actions can be assessed – nutrient reductions, stormwater management, and cesspool phaseout are specific areas where there is a pressing need to demonstrate this linkage and implement adaptive management.

Also, although much of our monitoring is supported by federal funds and driven by federal requirements, agencies and the collaborative should think more about management needs specific to this area and about interconnection of programs to move toward ecosystem-based management – fisheries management, wildlife conservation, and habitat restoration are specific and immediate opportunities to meet this challenge. The state's research enterprise should be encouraged to take an ecosystem perspective and to develop the foundation for models and methods for management application. Good examples for consideration in developing the systems-level plan might be "Chesapeake Futures" (http://www.chesapeake.org/stac/futreport.html) and "Fisheries Ecosystem Planning for Chesapeake Bay" (http://noaa.chesapeakebay.net/Fish/FEP_DRAFT.pdf)

The SAC feels strongly that personnel involved in monitoring and analysis be adequately (not minimally) trained and technically adept at applying sophisticated tools to this work. Rhode Island is blessed with great personnel resources from which to draw. A major management challenge is to tap into these resources in a manner that is most effective and efficient.

3. Principles

The SAC endorses the "Principles" stated by the EMC in the monitoring strategy and encourages full attention to them in practice. Each member of the Coordination Team should ensure that his or her agency consults with the EMC when new monitoring plans are being developed and informs the collaborative on status. Program descriptions, as outlined in the "Principles", should

enable the EMC to help achieve the synergy envisioned in its creation. Mechanisms should be established to keep close track of monitoring and related research supported or conducted by state and federal agencies and other entities.

Data management, data availability, and synthesis of results should be given greater attention. It is imperative that state funded data be freely available to anyone via the Internet. This includes raw, quality controlled, and processed data as well as supporting interpretative information. There should be no delay in the release or availability of raw data as soon as collected or converted into electronic files with the clear indication that the data have yet to be quality controlled and therefore are provisional. This is especially true for data collected from automatic sampling instruments that store data in computer compatible formats. NOAA has shown this approach works in its PORTS real time system. Quality controlled data should be available within a short time, depending on the effort required to perform the quality control. The release of processed data may take some additional time and supporting interpretative information may have to await the completion of the project. A specific schedule for release of all types of data should be part of any project. The Internet system should be designed to provide an intuitive interface to allow the general public, state agencies, resource managers and scientists with access to these different levels of data and analysis. These aspects are within the charge of the EMC but the collaborative, as well as the agencies, requires support in order to carry out its duties.

4. Process

In order to ensure close management connection of monitoring efforts, the SAC recommends that all monitoring programs be coordinated by the agencies (including NGOs in some cases) that have management responsibility. The EMC's responsibility for implementation of the monitoring strategy should be met by developing the strategy and its components, closely tracking and evaluating agency efforts, ensuring synergy and cooperation on shared requirements, and providing assistance where necessary. The CT should ensure that properly trained personnel and adequate infrastructure are available to adequately analyze and assimilate the information from monitoring programs. A competitive process should be used to obtain the best possible proposals in a credible and transparent manner. The SAC is available to assist in peer review or with development of a peer review procedure.

Tier II – Tactics

1. Rotating Basins

DEM proposes to implement a rotating basin approach to sampling rivers, streams, ponds and embayments. One or more watersheds will be sampled intensively each year, allowing for statewide coverage every five years. The rotating basin approach is undergoing pilot testing. The SAC looks forward to seeing those results but has several concerns about the approach. Of paramount importance is the question of whether the rotating basin approach will be capable of detecting trends in water quality. If we obtain different results from sampling events separated by 3-5 years, how do we relate those differences to management vs. natural variation? Do we have enough regularly sampled "reference" sites within the bay and its watersheds to help us evaluate and correct for annual variation in freshwater, temperature and wind that plagues interpretation of intermittent sampling?

Compounding this concern is the fact that the rotating basins approach does not tightly couple monitoring of the watershed to that of the receiving water. All of the area immediately surrounding Narragansett Bay would be monitored as a single unit in one year of the cycle. The proposed rotating assessment of coastal waters (embayments and salt ponds) would apparently not be synchronized with the cycle of basin assessments. Also, because some watersheds cross state lines, interstate cooperation should be sought and factored into sequence decisions.

The SAC encourages reconsideration of the sequence of rotating assessments. The committee also recommends specific efforts to chronicle the likelihood (probabilities) of the occurrence and co-occurrence of climatic conditions and extreme events linked with the assessments. In addition, interpretation of monitoring information from the rotating assessments should be developed in the light of long-term and continuous monitoring data, such as from fixed sites in the Bay, stream gages, and regularly sampled water quality monitoring sites.

2. Septic Systems and Stormwater Monitoring

Stormwater and septic system issues are pressing and illustrative of the need for water quality information beyond the binary (impaired or not) requirements of assessment regulations. Attention to stormwater and septic management is being driven by federal, state, and municipal mandates. Establishing an adaptive system of identifying management options, tracking management decisions and implementation actions, and monitoring the effects on water quality is needed to ensure adequate return on public and private investment. Monitoring should track both types of information.

First, information from permits and approvals is needed to track decisions and abatement designs. From "paper" records, we need to create a digital database on the location, extent and proportion of improvements within the watersheds of those coastal waters that are expected to be affected by the improvements. We should have data on the extent of sewering, cesspool replacements, and alternative systems. We should have information on the geographic location, extent and level of treatment associated with storm water management. Second, we should more intensively sample water quality in receiving water bodies (including groundwater) that are downstream of major stormwater and onsite wastewater improvements. Third, we need to assure that the data will be examined to help guide decision-makers as they consider additional public and private investments in these non-point source improvements.

Such a “system” should derive full benefit from the similarities of these issues across the state yet recognize and be responsive to the fact that prime management responsibility and the key to solutions are generally at the municipal, community, and individual property owner level. The demands of such an approach are potentially very large and the committee recognizes that this could overwhelm management benefits. The SAC encourages experimentation with pilot projects in both urban and rural areas. All possible synergy with rotating basin assessments and other monitoring efforts should be exploited. To a large degree, costs should be internalized and control exercised by entities such as stormwater management districts and community septic management organizations where possible.

3. Nutrients

Narragansett Bay, despite its generally strong flushing, exhibits symptoms of nutrient over-enrichment. Episodic, seasonal low dissolved oxygen conditions, particularly in the

Providence/Seekonk River, the upper Bay, and Greenwich Bay, are the clearest indications of eutrophication. Primarily with support through the National Marine Fisheries Service for the Bay Windows project, a system of monitoring for dissolved oxygen conditions has been established. Included in this system are 1) a network of fixed sites with continuously recording dissolved oxygen sensors; 2) periodic surveys near neap tide to provide denser spatial coverage and monitoring in shallower areas of the Bay; and 3) monthly surveys of the Bay channels with an undulating profiler. In addition to dissolved oxygen, the system monitors water temperature and salinity, chlorophyll, and phytoplankton. Data collected from this monitoring system should be disseminated in a timely manner and thoroughly analyzed. Long-term funding should be assured for elements of the system judged essential.

