Setting Targets for Restoration of the Hudson-Raritan Estuary

Report of an Interdisciplinary Workshop

Mark Bain, Dennis Suszkowski, Jim Lodge, & Lijie Xu
Cornell University and The Hudson River Foundation

HRF
cfe
Cornell Center for the Environment

January 2006

ABSTRACT

Bain M., D. Suszkowski, J. Lodge, and L. Xu. 2006. Setting Targets for Restoration of the Hudson-Raritan Estuary: Report of an Interdisciplinary Workshop. Hudson River Foundation, New York, New York.

Federal, regional, and city agencies are collaborating on the Hudson-Raritan Estuary Environmental Restoration Program. An interdisciplinary workshop with scientific experts and agency representatives was conducted (25-26 October 2005) to develop candidate objectives to guide restoration planning. The workshop was structured to generate target ecosystem characteristics (TECs) to serve as program objectives. TECs are the broadest planning element defined in measurable terms and the precise ecosystem conditions to be promoted in restoration projects. The workshop succeeded in developing many (23) and varied ecosystem targets. An analysis of the TEC definitions and justifications indicated workshop participants used two different conceptual approaches: physicochemical and biological properties of the ecosystem. These approaches can be considered to reflect "place based" and "species conservation" thinking. About two thirds of the TECs were local in scale and one third oriented to large spatial and ecosystem properties. The targets were mostly practical for implementation and useful in restoration planning. The workshop did not produce ecosystem targets defined in quantitative terms. Much more intensive and rigorous work by a small group of scientists will be needed to quantify TECs and select a smaller number for implementation. The most important contribution made by the workshop was the input of an interdisciplinary set of scientists defining restoration aims and ideas. That achievement produced a foundation to support evaluation, refinement, and justification of a final set of ecosystem targets to guide the formulation of a comprehensive restoration plan.

TABLE OF CONTENTS

Introduction

The natural features of the New York and New Jersey (NY/NJ) harbor, including its bottom topography, shorelines and adjacent wetlands, have been dramatically altered to accommodate the demands of the largest urban center in the United States. More than 80% of the harbor's tidal wetlands have been filled, nearshore waters have been converted to urban developments, a vast network of channels and berthing areas has been excavated, and countless tons of harmful pollutants have been discharged into the estuary. While many plant and animal species have adapted and even flourished within this altered environment, others have suffered declines and near obliteration, like the oyster. Several efforts are now underway to restore and rehabilitate habitats that have been altered or destroyed. Designing a future harbor and estuary ecosystem is a challenge that demands creative application of scientific knowledge and management experience. In 1992 the US National Research Council defined environmental restoration as returning an ecosystem to its former, undisturbed state. True ecosystem restoration is not possible in an intense human-dominated setting like the NY/NJ harbor. Acknowledging that raises a major conceptual impediment to restoration planning: what is the aim of efforts to make changes in the estuary?

The NY/NJ Harbor Estuary Program, the Port Authority of New York and New Jersey, Baykeeper and other organizations are working to acquire, restore, and protect wetlands. In addition, the Corps of Engineers was authorized to undertake a comprehensive restoration program in 1999: the Hudson-Raritan Estuary Environmental Restoration Program or HRE Program. This effort is now recognized as the primary mechanism for restoration of the harbor and estuary system. The program is also recognized as capable of conducting comprehensive ecosystem restoration on a par with nationally prominent efforts such as the Florida Everglades, the Missouri and upper Mississippi Rivers, and the CALFED Bay-Delta Program. However, three obstacles have limited the scope and rate of progress of the HRE Program and other large US restoration efforts. The first is a "master plan" with a strong science basis, clear objectives, and performance measures. Second, the integration of interdisciplinary thinking in program development so that a broad range of actions and benefits are considered. Finally, independent expert review of program plans and objectives. In the HRE Program more attention has been called for on restoration opportunities in all parts of the estuary, extending beyond the current focus of degraded wetlands, shorelines and isolated basins.

As a first step in resolving program impediments and building support, the Hudson River Foundation and the Center for the Environment at Cornell University initiated a project to engage a broad range of coastal scientist and engineers to develop candidate objectives for a comprehensive plan. This effort began with an interdisciplinary workshop (25-26 October 2005, New York, NY) involving 14 regional and national scientific experts, along with government agency representatives who are currently engaged in restoration activities in the estuary. The primary purpose was to develop candidate target ecosystem characteristics to guide HRE Program planning, and secondarily to identify measures of program progress. In short, the October 2005 workshop was an idea generating or "brainstorming" session with a wide range of participants. This report documents our approach, plans, results, and findings of the workshop titled *Setting Targets for Restoration of the Hudson-Raritan Estuary*.

Target Ecosystem Characteristics

We define the concept and term *Target Ecosystem Characteristics* (TECs) to serve as program objectives that can be measured and related to ecosystem health. Specificity in defining TECs is needed to effectively assess current conditions, evaluate alternatives, and report program progress. This definition allows TECs to be used as precise and quantifiable attributes of the desired future state of the HRE, and the attributes to be developed through restoration activities. This term and concept are similar to *essential ecosystem components* used in planning the Florida Everglades restoration. For a program oriented to habitat restoration, we expect our TECs will focus on biological, chemical, and physical properties of the estuary using precise measures of quantity and quality with specification of time and space scales.

We decided TECs should be quantified ecosystem attributes and that they numerically express quantity using specified units of measure. Descriptors should include spatial scope (e. g., geographic boundaries) and a time frame. Thus, a TEC should have the form:

The quantity of an ecosystem attribute in a region for a stated duration.

The elements of a target definition would then be:

[amount] [attribute] [area] [period]

Precise terminology facilitates impact assessment because a common language supports a common frame of reference. A standard format or grammar for communicating environmental planning information would facilitate comparisons among management cases, progress through time, and decision-maker understanding.

Once TECs are developed, performance measures for each ecosystem target can be defined and monitoring needs can be specified. For instance, a possible TEC might address shallow habitat that supports a particular species. A performance measure would then be developed that defines the desired attributes of the habitat in spatial units (hectares) with criteria meeting the habitat requirements of species (e.g., specific depth, substrate type, etc.), the proper setting (e.g. all shallow water in a certain part of the tidal prism), and defined time frame (e.g., cannot be violated for more than 20 days in a row). Progress would be documented as the change in habitat amount toward the target amount.

The workshop tested the initial feasibility of TECs as a basis for restoration planning. Below we report how our standards of ecosystem objective setting fared in a short workshop exercise.

