MARINE SCIENCES RESEARCH CENTER
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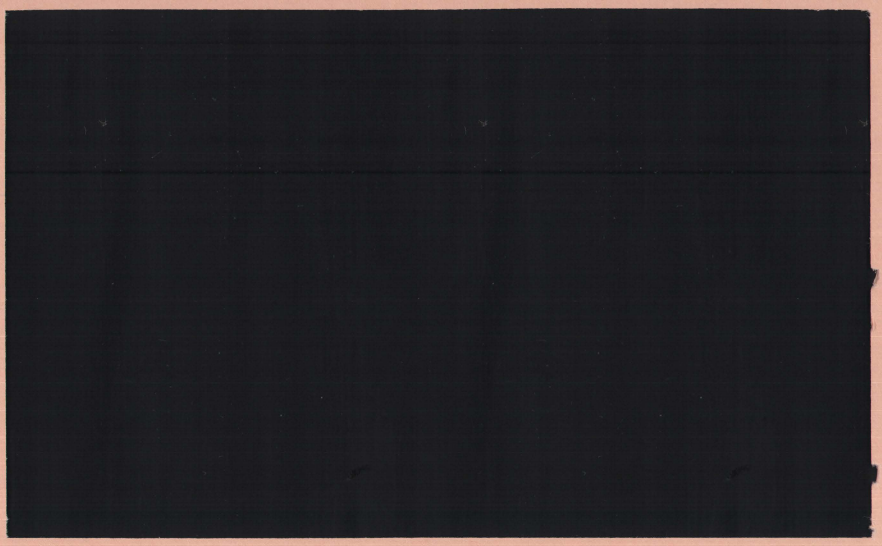
ON DEVELOPMENT OF AN ESTUARINE SCIENCE-MANAGEMENT PARADIGM

Report of a Workshop
20 September 1990

COAST Institute
of the
Marine Sciences Research Center



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PREFACE

This working paper is the first in a series of reports that will be prepared as part of a project to develop a model program -- a paradigm -- of research, monitoring and modelling in support of management of New York's important coastal marine systems.

INTRODUCTION

This a summary of the conclusions and recommendations of a workshop held on 20 September 1990 at the Hudson River Foundation. The goal of the workshop was to outline the elements of an ideal program of research, modelling, monitoring and education in support of better, more effective, management. It is to be the ideal program -- the paradigm -- of science in support of management, an Estuarine Science-Management Paradigm (ES-MP). The ES-MP is to be applicable to each of New York's major coastal marine systems.

At the outset of the meeting, everyone agreed that the essential elements of the Estuarine Science-Management Paradigm are

- research
- modelling
- monitoring
- education
- analysis/synthesis/interpretation of data for decision makers
- partnerships among scientists, managers and other decision makers.

It was agreed that research, modelling and monitoring are all inextricably linked and should be portrayed perhaps like the arrows in the often used recycling logo; each activity feeds the others. Partnerships among scientists, managers and the public; efforts to transform data into information and to stimulate the analysis, synthesis and interpretation of

data and information; and education are the energy sources that fuel the cycle.

The key parties who must be involved in the ES-MP are scientists, decision makers, educators and the public. Each has important roles to play. In our paradigm, the whole is greater than the sum of its parts. It is these partnerships that will set the ES-MP apart from other regional programs.

Because of the nature of the program that we are designing -- science in support of management/society -- it is important that for each major coastal system there be an explicit identification of the assets/values/uses that society considers to be important now and for the future. This identification must be achieved through broad consultation with the public. Having identified these assets/values/uses, the next questions become whether present management policies and practices can attain and sustain these characteristics and, if not, whether we have the scientific and technical knowledge and information needed to formulate appropriate management strategies -- strategies that will achieve the desired goals with acceptable levels of certainty. This analysis will lead to an identification of management issues -- of management questions -- and to a research program to provide the necessary information.

RESEARCH

For the Hudson River and estuary a logical point of departure would be those management issues identified at the Manhattan College Conference, 12-14 March 1990. Management issues should lead to the definition of the scientific program. In the ES-MP we strive for, the research component must be a research Program -- with a capital "P" -- and not merely a collection of research projects. This is one of the characteristics that should distinguish the ES-MP we are designing from the more traditional good, or even excellent, science programs. It is clear that in a program of science in support of management while excellent fundamental, unfettered research is essential, it is not sufficient to achieve the desired results.