Management measures to reduce nutrient loading, particularly from wastewater treatment facilities which are the largest source of nitrogen to the Bay, are underway. Nutrient loading from these plants is being monitored as a condition of their permits. Nutrient loading from major rivers (including load from the treatment facilities discharging to them as well as nonpoint sources) is being monitored by the USGS. River water quality monitoring by USGS will be restored to monthly frequency (it had been allowed to drop to quarterly) as part of the package of monitoring improvements expected to be funded through DEM.

Since nutrient availability has a pervasive influence on marine ecosystems, additional monitoring of many aspects of the trophic web might be appropriate. The proposed supplemental monitoring programs related to nutrients (monitoring of benthic community structure, zooplankton, and secondary productivity) may be timely in light of this and scheduled management actions. Those proposals are specifically considered in tier III comments below. At the request of the SAC, a meeting was held on May 25, 2005, involving researchers from EPA's Narragansett Laboratory and URI/GSO who are planning to do related work this year. No urgent unmet gaps were identified. The SAC, with the cooperation of the collaborative, will investigate what similar efforts may be undertaken in FY2006 with support by Sea Grant and other NOAA funds and EPA.

4. Biological Monitoring and Indices of Biological Integrity

Concerns about the role of biological monitoring in both marine and freshwater systems have been raised by several SAC members. First, variations in biological sampling procedures appear to influence results significantly. In freshwater, recent studies by James Karr and others (Doberstein et al., 2000; Lorenz et al., 2004) found that a sample size of 100 organisms (the current protocol for RI benthic invertebrate assessments) will strongly restrict the resolution of different classes of water quality. With 100 samples, a water body can only be placed into one of four categories (i.e., poor, average, good, excellent); thus the current method is capable of noting dramatic shifts in water quality, rather than serving as an early warning system for trends and changes. With additional samples per site (200 plus samples), Karr suggests that better resolution is possible. A recent URI analysis of macro-invertebrate sampling for trends found enormous variability in the water quality classification within the same site for a given year. The SAC suggests that riverine systems be closely analyzed for within season variability, within reach variability, the effect of sample size on IBI (Index of Biological Integrity) type assays, and the ability of this type of monitoring to detect meaningful water quality trends.

Efforts to develop a useful IBI for marine waters in the Bay have not produced consistent results. Comparison of EPA results with URI/GSO results (Calabretta and Oviatt) suggest that the

method by which sediment is obtained for benthic community analysis will affect the results and their interpretation as to status of the benthos.

In addition, there is concern that biological indicators are lagging, rather than immediate or leading, indicators. More conventional physical and chemical indicators may provide clearer and earlier measures of ecological conditions and, thus, be better investments. Despite these reservations about immediate utility of biological indicators, the committee has great hopes for their usefulness in the long-term to guide ecosystem management. Indices of macrofauna communities and guilds and pelagic/demersal or pelagic/benthic ratios are examples of multi-species measures that might prove meaningful and useful.

5. Fisheries

The committee recognizes the enormity of the task of trying to tie environmental variables to fish species composition, growth and production, especially based on existing data. A lot of work is being done currently to collect both environmental data and fish abundance data (or data on biota generally), but the Narragansett Bay system is extremely complex and sophisticated analysis of time series data will be required to make sense of it (wavelet analysis was cited as something to examine in this regard).

We have the sense that the Coordination Team can succeed only if they clearly define the problem in a way that is tractable. We understand that we are beginning a process of moving from fisheries management to ecosystem-based management; however, we are of the opinion that this transition is one that will take a decade or more. A fundamental aspect of the shift may require ecosystem measures in addition to single-species or even community measures.

In trying to define and work with tractable problems, it may make sense to implement spatially-explicit management and monitoring efforts in smaller, more enclosed areas, such as the upper Bay/Providence River, before tackling all of Narragansett Bay. A problem with fish sampling in this regard is that we need something between otter trawls and beach seining (perhaps a beam trawl) to sample the fish in these areas. This approach may represent a better way to expand fish survey work. Additional efforts should also be made to quantify the biomass of non-target but highly responsive species such as *Menidia sp*.

Present monitoring is generally adequate for fish stock assessment and management decisions. However, gaps in coverage have been noted. For example, there is a desire to add trawl stations in RI Sound to fill the data gap between inshore (state) and offshore (federal) trawl surveys. For defining essential fish habitat, we would like seamless estimates of fish densities per square meter. Concentrated monitoring will also be required for open aquaculture operations, perhaps as a condition for permitting, as that industry expands (see Wildish, 2001).

The DEM database on species abundances from a variety of survey methods has not been analyzed for long-term trends, community relationships, or other characteristics, primarily because there has never been enough money. As the bay has warmed over the past four decades, species distributions, seasonal occurrences, and predator-prey balances have shifted. The monitoring task is to compare recent data with historical data, where they exist. A series of reports on analysis of long-term data from trawl surveys is being prepared.

There are needs and opportunities for process-oriented studies to test particular hypotheses. For example, it has been hypothesized that winter flounder juveniles may have lower survival in deeper areas of the bay that are subject to seasonal hypoxia. This hypothesis could be tested with some targeted sampling (e.g. with a beam trawl). We also see a shift from demersal to pelagic fish that is most likely trophically mediated. Yet we do not have good time series of pelagic fish. This is a monitoring challenge. Additional catch reporting of pelagics may be of value. There must be a lot of energy transfer and consumption in the water column that we don't measure. New technologies could be applied to this problem (e.g. hydroacoustics) perhaps with some seed money. There is also a need to elucidate the food web (who eats whom).

6. Inland/Coastal Balance

The charge to the EMC (RIGL 46-23.2-6) says that it shall adopt a statewide monitoring strategy including seven key elements, the first three of which are an inventory of existing monitoring programs, an outline of additional programs the State needs, and a list of indicators that will be used to measure the health of the marine habitats of the State. The emphasis on marine habitats is clear, but the breadth of new monitoring programs should be greater. For example, section 46-31-5 of the legislation establishing the Coordination Team stresses the need for planning not only for reduction of pollution, protection and restoration of fish and shellfish, and management of aquatic nuisance species, but also for protection and restoration of aquatic and terrestrial habitat, conservation of open space, and promotion of smart growth practices. These topics span the inland-coastal continuum; presumably, that is why the term "watersheds" was included in the title of the legislation and the name of the Coordination Team.

RIGL 46-31-9 states that the strategy for the environmental monitoring program shall incorporate environmental indicators that include, *but are not limited to* [our emphasis]:

(1) land cover or uses within the shoreline buffers;
(2) water temperature, salinity, and pH;
(3) concentrations of nitrogen, phosphorus, dissolved oxygen, and bacteria;
(4) water flows and circulation;
(5) species assemblages and relative abundance of finfish, shellfish, and benthic invertebrates; and
(6) presence of aquatic nuisance (and invasive) species.

