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UNDERSTANDING PUBLIC VALUES AND ATTITUDES RELATED TO ECOLOGICAL RISK MANAGEMENT: AN SAB WORKSHOP REPORT OF AN EPA/SAB WORKSHOP

PREPARED BY THE EPA SCIENCE ADVISORY BOARD

September 19, 2001

MEMORANDUM:

SUBJECT: *Understanding Public Values and Attitudes Related to Ecological Risk Management: An SAB Workshop Report of an EPA/SAB Workshop* (EPA-SAB-EC-WKSP-01-001)

FROM: Donald G. Barnes, Staff Director ***/ Signed /***
EPA Science Advisory Board (SAB)

TO: The Honorable Christine Todd Whitman, Administrator
Environmental Protection Agency

I have attached *Understanding Public Values and Attitudes Related to Ecological Risk Management*: *An SAB Workshop Report of an EPA/SAB Workshop*. The Report documents a public workshop that occurred on May 23-24, 2001 in Washington, DC, and that was supported by SAB and several EPA offices, specifically: the Office of Air and Radiation; the National Center for Environmental Economics in the Office of Policy, Economics and Innovation; the Office of Research and Development; and the Office of Water.

This Workshop Report is the first of "a new product line" of outputs from the EPA Science Advisory Board (SAB). Historically, the SAB has generated Reports, Advisories, Commentaries, and Notifications of Consultations. All but the last constitute formal advice to the Agency which is transmitted after public review by one of the formally chartered Federal Advisory Committees that are a part of the SAB complex; i.e., the Executive Committee of the SAB, the Clean Air Scientific Advisory Committee, and the Advisory Council on Clean Air Compliance Analysis.

By way of contrast, an SAB Workshop Report simply captures the discussion that took place in a workshop setting of experts who were convened to discuss important technical issues associated with a particular problem confronting the Agency and the country. The Workshop Report does not represent an SAB consensus position nor does it convey any formal SAB advice, *per se*. It is simply a record of a high-level encounter of technically qualified people whose comments should inform the Agency as it deals with the issues under discussion. No formal response to the SAB is expected.

The concept of the SAB Workshop emerged from the 1997 Strategic Planning Retreat of the SAB Executive Committee at which the members declared their intention to"[t]ake on a catalytic role in conducting workshops on important scientific issues. In addition to generating advisories, commentaries, consultations, and reviews, the SAB will work with the Agency, professional societies, or others to insure that open workshops are conducted to address important scientific issues. Such workshops may involve outside experts in a rapidly developing field... or bring together various groups inside and outside of EPA around a common issue..."

As detailed in the attached report, the Ecological Risk Management Workshop engaged a broad spectrum of federal, state, and local experts and decision makers on an issue that has proven to be complex for all managers addressing ecological risk issues. In addition to increased understanding and awareness of the issue among the roughly 100 participants, the Workshop has already led to followup interactions between local leaders and researchers, plus resources materials that have contributed to a separate, formal SAB report.

The Science Advisory Board is interested in your reactions to the SAB Workshop concept and to suggestions for topics for future Workshops.

Attachment

NOTICE

This report has been written as part of the activities of the EPA Science Advisory Board, a public advisory group providing extramural scientific information and advice to the Administrator and other officials of the Environmental Protection Agency. The Board is structured to provide balanced, expert assessment of scientific matters related to problems facing the Agency. This report has not been reviewed for approval by the Agency and, hence, the contents of this report do not necessarily represent the views and policies of the Environmental Protection Agency, nor of other agencies in the Executive Branch of the Federal government, nor does mention of trade names or commercial products constitute a recommendation for use.

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A. INTRODUCTION

EPA and the Science Advisory Board co-sponsored an EPA/SAB workshop on May 23-24, 2001 entitled *Understanding Public Values and Attitudes Related to Ecological Risk Management*. The workshop had the goal of bringing ecological risk assessment, economic benefits assessment, and other social science research together to address a real environmental problem, air deposition of nitrogen in Tampa Bay Estuary. The workshop was not an advisory committee meeting, organized with the purpose of providing advice to the Agency. Instead, it was a public workshop designed to highlight and discuss in a public forum approaches that could supplement, complement, or expand current economic methods for characterizing benefits from protecting ecological resources. The workshop was the result of collaborative planning across the Agency. Sponsors included the Office of Air and Radiation; the National Center for Environmental Economics in the Office of Policy, Economics and Innovation; the Office of Research and Development, the Office of Water; and the Office of the Science Advisory Board.

The project was sparked by the work of the SAB's Valuation Subcommittee for the Integrated Risk Project. The workshop implemented a suggestion in the Board's report, *Toward Integrated Environmental Decision Making* (EPA-SAB-EC-00-011), to create a forum for open discussion on the topic of natural resource valuation. The workshop focused on a specific place, with specific ecological risk management problems. It provided an opportunity for in-depth discussion of alternative research strategies for understanding why people value protecting water resources in Tampa Bay against nitrogen deposition, and how much they value them. The conversation that occurred among researchers; state, federal, and local risk managers; and a diverse audience provided a springboard for discussion of how the Agency might generally expand its approaches for eliciting, characterizing and understanding public values.

The workshop focused on practical discussions to transcend "What We Have" currently in EPA's analytical toolbox for understanding "Forming, Eliciting & Considering Public Values." The SAB Report, *Toward Integrated Environmental Decision Making*, noted current problems in the following areas: (1) difficulty translating changes in ecological conditions into monetary units; (2) difficulty measuring values placed on keeping ecosystems viable ("existence values")--public often does not have knowledge about ecological impacts; (3) ecological services not reflected well in markets; and (4) difficulty measuring values such as equity and sustainability. The workshop aimed to shift the discussion to seek "What We Need," namely: (1) better methods to estimate value the public places on protecting ecological conditions; (2) better methods to incorporate values and preferences into decision-making; and (3) more open dialogue among scientists and between scientists and decision makers. The specific contribution of the workshop was to explore how social sciences have been and could be applied to ecological risk management Dr. Milton Russell provided a historical perspective in his presentation at the workshop. His remarks are included as Section B of this report.

The Tampa Bay Estuary Program was an active partner in the effort, since air deposition of nitrogen is the next frontier for that program, which has a well-articulated assessment of the ecological

damages associated with nitrogen pollution. The Bay is Florida's largest open water estuary and has successfully addressed nitrogen pollution from more traditional sources, such as sewage treatment plans. Benthic organisms, corals, waterfowl, and seagrasses have returned to the Bay. The Tampa Bay Estuary Program has a history of voluntary partnerships to meet environmental goals, demonstrated by its *Tampa Bay Estuary's Comprehensive Conservation and Management Plan; Partnership for Progress, The Tampa Bay Nitrogen Management Consortium Management Plan*, and the partners' agreement on an environmental goal and an indicator of concern--restoring seagrasses to 1950's levels.

The Bay Program offered its experience as a focus for the workshop, since new ecological risk management issues were appearing for the Bay Program and new research tools from the social sciences might be helpful. In the next 15 years, the Bay Program expects population in the Bay area to grow by 600,000. New sources of nitrogen pollution, the Bay's biggest problem, are air pollution from utilities, other industries and automobiles and runoff from lawns, streets and parking lots. These sources of pollution are expected to increase. The Tampa Bay Nitrogen Management Consortium estimated that large reductions in atmospheric deposition of nitrogen will be necessary if the Tampa Bay Estuary Program is to meet its nitrogen reduction goals. The science surrounding atmospheric deposition and its ecological effects is relatively new; there is uncertainty about risk assessment estimates; and less experience among Tampa Bay partners in dealing with controlling air emission than with land-based, stationary sources. Ms. Holly Greening, Senior Scientist from Tampa Bay Estuary Program, provided an introduction to risk assessment and risk management questions for the workshop participants. Her presentation is included as Appendix C of this report.

The Tampa Bay Estuary Program framed specific risk management questions, relevant to decisions to be made by federal, state and local governments concerning air deposition of nitrogen. EPA provided those questions to social science researchers, selected through a competitive process. The challenge to each of the researchers was to develop a proposed research plan that would detail methods for collecting, analyzing and interpreting social science data that would assist managers in addressing risk management questions at Tampa, where the nature, depth and breadth of public support for addressing air deposition issues are an issue. The researchers were asked to describe how they would provide information that would help managers make decisions, communicate decisions, and justify decisions related to protecting ecological resources.

The centerpiece of the Workshop were the presentations from researchers from four different social science traditions. The Science Advisory Board managed a competitive process that awarded contracts to four senior social scientists to prepare the research plans and participate in the workshop. (See Appendix E for a sample Statement of Work for one of the social scientists, describing in detail the tasks required for the research plan, including the specific risk management questions from Tampa Bay to be addressed.) EPA made awards to: Dr. Terry Daniel, Department of Psychology, University of Arizona, Tucson, Arizona; Dr. Robin Gregory, Decision Research, North Vancouver, British Columbia, Canada; Dr. Willett Kempton, College of Marine Studies, University of Delaware, Newark, Delaware; and Dr. James Opaluch, Department of Environmental and Natural Resource Economics,

University of Rhode Island, Kingston, Rhode Island. The full text of the Proposed Research Plans appears as Appendices F through I of this workshop report. The Executive Summaries for the Research Plans appear in Section 4 of the Report.

A panel of risk managers participated in the workshop, representing a diverse group of senior managers from EPA (Office of Air and Radiation, Office of Water, Office of Research and Development, Region 4, Office of Policy Economics and Innovation), the State of Florida, and Pinellas County, one of the partners in the Tampa Bay Estuary Managers. (The list of panel members appears in Appendix B.) The managers discussed how the four proposed research plans, if funded, could potentially help them make decisions, communicate decisions, and justify decisions related to protecting ecological resources in Tampa or in other places where ecological resource protection is an issue. They also were asked to discuss: (1) What opportunities do the approaches offer that current strategies for understanding values and attitudes do not?; (2) What follow-up actions would be desirable – either in the area of risk management or research?; and (3) What other kinds of problems do you think would benefit from the kinds of approaches described? The full text of the questions for panelists appear in Appendix D.

The Chair of the Workshop, Dr. Baruch Fischhoff, prepared a "Sense of the Meeting Summary" (Section A of the report), which captured major points from the panel discussion.

B. WORKSHOP CHAIR'S "SENSE OF THE MEETING" SUMMARY

Prepared by the Workshop Chair, Baruch Fischhoff[1]

B.1. Definitions.

The term "value" has multiple interpretations, which were identified, but not resolved, at the workshop. At the one extreme, the term refers to fundamental predispositions, moral precepts, and ethical standards. At the other extreme, it refers to the articulation of such basic values in specific contexts, reflecting preferences among alternative conditions. Moreover, people's "values" might be taken as they are, when valuation questions arise, or "constructed" through a process affording individuals an opportunity to learn about the issues and their feelings toward them. "Attitudes" typically are attached to focal objects, although without explicit consideration of alternatives (and the tradeoffs implied by choices among them).

As noted below, choosing the kind of values pertinent to a specific context is a critical aspect of designing an assessment process. Using common terminology is essential to effective collaboration, across disciplines as well as between professionals and practitioners. Rather than adopting any one discipline's conventions, this summary uses "value" for any evaluation derived by questioning individuals.

B.2. Environmental Science

a) Well-informed evaluations require accurate summaries of the science about the environmental systems involved, including the surrounding uncertainties and controversies.

b) The research agenda for that science should be sensitive to policy concerns, so that it focuses on the environmental science needed to inform public choices. Otherwise, research resources may not be efficiently allocated.

c) The environmental sciences need to include the social sciences. The social sciences are essential for predicting human demands on the environment and responses to interventions, for estimating economic impacts, for clarifying human dependence on environmental services and integrity, for eliciting expert judgment in policy-relevant forms, and for assessing public preferences among alternative policies.

d) Ensuring public understanding of environmental issues requires properly designed and empirically evaluated communication programs.

e) That communication should be proactive, so that authoritative information is in citizens hands as issues develop (and before misinformation shapes their beliefs).

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[1]University Professor, Carnegie Mellon University

B.3. The Science of Assessing Public Values

a) Research into public values and attitudes should meet the methodological standards of the appropriate social science disciplines (even if its subject matter is too applied to merit publication in theoretically oriented academic journals).

b) The research should be problem, rather than discipline driven. That will often require employing multiple methods, combining the strengths of different approaches.

c) When an evaluation question is posed to citizens, it is critical that it be interpreted as intended. Ensuring such comprehension requires proper preparatory work and empirical demonstration of success. Otherwise, citizens' responses may not be interpreted as they intended.

d) Researchers (here, as elsewhere) should be candid about the limits to their research. Claims of validity should reflect the basic research literature and direct demonstrations (i.e., showing the reliability of measures, their sensitivity to relevant changes in circumstances, and their insensitivity to irrelevant changes).

e) The resources invested in research should fit its contribution to the policy-making process. It is possible to spend too much and too little, as well as to misallocate resources between understanding environmental issues and evaluating them.

B.4. Policy Makers

a) Those who commission assessments of values and attitudes need to specify the kind of research that they want, helped by researchers who can clarify the methods that are available. Specification issues include:

1) Who are the relevant stakeholders, whose values or attitudes should be elicited?
2) How well informed should participants be, regarding the environmental science? Is their current level of understanding appropriate (in order to anticipate initial citizen responses to a topic) or should they be informed about the critical issues (in order to represent citizens who have invested in such understanding)?
3) How well informed should participants be, regarding alternative value perspectives? Should they respond with whatever values and attitudes come to mind or should they be presented with different views (as might occur through observing a public debate or reflecting privately over time)?
4) Should participants be encouraged to think of themselves as members of the community or to respond as individual consumers (or left to resolve their roles by themselves)?
5) Is the goal of the assessment procedure to produce estimates, needed as inputs to formal analyses, or to create a process that clarifies values and creates respectful relationships among participants?

b) Persuading citizens (either to change their values or to act on those values) needs to be distinguished from assessing their independently determined values. Both goals can be legitimate, but require different methods and relationships with citizens.

B.5. Stakeholders

a) Have a role to play in defining the problem being analyzed (lest their concerns be overlooked - leading to an erosion of trust and misallocation of research resources).

b) Are entitled to effective communication regarding the relevant environmental science and regulatory issues.

c) May need to be provided with multiple perspectives on the issues, of the sort that would arise with an intensive public debate.

d) May need multiple channels for receiving information and for providing input, suited to their habits, resources, and sophistication.

e) Must be seen in the context of their relationship to their community. Participants in a value-assessment process might help to legitimate its results for other citizens; they might also become captive of the process, losing contact with others.

B.6. Research Management

a) Policy makers need to provide core support for evaluation research, drawing on multiple relevant disciplines, so that appropriate methods are available, when managers need them. These developmental costs could be spread over many applications.

b) Research planning should create methods that, once developed, can be used efficiently in other contexts. The goal is achieving the maximum legitimate generalizability, at minimum cost. Four (non-exclusive) possibilities for pursuing this strategy:

1) Intensive demonstration projects that can be copied in other contexts, at reduced expense. (Further development of the Tampa Bay Estuary example might merit examination.)
2) Modular method development, creating pieces that can be assembled for new applications (e.g., ways to communicate environmental science, interactive programs for simulating the impacts of interventions, data analysis packages, guidelines and training for moderators).
3) Research into the generalizability of values and attitudes across contexts (recognizing that, when the assessment process itself is paramount, it needs to be repeated in each context, with the relevant individuals).
4) Independent case studies of evaluation processes, in order to show how these experiences could be viewed and improved.

c) Social scientists capable of adapting scientifically accepted methods to environmental settings are relatively scarce. That is especially true when the value-assessment process requires an understanding of environmental science and the difficult evaluation issues that often arise (e.g., changes occurring over long time periods, surrounded by great uncertainty). Three (non-exclusive) possibilities for expanding the ranks of qualified scientists:

1) Graduate and post-doctoral training opportunities.
2) Summer workshops for faculty from teaching institutions, interested in working on evaluation issues in their local communities.
3) Resources for easily adding social scientists to environmental science research groups where they are currently missing.

B.7. Research Needs (partial list)

a) Communicating the environmental science needed to make informed evaluations:

1) Uncertainty and controversy (e.g., why scientists seem so disputatious, how to reconcile competing claims in the new media).
2) The social processes of research (e.g., why and how scientists choose - and ignore - particular topics; how scientists identify and express disagreements; what peer review means).
3) Large-scale changes, especially the possibility of non-marginal (discontinuous) and irreversible changes in environmental systems.
4) Prioritizing information needs (so that participants are neither denied relevant facts nor drowned in irrelevant detail).

b) Helping people to think about the difficult values issues and choices posed by many environmental processes:

1) How to think about taking gambles with nature.
2) How to avoid paralysis through analysis.
3) How to anticipate their own future sense of loss or accommodation, with negative environmental changes.
4) How to understand the role of nature in their lives and well-being.

c) Developing better "constructive" value assessment processes (in which participants are helped to consider and evaluate alternative perspectives):

1) How to provide alternative perspectives in a balanced way.
2) How to integrate monetary and non-monetary concerns.
3) How to frame ecological valuation questions, including existence value.

d) Combining values derived from expressed preference studies (in which people are asked about them) and revealed preference studies (in which values are inferred from behavior):

1) How to infer values from (natural or designed) behavioral experiments (e.g., providing real-time information about energy consumption to drivers or home owners).
2) How does misunderstanding of environmental and economic issues affect market behavior?
3) How can econometric procedures be used to extrapolate expressed preferences from sampled populations to general ones?

e) Understanding the dynamic properties of values:

1) How do they change over time within age cohort, as the result of experience?
2) How do they differ across cohorts (e.g., teens versus adults of different ages)?
3) How should environmental policies accommodate these changes, especially when considering actions affecting future generations?

C. THE CHALLENGE OF ECOLOGICAL VALUATION

Prepared by Milton Russell,[2]
Co-Chair of the Science Advisory Board's Valuation Subcommittee
of the Integrated Risk Project

I am pleased to be here to provide some background and introductory remarks for this important workshop on meeting the challenge of ecological valuation.

Unfortunately, Al Maki, who was to join me in providing this background, found late last week that he would not be able to make the journey from Alaska. He has asked that I express his regrets and to offer his best wishes to the workshop.

I will start by recounting a true (if secondhand) anecdote that encapsulates why we are here today and why our efforts are so important.

The time was almost two decades ago.

The place was a decision meeting with the President.

The subject was a proposal from EPA to undertake a fairly aggressive program to combat acid rain.

And the defining moment occurred when David Stockman of OMB framed the issue with the question: "How many fish are your grandmother worth?" after having asserted that the program would cost about $6,000 per fish saved.

The President faced a real decision. Acid rain had real, negative ecological consequences. The acid rain control program would also use up real national resources that would then not be available to do other things, including achieve health improvements.

To make the decision responsibly in the public interest, it was essential for him to have the answers to a whole series of questions, these among them:

1. What would be the reductions in emissions of the proposed program?

2. What would be the effect of these reductions on the ecological end points of concern?

3. What would be the costs (in terms of other things people want) of making these reductions?

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[2]Senior Fellow, Joint Institute for Energy and Environment, Knoxville, Tennessee; and Professor Emeritus of Economics, The University of Tennessee, Knoxville.

4. And finally, the crux of our workshop today, how much would the American people value the expected improvements in ecological outcomes that would be bought with their money?

Only if that value were greater than the cost would this be a good deal for the American people. Only if they thought it was a good deal would the decision be supported.

To close out the anecdote, the EPA answers to these questions, especially the value one, did not make a persuasive case.

Jumping ahead a half-dozen years, the ensuing one-half billion-dollar National Acid Precipitation Assessment Program (NAPAP) research effort did provide more convincing answers to the first three questions. The political system ultimately decided that the ecological value of taking some control measures would be worth some costs-leaving to later to decide whether still more controls were necessary. And that's where the situation lies today-and the value question regarding the benefits from still tighter controls remains the most troublesome one to answer.

Before the acid rain issue and since, ecological valuation issues have been among the most vexing problems facing environmental policy makers. They are central to such headline issues today as global climate change, drilling in the Arctic National Wildlife Refuge, visibility in the Grand Canyon, air quality in the Great Smoky Mountains National Park, and our case study, nitrogen deposition in Tampa Bay.

Not surprisingly, policy makers have often turned to the economics profession for the guidance they need to make such judgments. Not surprisingly because the question of how to allocate limited resources to maximize something-in this case public welfare-is at the heart of what economists do. Valuation of alternative ecological outcomes is one of the components needed in many environmental decisions.

The economics profession has responded to that challenge by developing a coherent and rigorous framework for attacking the problem. It has created an ingenious but incomplete bag of tools for trying to get the data required to exercise that framework. And it has, for the most part, shown a becoming modesty about its overall success. This leads to the message that strictly economic approaches can now provide useful inputs into the policies regarding ecological protection, but these approaches cannot provide the "answer" by themselves.

That brings us to the origin of this workshop and to where Al Maki and I come in.

In 1996 EPA leadership urged the SAB to address the need for improved methods for measuring ecological benefits. This request was motivated by the widespread view that economic analysis, as then practiced, tended to undervalue ecological resources and was especially inadequate in dealing with long term issues and matters of intergenerational equity. SAB wrapped this request into its ongoing Integrated Risk Project and formed an

interdisciplinary Valuation Subcommittee to pursue the matter. Al Maki and I were co-chairs of this Subcommittee.

In my judgment, the key conclusions that resulted from the intense deliberations of the committee are these, and I quote:

> "1. For decision-making purposes in a governmental context, ecological valuation is an anthropocentric exercise ([that is] people's wishes count; there is no external set of values waiting to be discovered for application to decision making).
>
> 2. The value of anything reflects its contribution toward the achievement of some goal. The process of valuation cannot be separated from the need to reach agreement on goals.
>
> 3. Environmental valuation requires a diverse and interdisciplinary process involving interaction and deliberation among scientists, decision makers, and other stakeholders to identify goals and to define endpoints to characterize those goals.
>
> 4. Existing economic approaches, broadly considered, are consistent and coherent frameworks for valuation because they organize a system of trade-offs. However, they are not mechanisms for producing "the answer" because they may omit trans-economic values that may be important, may include some elements that are difficult or impossible to estimate, and may employ preference elicitation processes that are incomplete. [Therefore,]
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> 5. An expanded, rich, and complex process using multiple approaches is required to fully encompass ecological valuation."[3]

And finally, the Subcommittee ended its report with these words, which are a message to us today:

"Environmental valuation remains a craft embedded in political processes. Much additional research is needed in all areas that are important to estimating the benefits and costs of environmental management action."[4]

Just as important as what the Subcommittee concluded is what it did not find: An alternative to the basic economics paradigm that would yield useful policy guidance without the grungy, difficult, and often contentious process of trying to answer valuation questions such as the one I opened with, "How many fish are your grandmother worth?" And it looked. With the help of SAB staff, the Subcommittee collected and examined a goodly portion of the literature

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[3]"Toward Integrated Environmental Decision-Making (Peer Review Draft, May 3, 1999), Chapter 5, "Assessing the Value of Natural Resources," 5-3.

[4]Ibid., 5-51.

on the issue of ecological valuation. It also heard from a number of persons who provided their views on the issue.

I commend the report of this conscientious, wide-ranging and distinguished Subcommittee to your attention. Not because of the answers it reached, but because of the salience of the issues and concerns that it raised.

This Workshop is the next stage of the SAB's effort to respond to the challenge to improve processes to value ecological outcomes for decision-making purposes. It brings together researchers from different disciplines, risk managers, and stakeholders in the context of a problem that will require action. That action will affect the real people of the Tampa Bay area, who would bear its costs and reap its benefits. And these are the same people who must ultimately agree with any action taken, so their views matter.

This process over the next two days will provide important insights into how valuation can be improved and made more useful in dealing with the many other environmental decisions that will have to be made in the future.

I look forward to these proceedings and to the contributions of the researchers invited to share their views with us.

D. EXECUTIVE SUMMARIES OF FOUR RESEARCH PLANS COMMISSIONED BY EPA FOR THE VALUES WORKSHOP[5]

D.1. Tampa Bay NEP Research Plan: A Decision Science Perspective on Understanding Public Values and Attitudes Related to Ecological Risk Management, Prepared by Robin Gregory[6]

The purpose of this research plan is to outline an approach to understanding public values and attitudes relating to policy initiatives in ecological risk management. Although key elements of the approach are intended to be broadly applicable, the specific case study of nitrogen deposition by air to the Tampa Bay, Florida estuary is used to illustrate and provide supplementary details of the proposed approach. Understanding how the public views the problem of airborne nitrogen deposition, and what considerations it may use when evaluating alternative policy responses, is one of the primary questions now under study by the Tampa Bay National Estuary Program (TBNEP). In particular, the TBNEP seeks answers to questions concerning (a) the reasons why people care about protection of water quality in the Tampa Bay estuary, and (b) ways in which the broad range of stakeholder concerns can be evaluated and measured to facilitate their incorporation into risk-management policies.

This research plan focuses on the contribution of insights from the decision sciences to addressing these important questions. It represents one of four social science perspectives (the others being psychology, anthropology, and innovative economics) to understanding public values, which taken as a whole seek to broaden the range of techniques available to encourage public input and to develop an improved management plan for the estuary. In many respects the four approaches are complementary, so that both general techniques and specific study suggestions are expected to be quite similar. In other respects, however, the four approaches are quite different, with a decision science perspective giving particular attention to the ways in which values and tradeoffs are formed, to the quality and interpretation of expressed judgments and evaluations, and to the use of decision aids in clarifying stakeholder concerns and in developing defensible linkages between the value- and fact-based aspects of a proposed risk-management initiative. In light of the mandate for the research plan, this discussion of a proposed study approach will focus on insights and techniques that are based in the decision sciences and leave issues relating to the complementarity of the different approaches to presentations at the May, 2001 workshop and to subsequent discussions.

A variety of techniques from the decision sciences can assist the Tampa Bay NEP in developing plans for protection of the estuary that incorporate, and are responsive to, both the complexities of the ecological risk-management challenges and the interests and values of the

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[5]Full texts of these Research Plans appear as Appendices F through I of the Report. A sample of the "Statement of Work" to which the plans respond appears as Appendix E.

[6]Decision Research, 1201 Oak Street, Eugene, Oregon 97401

diverse set of stakeholders. Although implementation of the selected techniques would provide immediate insights, many of their benefits will become even more apparent over time, as the TBNEP moves on to the consideration of more costly and more controversial protection measures. Five principal types of benefits are foreseen.

A. Nurturing collaborative exchanges. Dialogue, both within and across stakeholder groups, has been and will continue to be an important reason for the success of the TBNEP. At Tampa Bay, open discussions need to occur among many different parties: between technical experts and laypersons, between natural and social scientists, between federal and state and local government employees, and among representatives of varying perspectives and opinions. The value-based approaches described in this research plan both foster and focus dialogue, whereas techniques for decomposing complex problems and addressing uncertainties will help to ensure that open dialogue also occurs among technical experts.

B. Implementing structured decision-making processes. Structured processes are essential for understanding the diversity of values and concerns that characterize different stakeholders and for using this information to create the best possible alternatives (in the form of recommended actions). Because they establish an open and transparent decision process, structured methods for involving stakeholders also provide a highly defensible mechanism for making policy choices, one that is viewed as legitimate because the steps are clearly delineated and because components of recommendations can easily be traced back to stakeholder expressions of value.

C. Clarifying sources of scientific uncertainty. Scientific uncertainty is unavoidable in programs such as the TBNEP, and over the next decade or two it is likely to increase as the Program's focus moves from land-based and point-source to airborne and farfield sources of nitrogen deposition. As a result, it is important to clarify differing perspectives among scientists and to attempt to understand the reasons for these differences, in terms of identifying the best actions for protecting the estuary and in terms of maintaining strong public support.

D. Learning over time. Developing management structures that can incorporate learning over time is fundamental to the long-run success of a program such as the TBNEP. Some of this learning will come in the form of staying in tune with the changing values of the residents of Tampa Bay. In addition, adaptive management processes are likely to form an increasingly important part of the TBNEP, because of the help they provide in establishing flexible management responses to reducing uncertainty that incorporate learning over time and, by carefully monitoring effects, reduce both the probability and expected cost of failures.

E. Improving the quality of communication. Communication up to this point in time has been relatively straightforward because the benefits of actions undertaken by the TBNEP have been widely supported and highly visible whereas the costs have been low. As the costs rise over time and the benefits become less salient, it will be important for the

TBNEP to continue to communicate effectively with its diverse group of stakeholders; this is likely to also become more difficult because the geographic area affected by TBNEP programs will become larger. Different strategies will be called for depending on whether the communication is about values or about facts; either way, an interactive, two-way communication process is recommended.

The past success of the TBNEP program appears to have created excellent conditions and motivation for undertaking a deeper look at both the values of stakeholders and the underlying science. Techniques from the decision sciences can be used proactively to learn more about the relationships among stakeholder concerns, the reasons for conflict among scientists, and the types of decision processes that will be viewed as continuing to create defensible, legitimate recommendations. The visible success of the program to date has created an unusual and welcome window of opportunity, one that should be embraced soon in anticipation of the more difficult tradeoffs, and less visible benefits, that are likely to come in the years ahead.

D.2. Tampa Bay Estuary Program Values Assessment: Charting Publicly Preferred Passages, Prepared by Terry C. Daniel[7] and Michael J. Meitner[8].

The goal of the proposed program of research is to identify and assess public environmental values associated with the Tampa Bay Estuary Program (TBEP) effort to restore and protect the ecological health of the bay by reducing (or halting increases in) aquatic nitrogen pollution. Specifically, the assessment will determine public preferences for nitrogen management options and associated ecological conditions to provide insight into the nature of and the bases for current and future public support for the TBEP effort. The study will illustrate the application of computer-based interactive survey methods being developed in the context of other environmental quality and risk assessments.

The TBEP (established in 1991) has set the goal of holding nitrogen loads in the bay to 1992-94 levels and restoring sea grass coverage to 1950 levels (minus permanently altered areas). Bay-wide nitrogen targets are achieved by a voluntary trading scheme in which increased loads from one source are balanced by reductions in another. The program has enjoyed substantial community support and nationally recognized success. Projected increases in population and development in the bay watershed will contribute additional nitrogen to the bay, so continued active management will be required to balance contributions from new sources against reductions in existing sources. As achieving nitrogen-reduction targets becomes more costly, currently agreed upon nitrogen load targets may be challenged, along with the associated ecological/sea grass protection goals. In this context, better understanding of relevant public beliefs and preferences will be important to guide policy-making and to build the public support needed to implement and sustain the TBEP management programs.

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[7]Professor of Psychology and Renewable Natural Resources, University of Arizona.

[8]Assistant Professor of Forestry, University of British Columbia.

To establish the relevant temporal and geographic context for the assessment, historic and contemporary environmental and social conditions will be presented to participants through computer graphic and environmental data visualization systems. A converging operations research strategy will separately assess public preferences for alternative nitrogen management/outcome scenarios by verbal-questionnaire, conjoint-rating and scenario-creation procedures. Preferences expressed in each of these contexts will be appropriately scaled and quantitatively related to physical parameters of total nitrogen (with associated sea grass coverage) and to the relative contributions of nitrogen from different sources. Obtained psychophysical relationships between preference indices and nitrogen pollution parameters will be compared across different stakeholder and general public samples to determine points of convergence and divergence in relevant public values, and to test the generalizability of findings. Comparison of findings between elicitation methods will be used to gauge the convergent validity of the assessment.

D.3. Understanding Public Values and Attitudes Related to Ecological Risk Management, Prepared by James J. Opaluch[9]

This proposed research will identify and quantify values for important natural amenities of Tampa Bay. The value measures will provide direct input into decision making regarding the alternative programs to control nutrient inputs into Tampa Bay, and will put this into perspective of other programs to improve the environmental amenities of Tampa Bay. This work is important for achieving continued progress in provision of important environmental amenities. Although recent years have seen much progress in protection and restoration of critical environmental amenities, many significant impacts and threats remain. Limited resources are available to resolve these issues, and competing social needs necessitates that management actions focus on resolving the highest priority issues in a cost effective manner. Simultaneously, communities are becoming increasing resistant to management solutions imposed from "outside". Continued progress towards achieving environmental improvement depends on establishing consensus management strategies that focus efforts towards addressing the key objectives at reasonable cost.

It is critically important that public values be represented in environmental decisions process, since public money is to be used to fund resource protection activities, the public will ultimately bear the costs management actions that increase cost to industry, and since under the Public Trust Doctrine, government managers are mandated to act as trustees for the public. This sets forth a challenge to identify the key environmental objectives of the community more clearly, and to focus management on the highest priority goals of the community, which underscores the importance of efforts to elicit priorities and values of the affected communities. Social scientists have much to contribute to these issues, having invested substantial research efforts towards understanding processes to identify and measure public values, and processes to develop consensus agreements among interested parties.

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[9]Department of Environmental and Natural Resource Economics, University of Rhode Island, Kingston, Rhode Island 02881

Measuring community environmental values in a way that can contribute to assessment of specific management actions is an inherently difficult task, and not one that is amenable to routine application of standard techniques. For example, it is a difficult task to determine how much people care about reducing nitrogen deposition in Tampa Bay, and what level of expenditure of public dollars is justified to support specific programs. The complex scientific nature of the problem also contributes to the challenges faced in this task.

A flexible approach is essential in order to focus on the most critical issues and controversies faced by the community, and to design an instrument that respondents can understand and that elicits values for key Tampa Bay amenities. Therefore, it is important not commit prematurely to a specific instrument design. Rather, the research process must first obtain a firm understanding of the key issues and controversies from the perspective of the various communities, and steps must be taken to design an effective survey instrument.

Thus, rather than simply applying a predetermined set of economic tools, we will set forth a research process to identify public values regarding critical natural amenities of Tampa Bay. First, we will obtain and carefully study documents that describe the critical issues faced in Tampa Bay in order to obtain background information on the problems faced. Much of this work has already been completed as part of developing the present proposal. The second stage of the research is to meet with the various interested parties to get a more detailed understanding of the important issues from various perspectives, and particularly to identify the important controversies. The goal of this stage in the process is to expand our knowledge base on critical Tampa Bay issues and, just as importantly, to develop a working relationship with the various parties. The next stage in the research will develop a list and description of important values concerning Tampa Bay amenities, and identify those that can reasonably be addresses within the context of the proposed study. We will then meet with Tampa Bay management teams to describe the values that will be estimated. This will be the final opportunity for input from the management team on the essential elements of the study, and we maintain flexibility up to this stage, so that values measured by the research efforts can be of highest utility to the management team.

Once we have come to agreement with the management council on the final set of values to be estimated, we will organize and implement a set of focus groups and, later, a set of verbal protocols with the goal of developing a survey instrument to measure important public values. Initial focus groups will involve general discussions of the issues of concern, and will be used to understand the perspective of participants, to identify how they think about issues, what language they use, which words are loaded or likely to be misunderstood, what kinds of background information needs to be provided, whether they care about the particular issues, and if so why. As the process moves along, more time will be spent on specific issues identified to be important to the developing survey and pretesting successive draft questions. The focus groups will include considerable discussion of the questions to ensure that participants understand the questions, and that the survey responses convey the information we are attempting to elicit.

These focus groups will provide excellent qualitative information that is useful for understanding values held by focus group participants. More importantly, the focus groups will provides essential insights that help to identify difficulties in survey questions, and suggest approaches that can be used to improve the survey design.

When we feel we have a workable draft survey, we will implement a set of verbal protocols on the draft instrument. Verbal protocols are carried out by having an individual complete the survey, while "talking aloud" to express what the individual is thinking about while answering the questions. This will provide addition insights into the thought process underlying the survey format, and the survey will be revised as appropriate, until investigators are confident that the survey provides the information being sought.

When the survey development process is complete, we will implement the survey using a sample of the public. The precise format of the survey will be determined through the rigorous survey development process described above, and we strongly recommend that we maintain the flexibility to determine the best survey instrument and means of implementation. However, we anticipate that the survey will be administered as an in-person, self administered survey. We also anticipate that adequate funds will not be available for probability sampling, and we can use standard weighting procedures to correct for non-representative samples, to the extent possible. We will also apply standard rationality tests to confirm that results of the survey indicate valid economic values.

The results of the survey will provide an assessment of public values for important amenities of Tampa bay and will link with available scientific studies to provide direct input into management options. We will carry out various "rationality tests" to confirm that the survey results are valid measures of values of specific amenities described and not, for example, symbolic expressions of concern for the environment, in general. The results are analogous to public referenda, but are much more informative to policy makers and are more flexible. As such, the results will provide essential public input into the management process and ensure that public values are represented in the public decision process.

D.4. The Effect of Values and Cultural Models on Policy: An Anthropological Approach to Environmental Policy in Tampa Bay, prepared by Douglas W. Christel, Dr. Willett Kempton, and Jennifer Harris[10]

Policymakers and administrators in the Tampa Bay region have observed high levels of public support for policies to reduce human impact on the Bay. This support has helped to make possible government actions that restrict water-borne pollution, nutrient loadings, and other anthropogenic impacts on the Bay. Current studies of the Bay's water and ecosystems suggest that further improvements will require action to reduce the impact of the deposition of airborne materials into the bay, which will require different types of policies, affecting different sources. Whether and how public support will extend into these new policy areas is not yet known.

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[10] University of Delaware, Graduate College of Marine Studies

The proposed research takes the approach, demonstrated in Kempton, Bister, and Hartley (1996), Bunting-Howarth (2001), and Kempton, Rayner, Harris, and Marker (2001) that support or opposition to policies can be understood by eliciting the public's values and cultural models. The goal of this research is to understand the values and cultural models that Tampa Bay residents apply to the Bay and to policies to preserve the Bay. Specifically, we will conduct interviews to elicit the values that lead residents to place priority on protection of the Bay relative to other social or personal priorities. The interviews will also elicit cultural models that people use to explain why various types of human impact cause damage, how different elements of the Bay ecosystem interact, and how protection measures can affect the preceding. Finally, the interviews will explore what is now known about air deposition into the Bay and its impacts.