Workshop Plan

The workshop was arranged as two half-day sessions starting at 1:00 pm on 25 October and ending at noon the following day. The location was the offices of the Hudson River Foundation at 17 Battery Place, New York, New York. The participants (Directory of Participants in Appendix A) were about equally composed of scientific experts (14) and management and policy professionals (13). The organizers, hosts, agency consultants, and one corresponding participant raised the total participants to 33. The workshop was preceded by a series of one-hour conference calls to define and discuss workshop expectations for all participants. Input from these calls was used to develop the final workshop agenda. After some introduction and orientation on 25 October, the agenda (BOX 1) was largely composed of small group work arranged by major habitat class: riparian, littoral, pelagic, and benthic. Breaks and whole group discussion of progress were interspersed among group work sessions. The original agenda dedicated one group work session to identifying and describing performance measures, but this was replaced with a third round of group work on ecosystem targets. Small group members stayed together throughout the workshop sessions. Final material from the work groups was entered on a standard TEC documentation form (BOX 2). A draft version of this report was provided to all participants for comment and then revised.

BOX 1

APPROXIMATE SCHEDULE OF ACTIVITIES AT THE WORKSHOP

TUESDAY 25th

Noon: Lunch

1:00 Welcome and the management need: Dennis Suzkowski

1:10 Purpose and approach: Mark Bain

1:20 Logistics and breakout group plan: Jim Lodge

1:30 Breakout groups for target generation

A. Land-water interface (riparian zone)
B. Shallow illuminated waters (littoral zone)
C. Water column in deep areas (pelagic zone)
D. Bottom layer in deep areas (benthic zone)

2:45 Break

3:00 Whole group discussion of progress

4:00 Breakout groups round II

5:15 Whole group discussion of next day

5:45 Break and open discussion

6:00 Dinner provided on site

....

WEDNESDAY 26th

8:00a Breakfast

8:30 Discussion of workshop progress

8:45 Breakout groups round III on targets

10:15 Break

10:30 Whole group session on targets

11:00 Wrap up, assessment of effort by all, discussion of next steps

12:00 Lunch and departure

BOX 2

TARGET ECOSYSTEM CHARACTERISTIC WORKSHEET

Developed by: ____

Short Title:

Definition [amount] [attribute] [area] [period]:

Justification:

Technical Merit –

Policy and Management Relevance –

Practicality –

Possible measures of performance:

Key information and data sources:

Pre-Workshop Conference Calls

One-hour conference calls were held in advance of the workshop so each participant could hear and question the workshop approach and expectations. Three major issues were repeatedly raised in these calls: knowing more about the management context, the proper basis of justification for ecosystem targets, and the scope of the restoration program. In response, a limited access web site was developed for workshop participants that housed a large volume (45 megabytes) of background material. Included were maps of the HRE Program area and reference papers on the approach and practices of coastal ecosystem restoration. The agenda for the workshop was adjusted, and the opening comments of the workshop addressed some of the common concerns.

Workshop participants were persistent that information be provided on past and current efforts to restore environmental quality to the New York harbor. They requested agency program goals and mission, and why restoration efforts were started and maintained in the system. The motivation was to understand the context for target setting in the workshop. The web site material provided abundant information to satisfy this participant need.

A second area of participant interest was defining the basis for ecosystem targets and restoration aims. Participants recommended and debated different perspectives on restoration benefits. Some commonly raised concepts were ecosystem services, natural reference conditions, and publicly valued ecosystem components. The relative merits of ecological function (e.g., food web support) were contrasted with ecosystem products such as fish harvest and bird observations. Overall, all the perspectives were considered as having merit and potential value in developing ecosystem target characteristics. The final major topic was the scale and scope to be used in considering the ecosystem and its enhancement. While there is a set geographic boundary for the system in the HRE Program, participants debated the perspective of whole ecosystem change and benefit versus locally focused actions and results. Also, the concept of a hierarchy of effects, processes, and change were discussed.

The advance conference calls appeared to establish the workshop approach and resolve broad concerns about the direction of the effort. In general the approach was considered acceptable and followed in the workshop proceedings. While the broad issues raised in the calls received some further discussion at the workshop, the time spent on overarching issues was limited and did not interfere with the development of material in the workshop.

Workshop Results

Material Generated

Working groups produced 23 ideas (Table 1) documented on completed or partially completed survey forms (Appendix B) for target ecosystem characteristics. Our initial review of this material categorized them by topic and spatial scale to provide an overview. While TECs focused on habitat (i.e., physicochemical conditions) were most common (6 of 23 TECs), a similar number (4) of TECs were aimed at land-water margins, hydraulic properties, and groups of biota. These four sets of ideas indicated contrasting thinking by the working groups because the TECs spanned places for the biota, water movement, transition areas, and the biota itself.

Other areas of TEC development were recreation (3) and water quality (2). Apparently the importance of public use of the harbor waters was determined to be critical and worthy of direct program attention. Elements of public interest were also found on other TEC survey forms (Appendix B). Somewhat surprising was that few TECs primarily addressing water quality. This may reflect the improved water quality conditions of the HRE ecosystem that previously degraded and limited the biota. Like public appeal, consideration of good water quality was seen on other TEC forms as a requirement of habitats, an indirect aim of some TECs (e.g., hydraulics), and an associated condition for biotic support. Thus water quality was prominent in restoration thinking by the workshop participants.

The spatial perspective of the working groups varied from a local orientation to system wide as reported on the TEC forms. Local scale thinking dominated (16 of 23 TECs) but system oriented TECs were important (7). System scale targets for restoration were invoked for all topics except recreation. Thus recreation may be the only ecosystem target that was visualized largely in terms of local actions by workshop participants. It appears that workshop participants were specifying system scale objectives as one level of restoration planning while also posing many local actions that would enhance the HRE ecosystem.

Table 1. Target ecosystem characteristics developed in the workshop with descriptions and classifications by topic and scale.