In designing the research Program one might use as an analogy the "Tight-Loose" concept proposed by Peters and Waterman in their book "In Search of Excellence." In our context it would mean that the research Program would be tight to the various management issues, but loose in the freedom that it would provide scientists to pursue those issues. This kind of tight-loose coupling is essential if the very best scientists are to be engaged in the Program and if their interests are to be retained. But, the coupling must also be "tight" to important management issues if the program is to succeed in achieving the objectives we have set. Attaining the appropriate balance of "Tight-Loose" will require good program management, management of a kind and at a level rarely seen, at least in the environmental field. It will require control -- that is after all what

management is -- but again the concept of tight-loose may be a good one to follow.

The Estuarine Science-Management Paradigm built around management issues should have both short term and longer-term research components. Managers must answer management questions now; that's the nature of management. The ES-MP should help in providing the best available information to those managers now and in forms that are helpful. But the urgency that characterizes the mangers' existence should not be allowed to be used as an excuse for not getting on with tackling the longer-term, more difficult scientific environmental questions that have been avoided for so long. Once again, because the paradigm would be an independent program outside of any agency control, it should have the freedom necessary to attack the next generation of research problems, and proper leadership can provide the courage to protect that freedom.

If the goal of the paradigm is to win the war -- to gain and retain the support of essential constituencies necessary to improve management of important coastal environments -- it must win some battles along the way, but winning the battles will not ensure the ultimate victory. The problems of coastal environments today differ little from those of a decade ago. Indeed, in most coastal systems the problems differ little from those of at least 50 years ago. The differences are largely in degree and not in kind. Our understanding of coastal processes, of how society has affected those processes, and our ability to formulate effective management strategies have been hampered by the limited funding and by

the scope and scale of research programs. The ES-MP should strive to take estuarine and coastal research to the next level. This is the only way that estuarine and coastal management can be taken to the next level. It will require multi-year support of multi-institutional teams to pursue truly multi-disciplinary research; an activity that has been talked about for years, but an activity for which funds have rarely been sustained long enough to test the value of the investment.

Another general feature of the paradigm is that there will be mechanisms for continually updating the "story" -- updating progress in understanding different aspects of the system as it evolves through new understanding and new knowledge, and in the ability to address management issues. Once again, this would distinguish the research component of the Estuarine Research-Management Paradigm from more traditional research programs, and even from research in support of management programs.

MODELLING

Modelling involves research and models are tools which allow us to describe the environment, or segments of it, or processes and allow us to make forecasts of how changes in one part of a system will be manifested in other parts of the system. Models come in all sizes, shapes and varieties but all share these features in common.

Models are sometimes spoken of as though they had an isolated, independent existence. This is never the case. A model is, of necessity,

one half of a duality. There must always be both the model and the thing modelled. A model reproduces some, but never all, of the features of the thing modelled. Thus, the prime requisite of any model is that the features of the thing to be modelled be known. Without knowledge of the features of the original, no "model" is possible.

We build models in order to get something more manageable than the original. The word "model" comes from the *Latin modulus* which means "a small measure".

Modelling is a component of research. Models are tools to turn data into information and they range from the simplest conceptual models to the most sophisticated mathematical models. Different kinds and sophistications of models are needed for different processes, characteristics, segments of a system and for different management purposes. The ES-MP should strive to develop and maintain a good match between the models available and the management needs. There is no universal model that will solve all of the questions and problems that might arise, but there are some very basic models that will be required for each major coastal system. These should be identified and developed, and mechanisms should be in place to ensure that they take full advantage of advances in knowledge and new data developed through the monitoring program.

It should be clear, then, that all but the most general models should be developed after the management issues have been identified. Going from a

management issue to the identification of the appropriate models requires research and the development of those models is indeed a research endeavor. Among the models needed to address questions that cut across many of the major issues in each coastal system are hydrodynamic and sediment transport models. The ES-MP should accelerate development of biological models that can be used to model different aspects of the food chain. It would be appropriate for the ES-MP to place a priority on refining the ability to model nutrient and phytoplankton dynamics and then to move modelling capabilities progressively up the food chain. Any models that are developed should be thought of in a larger context both geographically and in terms of multiple environmental media.