Appendix A--**SAB/EPA Workshop on "Understanding Public Values and Attitudes Related to Ecological Risk Management," May 23-24, 2001**

SAB/EPA Workshop on "Understanding Public Values and Attitudes Related to Ecological Risk Management"
May 23-24, 2001
Academy for Educational Development
1825 Connecticut Avenue, NW
Washington, DC

May 23, 2001

Welcome	Dr. William Glaze	9:00
Brief Overview of Workshop	Dr. Baruch Fischhoff	9:05
Background	Dr. Milton Russell	9:10
Introduction of Risk Managers and identification of risk managers' goals and interests in the meeting	Risk Managers	9:20
Introduction to Risk Management Questions at Tampa Bay	Ms. Holly Greening	9:40
Decision Scientist's Research Proposal - Presentation	Dr. Robin Gregory	10:00
Break		10:40
Questions from Panel		10:55
Questions from Audience		11:15
Lunch		11:35
Psychologist's Research Proposal - Presentation	Dr. Terry Daniel	12:40
Questions from Panel		1:20
Questions from Audience		1:40
Economist's Research Proposal - Presentation	Dr. James Opaluch	2:00
Questions from Panel		2:40
Questions from Audience		3:00
Break		3:20
Anthropologist's Research Proposal - Presentation	Dr. Willett Kempton	3:35
Questions from Panel		4:15
Questions from Audience		4:35
Concluding Remarks	Dr. Baruch Fischhoff	4:55
Adjourn		5:00

May 24, 2001

Discussion of Goals for Today's Discussions	Dr. Baruch Fischhoff	8:30
Risk Manager's Discussion Individual Risk Managers' Observations and Responses to Workshop Questions	Risk Managers	8:40
Break		10:10
Panel Discussion	Panelists	10:25
Audience Questions	Audience	11:15
Summary/Wrap Up	Dr. Baruch Fischoff	12:00
Adjourn		12:15

APPENDIX B--WORKSHOP PANEL

Panel for SAB/EPA Workshop "Understanding Public Values and Attitudes Related to Ecological Risk Management"

Chair

Dr. Baruch Fischhoff, Professor, Social & Decision Sciences, Department of Engineering and Public Policy, Carnegie Mellon University

Risk Managers

Ms. Beverly Banister, Director, Water Management Division, Region 4, Environmental Protection Agency

Mr. Fred Calder, Environmental Administrator, Bureau of Watershed Management, Florida Department of Environmental Protection

Dr. Al McGartland, Office Director, National Center for Environmental Economics, Office of Policy, Economics and Innovation, Environmental Protection Agency

Dr. Brian McLean, Director, Clean Air Markets Division, Office of Atmospheric Programs, Office of Air and Radiation, Environmental Protection Agency

Dr. Lee Mulkey, Associate Director for Ecology, National Risk Management Research Laboratory, Office of Research and Development, Environmental Protection Agency

Mr. Jake Stowers, Assistant County Administrator for Pinellas County, Clearwater, FL

Mr. Robert Wayland, Director, Office of Wetlands, Oceans and Watersheds, Office of Water, Environmental Protection Agency

Researchers

Dr. Terry Daniel, Department of Psychology, Environmental Perception Laboratory, University of Arizona

Dr. Robin Gregory, Decision Research, Vancouver, British Columbia

Dr. Willett Kempton, College of Marine Studies, University of Delaware

Dr. James Opaluch, Department of Environmental and Natural Resource Economics, University of Rhode Island

Other Presenters

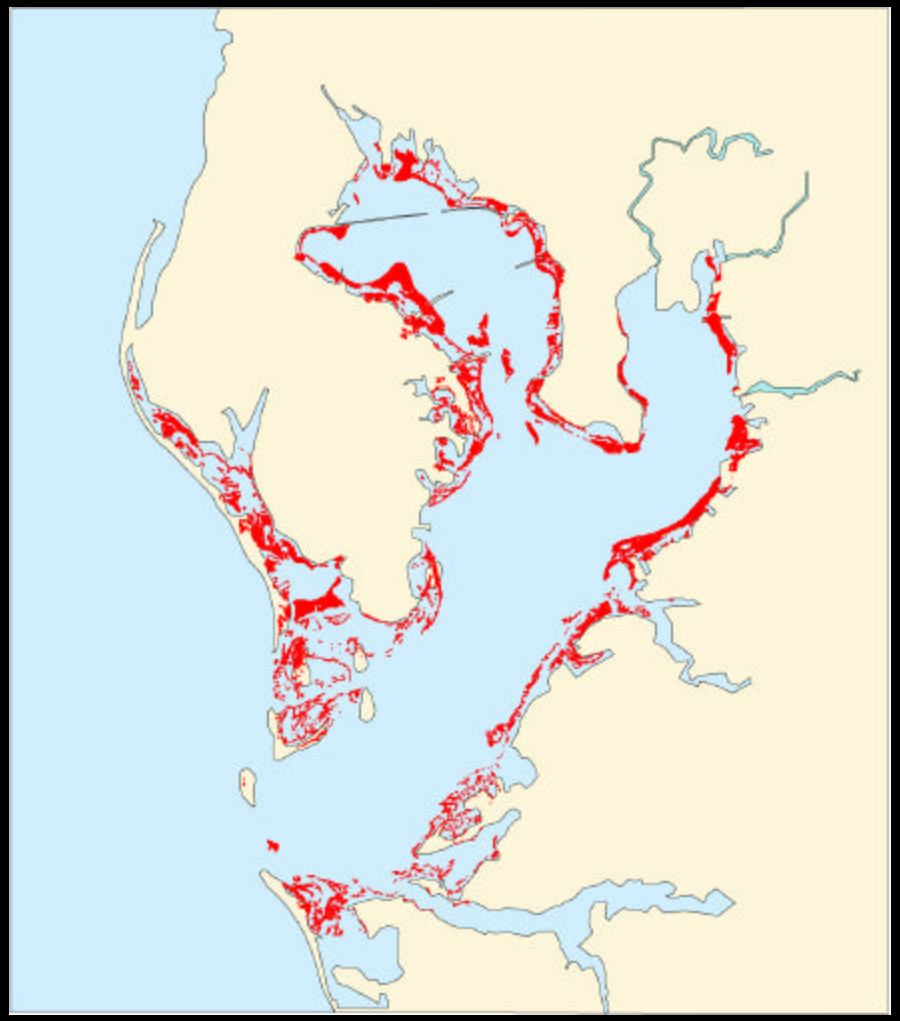
Ms. Holly Greening, Senior Scientist, Tampa Bay Estuary Program

Dr. Charles A. Pittinger, Principal Scientist, The Procter & Gamble Company

Dr. Milton Russell, Senior Fellow, Joint Institute for Energy & Environment, University of Tennessee

TAMPA BAY ESTUARY PROGRAM

TAMPA BAY ESTUARY PROGRAM

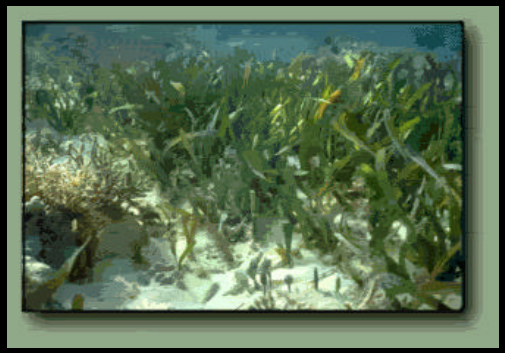


Difference Between 1950 and 1990 Seagrass Cover

TAMPA BAY ESTUARY PROGRAM

TBEP
NITROGEN MANAGEMENT STRATEGY PARADIGM

TN Load → Chlorophyll → Light Attenuation



Seagrass Light Requirement → Seagrass Growth & Reproduction

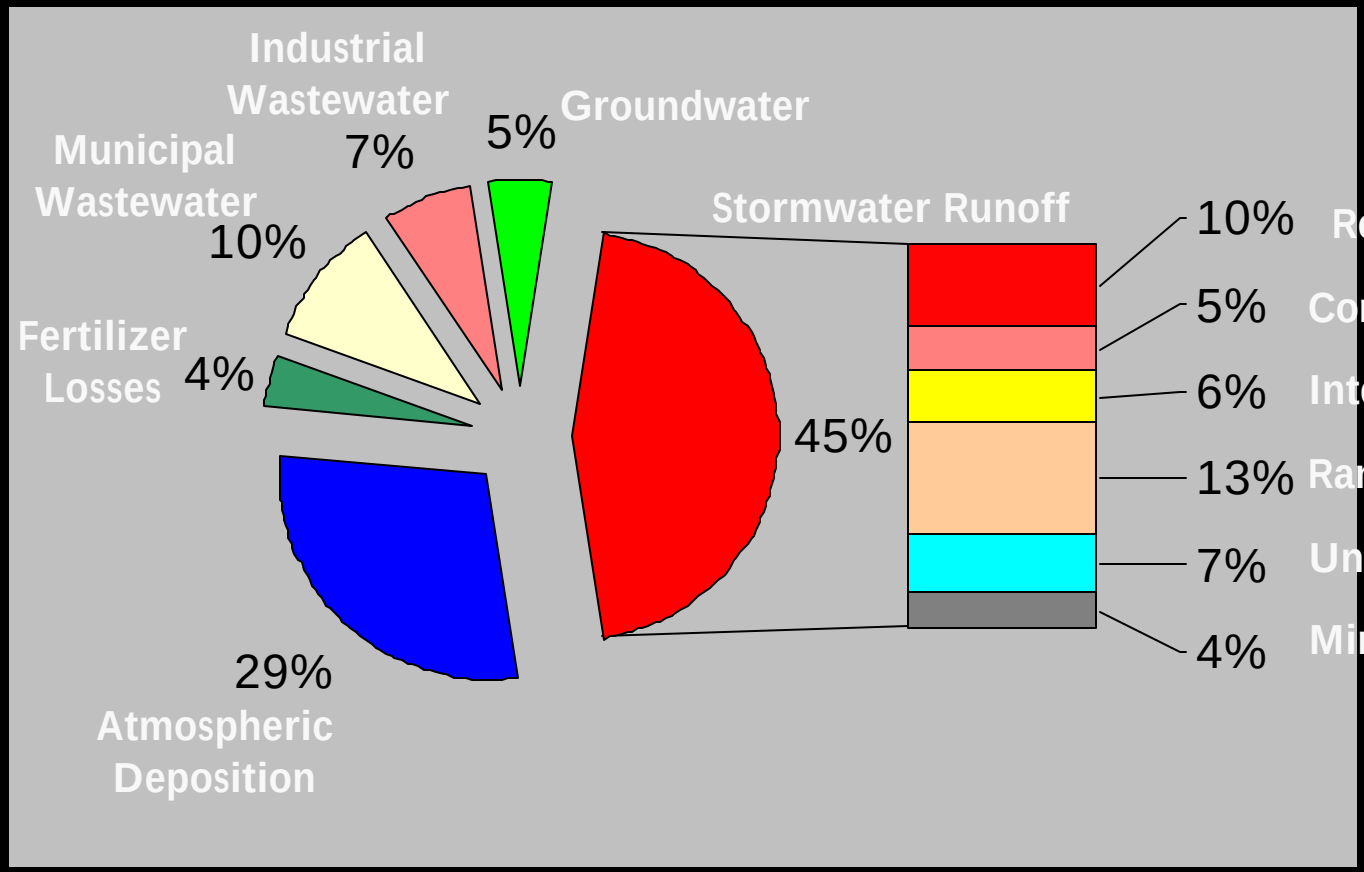
TAMPA BAY
NITROGEN MANAGEMENT GOAL

"Hold the line" at nitrogen loading estimated for 1992-1994. To compensate for expected growth, reduce or preclude additional nitrogen loading by 17 tons per year (starting in 1995).

Year 2000 Reduction Goal: 84 tons/year
This Reduction Goal has now been extended through 2004.

TAMPA BAY ESTUARY PROGRAM

TOTAL NITROGEN LOADING



TAMPA BAY ESTUARY PROGRAM

PUBLIC PARTNERS:

U.S. Environmental Protection Agency
Florida Department of Environmental Protection
Southwest Florida Water Management District
Environmental Protection Commission of Hillsborough County
Florida Wildlife Conservation Commission
Tampa Bay Regional Planning Council
Hillsborough County
Pinellas County
Manatee County
City of Clearwater
City of Tampa
City of St. Petersburg
U.S. Army Corps of Engineers
Tampa Port Authority
Agricultural Extension Services

TAMPA BAY ESTUARY PROGRAM

PRIVATE PARTNERS:

Florida Phosphate Council
Eastern Terminals
Florida Power and Light Company
Florida Strawberry Growers
IMC-Phosphate
CSX Transportation
CF Industries, Inc.
Cargill Fertilizer, Inc.
Pakhoed Dry Bulk Terminals
Tampa Electric Company

TAMPA BAY ESTUARY PROGRAM

NITROGEN MANAGEMENT CONSORTIUM ACTION PLAN HIGHLIGHTS

∅ Total of 105 projects by local governments, agencies and industry

∅ 134 tons per year reduction in N-loading expected by 2000

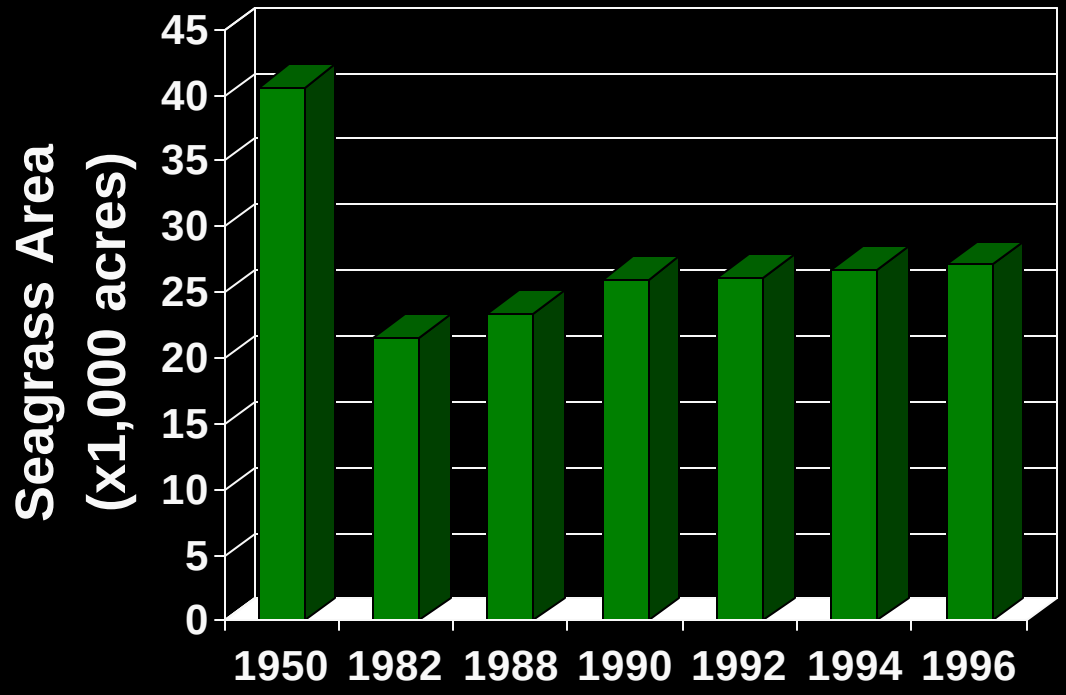
∅ Exceeds 1995-1999 reduction goal by 60 percent

∅ 95% of projects address nonpoint sources and account for 71% of total nitrogen load reduction

∅ 50% of total load reduction achieved through public sector projects, and 50% by industry

TAMPA BAY ESTUARY PROGRAM

TRACKING PROGRESS TOWARDS TBEP'S GOALS



GOAL: Recover an additional 12,350 acres of seagrass over 1992 levels, while preserving the bay's existing 25,600 acres.

STATUS: Since 1988, seagrass acreage is increasing at about 300 acres per year. At this rate, the goal will be reached in 30-40 years.

TAMPA BAY ESTUARY PROGRAM

TAMPA BAY NITROGEN MANAGEMENT CONSORTIUM
A COOPERATIVE APPROACH

∅ Originally non-regulatory, voluntary participation

∅ Consortium members pledge to exercise their best efforts to collectively meet nitrogen management goals

∅ Regulatory agency partners agree to exercise reasonable flexibility within the framework of their rules in the processing of permit applications for projects included in the Consortium Action Plan

∅ In 1998, technical basis and implementation by Consortium adopted by EPA as the TMDL for nitrogen for Tampa Bay

TAMPA BAY ESTUARY PROGRAM

TAMPA BAY NITROGEN MANAGEMENT APPROACH
ONGOING AND UPCOMING ISSUES

∅ Going from a voluntary reduction program to a TMDL: Technical and philosophical issues

∅ Perception that "we've done the easy things": How to encourage continued participation (public and private) as reductions become more difficult (and expensive) to obtain

∅ How and will the NMC be able to meet TMDL requirements, since this approach is "outside the box"

∅ Atmospheric deposition: Significant technical issues remain

∅ Public involvement: Needed in the future? And why ?

APPENDIX D--QUESTIONS FOR RISK MANAGERS

QUESTIONS FOR RISK MANAGERS
at SAB/EPA Workshop on "Understanding Public Values and Attitudes Related to Ecological Risk Management"

The Workshop will include a panel of risk managers who will be asked to comment on the Research Proposals presented. They will be asked:

1. How the kinds of research described might help them make decisions, communicate decisions, and justify decisions that might be taken in Tampa[1] or in other places where ecological resource protection is an issue?

2. What opportunities do the approaches offer that current strategies for understanding values and attitudes do not?

3. What follow-up actions would be desirable – either in the area of risk management or research?

4. What other kinds of problems do you think would benefit from the kinds of approaches described?

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[1]**Risk management questions identified by Tampa Bay Estuary Program. These were the questions that the Social Scientists presenting at workshop were asked to design a research strategy to help address:**

1. Major risk management questions involving nitrogen deposition facing decision makers at Tampa Bay:

1. As population growth increases, it will become more difficult to meet reduction goals through reductions in stormwater or through land use planning. Meeting long-term goals may require reductions from the air (e.g., from motor vehicle emissions, power plants, local and "outside" sources). What are values and attitudes towards reducing emissions from air sources among local interests and affected parties?
2. Local counties are facing decisions involving public transportation as a result of requirement to reduce emission of ozone. The requirement triggered by ozone nonattainment will also have an impact on nitrogen deposition and may reduce deposition of nitrogen. What are the values and attitudes related to reducing air deposition of nitrogen that may assist county and state officials making decisions involving public transportation?
3. What are the values and attitudes towards complying with the special cooperative mechanism set for implementing Total Maximum Daily Load (TMDL) for nitrogen for Tampa Bay? (The TMDL does not allocate sources for nitrogen; instead it sets an overall goal for the Bay)
4. How much will participants continue to reduce their contributions of nitrogen further and to what level?

2. Questions raised by the Tampa experience that are of interest to risk managers outside Tampa Bay:

a. Why do people take action collaboratively at Tampa?
b. Why there is broad support for restoring sea grasses to 1950's level as a goal?
c. Why are participants willing to work together for this common goal?
d. Why has this collaboration happened without any formal benefits analysis conducted on Tampa Bay goals?
e. Can this dynamic be captured at the national level?

APPENDIX E – SAMPLE STATEMENT OF WORK

CONSULTING SERVICES FOR AN EXPERT IN DECISION SCIENCE IN PREPARATION OF DRAFT RESEARCH PLAN NEEDED BY SAB/EPA WORKSHOP "UNDERSTANDING PUBLIC VALUES AND ATTITUDES RELATED TO ECOLOGICAL RISK MANAGEMENT"

STATEMENT OF WORK

Background

EPA is seeking to identify research and methods that could improve the capability of the Agency and other partners in environmental protection in understanding the values and attitudes towards protection of specific ecological resources at risk. It is seeking to identify research and methods that supplement or complement current methods for characterizing benefits associated with protecting ecological resources**.** In August 2000, EPA's Science Advisory Board (SAB) called for a workshop to "explore the topic of natural resource valuation more fully."[1] The SAB is collaborating with several other offices at EPA (Office of Policy, Economics and Innovation, Office of Water, Office of Air and Radiation, and the Office of Research and Development) to sponsor a workshop to focus on deposition of nitrogen by air to Tampa Bay Estuary. The Workshop is entitled "SAB/EPA Workshop on "Understanding Public Values and Attitudes Related to Ecological Risk Management."

The purpose of the workshop is to provide a forum for researchers in the social sciences to address the following questions:

Given that the state of knowledge about ecological and human health effects of nitrogen deposition are fairly well known in the Tampa Bay Estuary, EPA seeks answers to the following questions, in terms that are relevant to and readily comprehendible to Agency management:

A.Why do people care about protecting this water body, addressing current problems and preventing further nitrogen deposition?

B.How can we develop a fuller suite of methods to identify and evaluate/measure why and how much people care about protecting this water body?

The Workshop will center on several Research Proposals developed to highlight different approaches in the social sciences to understanding values and attitudes associated with protection of Tampa Bay against nitrogen deposition. The Workshop will also include a panel of risk managers who will be asked to comment on the Research Proposals presented. They will be asked to discuss how the kinds of research described might help them make decisions, communicate decisions, and justify decisions taken, both in the context of issues immediate to Tampa Bay and those associated with protection of ecological resources more generally.

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[1] *Toward Integrated Environmental Decision-Making*, August 2000, EPA-SAB-EC-00-011.

Appendix A contains information on: (1) risk management questions faced by decision makers concerned about air deposition to Tampa Bay, and (2) questions raised by the Tampa Bay experience for others decision makers concerned with protecting ecological resources.

Scope of Work:

The EPA requires a Research Proposal focusing on the application of decision science for use in a workshop. The primary task of this consultant shall be to develop a written proposal demonstrating how specific research applying approaches in decision science could help decision makers understand values and attitudes related to protection of Tampa Bay against nitrogen deposition. The expert shall also make a presentation of no more than 45 minutes in length at the Workshop on May 23-24, 2001 in Washington, D.C., summarizing the research proposal, answering questions about the Research Proposal, and participating in discussions during the 2-day workshop. The consultant shall be responsible for making travel reservations for hotel and local transportation (all travel costs reimbursable under the Purchase Order). The Research Proposal will be included in the report of the Workshop, along with documentation of the workshop discussions.

Delineation of Tasks:

Task 1. The consultant shall sign a conflict-of-interest form certifying that he/she has no known conflict of interest in performing the review.

Task 2. The consultant shall participate in the conference call with experts from Tampa Bay to address the consultant's questions regarding the background information provided. Conference call to be scheduled at a time convenient for all consultants involved in the Workshop and Tampa Bay personnel. Consultant to identify questions to be addressed in conference call to the EPA Project Officer by February 9, 2000**.**

Task 3. By April 15, 2000, the consultant shall prepare and deliver to the Project Officer a Research Plan. In preparing the Research Plan, use plain English and avoid jargon that is specific to your own discipline. For acronyms, spell out the term the first time it is used, with the appropriate abbreviation in parentheses; the abbreviation may be used thereafter. The Research Plan will include the following elements:

(a)Title of Project;

(b)Executive Summary: (1) What do you intend to do? (2) Why is the work important? (3) What has already been done? (4) How are you going to do the work? Two pages are recommended;

(c) Specific Aims. List the broad, long-term objectives and what the specific research proposed in this application is intended to accomplish. State the hypotheses to be tested or major question to be addressed. One page is recommended;

(d)Background and Significance. Briefly sketch the background leading to the present Research Proposal, critically evaluate existing knowledge, and specifically identify the gaps which the project is

intended to fill. State concisely the importance and relevance of the research described by relating the specific aims to the broad, long-term objectives. Two to three pages are recommended;

(e)Research Design and Methods. Describe the research design and the procedures to be used to accomplish the specific aims of the project. Include how the data will be collected, analyzed, and interpreted. Describe the methodology and its advantage over existing methodologies. Discuss the potential difficulties and limitations of the proposed procedures and possible alternative approaches to achieve the aims. As part of this section, provide a tentative sequence or timetable for the project. Twenty pages or less are recommended;

(f)Background on Related Research. Use this section to provide an account of related studies pertinent to the application information that will help to establish the appropriateness and utility of proposed project. This section may include description of where research of this kind has been used in decision making regarding ecological resources in the past. This description would include: (i) How was the resource valued?; (ii) How was the cost of control valued?; (iii) How was data used to reach a decision on restoration of the resource? Five pages are recommended. The complete references to appropriate publications may be listed and are not subject to page limitations;

(g)Literature Cited. List all references. The list may include, but may not replace, the list of publications identified in the "Background on Related Research." Each reference must include the title, names of all authors, book or journal, volume number, page numbers, and year of publication. The reference should be limited to relevant and current literature;

(h)Dates of Proposed Period of Support and Proposed Costs. Identify the proposed start date for the research and period of proposed research. By year and for the entire proposed period of support, itemize the following budget categories:

(i)Personnel costs. The titles of all persons who are involved on the project. Include all collaborating investigators, individuals in training, and support staff. Identify the role of each individual listed on the project. For each individual, list the percent of each appointment to be spent on this project. Enter the dollar amounts for each position for which funds are requested. The salary requested is calculated by multiplying the individual's institutional base salary by the percent of effort on this project.

(ii)Cost of supplies. Itemize any supplies costing more than $1,000.

(iii)Travel. Provide the purpose and destination of each trip and the number of individuals for whom funds are requested.

(iv)Other expenses by category and unit cost. These might publication costs, computer charges, rentals and leases, equipment maintenance, or service contracts.

(i)Budget for Entire Proposed Period of Support. Provide a table summarizing the totals under each budget for each year and for the entire proposed period of support.

One month before the consultant delivers the Research Plan, the consultant shall provide the Project Officer with the names and institutional addresses of two independent peer reviewers that the consultant shall identify as having requisite disciplinary expertise to review the Research Plan. The Project Officer will, with the assistance of consultants from the EPA Science Advisory Board, approve those peer reviewers.

At the time the consultant delivers the Research Plan, the consultant shall also deliver to the Project

Officer the text of peer reviews conducted by 2 independent peer reviewers approved by the Project Officer along with Conflict of Interest forms completed by the peer reviewers. At that time, the consultant shall also provide a memorandum to the Project Officer explaining either how any deficiencies found by the peer reviewers were addressed in the Research Plan delivered to the Project Officer or why they weren't addressed.

The consultant shall provide two paper copies and one electronic copy (Word Perfect 8) of the Research Plan to the Project Officer. The Project Officer will make the Research Plan available to participants in the Workshop through distribution of hard copy, email, and through the EPA/SAB website.

Task 4. The consultant shall prepare and deliver a 45-minute presentation in language that a non-expert would understands on the research plan at the Workshop. The consultant shall also participate in the entire workshop to answer questions from Agency staff and managers, SAB members and other members of the public. The consultant shall make paper and electronic copies of slides or handouts available to the Technical Project Officer at the time of the Workshop.

Deliverables

1)Names of 2 expert peer reviewers and their institutional Address	March 15, 2001
2)Research Plan	April 15, 2001
3)Two independent peer reviews of the Research Plan and Memorandum to the Technical Project Officer addressing peer review comments	April 15, 2001
4)Any slides or handouts used at the Workshop	May 23-24, 2001

Government Furnished Property/Materials (Information)

As background to the expert for generation of the Research Proposal, the EPA Project Officer will provide the following:

1.background material on EPA's current methods for characterizing benefits associated with protecting ecological resources

a.*Framework for the Economic Assessment of Ecological Benefits*, draft July 1998

b.*Assessing the Economic Value of Estuary Resources and Resource Services in CCMP Planning and Implementation; A National Estuary Program Environmental Valuation Handbook*, draft July 2000

2.information (Appendix A) on: (1) risk management questions faced by decision makers concerned about air deposition to Tampa Bay, and (2) questions raised by Tampa Bay experience for others decision makers concerned with protecting ecological resources

3.current documentation describing Tampa Bay's goals for controlling nitrogen deposition. Specific documents include:

a.*Tampa Bay Estuary's Comprehensive Conservation and Management Plan*

b.*Partnership for Progress, The Tampa Bay Nitrogen Management Consortium Management Plan*

c.Decision Document for Technical Approval/Disapproval of TMDL Submitted for Tampa Bay, Florida, 1998

d.*Tampa Bay Consortium to "Hold the Line" on Nitrogen Loadings*, Coastlines: 8, Fall 1995.

4.a conference call with experts from Tampa Bay to address researcher's questions regarding the background information provided. Conference call to be scheduled at a time convenient for all researchers and Tampa Bay personnel. Researchers to identify questions to be addressed in conference call to the EPA technical project officer by February 9, 2000.

5.names and contact information for staff at Tampa Bay Estuary Program who are available to take questions related to the Statement of Work outside the scheduled conference call time.

Evaluation Criteria

Factor (1):Demonstrated expertise in contractor's subject discipline, and demonstrated; expertise in applying that discipline to the area of ecological resource protection

Factor (2):Demonstrated ability to conduct research that has made a contribution to policy and decision making;

Factor (3):Demonstrated experience on a wide range of real-life policy issues that indicate ability to apply the contractor's specialized expertise to the "real world" issue of nitrogen deposition in Tampa Bay;

Factor (4):Effective communicators possessing the ability to explain research from their respective discipline to academic specialists from differing disciplines, as well as to risk managers, and to a lay audience.

Factor (5)Reasonable and competitive price.

Attachment A

Appendix A: Risk Management Questions for Workshop

Consultant to provide information about public values and attitudes that will help decision makers make decisions, communicate decisions, and justify decisions related to the questions below:

1.Major risk management questions involving nitrogen deposition facing decision makers at Tampa Bay:

a.As population growth increases, it will become more difficult to meet reduction goals through reductions in storm water or through land use planning. Meeting long-term goals may require reductions from the air (e.g., from motor vehicle emissions, power plants, local and "outside" sources). What are values and attitudes towards reducing emissions from air sources among local interests and affected parties?

b.Local counties are facing decisions involving public transportation as a result of requirement to reduce emission of ozone. The requirement triggered by ozone nonattainment will also have an impact on nitrogen deposition and may reduce deposition of nitrogen. What are the values and attitudes related to reducing air deposition of nitrogen and what are the benefits (monetary, quantitative and/or qualitative) to society from protecting water resources from air deposition from nitrogen that may assist county and state officials making decisions involving public transportation?

c.What are the values and attitudes towards complying with the special cooperative mechanism set for implementing Total Maximum Daily Load (TMDL) for nitrogen for Tampa Bay? (The TMDL does not allocate sources for nitrogen; instead it sets an overall goal for the Bay)

2.Risk management questions raised by the Tampa experience that are of interest to decision makers outside Tampa Bay:

a.What can be known about public values and attitudes towards protection of water resources in Tampa Bay or about benefits (monetary, quantitative and/or qualitative) to society from protecting them that can help explain why there is broad support for restoring sea grasses to 1950's level as a goal?

b.What can be known about public values and attitudes towards protection of water resources in Tampa Bay or towards benefits (monetary, quantitative and/or qualitative) to society from protection of those resources that can help explain why participants are willing to work together for this common goal?

c.What can be known about public values and attitudes towards protection of water resources in Tampa Bay that can help explain why participants' collaboration happened without any formal benefits analysis conducted on Tampa Bay goals?

d.What lessons can be learned from studying public values and attitudes towards airborne deposition of nitrogen and/or protection of water resources in Tampa Bay or benefits (monetary, quantitative and/or qualitative) to society from protection of water resources there that can help inform whether the dynamic at Tampa can be captured at the national level?

Tampa Bay NEP Research Plan: A Decision Science Perspective on Understanding Public Values and Attitudes Related to Ecological Risk Management

Author: Robin Gregory

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Tampa Bay NEP Research Plan: A Decision Science Perspective on Understanding Public Values and Attitudes Related to Ecological Risk Management

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1.0 Project summary

The purpose of this research plan is to outline an approach to understanding public values and attitudes relating to policy initiatives in ecological risk management. Although key elements of the approach are intended to be broadly applicable, the specific case study of nitrogen deposition by air to the Tampa Bay, Florida estuary is used to illustrate and provide supplementary details of the proposed approach. Understanding how the public views the problem of airborne nitrogen deposition, and what considerations it may use when evaluating alternative policy responses, is one of the primary questions now under study by the Tampa Bay National Estuary Program (TBNEP). In particular, the TBNEP seeks answers to questions concerning (a) the reasons why people care about protection of water quality in the Tampa Bay estuary, and (b) ways in which the broad range of stakeholder concerns can be evaluated and measured to facilitate their incorporation into risk-management policies.

This research plan focuses on the contribution of insights from the decision sciences to addressing these important questions. It represents one of four social science perspectives (the others being psychology, anthropology, and innovative economics) to understanding public values, which taken as a whole seek to broaden the range of techniques available to encourage public input and to develop an improved management plan for the estuary. In many respects the four approaches are complementary, so that both general techniques and specific study suggestions are expected to be quite similar. In other respects, however, the four approaches are quite different, with a decision science perspective giving particular attention to the ways in which values and tradeoffs are formed, to the quality and interpretation of expressed judgments and evaluations, and to the use of decision aids in clarifying stakeholder concerns and in developing defensible linkages between the value- and fact-based aspects of a proposed risk-management initiative. In light of the mandate for the research plan, this discussion of a proposed study approach will focus on insights and techniques that are based in the decision sciences and leave issues relating to the complementarity of the different approaches to presentations at the May, 2001 workshop and to subsequent discussions.

A variety of techniques from the decision sciences can assist the Tampa Bay NEP in developing plans for protection of the estuary that incorporate, and are responsive to, both the complexities of the ecological risk-management challenges and the interests and values of the diverse set of stakeholders. Although implementation of the selected techniques would provide immediate insights, many of their benefits will become even more apparent over time, as the TBNEP moves on to the consideration of more costly and more controversial protection measures. Five principal types of benefits are foreseen.

A. Nurturing collaborative exchanges. Dialogue, both within and across stakeholder groups, has been and will continue to be an important reason for the success of the TBNEP. At Tampa Bay, open discussions need to occur among many different parties: between technical experts and laypersons, between natural and social scientists, between federal and state and local government employees, and among representatives of varying perspectives and opinions. The value-based approaches described in this research plan both foster and focus dialogue, whereas techniques for decomposing complex problems and addressing uncertainties will help to ensure that open dialogue also occurs among technical experts.

B. Implementing structured decision-making processes. Structured processes are essential for understanding the diversity of values and concerns that characterize different stakeholders and for using this information to create the best possible alternatives (in the form of recommended actions). Because they establish an open and transparent decision process, structured methods for involving stakeholders also provide a highly defensible mechanism for making policy choices, one that is viewed as legitimate because the steps are clearly delineated and because components of recommendations can easily be traced back to stakeholder expressions of value.

C. Clarifying sources of scientific uncertainty. Scientific uncertainty is unavoidable in programs such as the TBNEP, and over the next decade or two it is likely to increase as the Program's focus moves from land-based and point-source to airborne and farfield sources of nitrogen deposition. As a result, it is important to clarify differing perspectives among scientists and to attempt to understand the reasons for these differences, in terms of identifying the best actions for protecting the estuary and in terms of maintaining strong public support.

D. Learning over time. Developing management structures that can incorporate learning over time is fundamental to the long-run success of a program such as the TBNEP. Some of this

learning will come in the form of staying in tune with the changing values of the residents of Tampa Bay. In addition, adaptive management processes are likely to form an increasingly important part of the TBNEP, because of the help they provide in establishing flexible management responses to reducing uncertainty that incorporate learning over time and, by carefully monitoring effects, reduce both the probability and expected cost of failures.

E. Improving the quality of communication. Communication up to this point in time has been relatively straightforward because the benefits of actions undertaken by the TBNEP have been widely supported and highly visible whereas the costs have been low. As the costs rise over time and the benefits become less salient, it will be important for the TBNEP to continue to communicate effectively with its diverse group of stakeholders; this is likely to also become more difficult because the geographic area affected by TBNEP programs will become larger. Different strategies will be called for depending on whether the communication is about values or about facts; either way, an interactive, two-way communication process is recommended.

The past success of the TBNEP program appears to have created excellent conditions and motivation for undertaking a deeper look at both the values of stakeholders and the underlying science. Techniques from the decision sciences can be used proactively to learn more about the relationships among stakeholder concerns, the reasons for conflict among scientists, and the types of decision processes that will be viewed as continuing to create defensible, legitimate recommendations. The visible success of the program to date has created an unusual and welcome window of opportunity, one that should be embraced soon in anticipation of the more difficult tradeoffs, and less visible benefits, that are likely to come in the years ahead.

2.0 Problem background: Understanding the context for estuary protection

Tampa Bay is one of 28 sites selected for the National Estuary Program (NEP), which is administered by the Environmental Protection Agency (EPA) with the goal of providing technical assistance and supplementary federal funding to initiate a voluntary estuary management plan. Tampa Bay is the largest open-water estuary in Florida (approximately 400 square miles), with inflows from four major rivers and 40 smaller streams. Three classes of wetlands (salt marshes, mangrove forests, and salt barrens) provide habitat for a wide range of plants and animals and form an essential part of the region's natural drainage and filtering system. The subtropical climate of the area has led to rapid growth, with the current population of more than two million people projected to increase by 15-20% over the next decade.

The Tampa Bay National Estuary Program (TBNEP) began in 1991 with a focus on developing and implementing an agreement among local participants that would result in a management plan to improve water quality and living resources in the Tampa Bay estuary. A Comprehensive

Conservation and Management Plan (CCMP) was finalized in December, 1996 with input from, and the support of, a broad range of local participants. This CCMP outlined a management and monitoring plan that included "binding commitments for nutrient reductions and habitat restoration" that would be revisited every five years by local participants as part of an innovative Interlocal Agreement (Imperial, 2000). In particular, the plan has focused on reductions in nitrogen emissions to the Bay, recognizing that lower nitrogen levels in turn lead to less algae growth in the water. The plan essentially proposes a menu of actions, built on eleven primary goals of the TBNEP relating to improving water and sediment quality, living resources, and related land uses.