In soliciting proposals for supplemental monitoring programs, the EMC adhered strictly to the above list. Perhaps that is reasonable, at least for the first round of proposals. But of the eight supplemental monitoring programs recommended by the EMC for funding, seven focus on the saltwater end of the inland-coastal gradient. Although the cumulative impact of water quality degradation is most obvious at that end, the source of the problem is frequently inland, where human land use affects groundwater quality and the integrity of streams, lakes, and freshwater wetlands. In most cases, mitigation measures can be applied most effectively near or at the source of those impacts as well.

The EMC does recommend monitoring changes in land use or land cover, and the extent of impervious surfaces in particular, both on the landscape as a whole and in coastal and riparian buffers. However, there is other important monitoring that should be done inland, particularly for wetlands, as described in more detail below. We should be closely tracking specific land use practices and making special efforts to evaluate the impacts of changes in management practices

at or near the source of the problem. This holds true whether one is speaking of new approaches to wastewater or storm water management, wetland regulatory programs, or habitat restoration.

Tier III – Monitoring Proposals and Gaps

A. Monitoring Initiative Proposed by DEM and Recommended by EMC

The recommended monitoring programs listed on pages 11-13 of the DEM Water Monitoring Strategy should significantly improve the state of knowledge of Rhode Island's bays, rivers, and lakes. In its initial findings (attachment 2), the SAC conveyed its understanding that a combination of state, federal, and other resources were expected to support these programs for FY2006. After reporting those findings, Susan Kiernan (DEM) corrected the committee's understanding and informed the CT that several monitoring programs were not expected to be funded. These were:

(1) Fish tissue sampling in lakes and rivers -- $180,000 (DEM has applied for and is awaiting approval of a request for funds in the amount of $35,000 to initiate this program.)
(2) Expanding the stream flow gage network by five stations -- $140,000
(3). Implementing a risk-based approach in beach testing for lakes (HEALTH) -- $100,000
(4) Unassessed lakes not addressed by volunteers (URI Watershed Watch) -- $46,000

After discussion, the Coordination Team decided to convey to the governor and general assembly its request for support for the DEM monitoring proposals included in the submitted budget as well as the additional stream gages and invasive species proposal by the EMC, modified to include close coordination and assistance with CRMC management plans. See attachment 4.

B. Proposed Supplemental Monitoring Programs

The proposed supplemental monitoring program topics are on target but the proposals themselves could be strengthened, some significantly, with agency input, particularly from DEM. Agency staffs are well positioned to understand monitoring needs and how expanded monitoring can assist in improving environmental management. In several instances the proposals do not fully describe ongoing related work, consequently their coordination with the overall strategy is unclear.

1. Coastal and Riparian Buffers

The proposed supplemental monitoring program for coastal and riparian buffers (Gregg et al.) represents an under-emphasized aspect of the monitoring program, the land areas. This specific proposal should be more closely connected to management needs and reflect a relationship to recently completed and on-going monitoring of riparian buffers. The major contribution of the proposed study would be provision of trend analysis data on land use/land cover and impervious surfaces throughout the Narragansett Bay and South Shore watersheds (including parts of CT

and MA). However, the usefulness to management decision-making of 5-year updates on impervious surface estimates has not been demonstrated. The anticipated 2006 update of the RIGIS land use/land cover dataset will provide more detailed information on land use and land cover in Rhode Island than the proposed study, and it will allow a more accurate description of coastal and riparian buffer zones and land use/land cover changes in Rhode Island since previous statewide land use inventories completed in1995 or 1988. A more complete strategy with respect to this aspect of monitoring should reference recent and on-going inventories of riparian habitats in the Woonasquatucket, Greenwich Bay, Pawtuxet, and Pawcatuck watersheds. In addition to assessment of condition, there is a need to identify potential riparian areas for restoration.

2. Invasives

The proposed supplemental monitoring program for bioinvasives (Gould and Endrulat) addresses an important emerging issue. This specific proposal is targeted to freshwater. Future monitoring should be extended to salt water. The proposal is well-developed and should be supported if possible. Further coordination with DEM and CRMC staff working on invasive species should be done to broaden invasive monitoring coverage. In addition, the committee suggests that careful thought is needed about what a management program for invasives should be and how it can be put in place to allow necessary actions to be taken quickly. The SAC urges a focus on a small set of known big problem species – developing a database and an action plan for those first, rather than to spending much time initially on a comprehensive database. The need for an action plan sooner rather than later is based on the fact that it is much easier to deal with early invasions than to eradicate problem species that have become established. Once it is clear that management needs are being met, continued expansion of the database would be in order.

3. Nutrients

Three of the proposed supplemental monitoring programs are related to nutrients – benthic community structure, zooplankton, and secondary productivity. These may be timely in light of proposed management actions to reduce nutrient discharges from sewage treatment plants. However, the committee felt that all of the proposals need to be developed more fully in the context of scientific and technical review, interaction with scientists already conducting monitoring programs, and connection to management actions.

One proposal (Sullivan and Oviatt) was to measure zooplankton species and abundance at upper Bay locations and to take advantage of samples already collected but not analyzed from Fox Island. Zooplankton are expected to respond rapidly and detectably to nutrient reduction and there is a paucity of data on zooplankton. It would be very useful to have baseline data. The NOAA Bay Window funding supports the monthly survey around the Bay with the NMFS NuShuttle. The NuShuttle captures zooplankton on a continuous plankton recorder and it also has an optical plankton recorder. So far, neither data set is available. The continuous plankton recorder data on gauze netting is being processed in Poland and could be available shortly. The SAC encourages the Bay Windows project to expedite processing of optical plankton recorder data and to make these data available as soon as possible. The Bay Windows project should also exploit available data for ground truth and identify any gaps that may need to be filled.

Another proposal (Oviatt) was to do benthic sampling. Benthic core sampling, except for a couple of holes at Bullocks Reach and Fields Point in the Providence River, is in good shape. In

2004 a suite of 15 core samples was collected from each of 4 upper Bay stations and Fox Island and these are being analyzed for baseline condition before treatment plant nutrient reductions. In June 2005, using National Coastal Assessment funding from EPA, samples will be taken at each of those 5 stations, including a Bullocks Reach Station and a Fields Point Station in the Providence River, using a sediment profile imaging camera for baseline condition prior to nutrient reduction. In June 2006 cores are planned to be collected from all 7 stations to observe conditions after nutrient reduction although funding has not yet been identified for this effort.