Special attention should be devoted to development of linked models. For example, a food web or sediment transport model might be linked, or coupled, to a hydrodynamic model. A particular example where effective linkages of models is needed is for ecosystem models and fisheries management models. Research on higher tropic levels, including fish and fisheries, should be nurtured and from the outset modellers and biologists should work together to ensure that the two efforts are compatible. In general, fisheries management models have not yet reached the level of sophistication needed to accommodate output directly from models reflecting more basic components of coastal ecosystems. Typically, a great deal of manipulation of output is necessary to use ecosystem models to address fisheries management needs. These adjustments may compromise important information generated by ecosystem models. More attention needs to be directed at carefully matching input requirements of

fisheries management models with output capabilities of ecosystem models. The ES-MP could make an important contribution by supporting development of linkages among ecosystems and fisheries management models.

PARTNERSHIPS AMONG SCIENTISTS

In the Estuarine Science-Management Paradigm there should be mechanisms to develop and maintain collaborations of modellers, theoreticians and observationalists. Once it is accepted that all of these activities are important and legitimate areas of research, their collaboration should be easier to accomplish. We look then to nurture development of a new research culture in the ES-MP. The development of that culture will be accelerated by the formation of teams that include the very best minds representing key areas of collaboration. These partnerships should be negotiated by the leadership of the ES-MP up front, in the proposal preparation phase. This is not meant to infer that guarantees should be given to individuals. They should not. Multidisciplinary, multi-investigator, multi-institutional collaboration should be encouraged and nurtured at the development phase and the proposals that result should be subjected to rigorous peer review before any funding commitments are made. It is implicit, however, that once funded, the commitment of support to these teams would extend beyond the normal one year cycle. One might think of commitments of three to five years. Again, we stress that as the research evolves there would be frequent and recurrent interaction with the managers through science-

management teams.

In the ideal conceptual program -- the ES-MP-- one might want to insist that every modelling proposal have an observational component and that every proposal of a primarily observational/experimental nature have a modelling component. It would also be appropriate for each proposal to indicate how it would utilize monitoring data that already exist, monitoring data that are being collected, and to stipulate what additional monitoring activity would be valuable.

The following topics were identified as good research-modelling-monitoring initiatives to start with.

- Sediment transport and resuspension -- contaminant uptake and release

- Nutrient dynamics and primary productivity

- Hydrodynamics

MONITORING

The first question to be asked by the ES-MP for each coastal system relative to monitoring is what monitoring program is needed to complement the research and modelling programs to address the major management issues that have been identified. Once this question has been

answered, a rigorous analysis should be made of the existing monitoring programs already being conducted to determine whether they are adequate for the purposes of the ES-MP. This should be done for each coastal system by a team of experts. If existing monitoring activities are adequate to meet the specific needs of the ES-MP, the next question is whether or not the data are readily accessible and whether there are assurances that the critical observational programs will be continued.

If there is any uncertainty, the ES-MP may wish to create its own monitoring program. This should be done only if existing monitoring efforts cannot meet the needs of the ES-MP. The keys will be in getting the appropriate data on a timely basis, having confidence in their precision and accuracy, and developing mechanisms to ensure that the data are transformed into information useful to the managers associated with the ES-MP.

The ES-MP should not attempt to coordinate all of the monitoring activities being carried out by federal, regional, state, county and city agencies in the coastal system. Effective monitoring programs are carried out to address specific questions, or to test specific hypothesis. That should be the trademark of the monitoring activities undertaken or assimilated by the ES-MP. Monitoring in the ES-MP should be viewed as a form of long-term research; observational programs to answer specific questions, to test specific hypotheses, to document the status and trends of important environmental properties, to provide early warnings of incipient problems, and to assess the efficacies of management actions.

Environmental monitoring programs are of great potential value, although few even approach that potential (National Research Council, 1990).

The monitoring data which are relevant to the ES-MP should be analyzed, synthesized and interpreted at least every two years, and perhaps every year. Each of the science-management teams should review these synthesized data sets and assess their relevance to the management issue being tackled.

In the ES-MP adequate support must be provided for synthesis/analysis/interpretation over the long-term. If there are budget problems, monitoring and synthesis efforts should not be among the first activities to be eliminated. There must be patience and a constancy of commitment to the monitoring program just as to the other components to the ES-MP.