Thus far, strong support has existed for the TBNEP initiatives and the program is widely considered a success. There are many explanations for this broad-based support, with a primary reason being the attention given by the TBNEP staff and consultants over the past decade to the development of close working relationships with a variety of local industry, regulatory agency, and government partners. Other reasons for the success of the first five years (1996-2000) of the TBNEP include:

1) a history of cleanup efforts in Tampa Bay going back to at least the late 1970s, when local upgrades in sewage treatment plants and new wastewater reuse programs combined with state-sponsored nonpollution abatement initiatives to reverse the historic downward trends in water quality of the 1950s and 1960s;

2) the relatively straightforward science associated with point-source cleanup options: technologies and costs for upgrading wastewater treatment plants, re-using wastewater, or minimizing storm water impacts from new development were all well understood;

3) the widespread use of the Tampa Bay resource base: many people in the region drive over one of several bridges every day, there are many swimmers and boaters, and improvements in ecological resources such as seagrass, fish, and birds are highly visible;

4) the visible success of these earlier water-quality improvements, with reductions in nitrogen loadings to Tampa Bay resulting in "dramatic improvements in water clarity and reductions in algae biomass" (Imperial, 2000); and

5) the shared institutional incentives and responsibility for cleanup; for example, all counties within the region face onto the Bay, and many of the private contributors to pollution (e.g., fertilizer production and runoff) were easily identified.

Many of these reasons for this early success, however, are unlikely to apply as strongly to estuary cleanup initiatives undertaken over the next decade or two: further improvements to water quality will be less dramatic visually, both the technologies and

associated costs -- the underlying science and economics -- will become more uncertain, source control will become more difficult as the program shifts to a greater emphasis on airborne nitrogen deposition, and the time frame for achievement of benefits becomes longer (e.g., seagrass recovery in some areas may take 20-25 years). With recent studies showing that perhaps ½ - 3/4 of all nitrogen depositions to the Bay may come in through the air, many of these changes are expected to be reflected in the upcoming 5-year plan (scenarios for 2001-2005) that is currently under review and, even more so, in succeeding plans.

Although related goals of the TBNEP (e.g., protecting cleaner areas of the Bay from toxic contamination) will remain important, the next plans are expected to focus on farfield and vehicle emission sources of airborne nitrogen (along with additional improvements to the wastewater collection system), indicating a shift from reductions in land-based sources of nitrogen to reductions in atmospheric deposition. . Clear benefits can still be identified, but there is likely to be increasing controversy about the conclusions of the underlying science (which is only about 10 years old) and greater uncertainty about the range of proposed actions and anticipated impacts. One sign of this shift is that the Technical Advisory Committee apparently has been considering multiple management scenarios, and although it is expected to chose a mid-range conservative option that will continue to achieve Nitrogen reductions of 17 tons/yr (thereby holding the line at 92-94 levels) there is an enhanced appreciation for, and concern about, the attendant uncertainty in these estimates. We anticipate that these changes, and the need for a more complete evaluation of benefits and costs, will become even stronger in future years, with the justification for each successive five-year plan (e..g, beginning in 2006, then in 2010, then in 2015, etc.) reflecting steadily rising costs and steadily lower benefits, which in turn increases the need of the TBNEP to know how the public views its recommended actions and where strong support exists and where it doesn't.

To a large degree, therefore, the early success of the TBNEP program can be attributed in part to the preceding degradation of the region, which had the effect that many of the program's early benefits were, in essence, low-hanging fruit, relatively easy to see and inexpensive to obtain. As a result, there was little need for a detailed evaluation of actions in terms of their costs, benefits, and risks. Similarly, there was little need for an aggressive campaign to communicate the pros and cons of the TBNEP (or its predecessors), due to the high level of community support and the readily-visible nature of program benefits. However, as the attention of the TBNEP shifts to less familiar, more uncertain benefits that could impose substantially higher costs on some local governments and industries or result in restrictions on individual behaviors, more attention will need to be given to the development of appropriate actions, to the evaluation of their benefits,

costs, and risks, and to the clear communication of these anticipated consequences to each of several interested parties. These are tasks ideally suited to the use of methods from the decision sciences; in large part, the discipline of the decision sciences has emerged over the past 50 years in response to problems of just this type, in which responsible policy choices need to be made in unfamiliar decision contexts that are marked by complexity (in particular, multiple players and conflicting dimensions of value), less visible ties between actions and their consequences, and greater scientific uncertainty.

3.0 Research background: Key elements of a decision science approach

This section reviews some of the key concepts from the decision sciences that have been used in earlier studies to help understand public values and attitudes toward ecological risk management initiatives. Together, they comprise a framework for helping risk managers, science experts, and community residents to jointly frame and make decisions that effectively address their goals and interests.

The starting point is one of the most robust research findings on decision making: when left to their own devices, people "systematically violate the principles of rational decision making" (Slovic, Fischhoff, & Lichtenstein, 1976). Individuals naturally respond to complex tasks by using their judgmental instincts to find an easy or adequate way through the problem at hand. People respond to probabilistic information or questions involving uncertainties with predictable biases that often ignore or incorrectly process important information (Kahneman, Slovic & Tversky, 1982). Because these qualities -- unfamiliar and conflicting value dimensions, uncertain science, limited feedback, and diverse participants – are viewed increasingly as characteristic of Tampa Bay (and most other ecological risk-management contexts), the task of developing broadly-acceptable estuary protection actions argues strongly for decision-aiding assistance. Six elements of a decision science approach are noted as particularly relevant: each concept is briefly introduced in this section, with more detailed examples included in the next section showing how specific techniques might influence the choice of policy approaches for the Tampa Bay estuary.

3.1 Structured decision aiding

Most decision problems are poorly structured: the problem itself is ill-defined, the values of interested parties are not precisely characterized, the uncertainties are unclear, and the

consequences of alternatives are not meaningfully expressed. As a result, the starting place for most decision science approaches is to carefully structure the process by which a decision is made, both descriptively (in terms of how the choice currently is understood by individuals) and prescriptively (how it would be understood if better information were available). This topic is a cornerstone of behavioral decision analysis (von Winterfeldt & Edwards, 1986) and, in turn, of multiattribute utility theory (Keeney & Raiffa, 1993). In general, a decision-aiding process should directly involve both technical (e.g., scientific) and public (e.g., community) participants in creating a framework that works through the following six tasks:

1) carefully defines the nature of the problem;
2) clearly characterizes "what matters" in the form of values or objectives, each of which is denoted in terms of a performance measure or attribute;
3) creates a broad set of attractive alternatives, responsive to these objectives;
4) employs the best available technical information to characterize impacts or consequences of the alternatives, including uncertainties;
5) identifies the tradeoffs that the alternatives entail; and
6) summarizes the areas of agreement, disagreement and reasons for those views among the stakeholders.

Values (or interests) denote what matters: the process and content considerations that together comprise what is important in the context of the specific decision problem at hand (Keeney, 1992). Value judgments, in turn, can be used to create more attractive alternatives that stand a better chance of achieving wide support, because they directly anticipate and address the concerns of the principal parties involved in the environmental dispute. Other benefits include identifying the reasons why different stakeholders disagree or agree, which (in contrast to approaches based on dispute resolution) can serve as a cornerstone of efforts to create broadly-supported actions (Gregory, McDaniels & Fields, in press). In many cases, this exercise of carefully defining values helps stakeholders to see that many values are shared even if the relative weights placed on the value dimensions (see Section 4.3) are quite different.

In the context of Tampa Bay, a structured approach to decision making would start by carefully defining the problem at hand (e.g., what is "in" or "out" of the policy context) and then eliciting the values of interested parties in some detail, emphasizing not just environmental concerns but also issues related to economics, health and safety, community development, and social considerations. The ability of alternative policies to address these diverse values would be assessed in terms of explicit performance measures, which in turn serve both to enhance the creation of new policy options and to operationalize a careful tradeoff analysis, which examines

how much of one valued objective (e.g., jobs or habitat) is desirable in light of the costs it imposes on another objective (e.g., expenditures or visibility). The results of the tradeoff analysis then can be used to guide the creation and selection of preferred alternatives. Cycling iteratively through these elements, encouraging participants to express and explore their values fully and then refining the associated information on consequences until participants are satisfied they can provide well-informed judgements about which alternatives they support, is a key to successful environmental management deliberations (Gregory, Keeney, & von Winterfeldt, 1992).

3.2 Framing and context

Framing refers to the context in which a choice or judgment is made. Research has shown that different participants – the individual (or group) making the choice, the agency interested in the outcome of a vote or assessment, the media – often frame the same decision problem in different ways and that this can significantly effect how policy options are evaluated. Although framing can occur either unconsciously or consciously, in most of the situations relevant to eliciting expert and public input to environmental policies the creation of a frame is inevitable. This view suggests that stable or "true" values for many environmental resources generally do not exist but, instead, that values will be created or constructed in the course of an elicitation procedure in relation to the cues and signals that are provided (Slovic, 1995; Payne, Bettman & Johnson, 1999). Thus, attempts to avoid biasing individual perspectives in favor of the "neutral" communication of information are missing the point: if bias is to be expected, then it should be done consciously and in such a way that the individual is helped to formulate a sense of his/her own value that is well informed, has some internal validity, and is at least moderately reliable (e.g., if asked the same valuation question in two weeks, the person would answer similarly).

One of the ways in which decisions are affected by context is in terms of effects on decision processes and, in turn, the influence of several judgmental biases. As proposed by Tversky & Kahneman (1974; 1981), decision makers use "heuristics," or simplifying rules of thumb, to arrive at judgments. Decision heuristics can be helpful, in that they reduce the time and effort needed to make judgments, but they also can lead to systematic biases in judgment. Examples include the "representativeness" heuristic, whereby the likelihood of an event is often judged in terms of how closely it resembles another supposedly similar event, and the "availability" heuristic, in which the frequency of an event is assessed in terms of the ease with which occurrences can be brought to mind. Because technical experts are just as prone to these (and other) judgmental short-cuts as are other citizens, it is important to strive to limit the influence of these heuristics on consequential decisions; as a result, decision analysts have proposed numerous tools for helping individuals to "debias" their judgments.

Another of the principle illustrations of framing is the observed difference in people's responses to a gain and to the experience of a formally equivalent loss. In most cases, the loss is felt much more acutely, so that an individual who receives (as a gain) the same amount he has lost will not feel indifferent but will have suffered a decline in well-being. This behavioral response, quite different from that predicted by conventional utility theory, is anticipated by the S-shaped value function adopted in Prospect Theory (Kahneman & Tversky, 1979), which emphasizes the significance of the reference point used to frame responses (see Figure 1).

One prediction of this disparity in responses to losses and gains is that the public will show unusually strong support for initiatives that attempt to restore prior losses; an environmental improvement action that is framed in terms of returning to an earlier, better status will be evaluated more favorably than will an otherwise identical action that is framed as an improvement from current status, with no reference to an earlier state. In the case of Tampa Bay, one implication is that surprisingly strong support will be indicated for the restoration of seagrass beds, because their return is coded as the lessening of a prior loss rather than as an improvement from current conditions.

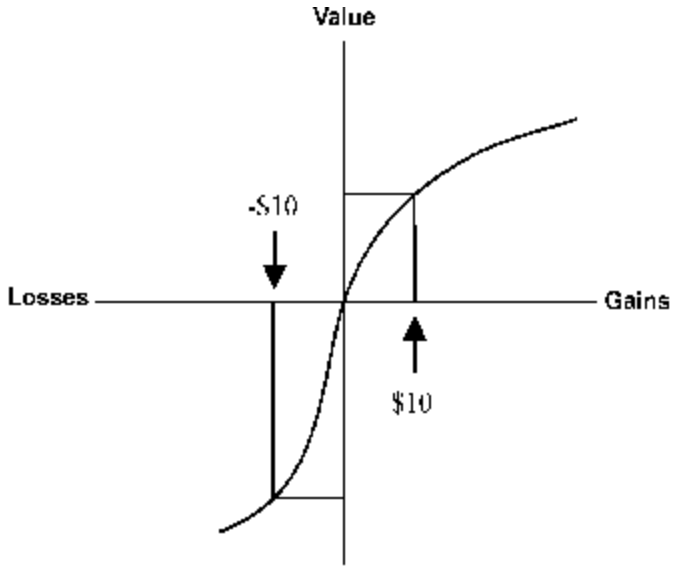


Figure 1: An example Prospect Theory value function (based on Kahneman & Tversky, 1979).

3.3 Affect and emotion

Findings in recent research on judgment and choice acknowledge the importance of affect and emotion as key elements in how individuals form judgments and make decisions. The two concepts are related but distinct: affect refers to the valence (i.e., goodness or badness) of a

stimulus or to associated feeling states such as happiness or sadness, where emotions refer to the arousal (e.g, anger or excitement or outrage) experienced in relation to a stimulus. Both affect and emotion hold strong links to perceptions of the effectiveness of risk managers, such as trust and credibility, and in turn to the willingness of stakeholders to engage in a policy-focused dialogue.

Although the mechanisms often remain obscure, it is well known that affective and emotional reactions play a significant role in the processing of information and, as a result, can strongly influence a person's judgments and choices. Currently, the Tampa Bay NEP appears to be widely viewed as a positive and responsible force for change. But if the "low hanging" fruit analogy is correct, then as higher-cost and less-visible actions (i.e., less-accessible fruits) become the focus of attention, retention of this positive image may be threatened. It may therefore be wise for the TBNEP to become more proactive in its risk communication initiatives so as to anticipate some negative responses in the future and to contain these by virtue of an open decision process that is defensible and maintains broad stakeholder acceptability.

3.4 Uncertainty

One of the cornerstones of the NEP is high-quality science. Unfortunately, as the program focus shifts from point to non-point sources of N deposition and from land-based to air-borne emissions, the underlying science becomes more problematic. This has several troubling implications: the range of impact estimates may become greater, scientists may disagree with each other's conclusions (regarding the cost of cleanup as well as the magnitude of nitrogen depositions from a source), and the choice of an appropriate policy response may become less clear. Although careful studies may reduce some of this uncertainty, much will be unresolvable in the short run given the nature of the processes in question and the newness of the science.

A variety of approaches from the decision sciences may be useful at Tampa Bay in terms of working with this uncertainty regarding physical processes or the efficacy of proposed treatments. For example, the decompositional emphasis of multiattribute techniques (Keeney & Raiffa, 1993) is often helpful in breaking highly complex problems into simpler parts, which is useful as tool for stimulating dialogue and introspection among dissenting scientists. Decision trees (Clemen, 1996) are often used as a way to explicitly incorporate, and to compare, probabilistic judgments about the likelihood of a series of events. Adaptive management approaches (Holling, 1979; Walters, 1986), which advocate flexibility in the face of uncertainty and embrace an explicitly experimental approach to learning, also have been widely employed as a means for managing environmental risks and dealing constructively with change.

3.5 Time

The decisions being made at Tampa Bay involve time as a central feature, both in terms of the decision making process itself (i.e., some decisions are made quickly, others require extensive consultation and discussion) and in terms of their impacts (i.e., some decisions result in short-term effects, others in consequences that accrue over decades). In order to facilitate making decisions over different time periods, policy analysts and economists have developed the notion of a quantitative discount rate: the rate by which future outcomes can be expressed in terms of the present. Generally, a project's returns are thought of as a stream of benefits and costs over time, discounted back to Year 1 (so comparisons can be made) using a discount rate of 4% - 10%. This has the practical implication that costs or benefits occurring later count less than those occurring sooner and, by extension, that impacts occurring more than about twenty years from now are essentially negligible in terms of the quantitative analysis of impacts.

Recent work by decision scientists has shown that this practice, although widely accepted, may be too simple. For example, people tend to use higher discount rates for near-term than for far-term events (Loewenstein & Prelec, 1992), which suggests that using a single higher rate may unfairly diminish the value of longer-term outcomes. Studies also show that people tend to use lower rate for losses than for gains (Benzion et al., 1989), which is consistent with the higher value placed on losses. There is also some indication that people may hold different discount rates depending on qualities associated with the items in question, which may in part be why several studies have found different rates for financial and for environmental goods. These results may be important in developing long-range plans at Tampa Bay, because recommended actions will result in impacts over different time periods (e.g., after wastewater treatment plants reduced their N loads in 1980, ambient chlorophyll concentrations in the Bay did not respond for nearly 5 years). In addition, whenever a variety of different economic, environmental, and social effects occur, it is likely that some consequences will take place more quickly than others; for example, economic impacts often occur more quickly than do biological effects. This can lead to asymmetric distributional impacts in the short run and, in turn, to questions about the equity of program actions.

3.6 Defensibility

The criteria by which decisions come to be viewed as legitimate and defensible is at the intersection of the decision sciences and political science, psychology, and negotiations. For the decision maker, establishing and documenting a justifiable *process* for making a decision is often critical, particularly in situations where uncertainty is high and so the *outcome* is difficult to predict. In such cases, a decision science perspective emphasizes that a good decision

process cannot guarantee a good decision and, in turn, a good decision cannot guarantee a good outcome (e.g., due to factors external to the decision environment, such as the weather or national politics, that may affect how things turn out). However, a good process can provide a strong rationale for what is done and encourage stakeholder buy-in to recommended actions.

Up to this point, it has been important for the Tampa Bay NEP to demonstrate the use of "state of the-art" science as a means for achieving legitimation. However, as the policy choices become more difficult, the importance of being able to justify program decisions may increasingly mean that managers face a tradeoff with other objectives, such as achieving the lowest-cost solution or achieving the best outcome (because of its greater uncertainty in comparison to other alternatives). In such cases, we expect that a greater reliance will need to be placed on the decision process as a basis for the legitimacy of TBNEP actions, in part because the outcomes of recommendations will become more difficult to predict. We also anticipate that legitimation criteria such as the understandability, accuracy, equity, or transparency of proposed actions will need to be identified more directly by the Tampa Bay staff in the future and, in turn, used as explicit criteria for assessing alternative policies.

4.0 Research design: Decision science techniques to address key issues at Tampa Bay

The focus of this section of the research plan is the use of widely-employed decision science tools to help the Tampa Bay NEP understand and respond to public concerns stemming from environmental policy initiatives at Tampa Bay. The discussion is oriented around four topics that appear to be critical determinants of the long-run success of the Program, based on materials distributed by the Tampa Bay NEP office (in particular, Holly Greening) and the Washington EPA office (in particular, Angela Nugent). Each of these topics represents a challenge and, as such, can be viewed as either a problem or an opportunity. In each case, appropriate decision-science techniques are briefly noted and special implementation concerns are highlighted.

In evaluating the appropriateness of these methods, it is important to keep in mind that, although many techniques of social scientists are different from those of natural scientists, similar criteria exist for distinguishing a high-quality from a low-quality performance on the part of the researcher. Thus, social scientists follow a hypothesis-based model, establish meaningful peer-review processes, and disagree about the interpretation of data just as do their colleagues in the natural sciences. There is art and an interplay of values and methods in the practice of social sciences such as decision making or psychology or economics but (arguably) no more so than in the practice of natural sciences such as biology or ecology or chemistry (von

Winterfeldt & Edwards, 1986). Further, social science investigations of ecological risk follow the familiar pattern of determining what considerations and factors are appropriate (risk perceptions), how the problem can best be assessed or evaluated (risk assessment), what conflicts contextualize and balance the formal analyses (risk management), and how best to communicate results to peers and to a more general audience (risk communication) (Fischhoff, 1989). The discussion of the four topics presented below follows this same pattern, starting with participants' values (perceptions) and scientific uncertainty (assessment) through to tradeoffs and balancing objectives (management) and, finally, to a discussion of communication needs.

4.1 Understanding stakeholders' values and concerns

Issue

What values held by people living in the Tampa Bay area are likely to be affected by TBNEP actions? How are participants' different concerns or values related? For most people, for example, nitrogen deposition is only one component of a much larger package of environmental considerations, including emissions of ozone, public transportation options, and population growth in the area and the state. These concerns, in turn, link to issues of control (to what extent should regulations limit the actions of individuals?), governance (to what extent should outsiders have a say about our city or region?), collaboration (when do community participants work together?), and timing (how urgent is it that activities be undertaken right away?) that can strongly influence the acceptability of different policy options. Disentangling these different influences and sources of value is essential to permit the development of policy options, and (subsequently) their evaluation, in ways that help to ensure that stakeholder assessments are defensible and address those elements of a plan that decision makers think are being evaluated.

Techniques

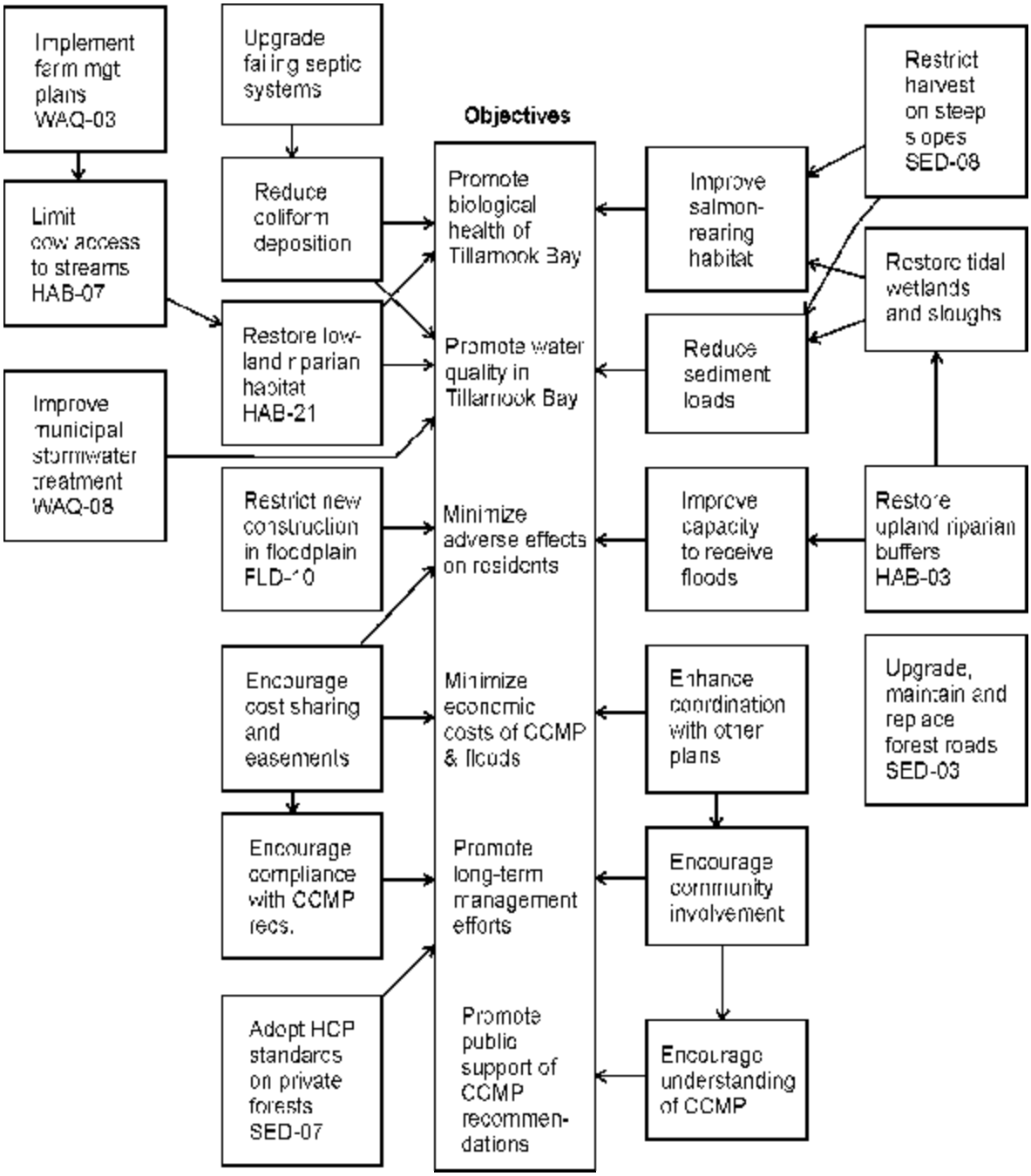
A. Small-group structured consultations

For a citizen of the Tampa Bay area, it is difficult to know how to think about the relative benefits, costs, and risks of any proposal to decrease the deposition of airborne nitrogen to the estuary. For one thing, the relevant values change as the specific problem changes. Further, any choice is likely to involve conflict across different types of values: protection of the environmental will increase and so, presumably, will both human and ecological health (which is good), but there will be some economic costs involving, perhaps, the loss of jobs or revenue (which is bad) and perhaps some social or cultural changes (which may go either way). In many cases, the achievement of a primary goal of the Program, such as reducing nitrogen from emission

sources, may yield related benefits that are just as important, such as sediment removal and the reduction in toxics from suspended solids associated with the completion of stormwater projects. In addition, some people may feel that the long-term impacts of a policy proposal include changes in the image of the community or in the quality of life for residents (as Tampa Bay continues to grow larger), so that qualitative and emotional considerations might also be important. The problem therefore involves many value dimensions, and each of these different values or objectives (in terms of a specific plan) can be thought about in terms of one or more performance measures or attributes:

Objective	*Attribute*	*Anticipated change*
environment	reduced nitrogen loads	better
health	reduced algae growths	better
economic	lost revenues	worse
social/cultural	new recreation opportunities	???
community image	big city qualities	???
quality of life	stress levels	???

A small group consultation process typically would involve either a cross-section of public and expert views (e.g., 10-15 people who are essentially representative of the diverse perspectives of the area, including public citizen representatives, scientists, industry, and members of the Policy Board) or representatives of a single point of view (in which case multiple groups would be held). In contrast to a more informal focus-group setting, which typically (as in Tampa Bay during the mid-1990s) are called to provide feedback, decision-aiding help is provided by an analyst/facilitator who, working interactively with participants, assists in identifying the key value considerations and in thinking through why each dimension might matter (Keeney, vonWinterfeldt, & Eppel, 1992; Gregory, 2000). This value-structuring goal is accomplished through the use of tools such as *value trees,* which connect higher- and lower-order values, and *means-ends diagrams* (see Figure 2), which separate fundamental objectives (those of essential concern) and means objectives (important because of their indirect effect on more fundamental concerns). Understanding these value distinctions can help in discovering the root causes of disagreements among stakeholders and finding creative policy options.



NOTE: The six fundamental (ends) objectives are shown in the center box. Means objectives, many of which become actions in the Tillamook CCMP, are shown at the sides. An arrow denotes "influences," between means objectives and from means to ends.

Figure 2. Means-end diagram for Tillamook Bay NEP (from Gregory, 2000).

Means-ends diagrams have proven to be a particularly useful tool in creating alternatives that are responsive to the different values and concerns of stakeholders (Gregory, 2000). For example, one person may view reducing nitrogen loads as a means to reducing algae growth and, in turn, creating higher property values due to improved water quality; for another person, reducing nitrogen loads may be a means to improving fishing opportunities and, in turn, a chance to spend more time on family outings. Both these individuals would care about reducing nitrogen loads but for very different reasons. Similarly, because the benefits of increased seagrass beds may include both improved fisheries and clearer water (as the result of filtering land-based runoff), different policy responses may be favored by residents who view seagrass as a means to either of these objectives as compared to those who primarily value seagrass restoration itself.

B. Structured survey

An alternative to small groups would be to use a structured survey. The type of survey that is envisioned here is very different from the typical opinion poll or attitude survey, which for the most part fail to provide respondents with either the information or context required to form careful and valid responses. As a result, there is often a large gap between the immediate opinions expressed in the survey and people's behaviors and attitudes over the longer run. In structured surveys, in contrast, a series of questions are asked that mimic a conversation, setting up linked sets of questions (or paths; see Figure 3) that probe expressed opinions, allow for learning about one's own values, and test the strength of the different components that contribute to support or opposition toward a proposed management action.

Several different structured survey options are possible. McDaniels (1996) used a structured value survey to conduct a referendum of three alternatives for managing sewage waste disposal in Victoria, Canada. Gregory et al. (1997) used a decision-pathways survey (in which each pathway serves as a distinctive mental model) to compare resident's support for various forest vegetation management options. One advantage, in comparison to small-group approaches, is that more participants can be involved, although somewhat less in-depth responses will be obtained and the time provided for learning is greatly shortened. Another advantage of a survey is that it would permit statistically significant comparisons of the views of different groups living in the Tampa Bay area toward various policy options, including (a) samples split by age, for example residents under age 30 or over 65; (b) a study of the views of newcomers to the area, which could be useful since 300,000 new arrivals are expected by 2010; (c) differences in expressed values by gender or by geographic location, such as people living in different counties.

Implementation

A public opinion poll was conducted for the Tampa Bay NEP in 1991. Since this time, there have been substantial changes in the population of Tampa Bay, in the accomplishments and regional profile of the TBNEP, and in the status of water protection in the estuary. For all these reasons -- along with the importance of conducting a more meaningful, value-structured survey -- it is recommended that either small-group consultations or a structured survey be undertaken in the near future. If small-group work is done, both the definition of the problem under consideration and the selection of participants (as representatives) would be critical. If a structured survey is done, it should be designed and the results analyzed by a team with both decision-science and survey research backgrounds, although the implementation of the survey

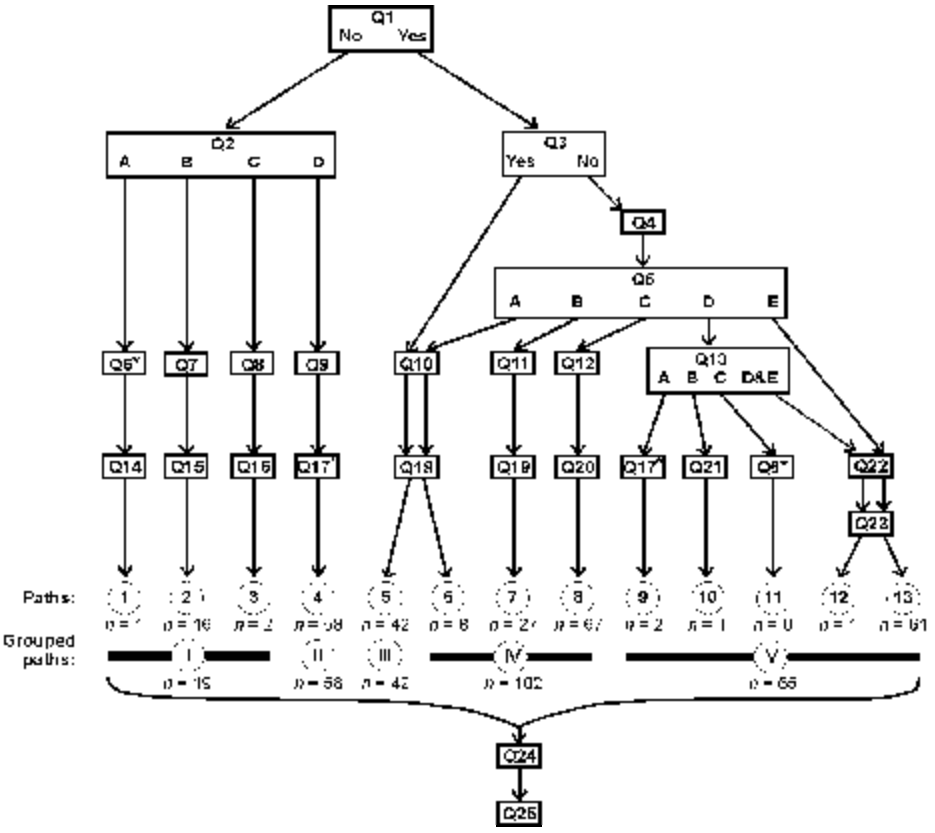


Figure 3. Example branching decision-pathways survey structure (from Gregory et al., 1997).

could be done by any reputable local firm with CATI (computer assisted telephone interviews) capability. Some small-group work should be done in advance, to learn more about value structures of Tampa Bay residents as an aid to survey design and as a guide to the construction of the mental models or pathways.

Costs for the small-group structured consultations would vary with the length of time that the group, or groups, were to meet. Much can be learned through one (or several) “decision framing” workshops lasting two-three days and focusing on the framing of the problem and the identification of key decision elements (using basic decision-structuring tools such as vaelu trees, influence diagrams, decision trees, and the like). With up-front preparation and a final report, each workshop might cost $20 -25,000. Ongoing groups, meeting perhaps once every two weeks for a period of several months, would involve higher expenditures (e.g., $50,000 - $75,000) but typically are required in situations such as protection of the Tampa Bay estuary where multiple value dimensions are involved and the management actions are relatively complex . A structured survey would cost perhaps $135 - $150,000, including a subcontract of approximately $50 - $65,000 for the conduct of the survey itself (which presumably would go to a local firm with computer-assisted telephone interview capabilities). The remaining $85,000 would roughly be split equally between initial small-groups, survey design and pre-testing, and data analysis and reporting.

4.2 Understanding scientific uncertainty

Issue

Scientists do not know all they want to know about the deposition of nitrogen into the Tampa Bay estuary. The importance of these knowledge gaps is expected to increase as the focus of the TBNEP moves from land-based to airborne depositions. This uncertainty has several implications:

- creates large ranges associated with the quantity or timing of anticipated impacts, typically due to the uncertainty associated with discrete future actions or with a lack of study results. For example, if Tampa Electric Company switches a large power plant from burning coal to natural gas, nitrogen deposition to the bay could be reduced by several hundred tons each year.

- creates controversy among scientists, due to disagreements in their interpretation of data. For example, estimates for airborne nitrogen deposition in 2010 range from 150 tons/year to 580 tons/year (Greening, pers comm), which is a large range and creates problems for policy formation as well as stakeholder communication efforts. Presumably, some scientists will think the lower end of this deposition range is more likely, others the high end; knowing more about their reasoning could help to narrow the range and improve management.

- creates frustration among residents, who typically believe that good science is not equated with uncertainty. Over time, a failure to understand the reasons for the uncertainty in consequence estimates can lead to an erosion of support for the TBNEP (as well as, from a technical perspective, inferior policy choices).

Techniques

A. Decision trees and event trees

Decision trees, event trees, and influence diagrams (which help to show the structure of problems; see Section 4.4) are all commonly used to help individuals think through a range of different decision possibilities. They provide useful visual and computational assistance in the many cases where a combination of decisions, consequences, and probabilities quickly results in problems of daunting complexity (Keeney (1982: 806) defines decision analysis as "a formalization of common sense for decision problems which are too complex for informal use of common sense."). Both decision and event trees flow from left to right, with branches representing the different alternatives that are possible. The primary elements include:

- decisions to be made (represented by squares)
- chance events (represented by circles)
- consequences (specified at the ends of branches).

An example decision tree (simplified, but with all three elements included) is shown below.

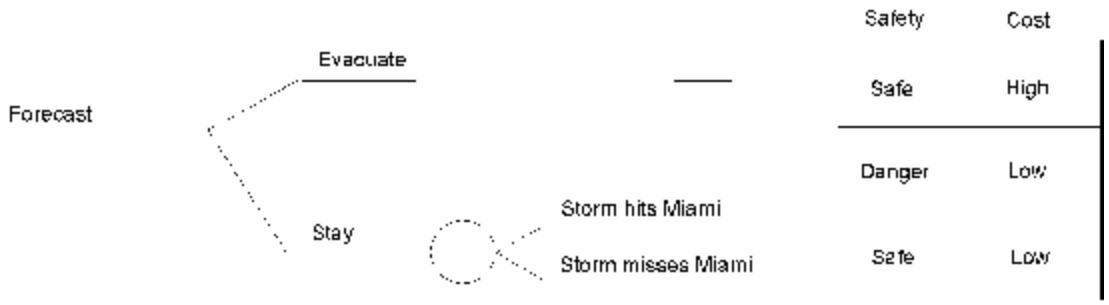


Figure 4. Example showing key elements of decision tree (from Clemen, 1996)

Formal rules exist for the development of a detailed decision tree; for example, the branches from each chance node must correspond to a set of outcomes that are mutually exclusive (i.e., only one of them can happen) and collectively exhaustive (i.e., one of the specified outcomes has to occur). The order in which elements are shown is also crucial; placing a chance event before a decision -- the probabilistic future price of natural gas before a decision to convert - means that the decision is conditional on a specific chance event having occurred (e.g., if gas price is high then don't convert, if gas price is low then convert). Key elements to be included as part of an influence diagram or a decision or event tree for Tampa Bay might include:

- whether Tampa Electric Co. power plant switches from coal to natural gas
  - no switch (due to price increases for natural gas)
  - small plant switches from coal to gas (sooner vs. later)
  - large plant switches from coal to gas (sooner vs. later)

- whether a new natural gas pipeline is completed to Port Manatee
  - new merchant plants are built to provide power to grid
  - no new merchant plants are built
- the magnitude of future population increases in Tampa Bay
  - 10% growth, 2000 - 2010
  - 20% growth, 2000 - 2010

Decision trees are also a useful mechanism for displaying the sequential nature of some decisions: one action must be taken first in order to facilitate a later, related action. Questions of timing, and in particular differences in the timing of the economic and biological effects of NEP actions, are likely to become increasingly important over the next 10-20 years.