Two proposals (Nixon et al.) addressed secondary productivity – one using quahog shell growth and another using RNA/DNA of winter flounder. A concern about the RNA/DNA measurements in the flounder proposal is that those ratios reflect only instantaneous growth rate rather than a growth rate that would reflect ambient conditions. Otolith measurements might be more reflective of nutrient conditions but are difficult to make because of the geometry of the otolith structure in winter flounder. Other concerns have been raised about interpretation of quahog shell growth. Would the measurements reflect primary productivity levels or other filter-affecting parameters like low dissolved oxygen (or even toxics)? Rice has collected data that indicate quahogs in the lower Providence River had typical growth-ring widths for their age but lower meat weights than populations farther down the Bay. Carefully controlled laboratory experiments may be necessary to interpret data. Even more basic questions arise as to the relationship between growth rates and ecosystem functioning. Is maximum growth rate a desirable overall ecosystem condition or more appropriate for an agricultural/aquacultural context? This work should compete as a research project. The SAC feels that utility for management needs to be demonstrated before being considered as a monitoring program.

4. Submerged Aquatic Vegetation (SAV) (eelgrass and macroalgae)

It is our understanding that support is expected in FY2006 for efforts toward the aims of, though not as comprehensive as, the proposed supplemental monitoring programs for eelgrass (Traber et al.) and macroalgae (Deacutis et al.). The committee encourages aerial surveys to cover the coastal ponds, Little Narragansett Bay, and the Sakonnet River, in addition to Narragansett Bay, if possible. Appropriate ground-truthing is necessary. Macroalgae monitoring methods are experimental. The SAC suggests that a strategy for macroalgae monitoring be reconsidered after the results of the coming season's efforts are available.

The committee would encourage an overview of current eelgrass assessment efforts, together with an evaluation of the results of restoration, protection, and development activities in RI in recent years. Special emphasis should be given to eelgrass restoration sites and sites where CRMC has placed special conditions on permits to protect eelgrass. Special emphasis should also be given to reference sites that might indicate the health of naturally occurring eelgrass populations and help distinguish the effects of good years and bad years from the effects of management interventions. Monitoring protocols should also be assessed. Three randomly selected subsections (out of 25) in a 1-m^2 quadrat might well be insufficient to accurately estimate shoot density, especially where density varies widely. A running mean of density against the number of plots sampled might indicate the minimum sample size needed to achieve accurate density estimates. Canopy height is a stand characteristic and so should be measured in the field. If this is impractical, and measurements must be taken on plants in the lab, the variable might be termed "plant height" instead. This assessment should be conducted in coordination with the RI Habitat Restoration Team.

4. EMC Coordination

The EMC has served as a valuable mechanism for convening the wide range of parties involved in monitoring. Its work may be the best example of coordination related to the Coordination Team to date. At present, however, its work is not supported. Its work is not done and some support is necessary for it to continue. The SAC intends that its recommendation for support for the work of the EMC be recognized as an important general finding (tier 1). Inclusion of comments in this tier is intended to address the specific proposals in the strategy regarding its work.

The EMC has also provided valuable technical assistance with data. Improving data access and availability are critical to the success of a monitoring strategy. Different agencies and investigators properly use different methods for managing their data. Some lack skills to easily make data available. The EMC has provided valuable assistance. The collaborative also supports internet access to enable users to locate and be connected to various data sets. These services should be recognized and supported.

The SAC encourages the EMC to consider its proposed communication strategy from a scientific perspective. What are the indicators and metrics that will tell us if the communication strategy is successful? Will there be periodic tests? How will know if our communication is reaching the diverse audiences within the state? How will we know if the communication strategy is improving environmental management? Will social scientists be invited to review the communication devices and suggest improvements? Can the communication strategy be compared to those used in other regions that have benchmarks for success?

C. Additional Monitoring Efforts

Several efforts viewed as important by the SAC were not included in the monitoring initiative proposed by DEM or the supplemental monitoring projects. The committee would like to call attention to the following monitoring needs.

1. Wetlands Monitoring

Wetland monitoring is an important omission from the EMC's supplemental monitoring proposals and the strategy in general. Inland and coastal wetlands are among the most important and most vulnerable habitats associated with Rhode Island's bays, rivers, and watersheds. Monitoring of the extent, composition, and condition of the state's wetlands is essential for a variety of regulatory and non-regulatory purposes. Among these are state and federal wetland regulatory reviews and enforcement, cumulative impact assessment at the watershed scale, wetland restoration planning and evaluation, gauging the effectiveness of regulatory programs, conservation and open space planning, assessment of habitats for species of concern under the new State Wildlife Grants (SWG) program, and assessing the impact of invasive species and sea level rise on wetland integrity and functions.

Under the Clean Water Act, EPA requires all states to monitor and report on the condition of the waters of the United States, including wetlands. In response to this requirement, RIDEM recently released a draft document entitled, "Rhode Island Wetland Monitoring and Assessment Plan" (NEIWPCC and RIDEM 2005). This plan lays out a comprehensive approach for monitoring and assessing wetland extent and condition, human impacts, and management

effectiveness statewide, using landscape assessments, rapid field assessments, and intensive site assessments. It is too early to discuss this plan in detail due to its draft nature; however, when the plan is in its final form, it should be integrated into the overall monitoring framework that the EMC and the CT are developing. DEM and EMC should collaborate closely to insure that projects proposed and conducted under the Wetland Monitoring and Assessment Plan meet EMC standards and requirements for data sharing and quality control.

In their draft wetland monitoring and assessment plan, NEIWPCC and DEM stated that, "Ideally, a landscape assessment tool for wetlands in RI would begin with an update of the required GIS data layers" (p. 14). We concur. An update of the RIGIS land use dataset is tentatively scheduled for 2006. Ideally, the RIGIS wetlands dataset, which was created by interpretation of 1988 aerial photographs, should be updated at the same time, using the same imagery. In our view, updating of the RIGIS wetlands dataset would be critical to the success of the proposed statewide wetlands monitoring and assessment program and, more specifically, essential to the effectiveness of DEM's and the RI Coastal Resource Management Council's (CRMC) land use regulatory programs. See Attachment 5 for more details on the need for updating of the RIGIS wetlands dataset.

The SAC strongly recommends that the planned wetlands monitoring and assessment program, and the updating of the RIGIS wetlands dataset in particular, be given high priority for implementation under the statewide environmental monitoring strategy currently being developed by the Coordination Team and EMC.

2. Critical Fish Habitat

Currently the state does not have a definition of critical fish habitat (CFH) or identification process for mapping these habitats. All of RI waters are defined as Essential Fish Habitat under the federal Sustainable Fisheries Act. However the act also defines Habitat Areas of Particular Concern (HAPCs). CFH and HAPCs could be defined similarly. Monitoring of fish habitat is important to understanding how regulated and unregulated activities and environmental factors (such as water temperature, water quality, aquatic vegetation, substrate, etc.) are impacting areas that are used for various life stages for species in RI waters.