Target ecosystem characteristic	Description of attribute or restoration actions	Topic	Scale
Benthic nursery habitats	Increase the quantity and quality of benthic habitats supporting fish and invertebrate nursery functions	Habitat	System
Key bird habitats	Improve nesting sites, foraging areas, resting areas, and water dependent bird species	Habitat	Local
Natural tributary geomorphology	Improve and restore natural channel conditions for aquatic life support	Habitat	Local
Shallow subtidal habitats	Enhance mosaic of shallow water habitats for benthic animals, fish, and birds	Habitat	Local
Shallow shoreline waters	Incease self-maintaining, shallow, illuminated, oxygenated waters along walled shorelines	Habitat	Local
Productive pelagic waters for young fish rearing	Promote stable water masses with high plankton concentrations supporting larval and young fish production	Habitat	Local
Wetland areas	Add riparian forests, maritime forests, freshwater wetlands, and salt marshes	Margins	System
Shore zone management	Implement and strengthen nature reserves, monitoring and adaptive management, conservation institutions, scientific investigation, citizen involvement	Margins	System
Stable shoreline areas	Enhance and increase shoreline and riparian buffers	Margins	Local
Natural shoreline areas	Remove human material to allow natural vegetation and shoreline landform	Margins	Local
Quality enclosed and confined waters	Enhance quality of poorly flushed, enclosed waters with local pollutant sources and sediment contamination	Hydraulics	Local
Productive borrow pits	Increase productivity, oxygen levels, and water circulation	Hydraulics	Local

Table 1, Continued

Free flowing channels	Remove obstacles to water flow by structures and debris in constrained channels	Hydraulics	Local
Hydrologic connectivity	Remove or modify constrained channels and connections between open waters	Hydraulics	Local
Anadramous fish populations	Provide habitats and improve populations of sturgeon, river herring, shad, striped bass, and other migratory species	Biota	System
Controlled invasive species	Manage invasive species to promote native species and ecosystem function	Biota	System
High benthic productivity supporting fish and shellfish	Increase biomass production of benthic organisms (infauna, epifauna, megafauna)	Biota	System
Functioning oyster reefs	Develop oyster reefs large enough for locally detectable water quality effects	Biota	Local
Accessible shoreline wetlands	Provide public access to water front areas and wetlands for nature exposure	Recreation	Local
Recreational boating zones	Create small craft and non-motorized boat access points, information kiosks, and public waterfront areas	Recreation	Local
Water contact recreation	Reduce human health threats due to contaminated sediments, disease-causing microorganisms, toxic materials, pathogens, and other health risks	Recreation	Local
Contained storm water runoff	Reduce sources of untreated storm water and sewer system outflows	Water quality	System
Minimal hypoxic waters	Improve water quality with local actions such as water circulation, untreated discharges, and local pollutant sources	Water quality	Local

Technical Justifications Used

Enhancing support for the biota and species of the harbor was the dominant (12 of 23 TECs) justification for ecosystem protection and restoration targets. The species invoked were diverse and ranged from familiar fish and birds to assemblages of invertebrates. In addition, the enhancement of biodiversity and protected (endangered and threatened) species was used for justifying some (3, 2 respectively) targets. Often (6) habitat was the aim of targets with support roles such as nursery sites for species or groups of organisms.

A second justification approach was often (6) aimed at quality of habitats and land-water margins. TECs linked to habitat quantity and diversity often referenced to natural conditions. Quantities of certain habitat classes were themselves used as targets: wetland area, length of clean and open shorelines, and length and width of riparian buffers. Finally, quality of some human made habitats were identified: borrow pits, cul-de-sac waters, and enclosed basins.

Necessary environmental conditions for a quality harbor ecosystem often (7) specified that water quality should meet established criteria. Pathogens, toxic sediments, and nutrient pollutants were included in this way. Hydraulic properties and other environmental factors were also used in justifying TECs. For example, waterway morphology should promote water movements, and certain areas should be protected to mitigate natural disasters, reduce human health threats, and increase survival of benthos. Economic benefits were included with regard to targets addressing human activities such as swimming and boating, public access, and water oriented recreation such as fishing.

Policy Considerations Invoked

Working group statements addressing policy and management relevance generally involved laws, regulations, permits, and public benefits. Legislation focused on endangered and threatened species, and the control of invasive species were invoked for some ecosystem targets. Regulatory obligations were commonly (6) raised in statements related to issues such as wetland conservation, shoreline development, and land use zoning. Often water quality (5) was listed with specification of standards for dissolved oxygen, PAH, nutrients, toxic contaminants, TMDL (total maximum daily load) requirements, and sewage discharge from combined sewer overflows. Potential public benefits and satisfaction produced by fish harvests, bird observations, and species existence (e.g., oysters) were common policy considerations. Additional social benefits addressed public education and environmental justice.

Issues of Feasibility

We judge that most of the TECs were developed with practical considerations prominent in the discussions because most appear very feasible to implement. In general, TECs aimed at plants appeared more specific and feasible than TECs for animals. Limited specification of details were sometimes related to impediments such as the lack of basic biological knowledge on forage conditions, fish use of habitats, and substrate characteristics. However, sampling methods for familiar taxa like fishes seemed very feasible.

TECs that focused on habitat appear practical to implement although substantial investment of time and effort would be needed. Construction work will often be required to recover habitats although some TECs were aimed at available opportunities. Opportunistic habitat restorations include barriers or enclosures to protect existing shallow waters or raising low marsh areas to high marsh. TECs associated with land-water margins may require high resolution modeling support to establish accurate inundation patterns. While current models of harbor water flow and species physiological requirements could be used directly, some TECs will require additional hydrodynamic modeling to judge feasibility. Advance assessment of pathogens and sediment contaminants will often be needed for judging feasibility in specific TEC actions on water quality. Long-term viability of restoration actions was considered for some TECs, for example, vulnerability to sea level rise and shoreline stability. Comments on cost effectiveness appeared with some TECs to justify practicality, and the use of easily obtained materials (e.g., dredged materials from other projects) was included as example feasibility considerations. However, some TECs, such as controlling invasive species, will have high long-term costs due to continuing site management needs.

Open Discussions and Workshop Comments

Unstructured discussion and comment on the workshop took place during three open sessions (>2 hours total) during the workshop and through voluntary letters of comment (4, a page or more) after the event. Major themes were the format and operation of the workshop, conceptual scope of work, quantification of targets, structure of the restoration program, and follow up actions.

The structured nature of the workshop and the use of specific forms (Box 2) for participant input were seen by some as restrictive. The aim of identifying ecosystem targets could be considered as an effort to define restoration projects. There was not broad opposition to the format and operation of the workshop, but constraints were perceived and noted with examples. Some harbor enhancement strategies that were not considered in the workshop were: estuarine protected areas, addressing episodic events like hypoxia, promoting harbor scale changes such as water pathways, and accommodating small scale issues like anoxic benthic boundary waters. Considerations beyond targets limited the evaluation of tradeoffs among targets, objectives, and potential projects. Participant expertise in some disciplines was also discussed as limited; no one covered amphibians for example.