B. Expert judgment elicitations

If a decision tree were to be used to clarify the importance and probability of future outcomes at Tampa Bay, where would the information for each branch of the tree come from? In some cases existing local data bases will be adequate and, at times, information from similar locations will be helpful (e.g., areas where power plants underwent similar types of fuel conversions). In many cases, however, the best information will reside in the minds of experts. In such situations, a decision-science perspective advocates the use of a structured, quantitative process for eliciting this information (Keeney & von Winterfeldt, 1991). One reason why a quantitative process is recommended is that qualitative statements of uncertainty (e.g., “a small chance”) are vague and can have different meanings to different individuals. Qualitative statements also can mask vagueness about the question being judged and hide important variations among the selected experts. In addition, it helps to assess the confidence that each expert has in his or her own judgment and to establish a consistent basis for collecting the knowledge so as to facilitate the comparison (and aggregation) of judgments across individuals.

In the typical case, information is collected in the form of a cumulative probability distribution, showing (for the event in question) the 0 - 1 probability associated with the occurrence of different levels of the event. Responses are shown as probability distributions, which both quantifies the expressions of likelihood (e.g., the implied probabilities when an event is said to be “highly likely” or “nearly impossible” or “occurring reasonably often”?) and facilitates the visual comparison of the judgments. Some training in decision making is often helpful, so that the influence of some of the more common biases in judgment can be minimized.

For most problems, posing questions as part of an expert judgment elicitation helps to highlight unanticipated differences in interpretation. For example, suppose the question (see Figure 5) is

"How much additional seagrass do you think will grow back into this specified area (as shown on a map) by 2010." Different people may interpret the question differently -- What is the starting point for the "additional" growth? Are all types of seagrass covered or only certain types? How established does the seagrass need to be to count as having grown back? --but even after these issues are made explicit, the range of estimates derived from the experts may well differ significantly. This is illustrated in the three example distributions shown below, which vary in terms of how much seagrass currently exists (compare experts A and B), the time-path for future growth (compare A and C), how the problem is decomposed (see expert B), and the eventual maximum amount (compare B and C).

Despite these differences, in a typical case the individuals would be unaware prior to the elicitations that such large differences existed among their perspectives, because the questions never had been posed in quite this way. In all such cases, a related recommendation is that the variations should not be suppressed but rather explored carefully, to encourage an open exchange of information which might then lead to additional consensus among the group or, perhaps, to the identification of further studies.

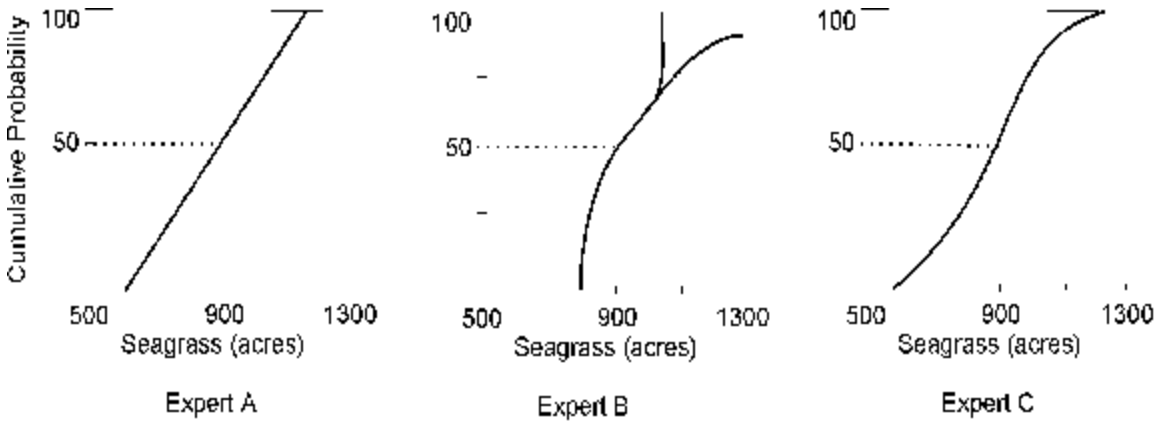


Figure 5. Example cumulative probability distributions from three experts for the question, How much additional seagrass will grow back into the specified area by 2010?

C. Adaptive management and learning

Different management responses can be made in response to uncertainty. One is to essentially ignore the uncertainty by going with the most likely scenario. Another is to postpone any decision until more information becomes available and the uncertainty is reduced or resolved. A third possibility is to undertake multiple approaches and retain flexibility as results are monitored and more is learned. An adaptive management approach embraces this third path, incorporating an active approach to learning as part of protection activities. Based on ideas of

the ecologists C.S. Holling (1979) and C. Walters (1986), adaptive management incorporates an explicitly experimental approach to learning as a way to reduce uncertainty. By carefully monitoring results (e.g., the ecological, social, economic, and cultural impacts of alternatives) and incorporating mechanisms for learning from successive trials (which may occur at one location or at many locations), an adaptive approach (see Figure 6) recognizes that some failures will need to occur in order to learn about the limits of a system and to retain flexibility in management options.

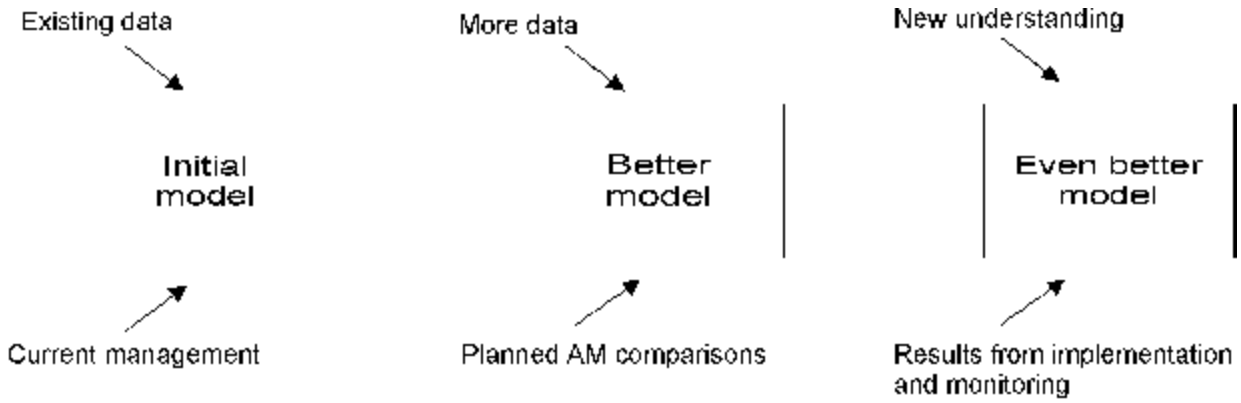


Figure 6. A model of the adaptive management process (based on Holling, 1979)

Nevertheless, the barriers to adaptive approaches that provide learning are formidable, arising from the political, institutional, and human settings in which risk management efforts are pursued (Gunderson, Holling & Light, 1995). As a result, most of the major planning exercises for implementing adaptive management policies have not been carried out, primarily because decision makers wanted near-term solutions or were more concerned with fine-tuning solutions that appeared to be best rather than preparing for the inevitable ecological, economic, or social surprise. Decision-analysis techniques can help to implement adaptive management approaches in three ways: first, by keeping track of the low-probability but high consequence adverse events that can occur if all does not work out as planned; second, by assisting in the development of explicit measures of learning, so that reductions in uncertainty over time are correctly perceived to be a benefit of acceptable risk management policies; third, by helping to set priorities for which management policies are most important to test.

Implementation

An initial focus for addressing uncertainty at Tampa Bay might explore estimates regarding the relative contributions of (a) atmospheric deposition sources of nitrogen from the watershed and (b) airborne nitrogen sources located outside the watershed along with (c) the ecological

consequences of nitrogen deposition. These elicitations would seek to identify both the uncertainty associated with future contributions from each source and the uncertainty about the associated effects. Although additional study might be warranted, experience suggests that a great deal could be learned from two short (2-4 day) workshops involving 4-6 recognized experts, who would be given some initial training in the type of judgments required: the first would focus on problem decomposition and structuring the uncertainties, and the second would elicit the probabilities and discuss reasons for similarities and differences across participants. The answers would be important to the overall effectiveness of the TBNEP efforts, because presumably some sources of deposition are more easily controlled than are others and, in addition, mitigation plans should be reviewed and adjusted periodically to reflect the most recent information on protection efforts. Further, if additional studies confirm that atmospheric deposition accounts for as much as 75% of all loadings in the Bay, then there might be regulatory implications in the event that the TMDL (as a measure of the Bay's "assimilation capacity") or other baseline measures of program effectiveness would require adjustment.

Costs for the recommended approaches again would vary depending on the breadth and depth of the analysis. Significant insight into the structure of ecological risk problems and management options can be gained from simple decision trees, in the course of short (3-5 day) workshops that might cost $30,000; clarifying the associated uncertainties and, in particular, conducting studies to test and refine the available information would involve additional resources. Expert judgment approaches naturally lend themselves to short workshops of 2-3 days, but only after a problem has been well defined (although the up-front costs here largely could be borne by the TBNEP staff, with outside decision-science consultants coming in only to conduct the workshop). Typically, consultants might address a series of problems by holding multiple, topic-specific workshops. Adaptive management approaches typically require extensive modeling of options and, often, some initial testing of approaches and monitoring of results. Costs are difficult to estimate, in the absence of a specific proposal, but it is probably unrealistic to think of initiating an active learning process using adaptive management approaches for a commitment of less than $50-75,000 and a time frame involving anywhere from several months to several years.

4.3 Achieving a balanced plan: addressing tradeoffs

Issue

The residents of Tampa Bay want more of many things: cleaner water in the Bay, good employment opportunities, a healthy industrial base, better opportunities for recreational activities, improved health, and reasonable living expenses. Up to this point in time, by and

large, they have been able to achieve many of these goals at a low or negligible cost. Over the next decades, however, the inevitable conflict in these multiple desires will become more evident: improvements in one dimension will lead to tough choices and, at that point, help will be needed in constructing a plan that balances the needs of the different public, industry, and agency stakeholders. Whereas economic approaches might seek to estimate the monetary value of proposed plans (in terms of residents' expressed or revealed willingness-to-pay), a decision science approach focuses instead on the balancing of different values and priorities, which involves the explicit consideration and determination of acceptable tradeoffs.

One way in which tradeoffs will show up at Tampa Bay is in the priorities attached by different stakeholders to specific aspects of the estuary protection plan. Understanding the reasons for similarities and differences in the importance of proposed estuary-protection actions will help the TBNEP staff to develop alternatives that are more likely to receive broad stakeholder support. For example, some initiatives attractive to technical experts may receive a surprisingly low level of public support, whereas other initiatives (e.g., seagrass restoration) may achieve a surprisingly high level of support; in both cases, a decision science perspective on problem framing and the construction of value tradeoffs may help to explain these findings. Other important tradeoffs may derive from distributional considerations: tough controls on agricultural runoff or on immigrants presumably would more strongly affect Hillsborough County or Manatee County (which still have large agricultural and range areas) than Pinellas County (which is large built out). Overall, four decision science approaches to dealing with tradeoffs are particularly relevant to the policy choices likely to be facing the Tampa Bay NEP managers.

Techniques

A. Consequence tables

The development of a consequence table is an important step in operationalizing a decision-sciences approach. The idea is simple: for each major action or initiative that is proposed, an "objectives by alternatives" matrix is created that clarifies the consequences associated with each action in terms of the expressed objectives. The various alternatives are shown across the top of the matrix, with objectives shown along the left-hand side; entries display the change in performance measures or attributes of each objective that are anticipated for the designated alternatives. This allows the main impacts of each option to be displayed in a way that quickly identifies how participants' values will be affected and whether all important considerations are being evaluated. The use of a consequence matrix also eases the visual identification of dominated alternatives, in which one option is clearly better than another on all criteria.

	Alternative A	Alternative B	Alternative C
Objective 1			
Objective 2			
Objective 3			
Objective 4			

Example Consequence Table

The consequence table provides a surprisingly powerful tool for the analysis of competing options. If it is comprehensive, then all reasonable options are shown (in terms of the listed alternatives) as are all reasons why any alternative will matter (in terms of the objectives). Anything left off the table is unimportant -- either its consequences are not important (in which case no associated values are shown) or its consideration is not realistic (in which case it does not represent a viable alternative). Different options may be weighted differently by different stakeholders, in terms of the relative importance of objectives (including zero weights on some objectives). Further, the consequence table can assist in creating new alternatives (for the example, new options “D” or “E”) that combine some of the good ideas already generated in novel ways and may be preferable to any of alternatives previously discussed.

B. Swing weights and even swaps

There are many different methods for helping stakeholders to think through tradeoffs and their implications. One widely-adopted approach, known as “swing weighting,” starts with the description of a hypothetical alternative that would result in the worst level of impact for each of the expressed values (e.g., the fewest acres of habitat restored, the lowest number of jobs, etc). Participants are then asked to rank the objectives in terms of which impact they would most prefer to “swing” from the worst to the best (e.g., the most acres of restored habitat, etc.). In a subsequent step, the ranked objectives are rated quantitatively so that explicit comparisons of their relative importance can be made (keeping in mind that these ratings are specific to the problem context under consideration). The more important dimensions of value then will be weighted more heavily in the subsequent decisions. Similar results can be obtained using paired comparison and a variety of other weighting approaches; the choice of a technique should reflect the cognitive styles and capabilities of the group or individuals involved (von Winterfeldt and Edwards, 1986).

Another tradeoffs technique builds on the use of a consequence table to simplify decisions by focusing on the elimination of dominated alternatives (or alternatives that are so close they can be considered to be “practically” dominated; see Hammond, Keeney & Raiffa, 1999). By looking

for “even swaps”, the two options are rendered equivalent for the cited dimension of value. An example would be a choice of jobs in two cities: the choices might differ in terms of responsibilities, salary, and (for the cities) rainfall, but if the cost-of-living-adjusted salaries offered are the same (or nearly the same) then this dimension is not helpful to making the choice because it does not discriminate between the jobs.

Consider, in the case of Tampa Bay, the three alternatives shown below. Each represents a simplified plan for restoring a portion of the estuary. Only three consequences are shown: the cost (in millions of dollars), the new fish rearing habitat that will be created (in acres), and the new days of recreational fishing. At first, the choice between A, B, and C appears confusing: C is cheaper but also has lower environmental benefits and creates fewer recreational options,

	Alternative A	Alternative B	Alternative C
Cost ($)	40	55	30
New Habitat (Acres)	115	210	100
Rec’l fishing (Days)	18	15	9

whereas B provides the most new fish habitat but also costs more whereas A is best for recreation. Looking only at Alternatives A and B, suppose that people are willing to pay $15 million (but no more) to create 60 additional acres of habitat. Reflecting this “even swap” tradeoff in A (as shown below), the cost rises to $55 while the new rearing habitat increases to 175 acres. For the two objectives cost and habitat, the choice between A and B is now easy: B is clearly superior, because the costs are equal (so this dimension becomes irrelevant to the choice) and B provides an additional 35 acres of habitat. By working through even swaps for the other tradeoffs, in turn, the choice of a preferred alternative will gradually become clear.

	Alternative A	Alternative B
Cost ($)	~~40~~ . . . 55	55
New habitat (Acres)	~~115~~ . . . 175	210

C. Reference points: Understanding gains & losses

A decision science perspective on gains and losses helps to understand the question: Why is the support for some components of protection plans surprisingly strong and, for others, weaker than anticipated? The answer comes back to the Section 3 discussion of framing and the finding that some changes are coded as gains whereas others are coded as the restoration of losses. Given the asymmetrical value function of Prospect Theory (Kahneman & Tversky,

1979), losses count for more than gains. Extensive research in the decision sciences has demonstrated that the framing of options as the restoration of a loss or damage rather than as a gain or improvement can result in a 2- or 3-fold difference in expressed measures of value (including dollar-based valuations such as expressed willingness to pay).

The technique for distinguishing gains from losses is simply to ask people how they think about a proposed action. Their explanation -- in terms of whether they naturally adopt a gain or loss as their reference point -- will help to explain differences in public responses to proposed actions, for example why there is such broad support in the Tampa Bay area for restoring sea grasses to 1950s levels. If the reference point were current conditions (see Figure 7 below), then each new acre of seagrass would be viewed as an improvement or gain. But if the reference point were the 1950s, then each new acre would be seen as reducing an experienced loss and, therefore, worth more. Generally, the restoration of a prior loss will be considered more valuable -- by a factor of two, three, or more -- than the achievement of a similar gain (Knetsch, 1990; Gregory, Lichtenstein & MacGregor, 1993).

The framing of changes as gains or losses also carries emotion and affect. The value structuring techniques described earlier help to capture this more qualitative side of stakeholder responses and enlarge the domain of concerns that are considered legitimate. This adds credibility to the consultation and evaluation process and helps to increase its ability to absorb, and be responsive to, changes in stakeholder perceptions over time.

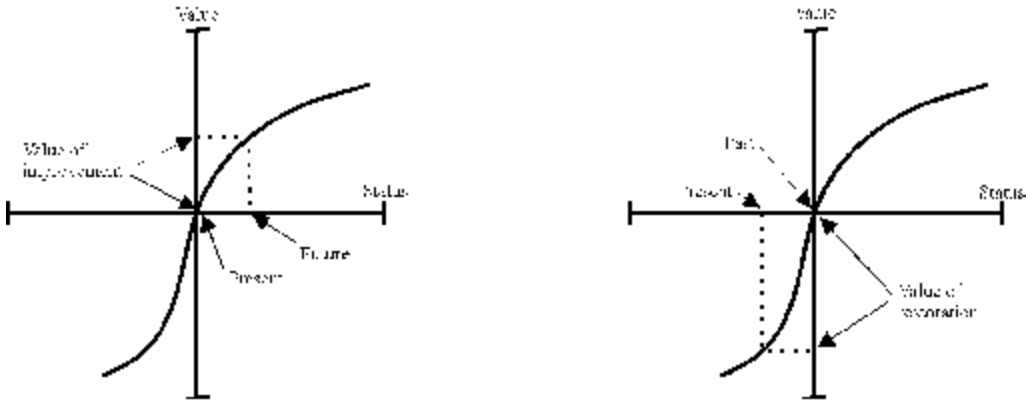


Figure 7. Comparison of environmental gains and losses (from Gregory, Lichtenstein & MacGregor, 1993).

D. Evaluability

Participants in public consultation processes are often asked to provide input in ways that are not at all user friendly from a decision making perspective. For example, participants in an economics-based evaluation study (e.g., a typical Contingent Valuation survey) might be asked

whether they would willingly pay an extra $20/year in added local taxes in support of an action that would yield higher levels of water quality. The problem with such questions is that the decision context is not easily evaluable, because there is nothing to compare it to: How else could the $20 be spent? Are there other plans for protecting water quality? How much would they cost? Would almost the same benefits be realized for $5/year? Could much more be accomplished for $25/year?

Techniques for incorporating concerns about evaluability address questions such as these by recognizing that comparative judgments across dimensions are easier than single judgments that lack a frame of reference. Consider the following example from a study by C. Hsee (1996), one of the originators of the evaluability concept. A choice is to be made between two dictionaries. One dictionary (A) has 10,000 entries and the cover is like new. The second (B) has 20,000 entries but a torn cover. Which would you prefer? Three identical groups of subjects were selected. A first group was given Dictionary A, a second Dictionary B. Participants were willing to pay more for Dictionary A ($27) than for Dictionary B ($20), suggesting that the torn cover (an affective dimension) counted for a lot:. A third group of subjects was given information on both dictionaries and asked to assign prices. For these participants conducting a joint evaluation, the preference was reversed and Dictionary B was now priced higher ($24 as compared to $19). Which is the better evaluation process? A decision science perspective would argue strongly for the joint evaluation with explicit information presented on the multiple dimensions of the choice. The reason is that, in joint evaluation with multiple alternatives, participants were able to compare one option to another and, as a result, the more difficult to evaluate attributes (in this case, the number of entries) became easier to consider and, therefore, exerted a relatively greater influence.

The concept of evaluability has important implications for the presentation of information to the Policy Board and other citizens of Tampa Bay. Including multiple alternatives and presenting information about how they compare on specific outcome or process attributes will help to ensure that the implications of all relevant alternatives are understood and that, by comparing dimensions of value, the more difficult-to-evaluate aspects of alternatives will not be neglected. As a result, a higher quality choice will be made -- one that is more likely, in the long run, to reflect the interests of decision makers and to improve the welfare of citizens of Tampa Bay.

Implementation

Each of the approaches introduced for dealing with tradeoffs -- consequence tables, even swaps, reference points for gains or losses, and multiple alternatives for improving evaluability – seek to provide information that makes it easier for individuals to consider tradeoffs in their judgments about an action. Any of these approaches is compatible with either small-group or survey formats. Including information of this type helps individuals to think about tradeoffs, which

often are cognitively and/or emotionally difficult (and, at times, are therefore resisted), and it helps to broaden the communication process because trade-off judgments are elicited directly from stakeholders. If policy makers fail to elicit explicit tradeoff judgments then the consultation process is open to criticism: participants are not fully informed, and the interpretation of information about their preferences by the decision makers may not mesh with what people truly desire.

Costs for implementing these techniques are relatively low, particularly in light of the insight that can be achieved. Both consequence tables and even swaps involve a different way of organizing and looking at information that already may be in hand, so it is again a situation where substantial gains can be made -- including, in many cases, the creation of new alternatives -- in the context of a 2-3 day workshop (so, with some time for preparation and reporting, perhaps $25-30,000). Bringing in techniques for recognizing and working with both gains/losses and evaluability issues need not involve any additional costs; it is more a question of adopting a behaviorally-informed perspective that is more in line with how people naturally think about and address a wide variety of policy and management problems.

4.4 Communicating with stakeholders

Issue

Two aspects of communication are important to the Tampa Bay estuary protection efforts. The first, which seems to have been done very well, involves helping the public to know about the initiatives under consideration as part of the TBNEP and how they can contribute to the TBNEP program (including specific information about whom to phone or e-mail, how long to expect to wait for a reply, the status of current initiatives, etc.). The second type of communication is about building an understanding of stakeholders' concerns and developing broadly-acceptable actions that will help to protect the estuary. This second type of communication involves the establishment of trust and an ongoing two-way dialogue, about factual information as well as values and emotions and ethical principles, and fits within the broader framework of achieving negotiated settlements or creating alternatives that are supported by key participants. Topics include (a) how complex scientific issues, such as the mechanisms by which nitrogen is deposited from the air, can be presented so that the choices made by public stakeholders are well informed from a technical perspective and (b) how complex values and tradeoffs, including the observed willingness of citizens to support restoration activities more strongly than they will support environmental improvements, can be presented so that both technical stakeholders and policy makers are well informed about the views and opinions of citizens.

Techniques

A. Influence diagrams

Earlier sections discussed the use of decision-science techniques for distinguishing means from fundamental objectives and for developing value hierarchies. Influence diagrams are a closely related technique for structuring the various elements of more complex decisions -- what choices are to be made, what alternatives are available, what uncertainties are important, and what are the likely outcomes. In the context of communicating with stakeholders, influence diagrams constitute a simple and effective tool for clarifying what needs to be communicated about and, thus, provide an accessible technique useful to all parties in making sure that communication efforts are sufficiently comprehensive and detailed (Shachter, 1986).

The essence of an influence diagram (as with a decision tree) is the use of different shapes for different decision elements (or nodes), which are then linked with arrows to show their relationship (see Figure 8). Decisions are represented by rectangles with square corners and chance events by ovals. A rectangle with rounded corners represents consequences (as well as some other related uses). In the simple influence diagram shown below, the decision by partners of the TBNEP is whether investment funds should be committed to a specified estuary protection action. There is uncertainty about whether the investment will fail or success, which in turn affects the return on the investment (i.e., the consequence). The investment node influences the return, but there are no arrows from the chance node to the decision because at the time the decision is made it is not known whether the action will succeed. This same logic is helpful in more complex decisions in tracing through an anticipated sequence of events; probabilities for different levels of success also can be entered if this information is available. The use of even very simple influence diagrams can help to demonstrate how stakeholders understand a problem and, in turn, whether the information that is provided to them is sufficiently complete for an informed decision to be made.

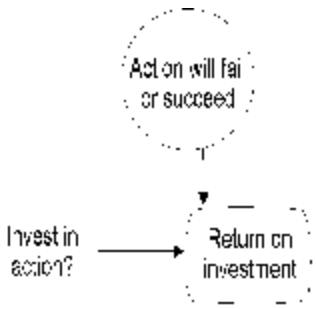


Figure 8. Example influence diagram for an investment decision by TBNEP partners

B. Mental models

A key aspect of communicating effectively with different stakeholder groups is learning about the mental models they employ to make sense of information and to help evaluate choices or policy

options. As developed in the past decade (see Bostrom, Fischhoff & Morgan, 1992), a mental models approach uses the results of loosely-structured interviews to map out how an alternative is thought about, based on a picture of the key relationships among cognitive components. Different models are likely to exist for different groups, so an important consideration is the number of groups that will be considered and the depth of responses that will be used to characterize their thinking. This information, in turn, is very useful to decision makers who are seeking to communicate with these individuals because it helps to identify the types of cause-and-effect linkages believed to exist.

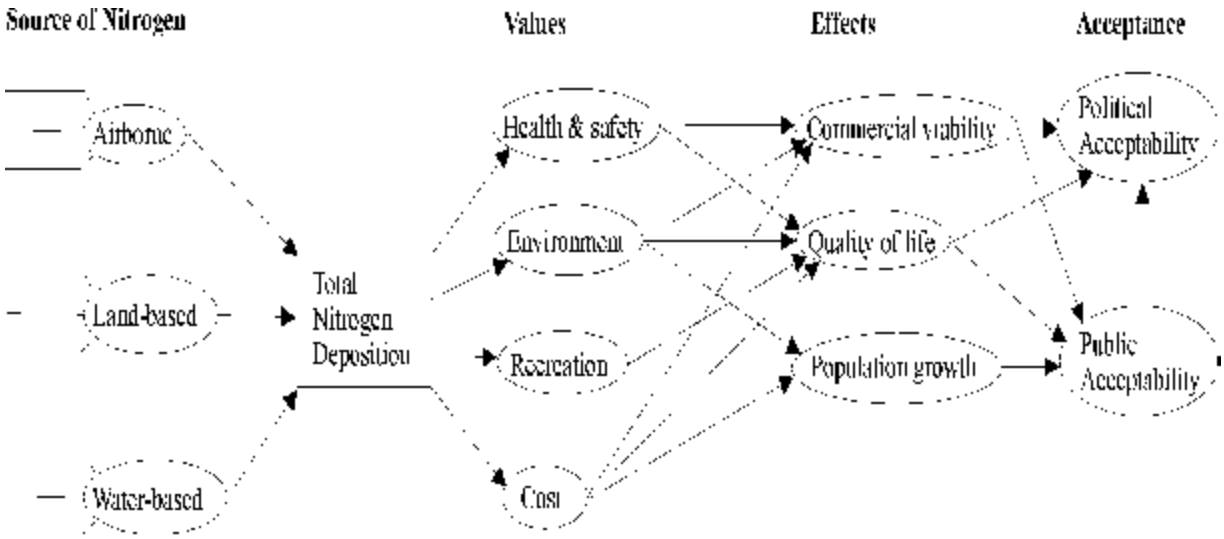


Figure 9. An illustrative mental model for Tampa Bay

At Tampa Bay, a natural use of mental models would be to help understand the processes thought to be involved in the air deposition of nitrogen. What sources of nitrogen are considered to be most important? What do people think happens to the nitrogen once it is in the water? What types of experiences are thought to be affected by higher or lower rates of nitrogen in the air and in the water? This information is helpful as a way to understand the concerns of Tampa Bay residents and as a way to anticipate their responses to proposed plans.

Implementation

Both influence diagrams and mental models represent techniques that are designed to foster understanding through a two-way dialogue between the TBNEP and its various stakeholders (as well as among the stakeholders themselves). They are common sense applications of decision science concepts, proven to be helpful in organizing communication and in facilitating meaningful exchanges. In contrast to some of the other decision science tools (e.g., for dealing with uncertainty), the basic use of both influence diagrams and mental models can be taught

quickly and these techniques can be employed readily in helping to understand stakeholder values and to develop directly responsive ecological risk policies.

Costs associated with influence diagrams, as with other problem-structuring techniques used by decision scientists, are relatively low and often significant progress can be made in understanding stakeholder values related to an environmental risk problem in the course of a 2-3 day workshop (as previously noted, costing perhaps $25-30,000 including some preparation and reporting costs). Although the workshop might have a specific issue focus, the benefits of using these techniques would extend to other problems facing the TBNEP. Mental models research typically requires a more extensive involvement with stakeholders and some interaction over several weeks or months to conduct personal interviews and to adjust and refine insights, so that costs of perhaps $50 - 75,000 would be typical.

5.0 Summary schedule and costs

Developing a schedule and proposed costs for Implementation of these suggested approaches at Tampa Bay is difficult for two reasons. The first is that limited information has been provided regarding the current status of knowledge about the values and tradeoffs of different stakeholder groups. The second reason is that several of the proposed techniques can be used either as stand-alone approaches for understanding the values and reasoning of public and expert stakeholders or, alternatively, they can be used in association with one or more other techniques. For example, small -group structured consultations can provide substantial insights on their own or, in some cases, they can provide input to a structured survey. In both cases, the scale and costs of the effort will, in turn, vary greatly with the scope of the data that is desired and the types of information concerning subgroups within the population (e.g., splits of the sample by geographic location, length of residence in Tampa Bay, age, gender, or preferred activities). All these questions can of course be addressed through discussions between potential decision science consultants and the TBNEP staff, but these discussions have not yet taken place.

There are also close linkages among the different techniques that are presented in Section 4. For example, influence diagrams are often used as part of value-structuring efforts along with value trees and decision trees. All three of these tools are frequently used together as part of expert judgment elicitations, and influence diagrams are employed as aids to help build common understanding among technical experts (similar to the use of hypothesis diagrams). Mental models of experts also can be used as a tool to help understand the reasons for differences of opinion among scientists. Using even swaps to simplify a decision requires the prior

construction of consequence tables, which in turn serve as an aid to the comparison and evaluation of options. There is also extensive feedback from the facts-based to the values-based portions of the overall approach. For example, an adaptive management trial may provide information that influences what is known about the range of likely effects of a proposed action and this, in turn, may influence the priority assigned by stakeholders to certain of their value judgments. Thus, the linear presentation followed in Section 4 masks the close interrelationships among the use and results of many of these techniques in practice.

Approximate study schedule

September 2001.....June 2002.....March 2003

Discussions with TBNEP staff.....

Understanding stakeholder values and concerns.....

Small-group structured consultations.....

Structured survey (options).....

Understanding scientific uncertainty.....

Decision & event trees.....

Expert judgment elicitations.....

Adaptive management and learning .....

Achieving a balanced plan: addressing tradeoffs

Consequence tables, swing weights, even swaps.....

Reference points (gains & losses).....

Presentation of options (evaluability).....

Communicating with stakeholders.....

Influence diagrams.....

Mental models.....

The proposed schedule shows a start date for the anticipated studies of September, 2001 and a completion date approximately 18 months later. Following initial discussions with the TBNEP staff and with key local, state, and federal Partners, a likely starting point is to begin with dual efforts aimed at improving (a) the understanding of similarities and differences in stakeholder values and concerns and (b) the understanding of scientific uncertainty associated with airborne depositions of nitrogen to Tampa Bay estuary over the next 20-25 years. These studies would take place over approximately a 6-9 month period. Incorporating this information as part of specific plans and proposals for actions would then take center stage, with issues of tradeoffs being addressed by community and value-based participants and issues of reducing scientific uncertainty and learning being addressed by technical and science-based participants. The time-frame for these components of the overall decision-science studies is again difficult to estimate but is depicted as occurring primarily over a 9 month period.

Communication with the full range of stakeholders is shown as taking place throughout the study. This communication would continue to occur after completion of the specific decision-science research by the consultants, with members of the TBNEP staff taking the lead and using new decision-science tools to help ensure that meaningful, two-way communication occurs on a regular basis.

The estimated costs of each activity already have been noted as part of the Implementation portions of the Section 4 review. These costs are summarized below.

Estimated study costs (personnel only)

Discussions with TBNEP staff.....		$ 20,000
Understanding stakeholder values and concerns.....	$ 30,000 -	$135,000
Small-group structured consultations.....		
Structured survey (includes subcontract).....		
Understanding scientific uncertainty.....	$ 40,000 -	$ 75,000
Decision & event trees, influence diagrams.....		
Expert judgment elicitations.....		
Adaptive management and learning		
Achieving a balanced plan: addressing tradeoffs.....	$ 30,000 -	$ 60,000
Consequence tables, swing weights, even swaps.....		
Reference points (gains & losses).....		
Presentation of options (evaluability).....		
Communicating with stakeholders.....	$ 25,000 -	$ 75,000
Influence diagrams.....		
Mental models.....		

The research plan also is supposed to distinguish between the major components of estimated study costs, including personnel costs, travel, supplies over $1000 (which are not needed in this case) and “other” expenses. The personnel costs that are shown above would vary substantially depending on the stated needs of the Tampa Bay NEP staff, the needs of local Partners (who might, for example, request either frequent or infrequent presentations and updates from the consultants), the ability of the Tampa Bay staff to cover many of the project requirements, and the use of graduate students or other less-senior personnel. For example, the first component of costs (Discussions with NEP staff) was quite low for the work that R. Gregory, K. Wellman, and others completed as part of estuary protection efforts at Willapa Bay, Washington (approximately $10,000) but significantly higher for the work conducted at

Tillamook Bay (approximately $40,000) as a result of the greater complexity of the problems at the Tillamook Bay estuary and the less-complete status of the required natural- and social-science information.

The only significant component of “other expenses” would be the costs of a subcontract to conduct a structured survey of residents in the Tampa Bay region. This is estimated to range from $50,000 - $65,000, depending largely on requirements of the sample size and survey design. No supplies costing over $1000 are anticipated to be required

The proposed decision science contributions to understanding public values and scientific reasoning all involve a significant amount of hands-on work which will need to be done in the Tampa Bay area, often with members of the TBNEP. Depending on the initiatives favored by Tampa Bay staff, it is estimated that perhaps 8-10 trips would be needed for the principal investigator and probably a similar amount for at least one other team participant. As a result, travel and hotel costs might be on the order of $20,000. However, the amount of travel costs will vary substantially depending on the identity of the selected decision-science participants. For example, the author of this Research Plan (R. Gregory) and the two peer reviewers (T. McDaniels & D. VonWinterfeldt) all have extensive experience in the conduct of the studies described here, but they also all live on the west coast. As confirmed by the many references that are made here to their work, other leading candidates who combine both research and applied experience in the decision sciences include both R. Clemen (Duke University) and B. Fischhoff (Carnegie Mellon University), who live substantially closer to the Tampa Bay area, as well as R. Keeney (University of Southern California).

6.0 References

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Tampa Bay Estuary Program Values Assessment: Charting Publicly Preferred Passages

Proposal submitted to

US Environmental Protection Agency
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by

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Tampa Bay Estuary Program Values Assessment: Charting Publicly Preferred Passages

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Executive Summary

The goal of the proposed program of research is to identify and assess public environmental values associated with the Tampa Bay Estuary Program (TBEP) effort to restore and protect the ecological health of the bay by reducing (or halting increases in) aquatic nitrogen pollution. Specifically, the assessment will determine public preferences for nitrogen management options and associated ecological conditions to provide insight into the nature of and the bases for current and future public support for the TBEP effort. The study will illustrate the application of computer-based interactive survey methods being developed in the context of other environmental quality and risk assessments.

The TBEP (established in 1991) has set the goal of holding nitrogen loads in the bay to 1992-94 levels and restoring sea grass coverage to 1950 levels (minus permanently altered areas). Bay-wide nitrogen targets are achieved by a voluntary trading scheme in which increased loads from one source are balanced by reductions in another. The program has enjoyed substantial community support and nationally recognized success. Projected increases in population and development in the bay watershed will contribute additional nitrogen to the bay, so continued active management will be required to balance contributions from new sources against reductions in existing sources. As achieving nitrogen-reduction targets becomes more costly, currently agreed upon nitrogen load targets may be challenged, along with the associated ecological/sea grass protection goals. In this context, better understanding of relevant public beliefs and preferences will be important to guide policy-making and to build the public support needed to implement and sustain the TBEP management programs.

To establish the relevant temporal and geographic context for the assessment, historic and contemporary environmental and social conditions will be presented to participants through computer graphic and environmental data visualization systems. A converging operations research strategy will separately assess public preferences for alternative nitrogen management/outcome scenarios by verbal-questionnaire, conjoint-rating and scenario-creation procedures. Preferences expressed in each of these contexts will be appropriately scaled and quantitatively related to physical parameters of total nitrogen (with associated sea grass coverage) and to the relative contributions of nitrogen from different sources. Obtained psychophysical relationships between preference indices and nitrogen pollution parameters will be compared across different stakeholder and general public samples to determine points of convergence and divergence in relevant public values, and to test the generalizability of findings. Comparison of findings between elicitation methods will be used to gauge the convergent validity of the assessment.

Specific Aims

The goal of the proposed program of research is to identify and assess public environmental values associated with the Tampa Bay Estuary Program (TBEP). The proposed assessment specifically seeks to determine the nature of and the bases for current and future public support for the TBEP effort to restore and protect the ecological health of the bay by reducing (or halting increases in) aquatic nitrogen pollution. The principal strategy is to secure sufficient voluntary reductions in nitrogen contributions from many individual sources to compensate for expected increases in overall nitrogen as the bay area population continues to grow. Of particular interest is the Tampa Bay community's understanding of and support for efforts to reduce contributions from atmospheric nitrogen deposition. In addition to these site-specific assessment objectives, the study will illustrate the application of computer-based interactive survey methods being developed principally in the context of assessing public perceptions of environmental quality and natural hazards in forest environments.