The following are habitats that are considered CFH for various life history stages of a number of species in Narragansett Bay:

1. Deep Channels - Certain species (e.g., winter flounder) use the deep channels of the Bay for movement in and out of the Bay and for movement to the upper Bay spawning areas (e.g., lower East Passage from Gould Island south).
2. Deep Depressions - These areas appear to be important to a number of species as cold water refugia (e.g., Warwick Light, Sakonnet River off Fogland Point, north of Mt. Hope Bridge, hole southwest of Hog Island).
3. Shallow Water - Many species utilize shallow areas of the Bay (<5 meters) especially quiet coves for spawning and nursery areas (e.g., Wickford Harbor, coves of the Providence River, Ohio Ledge, around Fox Island, Barren Ledge south of Conimicut Point).
4. River Mouths - Certain areas around river mouths where fresh and marine waters mix appear to be important to many species (e.g., mouth of the Warren River is an important nursery area).
5. Submerged Aquatic Vegetation (SAV) - Predominately eelgrass (*Zostera marina*) is an

important spawning, nursery, refugia, and feeding habitat.
6. Rocky Habitats - These habitats with their attached rockweed are important to many species (e.g., tautog & cunner).
7. Kelp Beds – These are very important for species such as dogfish and skates (e.g., lower West Passage from Bonnet south, mouth of Sakonnet River off Sachuest Point).
8. Salt Marshes – Salt marshes are very important as spawning and nursery areas. Habitat contiguous to salt marshes is also important.
9. Shell Habitat - These areas both living and dead are important to many species.
10. Mud Flats - These areas include the intertidal zones down to the 1 meter contour where there is at least 75% mud. The areas are particularly important to many species of shellfish (e.g., Oakland Beach, Nausauket Beach).

Attention should also be paid to important but more common habitat such as soft bottom areas.

The above are habitat types that may be considered critical for certain life history stages of particular species. It should also be noted that these constitute only the physical habitat; other parameters such as dissolved oxygen and nutrient loading are also important "habitat" factors to consider when protecting or restoring critical habitat. An irony in Narragansett Bay is that some of the best habitats are located in the upper Bay adjacent to population concentrations.

For many species and life history stages what constitutes critical habitat is known. However, the spatial distribution and aerial extent of these habitat types in Narragansett Bay is either not adequately mapped or not mapped at all. In order to implement a program to protect, manage and restore CFH in Narragansett Bay a comprehensive effort to identify and map these habitat types must be implemented.

Many monitoring programs, in part, support documentation of fish habitats. Submerged aquatic vegetation areas are being assessed. Various CRMC and Sea Grant-funded efforts such as Bay May and Coast Map are collecting information on bathymetry, bottom texture and reflectance, sediment characteristics, etc. The Corps of Engineers and CRMC have collected information related to dredging and shoreline condition. NRCS is supporting investigation of sub-aqueous soils. However, identification of critical fish habitat areas has not been completed.

The State should consider a study to identify and map where Critical Fish Habitats currently exist, define areas not considered critical fish habitat, and identify areas where restoration efforts should focus. Better protection of CFH might be warranted. The state should consider a framework for managing CFH. A model for this effort might be taken from a report done for the state of Maine entitled: Maine's Coastal Wetlands: I. Types, Distribution, Ranking, Functions and Values (Ward, 1999)

Attachment 1

Review, Evaluation, and Prioritization of Environmental Monitoring Collaborative Strategy

As provided for in statute, the Science Advisory Committee (SAC) is responsible for the review of the environmental monitoring strategy. The Coordination Team requests the following process for review of the Environmental Monitoring Collaborative (EMC) strategy.

- EMC completes prioritization of monitoring actions based on need, cost, and effectiveness of proposed activity to provide meaningful measurement of selected parameter. The EMC should report back to the Coordination Team on priorities by April 1, 2005.

- The SAC consults with Chair of EMC to provide context for completed EMC report and its recommendations and to ensure collaboration between SAC and EMC

- If necessary, SAC will contact authors of the proposed supplemental monitoring activities for questions and discussion

- The EMC monitoring report in its entirety will be subject to the peer review process. The peer review should be completed by July 1, 2005, so that any recommended actions can be addressed in the upcoming budget cycle

- Coordination Team could request that the Public Advisory Committee conduct parallel review process of the EMC strategy and provide comment and recommendations to the Coordination Team

- The SAC can draw from SAC, PAC and elsewhere, to review proposed monitoring actions, evaluate effectiveness, and provide recommendations regarding monitoring priorities that the SAC will consider and use in developing report to Coordination Team

- SAC can bring in experts from outside of Coordination Team and SAC to participate in reviews

- Review criteria: (1) must have the ability to address management needs; (2) prioritization of monitoring actions must be based on need, cost, and effectiveness of proposed activity to provide meaningful measurement of selected parameter (review EMC prioritization work in EMC report); (3) proposals must be filtered through the principles included in the EMC report; (4) proposed monitoring activities must be sustainable with implementing parties identified and committed; and (5) monitoring actions should first build on existing data sets to support assessment of trends.

- The SAC will reach consensus on recommendations to be submitted to the Coordination Team for review; the peer review process will include space for minority opinions in report while moving forward with majority decision

- For any aspect of this work, SAC can determine if Ad Hoc Group assistance is needed and can request that Ad Hoc Group take on certain tasks

- Coordination Team acts on SAC recommendations or, if PAC review is conducted, on recommendations of both groups

Attachment 2

May 16, 2005

TO: Coordination Team
Environmental Monitoring Collaborative

FROM: Science Advisory Committee

SUBJECT: Environmental Monitoring Strategy

Based on an initial review of the environmental monitoring strategy, the Science Advisory Committee offers the following findings:

1. The strategy is a very significant step forward for the state. For the first time, it provides a detailed, integrated picture of major monitoring programs. The Environmental Monitoring Collaborative as a whole and DEM, in particular, deserve a great deal of credit for developing this strategy in a very short time.

2. The strategy should be recognized as still developing and, even when mature, will be dynamic. The Coordination Team should support its continued development as a high priority. Each member of the Coordination Team should ensure that his or her agency consults with the Environmental Monitoring Collaborative when new monitoring plans are being developed and informs the collaborative on status. Mechanisms should be established to keep close track of monitoring and related research supported or conducted by federal agencies and other entities. The present picture of monitoring is incomplete. The Coordination Team should also seek to provide the collaborative with at least a minimal level of support for staff to facilitate continued development and implementation of the strategy.

3. Monitoring programs and, particularly, new proposals should be tightly coupled to management needs. Specific agency needs and the management actions that will be affected should be identified and considered strongly in the design or redesign of monitoring programs. Tracking of management actions should be linked to monitoring so that the effectiveness of those actions can be assessed. Also, although much of the monitoring is supported by federal funds and driven by federal requirements, agencies and the collaborative should think more about management needs specific to this area and about interconnection of programs to move toward ecosystem management.

4. The recommended monitoring programs listed on pages 11-13 of the DEM Water Monitoring Strategy should significantly improve the state of knowledge of Rhode Island's bays, rivers, and lakes. It is our understanding that a combination of state, federal, and other resources are expected to support these programs for FY2006.

5. The proposed supplemental monitoring program topics are on target but the proposals themselves could be strengthened, some significantly, with agency input, particularly DEM. Agency staffs are well positioned to understand monitoring needs and how expanded monitoring can assist in improving environmental management. The committee expects to continue its

review of the monitoring strategy and provide a more complete and detailed report to the Coordination Team and the collaborative by July 1, 2005 as requested.