The fundamental basis of restoration was not seen as well addressed under the workshop structure. Major issues of restoration goals and strategy were not covered. Examples of issues left behind were: key social and cultural dimensions, nature of ecosystem goods and services to be provided, optimization of productivity and biodiversity, creating a self-sustaining system, and historic conditions as a restoration goal. Participants were not asked to judge some key questions about the ecosystem: is the harbor clean, are species viable, are populations adequate, and are the nature needs of people being met? There was a wide range of opinions on these broad restoration issues and it appears a strong workshop plan worked to limit the scope of debate.

The capability to state target ecosystem characteristics in precise and numeric terms was debated, and almost none of the resulting TECs fully met the format requested on the TEC worksheet. Participants were clearly split on the feasibility and timing of quantitative target setting. One view was that adequate information, understanding, and research was not available thus making quantitative targets impractical. In addition, participants promoting this view sometimes added that the extent and mix of habitats in the harbor should to be determined from information on requirements for a healthy ecosystem. The opposing viewpoint emphasized that complete knowledge is not needed to specify restoration targets, and that waiting for a comfortable level of information will take many years. The concern of these participants seemed to be a potential loss of restoration opportunities that exist now.

Considerable debate took place on the overall organization of the restoration effort. While this was not a topic for the workshop, time was allowed to comment on the institutional structure of the restoration program. Some participants felt that there was little accountability and leadership for ecosystem restoration, the capacity to use workshop products was poor, and a highly visible group needs to administer the program. Other participants commented that an overall institutional structure was in place, and the workshop was an early step in forming a comprehensive plan. Only modest effort was made to educate participants on the institutional setting or history of the restoration effort. Also, participants were not selected to be those with good knowledge of the HRE program and its work.

A final important but concise issue raised was what follows the workshop. Suggestions were made to do a technical publication using the results, issue a news release, release a conclusions statement, initiate similar public and stakeholder events, and complete a report on the workshop.

Conclusions

Our ecosystem target setting workshop was developed to address two needs of the HRE Program: a master plan and interdisciplinary scientific input. The workshop constituted an early task for restoration planning by generating a broad and varied range of candidate targets. Ecosystem restoration planning is expected to have a strong science basis, clear objectives, and quantifiable performance measures. Our workshop was structured in response to these three expectations because the key participants were scientists, ecosystem target characteristics serve as clear program objectives, and performance measures were on the workshop agenda. Workshop participants included a wide range of disciplinary specialists with diverse scientific and management experience so that a broad range of targets would be considered and specified.

The workshop succeeded in developing many (23) and varied ecosystem targets. Open workshop discussions invoked some broad planning philosophies and goals such as ecosystem services, natural reference standards, ecosystem functioning, and public interests. However, due to the tight structuring of activity, the workshop yielded specific ecosystem targets that are mostly practical for implementation and useful in restoration planning. Thus we aimed for, and achieved, scientist generated restoration objectives. A limitation was that these targets were framed without a strong unifying theme for a future harbor ecosystem. The value of our objective-level work can be judged through time. At present we have no basis for predicting the relative merits of restoration via a series loosely related enhancement actions versus restoration driven by an ecosystem scale imperative.

The workshop did not produce ecosystem targets defined in quantitative terms and a set of associated performance measures. We believe this was partly due to time constraints but some participants felt it is unrealistic to pose quantitative definitions in a group brainstorming assignment. We can conclude that much more intensive and rigorous work will be needed to quantify TECs. A small team working at a pace that allows compilation and synthesis of technical and biological information could achieve this goal. Although our TEC format specifications were not met, the critical large set of ideas was obtained.

Results of the workshop concerning the TEC topics and spatial scales are informative of the thinking used by a mixed group of scientists and HRE managers. Creating and protecting habitat in the HRE system was the most common rationale of the working groups. However, a substantial number of TECs focused on macrohabitat transitions (land-water margins), water dynamics (hydraulic properties) and biotic groups. Pooled together these alternatives to habitat were twice as common. Public interest focused TEC development also occurred, but at a relatively low level. The realized range of TEC topics demonstrated that a mixed group of specialists could produce a wide array of ideas for restoration planning. We also noted that related TECs emerged from different working groups in a manner unrelated to our initial topic assignments.

The nature of the 23 TECs indicated the workshop participants applied two different perspectives in forming ideas and definitions: physicochemical and biological properties of the ecosystem. We might roughly consider these as “place based” thinking versus “species conservation” thinking. Often TECs of both types came from the same working group showing that the workshop participants could apply their knowledge broadly. A similar pattern of contrasting perspectives was seen in the spatial scale of the 23 TECs. About two thirds of the TECs were local in scale and one third oriented to large spatial and system properties. Again, it seems the participants were often able to contribute at both scales because working groups produced TECs of both types, and each type covered almost all topics considered.

Justifications for TECs were dominated by enhancing species or taxonomic groups. Broader concepts of biodiversity conservation and endangered species protection were sometimes invoked. Likewise, environmental improvements from changes in physicochemical and hydraulic properties were also used. This range of ideas and concepts for justifying TECs again show a diversity of considerations and perspectives emerging from the workshop.

The policy and management relevance of TECs were most often linked to laws, regulations, and government priorities. Public benefits and interests were considered, and two TECs focused on public use (boating, shoreline access) further supporting attention on social values. While restoration planning emphasizes science, public input is important and will need to be addressed in later restoration planning. This was not attempted at the workshop because the application of scientific thinking to TEC development seemed very ambitious for the allowable time.

Workshop participants produced a long list of target ecosystem characteristics for use in formulating an HRE restoration plan. The 23 TECs are the product of an interdisciplinary science and management group. For direct use in restoration planning, seven additional tasks will need to be completed. First, the workshop list of TECs will need to be reduced to a manageable number for use. Second, public interests, stakeholder reactions, and agency priorities should be incorporated in the TEC selection process. Once reduced in number, final TECs will need to be restated (#3) in specific quantitative terms, and supported by detailed justification and parameter documentation (#4). Fifth, measures of performance or progress will need to be developed for each TEC. During this work, an independent technical review and responsive revision will need to be done (#6) prior to final task - reporting.

The most important contribution made by the workshop on *Setting Targets for Restoration of the Hudson-Raritan Estuary* is the generation of a wide array of ideas from a scientific group. That achievement produced a foundation to support evaluation, refinement, and justification of a final set of ecosystem targets to guide the formulation of a comprehensive HRE restoration plan.