The proposed value assessment objectives are complementary with, but distinct from other potentially important valuation goals. Different valuation methods would be needed to address the value/worth of Tampa Bay (as compared to other bays, or other environmental or social resources), the economic impact of Tampa Bay (on local, regional or national economies) or the cost/benefit efficiency of the TBEP (responding to program evaluation regulations). Similarly, different methods would be required if the goal were to negotiate and resolve conflicts among potentially competing interests (e.g., commercial versus recreational fishers) or to devise or evaluate alternative political/administrative schemes for furthering the attainment of environmental policies or management objectives of the TBEP. The proposed assessment will contribute to a comprehensive policy valuation by illuminating and quantifying the relative preferences of contemporary citizens of Tampa Bay for an array of alternative nitrogen management strategies.

Contemporary preferences for alternative nitrogen management policies and associated environmental conditions are taken to be an indicator of future preferences, and the basis for predicting public support for (and/or compliance with) those policies/conditions when they are encountered in the future. The success of the assessment then depends upon the extent to which projected preferences are consistent with those that are realized when the assessed policies/conditions are achieved. The ultimate *predictive validity* criterion cannot, of course, be affirmed until after the fact, and even then only if the projected management actions and environmental conditions are in fact achieved. Several traditional validity indicators will be derived from the contemporary data, including the consistency of expressed preferences between respondents (*internal reliability*) and the ability of the preference measures to discriminate between the policy/outcome options assessed (*discriminant validity*). The consistency of preferences within respondents (e.g., transitivity) will also be investigated. Observed violations of prescribed rules of valuation logic will be interpreted not so much as a measure of assessment invalidity

as an indicator of valuation practices that are likely to be applied by relevant publics in the context of actual environmental experience.

An important feature of the proposed assessment is that parallel applications of different preference elicitation methods will allow measures of *convergent validity.* Where different methods converge on similar conclusions (*method invariance*) confidence in the validity of the assessment is increased. Inspection of inconsistencies between methods will help to identify aspects of the valuation context that may ultimately affect public support for the assessed policies/outcomes in the "real world."

Background and Significance

Post World War II population growth and development in the Tampa Bay watershed had many negative impacts on the health of the estuary. Dredge and fill development around the bay had dramatic and long lasting impacts. By the1970's stormwater runoff from agricultural, industrial and residential developments within the watershed and direct discharge of partially treated wastewater from burgeoning municipalities had devastating effects on the bay. Fish and shellfish stocks were in decline. Estuarine bird populations were reduced to fractions of previous levels. Beaches were frequently unsafe for human use. Nutrient laden runoff and wastewater discharge raised nitrogen concentrations in the bay to over five times previous levels. Algae blooms clouded the water, obstructing sunlight and causing the loss of half of the sea grass beds, and triggering a general ecological decline throughout the bay (e.g., Johansson & Greening, 2000; TBEP, 1996; Wang et al, 1999).

The (US) Clean Water Act (1970) and associated state and local legislation lead to substantial improvements in wastewater treatment systems, sharply reducing nitrogen discharges into the bay. By the early1980's nitrogen loads were reduced to less than half the levels of a few years before. Where dredging, filling and other permanent alterations of the bay did not preclude them, sea grasses began to recover. A 20% increase in sea grass coverage was recorded between the initiation of water quality improvements at the end of the 1970's and 1992. Evidence of commensurate improvements in the general ecological health of the bay was also observed.

Estuary restoration and protection

The Tampa Bay Estuary Program (TBEP) was established in 1991 to address water quality and habitat protection in Tampa Bay. The TBEP successfully adopted a community-wide plan to "hold the line" on nitrogen loads in Tampa Bay to restore and protect the ecological health of the estuary. An extensive nitrogen-monitoring program was established and sea grass coverage was adopted as the key indicator of ecological conditions. A coalition of federal, state and local government agencies and local industries set the goal of holding nitrogen loads in the bay to levels measured in 1992-94, and restoring sea grass coverage to 1950 levels (minus

permanently altered areas). The basic strategy is to achieve the bay-wide nitrogen target by a voluntary trading scheme in which increased loads from one source (or one sub-watershed/jurisdiction) are balanced by reductions in another (Bacon & Greening, 1998). In the first five years of the program (to 1996) nitrogen load targets were largely met, and sea grass coverage increased by 20% over the low point recorded in the 1980's. This pattern of improving conditions was temporarily disrupted by substantial increases in nitrogen, with subsequent sea grass losses, triggered by high rainfall in 1997-98 associated with the El Nino. Still, the success of the program has lead to national recognition of the TBEP as a model for community cooperation to achieve estuary restoration and protection. Review of the program in 2001 reaffirmed the hold the line strategy and extended the bay-wide cooperative nitrogen management program (Janicki Environmental, Inc., 2001).

Projected increases in population and development in the bay watershed are expected to contribute additional nitrogen to the bay. Thus, holding the line at 1992-94 levels will require continued active management to balance contributions from new sources against reductions in existing sources. While some reductions can still be achieved by further improvements in wastewater treatments and control of stormwater runoff, the largest current source of nitrogen (at least 29%) is direct atmospheric deposition into the bay (Greening et al, 1997). By some estimates when nitrogen deposited on land within the watershed and subsequently washed into the bay is included, the contribution from atmospheric sources rises to over 60%.

Airborne nitrogen is primarily derived from industrial point sources (estimated at 70%), especially coal-fired power plants around the bay, and mobile sources including cars, trucks and boats (30%). Determining the actual contribution of point sources is complicated by atmospheric transport into and out of the bay watershed. While mobile sources represent a smaller proportion of nitrogen emissions, most of this source is deposited in the local area.

Public support

The success of the TBEP to date is undoubtedly based on the very effective coalition that has been formed among government agencies and relevant industries in the bay area. Community interest in bay conditions is encouraged by the proximity and visibility of the bay, and by the fact that a clean and healthy bay directly and indirectly contributes to a wide array of benefits appreciated by most residents and visitors. While there is certainly the potential for conflicts among different users, the overwhelming theme is that all benefit from an ecologically healthy bay.

The actions that produced the impressive improvements in bay conditions in the 1980's and 90's have enjoyed substantial public support--or at least have met with little public resistance. In part this may be attributed to the widely recognized unhealthy condition of the bay at the time, and the undeniable need (strengthened by health-related legal requirements) to improve sewer treatment facilities. The problems in the bay were immediate and unambiguous (declining fish stocks, lost or inedible shellfish, unsanitary beaches, murky water) and the linkage to management

actions (cease dumping "partially treated sewage" into the bay) could be readily appreciated without elaborate scientific justifications. The dramatic improvements in conditions that followed upgrading of wastewater treatment facilities likely reaffirmed the basis for broad public support.

Maintaining public support for bay restoration and protection in the coming decades, may be more difficult. Current conditions in the bay are quite good compared to conditions likely to be in public memory, so the impetus for management actions (and public concern) is not so strong as it was in the 1980's. While the TBEP's ecological goals call for nearly a 50% increase in sea grass coverage between 1991 and 2010, achieving this goal is largely dependent upon the "hold the line" strategy--keeping bay nitrogen loads at 1992-94 levels in the face of projected growth-related increases. From a public perspective, preventing deterioration of current conditions is unlikely to elicit the same levels of enthusiasm as the dramatic improvements offered in 1970's and 80's. Past improvements were gained by large reductions in substantial and easily identified and understood pollution sources, mostly achieved with little direct public input or awareness. If (when) achieving nitrogen targets becomes more costly (in dollars and life-style compromises), garnering and maintaining broad public support for the program could become much more important, and more difficult than it has been.

Holding to 1992-94 nitrogen levels in the future will increasingly be based on trading off marginal increases and reductions among many different sources. Achieving necessary reductions is likely to require more significant and more direct involvement of the public, such as changing public and residential landscaping practices, increasing costs of electricity and/or constraining automobile and recreational boat uses (TBEP, 1996). In this context, conflicts are likely to revolve around how much bay protection (nitrogen reduction) is to be achieved, at what costs, and to whom. These conflicts will be actualized by the effects of management decisions about how to balance the nitrogen budget for the bay among the multiple contributing sources. Moreover, public appreciation of one of the key target sources, atmospheric deposition, may depend upon understanding (and believing) a rather complex chain of physical, chemical and biological processes and reactions that have only recently been fully recognized by scientists (Greening et al, 1997).

Future policy contexts

General public support for keeping Tampa Bay clean and healthy is likely to continue to be strong. An aggressive and well-conceived public education campaign has laid an important foundation for community-wide understanding and support of the TBEP nitrogen management program. Public support is not likely to be seriously tested in the immediate future, however, as most near term nitrogen load targets (e.g., the 2010 target) are already assured (or exceeded) by ancillary reductions in point-source contributions associated with the conversion of major coal-fired power plant (Janicki Environmental, Inc., 2001).

In some respects this "reprieve" could exacerbate resistance in the future when achieving further nitrogen reductions will likely require actions that have more direct impact on the public. Nitrogen load allocations among industries and between jurisdictions can be expected eventually to become more consequential, and more controversial. The current voluntary trading scheme may be challenged, providing impetus for a shift toward more formal regulations setting nitrogen loads and source allocations. The public may well care whether the costs of future nitrogen controls come in the form of rising taxes, increased utility bills or constraints on their transportation choices. Communities associated with cleaner segments of the bay may resent paying any price for pollution being generated in other parts of the bay. The currently agreed upon 1992-94 bay-wide nitrogen load target may be challenged, along with the associated 1950-based sea grass/ecological protection goals. In this context, better understanding of public beliefs and preferences regarding ecological goals and nitrogen management options will be important for guiding policy making and for building the public support needed to implement and sustain the TBEP management programs.

Research Design and Methods

The proposed research will identify and assess public preferences and support for alternative nitrogen management strategies for Tampa Bay. Representations of alternative management actions and expected outcomes will be developed from existing documentation and through direct interaction with the scientific and technical staffs of the TBEP and participating members of the Tampa Bay Nitrogen Management Consortium. Historic and contemporary environmental and social conditions relevant to nitrogen management in Tampa Bay will be reviewed and represented to establish the relevant temporal and geographic context for future environmental policy choices. Computer graphic and environmental data visualization systems will be employed to portray projected future environmental and social condition "scenarios" associated with alternative nitrogen management strategies. Following a converging operations research strategy, public preferences for alternative Bay futures will be separately assessed by verbal questioning, by a conjoint rating procedure and by an interactive scenario-creation procedure. Preferred nitrogen management goals and nitrogen source-allocations will be compared across different stakeholder groups to determine points of convergence and divergence in relevant values, and to assess the generalizability of findings and conclusions. Comparison of findings between methods will be used to gauge the convergent validity of the value assessment.

Following a psychophysical approach, public preferences for alternative nitrogen management scenarios will be quantitatively related to specific components of relevant nitrogen-reduction management actions, specifically the setting of total nitrogen loads and the allocation of loads across sources. The first stage of the assessment will focus on the articulation and representation of relevant biophysical and social conditions associated with historic, contemporary and projected future nitrogen-load/ecological-quality scenarios in Tampa Bay. In this stage detailed designs and materials for the conjoint rating and scenario-creation value assessment

procedures will be developed, tested and refined. The second stage of the assessment will identify and articulate public perceptions and understandings of nitrogen management-relevant environmental values through a series of small group sessions representing key stakeholder and resident groups in the Tampa Bay community. Small group sessions will contribute directly to the values assessment, and they will also be used to develop a shorter, "distilled" values assessment procedure to be applied to a larger general public sample in the next stage of the research. The third stage of the assessment will culminate in a survey of a broader sample of the Tampa Bay community to test and extend the generalizability of the findings and conclusions from the more intensive small group sessions.

Data collected in the small groups and the general survey will be analyzed and findings and conclusions will be summarized and presented for review to representatives of the TBEP, other interested environmental management agencies and public stakeholder groups. Feedback regarding the overall findings and conclusions of the assessment from both management and public perspectives will be incorporated into the final report of findings, conclusions and recommendations for the TBEP.

Stage 1: Nitrogen management scenarios

The key objectives for this stage of the research are to assemble and verify nitrogen management relevant biophysical conditions and relationships in Tampa Bay and to develop representations of those conditions and relationships that can be readily comprehended by the public in a values assessment context. Conditions and processes represented by scientific environmental data will be translated into "scenarios" to represent relevant management alternatives and outcomes to public participants. Data visualization technologies and geographic information system modeling and display systems will be combined with interactive computer graphics and verbal (voiceover) narration to communicate appropriate aspects of nitrogen management issues and action alternatives and value-relevant outcomes to public audiences.[1]

Biophysical conditions and processes--The relevant geographic context for the proposed value assessment is Tampa Bay (and its sub-bays) and the associated watershed. This area is already represented by a number of excellent historic and contemporary maps, geographic information system (GIS) coverages, aerial photographs and satellite images. Of particular importance are the landuse and

[1] The following characterization of nitrogen management options and relevant public value issues is based on a review of existing documents and a brief field inspection of Tampa Bay and the associated watershed by the investigators. Correspondence and direct interviews have also been conducted with TBEP staff and others familiar with the ecology and management of the Bay and with the history and current status of relevant public knowledge and attitudes in the community. The investigators also attended a meeting of the Tampa Bay Nitrogen Management Consortium at which the last five years (approximately1995-2000) of the TBEP program were reviewed and evaluated, and recommended actions for the next five years (2001-2005) were presented and approved. The activities proposed in the following sections anticipate that substantial additional review and interaction with TBEP and Consortium technical staffs will be required to develop appropriate technically accurate representations of nitrogen management options and outcomes.

drainage maps that are important for showing how stormwater runoff carries nitrogen into the bay, and how stormwater management activities could reduce that flow. Future condition scenarios will be supported by existing maps and data regarding projected population growth and landuse change (development) in the watershed and by model projections of the nitrogen load consequences of those changes.

Relevant environmental conditions are represented by water and air quality monitoring data (with progressively less detailed data prior to about 1995) and sea grass coverage (the selected principal indicator of ecological conditions in the Bay) dating from 1950, with biannual coverage data beginning by the 1990's. The history of significant nitrogen management activities and their effects on nitrogen loads in the bay is another important data resource supporting the development of representations for the proposed values assessment.

Environmental/social condition scenarios--The above-described data sources will be exploited to develop graphic representations of the bay and watershed suitable for presentation to lay public audiences. Scenarios will be developed to represent principal temporal and geographic features of the biophysical and social contexts in which future nitrogen management actions and outcomes are most likely to be encountered by members of the Tampa Bay community. The temporal context for the assessment will begin in 1950, proceed to the present (2002) and then extend by projection to 2010, the end of the current planning-management policy period.[2]

Representations of key nitrogen management-relevant environmental and social conditions in Tampa Bay will be composed primarily of maps (and/or aerial photos-satellite images) highlighting relevant features. Maps will be supported by voiceover narration and a sample of relevant ground level views of familiar sites in the bay area (e.g., views of the bay from bridges, beaches and parks, residential areas, etc). Ground level views will depict indicators of ecological (e.g., sea grasses, water clarity, birds and wildlife) and social (e.g., residential, commercial and industrial development, traffic, relevant recreational facilities and activities) conditions appropriate to the depicted time period.

A general map showing contemporary Tampa Bay, the estuary, the watershed boundary and the surrounding human development will provide an initial introduction

[2] Review of data and projections of changes in nitrogen sources and loads indicates that nitrogen reduction targets for 2010 will likely be met (or exceeded) with little or no direct public action or support, or even the need for significant public involvement. Because of the nitrogen reductions that will accompany the conversion of a key power plant from coal to natural gas, the public is not likely to be faced with any substantial value conflicts in the 2010 time frame. It is recommended that the currently specified planning-assessment horizon be extended to whatever future date would yield projected needs for significant nitrogen reductions. Such an extension would allow pertinent value questions to be raised in the context of more significant potential conflicts requiring actions and tradeoffs that would more substantially affect and involve the public. This extended time frame would create a management policy decision context in which precise and systematic public value assessments would be better motivated and better justified. The proposed procedures that follow assume TBEP targets appropriate to the previous projections (prior to the power plant conversion) that bay nitrogen loads could increase to 5775 tons / year by 2010, without continuing nitrogen reduction actions.

and orientation for small group and (later) general survey participants. This basic map will subsequently be enhanced by addition of a simplified overlay of surface water flows into the bay, with an accompanying narrative explanation to establish the meaning of "watershed" and to provide background for the stormwater runoff issues raised later. Additional versions of the map will feature past, present and future patterns of landuse, highlighting development and other uses that are relevant to nitrogen management in the bay. Maps, accompanied by appropriate voiceover narration and ground-level pictures, will be used to communicate relevant environmental and social conditions for (at least) time periods shown in the table below. In each case these representations will be developed and refined through review and interaction with TBEP and other appropriate technical experts to assure that a valid and accurate representation of the relevant science and data is achieved. An important goal is to clearly communicate relevant social and environmental conditions, without sensationalizing or directing respondent's expressed preferences.

1950	The basis for the nitrogen load/sea grass targets for the TBEP management plan
1976-78	The "low point" in bay conditions just prior to implementation of improved sewer/wastewater treatment systems in neighboring communities
1992-94	The period when substantial recovery of the bay had occurred, and the basis of the nitrogen load and source allocation targets in the TBEP
2002	The "current conditions" for the values assessment
2010	The target time period for which the alternative nitrogen management strategies are to be evaluated

In addition to the above scenarios two brief environmental "tutorials" will be developed. The first will depict a simplified version of the *nitrogen -> eutrophication -> decreased light penetration -> loss of sea grasses* paradigm that is the basis of the TBEP nitrogen management/ecological protection program. Understanding of these relationships is essential for informed decisions about the overall nitrogen management program. The second tutorial will introduce a simplified version of the mechanisms of atmospheric nitrogen deposition into the bay (and watershed). Understanding of this process and source of nitrogen in the bay is essential for informed decisions about the air quality components of the nitrogen source allocation program. Finally, an interactive display system (described below) will be developed to depict different allocations among the various nitrogen sources targeted by the TBEP, and to provide a mechanism for participant's to report their desired overall nitrogen levels (with associated sea grass coverage) and source allocations. As for the condition representations described above, the tutorials and source display system will be developed through a systematic process of review and interaction with TBEP and other appropriate technical staffs to assure an accurate and sufficient portrayal of these key aspects of the nitrogen management processes. Pilot testing with appropriate representatives of public groups will be used to assure comprehension, and to refine materials and presentation procedures.

All orientation, scenario and tutorial materials will be developed in digital formats allowing presentation on individual and/or networked computers. Depending upon features of specific venues and presentation conditions, materials will be delivered over local or wide-area networks. Local networks will be used for the smaller group sessions, while both local and wide-area (www) networks will be used for the general survey. Computer implemented group and general survey procedures provide for a greatly expanded range of presentation media and materials, as well as allowing on-line data collection and automated analysis capabilities to facilitate interactive control and immediate review of results. An additional advantage is that small group procedures can be rigorously standardized and a detailed 'trace" of the process and outcomes can be recorded for later review.

Stage 2: Small group interactive value assessment

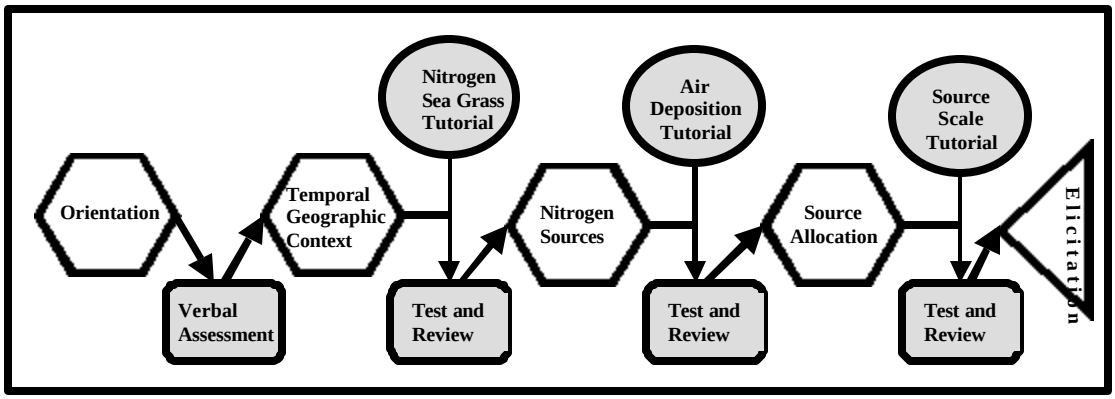
The use of small groups in this stage of the research will allow interactive presentation of issues and a deeper consideration of the bases for expressed preferences. A converging operations strategy will employ three basic presentation/response formats: low-information/verbal response, high-information/conjoint rating and high-information/scenario creation. Results will be compared across methods to find consensus values and to gauge the conjoint validity (method invariance) of expressed preferences and behavioral intentions. Any divergence in findings between methods will be inspected to identify specific methodological and contextual factors that may have important effects on public experience of and preferences for ultimately realized management policies and outcomes.

Participant sampling—Selection of participants for the small group sessions is not intended to provide a representative random sample of the Tampa Bay communities. Neither are these sessions intended to induce consensus among the different interests represented, nor are they intended to reach any particular group decisions about bay management options. Rather, the primary goal for this phase of the study is to sample and articulate the range of public understandings, concerns and values relevant to the TBEP nitrogen management program. In this stage of the assessment special attention is given to previously identified stakeholder groups/interests that would likely be influential in determining public support of bay management actions and effects. In that regard, identifying divergences of understandings and preferences is as important as finding consensus.

Preliminary review indicates five primary stakeholder groups with substantial and specific interests in bay conditions: *recreational fishers*, *recreational boaters*, *environmental interest groups* (e.g., Manasota 88), *bay-side residents/property owners* (e.g., Apollo Bay) and *destination tourists*. Additionally, general *residents/citizens* from each of the three counties fronting on the bay (Pinellas, Hillsboro and Manatee) should be represented. Representatives of these eight stakeholder groups (and any others identified) will be recruited and assigned to one of four separate group sessions of approximately 12-16 participants, each composed of a cross section of the identified interests/stakeholders.

Small groups are intended to provide useful value assessments in their own right, but they will also be used to evaluate the efficacy and validity of the developed assessment materials and procedures, and to develop a reduced set of materials and procedures for the subsequent general survey. Prior to implementation, detailed procedures and materials for small group sessions will be developed and refined through a pilot testing procedure using convenient surrogate participants. The goal is to develop a clear and engaging process that can be accomplished in a half-day session.

Small group procedures—The planned components and sequence of small group sessions is summarized in the diagram below.



Each session will begin with a general introduction to the goals and procedures for the session. A brief *Orientation* to Tampa Bay will be followed by an initial *Verbal Assessment*. Sessions will proceed through a series of presentations designed to inform and instruct participants about conditions and processes that underlie the TBEP nitrogen management program. The *Temporal and Geographic Context* will graphically identify the Tampa Bay watershed and review the history of nitrogen-related changes to ecological conditions. A short *Nitrogen-Sea grass Tutorial* will explain the nitrogen-eurotrophication paradigm that is the basis for the nitrogen reduction program. The *Nitrogen Sources* presentation will identify major nitrogen contributors, supplemented by the *Air Deposition Tutorial* that briefly explains how nitrogen in the atmosphere gets into the bay. The *Source Allocation* presentation will identify major nitrogen source classes and subclasses aided by an interactive graphic *Source Scale Display*. Short *Review and Discussion* sessions will be interspersed as shown to monitor participant understanding and to provide opportunities for comments and group discussion. Following this background and context, the preference *Elicitation* will begin using either scenario creation or conjoint rating procedures.

In the *Verbal* A*ssessment* participants will respond individually to a series of verbal questions regarding values (potentially) associated with alternative nitrogen management methods and outcomes. Exact forms and contents of questions will be developed in pilot testing, but key issues are exemplified in the following open-ended questions:

How would you characterize the current condition of Tampa Bay?

What are the most important reasons for protecting the ecological health of Tampa Bay?
What do you believe are the most serious threats to the health of Tampa Bay?
What do you think are the best ways to protect the health of Tampa Bay?

The objective of this initial assessment is to determine participants' preferences based only on existing (pre-assessment) perceptions and understandings of the issues. Responses will include open-ended, checklist and simple rating scale formats typically used in verbal survey assessment methods. Questions will be presented on individual computer screens, and participants will respond individually by entering their ratings, choices or open responses directly. Provisions will be made for those wishing to write out their open responses.

Temporal and geographic context--The next section of the small group sessions will start with the graphic orientation to Tampa Bay and the watershed, using the map/narration/water-flow representation described above. The historic context for the assessment will be established by presenting the 1950 scenario. The map will display the landuse (development) theme. Voiceover narration will report population figures and describe the relevant environmental and social conditions for the represented period, supported by appropriate pictures (wildlife, fish, birds, beaches with bathers, bay with fishermen, sea grasses under clear water) cycled briefly in an inserted window. The voiceover will then describe the population and development growth from 1950 to 1976-78, as the landuse map changes progressively to display 1976-78 conditions. Changing environmental and social conditions will be briefly described, while representative pictures of conditions for the period are shown in the photo window (increasing development and traffic, inflow to the bay, fewer fish, fewer birds, beaches closed, reduced sea grass coverage, murky water) to support the narration. Actual historic photographs will be used where possible, but digital visualizations may be created where appropriate historic sources are not available. The narration will acknowledge the severe effects of dredge and fill development along the shore, and the discharge of "partially treated sewage" into the bay.

Nitrogen pollution will be identified as a major problem producing the depicted ecological decline in the bay in the late 1970s and early 1980s. The *Nitrogen-Eutrophication Tutorial* will be introduced. This short tutorial will employ computer graphics, including some schematic or "cartoon" formats to illustrate the basic processes by which nitrogen pollution affects the health of the bay, with an emphasis on sea grasses as a key ecological indicator. The tutorial will emphasize the effects of excess nitrogen in the bay, pointing out that sea grass recovery typically "lags" behind reductions in nitrogen concentrations.

Following the eutrophication tutorial the presentation will return to the 1976-78 scenario-map. Voiceover will describe the major sewage-plant renovation program in 1978-80, and note the achieved reduction in nitrogen loads (total annual nitrogen was reduced by more than half, and treatment plant contributions dropped from 40% of the total annual load to 10%). The subsequent (delayed) recovery of sea grasses

will be described, along with documented improvements in wildlife diversity and numbers and other indicators of the improving health of the bay. Increased population and development to 1992-94 will be described as the watershed map displays the change from 1976-78 landuse. Narration will note that in spite of the increased growth and development, improved wastewater treatment and other management actions allowed nitrogen levels in 1992-94 to remain at less than half of the 1976-78 levels. Description of improved ecological conditions will be accompanied by appropriate ground level photographs (increased wildlife, greater sea grass coverage, clearer water, bathers on the beaches, fishers on the bay, etc).

The map of 1992-94 landuse will progress to current conditions (2002) as the voiceover describes the increase in population and development and the transition to current ecological conditions. Contemporary bay and community photographs will support the presentation. The narration will briefly describe the flush of nitrogen and the declines in sea grasses and general conditions caused by the el Nino rains of 1997-98. The fact that similar nitrogen load increases were observed in other, less developed bays in the region will be noted, along with current indications that bay conditions (sea grasses) are returning to their previous trajectory of improvement.

A short *Review and Discussion* will be interjected at this point in the session to determine respondents' understanding of the geographic and historical context and the eutrophication tutorial. Individual participant's on-line responses to a short series of questions will be analyzed immediately and used to motivate and guide group discussion. As responses indicate, the geo-temporal contexts and nitrogen-eutrophication processes will be reviewed and discussed to clarify any ambiguities or misunderstandings.

Nitrogen sources--The session will proceed with the return of the initial water-flow overlay map, and the process of nitrogen introduction through runoff will be briefly described. The concept of different nitrogen flows from different landuses will be emphasized and a simple (partial) pie chart will show current (2002) stormwater source contributions, with appropriate "slices" added to the chart as each source (*commercial/industrial/mining*, *agriculture*, *residential* and *undeveloped land*) is described. Direct discharges from municipal wastewater and industrial discharges and chemical/fertilizer spills into the bay will also be described, and these components (slices) will be added to further fill out the chart.

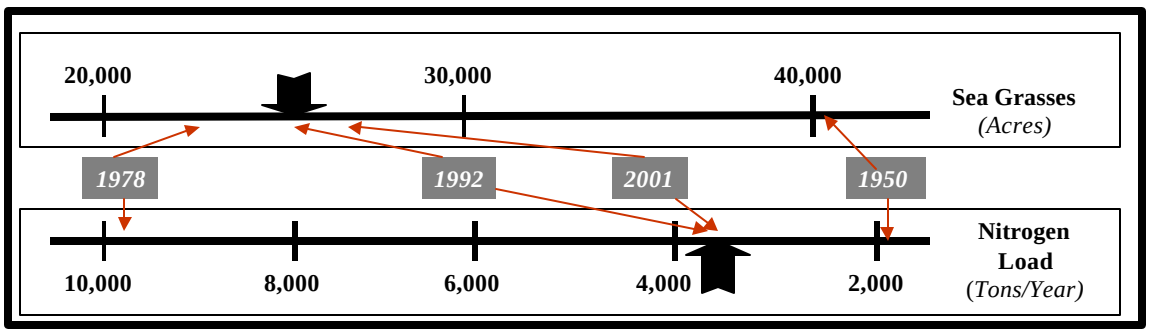
Atmospheric deposition sources (29%) will be introduced. The *Atmospheric Deposition Tutorial* will be presented showing how airborne nitrogen is directly deposited into the bay. Nitrogen deposition on land will also be mentioned, noting that land deposition is ultimately washed into the bay and, by some accounts contributes a substantial portion of the total nitrogen from stormwater runoff (potentially tripling the total nitrogen load derived from atmospheric sources). The issue of local versus regional origins for airborne nitrogen will be raised, acknowledging that most deposition is believed to be from local sources, and that virtually all (mobile-source) emissions from cars, trucks and boats are deposited in the local area. The respective contributions of (point-source) emissions from

electric power plants (14.5% of bay total in 1994) and other industries (4.35%) and from (mobile sources) cars, trucks and boats (10.5%) will be identified and described. Finally, the small slice (5%) that represents the (natural) contribution from groundwater (springs) will be added and described.

A second *Review and Discussion* session will focus on nitrogen sources, including the effects of landuse on the amount of nitrogen in stormwater runoff, nitrogen discharge from municipalities (sewer treatment facilities) and industry, including fertilizer loss and spills, and the processes of atmospheric deposition. The goal of this session is to insure that participants understand how different sources contribute nitrogen to the bay and how much nitrogen is currently contributed by each source. Again, participants will respond individually to a short "test," followed immediately by a review of the results and a discussion directed at clarifying any indicated ambiguities, misunderstandings, or disbelief.

Source allocation-- This session will begin by re-presentation and review of the nitrogen-source pie chart. The TBEP-Consortium program to "manage the total annual nitrogen load in the bay by determining the share that each of the various sources contributes" will be briefly introduced. The *Source Scale Display*, illustrated below, will be used to present the concept of load allocation. The scale display will be animated for the presentations described in this section, and will become interactive and used as a response system in the subsequent scenario creation part of the assessment. Total nitrogen (tons per year, T/y) and sea grass (acres) scales will be linked by the historically observed (and modeled future) functional relationship between nitrogen loads and sea grass declines and recovery. Sea grass coverage will be described as the key indicator of the overall ecological health of the bay. TBEP and other relevant expertise will be consulted to assure that the proper functional relationships are accurately portrayed in the display.

The total nitrogen and sea grass scales will be introduced first, with scale markers set and labeled for 1950. This component of the display, with scale markers set for the 1992-94 levels and levels for other time periods noted, is illustrated below.[3]

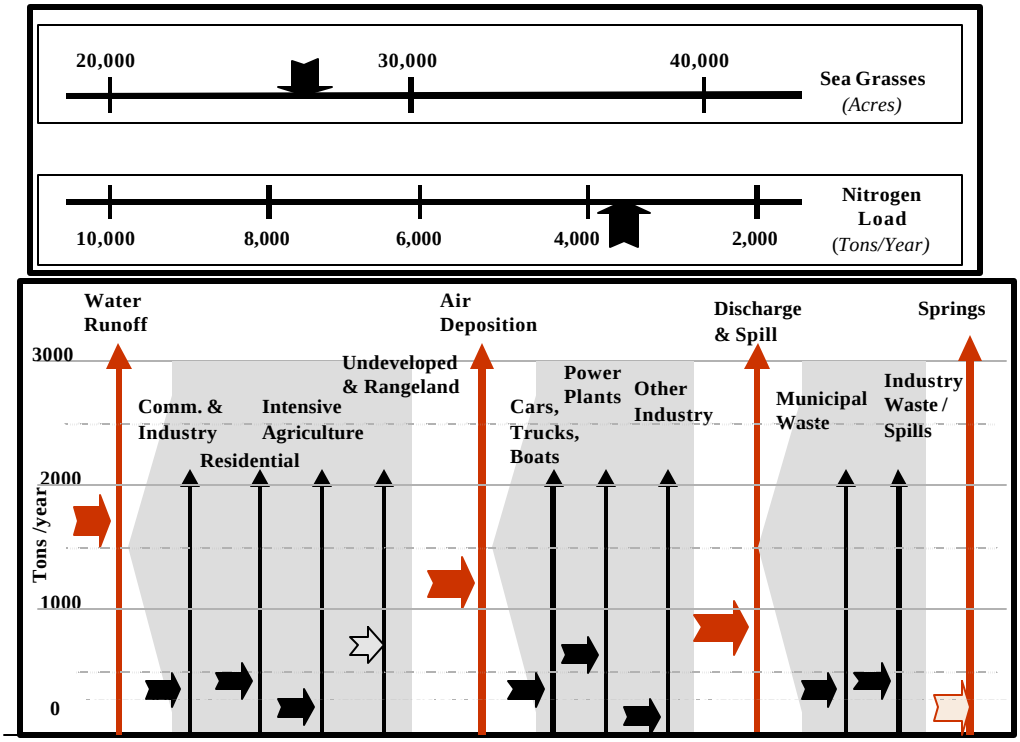


[3] The illustrations included here are sufficient to portray the basic concepts for the source scale display, but the final graphic details of the system will be developed further in the first stage of the project. In particular, the source class and subclass scales will likely be scaled separately, to emphasize the relative differences among subclasses within major classes and to facilitate participant manipulation and interactive use of the scales, as described in following sections of the proposal.

Documentation indicates that total nitrogen load was about 2000 T/y (which will be indicated as approximately the minimum achievable level for modern Tampa Bay) with sea grass coverage at 41,000 acres. Voiceover narration will remind participants of the history of population growth and development in the bay area, including dredging and filling and other developments that permanently removed over 3000 acres of potential sea grass habitat. The sea grass marker will move to 38,000 acres, and the narration will identify this as the estimated maximum remaining potential sea grass coverage for Tampa Bay.

The narrator will review the municipal wastewater disposal and other key nitrogen contributors of the time, as the total nitrogen marker moves to the 1976-78 level (just less than 10,000 T/y). Lagging behind the nitrogen marker, the sea grass marker will move from 38,000 (the noted potential coverage) to just under 22,000 acres (coverage recorded in 1982). Voiceover will review the sewage treatment enhancements in 1978-80, and the nitrogen scales will move to show the recorded reductions in nitrogen load (dropping to just under 4,000 T/y). The total nitrogen marker will move to the 1992-94 position (3800 T/y) as the voiceover briefly reviews the associated increases in development and population, the continuing benefits of the reduced pollution from municipal wastewater discharge and any other significant nitrogen increases or reductions observed over this period. The sea grass scale marker will follow the changes in the total nitrogen scale, after a noticeable delay. Narration will remind participants of the "lag" of sea grass response to changes in nitrogen loads as the sea grass scale moves to about 27,000 acres (the coverage recorded in 1996).

The narration will generally describe the surge in nitrogen loadings observed after the unusually heavy rainfall of 1997-98 attributed to the el Nino. The fact that similar nitrogen surges were observed in other, less developed bays in Florida will be noted, with an emphasis on the variability and uncertainty inherent in complex natural systems. The Total and Nitrogen and Sea grass scale markers will move in consort with the narration (with appropriate time lags), stopping below 25,000 acres (the 1999 level). The nitrogen reductions achieved by the conversion of power plants, and any other significant increases or decreases that have occurred, will be noted as scale markers progressively move in tandem to their current (2002) positions.



The major source class and subclass scales will now be added to the display, as shown above, with markers set at 1992-94 levels (1710 T/y, 1102 T/y, 798 T/y and 190 T/y, respectively for major source classes). Narration will describe the contributions of each of the four major nitrogen source classes (*Stormwater Runoff*, *Direct Discharge*, *Atmospheric Deposition* and underground *Springs*). As each class is described the associated markers will move to their appropriate current (2002) positions on the source class scales. The subclass contributions will then be added and described within each major source class. As each subclass is described the relevant nitrogen contribution markers will be set to the current (2002) T/y contributed by each. It will be noted that contributions from many of these sources have been reduced by environmental management efforts, but that there are "practical limits" to the reductions that can be achieved in Tampa Bay given the current levels of population and development. The estimated "achievable minimum" contribution for each scale (to be determined in consultation with relevant TBEP and other experts) will be described and marked on the respective subclass scales.

Future condition projections--The small group sessions will continue with the *Source Scale Display* being replaced by the map representation of the bay-watershed landuse map showing current (2002) development patterns. The voiceover will describe projected population and development increases to 2010 (or other date), as the developed area displayed on the map changes to reflect projected increases. Projected landuse will be shown in lower color saturation than the existing development and the uncertainty of projected conditions will be noted in the narration. Appropriate surrogate pictures and/or digitally edited scenes will show future increased traffic, additional power plants and other new development based on projections by relevant planning agencies.

The *Source Scale Display* will reappear with all markers set for current (2002) levels. Voiceover will explain that more people, more cars, more energy consumed and more development means more nitrogen in runoff and in the air. Total nitrogen, source class and subclass markers (also in lower saturation color) will move to the projected 2010 (2020) positions with the stated assumption of no action to further reduce nitrogen loads. The sea grass scale will move down to 23,000 acres, the estimated future coverage based the previous 2010 nitrogen projections (5775 T/y in some documents, but updated projections for nitrogen and sea grasses for the appropriate planning period will be used in the proposed study).