6. The proposed supplemental monitoring program for riparian buffers represents an under-emphasized aspect of the monitoring program, the land areas, including wetlands. The committee expects to offer further comments on terrestrial monitoring when its review is completed. This specific proposal should be more closely connected to management needs and reflect a relationship to recently completed and on-going monitoring of riparian buffers.

7. The proposed supplemental monitoring program for bioinvasives addresses an important emerging issue. This specific proposal is targeted to freshwater. The proposal is well-developed and should be supported if possible. Further coordination with DEM and CRMC staff working on invasive species should be done to broaden invasive monitoring coverage. In addition, the committee suggests that careful thought is needed about what a management program for invasives should be and how it can be put in place to allow necessary actions to be taken quickly.

8. The proposed supplemental monitoring programs related to nutrients (monitoring of benthic community structure, zooplankton, and secondary productivity) may be timely in light of scheduled management actions. However, the committee felt that all of the proposals need to be developed more fully in the context of scientific and technical review, interaction with scientists already conducting monitoring programs, and connection to management actions. The SAC felt that these proposals had probably been developed quickly to respond to deadlines, but that it was important to "get it right" before plowing ahead. The committee, with the cooperation of the collaborative, will investigate what similar efforts may be undertaken in FY2006 with support by Sea Grant and other NOAA funds and EPA.

9. It is our understanding that support is expected in FY2006 for efforts toward the aims of the proposed supplemental monitoring programs for eelgrass and macroalgae. The committee encourages any aerial surveys to cover the coastal ponds, Little Narragansett Bay, and the Sakonnet River in addition to Narragansett Bay if possible. The committee expects to offer further comment on these monitoring programs when its review is completed.

We hope that the comments offered here are constructive and helpful toward the evolution of a truly effective monitoring system for Rhode Island.

Attachment 3

Kleinschmidt Report to PNB (2003)	Charge to RI Environmental Monitoring Collaborative (RIGL 46-31-9 (e))	DEM Monitoring Plan[1] & RIEMC Projects
Landscape Composition (Bay)		
Shoreline buffers	Land cover or uses w/in the shoreline buffer	RI Natural History Survey proposal to RIEMC
Landscape Composition (Watershed)		
Impervious surface	Land cover or uses w/in the shoreline buffer	RI Natural History Survey proposal to RIEMC
Shoreline buffers		RI Natural History Survey proposal to RIEMC
Protected undeveloped land		RI Natural History Survey proposal to RIEMC
Population density		
Habitat Condition (Bay)	Presence of aquatic nuisance species	
Coastal wetlands		RI Natural History Survey proposal to RIEMC
Benthic habitats		GSO benthos monitoring, SAV monitoring proposal
Habitat Condition (Watershed)		
Anadromous fish habitat		
Freshwater wetlands		In Development by DEM Wetlands Division
Forested lands		RI Natural History Survey proposal to RIEMC
Water and Sediment Condition (Bay)		
Water temperature	Water temperature	DEM water monitoring plan
Salinity	Salinity	DEM water monitoring plan
Oxygen	Dissolved Oxygen	DEM water monitoring plan
Nitrogen	Nitrogen	DEM water monitoring plan
Pathogens	Bacteria	DEM water monitoring plan
Metals		DEM water monitoring plan
Organics		DEM water monitoring plan
Total Suspended Solids		DEM water monitoring plan
Flows and circulation	Water flows and circulation	NBC hydrological modeling project
Water and Sediment Condition (Watershed)		
Water temperature	Water temperature	DEM water monitoring plan
pH	pH	DEM water monitoring plan
Oxygen	Dissolved Oxygen	DEM water monitoring plan
Phosphorous	Phosphorous	DEM water monitoring plan
Nitrogen	Nitrogen	DEM water monitoring plan
Pathogens	Bacteria	DEM water monitoring plan
Metals		
Organics		DEM water monitoring plan
Total Suspended Solids		DEM water monitoring plan
Hydrology/flows	Water flows and circulation	DEM water monitoring plan

[1] *This includes monitoring by partner agencies outside DEM such as the Health Department, Narragansett Bay Commission, and URI Watershed Watch*

Fish and Wildlife Populations and Biodiversity (Bay)	Presence of aquatic nuisance species	
Fish and Invertebrates	Species assemblages and relative abundance (finfish)	DEM water monitoring plan
Shellfish	Species assemblages and relative abundance (shellfish)	DEM water monitoring plan
Benthic Organisms	Species assemblages and relative abundance (benthic macroinvertebrates)	GSO benthos project
Birds and Marine Mammals		
Chlorophyll		DEM water monitoring plan
Primary production		DEM water monitoring plan
Fish and Wildlife Populations and Biodiversity (Watershed)	Presence of aquatic nuisance species	
Fish and Invertebrates	Species assemblages and relative abundance (finfish)	DEM water monitoring plan
Macroinvertebrates	Species assemblages and relative abundance (benthic macroinvertebrates)	DEM water monitoring plan
Birds and Mammals		
Reptiles and Amphibians		
Chlorophyll		DEM water monitoring plan
Primary production		DEM water monitoring plan

Attachment 4

Coastal Institute
Narragansett Bay Campus
University of Rhode Island
Narragansett, RI 02882

R.I. Bays, Rivers & Watersheds Coordination Team

Tel 401.874.6233
Fax 401.874.6899
www.ci.uri.edu/ribayteam

June 3, 2005

The Honorable Donald L. Carcieri
Governor
State of Rhode Island
State House
Executive Chambers - Room 222
Providence, RI 02903

The Honorable William Murphy
Speaker of the House
House of Representatives
State House
Providence, RI 02903

The Honorable Joseph Montalbano
President of the Senate
Rhode Island Senate
State House
Providence, RI 02903

Dear Governor Carcieri, Speaker Murphy, and President Montalbano:

As you know, the R.I. Bays, Rivers and Watersheds Coordination Team has been implementing the scope of work for the development of the bays and watersheds systems-level plan as required by statute. As part of that work, the R.I. Environmental Monitoring Collaborative has produced a bay and watershed monitoring strategy. In order to meet critical need and take advantage of new or existing efforts, several of the elements of that monitoring strategy require the immediate attention of the Governor's Office and the General Assembly.

At the Bays, Rivers and Watersheds Team meeting on May 18, 2005, the Coordination Team members discussed elements of the strategy. Both the Environmental Monitoring Collaborative and the Team's Scientific Advisory Committee reported that, through their deliberations, they had identified a few key actions that could provide great benefit if they could be undertaken within the FY2006 budget cycle. The Team directed me, as Acting Chair, to draft a letter to you requesting that the following urgent actions be included in the FY2006 budget process.