APPENDIX A

Directory of
Workshop Participants

Directory of Workshop Participants and Contributors

Organizers & Hosts:

Mark B. Bain
Center for the Environment
Cornell University
200 Rice Hall
Ithaca, NY 14853-5601

Dennis Suszkowski
Science Director
Hudson River Foundation
17 Battery Place, Suite 915
New York, NY 10004

James Lodge
Hudson River Foundation
17 Battery Place, Suite 915
New York, NY 10004

Clay Hiles, Executive Director
Hudson River Foundation
17 Battery Place, Suite 915
New York, NY 10004

Science Experts:

Bernd Blossey
Associate Professor
Department of Natural Resources
Cornell University
Ithaca, NY 14853

Alan Blumberg
Professor and Director
Department of Civil & Environmental Engineering
Stevens Institute of Technology
Hoboken, NJ 07030

Daniel B. Botkin
Professor Emeritus
Ecology, Evolution & Marine Biology
University of California
Building 235, 3311 Life Sciences
Santa Barbara, CA 93106
[Current Mailing Address:
245 8th Avenue
New York, NY 10011]

Alexander Brash
National Parks & Conservation Assn.
731 Lexington Avenue, 6th Floor
New York, NY 10022

Robert J. Diaz
Virginia Institute of Marine Science
1208 Greate Road
Gloucester Point, VA 23062

Frank Nitsche
Dohherty Associate Research Scientist
Lamont-Doherty Earth Observatory
Columbia University
61 Rt. 9W, Oceanography 109B
Palisades, NY 10964-8100

Kevin Farley, Professor
Civil & Environmental Engineering Department
Manhattan College
4513 Manhattan College Parkway
Riverdale, NY 10471

Frank Steimle
Sandy Hook Laboratory
National Marine Fisheries Service
74 Magruder Road
Highlands, NJ 07732

Jeffrey S. Levinton, Professor
Department of Ecology & Evolution
SUNY at Stony Brook
Stony Brook, NY 11794-5245

John Waldman
Biology Department
Queens College, CUNY
65-30 Kissena Boulevard
Flushing, NY 11367-1597

Paul Mankiewicz, Director
Gaia Institute
440 City Island Avenue
City Island, NY 10464

Pace Wilber
Landscape Character & Restoration
NOAA Coastal Services Center
2234 South Hobson Avenue
Charleston, SC 29405-2413

John M. Nestler, Director
Environmental Model & System Wide-Assessment Center
US Army Engineer Research & Development Center
3909 Hall Ferry Road
Vicksburg, MS 39180-6199

David J. Yozzo
Senior Program Manager
Barry A. Vittor & Associates
1973 Ulster Avenue
Lake Katrine, NY 12449

Management & Policy:

Edward A. Ames
Chairman of the Board
Hudson River Foundation
17 Battery Place, Suite 915
New York, NY 10004

Dan Miller
Hudson River Estuary Program
Bard College, Field Station
Annandale, NY 12504

Charles deQuillfeldt
NYC DEC
205 N. Belle Mead Road
East Setauket, NY 11733

Robert Nyman
NY/NJ HEP
US EPA
290 Broadway, 24th Floor
New York, NY 10007-1866

Tom Hodson
U.S. Army Corps of Engineers
26 Federal Plaza
New York, NY 10278-0090

Paul Sabalis
U.S. Army Corps of Engineers
26 Federal Plaza
New York, NY 10278-0090

Leonard Houston, Chief
Environmental Analysis Branch
US Army Corps of Engineers
New York District
26 Federal Plaza
New York, NY 10278

Rosalie Siegel
Port Authority of NY/NJ
225 Park Ave. South,12th floor
New York, NY 10003

William Matuszeski
Board of Directors
Hudson River Foundation
17 Battery Place, Suite 915
New York, NY 10004

William Slezak
Biologist
Navigation Branch
US Army Corps of Engineers
26 Federal Plaza, 19th Floor
New York, NY 10278

Chris J. Villari
NYC DEP
36-05 Horace Harding Expressway
4th Floor
Corona, NY 11368

Bob Will
U.S. Army Corps of Engineers
26 Federal Plaza
New York, NY 10278-0090

Chris Zeppie
Port Authority of NY/NJ
225 Park Ave. South,12th floor
New York, NY 10003

Agency Consultants:

Ray Hinkle
URS
201 Willowbrook Boulevard
Wayne, NJ 07470

Jennifer Curran
HDRLMS
One Blue Hill Plaza, 12th Floor
Pearl River, NY 10965-8509

Corresponding Participant:

Joan G. Ehrenfeld, Professor
Department of Ecology, Evolution & Natural History
Rutgers University
14 College Farm Road
Cook College
New Brunswick, NJ 08901

APPENDIX B

Completed Survey Forms for Documenting Target Ecosystem Characteristics

1. Benthic nursery habitats

Developed by: Group D   Benthic Zone

Short Title Benthic Nursery Habitat

Definition: The variety, quantity, and quality of benthic habitat to support a variety of fish and invertebrate nursery functions (cover, trophic support). This includes a mosaic of shell fish beds, sandy bottom, soft and hard mud bottom, rocky bottom, and man-made structures.

Justification:

Technical Merit
- Nursery habitat is critical for sustaining populations of recreationally and commercially important species. A variety of different habitat types are essential for long-term sustainability.

Policy and Management Relevance –
- Fisheries

Practicality -
- Substrate classification is practical with acoustic methods. Biomass quantification will be more challenging due to vulnerability of habitat to sampling techniques. The target proportion and extent of different habitat types needs to be determined based on manageable list of target species.

Measures
- Measure habitat associations of target juvenile fish/invertebrates to identify most utilized physical/chemical environments. Quantitative measures of aerial extent of habitat types.

Information and Date Sources
- Benthic substrate mapping for part of the estuary is underway. Literature needs to be mined for larval/juvenile habitat associations.

Assumptions, Unknowns, Problems Posed
- Optimal ratio of substrate type for high recruitment success of target species is unknown.
- More information on relation between substrate/environment and target species might be necessary.

2. Key Bird Species

Developed by: Riparian Zone – Land Water Interface - Group A

Short Title: Improving Estuarine Bird's Habitat

Definition: Improving the nesting sites, foraging areas, and resting areas for various assemblages of estuarine dependent bird species in NY Harbor (i.e., harbor herons, colonial seabirds – terns, plovers, salt marsh species – harriers, seaside sparrows).