The narration will note the TBEP and collaborators' program to "manage nitrogen pollution in Tampa Bay in order to protect the ecological health of the bay" (as indicated by sea grass coverage). The previously noted limits to the amount of reduction that can be achieved for any given nitrogen source will be mentioned, along with the fact that it becomes progressively more difficult to achieve further reductions in a given source as the minimum limit is approached. Some specific ways to reduce nitrogen loads will be briefly described for each source subclass. For example, reducing the load from the Power Plant subclass of Atmospheric Deposition might be described as requiring:

> *Retrofit and/or conversion of existing coal-fired power plants to natural gas and/or more stringent pollution controls on new plants, likely resulting in increased electricity costs for everyone in the Tampa Bay region.*

Where appropriate, potential "fringe benefits" other than protecting bay ecology will also be pointed out. For example, reducing power plant emissions would provide visibility and respiratory health benefits in addition to reducing the level of nitrogen in the bay.

Another brief *Review and Discussion* session will be interjected to ascertain participants' understanding of bay nitrogen sources and the concept of load allocations among sources. A short individual response 'test" will be followed by review and group discussion of results. The various means of reducing contributions from the various subclasses will be covered, along with their respective costs and fringe benefits. The purpose here is to consolidate understanding of current sources and the limits to reducing their respective loads by the various means available, in preparation for proceeding to one of two preference elicitation procedures.

Individual scenario creation--Half of the participants in each small group will proceed to create their own preferred nitrogen load scenarios (total nitrogen, source class and subclass allocations). The remaining half will proceed to a conjoint rating procedure. The scenario creation procedure will employ the *Source Scale Display* used for the presentation above, now activated in an interactive mode. Participants will be able to individually move the nitrogen load markers to represent their preferred total nitrogen loads and source allocations. The sea grass scale marker will not be adjustable, but will move to represent the expected effects on the bay of each change in total nitrogen. The scenario creation procedure places the

participant in a “management perspective” context; i.e., the participant must set an overall nitrogen level for the bay (with the associated sea grass coverage-ecological conditions) and then specify which sources will be reduced by what amounts to achieve that level. In contrast the conjoint rating procedure (described in the next section) will require participants to express their preferences by choosing among (and rating) a set of predetermined total nitrogen/source allocation scenarios strategically constructed by the investigators. The choice procedure puts the respondent in a “citizen-consumer” context. Analysis of similarities and differences in preferences expressed from these two perspectives is an important part of the converging operations strategy of this assessment.

Participants assigned to the scenario creation procedure will first be given a brief tutorial on how to use the interactive scale display. They will learn to move the total nitrogen marker using the computer mouse. As the total nitrogen marker moves, the sea grass scale marker will move (with a noticeable delay) to the location implied by the nitrogen load scale. Movement will be based on the functional relationship between nitrogen and sea grass coverage to be determined in collaboration with the appropriate TBEP and other cooperators' technical staffs. Participants will be encouraged to move the scale back and forth to explore the relationship between nitrogen loads and sea grass coverage (the selected key indicator of ecological condition in the bay). The sea grass coverage scale can not be directly adjusted, but will respond to movement of the total nitrogen scale marker. The 1950 and 1976-78 values, now familiar to participants will be designated to define the endpoints of the total nitrogen and sea grass scales, and 1992-94 and 2001 (2002) levels will be indicated to anchor the middle regions of the scales. The TBEP target of 38,000 acres of sea-grass coverage (the 1950 coverage minus permanently altered areas) will be indicated as the estimated maximum potential future coverage.

The tutorial will then move to the major source class scales. The markers for these scales will be moved one at a time, with the remaining scale markers automatically "harnessed" to maintain the set value of the total nitrogen load and to preserve the TBEP target (1992-94) relative load allocations. Movement of a source-class scale marker will automatically produce adjustments to the associated subclass markers to achieve the indicated load for the class without altering the load allocations among subclasses. The tutorial will then proceed to the subclass markers, which may also be moved one at a time, with the constraint that the associated source-class marker will remain at the indicated setting. As each subclass marker is adjusted, the remaining subclass markers within the source class will move automatically to achieve the set total for the class, preserving their relative allocations. Appropriate minimum achievable values (establishing maximum possible reductions) will be determined and indicated on each source class and subclass scale and participants will be instructed that no source may be set below this limit. Participants will be reminded that there may several different ways to achieve reductions in each source, and that it is progressively harder to achieve further reductions in any source as the minimum achievable level is approached.

Following the tutorial, participants will be given a brief “test” to insure that they understand how to use the scales. They will then proceed individually to create their own preferred nitrogen load/source-allocation scenarios. The beginning point for all scales will be the previously projected values for 2010, assuming no further actions to maintain current nitrogen loads in the bay. The "rules" of the creation procedure are that the participant must first set the total nitrogen scale to their preferred position (above the 2,000 T/y minimum) by moving the marker arrow with the computer mouse. The sea grass coverage scale will move automatically (with an upper limit of 38,000 acres) with the total nitrogen scale, but can not be moved directly by the participant. The source class and subclass scales will automatically move proportionately to achieve the indicated total nitrogen load without altering the allocation among subclass scales. The participant may choose to exit this part of the procedure at this point, accepting the original allocations among sources and sub-sources (essentially consistent with the TBEP allocation plan). If selected total nitrogen settings require one or more source class and/or subclass scale to move below their indicated minimum achievable levels, the participant will be alerted that a reallocation of source class and/or subclass loads will be required.

If the participant wishes (or is required) to adjust the allocation among source classes, he/she will then select one of the major source-class scales and adjust that scale by moving the marker arrow up or down (using the computer mouse). *Stormwater Runoff*, *Discharge*/*Spills*, and *Atmospheric Deposition* may be adjusted, but the groundwater/*Spring* scale will remain fixed throughout the session. When the first chosen scale is moved (up or down) the remaining two scales (and the associated subclass scales) will automatically adjust proportionately (without changing their relative load allocations) in accordance with the fixed total nitrogen load. When the first chosen source-class scale has been set, the participant may select the next source class scale to adjust, or indicate that they are satisfied with the displayed allocation and exit this part of the procedure.

Setting the second major source scale (the first remains fixed) will force the third scale into a final position. The participant can accept the indicated major source class allocation, reset the source classes to their initial positions (keeping their total nitrogen setting and repeating the adjustment procedure), or reset the entire display to the original positions and start again by moving the total nitrogen marker to a new position. If selected settings move any subclass scale below the marked minimums, the participant will be alerted that additional source adjustments will be required.

With total nitrogen and major source class allocations fixed, the participant may proceed to adjust the sub-class loads within each source class. For example, the allocation of loads can be adjusted within the *Stormwater Runoff* source class by first selecting one of the subclass scales and moving the load marker to the preferred position. The remaining two moveable subclasses (the *Undeveloped/rangelands* subclass will remain fixed throughout the procedure) will automatically move appropriate to the fixed source class load, retaining their original relative allocations. The second subclass scale can then be selected and adjusted, with the

third automatically moving accordingly. All subclass scales must be set at or above their marked minimum achievable levels.

The participant may then accept the indicated subclass allocation, or reset the subclasses and begin again. If desired, the participant can proceed to adjust subclasses within the next major source class. The *Atmospheric Deposition* source class offers three subclasses and the *Discharge/Spill* source class offers two (so only one subclass scale adjustment is possible). Final scale values set by each participant will directly indicate the preferred levels of total nitrogen, and the preferred pattern of source class and subclass reductions for achieving those levels.

Conjoint rating elicitation procedure--This value assessment procedure will provide an expression of preferences for specified sets of total nitrogen and source allocation scenarios from a "citizen-consumer" perspective. Scenarios will be presented in pairs and the participant will indicate which member of each pair is most preferred, and then rate the magnitude of the preference difference between the two alternatives by allocating 100 points between them (e.g., 100/0, 60/40, 50/50).

If total nitrogen levels and major source and subclass allocations were all free to vary an infinite set of scenario alternatives could in principle be developed. The number of different 2010 scenarios will be systematically constrained to create a total of 30 paired comparisons. The specific "critical" alternatives to be created are summarized in the table below.

Total Nitrogen/Sea Grass Comparisons: *source allocations fixed, 2010/20 standard*
Low Load (approx. 2800 T/y, with sea grass maximized at 38,000 acres) TBEP Target (3800 T/y - 38,000 acres) Moderately High Load (approx. 4800 T/y - 28,000 acres)
Major Source Class Comparisons: *total nitrogen and subclass allocations fixed, TBEP standard*
Stormwater runoff reduced to minimum (other classes reduced proportionately) Direct Discharge/Spill reduced to minimum Atmospheric Deposition reduced to minimum
Subclass Comparisons: *total nitrogen level and major class allocations fixed, TBEP standard*
Stormwater Runoff Class Residential runoff reduced to minimum (others reduced proportionately) Commercial/Industrial runoff reduced to minimum Agricultural runoff reduced to minimum
Direct Discharge/Spill Class Municipal wastewater discharge reduced to minimum Industrial waste/fertilizer spills reduced to minimum
Atmospheric Deposition Class Power Plant sources reduced to minimum Commercial/Industrial sources reduced to minimum Mobile sources reduced to minimum

Alternatives will represent a range of total nitrogen levels/sea grass coverage (with source allocations fixed), major source allocations (one at a time, with total nitrogen and subclass proportions fixed) and subclass allocations (varied one at a time, with total nitrogen and major source allocations fixed). To further reduce the number of possible comparisons a common "standard" scenario will be created and compared against each of the other alternatives within each set. The standard scenario for the total nitrogen alternative set will have total nitrogen/sea grass coverage and all major and subclass allocations fixed at the projected 2010 (2020) levels without the TBEP nitrogen reduction program (i.e., 5775 T/y, with appropriate projected sea grass coverage). The standard alternative for the Major Source Class and for the Subclass sets will be the TBEP target of 3800 T/y - 38,000 acres, with source allocations as in 1992-94.

Each of the 14 alternatives listed in the table above, along with the No-TBEP/2010 (2020) and the TBEP-target standard alternatives, will be created and displayed using a facsimile of the *Source Scale Display* system described above. Pairs (the appropriate standard and an alternative) will be presented together on a computer screen with the scale markers set to the positions appropriate to the respective alternative. Sixteen additional pairs will be created by contrasting selected individual alternatives from within the total nitrogen, major source class, and subclass sets (e.g., Low versus TBEP-target, Runoff minimum versus Air Deposition minimum, Mobile versus Power Plant minimum). These pairs will allow testing of the transitivity of individual choices, as well as providing some variation from the standard-alternative pair presentations. Assignment of alternatives to locations on the screen (top versus bottom) and the order of choice-pairs will be randomly determined for each participant.

Responses will be registered by mouse clicks on buttons shown on the computer screen. Participants will first be required to indicate the preferred alternative, and then indicate a position on a 0/100 - 100/0 scale to record their rating of the magnitude of preference difference between the alternatives evaluated. Choice and rating data will be directly recorded into a database.

Preferred means for achieving indicated reductions--Once the participant accepts a final total nitrogen load and source allocation or completes the conjoint rating procedure, he/she will be asked to rank the alternative means of achieving the selected load targets in each subclass. Participants will be asked to assume that substantial reductions are required from a given source subclass (e.g., *Atmospheric Deposition--Mobile* sources) and then presented with 3 to 5 alternative means of achieving that reduction. For example, the options for the mobile atmospheric source may include:

> *reinstate emissions testing and standards for automobiles* (a recently discontinued program);
> *develop a public transportation system* (similar to the light rail recently proposed for the Olympics development);

require special gasoline additives (increasing the cost of fuel); or
impose a special tax on automobiles based on fuel consumption. [4]

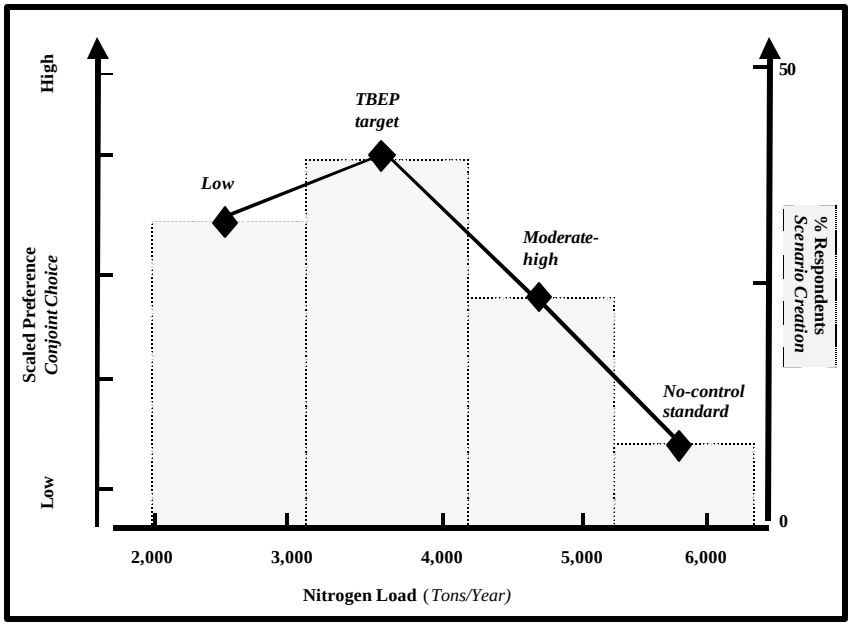
The options within each of the 8 (3 + 3 + 2) source subclasses will be ranked individually by each participant. The order of presentation of subclasses and means-options within subclasses will be randomized for each participant. Participants will be reminded that each option implies some "costs" to individuals and to the community, and that some of the options may provide "fringe benefits" beyond the effects of reducing bay-nitrogen loads. Participant responses will be recorded on-line and ranks for each option within each subclass will be used to calculate preference indices for each means of achieving nitrogen reductions. Reduction-means preference scores will be compared within and between small groups and (later) represented stakeholder groups.

Respondent characteristics--Finally, each participant will answer a short set of questions to determine relevant personal characteristics. Demographic items will generally classify participants in terms of age, education, household income, and gender. Zip code will determine residence location relative to the bay. Other questions will classify participants with respect to length of time in the area, frequency and types of direct and indirect uses and experiences of the bay and relevant interests/concerns, including memberships in relevant special interest groups or organizations.

Converging operations analysis--Indicated source levels from the scenario creation procedure will be scaled (standardized) individually and compared across participants within and between small group sessions (and later across stakeholder groups) to assess internal consistency and to identify any significant conflicts or minority opinions. Total nitrogen settings (T/y) will be treated as ratio-scaled measures in the analyses. ANOVA will be used to compare preferred total nitrogen loads between sessions and stakeholder groups. Source class and subclass settings may be treated as either ordinal or interval scale values, constrained by the individual total nitrogen settings selected by each participant. Correlation and regression analyses will be used to explore the interrelationships among source classes and subclasses and to identify distinguishable preference patterns within and between the stakeholder groups represented. The conjoint rating procedure will yield percent choices (and standardized paired comparison scales) and mean difference-magnitude ratings (and standardized scale values) computed for each of the alternatives within total nitrogen, major source class and subclass sets. Obtained values will be used as the indicators of preference weights for total nitrogen/sea grass coverage, and nitrogen-source reduction priorities within respective major source class and subclass alternative sets.

[4] It may be possible (if appropriate cost functions were available) to include specific dollar costs for achieving reductions in some or all of the source subclasses. The benefits of doing so would be some opportunity to infer "willingness-to-pay" values (given typical economic valuation assumptions), but at the expense of further complicating the task for participants.

Choices and ratings of total nitrogen alternatives in the conjoint rating (citizen-consumer) procedure will be analyzed to produce a preference scale over the range of alternatives tested (including the standard). Discriminant validity of the assessment will be indicated by significant differences across the tested total nitrogen and source allocation options. The psychophysical function relating expressed preference to total nitrogen load may not be monotonic. Public support for the TBEP program would be indicated by an inverted U function, as illustrated below, with both higher and lower nitrogen-load alternatives being less preferred than the TBEP-target load.



To be consistent, the frequency distribution of preferred total nitrogen values (aggregated into categories consistent with the choice alternatives) derived from the scenario creation procedure should produce similar results. The frequency distribution of preferred total nitrogen levels should show a similar inverted U pattern, and have a mode at the TBEP-target load. Alternatively, the choice-derived scale and/or the scenario-creation values could indicate a maximum preference above (or below) the TBEP target, indicating a difference between public preferences and the nitrogen management program goals. The correspondence between choice derived and scenario created nitrogen-preference functions provides an indication of convergent validity (method invariance) between the citizen consumer and manager perspectives. Divergence between these two scales will be inspected to determine the nature of context effects that might be expected in direct public response to the assessed nitrogen management options.

Source class and subclass allocation preferences directly indicated in the individual scenario-creation procedure will be compared (correlated) with the preference weights implied by the conjoint choice/rating procedure. Values from the interactive scale method and from the conjoint rating procedure should be consistent, as indicated by high positive correlations between source class and subclass scale values/weights. To the extent source-class values are consistent, the convergent validity of source allocation preferences from both procedures will be

indicated, and confidence in their mutual conclusions will be increased. Where source allocations/weights differ significantly the specific patterns of differences will be inspected to determine the implications for preferences elicited by direct experience of the assessed policies and outcomes.

The small group session will be completed by a review and general discussion of the results with the participants. Summary statistics and charts will be displayed immediately, along with the results of the analysis of the initial verbal questions. Discussion will be directed at identifying and explicating points of consensus and disagreement among the respondents, including any observed differences between elicitation procedures. The goal of this review is allow respondents to see and comment on the implications of their expressed/implied preferences, and to review participants' final understanding of the issues. The presentation and preference elicitation procedures used in this assessment will also be reviewed and evaluated at this time with the goal of developing the general survey procedures.

Stage 3: General survey

The small group sessions will provide an assessment of the preferences of high-interest participants, in a high-information interactive group context. Informed and carefully reasoned preferences from key stakeholder groups are important guides to policy making, but they may not be representative of general public reactions, which are likely to be based on less information and less carefully considered reasoning. A more general, more representative survey of pubic preferences provides another important perspective for managers and policy makers, and may be especially important in negotiating any conflicts among the more intensively concerned (minority) stakeholder groups. Thus, a short (approximately 20 minutes per respondent) general survey of a more broadly representative sample of Tampa Bay area residents will be developed and implemented to extend the findings from the small group sessions. The general survey will employ a subset of the setting/history and other materials used for the small groups, and emphasize elicitation of preferences for a more limited set of key policies/outcomes. Experience with and evaluations of the small group procedures will be used to guide development of the specific materials and procedures for the general survey.

Survey design-- An interactive, computer implemented "questionnaire" distributed over the internet (www) will be the primary format for the general survey. The goal of the internet survey is to achieve an assessment of nitrogen load and source allocation preferences based on a broader sample of Tampa Bay residents. Key historical background and nitrogen process information will be presented in an abbreviated form. A smaller set of source allocation options will be presented and preference expressions will be restricted to choices among fewer alternatives. Direct source allocation adjustment procedures (if implemented) may be simplified and more limited.

Survey sampling--Interactive computer systems provide important advantages for the presentation of complex environmental process and condition information, and for

communicating public preferences and concerns. At the same time, achieving a truly representative sample of any general public population is potentially hampered by the lack of universal access to adequate networked computing equipment and by the operating skills of participants. Much as in early telephone surveys, sampling biases could have serious effects on the external validity/generalizability of findings.

The proposed assessment will address sampling problems in several ways. First, the small group sessions described above will provide an indication of the range of preference differences (and consensus) that may exist among the specifically targeted special interests represented. Second, a series of intercept-sample interviews will be conducted in central locations (e.g., major shopping centers or other frequently used public venues) strategically distributed across the Tampa Bay area. At each location a suitable space will be secured and equipped with a number of networked computers (or arrangements may be made to use an existing computer facility). Potential participants will be approached and invited to participate in the survey. Finally, a formal random sample of Tampa Bay area households will be selected and solicited by mail to participate in the interactive internet (www) survey.

Survey implementation--To address the obvious problems of computer access in the mail solicitation procedure, an analog of the Dillman multiple-contact procedures will be applied. First, a random sample of households in the three bay-adjoining counties will be selected and contacted by mail. Introductory and motivational materials and instructional/tutorial information for accessing and performing the survey on the internet will be provided. In addition, each potential participant will be provided with a card with a unique identification code. Those who have access to a suitable networked computer will be asked to log on to a specified web site to participate. For those who do not have direct access to a suitable computer, a list and directions will be provided to a number of suitable public (e.g., libraries, schools) and private (e.g., internet cafes) facilities in the community that have been solicited to cooperate in the study. After two weeks (the time specified for responding) a second mailing will remind those who have yet to respond, again providing the identification code and access information, and urging their participation. In addition, the schedules (several full days scattered over the following two weeks) and locations for the intercept interviews will be provided, along with an invitation to come by with their identification code and participate. Finally, after the second two-week period those who have still to reply will be contacted by telephone and solicited for a personal interview/survey at their home or other desired venue. An interviewer equipped with a laptop computer will meet the participant at the designated time and place and conduct the survey.

Careful records will be maintained regarding the specifications determining the original mail-out sample and the members of that sample that participated at each stage of the progressive solicitation process. Comparison of specification parameters (geographic and demographic) will indicate how well the obtained sample matched the original randomly selected sample. Demographic, bay-use and relevant interest characteristics of participants in the intercept interviews and the

separate stages of the mail solicitation survey will be compared for further indications of bias in the final samples. The representativeness of the overall value assessment will be indicated by the correspondence between mail-out sample parameters and the characteristics of final participants within and across the selected small groups, intercept and mail-solicited samples.

Analysis of results of the general survey will parallel those described for the small group sessions above. The principal data are the functional relationships between total nitrogen and source allocations and the measures of preference obtained. If choices and/or scale adjustments indicate that the TBEP nitrogen/sea grass targets are the most preferred, public support of the program would be indicated. Overall or identifiable subgroup preferences for lower or higher total nitrogen or source allocation targets would indicate areas where program goals may need to be changed, or where public education and involvement efforts may need to be increased. Rankings of the various means of achieving desired nitrogen reductions for each source subclass indicate the relative acceptability of these options, and should suggest operational priorities for management programs to achieve nitrogen goals.

Background and Related Research

The conceptual basis for this assessment is drawn from psychological theory and research in perceived environmental quality assessment (e.g., Craik & Zube, 1977; Daniel & Vining, 1983) and behavioral risk/decision sciences (e.g., Payne et al, 1992; Slovic et al, 1990). Central tenants of this model are that public environmental values are relative, not absolute (Kahneman et al, 1999), and that particular value hierarchies are largely constructed, rather than retrieved (Fischoff, 1991; Gregory, 2000; Slovic, 1995), and thus are highly sensitive to contextual factors created by the assessment process. At a more fundamental level the approach taken in this assessment is consistent with contemporary "modular" or "multiple-channel" models that characterize the human information processor as a collection of distinct semi-independent psychological/neurological systems each specialized to accomplish particular cognitive, affective and behavioral tasks (e.g., Buck, 1985; LeDoux, 1995; Milner & Goodale, 1996). In this model, values are expected to be multidimensional, situational and not necessarily commensurate. Causal relations will sometimes run from values to preferences to actions, and sometimes the reverse (e.g., Zajonc, 1980). For some value assessment models the apparent inconsistencies, incommensurabilities and intransitivities would be interpreted as serious faults in valuation logic. For psychologists (and for public environmental managers) they are facts of life.

An important implication of the basic modular-contructivist model for public environmental value assessments is that each assessment must determine what the appropriate valuation context should be. That is, the assessor must determine the specific means for representing the relevant management actions-environmental outcomes at issue, the media and procedures for presenting those representations to observers-participants, and the methods and formats for eliciting and recording the

overt indications of preferences/values for those alternatives. The "right" context is that which will lead to valid and useful projections of preferences, support and/or compliance when the assessed policies-conditions are realized and encountered in the "real world"(Daniel, 1992; Daniel & Meitner, 2001). To the extent that realized environmental preferences/support/actions depend upon perceptions, understandings, emotions and/or other psychological processes that are not adequately or appropriately elicited by the assessment procedure, then, however elegant, internally consistent or logically correct, the resulting value assessments will not be valid--or useful to managers. While the desired goals for value assessment design are clear enough, achieving the "correct" assessment is at least problematic.

Environmental value assessments are substantially constrained by the current state of knowledge about the subject environmental problem-system, by technical limitations of management implementation systems and facilities, and by typically large uncertainties about future environmental conditions, mostly induced by events and processes outside of human control. On top of these environmental science and management technology limitations, the target for assessments is typically *future* values, requiring rather strong assumptions about the temporal stability of contemporary preferences (support, compliance), sometimes extended to generations not yet born. It follows that it is unrealistic to believe that any currently feasible environmental value assessment procedure could achieve (or prove) perfect validity. Assessment procedures can seek to represent as closely as possible the environmental, social and behavioral contexts that are expected to obtain at the places and times that the subject environmental management policies-outcomes will be encountered. Whatever surrogate representation of the target valuation situation is selected, the validity of the assessment results should be supported by systematic tests (e.g., Campbell & Fiske, 1959: Cronbach & Meehl, 1955).

While “ultimate” validity is not a realistic target for environmental value assessments, there is some knowledge about the relative advantages and limitations of available and feasible representational and procedural options. Contrary to frequent practice, empirical research and relevant psychological theory concurs that verbally expressed values for verbally described environmental/social conditions may address a peculiar and unrepresentative subset of value-relevant environmental perceptions and responses (e.g., Milner & Goodale, 1996; Weiskrantz, 1988). For many important environmental value dimensions, verbal descriptions are singularly inappropriate. Descriptions of the features of a landscape are generally not a sufficient basis for meaningful expressions of aesthetic preferences, except in the limited case where the differences among alternatives are very substantial and essentially categorical (Daniel & Ittelson, 1981). In cases where the relevant dimensions of environmental change are subtle and graded, verbal descriptions may beg the environmental values question altogether; *Which would you prefer, no pollution in the bay, a little pollution …?*

Graphic representations offer an attractive and frequently used alternative to words for representing value-relevant environmental conditions. Photographic

representations have been an obvious choice for assessments focused on visual properties of the environment, and photographs have proven valid representations for assessments of landscape scenic beauty (e.g., Daniel & Boster, 1976; Shuttleworth, 1980; Zube, 1974) and visual air quality (Latimer et al, 1981; Malm et al, 1981; Stewart et al, 1984). Computer simulation and visualization techniques, such as digital video imaging (e.g., Orland, 1993; Vining & Orland, 1989) have expanded representational options. Tests of the representational validity of digital images have largely been successful (e.g., Bergen et al, 1995, Oh, 1994), but there are indications that very near photographic quality is required (Daniel & Meitner, 2001). Computer simulations are playing an increasing role in environmental planning and in environmental perception research (e.g., Marans & Stokols, 1993; Sheppard, 1989). Simulation models have been effectively coupled with computer graphics systems to achieve more sophisticated and better-controlled environmental representations (e.g., Bishop & Hull, 1991; Clay & Gimblett, 1998; House et al, 1998; Thorn et al, 1997). Techniques that combine computer simulation modeling with map and 3-D terrain graphic displays (e.g., Bishop et al, 1995; Pietsch, 2000) offer the promise of better representing environmental problems that involve complex geographic and spatial relationships, but systematic tests of the validity of these representations remain to be done. "Virtual reality" technologies are advancing at an astonishing pace, offering assessors expanding opportunities for animated and interactive environmental representations (e.g., Bishop et al, in press; van Veen, et al, 1998; Verbree et al, 1999). Only a few systematic tests of the representational validity of these systems have so far been attempted, but results are encouraging (e.g., Rohrmann & Bishop, 2001).

Appreciation of the TBEP nitrogen management program requires an understanding of a number of complex biophysical processes with effects that extend over space and time. Managers' understanding of the problem, and the possible solutions to it, is supported by years of scientific training and by large volumes of relevant geographic and historical data. Meaningful public involvement in the nitrogen management decision process requires that they share some of this training and information. The proposed assessment procedure applies a number of environmental representation and communication methods that have admittedly not been tested in the specific context of problems like the management of nitrogen pollution in Tampa Bay. For that reason, the assessment has been designed to allow systematic comparisons across several methods of environmental representation and several modes of response. While this converging operations strategy may not be maximally efficient, it does provide for explicit tests of the validity of assessment results, offering important protection in a situation where the "correct" procedure cannot be known.

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Tampa Bay Estuary Program Values Assessment: Charting Publicly Preferred Passages

Terry C. Daniel and Michael J. Meitner

Attachment

Schedule and Budget

Reply to Reviews

Proposed Project Schedule

Task		Date
Project initiation		July 1, 2001
Biophysical scenarios developed and verified		September 1, 2001
Representation materials and presentation procedures developed and tested		January 1, 2002
Small group interactive assessments completed		April 1, 2002
General internet survey design developed		September 1, 2002
Survey materials and procedures developed and tested		January 1, 2003
Intercept and internet survey completed		March 1, 2003
Results review and feedback completed		May 1, 2003
Final Report		June 30, 2003

Proposed Project Budget

		Year 1		Year 2		Totals
Salaries						
PI		$17,616.90		$9,227.90		$26,844.80
GRA		$14,979.30		$7,489.65		$22,468.95
RA		$3,000.00		$3,200.00		$6,200.00
ERE		$4,440.76		$2,325.58		$6,766.34
Operational Expenses						
Sub-contracts						
UBC visualization		$30,000.00		$20,000.00		$50,000.00
on-site services		$5,000.00		$5,000.00		$10,000.00
Participant expenses		$15,000.00		$5,000.00		$20,000.00
HW/SW		$5,000.00		$3,000.00		$8,000.00
Supplies		$2,000.00		$3,000.00		$5,000.00
Travel		$6,000.00		$3,000.00		$9,000.00
Total Direct		$103,036.96		$61,243.13		$164,280.09
MTDC		$88,036.96		$51,243.13		$139,280.09
TDC - .50 (UBC contract)						
Indirect (25% MTDC)		$22,009.24		$12,810.78		$34,820.02
Project Totals		$125,046.20		$74,053.91		$199,100.11

Notes to budget

Detail for Salaries

Salaries	Year 1 Base (annualized)	Year 1 %	Year 1	Year 2 Base (annualized)	Year 2 %	Year 2
PI (Daniel)	106,014.67	16.6	17,616.90	108563.53	85	9,227.90
GRA	31,938.81	46.9	14,979.30	32869.97	22.8	7,489.65
UGRA (temp)	3,000.00	100	3,000.00	3,200.00	100	3,200.00

Subcontract (UBC) Details

	Year 1	Year 2	Totals
Student RA (inc benefits)	11,271.00	11,299.00	22,570.00
Programmer	3,375.00	1,000.00	4,375.00
Travel	6,000.00	4,000.00	10,000.00
Computer Lab Fees	7,925.00	2,750.00	10,675.00
Total Direct Costs	28,571.00	19,049.00	47,620.00
5% Overhead	**1,429.00**	**951.00**	**50,000.00**

On-site Services (estimated)

Year 1	Year 2
Temporary hire, local assistants estimated 300 hrs @ 16.67/hr	Temporary hire, local assistants estimated 300 hrs @ 16.67/hr

Participant expenses (Estimated)

Year 1 (small groups)	Year 2 (intercept and general survey)
Participants: 4 sessions x 15 @ 150 ea = 9,000.00	5 venues @ 200/da ea = 1000
Rent computers 4 session x 15@ 100ea = 6,000.00	160 paid participants @ 25ea = 4000

Hardware/Software and Supplies (over $1000)

One laptop computer with wireless network card $2, 700.00

Travel

Year 1	Year 2
Trip 1 Tucson -Tampa return T Daniel (10 days) Meet TBEP staff, arrange small group venues **Trip 2** Tucson - Tampa, return T Daniel + 1 Grad Res Assistant (10 days) Conduct small group sessions	**Trip 1** Tucson -Tampa return T Daniel + 1 Grad Res Assistant (10 days) Conduct intercept survey

Understanding Public Values and Attitudes Related to Ecological Risk Management

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Understanding Public Values and Attitudes Related to Ecological Risk Management

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Executive Summary

This proposed research will identify and quantify values for important natural amenities of Tampa Bay. The value measures will provide direct input into decision making regarding the alternative programs to control nutrient inputs into Tampa Bay, and will put this into perspective of other programs to improve the environmental amenities of Tampa Bay.

This work is important for achieving continued progress in provision of important environmental amenities. Although recent years have seen much progress in protection and restoration of critical environmental amenities, many significant impacts and threats remain. Limited resources are available to resolve these issues, and competing social needs necessitates that management actions focus on resolving the highest priority issues in a cost effective manner. Simultaneously, communities are becoming increasing resistant to management solutions imposed from "outside". Continued progress towards achieving environmental improvement depends on establishing consensus management strategies that focus efforts towards addressing the key objectives at reasonable cost.

It is critically important that public values be represented in environmental decisions process, since public money is to be used to fund resource protection activities, the public will ultimately bear the costs management actions that increase cost to industry, and since under the Public Trust Doctrine, government managers are mandated to act as trustees for the public. This sets forth a challenge to identify the key environmental objectives of the community more clearly, and to focus management on the highest priority goals of the community, which underscores the importance of efforts to elicit priorities and values of the affected communities. Social scientists have much to contribute to these issues, having invested substantial research efforts towards understanding processes to identify and measure public values, and processes to develop consensus agreements among interested parties.

Measuring community environmental values in a way that can contribute to assessment of specific management actions is an inherently difficult task, and not one that is amenable to routine application of standard techniques. For example, it is a difficult task to determine how much people care about reducing nitrogen deposition in Tampa Bay, and what level of expenditure of public dollars is justified to support specific programs. The complex scientific nature of the problem also contributes to the challenges faced in this task.

A flexible approach is essential in order to focus on the most critical issues and controversies faced by the community, and to design an instrument that respondents can understand and that elicits values for key Tampa Bay amenities. Therefore, it is important not commit prematurely to a specific instrument design. Rather, the research process must first obtain a firm understanding of the key issues and controversies from the perspective of the various communities, and steps must be taken to design an effective survey instrument.

Thus, rather than simply applying a predetermined set of economic tools, we will set forth a research process to identify public values regarding critical natural amenities of Tampa Bay. First, we will obtain and carefully study documents that describe the critical issues faced in Tampa Bay in order to obtain background information on the problems faced. Much of this work has already been completed as part of developing the present proposal. The second stage of the research is to meet with the various interested parties to get a more detailed understanding of the important issues from various perspectives, and particularly to identify the important controversies. The goal of this stage in the process is to expand our knowledge base on critical Tampa Bay issues and, just as importantly, to develop a working relationship with the various parties. The next stage in the research will develop a list and description of important values concerning Tampa Bay amenities, and identify those that can reasonably be addresses within the context of the proposed study. We will then meet with Tampa Bay management teams to describe the values that will be estimated. This will be the final opportunity for input from the management team on the essential elements of the study, and we maintain flexibility up to this stage, so that values measured by the research efforts can be of highest utility to the management team.

Once we have come to agreement with the management council on the final set of values to be estimated, we will organize and implement a set of focus groups and, later, a set of verbal protocols with the goal of developing a survey instrument to measure important public values. Initial focus groups will involve general discussions of the issues of concern, and will be used to understand the perspective of participants, to identify how they think about issues, what language they use, which words are loaded or likely to be misunderstood, what kinds of background information needs to be provided, whether they care about the particular issues, and if so why. As the process moves along, more time will be spent on specific issues identified to be important to the developing survey and pretesting successive draft questions. The focus groups will include considerable discussion of the questions to ensure that participants understand the questions, and that the survey responses convey the information we are attempting to elicit.

These focus groups will provide excellent qualitative information that is useful for understanding values held by focus group participants. More importantly, the focus groups will provides essential insights that help to identify difficulties in survey questions, and suggest approaches that can be used to improve the survey design.

When we feel we have a workable draft survey, we will implement a set of verbal protocols on the draft instrument. Verbal protocols are carried out by having an individual complete the survey, while "talking aloud" to express what the individual is thinking about while answering the questions. This will provide addition insights into the thought process underlying the survey format, and the survey will be revised as appropriate, until investigators are confident that the survey provides the information being sought.

When the survey development process is complete, we will implement the survey using a sample of the public. The precise format of the survey will be determined through the rigorous survey development process described above, and we strongly recommend that we maintain the flexibility to determine the best survey instrument and means of implementation. However, we anticipate that the survey will be administered as an in-person, self administered survey. We also anticipate that adequate funds will not be available for probability sampling, and we can use standard weighting procedures to correct for non-representative samples, to the extent possible. We will also apply standard rationality tests to confirm that results of the survey indicate valid economic values.

The results of the survey will provide an assessment of public values for important amenities of Tampa bay and will link with available scientific studies to provide direct input into management options. We will carry out various "rationality tests" to confirm that the survey results are valid measures of values of specific amenities described and not, for example, symbolic expressions of concern for the environment, in general. The results are analogous to public referenda, but are much more informative to policy makers and are more flexible. As such, the results will provide essential public input into the management process and ensure that public values are represented in the public decision process.

Specific Aims

The proposed research has the following general objectives:

1. Improve our understanding of the important dimensions of values that the public holds for environmental amenities,
2. Obtain qualitative information regarding why the public cares about Tampa Bay amenities,
3. Identify and quantify public values for important natural amenities of Tampa Bay,
4. Use these value estimates to assess specific policy options available for managing the Tampa Bay environment.

The discussion below will outline a research process to identify a set of economic tools for measuring qualitative and quantitative aspects of values that the public hold for Tampa Bay environmental amenities. Detailed information will be obtained regarding the various issues of importance from different perspectives, and the critical controversies that are faced in managing Tampa Bay resources. This information will be both in qualitative and quantitative form.