In the ES-MP monitoring program mechanisms should be put in place to be on the alert for new technologies that may permit looking at the coastal system more efficiently or more effectively, or in new and different ways. Before incorporating any new technology, special care should be exercised to ensure consistency of the data to the extent possible. Monitoring programs should receive routine periodic checkups -- perhaps every three years -- to determine whether they are still playing a useful role. Programs or parameters may be added or dropped, as appropriate. In part, this will be done through the annual evaluations by the management-science issue teams.

Since the ES-MP will be driven by societal values and uses, the monitoring of important values and uses should not be overlooked. Social scientists should be included in these initiatives. Some of the more important parameters such as the frequency and intensity of human uses of the system for different kinds of recreation and aesthetic qualities may not be measured by the existing programs of other agencies.

The public can play important roles in a comprehensive environmental monitoring program, particularly in the monitoring of values and uses such as wildlife, aquatic vegetation, recreational boating, number of bathers and the frequency of other uses of the coastal system by the public. Special educational training programs for participants in public monitoring programs can be effective. Public observers can produce data that might otherwise not be available. If the public is involved, mechanisms must be developed from the outset to coordinate the activities of public observers so that the data are reliable and so that the public groups can be kept involved over the long haul. This requires that they see how their data are being used and that the data be reported and disseminated.

One useful mechanism could be the equivalent of the Chesapeake Bay monitoring program's "Bay barometer". The "Bay barometer" appears on a regular basis in Chesapeake Bay region newspapers to provide a chronicle of changing conditions of interest to the public.

AN OUTLINE OF THE STEPS IN APPLYING THE PARADIGM

The Paradigm starts with an identification of assets/values/uses which society wants to protect or enhance in each major coastal systems. This step must involve broad consultation to assess the public's desires. The explicit and detailed identification of those qualities is followed by an enumeration of specific management issues; each stated richly. These management issues will change with time, but in all cases the scientific program should be responsive to them. The tasks will be to maintain a good match between management issues and the scientific Program, and to retain enough flexibility and autonomy so that the scientific Program takes a long view. It must be characterized by patience and constancy of commitment. This will ensure that ES-MP will enhance the probability of coming up with the kinds of knowledge and information that will be needed in the future for long-term effective management. The research program of ES-MP must be protected against the whims of society which characterize the normal agency-supported research programs, programs that often are whipsawed by political winds driven by the "pollutant of the week syndrome.

For each major management issue identified, the appropriate first step is to determine whether or not it can be addressed adequately with existing data and information -- how well it can be addressed, to what level of accuracy and richness. Once a major management issue has been selected, there should be one, or more, carefully orchestrated vertical integration

efforts aimed at fairly specific themes. These synthesis efforts should be done by a group of experts no larger than is needed to cover the essential elements of each issue. These teams should be put together by the leadership of the ES-MP through a negotiation process and not through a broadside request for proposals. Each review teams also should make a first order cut at defining the research needs, short-term and long-term, to address the management issues.

These statements of "research needs" would then be reviewed, revised and refined and transformed into a research Program. The difference between what we are proposing and the more usual research initiative would be that indeed it would be a Program, a Program with a capital "P". The Program will be made up of projects, -- most solicited through RFP's -- but mechanisms will be put in place by the ES-MP so that the projects are integrated into a Program. Much of this responsibility will be placed on the P.I.'s in mechanisms described later. All proposals should be peer-reviewed at the most rigorous level. In the selection process flexibility and openness to wild ideas must be ensured. As mentioned elsewhere, all P.I.'s will have an obligation to be part of a science-management team which meets periodically (probably quarterly) as a group to review progress on the science and how it relates to the management issue and to ensure responsiveness, interaction and integration.

These teams of scientists and managers also will meet on an annual basis in a more formal setting to prepare a white paper on the science and

management issues. These will be evolving, dynamic reports produced in serial form to provide good chronicles which document the ways in which the science has been responsive to management needs and how the research results have actually been incorporated into management policies and practices.

EDUCATION

In the Estuarine Science-Management Paradigm, education plays a vital role along with research, modelling and monitoring. Education is the mechanism for keeping the public informed and supportive. It also is the mechanism for training the next generation of scientists, managers and informed and concerned citizens -- citizens who elect our decision makers.