- Islands/colony sites for herons
- Islands/colony sites for terns, piping plovers
- Expanded marsh areas for foraging
    - High marsh areas for harriers, short-eared owls, m sparrows, etc..

Justification

Technical Merit –

- Helping endangered/threatened species
- Improving fish habitats – where herons do well fish do well

Policy and Management Relevance -

- Charismatic megafauna
- Recreation opportunities – bird watching

Practicality –

- Use of sediments
- Trade-offs of shallow water areas, islands, sediment issues, public opinion
- Lack of knowledge of where species forage
- Difficulties of restoring high marsh over low marsh

Measures

Information and Date Sources

- Harbor Heron Reports
- Colonial Seabird Groups (Manomet work http://www.manomet.org/WHSRN/)

Assumptions, Unknowns, Problems Posed

3. Natural Tributary Geomorphology

Developed by: Riparian Zone – Land Water Interface - Group A

Short Title: Restoration and long-term management of natural geomorphology of NY Harbor tributaries.

Definition: Long-term management of the natural conditions and geomorphology of the tributaries.

Justification

Technical Merit -

- Natural geomorphology of streams is one of the primary characteristics, and is essential to production, biodiversity, and all aquatic life.

Policy and Management Relevance -

- Emphasis on Expense Budget implications versus just Capital budget.
- Land use zoning.
- Need for long-term monitoring.

Practicality -

- Construction practical,
- Opportunities limited.

Measures

- O2, chemical measures
- Biodiversity indices
- Depth and sinuosity characteristics.

Information and Date Sources

- Lots

Assumptions, Unknowns, Problems Posed

4. Shallow Subtidal Habitats

Developed by: Littoral Zone – Shallow Illuminated Waters - Group B

Short Title

Restoration and Increase of Scale and Productivity of shallow subtidal habitats

Definition

1. Restore and enhance the overall mosaic of original habitat types.
2. Restoration of major biological shallow subtidal habits including:
   (1) hard surfaces on docks and (double) bulkheads increasing surface area for hard bottom organisms like mussels, barnacles and other food for fishes;
   (2) oyster reefs;
   (3) clam beds;
   (4) sandy low-sloping bottom refuges for fish;
   (5) shallow water benthos with dominance by healthy bioturbated sediment dominated by deep-burrowing benthos;
   (6) sea grass plus scallops;
   (7) Terrapin and Horseshoe Crab feeding grounds and subtidal access to intertidal; and
   (8) shore bird feeding waters coupled with shore nesting refugia.

3. Using practical engineered and biologically sensitive solutions to restoration such as building of protected shallow water habitats, sloping bottoms, reef/seagrass and structured shorelines to encourage sediment deposition and clam growth.
4. Designing at scales of habitat restoration and enhancement that ensure success in terms of creating suitable habitat, sustainability of populations such as focal areas for oyster larval spread and growth, and restored ecosystem services such as enhanced nutrient removal, water column filtration, reduction of hypoxia and provision of prey organisms for higher trophic level species consumed by humans, protection of shoreline by biologically enhanced structures. Define appropriate velocity gradients, salinity gradients, depths and flow patterns in water bodies that preserve and avoid flushing of larvae, to locate clusters of sites for restoration.

Justification

Technical Merit -
1. Attempt to reproduce the diversity of habitats to enhance the resilience of the overall shallow system. As one sub-habitat declines, others may be increasing, thus maintaining ecosystem functions such as filter feeding, juvenile refugia, and overall structure of the habitat mosaic. Diversity also involves more complete exploitation of resources such as different sizes of planktonic microorganisms.

2. Engineered restoration will enhance but also will accelerate habitat re-growth and will also improve protection of the shoreline by nearshore biologically dominated habitats (e.g., oyster reefs,). An important merit of this approach is that habitats can be selected on the basis of standard criteria of water velocity, past occurrence of organisms and habitats.

3. Success of the scale approach develops from
   (a) the strategic location of focal points of restoration;
   (b) an understanding of the scale of spatial factors tuned to biological traits of individual species (such as adult population density, larval dispersal distance and currents to create a sustaining population);
   (c) knowing the total shoreline length required to maintain connectivity between populations and guarantee that some local populations will survive in a bad year.

Policy and Management Relevance -

1. Addresses CCMP goal of restoring oysters.
2. Integrating enhancement of shallow water biological habitats with human use of the shoreline and protection of shoreline property.
3. Provision of fish habitat diversity and essential fish habitat.
4. Beneficial use of dredged materials.

Practicality -

1. Structures involved can be built with Standard engineering and materials.
2. Materials such as rocks and sand, are now available.- Cost effectiveness
3. Opportunities for renovation of failing bulkheads and other shoreline structures present themselves continuously.
4. Standard water flow and physiological limitation models and studies can be used to locate sites to start restoration and create nuclei of habitats from which populations can spread naturally.

Regulatory agencies

Measures

Oyster restoration as a model: oyster density, body size, growth rate, associated fauna, reef architecture, oyster recruitment and larval availability, oyster survival, disease.

Information and Date Sources

NYS DEC habitat map under the supervision of E. Blair.

Assumptions, Unknowns, Problems Posed

5. Shallow Shoreline Habitats

Developed by: Pelagic Zone – Water Column in Deep Areas - Group C

Short Title: Shallow water habitat along open bulk-headed shoreline.

Definition: Create varied size units of shallow water within maximum penetration of photic zone, semi-enclosed or wave protected, adjacent to shoreline, self maintaining, maintains adequate oxygen.

Justification

Technical Merit

- Absence of this original habitat type in much of the system; encourage more natural fish community and improve fish nursery areas.

Policy and Management Relevance -

- Would provide for higher aquatic diversity thus contributes to biodiversity. Protected areas could also serve as small craft boating sites.

Practicality -

- Can be accomplished with feasible engineering measures in some locations. The construction on barriers or enclosures is possible.

Measures

- Soften or create shorelines in front of bulkheads; build barriers or wave attenuators on river side to create embayments of slacker water.
- Numbers created
- Could aim for 20 in 20 years.