We anticipate that the values to be assess will include use values and non-use values. Use values that we potentially will estimate include values associated with recreational uses, such as swimming, fishing, boating and wildlife viewing, aesthetic qualities of the bay and commercial uses. Non-use values will include individual's values associated with maintaining Tampa Bay natural amenities that go beyond specific uses. The final selection of values to include will depend upon their importance to managers and the community as indicated in interviews and focus groups, and the extent to which the values are relevant to assessing specific management policies.

A quantitative assessment will be obtained for amenable values that are identified as most critical to determining the best set of management actions. The results of economic survey methods are analogous to a public referendum, except that surveys allow more flexibility in assessing public support for programs that vary in terms of (1) amenities considered, (2) the degree of environmental protection and (3) the cost of the program. For example, the output of an economic analysis could inform policy makers on the fraction of the public that would support alternative sets of programs to protect environmental amenities. The results can also be used to identify the public input regarding the "best" set of policy actions to be instituted within a given budget. These quantitative value measures can be used to assess specific control policies, thereby providing management teams with specific information that is directly applicable to important policy questions that they face.

Background and Significance

Tampa Bay is the largest open-water estuary in Florida, spanning about 400 square miles within a 2,200 square mile watershed. The estuary supports many species of fish and wildlife ranging from mammals like manatees and bottlenose dolphins, to birds like pelicans and ibis, to fish species like snook and red drum. Mangroves in Tampa Bay serve as breeding grounds for 25 bird species, including pelicans, egrets, herons, cormorants, terns, ibis and spoonbills. Many other birds winter in Tampa Bay, including as the American white pelican and several species of sandpipers. Tampa Bay supports commercial and recreational uses, and provides natural amenities to the population of over 2 million that reside in the surrounding area.

However, population growth surrounding Tampa Bay threatens the very amenities that drew people to the area in the first place. The most significant adverse impacts to the bay occurred from about 1950 through the about 1980, due primarily to pollution and to dredge and fill operations. Excess nutrients entering the bay have led to algae blooms that reduce visibility and oxygen levels in the bay, adversely affecting habitat quality. Seagrasses that provide habitat for many species of fish and shellfish are particularly sensitive to

problems resulting from excess nutrients. Over half of the bay's historic seagrass beds have been lost, contributing to a decline in the bay's commercial and recreational fisheries. Scallops have virtually disappeared from the bay, and other shellfish harvests were sharply curtailed due to bacterial contamination. Many species of birds have also suffered a sharp decline.

Restoring habitats that were damaged in the past, and protecting existing habitats is vital to maintaining many bay functions. Starting in the late 1970's, large investments were made to improve the Tampa Bay environment, including upgrading wastewater treatment facilities and increased water recycling, aimed at reducing nutrient inputs into the bay. These efforts have improved water in the bay, and significant recovery of seagrass beds has resulted. These habitat improvements, combined with steps to manage fisheries, have helped to reverse the decline in important fish species such as snook and red drum.

But despite many successes to date, the bay still suffers from significant environmental impacts and threats, particularly from excess nutrients and toxic pollutants. Continued growth in the area is expected to lead to an increase in nutrient loadings into the bay. Recent studies have also revealed that atmospheric deposition of nitrogen is a far more significant source of nutrients than was previously believed. Together, these threaten to reverse the gains made to date unless further control actions are taken.

The Tampa Bay Estuary Program (TBEP) was formed in 1991 under the National Estuaries Program (NEP) in response to these impacts and threats of future impacts to bay resources. The NEP was created to help develop a consensus among stakeholder groups to contribute to management of estuaries of national importance. A hallmark of the NEP is direct involvement of all interested parties, including the public, as partners in the management process, and integration of science into these types of public decision processes.

Under the TBEP a plan was developed to manage environmental resources in Tampa Bay (Tampa Bay Estuary Program, 1998). Among the most prominent of the initiatives in the plan was control of nitrogen inputs as a means of restoring seagrass beds. Seagrass beds were targeted both because of their ecological importance as habitat and as a barometer of overall quality of the bay's waters. A follow up joint effort by local governments, agencies, and industries in the region developed a specific plan of action (Tampa Bay Nitrogen Management Consortium, 1999) to implement the nitrogen management elements of the Tampa Bay management plan.

To date, little work is available to assess values within Tampa Bay. The proposed research will apply economic methods for measuring public values, and for integrate values into the public decision process in Tampa Bay. The economics literature on valuation methods is enormous, and this brief background section will not attempt a comprehensive assessment of the state of the art. Rather, it will provide a brief review of the concepts and methods as they pertain to issues faced in Tampa Bay, will discuss how these concepts are relevant to the present effort and will discuss one comprehensive economic study that applies a series of economic methods to assess environmental amenities as part of the Peconic Estuary Program on Long Island, New York (Opaluch et al, 1993).

Economists generally divide values into use values and non-use values (or "Passive use" values). Use values are generally associated with an activity that involves the amenity. For example, recreational swimming embodies a use value for clean water. Similarly, a use value may be obtained by traveling to see the Grand Canyon. Non-use values are values that are associated with an amenity even if you do not use it. For example, I may hold a value for continued existence of the Grand Canyon in its natural state, even if I never expect to see it. Residents of Tampa Bay communities might value environmental improvements, above and beyond their potential uses of the bay, and people from throughout the United States may value maintaining of manatee populations in Tampa Bay even if they will never see them.

As indicated above, Tampa Bay provides residents with a host of use and non-use values, and economists have developed tools for measuring each (e.g., Freeman, 1993; Mitchell and Carson, 1989). A comprehensive economic analysis for the Peconic Estuary Program, part of the NEP, applied several of these approaches to measure different categories of values for the Peconic Estuary (Opaluch et al, 1998). Given the size of the economic valuation literature, this proposal will discuss the approaches applied to the Peconic estuary as an illustration of how economic methods can and have been applied to assessing public values for environmental amenities.

The Peconic estuary economic studies used a multi-phased plan to assess various use and non-use values. Phase I of the study focused on market values associated with the estuary by carrying out an economic impact analysis of the Peconic estuary (Grigalunas and Diamantides, 1996). This phase was a modest effort that provided a perspective on the levels of economic activities that are supported by the estuary, in terms of number of establishments in different economic sectors, and the associated levels of employment and wages. A second element of the market analysis of phase I identified opportunities and constraints faced by potential mariculture operations in the estuary.

Phase II was comprised of a series of economic studies that focused on non-market values supported by the estuary (Opaluch et al, 1998). These studies were used to identify and estimate various components of values associated with natural amenities, and the results of the various studies can be combined together to assess values associated with specific management actions to protect and restore amenities.

Phase II included a recreational use study, a property value study, a wetlands productivity analysis, a resource valuation study. The recreation study used a survey to collect primary data to identify levels of various recreation activities supported by the estuary, and to collect detailed trip information. The Recreation study used this data to estimate values of various recreation activities, and how participation rates and values would change with given changes in the quality of recreation activities. This allowed us to calculate recreational benefits associated with policies, such as those that improve water quality or increase fish populations. Thus, the recreation survey can estimate values associated with recreational uses, but excludes other values, thereby necessitating additional methods to measure other values.

The property value study used standard methods to determine how various attributes contribute to the selling price of houses. The study included the usual attributes describing the house, such as the number

of rooms, square footage of the house, size of the lot, size of garage, etc. The study also included environmental attributes that the home owner would enjoy, such as nearby open space, farm lands, wetlands, etc. If homeowners enjoy services associated with these environmental amenities, then one would expect the price of a house to be bid up if it has special amenities. For example, if a house has an ocean view, then one would expect that people would be willing to pay more for that house than they would for a house identical is all other ways, but without an ocean view. Therefore, we would expect that the selling price for the house would be reflective of the potential homeowners values associated with an ocean view. The property value study was used to estimate values associated with adjacent open space, wetlands and farmland, among other amenities. However, the housing prices only indicate amenity values received by home owners living adjacent to specific amenities. Thus, these values exclude other values associated with amenities, such as the value obtained by people visiting the area, etc.. So other methods are needed to capture other components of value.

The resource survey used conjoint analysis to estimate values associated with various environmental amenities, including open space, farmland, salt marsh, eelgrass, safe shell fishing areas. A sample of the public was presented with a pair of alternative programs to that would provide specific levels of protection for these resources at a stated cost, and respondents were asked which program they prefer, or whether they preferred "neither program". This study approximates a public referendum on protection of various environmental amenities.

In theory, such a study could capture all use and non-use values associated with these amenities. However, focus group participants indicate that respondent were not considering certain categories of values when answering the questions. For example, in terms of open space amenities, the respondents seemed to consider the value of open space as a "generic amenity" that affects the character of the region as a whole. But focus group participants but didn't consider amenity values to immediately adjacent landowners, nor did participants appear to consider possible water quality benefits that might result from reduced development. Therefore, to include all categories of values, this study had to be augmented with other studies, described in this section.

The various parts of the Phase II were combined together to estimate three components of values: the contribution to the open space throughout the region, which effects the overall the character of the community, the amenities provided to property owners who live immediately adjacent to each open space parcel and the contribution of undeveloped land to reducing point and non-point pollution, affecting use and nonuse values associated with changes in water quality. The resource survey was used to estimate the value of open space as a general amenity. The results of the property value study was used to estimate the amenity value to adjacent property owners. Finally, the work is currently being linked to ongoing water quality modeling efforts that will determine impacts of activities on water quality in the Peconic (Tetra Tech, 2000). The results of our recreation survey are being linked to this water quality model to determine the effects of loss of open space on the quality and quantity of recreation activities in the Peconic. Together, these three studies include a wide range of values for open space amenities.

Research Design and Methods

Measuring community environmental values in a way that can contribute to assessment of specific management actions is an inherently difficult task, and not one that is amenable to routine application of standard techniques. For example, it is a difficult task to determine how much people care about reducing nitrogen deposition in Tampa Bay, and what level of expenditure of public dollars is justified to support specific programs. The complex technical issues regarding the problem also contribute to the challenging nature of the task.

Considerable judgment, based on experience and training of the investigators, is required to design and implement a process to provide defensible value estimates. And the creation of a strong research process is just as important applying as sound tools. Themes that are critical to the success of the research effort are establishing a two-way communication to obtain information on values, and to ensure that the information obtained be directly relevant to the critical management questions to be addressed. To do so, the research team will work in close cooperation with, and be sensitive to, the needs of the affected communities, including both the various publics and resource managers. Indeed, this research process is best viewed as a component of the larger program to develop consensus within the community, and therefore faces the same challenges. Addressing these challenges requires a sound research strategy, a strong research team with considerable experience, and a willingness to work actively with the program staff and with the various affected communities.

The research team must be aware of the unique aspects of the estuary and it's communities. This includes the natural environment, the social environment of the people in the community and the political aspects of decision making and implementation. Thus, the process begins with a thorough grounding of the research team with the principal issues faced in the project area. First, the research team will obtain and thoroughly study various reports and background documents to familiarize themselves with the critical issues. Much of this work is already complete, as part of developing the present proposal. Obtaining this working knowledge prior to meeting with local groups will help researchers establish credibility, and facilitate their acceptance by the local communities as "knowledgeable insiders" rather than "naïve outsiders".

For example, our work in the Peconic estuary on Long Island, New York was facilitated by the fact that we were from southern Rhode Island, less than 50 miles away, and that we faced very similar issues related to water quality, tourism, rapid loss of undeveloped land, etc. One theme we frequently emphasized at various meetings was that we felt very much at home in the Peconic, coming from a similar environment that faced closely related issues. The researchers are part of the management process, and the success of the research effort is dependent upon similar issues related to developing a consensus decision process. Establishing a close working relationship with a firm basis of trust is an important part of a successful research process.

The next step in the process is to meet with the principal parties involved in the management process, including knowledgeable and involved members of the public. The goal of this stage is to develop a more thorough understanding of various perspectives regarding the important issues faced, to learn more about the larger research program in place upon which to build, to identify critical controversies that must be dealt with and to establish a close working relationship with the principal actors.

With this critical background information, researchers will identify the specific sets of values to be assessed, and the best tools for assessing those values. For the Tampa Bay case study of atmospheric deposition of nitrogen, values are associated with habitat, especially for seagrasses, improved water clarity, etc. Tampa Bay habitats support commercial and recreational uses, and provides natural amenities to the population of over 2 million that reside in the surrounding area. The estuary supports many species of fish and wildlife ranging from mammals like manatees and bottlenose dolphins, to birds like pelicans and ibis, to fish species like snook and red drum. Mangroves in Tampa Bay serve as breeding grounds for 25 bird species, including pelicans, egrets, herons, cormorants, terns, ibis and spoonbills. Many other birds winter in Tampa Bay, including as the American white pelican and several species of sandpipers.

But these values are best understood within the larger context of environmental and social needs of the area. So values associated with nitrogen deposition are best understood within the broader context of values for amenities of Tampa Bay, and indeed within the context of broader social values. Very different values are likely to be important for working class communities, versus urban poor, versus the upper middle class versus commercial fishermen. It is critically important to capture critical elements of values of all affected communities. For many extremely poor communities, subsistence fishing values can be of primary importance, while more affluent communities may place primary importance on the health of marine mammal populations or scenic vistas. These are very different types of values, and different methods may be most appropriate for measuring each, while avoiding double counting.

Given this critical background information, the specific values to be focused upon will be identified, and researchers will begin to identify appropriate economic methods for measuring each of these values. At this stage in the process, we will meet with Tampa Bay management teams to describe the values to be identified in a qualitative manner, and which values our quantitative analysis will focus on. This is the final opportunity for the input into the essential elements of the survey process.

Economic methods identify management-relevant values by focusing on explicit or implicit tradeoffs that are embodied in choices. Tradeoffs are faced, for example, when decision makers prioritize actions to reduce nutrient emissions within a limited budget. This key notion is recognized by the Tampa Bay Estuary Program in its stated goal to "ensure that increasingly limited public funds are spent in a manner that best benefits the bay and the people who live around it" (Tampa Bay Estuary Program (1998)). For example, values measured by economic methods can be used to determine the best set of actions for a given budget, where "best" is defined as those that are most consistent with the values of the communities. Economic analyses can provide useful input into decisions regarding management actions.

In order for the information to be of use for managment purposes, it is critical that values be measured in a quantitative fashion. For example, an attitude study might find that the public cares more about manatee populations than fish populations. Yet there may be few management actions that are available to protect and restore manatees, and those programs might be both very expensive and not very effective. In contrast, there may be many inexpensive and highly effective programs to restore fish. The question then becomes whether it is of higher priority to spend public funds to make a small change in the population of manatees, or to make a much larger change in the population of fish. The quantitative assessments provided by economic methods provide useful input into this sort of decision faced by resource managers.

People hold both use and non-use values for amenities like clean waters or habitat of Tampa bay. Use values concern activities like fishing, swimming, boating, wildlife viewing, or enjoying views of the bay. Non-use values concern the values that people have for bay resources beyond their use. The people around Tampa Bay might hold values maintaining a clean bay that extend beyond their uses of the bay. Many people throughout the United States may hold non-use values for preserving manatee populations in Tampa Bay, even if they will never travel there to see them.

Our initial meetings and focus groups will be used to identify the extent to which each of these values are important to Tampa Bay communities, particularly with respect to use versus nonuse values. This will help to determine the appropriate tools to apply. Economists have developed tools for quantifying each of these types of values. Use values are generally associated with some sort of action (e.g., traveling to the beach). Data can be obtained on these activities, and values can be inferred from tradeoffs faced when taking that action. The first category of approaches is called "revealed preference" approaches, where actions reveal values or preferences. Revealed preference approaches include market approaches and non-market approaches, such as the travel cost approach, the hedonic property value approach and the household production approach. (see, e.g., Freemen, 1993)

Revealed preference approaches are based on data in the form of what people actually did in order to infer a value for the activity. If someone chooses to pay $30 to go fishing on a charter boat, then the activity must be worth at least $30 to them. If someone chooses to go on a $50 charter that has a higher expected catch rate and is otherwise identical, then that difference in expected catch rate must be worth at least $20 ($50-$30) to them. By observing participation rates at varying prices and qualities, revealed preference methods allow one to infer values for activities at different level of quality. This allows one to identify values regarding the number of days, as well as for changes in quality.

Application of economic methods is relatively straightforward for market activities, where people pay a price to participate. For activities with no explicit price (e.g., fishing from shore), implicit prices can sometimes be constructed. For example, if the individual has to travel to go fishing, then price of participating in recreational fishing is the cost of traveling to the site, including the implicit cost of the time spent traveling to the site. If an individual is willing to travel a longer distance to go fishing at a site with higher expected catch rates, they are revealing that they are willing to pay at least that additional cost for higher catch rates. If managers can estimate how policies to improve fish habitat can affect catch rates, then

revealed preference methods can identify the benefits that those policies provide to recreational fishing activities.

Nonuse values are not generally associated with any particular activity that can be measured. An individual might value knowing that manatees populations of Tampa Bay are protected, but simply enjoying that knowledge doesn't require any particular action by the individual, so we can't observe tradeoffs that the person is willing to make. Economists have developed what are known as "stated preference" approaches to measure these types of values. With stated preference approaches, hypothetical questions that embody tradeoffs are asked, and the responses are used to elicit values. For example, a stated preference approach might ask respondents whether they would vote for a program to reduce nitrogen emissions, with specifically described improvements in Tampa Bay amenities, given that it will increase their electric bill by a stated amount per year. By varying the stated amount across respondents, standard economic methods can be used to infer acceptable tradeoffs between higher electricity prices and changes in environmental amenities.

Stated preference approaches can be applied to use values as well as nonuse values, and are particularly appropriate for evaluating conditions that don't currently exist. For example, suppose there is a beach in Tampa Bay that has been closed for years due to water quality concerns, and managers wanted to know how many people would visit the site if water quality were improved to some specified level. Or suppose managers wanted to assess the value of building a boat ramp at a site where none have ever existed. In this case, we can't directly observe what people would do, since the amenity is not presently available. One could possibility extrapolate from other "similar" sites, if some are available. Or stated preference methods could be applied by asking people how their participation in an activity would change if the hypothesized program were implemented.

Stated preference methods are very powerful, but they also embody considerable peril. The power arises since they can, in principle, be applied to virtually any situation imaginable. The peril arises because responses might indicate something other than that intended by the researcher. For example, a response may indicate symbolic support for environmental programs in general, rather than indicating an acceptable tradeoff for the specific amenity being considered. Or respondents may not know how they would behave without actually experiencing the situation, since it may be difficult to predict how one would behave in a situation that is far from one's previous experience. Thus, one might expect stated preference techniques to be more reliable in familiar situations with choices that the respondent has experienced many times. Unfortunately, the circumstances when stated preferences methods are most needed, where there is no "similar" experience from which to extrapolate, are exactly the situations where stated preference methods are more challenging to apply.

A rigorous survey development process is key to creation of a survey instrument that is understandable to respondents and that elicits the information being sought by managers. A workable survey that elicits the appropriate information requires a two-way communication between researchers and survey respondents.

The survey must pose questions that are meaningful and that elicit the thought process that researchers seek, so that respondents reveal acceptable tradeoffs.

Ultimately, we want to identify values regarding impacts on bay amenities that people care about, and the levels of nitrogen concentrations in the emissions of nearby power plants are not necessarily very meaningful to the public. Available scientific studies will be used to establish the sequence of linkages from specific emission control actions, to changes in nitrogen emissions, to nutrient concentrations in Tampa Bay, to impacts to important natural amenities like seagrasses, and ultimately to populations of important fish and shellfish species, etc. In doing so we face a host of complex and technical issues that stretch our scientific knowledge to its limits. Simultaneously, we face the challenge of getting people to understand the critical issues being faced, and communicating their values. If respondents interpret questions is a manner other than intended by the researcher, survey results can be meaningless or misleading.

We will implement a rigorous development process that includes direct interaction with individuals that are representative of those ultimately to be surveyed. We will carry out survey development and pretesting by giving participants successive draft survey instruments, which are completed by participants, followed by discussion of what respondents thought of the survey, and why they answered questions as they did. This will ensure that respondents are expressing their preferences for natural amenities by making tradeoffs as intended by the researchers. Survey instruments are successively revised in response to feedback by participants, and retested until we are confident that the survey is working as intended.

Depending on the complexity of the issues faced by survey respondents, we may have to go through 10 to 20 draft survey instruments, with time for revisions in between. This process can easily take 3 to 9 months or more to complete. On a difficult topic, such as atmospheric deposition of nitrogen, it can be wise to spend something on the order of 80 percent of the effort developing the survey instrument, and only 20 percent of the effort implementing the survey and analyzing the resulting data. When faced with challenging topics, survey processes are not cheap or easy. Indeed, a "quick and dirty" survey can easily be more misleading than helpful.

Methods for implementing stated preference approaches have been greatly refined over the years. Various categories of biases have been identified, much effort has been placed in attempting to determine whether biases appear to be at issue in particular case studies, and methods have been developed to minimize biases (e.g., Mitchell and Carson, 1989). Although this literature provides guidance, there is ultimately no substitute for a rigorous survey development process that includes direct feedback from people representative of those who will actually be surveyed, followed by successive revisions to draft survey instruments.

We will employ a series of focus groups for this purpose. Focus groups are small discussion groups led by a skilled moderator. Initial focus groups will involve very general discussions of the issues of concern and are used to understand the perspective of participants, to identify how they think about issues, what

language they use, which words are loaded or likely to be misunderstood, what kinds of background information needs to be provided, whether they care about the issue, and if so why.

As the process moves along, more time will be spent concentrating on specific issues identified to be important to the developing survey and pretesting successive draft questions. This latter activity is particularly critical for developing a workable survey. These focus groups will include considerable discussion of the questions, including both broad open-ended questions, such as what participant thought about the survey, and more targeted questions, like what they were thinking about when they answered each individual question, or when they read a particular term, such as habitat or atmospheric deposition. Doing so provides feedback on whether participants understood the question, and whether the logic used in coming to their response is consistent with the thought process that the instrument is attempting to elicit (typically, evaluating some sort of tradeoff). This provides excellent qualitative information that is useful for understanding values held by focus participants. More importantly, it also provides essential insights that help to identify difficulties in survey questions, and suggest approaches that can be used to improve the survey design.

Once a workable survey is created, verbal protocols will be used to complete pretesting process. The verbal protocol method is applied to a single individual, rather than a small group, and asks the individual to think aloud as the fill out the draft survey. The procedure is taped, and a facilitator is generally present to encourage the individual to continue talking if they become silent. This approach has the advantage that respondents don't need to recall what they were thinking when they answered the survey question, there may be less of a tendency for respondents to "rationalize" responses *ex post*. One disadvantage to the verbal protocol method is that the process is self directed, so you can't ask specific questions that that might arise, nor do you get the kind of interaction that you might in a focus group, where individuals react to what others say. Also, using focus groups allows feedback from a larger total number of individuals with a given investment of time. Our survey development process will include a combination of focus groups and verbal protocols to get the best of both approaches.

Communicating the scenario in a way that is understandable to survey respondents is a critically important part of the survey process, especially when the commodity is less familiar. Depending upon how the survey is implemented, information can be presented using pictures, drawings, figures, etc. We have become experienced with various visualization tools for communicating scenarios to survey participants. We pioneered the use of videos for providing background information for surveys (Opaluch et al, 1993). Videos have many advantages over written material. People are very used to watching presentations, are much more attentive to a video presentation, and far more capable of absorbing information when presented in a video format than when that same information is presented as several pages of paragraph text. Our experience has found that a well produced video excites participants, and encourages them to get involved in a survey, while presenting the same information as several pages of paragraph text tends to intimidate and sometimes bore, or even alienate respondents. We are also experimenting with new technology-based tools such as digital imagery and virtual reality systems to help participants better visualize scenarios.

Depending upon the level and complexity of background information needed, we will considering using a video to present background information. Although videos can be expensive to produce, modern computer technologies have contribute to significantly reducing the cost. For example, a Powerpoint presentation of background information can be developed and refined though the focus group process. During survey development, the successive draft scripts can be read to focus group participants while they watch the visuals in the presentation. Once the presentation is completed, the script can be recorded and linked to the appropriate slides in the Powerpoint presentation, which is then shown to respondents prior to taking the survey. Or the presentation can be turned into a video, either by exporting the presentation directly to video tape, or by creating a video production using Powerpoint presentation as a "proof".

This greatly reduces the cost of creating an audio-visual presentation for providing background information. However, this somewhat complicates the logistics of survey implementation, and places limits on venues in which the survey can be implemented. Nevertheless, we will develop a audio-visual presentation if we find that a considerable amount of complex background information needs to be presented to respondents.

It is important that the question make the degree of environmental improvement clear and relevant to survey respondents. In many cases, a format that seem perfectly clear to "experts" is not at all meaningful to the general public. And conversely, in some cases question formats that seem confusing to "experts" can be perfectly clear to members of the public. We will carefully pretest surveys to make sure questions are clear to respondents.

The information presented and the question format used must both be meaningful to respondents. For example, presenting environmental improvements in terms of nitrogen concentrations of power plant emissions would not likely be meaningful to respondents, since they would not likely have an understanding the implications for the critical amenities in Tampa Bay that are valued by respondents. Respondents would likely answer the questions, but the responses would not indicate values for Tampa Bay amenities if respondents don't have the information needed to make the linkages to species of concern. Rather, respondents would ideally be given information on changes in populations of important species, for example, relative to "no action" levels. Clearly, successive pretesting of draft formats for this information is critical for developing a workable survey.

In our focus groups, we will consider several alternative question designs to find which one works best with respondents. For example, we will test a "referendum" format, where we ask respondents whether they would vote for a program to control nitrate deposition at a stated cost that results in a stated improvement in Tampa Bay amenities. By varying the stated payment, one can identify the percentage of respondents who indicate that they would vote for the program at each amount, then estimate a "mean" (or median) willingness to pay for the program. Use of a mean willingness to pay is based on the notion that those who favor a policy could potentially compensate "losers", and all parties could be made better off. However, actual compensation is rare.

Use of a median willingness to pay is analogous to voting, in that it identifies programs that would be supported by 50% of the respondents. If the cost of the program is less than the median willingness to pay, the survey results suggest that the proposed program would pass a referendum. By varying the stated environmental improvement and the cost, one could identify percent of the public that would support different programs, providing useful input to management committees.

We will also use focus groups to pretest a conjoint format for questions, where complex commodities with several attributes are presented to respondents. The term "conjoint" is derived from the fact that the attribute levels are considered jointly by survey respondents. For example, a conjoint analysis could specify a multifaceted program for environmental protection, where the attributes describe stated levels of protection for different of different amenities (e.g., birds, manatees, fish, etc.) in Tampa Bay at a stated cost. Some programs might be more protective of certain fish species, while other programs might be more protective of birds or marine mammals.

By applying a statistical design over the levels of the attributes, the results of the survey can be used to identify the relative importance of each attribute to the respondent. If one of the attributes is dollars, then researchers can elicit the importance of each attribute relative to monetary payments, so that monetary values can be calculated. However, conjoint methods can also be used to measure relative values of different amenities, without dollar values, and decision makers can use the resulting information to determine the public's stand on the best set of resource protection actions to implement within a given budget.

We will consider alternative designs for conjoint questions. For example, respondents could be asked to rate different programs that provide varying levels of protection for different species, or they could select the program that they prefer. Frequently conjoint analyses are set up as paired comparisons, where respondents are presented with two options, and are asked which of those two options they prefer. For example, the options might be two different beaches, each with a given sets of attributes (e.g., facilities, distance, entrance fee, etc.). Respondents then might be asked which of those two are preferred. So one beach might be more expensive, but have better water quality. Presenting respondents with choices like these can help to identify acceptable tradeoffs for respondents. Or one could specify alternative programs for protecting and restoring natural amenities, each with different levels of protection for each amenity and different costs. This can be used to identify the public values and priorities for programs to protect various environmental amenities, which provides input of direct relevance to policy makers.

The paired comparison approach has an additional advantage of presenting respondents with a more balanced choice. So instead of asking how much the individual would pay for a stated amenity, where the respondent is explicitly asked to tradeoff dollars for an amenity, respondents are instead presented with two alternative programs, and asked which program they prefer (and they may be allowed to indicate that they prefer "neither program"). Identical tradeoffs may be implied, but the task being carried out by the respondent is different, and one approach could be more effective in eliciting the information that the managers need to support their decisions. In determining which approach is more effective, there is no

substitute for succession of pretests that include direct feedback from individuals who are representative of the ultimate sample, and subsequent revision of the survey.

Frequently, scientific experts, resource managers and the public alike express skepticism for the whole notion of placing dollar values on environmental amenities. The conjoint approach has the advantage that it can be used to identify relative values or priorities for different environmental amenities. The could be useful, for example, in determining the best set of actions to be undertaken with a fixed budget, without placing dollar values on environmental amenities. Yet if conjoint questions include a stated program cost as an attribute, conjoint result can also be used to place dollar values on amenities, if desired.

We will place considerable emphasis on making questions as realistic and familiar to respondents as possible. Also, we will take steps to ensure that respondents believe that there are real consequences to the choices expressed in the survey. For example, respondents might be told that the results of the survey will be passed on to policy makers who could base policy upon the results of the survey. We will also work closely with managers to ensure that the results are expressed in a way that is mostly useful for managers.

The results of an our economic analysis will allow us to base policy recommendations on something approximating a referendum, but doing so in survey form provides more flexibility. For example, an actual referendum would, of necessity, pose only one level of provision of the amenity at one stated cost. However, a survey could specify different levels of provision and different costs, either in different questions to a given individual or across individuals. So, for example, one might find that a majority of the public would not support a program that improves water quality to "pristine" levels at a great cost, but they would support a more modest program that achieves a lower, yet still beneficial, level of water quality at a far lower cost. Or a series of questions might help managers identify the percent of the public that would support alternative programs that focus on different amenities and that vary in terms of cost and environmental effectiveness. This could provide resource managers with a great deal of very useful information regarding public values for potential programs.

The next stage in the research is to implement the studies. There are many technical issues related to implementation and data analysis. However, while important in obtaining accurate and reliable measures, these issues are not directly related to the task at hand. This discussion focuses only on issues related to sampling and carrying out “rationality tests” on the results of the final survey.

Ideally, surveys should be implemented using probability sampling, which provides samples that are representative of the population of interest. However, probability sampling procedures can be very expensive, and may be beyond available budgets. To the extent that sampling procedures imply a non-representative sample, efforts will be made to identify and correct for this problem. For example, it is often found that response rates are higher for respondents who are wealthier and better educated. In such a case, it is fairly straightforward to use weighting procedures to correct for this type of non-representative sample. It is more difficult to correct for biases that might result from, for example,

samples that are non-representative in terms of environmental concerns, or other factors that cannot be easily identified and corrected using standard demographic information for the population at large. However, note that similar issues are faced with voting processes.

A major concern with results from valuation surveys is whether respondents indicate values for the specific commodities described, versus whether responses indicate "symbolic" concern for environmental amenities, in general. As discussed in detail above, we will make considerable effort in our survey development process to develop questions that elicit well defined values for specific amenities. We will also design our survey instrument so that it is amenable to various "rationality tests", including scope tests (e.g., NOAA, 1993) and additivity tests (McFadden and Leonard, 1993). that can be used to confirm that the survey was successful in avoiding symbolic responses. Scope tests compare stated values for more inclusive versus less inclusive amenities. If survey results are "symbolic" one would expect to find that values do not vary with the commodity specification. In contrast, if results are well defined amenity values, then one would expect to find higher values associated with more inclusive commodities.

Additivity tests are more rigorous rationality tests, whereby the value for a composite commodity is compared to the values of the component parts. So the total value of two commodities obtained together should be equal to the value of the identical commodities obtained sequentially.

Given a set of results, economic studies can be linked to scientific analyses to determine public values associated with alternative management policies. For example, economic studies might determine how the number of recreation days and the value per day vary with water quality. Scientific studies could be used to determine how water quality and fish populations could be affected by management actions. By linking these studies, we could determine how the values of recreational swimming and fishing are affected by a stated policy aimed at improving water quality. Similarly, one could determine how policies to protect and restore manatee populations contribute to the associated non-use values.

Summary

Economic methods can be used to measure values and provide direct and quantitative input into difficult decision problems, such as environmental management decisions in Tampa Bay. Economic methods provide public input into management decisions that is analogous to voting processes, particularly when median, as opposed to mean, values are applied. In such as a case values are measured for a "representative" (median) member of the public, which can be used to indicate which programs would pass a public referendum.

Being analogous to voting processes, and economic methods have similar strengths and weaknesses. In terms of weaknesses, the public is not necessarily the best informed of all parties about environmental issues. Difficulties are faced in both cases regarding informing the public of the implications of policies being

considered. Also, there can be other problems implementing both voting processes and economic methods, such as obtaining non-representative samples, etc.

Although analogous to a public referendum, surveys are far more flexible and can be designed to provide more information to managers. For example, surveys can pose different levels of protection of natural amenities, different amenities and different levels for the cost. This can provide a rich body of information regarding the percentage of people that would support a host of different restoration programs, which can provide input into management decisions regarding public values for natural amenities and for programs to protect or restore those amenities. The results can be used, for example, to identify the set of environmental programs that best meet public values, given a limited budget. This information is essential in achieving the state objective of the Tampa Bay Estuary Program to "ensure that increasingly limited public funds are spent in a manner that best benefits the bay and the people who live around it" (Tampa Bay Estuary Program (1998)).

Economic methods can also help managers understand components of value. For example, economic methods can be used to identify values associated with specific amenities, and various dimensions (e.g., quality versus quantify) of amenities. Methods can also estimate use and non-use values, so we can find whether values are associated with specific activities that utilize the resource, or whether nonuse values dominate, so that values are associated with existence of the amenity in its own right, above and beyond human use.

However, measuring values for complex commodities such as environmental amenities is an inherently difficult task. A thoughtful and rigorous research process is a critically important component of obtaining meaningful value estimates. Methods must be flexible, and with specific design decisions made as part of a two-way communication between researchers and the public. The program team must have the experience to adapt the direction of the research and fill information gaps as necessary to meet the program needs and in order to identify the best means for eliciting values.

This underscores the need for a strong research team, with strong experience and training. It also reinforces the need for an adequate time and budget to carry out the process. So it is important to include economists early on in the research, so there is adequate time to implement the necessary stages of the process. Quick and dirty surveys can be more misleading then informative. But a thoughtful survey can provide essential public input into public decision processes, and are well worth the cost, especially given that government managers are spending public funds, and are therefore mandated to act as trustees for the public.

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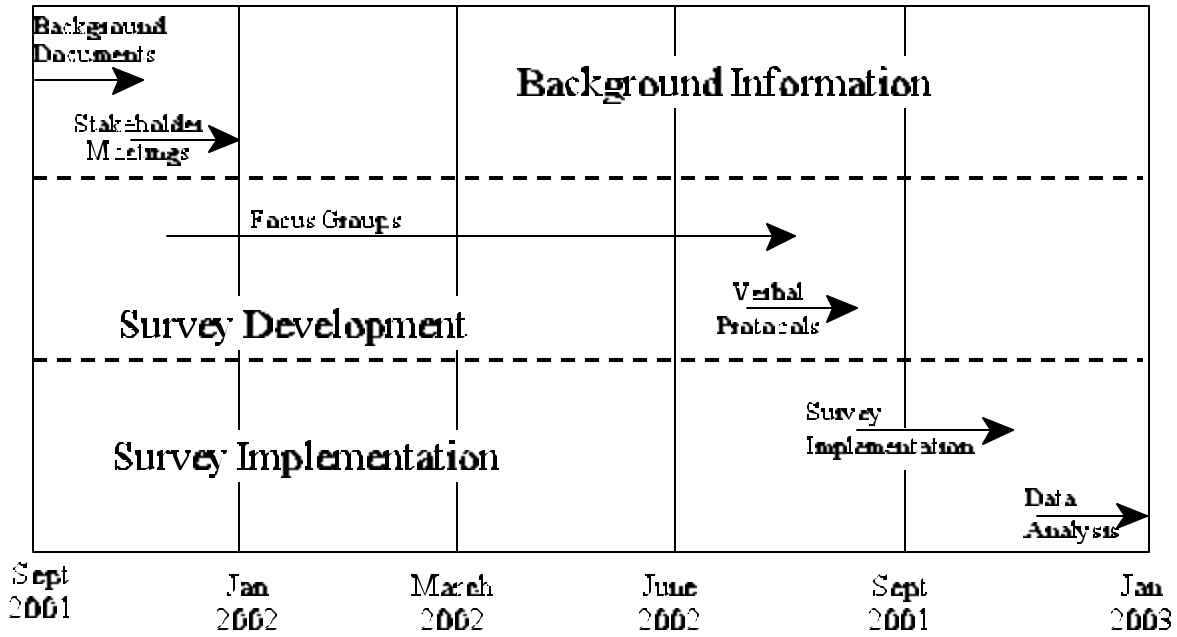
Tentative Project Timeline*



* Note timeline excludes analyses of specific policy options. These would be coordinated with managers and scheduled for completion of supporting science studies.

Budget*

Dates: 01-Sep-01
01-Jan-03

Personnel Costs

Senior Professionals	400 hours @	$150	$60,000
Junior Professionals	300 hours @	$75	$22,500
Research Associates	1000 hours @	$35	$35,000

$117,500

Supplies

Document Purchases	$500
Focus Group Materials	$3,500
Survey Printing and Distribution	$5,000
Telephone	$500

$9,500

Travel

Meetings with Key Personnel	$5,000
Focus Groups	$3,000
Survey Implementation	$2,500

$10,500

Total $137,500

* Budget includes all activities except for assessment of specific management activities

The Effect of Values and Cultural Models on Policy:

An Anthropological Approach to Environmental Policy in Tampa Bay

Prepared for
SAB/EPA Workshop:

"Understanding Public Values and Attitudes Related to Ecological Risk Management"

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Executive Summary

Policymakers and administrators in the Tampa Bay region have observed high levels of public support for policies to reduce human impact on the Bay. This support has helped to make possible government actions that restrict water-borne pollution, nutrient loadings, and other anthropogenic impacts on the Bay. Current studies of the Bay's water and ecosystems suggest that further improvements will require action to reduce the impact of the deposition of airborne materials into the bay, which will require different types of policies, affecting different sources. Whether and how public support will extend into these new policy areas is not yet known.