The following elements were identified for consideration in the educational program of the ES-MP.

- K-12 education to produce an educated citizenry.

- Undergraduate education. Design a broad scale curriculum for a four year bachelors degree in environmental science, perhaps to be taken in conjunction with another major in a specific discipline. New York might take the lead in defining the elements of a curriculum using a process similar to that used in the late 1950's and 60's to develop the Physical Sciences

Study Curriculum, the Biological Science Study Curriculum and the Earth Sciences Studies Curriculum -- but at the undergraduate level, rather than at the secondary school level which was the target of the other initiatives.

- Public education. A rich and varied public education program should be offered to keep the public informed and on board.

- Graduate student education. Training the next generation of technicians, research scholars and managers is needed to ensure that there will be an adequate standing stock of these specialists. Also, the support of graduate students to work on specific coastal systems leads to strong bonding of these individuals to the water body that they study and contributes to ensuring a high level of sustained interest and research activity in those coastal systems.

- Education of scientists to be sensitive to management and public needs/concerns/issues. This will be a hallmark of ES-MP.

- Education of educators. Generalists and specialists are needed to teach children and adults. Programs for high school teachers is an effective way of getting to a large number of students. Programs that take teachers out in the field with specialists -- on ships, to beaches, to wetlands -- is an

effective way of transferring information and of generating a sense of excitement about environmental research and stewardship.

- Education of the managers to be sensitive to public concerns and priorities and to recent advances in research ... another hallmark of the ES-MP.

- Establish sabbaticals for managers to spend time at academic institutions and for academics to spend time in management agencies. Such a program will lead to new partnerships and strengthen existing ones.

- Establish an estuarine fellowship program for journalists to spend periods of 3-12 months in colleges, universities or in state environmental management agencies. This program should result in better, more accurate, reporting on environmental issues.

- Prepare films for public television.

- Develop an environmental nature interpretive center for each major coastal system; ensure that each center is adequately staffed with experienced and knowledgeable educators and that there are accurate, up to date educational materials.

ANALYSIS/SYNTHESIS/INTERPRETATION

One of the features that will distinguish the proposed Estuarine Research-Monitoring Paradigm from other regional coastal programs is its commitment to the timely transformation of data into information, into informational products tailored carefully to the special needs of important user groups, particularly decision makers charged with management of these system and their living resources.

A key component of the ER-MP for each coastal system will be a unit dedicated to the transformation of environmental data into information and the analysis, synthesis and interpretation of data and information. The unit will have a very small permanent staff (1-3 people) whose primary function will be coordination. The unit will rely on principal investigators, on science-management teams and on other experts using a variety of mechanisms described in other sections of this report.

ON FORGING PARTNERSHIPS AMONG SCIENTISTS, MANAGERS, AND THE PUBLIC

If the Estuarine Science-Management Paradigm that we have described is to be successful, it not only must fund outstanding research, it must provide for a continuing integration of new knowledge and understanding into an evolving story of how the particular coastal system operates and of what important scientific questions remain. It also must provide mechanisms for scientists and managers to work together to translate

this improved understanding into management policies and practices to ensure that the values and uses which society wants for that system are achieved and sustained. This is a tall order. It requires a higher level of cooperation and collaboration among scientists, engineers, managers and the public than has ever been demonstrated, at least in any coastal system. It requires sustained partnerships between scientists and managers and it will be enriched if those sustained partnerships also include people from environmental organizations and other public interest groups. Partnerships depend upon open, honest and frequent exchange of ideas on important issues. They require the sharing of a vision and a dream. They require that individuals involved respect and have confidence in each other. They require an identification and acceptance of appropriate roles based upon expertise.

We propose that for each major coastal system there be created a science/management/environmental roundtable that brings together leaders from the scientific community, the environmental community and the management community on a periodic basis, perhaps monthly, to explore major findings and issues. If this mechanism is to work, it will require a commitment from individuals at the highest level of important institutions. It is a worthwhile experiment. The chances of success will be enhanced if each roundtable is moderated by someone who commands the respect of the other members of the roundtable and who is able to articulate the issues, keep the vision alive and keep meetings on track so that the participants feel that they are engaged in an important undertaking.

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