Information and Date Sources

Assumptions, Unknowns, Problems Posed

6. Productive pelagic waters for young fish rearing

Developed by: Pelagic Zone – Water Column in Deep Areas - Group C

Short Title: Nursery water mass

Definition: One persistent highly productive plankton water masses in each non-channel system zone

Justification:

Technical Merit

- Enhanced larval and juvenile fish survival and growth associated with zooplankton forage assumed to be linked to phytoplankton densities

Policy and Management Relevance -

- While some planktivorous fishes are highly abundant in open harbor waters, there are planktivorous feeding life stages of other fish now in reduced abundances (e.g., American Shad, Alewide, Blueback Herring)

Practicality -

- Unknown; need hydrodynamic modeling to consider feasibility

Measures

Information and Date Sources

Assumptions, Unknowns, Problems Posed

Possible a compensating mechanism for upriver productivity problems

7. Wetland areas

Developed by: Riparian Zone – Land Water Interface - Group A

Short Title: Increase overall wetland areas: Forests, freshwater, salt marsh.

Definition: Maintaining and increasing wetlands throughout area. Including specifically riparian forest, maritime forest, freshwater wetlands, and salt marshes.

Justification

Technical Merit -

- Habitat for many species
- Preserving biodiversity, Increase habitat for native species, Increase Fish habitat, increase Bird Habitat
- Improve recreational opportunities
- Maintaining and increasing area for absorbing storm water
- Increase fish production

Policy and Management Relevance -

- No net loss of wetlands – law
- Increase in area needed to increase native species' populations

Practicality -

- Highly practical
- Low marsh much easier to restore than high marsh

Measures

- Area of vegetation type
- Species diversity indices

Information and Date Sources

Assumptions, Unknowns, Problems Posed

Invasive species

8. Shore zone management

Developed by: Riparian Zone – Land Water Interface - Group A

Short Title: General recommendations:

- Sea-level rise and climate change
- Nature Preserve set-aside
- Monitoring and adaptive management
- Need for an appropriate institutional structure for success
- Independent, objective, scientific panel.
- Citizen Involvement

Information and Date Sources

- Examine Upper Mississippi Plan

Everglades, etc…

9. Stable shoreline areas

Developed by: Riparian Zone – Land Water Interface - Group A

Short Title: Adequate Shoreline Buffer

Definition: Enhance shoreline protection through enhanced buffers.

Justification:

Technical Merit -

- Protect shoreline edge, decrease siltation, absorb storm waters, protect against flooding.
- Protection of riparian zone, well known to be important to naturally functioning of estuary.
- Protect area from future effects from sea-level rise, increased hurricanes, and other storms.

Policy and Management Relevance -

- Current regulations permit development close to shoreline, regulations should bring NYC in alignment with State regulations.
- Regulations should promote native vegetation all along shorelines.

Practicality -

- With sea level rise, this may require continual monitoring.
- Very practical, just legal wrangling.

Measures

- Width of buffer zones.

Information and Date Sources

- Assumptions, Unknowns, Problems Posed

10. Natural shoreline areas

Developed by: Riparian Zone – Land Water Interface - Group A

Short Title: Shoreline Debris

Definition: Removal of the shoreline debris that impedes that natural vegetation, and brings estuary back to natural formation. Removes dumped "rip rap", deposited floatable debris, and other wrack.

Justification

- Restore shoreline vegetation
- Increase species' habitat
- Aesthetics

Technical Merit -

Policy and Management Relevance -

Practicality -

- Change DEC view/law
- Very

Measures:

- Percent reduction of area covered by junk/debris

Information and Date Sources

- JB Baykeeper
- Am. Littoral Soc.
- NYC Audubon

Assumptions, Unknowns, Problems Posed

11. Quality enclosed and confined waters

Developed by: Pelagic Zone – Water Column in Deep Areas - Group C

Short Title: Cul-de-sac habitats:

Definition: Protected (usually bulk-headed) and poorly flushed enclosed and typically narrow waters, often with local pollutant sources and sediment contamination. 1 project site a year per zone when possible due to limited options in some zones.

Justification:

Technical Merit -

- Increase productive shallow water habitat; eliminate poor water quality in bulk-headed areas with limited flushing.

Policy and Management Relevance -

- Minimize local CSO impacts at a publicly detectable scale

Practicality

- Minor re-engineering can enhance enclosed waters. Much initial survey information is now available.

Measures

- Dredge sills; remove bulkheads and soften edges; construct marshes at shallow ends; feed freshwater storm runoff to heads of canals; encourage or plant filter-feeding shellfish such as oysters and mussels.

Information and Data Sources

- Bottom profile, sediment assessment

Assumptions, Unknowns, Problems Posed

Project rate of 1 per year was selected to allow steady gradual progress to afford learning by doing experience on this type of habitat.

12. Productive borrow pits

Developed by: Pelagic Zone – Water Column in Deep Areas - Group C

Short Title: Borrow pits

Definition: Enhance borrow pits to be high productivity, oxygenated, well mixed benthic habitats in Jamaica Bay or other lower harbor sites

Justification:

Technical Merit -

- Problems clear

Policy and Management Relevance -

- High quality borrow pits provide clear benefits for fish habitat.

Practicality -

- These can be filled with coarse dredged material available from other projects.

Measures

Information and Date Sources

- There are about six opportunities in Jamaica Bay.

Assumptions, Unknowns, Problems Posed

Some borrow pits are productive and others are not. Likely due to O2 and this needs to be surveyed and understood.

13. Free flowing channels

Developed by: Pelagic Zone – Water Column in Deep Areas - Group C

Short Title: Enhance current flows I

Definition:
Remove all idle structures adding friction to tidal currents in constrained channels: Arthur Kill, Kill van Kull., and possibly other channels. Quantity per year: 3 1-mile reaches per year.

Justification:

Technical Merit -

- Hydrologic changes due to channel friction can be modeled for precise benefits
- Policy and Management Relevance -

Practicality -

- May not be feasible to realize benefits at implementation levels using idle structures.

Measures

Information and Date Sources

Assumptions, Unknowns, Problems Posed

14. Hydrologic connectivity

Developed by: Pelagic Zone – Water Column in Deep Areas - Group C

Short Title: Enhance current flows II

Definition: Eliminate hydrologic connections (culvert, channels, etc.) that constrain flows among littoral and shore area waters and open waters. Rate should be a steady rate of 3 projects per year dispersed across the system.

Justification:

Technical Merit -

Enhanced water circulation will likely improve water quality at the local scale.

Policy and Management Relevance -

Can have significant local benefits

Practicality -

Easy to achieve with basic site information on channel and culvert dimensions

Measures

Information and Date Sources

Assumptions, Unknowns, Problems Posed

15. Anadromous fish populations

Developed by: Riparian Zone – Land Water Interface - Group A

Short Title: Anadromous Fish

Definition: Fish species such as sturgeon, river herring, shad, striped bass.

Justification:

Technical Merit -

- They were here.