The proposed research takes the approach, demonstrated in Kempton, Boster, and Hartley (1996), Bunting-Howarth (2001), and Kempton, Rayner, Harris, and Marker (2001) that support or opposition to policies can be understood by eliciting the public's values and cultural models. The goal of this research is to understand the values and cultural models that Tampa Bay residents apply to the Bay and to policies to preserve the Bay. Specifically, we will conduct interviews to elicit the values that lead residents to place priority on protection of the Bay relative to other social or personal priorities. The interviews will also elicit cultural models that people use to explain why various types of human impact cause damage, how different elements of the Bay ecosystem interact, and how protection measures can affect the preceding. Finally, the interviews will explore what is now known about air deposition into the Bay and its impacts.

Specific Aims

This proposal seeks to better understand the nature of public support for environmental protection, and to incorporate public values and cultural models into environmental decision-making by agencies. This proposal will further develop research methods that specifically identify values and attitudes toward protection of natural resources at risk. With these findings and methods, the Environmental Protection Agency (EPA), along with other Federal agencies, will be able to comprehensively understand public support and identify potential roles for public input in developing environmental policy.

We propose to demonstrate the utility of our methods in pinpointing the values, beliefs, and attitudes used in defining public support or opposition for environmental protection measures. These general goals will be researched through the proposed project for specific environmental problems in a specific location, the Tampa Bay. Since its inception in 1991, the Tampa Bay National Estuary Program (TBNEP) has strived to protect the resources of Tampa Bay. In developing the Comprehensive Conservation and Management Plan (CCMP), the TBNEP stressed the need to incorporate public input into all facets of the program. The CCMP, however, failed to address public misinterpretation of specific issues, such as atmospheric deposition of nitrogen, and the public values, beliefs, and attitudes fundamental to their support of environmental policy.

With an understanding of citizen values and cultural models in this place, Federal, state, and local environmental legislation and policy will be better equipped to address the concerns of citizens and user groups, facilitating broad-based support for future initiatives. The major question addressed in our study

will be, “What are the values, beliefs, and attitudes used by the general public to support environmental protection of the Tampa Bay?”

Background and Significance

South Florida has experienced a steady increase in population since the beginning of the 20th century. Following the flow of people came development and urbanization with land use, flows of materials, runoff, air pollution, and other impacts altering natural systems. Communities had sprung up where wetlands once thrived and soon these natural landscapes were being altered to accommodate the influx of new residents (Rapport *et al.*, 1998). New estimates project the population of the Tampa Bay region to increase up to 17% by the year 2010 with 2.34 million people living within the vicinity of the Bay (TBNEP, 1996: p. 3). This will further strain the region’s remaining natural resources.

However, since the 1970’s there has been an increasing concern about the human impact upon the environment (Dunlap, 1991). In 1990, a poll indicated that 71% of the Florida population desired an increase in funding for environmental protection, ranking it 3rd in priority issues (SAFE, *2001*).

One of the first efforts to include public participation in environmental policy implementation in Florida took place in the Kissimmee River Basin. By the mid 1970’s environmental degradation was evident. Legislation was enacted and programs put in place in the 1980’s. Public debates and special symposia were held to inform and involve participants in the process of evaluating and improving existing regulatory protection measures. Rapport *et al.* (1998) relate, "The evolution of societal values and their integration with biophysical, political,

institutional, and socio-economic realities is stimulating citizens and Government agencies to re-evaluate a century of activities in the South Florida landscape." This was a local example in which, according to Rapport *et al.*, societal values emerged significantly enough where they had an impact on environmental policy, and facilitated policy implementation (1998).

Concurrently, environmental concern began to be seen in the Tampa Bay area through actions such as the initiation of the Tampa Bay National Estuary Program (TBNEP) and the development of the Comprehensive Conservation and Management Plan (CCMP). Throughout the CCMP for Tampa Bay, managers call for active participation of the public in all aspects of the management of Tampa Bay. They say that success of the plan relies on "sustaining broad-based citizen support for bay restoration and protection" (TBNEP, 1996: p. 54). Several programs were enacted to reach out to the public ranging from public newsletters and an active community advisory committee, to public focus groups (p. 250). However well-intended these activities were constructed to be, they failed to address crucial public values underlying environmental concern. For instance, it was acknowledged that the public was incorrectly identifying sources of bay pollution, yet little was done to address these misconceptions (p. 245-246).

Throughout environmental policy literature, evidence of public values regarding specific environmental policies, let alone atmospheric deposition of nitrogen, is scarce. Many authors comment on the importance of this type of information, yet few studies have been performed. Fiorino relates, "institutions for drawing the lay public's views into policy deliberations are rarely studied and only occasionally tested" (1990). Schultz and Zelezny believe that understanding

the "values and motives that underlie environmental concern and behavior is needed before we can move toward more effective environmental policies" (1999). Canter, Nelson, and Everett (1994) agree, stating, "what is lacking is a body of literature that specifically focuses upon factors influencing risk perception for the water environment" (referring to water quality concerns).

One of these factors is public environmental values. Little is known or understood on what the public considers important and why they feel this way. The lack of sufficient understanding of these values and the utility of such information necessitates their examination. Indeed, this information is becoming increasingly more important to many institutions.

A few Federal agencies have developed goals that concentrate on identifying and understanding target audiences, including the general public, affected by agency regulations. For example, the EPA stresses the need to identify environmental attitudes, beliefs, and values of the agency's targeted audience (EPA, 1997). The NEP emphasizes that decision makers must know who is affected and how they are affected as well as how the public values change in the quality of environmental resources (NEP, 2000). The Environmental Law Institute agrees, urging the National Oceanic and Atmospheric Administration (NOAA) to include these practices in future policy decisions (ELI, 2000). However, these goals have, so far, resulted in few studies, and fewer examples of policy made on their basis.

Identifying target users or publics and their respective values and perceptions is just the beginning of the process of incorporating these values into public policy. Decision makers must not only identify these concerns, but they

must apply them in their decision process. However, this does not always happen in practical decisions. Lofstedt suggests that many problems may be culturally structured and cannot be fixed by technological advances and must therefore be addressed by understanding underlying public perception (1995).

Kellert and Clark state that the "need to understand values associated with natural resources is often overlooked during the process of policy development" (1991, cited in Casagrande, 1996). These values should be incorporated into the early development of any policy program and are a vital foundation on which to build upon (EPA/SAB, 2000). By ignoring the needs of sub-populations, interest groups, and other portions of the general public, the benefits of policy implementation are not always felt by those that bear the cost (NEP, 2000). Understanding the needs of all stakeholders involved is key to "highlight[ing] the consequences that require most careful attention and the tradeoffs that matter most" (Gregory, 2000; Harwell, 1999). Incorporating the process of understanding public values, beliefs, and attitudes into the other practices Federal agencies use in developing public policy will allow for more relevant and appropriate policies applicable to the target audience.

Research Design and Methods

The TBNEP has conducted both a survey and a number of focus groups to gather information on public attitudes. In 1992, a survey was conducted addressing the general public and registered boaters who regularly use the bay. This survey aimed to identify and assess public perceptions and attitudes regarding the Tampa Bay ecosystem and the measures intended to protect it

(Kastancuk and Burton, 1992). This study indicated that in most cases, the opinions of boaters did not significantly differ from that of the general public. The differences that were observed, however, indicate that the cultural models used by the boating group were more accurate and in line with current scientific understanding than were responses from the general public. Following up on this study, focus groups were conducted in 1996.

The proposed work would go beyond the attitudes studied in this prior research and seek the underlying values and cultural models. We believe the best way to understand the values and attitudes associated with the protection of Tampa Bay against nitrogen deposition lies with semi-structured interviews. Using this method, an interview guide is constructed. This guide consists of a list of questions or topics that are to be covered in a particular order. The answers to the preceding questions lead into the latter questions. Answers thus build upon one another and develop a complete picture of what we are trying to study.

The semi-structured interviews should be conducted to study sectors of the public involved with the Tampa Bay ecosystem: the general public, non-governmental organizations (NGO's), and bay users, such as recreational boaters. Based on reviewer comments, we considered other bay users, such as commercial or recreational fishers. However, managers familiar with the local economy reported that most fishing takes place in the Gulf of Mexico, not in Tampa Bay (H. Greening, personal communication). No other coherent user group susceptible to sampling is known. However, the interview includes a question about "other uses of the Tampa Bay", and other user groups will be considered if this data reveals them.

Studying the general public gives us a sense of how voters will react to public information and policy decisions. NGO's represent specific environmental interests within the region. They are well educated regarding environmental issues, are very active in policy planning and decision-making, and often reach out to the general public to inform and build support for specific initiatives. Finally, the boating community is a specific user group highly affected by environmental policy decisions regarding Tampa Bay, who may themselves balance regulations restricting their recreational activities against the value of protecting the Bay. Although recreational users and environmental NGO's are not typical members of the public, they represent some of the public constituencies and they may also be valuable in more clearly articulating values and cultural models shared by the broader public. In a qualitative-based study, we propose eight interviews be conducted with the NGOs, eight with the boaters, and twenty with the general public.

These groups can be sampled as follows. To sample the general public, random sampling would be employed based on selection of addresses, possibly combined with convenience samples from public places. NGO's are based throughout the Tampa Bay area and can be contacted through their representative offices, ideally sampling a diversity of NGOs based on the advice of locally-knowledgeable individuals. The boating community can be sampled where they access the bay: at public boating ramps. In case boaters at ramps are too rushed for the interview, we would try other approaches such as approaching them while waiting in line to either launch or retrieve their boats, interviewing boaters at

local refueling or gas docks, and actually going out on the water and interviewing anchored boaters who might have the time to devote to assisting us in our study.

Tape-recorded interviews and notes would be analyzed for content to determine values and cultural models, as well as any additional attitudes or beliefs. The common values are then used to discuss what is important to the various groups studied regarding environmental protection of Tampa Bay. These methods are described in more detail in Kempton, Boster, and Hartley (1995).

In the preparation of this proposal, a pilot study was performed to determine if the methods described above could elicit commonly shared cultural models and also the values underlying attitudes and policy preferences. Several informants representing the general public were sampled at a mall in Tampa, and a representative from a local NGO was interviewed over the phone. No representatives from recreational boating interests were sampled. The pilot survey instrument used follows:

Interview Questions for EPA/SAB Workshop: Pilot Survey

RECORD ON PAPER:

Date
Time
Informant #

Introduction: Hi, I'm Doug Christel, a graduate student in Marine Policy at the University of Delaware. We are doing interviews to try to understand public values associated with the Tampa Bay. Could I ask for your opinion? Your identity will be kept entirely confidential [In fact, I'm not even writing down your name]. Since the questions require verbal answers, we will use a tape recorder. Is that all right? This interview will take about twenty minutes.

1. How long have you lived in the Tampa Bay area?

2. What have you heard about threats to the Tampa Bay, or changes in the Bay? [Prompt] [List]

3. What do you think is causing _____? (Fill in with threats and changes given above) [Prompt if needed] Why do you think that is happening? [Get cultural models, what causes what, etc.]

4. Are you concerned about _____? (Again, fill in with threats from 2) Why? [Prompt if needed to get basic values]

5. Have you heard about the steps being taken to protect the Tampa Bay? If yes: What have you heard about? [List]

6. Do you think those steps/measures would help the Bay? Why or why not? [Prompt as necessary to cover each step, program, or measure, and why they think it would work. This should get more on cultural models.]

7. Do you agree with these measures? Why or why not? [Prompt]

8. What other things should be done to protect the Bay?

Only if not covered above:

9. How do seagrasses play a role in Tampa Bay? What about nutrients?

10. Have you heard about any effects of substances in the air getting into the water in the Tampa Bay? What have you heard? Would you expect this to be a major problem for the Bay, a minor problem, or not a problem at all? Why?

11. Where did you get your information about all of the topics discussed previously?

12. What sources do you feel are the most trustworthy and reliable regarding those topics?

13. Do you, yourself, participate in any recreational activities on the Tampa Bay, or use it for any other forms of enjoyment?

14. Is your own employment dependent on the Tampa Bay? [Get occupation, if so.]

That's all of our questions. Do you have any additional comments?

END

The results of these pilot interviews demonstrate the range of understanding of environmental issues within the Tampa Bay community. For

anonymity, we will refer to participants in the study as informants #1, #2, and #3.

Informant #3 has lived in the Tampa Bay area since 1971. However, in her thirty years of residence, she says she has *not* witnessed *any* changes in the Bay's condition, water quality, or abundance of plant and wildlife. She said she has never really paid any attention to the Bay. What she has observed, however, is the planting of seagrasses all over the Bay. She thinks this is a good practice, but fails to indicate why. She states vehemently, "I want the Bay clean…that's all!" However, she is fervently opposed to any increase in vehicle emission regulations and does not wish to help pay for a cleaner environment. This informant illustrates a case of a person who may have environmental values, but who is not very knowledgeable and is not willing to make personal sacrifices in order to pay for environmental protection. (Further interviewing would be required to understand the reasons for this and whether it could be addressed, say, by better communications or by alternative policies.)

On the other end of the spectrum, Informant #2 knew more information regarding present environmental conditions in the Bay than was expected from members of the general public. This gentleman has lived in the area for 30 years and is significantly more aware of the present conditions of the Bay than Informant #3. He regularly takes walks along the Bay and enjoys simply being in the outdoors. Unlike Informant #3, however, he *has* observed many changes in the Bay. He states that seagrasses have come back, fish have returned, oysters are starting to settle once again, water quality is dramatically improving, and development seems to be slowing along the waterfront. He is very contented with

the degree of protection now enacted throughout the Bay and wishes it to continue. He believes that there is a dormant environmental sensitivity within the general public. He states that this sensitivity is mainly expressed when conditions have deteriorated beyond repair. Only after this has happened will environmental values and attitudes take over and become a driving force in environmental protection helping initiate protective measures.

As expected, our interview with a local NGO representative, Informant #1, produced an enormous amount of information regarding local environmental conditions. Many environmental threats were brought up along with a long list of changes in the Bay over the last 21 years he has resided in the area. These issues include: water quality, overfishing, nutrient loading, air quality issues (specifically NO_x, Sulfur, and O_2 emissions), and land development. He noted that many issues have been successfully addressed and are now improving greatly. Of the changes in the Bay witnessed by this informant, social changes seemed to stand out most. He has witnessed the development and establishment of a "broad, diverse environmental community." Citizens, scientists, and industry alike have worked together to help improve the conditions of the Bay. He states that efforts were neither political nor partisan: everyone participated, analyzing issues in a "holistic manner." He states, "It's a Bay problem" which doesn't stop at jurisdictional boundaries.

From the standpoint of Informant #1, we should protect the Tampa Bay for reasons Kempton, Boster, and Hartley describe as "biocentric," indicating the inherent rights/value of nature (1995: 87). Human activity and development of the watershed has gone on for too long and has limited the ability of the region to

access fresh water; a concern Informant #2 addressed as well. Informant #1 also states that the local community perceives that development poses a threat to wildlife and water availability. Informant #1 believes that there is very strong public support for environmental protection (to protect local wildlife and habitats), but he believes the public fails to know what it takes to protect these resources.

These three informants have illustrated the range of possible responses that could be gathered using the methods described above. Informant #3 had not witnessed any changes (positive or negative) in the Bay's condition since she's lived in the area. She stated that a clean bay is important to her, but did not offer any reasoning behind this statement. She wants more environmental protection, but at no extra cost to herself. Informant #2, on the other hand, reports observing many changes in the condition of the Bay -- the reemergence of fish, shellfish, and seagrasses to the area. He understands that habitats such as seagrasses support other organisms (shellfish) and values the Bay for what it can provide to organisms as well as to humans. He states, "I run along the Bay; it's important to me," suggesting "biocentric" and "anthropocentric" values respectively (Kempton, Boster, and Hartley, 1995: 87, 89). He states that developers are more concerned with property rights and development rather than ecological preservation, an example of a cultural model used to explain why others oppose environmental protection (Kempton, Boster, and Hartley, 1995: 54-55).

The effectiveness of these interview methods to bring out environmental values has been demonstrated in this simple pilot study. Elicited values include the intrinsic right/value of nature, the aesthetic value of nature, and utilitarian

values. However, we did not get enough information to be sure of what cultural models were held and how they were used to understand environmental threats and policy effectiveness. A more comprehensive study performed with more informants from all user groups will provide a more complete inventory of values, and would allows us to also identify cultural models citizens use to understand these issues.

Advantages over other methodologies

The semi-structured method of interviewing allows the researcher to direct the flow of information to specifically address particular concerns without limiting the response of the informant or excluding unanticipated but relevant information. A general survey instrument is constructed which allows for flexibility and adaptability in data gathering. Although allowing for considerable flexibility in eliciting responses, the researcher is still in control of progress of the interview and can redirect answers to reflect desired intentions of the research (Bernard, 1995: 210).

Researchers are able to build on the answers given by the informant to delve deeper into the reasoning behind such answers. Researchers can follow new leads and gather unexpected, but pertinent information. Therefore, a more comprehensive understanding of the underlying factors and motivations for beliefs and actions can therefore be elicited.

Semi-structured interviews conducted face-to-face offer other advantages as well. Researchers are able to clarify answers on the spot and get more detailed information than a mailed survey (Bernard, 1995: 258). The questions can be more direct, more specific, or more general depending on the knowledge of the informant. This adaptability maximizes the utility of the variety of informants' responses.

Although qualitative in nature, semi-structured interviews can be used in making policy decisions. In fact, the work by Kempton, Boster, and Hartley (1995) has been used by the World Wildlife Fund to set up focus groups to address the issue of global climate change. Also, former Secretary of the Interior Hodell has used this work in policy speeches regarding the Endangered Species Act.

Potential difficulties and limitations:

There are several potential difficulties involved with this type of research. In semi-structured interviews, it is often difficult to statistically distinguish results among groups. These interviews do not produce quantitative data. Instead, they elicit qualitative data. Informants are able to answer the questions as they wish without a standard set of answers as is sometimes used in a mailed survey. Hence, answers across informants are not strictly comparable. Without gathering equivalent answers among informant groups, groups cannot be compared with statistical significance.

The reason for proposing this method, despite the above-enumerated difficulties, is that semistructured interviews are the best way to elicit previously

undocumented values and cultural models. As noted in the literature review, neither are known nor addressed in the discussion of nutrient loadings in water or regarding estuaries. Once the proposed research establishes the basic values and cultural models, subsequent surveys could be constructed in order to provide more quantitative information, if there were a need for it.

A potential extension:

One reviewer suggested an expansion of the project to include a larger sample and more quantitative methods. The reviewers acknowledged that the qualitative data, from semi-structured interviews as described above, would be valuable in itself. But one suggested that the results from those interviews could subsequently be used for a second set of structured interviews. We describe that potential extension to the proposed research here, and separate it in the budget.

After the semistructured interviews are analyzed and we have established some of the cultural models and values of residents and resource users, a survey would be conducted (if this second phase were to be done). The survey would test for the frequency of components of the above (using standard statistical analysis), and whether they are shared or differ sharply among groups (using consensus analysis). Examples of the former include Kempton and Falk (2000), and of the latter Kempton, Boster and Hartley (1995:189-212). This would be a mailed survey of a random sample of residents; if the semistructured interviews suggest differences among groups, it would also include samples of recreational boaters and/or environmental group members.

Background and Related Research

The lack of literature specific to atmospheric deposition of nitrogen has previously been addressed. However, there have been many articles describing the practicality, utility, and importance of understanding public values concerning environmental issues. These articles not only describe how values may direct public opinion, but they also describe how values can affect policy decisions.

Before we examine public environmental values, we must first define how this term is used in the literature. According to Kempton, Boster, and Hartley, values are defined as "guiding principles of what is moral, desirable, or just" (1995: 12). To Rokeach (1973), values can be considered to be "general internal standards that transcend specific situations." He continues, stating that values may "guide behavior independently of cost/benefit calculations" (Cited in Karp, 1996). The ability of values to transcend the addition of new information and changing environmental conditions is of great use to anthropologists as it provides for a firm foundation on which these new conditions can be addressed, analyzed, and interpreted (Stern *et al.*, 1995).

Values combine with beliefs to form attitudes. Attitudes are then incorporated into mental models, cultural models, and myths. Myths incorporate "general perceptions with which participants identify" and allow for the interpretation of current situations (Peterson and Horton, 1995). A mental model is characterized as "a simplified representation of the world that allows one to interpret observations, generate novel inferences, and solve problems" (Kempton, Boster, and Hartley, 1995: 10). Cultural models are models that are "shared within a culture or social group" (Kempton, Boster, and Hartley, 1995: 10).

"They are used to understand global environmental problems, they reinforce and justify environmental values, and they are the basis for reasoning that leads to preferences for some environmental policies over others" (Kempton, Boster, and Hartley, 1995: 39). For more general background on cultural models, including diverse examples outside the environmental field, see Holland and Quinn (1987).

Individuals may share similar attitudes towards environmental issues for vastly differing reasons (Schultz, 2000). In many cases, various cultural models may be used to address one particular environmental concern. Different user groups often use different models. Therefore, it is important to not only identify and understand the values of your target audience, but to identify which individual model these user groups are using to analyze specific environmental issues. Kempton, Boster, and Hartley caution that inappropriate cultural models used by the general public may lead to misdirected concern and ineffective policy decisions (1995: 66,77,85); this corresponds to earlier findings that inappropriate mental models can interfere with classroom learning (McCloskey, 1983).

Kempton, Boster, and Hartley have documented the use of inappropriate cultural models applied to environmental issues. A clear example of this practice is demonstrated in the misuse of the pollution model to address the problem of green house gases. Their pollution model consists of four key elements:

1. Pollution consists of artificial chemicals
2. These chemicals are toxic to humans and may not produce adverse effects until a later time
3. The main sources of these chemicals are predominately industrial and automotive
4. Pollution can be reduced by using filtering equipment

(Kempton, Boster, and Hartley, 1995: 64-65).

What Kempton, Boster, and Hartley found was that a large majority of the American public considered greenhouse gases to be pollution, and thus applied the above elements of the pollution cultural model to this problem. However, the primary gases contributing to the greenhouse effect, CO_2 and CFCs, are nontoxic. Similarly, greenhouse gases are not particulates, so they cannot be filtered using any existing technology. In fact, these filtering mechanisms suggested by the public actually reduce power plant efficiency causing more CO_2 to be released exacerbating the problem (Kempton, Boster, and Hartley, 1995: 65).

In order for policies to accurately address the priorities of the public, decision-makers must first understand cultural models being used to interpret current environmental conditions. Kempton and Falk relate, "Cultural models become problematic when old models are applied to new phenomena they do not match" (2000). Thus, inappropriate cultural models applied to environmental issues lead to policy misconceptions and improper public concern. For a complete description of how old models are currently being applied to new environmental conditions, refer to Kempton and Falk's discussion of *Pfiesteria* (2000).

Laypeople, or the general public, incorporate new environmental information into their existing cultural models and rely on these models to interpret environmental policy initiatives (Kempton, Boster, and Hartley: 123, 126, 2). Values used in conjunction with cultural models determine what is important to a user group and, in turn, direct policy preference (Kempton, Boster, and Hartley, 1995: 159). Non-environmental values and beliefs can also be incorporated into understanding how user groups perceive environmental

problems. Paolisso points out, "We cannot, for example, understand commercial watermen's [commercial fishermen's] responses to pending blue crab fishery regulations without understanding the cultural model of nature, which includes religious and spiritual beliefs and values about nature" (personal communication). The watermen value faith and trust in God; this influences how they look at nature. Similar spiritual connotations are noted in Kempton, Boster, and Hartley as religious values towards nature (1995).

Anthropological interviewing can reveal environmental and non-environmental values used by the general public. Paolisso states, "A key role for anthropology is to investigate how stakeholder groups use different or complementary sets of cultural beliefs and values to construct models of environment and pollution" (1999). In their work, Paolisso and Maloney utilize semi-structured interviews, among other techniques, to gather values, beliefs, and cultural models used by Maryland farmers regarding *Pfiesteria* (2000). This methodology can reveal and harness the power of the public concern (Lofstedt, 1995). The power of public concern can support or oppose particular environmental policies.

Decision-makers and regulatory agencies often use the power of public concern to support environmental protection measures. However, public concern over an issue is not the only factor that affects public policy support. As addressed in Bunting-Howarth (2001), cultural models of the government and science can affect policy preferences. These cultural models of and attitudes towards government and science in defining environmental problems and associated solutions may be altered during public collaborative decision-making

processes (Bunting-Howarth, 2001). Thus, public participation processes can foster shared cultural models, definitions of environmental problems and policy preferences (Bunting-Howarth, 2001). By knowing values and cultural models the general public uses to address environmental problems and policies, not only can agencies and governmental bodies gain an understanding of what is important to the population, but they can use this information to construct environmental policies the general public will accept, ratify, and be willing to work together to achieve environmental goals.

Public participation is essential to insure that the environmental objectives of the people coincide with those of the decision-makers and represent the "fundamental values of society" (Harwell, 1999; CBEP, 2001). Public participation is the means by which "public concerns, needs, and values are incorporated into governmental decision-making…with the overall goal of better decisions supported by the public" (Maloff, 2000).

Rapport *et al.* relate "the identification of community values necessarily entails a participatory process in which all community interests are represented" (1998). Through this process, user groups identify aspects of the natural resource they find most important. In this manner, values are derived from the community. Working together, user groups, the general public, and local government officials were able to assemble together similar values and incorporate them into unifying objectives for the Kissimmee River Basin to combat and correct what they felt were inappropriate development practices.

Similarly, Toth and Aumen (1994) stress the need for acknowledging social, cultural, and economic issues and concerns into the planning process.

They also encourage maintaining good communication throughout all user groups, the general public, and government officials involved in the policy development process (cited in Rapport *et al.*, 1998). Keeping alive communication and cooperation between groups is essential in the policy process. It is important to understanding the positions held by the various user groups involved with any public policy program such as the TBNEP. Understanding the reasoning behind policy preference, including evaluating the needs and interests of various user groups affected by policy decisions could, as Smith and Jepson (1993) state, "enhance the probability of cooperation."

To Peterson and Horton (1995), "it seems appropriate for the public to participate in policy decisions regarding the environment within which they live." Public participation in the process of implementing environmental policy takes on many forms: surveys, focus groups, public opinion polls, and educational programs to name just a few. Public outreach and educational programs have been used by many environmental agencies and organizations to better inform the general public on current environmental issues. However, not all have proven successful. Loftstedt illustrates this point with an outreach program implemented in the United Kingdom (1995). The UK Department of the Environment (DoE) produced an expensive media campaign regarding global warming. However, Loftstedt states that the DoE failed to address the fact that the general public often confused global warming with ozone depletion (1995). This is remarkably similar to confusion found by Kempton, Boster, and Hartley in their study in the United States (1995). Subsequently, the program failed to increase environmental awareness and was a waste of time and money. This example further illustrates

the importance of understanding the degree of environmental awareness possessed by the general public as well as understanding the cultural models and underlying values used by the public to address environmental issues.

Understanding how the general public perceives the environment and the measures put into place to safeguard natural resources is just the beginning. Continued interaction with the general public is needed throughout the length of the program. "A well-crafted outreach program that enlists and involves diverse interests as partners in bay restoration and protection is a hallmark of all successful National Estuary Programs" (TBNEP, 1996: p. 245). Public outreach could include periodically assessing the priorities of citizens regarding environmental protection. In this manner, priorities are constantly updated to assure more efficient resource protection with the greatest amount of public support. By involving the general public in all levels of environmental protection, a sense of community pride develops and environmental awareness is subsequently enhanced.

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Semi-Structured Interview Budget

A. SALARIES & WAGES				AGENCY	GRANTEE
1. Senior Personnel				Year 01	
a. Prin. Investigators				$6,176	$0
b. Associates				$0	$0
Subtotal				$6,176	$0
2. Other Personnel					
a. Professionals				$0	$0
b. Graduate Students				$24,000	$0
c. Secretarial/Technical				$0	$0
Total Salaries & Wages				$30,176	$0
B. FRINGE BENEFITS				$1698	$0
TOTAL SALARIES, WAGES, & BENEFITS				$31,847	$0
C. PERMANENT EQUIPMENT				$0	$0
D. EXPENDABLE SUPPLIES & EQUIPMENT				$1,000	$0
E. TRAVEL					
1. Domestic				$7,600	$0
2. International				$0	$0
Total Travel				$7,600	$0
F. PUBLICATION & DOCUMENTATION				$0	$0
OTHER COSTS					
1. Ship Charges				$0	$0
2. Tuition				$0	$27,608
TOTAL DIRECT COSTS (A through F)				$40,474	$27,608
INDIRECT COSTS					
Year 01: Agency	51.0%	of	$40,474	$20,642	
Grantee: Unit	51.0%	of	$0		$0
State	51.0%	of	$0		$0
Other	51.0%	of	$0		$0
TOTAL INDIRECT COSTS				$20,642	$0
TOTAL COSTS				$61,116	$27,608

Additional Quantitative Interviews and Analysis

A. SALARIES & WAGES	AGENCY	GRANTEE
1. Senior Personnel	Year 02	
a. Prin. Investigators	$6,407	$0
b. Associates	$0	$0
Subtotal	$6,407	$0
2. Other Personnel		
a. Professionals	$0	$0
b. Graduate Students	$12,475	$0
c. Secretarial/Technical	$0	$0
Total Salaries & Wages	$18,882	$0
B. FRINGE BENEFITS	$1,762	$0
TOTAL SALARIES, WAGES, & BENEFITS	$20,664	$0
C. PERMANENT EQUIPMENT	$0	$0
D. EXPENDABLE SUPPLIES & EQUIPMENT	$0	$0
E. TRAVEL		
1. Domestic	$0	$0
2. International	$0	$0
Total Travel	$0	$0
F. PUBLICATION & DOCUMENTATION	$0	$0
G. OTHER COSTS (ICR Applied)		
1. Computer Costs	$0	$0
2. Consultants	$13,500	$0
Subtotal	$13,500	$0
OTHER COSTS		
1. Ship Charges	$0	$0
2. Tuition	$0	$14,370
TOTAL DIRECT COSTS (A through F)	$34,144	$14,370
INDIRECT COSTS		
Year 01: Agency 51.0% of $34,144	$17,413	
Grantee: Unit 51.0% of $0		$0
State 51.0% of $0		$0
Other 51.0% of $0		$0
TOTAL INDIRECT COSTS	$17,413	$0
TOTAL COSTS	$51,557	$14,370

Review of Proposal by James Falk

From cover email:

Willett: See attached for a few comments on your proposal. Overall, I thought it was clearly written and could provide some very interesting and useful information for the Tampa Bay Estuary Program. Jim

Attached specific comments:

Overall, I thought the proposal was well-written and it clearly describes an approach to determining values of Tampa Bay residents. The comments discussed below focus more on your methodology than any other aspect of the proposal.

1. One of the statements that you make is that there is a lack of public input on atmospheric deposition of nitrogen to the Tampa Bay system. I assumed that this implies you were going to concentrate on obtaining this information during your interviews, however only question 10 in the structured interview list of questions focused on this aspect of air-borne substances.

2. Is there a need to acquire demographic information of any kind during interviewing?

3. When you mention "the general public", isn't it more a "select sample of the general public". I don't think you expect your targeted groups for interviews to represent <u>all</u> the general public of the Tampa Bay area.

4. Can you indicate how many interviews you expect to get from each of the 3 target groups? I think that this is especially important since you don't want to over-represent the views of NGO's since they usually (as you noted from pilot test) provide a great deal of information that may not represent view of the average Tampa Bay resident.

5. Are there other user groups that use the bay (for recreation or commercial uses) that might be important to target for interviews other than recreational boaters?

6. When you talk about interviewing boaters at boat ramps, 20 minutes is a long time to hold up a boater who is pulling his boat out of the water. Take it from someone who has talked to boaters and had a number of students talk to them over the years. It is difficult to keep them for that long of time, especially considering the format of your questions. I have found they like short, simple questions to answer, not one's that require a great deal of thought. If you indeed want boater input, I would suggest you re-think where the boater interviews would take place.

7. I thought question #13 was poorly-worded. Maybe something like:

   Do you, yourself, use the Tampa Bay for any forms of recreation or other enjoyments? or

   Do you, yourself, participate in any recreational activities on the Tampa Bay, or use it for any other forms of enjoyment?

8. I thought you did a good job discussing your difficulties and limitations, and I am wondering since you can't distinguish statistical differences among different groups surveyed is it necessary to identify the 3 distinct groups you plan to target for interviews?

9. I think you make a very valid point that this proposed research may be a first step to identify basic values and cultural models and that more quantitative research may be a second step necessary to fully understand the attitudes and opinions of select interest groups. Do you plan to review some of the earlier survey results (I think you mentioned the estuary program had conducted earlier public opinion surveys) to help frame some of your interview questions?

10. Are there any success stories you can share as examples of how information acquired from semi-structured interviews have been useful in policy decision-making?

Response to Falk review:

Five comments were accepted as stated and addressed through changes in the text of the proposal: 4, 5, 6, 9, and 10. Those requiring responses are below.

Comment #1: We are not studying public input. Our study proposes to examine publicly held values, attitudes, and cultural models to *enhance* public input.

Comment #2: No, there is no need to acquire demographic information as we do not have a use for that information in this study.

Comment #3: If responses from specific target groups (general public, boaters, NGOs) within the text could be inferred to represent the views of the "general public" at large, clarification of labeling was used to correct any possible misinterpretations.

Comment #7: We selected the second suggestion for changing the wording of the question: "Do you, yourself, participate in any recreational activities on the Tampa Bay, or use it for any other forms of enjoyment?"

Comment #8: We will demonstrate differences observed among groups if it seems sensible in the context of the discussion. However, we will qualify that by stating that the differences observed may not be statistically significant.

Comment #9: We did consider earlier survey results described in the Tampa Bay Public Opinion Poll. However, we conclude that this source will not change the questions used in our interviews. We did reexamine the implications of certain questions used in the opinion poll. We address these implications in the text.

Review of Proposal by Michael Paolisso:

April 23, 2001

From: Michael Paolisso
Department of Anthropology
University of Maryland

Dear Douglas and Willett:

I've reviewed your proposal with great interest, since the topic of cultural models and environmental values is central to my own work on the Chesapeake Bay. I think you have the makings of a fine research project. I would like to make only the following few comments or observations, which you may find useful as you finalize the proposal.

1. For the non-anthropological audience, I think slightly more description of cultural models by way of examples would be useful. Citing the Kempton et al. 1995 is certainly our most developed work to date. However, we now have other examples, such as Willett and Falk's cultura models or Pfiesteria, our own work on cultural models of Pfiesteria, environmental and pollution (the most recent issue of Human Organization has our summary of some of this other cultural model work. What about Bunting-Howarth's use of cultural models in her dissertation. I would also include a little of the Holland and Quinn, Bradd Shore, D'Andrade citations, etc. I think the reader/reviewer/non-anthropologist would benefit from knowing that cultural models are being used by various researchers for various topics. The point being to substantiate their research and policy usefulness.

2. In reading your proposal, I was struck by the good but brief discussion of the link between environmental values and cultural models, a topic we are currently grappling with as well. While the proposal does a good job of describing environmental values, there is less description, even hypothetical, where these environmental values fit within our cultural models. Implicit in this statement is our own orientation that cultural models include non-environmental beliefs and values. We cannot, for example, understand commercial watermen's responses to pending blue crab fishery regulations without understanding the cultural model of nature, which includes religious and spiritual beliefs and values about Nature. Watermen value faith and trust in each other and God, and that influences how they look at nature and the part of nature that is environment (which may be that part that is affected by human actions). So, when we seek to model their views on regulating blue crabs, we need

to go well beyond environment in our cultural models and include a range of values. Environmental values are a part of our cultural models. How they articulate with environmental knowledge and attitudes in these models is, I think, a critical area that you could explore with your Tampa Bay research.

3. As Willett has heard me say before, while I strongly agree and support the semi-structured emphasis of your research, it seems that without some quantitative analysis, an opportunity is lost. This quantitative could be very qualitative in nature. Why not do some free listing and pile sorting, for example, or a few agreement questions similar to those used in Kempton et al. 1995? This need not take much time. It would give you some numbers for comparison across groups, let you present some results graphically (multidimensional scaling), and allow you to test for consensus. Maybe your respondents would be willing to fill out a mailed questionnaire after your interview? Wouldn't take much time, and you have already established rapport, and probably improved the likelihood of getting a response. Ten to 15 agreement statements based on your analysis of the semi-structured data would be very informative.

4. I was not clear on your sample size per group, and whether you will be using the pilot questionnaire again, or some other instrument for the semi-structured.

5. What about the political ecology factors? We are finding the need to contextualize our cultural model research within a broader (and quite amorphous) political ecology framework. In addition to differences in cultural models, there are differences in political and economic interests. In our recent Human Organization article we touch a few political ecology concerns to our cultural model research.

   Again, I think you have the makings of some important research, and your proposal has much of what you need to successfully undertake your work. Good luck, and keep me informed of your progress.

Michael

Response to Paolisso review:

Three comments were addressed throughout the text of the proposal: 1, 2, and 3. Responses to others are below.

Comment #4: The sample size per group was addressed in Dr. Falk's comments and subsequently changed in the Research Design and Methods section of the

text. We believe that this instrument worked well for the pilot study. Our intentions are to only modify this instrument as recommended by the reviewers including Dr. Falk's Comment #7.

Comment #5: We will include descriptions of cultural models concerning political and economic interests if provided by respondents. Otherwise, we will not include an analysis of political ecology factors.