First and foremost, the Coordination Team recommends that the Governor's proposed FY2006 budget request of $983,000 to establish a water quality monitoring program within the DEM Office of Water Resources be funded in FY2006 as requested. This initiative will support critical baseline monitoring activities identified as priorities in the R.I. Water Monitoring Strategy, prepared by DEM in coordination with the Environmental Monitoring Collaborative. The Governor's baseline monitoring initiative is widely supported and regarded as the highest priority action and needs to be fully funded.

Secondly, through its process of working with both the Coordination Team's Scientific Advisory Committee and the RI Environmental Monitoring Collaborative, the Team has identified two priority monitoring program needs for which additional funding is needed to initiate implementation. While these are key actions, the Team identified these as the next tier of immediate priorities; funding allocated for these actions should be in addition to full funding for the DEM monitoring program referenced above.

- The Team recommends $140,000 to install and operate an additional five water flow monitoring stations in key rivers. Added to an existing 20 station network with associated groundwater monitoring wells, this system is the State's primary means of assessing and projecting drought conditions that affect public safety and welfare. The additional stations will also provide data critical to watershed management and assessment of pollution sources to the State's waterbodies. The locations to be added will reflect priority actions from a plan jointly developed by the Water Resources Board, DEM and the federal USGS.

- The Team recommends $96,000 to be used by the R.I. Natural History Survey who, in partnership with RIDEM and RI CRMC, will develop a bio-invasives monitoring strategy and response plan that encompasses marine, freshwater and terrestrial ecosystems. This partnership will provide the expertise and experience to effectively address this problem. Initiating this effort in FY2006 would allow close coordination with CRMC's ongoing development of a marine invasive species management plan and provide Rhode Island with a fully integrated bio-invasives response strategy. This program will give the State a means to detect and prevent the establishment of invasive species that can rapidly cause severe economic and environmental damage.

The fact that the agencies that make up the R.I. Bays, Rivers and Watersheds Coordination Team have examined these needs together and unanimously recommended the above actions is a clear sign that the Coordination Team framework is already providing value to our efforts to work together more effectively to protect and restore the Bay and watersheds.

The R.I. Bays, Rivers and Watersheds Coordination Team asks that you take these recommendations under consideration for inclusion in the FY2006 budget.

Sincerely,

Richard C. Ribb

Richard C. Ribb
Acting Chair

cc: Daniel Varin, Chair, R.I. Water Resources Board
Paul Pinault, Executive Director, Narragansett Bay Commission
John O'Brien, Chief, R.I. Statewide Planning Program
Michael Sullivan, Acting Director, RI Department of Environmental Management
Michael McMahon, Director, R.I. Economic Development Corporation
Meg Kerr, Chair, R.I. Rivers Council
Michael Tikoian, Chair, R.I. Coastal Resources Management Council
Peter August, Chair, Environmental Monitoring Collaborative
Christopher Bergstrom, Executive Director, R.I. Economic Policy Council
Donald Pryor, Chair, Scientific Advisory Committee
Chip Young, Chair, Public Advisory Committee

Attachment 5

Recommendation for Statewide Wetlands Mapping Update

Rhode Island Bays, Rivers, and Watersheds Coordination Team
Scientific Advisory Committee
June 9, 2005

Summary

Inland and coastal wetlands are among the most important and most vulnerable habitats associated with Rhode Island's bays, rivers, and watersheds. Monitoring of the extent, composition, and condition of the State's wetlands is essential for a variety of regulatory and non-regulatory purposes. Among these are State and Federal wetland regulatory reviews and enforcement, cumulative impact assessment at the watershed scale, wetland restoration planning and evaluation, gauging the effectiveness of regulatory programs, conservation and open space planning, assessment of habitats for species of concern under the new State Wildlife Grants (SWG) program, and assessing the impact of invasive species and sea level rise on wetland integrity and functions.

The current RIGIS wetlands dataset was created by interpretation of 1988 panchromatic aerial photographs and is desperately in need of updating. Ideally, the State's wetlands should be remapped concurrently with the update of the RIGIS land use dataset scheduled by the Rhode Island Statewide Planning Program for 2006. A 2001 University of Rhode Island study funded by Region 1 of the U.S. Environmental Protection Agency (EPA) recommended that new maps be produced through stereoscopic interpretation of large-scale, color-infrared aerial photographs, coupled with the use of a digital transfer scope. Re-mapping of the State's wetlands also would be critical to the success of the R.I. Department of Environmental Management's (RIDEM) new Wetland Monitoring and Assessment initiative developed under a Clean Water Act directive from EPA. The Scientific Advisory Committee of Rhode Island's Bays, Rivers, and Watersheds Coordination Team strongly recommends that this initiative, and the updating of the RIGIS wetlands dataset in particular, be given the highest priority for implementation under the statewide environmental monitoring strategy currently being developed by the Coordination Team and the R.I. Environmental Monitoring Collaborative (RIEMC).

Wetland Functions, Impacts, and Protection

Inland and coastal wetlands (e.g., swamps, marshes, bogs, fens, wet meadows, aquatic beds, and mudflats) are among the most important and most vulnerable habitats associated with Rhode Island's bays, rivers, and watersheds. Their ecological functions and values to society are numerous and include: habitat for a diversity of fish, shellfish, and wildlife, including many rare, threatened, and endangered species; flood storage and desynchronization; water quality improvement; groundwater recharge and discharge; water-based recreation; and open space in urbanizing areas.

Many of Rhode Island's original wetlands had been destroyed or severely degraded by drainage, filling, excavation, impoundment, water pollution, and alteration of adjacent upland vegetation prior to enactment of protective legislation for coastal and freshwater wetlands in 1971. Land

use regulatory programs designed to maintain the integrity of remaining wetlands have been carried out by the Coastal Resources Management Council (CRMC) and RIDEM and its predecessors since then. For both regulatory and non-regulatory purposes, it is critically important to track the extent, composition, and condition of Rhode Island's wetlands. The best available data on wetland acreage, location, and type are contained in the RIGIS wetlands dataset.

Creation and Use of the RIGIS Wetlands Dataset

In the late 1980s and early 1990s, Rhode Island wetlands and land use were mapped under two separate contracts as part of a State landfill siting project funded by the R.I. Solid Waste Management Agency. The wetlands and deepwater habitats of the State were mapped by IEP, Inc. (1990) of Northborough, Massachusetts using 1:24,000-scale panchromatic (black and white) aerial photographs taken in the spring of 1988. Wetlands were identified, delineated, and classified using a mirror stereoscope; the minimum mapping unit was ¼ acre. There were 10 inland wetland types and 6 coastal wetland types based on a modified version of Cowardin et al. (1979).

Wetland delineations were entered into RIGIS and made accessible to anyone with access to RIGIS. RIGIS wetlands data were more recent, more detailed, and more accurate than National Wetlands Inventory maps produced by the U.S. Fish and Wildlife Service from 1:80,000-scale panchromatic aerial photographs taken in 1975, and far more detailed than wetlands maps in most other states.

RIGIS wetlands data have been used daily by a wide range of State and Federal agencies, municipal governments, educational institutions, nongovernmental conservation organizations, private environmental consulting firms, and individual citizens. Uses have included regulatory reviews, conservation and open space planning, construction planning, scientific research, wildlife habitat assessment, Natural Heritage Program inventories, and wetland restoration planning.

Need for Wetlands Mapping Update

As noted above, the current RIGIS wetlands dataset was derived from 1988 aerial photographs. Supported by an EPA Section 104 (b) (3) grant, Miller et al. (2001) surveyed the needs and opinions of wetland map users in Rhode Island, consulted regional mapping experts to identify suitable methods for meeting user needs, and laid out several options for the State to consider should it decide to update these data. They
recommended that new maps be made through stereoscopic interpretation of 1:12,000 (or 1:5,000) color-infrared aerial photographs and image transfer using a digital transfer scope (DTS). Since that report was published, RIDEM has continued to research technical approaches and costs associated with re-mapping of the State's wetlands.

The RIGIS land use dataset, which also originated in 1988, was revised once, in 1995. The Rhode Island Statewide Planning Program (Department of Administration) plans to update this coverage again in 2006, using 2003/2004 color orthophotography obtained by the R.I. Department of Transportation (RIEMC 2005). RIEMC strongly endorsed the planned update of the RIGIS land use data, but made no mention of the need for an update of the wetlands dataset. When the original RIGIS land use dataset was created from 1988 aerial photographs, the

boundaries of all wetlands at least ½ acre in size were simply copied from the wetlands dataset, which had been developed from the same aerial photos. Ideally, the wetlands dataset should be updated at the same time as the land use dataset. Updated wetlands maps and associated trend analyses would serve several important purposes; among those are the following:

- facilitating permit reviews and enforcement of land use regulations by RIDEM and CRMC, as well as the U.S Army Corps of Engineers under Section 404 of the Clean Water Act and NRCS under the Food Security Act;
- tracking changes in wetland area and types since 1988 to identify possible causes of change and to assess the impact of such changes on flood levels, stream flow rates, and water quality in Rhode Island's rivers, lakes, and tidal waters;
- facilitating identification and prioritization of potential wetland restoration sites;
- evaluating the effectiveness of regulatory programs (e.g., permitted wetland losses, non-permitted losses, and success of mitigation projects);
- assessing the impact of proactive restoration on the State's wetland resource;
- aiding in habitat assessment and monitoring for wildlife species of concern under the new State Wildlife Grants (SWG) program;
- providing a basis for assessments of the impact of invasive plants on wetland habitats; and
- assessing the potential impacts of climate change (sea level rise) on tidal marshes.

To meet the variety of needs identified by Miller et al. (2001), wetland maps must include classification information (i.e., wetland types, based primarily on dominant vegetation). Such information is required for wildlife habitat evaluation and to accurately assess changes in habitat due to natural causes (plant succession); illegal clearing, filling, excavation, or hydrologic manipulation; mandated mitigation projects; proactive restoration; or the spread of invasive plants. Although it is possible to update the RIGIS land use dataset using digital color photography through "heads-up digitizing" on a computer screen, that approach is not sufficiently accurate for wetland classification. Instead, we recommend that stereoscopic interpretation of large-scale, color-infrared photographs be used for wetland mapping, as suggested by Miller et al. (2001), and that those same photographs be used for the land use update. This approach would insure the proper integration of these two datasets.

Attachment 6

Literature Cited

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. U.S. Fish and Wildlife Service, FWS/OBS-79/31, Washington, D.C. 131 pp.

Doberstein, Craig P. et al. 2000. The effect of fixed-count subsampling on macroinvertebrate biomonitoring in small streams. Freshwater Biology 44: 355-371

IEP, Inc. 1990. Final report: Development and digitization of wetlands data for environmental planning. Prepared for URI Environmental Data Center, Department of Natural Resources Science, by IEP, Inc., Northborough, Mass. !5 pp. + appendices.

Lorenz, Armin et al. 2004. 'Electronic subsampling' of macrobenthic samples: how many individuals are needed for a valid assessment result? Hydrobiologia 516: 299-312

McBride, Margaret et al. 2004. Fisheries Ecosystem Planning for Chesapeake Bay. Chesapeake Fisheries Ecosystem Plan Technical Advisory Panel. American Fisheries Society

Miller, N.A., F.C. Golet, and P.V. August. 2001. Options for mapping Rhode Island's wetlands: Recommendations based on user needs and technical, logistical, and fiscal considerations. Final research report prepared for R.I. Department of Environmental Management, Office of Water Resources, Providence, R.I. and U.S. Environmental Protection Agency, Region 1, Boston, Mass. 53 pp.

NEIWPCC and RIDEM. 2005. Rhode Island wetland monitoring and assessment plan. Draft report prepared by New England Interstate Water Pollution Control Commission, Lowell, Mass., and R.I. Department of Environmental Management, Office of Water Resources, Providence, R.I. 39 pp. + references.

RIEMC. 2005. A strategy to begin development of an environmental monitoring framework to support systems-level planning for Rhode Island's bays, rivers, and watersheds. Report by the Rhode Island Environmental Monitoring Collaborative to the Rhode Island Bays, Rivers, and Watersheds Coordination Team. January 2005. URI Coastal Institute, Narragansett, R.I. 39 pp. + appendices.

Ward, Alison E. 1999. Maine's Coastal Wetlands: I. Types, Distribution, Ranking, Functions and Values, DEPLW1999-13, Bureau of Land & Water Quality Division of Environmental Assessment, Augusta, ME.

Wildish, D. J. et al. 2001. Cost-effective monitoring of organic enrichment resulting from salmon mariculture. ICES Journal of Marine Science 58: 469-476

Coastal Institute
Narragansett Bay Campus
Box 36
University of Rhode Island
Narragansett, RI 02882

Tel 401.874.6513
Fax 401.874.6869

www.ci.uri.edu/ribayteam

THE RI BAYS, RIVERS AND WATERSHEDS COORDINATION TEAM SCIENTIFIC ADVISORY COMMITTEE
MEMBERSHIP

David Bengtson
Professor
University of Rhode Island
College of Environment and Life Sciences

Jeremy Collie
Professor
University of Rhode Island
Graduate School of Oceanography

Christopher Deacutis
Narragansett Bay Estuary Program
University of Rhode Island
Narragansett Bay Campus

Laura Ernst
Project Manager
ESS Group, Inc.

Mark R. Gibson
Deputy Chief
RI Department of Environmental Management
Division Fish and Wildlife

Art Gold
Professor
University of Rhode Island
College of Environment and Life Sciences

Frank Golet
Professor of Wetland Ecology
University of Rhode Island
College of Environment and Life Sciences

Julie Lundgren
Conservation Scientist
The Nature Conservancy

Candace A. Oviatt
Professor
University of Rhode Island
Graduate School of Oceanography

Donald Pryor
Center for Environmental Studies
Brown University

Saul Saila
Professor Emeritus
University of Rhode Island
Graduate School of Oceanography

Craig Swanson
Principal
Applied Science Associates, Inc.