Policy and Management Relevance -

- It supports existing legislation.
- Dam removal, river passage issues.
- Stream reconstruction for O2, depth, siltation issues.

Practicality -

- very

Measures

- Fish population in each river

Information and Date Sources

- Rahway work
- Bronx River work

Assumptions, Unknowns, Problems Posed

- Problems: Invasive species: crabs, tunicates, phragmites

16. Controlled invasive species

Developed by: Riparian Zone – Land Water Interface - Group A

Short Title: Management of Invasive Species

Definition: Manage invasive species in order to promote native species biodiversity and natural functionality of ecosystems.

Justification:

Technical Merit -

Improving biodiversity

Policy and Management Relevance -

Practicality -

- Practical but expensive.
- More practical for plants than animals.

Measures

- Exotic species dominance in an area (plants by coverage, animals by #).

Information and Date Sources

- Assumptions, Unknowns, Problems Posed

17. High benthic productivity supporting fish and shellfish

Developed by: Group D Benthic Zone

Short Title: Benthic productivity that supports fisheries (fish/crab communities)

Definition: The benthos (infauna, epifauna, megafauna) are important in providing food to fisheries species, the level of secondary production is a key ecosystem characteristic that is a barometer of ecosystem 'health'. It provides an estimate of the energy flowing through the ecosystem (for example; gC/m2/yr).

Justification:

Technical Merit -

- Benthos provide an important ecosystem service to fishes that eat benthos, the level of secondary production is also a measure of the value of the bottom to support fishes. The level of secondary production is also an estimate of the 'health' of the ecosystem. Production is not a static measure and provides a means of estimating trophic transfer form primary producers to secondary producers to tertiary consumers.

Policy and Management Relevance -

- Production estimation encompasses three levels of relevance: 1 - Fisheries are support by public policy and easily understood characteristic of an ecosystem. 2 – Contaminant issues: It is also expected that fisheries production is clean and uncontaminated, and suitable for human consumption. Potential for toxic transfer through the food web can also be assessed via body burden. 3 – Water/sediment quality issues: Areas of low secondary productivity typically have sediment loading/quality or water quality (for example; low dissolved oxygen, high PAH concentrations) and would point to problem areas within the system.

Practicality –

- Feasibility of measuring secondary production: methods vary from easy to hard. Information is needed on fish utilization and substrate characteristics. Reliability of estimates are directly related to the effort expended. Reliable estimates of energy flow are not simple to obtain and require a sound understanding of the problem to be addressed and an appropriate sampling design.

Measures:

- Many indirect (e.g., secondary production models, such as Tambioloa and Downing (1999/2000), Brey (1990)) methods, several direct methods (e.g., biomass by sieve class (Edgar 1990). Methods reviewed and compared by Wilber and Clarke (Estuaries 1996). Need population and biomass statistics on benthos. Fish data (e.g., fishery independent monitoring data) to provide context to production estimates would also be needed (i.e., are the benthos producing enough to sustain the fish?, examples from Georges Bank, Matagorda Bay (TX), Europe (Möller et al. 198X). Toxicity testing done throughout the Harbor (all substrates and areas, not just dredged areas) to ensure production is reasonably contaminant free to avoid human health problems. DO concentrations in bottom waters (<1 m off bottom) monitored during periods of high temperature and water column stratification to help interpret production estimates.

Information and Date Sources:

- Large literature base on importance of benthos to fish/crabs, estuarine secondary production, and energy flow models. This literature base needs close examination and assessment to determine applicability to HRE. After this assessment, the level of production within Hudson system could be compared over time and to other systems.

Assumptions, Unknowns, Problems Posed:

- Fish are important, fish eat benthos, we want to eat clean fish.

18. Functioning oyster reefs

Developed by: Pelagic Zone – Water Column in Deep Areas - Group C

Short Title: Oyster reefs

Definition: Restored oyster reefs to the extent that they would have a locally detectable water quality improvement.

Justification:

Technical Merit -

- Keystone species in estuaries; known to have a large beneficial effect on coastal ecosystems. A mechanism for benthic-pelagic coupling.
- Policy and Management Relevance -
- There are other benefits beyond water quality improvement on the local scale.

Practicality -

Measures

Information and Date Sources

Assumptions, Unknowns, Problems Posed

- Pilot studies needed, critical parameters for reef design needed. Included are most filtering shellfish.

19. Accessible shoreline wetlands

Developed by: Riparian Zone – Land Water Interface - Group A

Short Title: Hudson River and East River Wetlands for Recreation.

Definition

Restore/Create wetlands that are accessible to the public. So that all people can have access to and interaction with the river and wetlands.

Justification

- Environmental justice
- Education

Technical Merit

- Recreation
- Natural areas have social and psychological values
- Increase native species

Policy and Management Relevance

Practicality

Measures

- Area available
- Visitation/ Usage

Information and Date Sources

Assumptions, Unknowns, Problems Posed

20. Recreational boating zones

Developed by: Pelagic Zone – Water Column in Deep Areas - Group C

Short Title: Recreational boating zones

Definition: Two recreational boating areas in disparate parts of the system for different user groups that is exclusive to non-motorized boats, access points, information kiosks.

Justification:

Technical Merit -

- Will need survey of boating interests and impediments.

Policy and Management Relevance -

- Benefits an actively engaged segment of the public. Education programming is highly compatible and would likely develop without dedicated funding.

Practicality -

- Highly likely to find compatible use areas.

Measures:

Information and Date Sources

Assumptions, Unknowns, Problems Posed

21. Water contact recreation

Developed by: Group D Benthic Zone

Short Title: Sediment Quality to Support Primary Contact Recreation

Definition: Sediments serve as a repository of disease-causing microorganisms and toxic contaminants. Release of pathogens and toxic contaminants to the water column in swimming areas and direct ingestion of sediment (particularly by young bathers) may present serious health risks.

Justification:

Technical Merit -

- Pathogens and many toxic contaminants are likely to exist in sediment at elevated concentrations. Release of pathogens and toxic contaminants from sediment will occur by tidal action and human activity during wading. In addition, direct…

Policy and Management Relevance –

- The use of waters for swimming, wading, etc. is important particularly in the outer areas of the harbor. Beach closures due to pathogen and toxicant contamination can severely limit the use of the resource and have a significant economic impact of beach areas.

Practicality –

- Measurement of pathogens in sediments (using an appropriate indicator organism or set of indicator organisms) provides a feasible assessment tool. Direct measures of toxic contaminants in sediment provide an indication of associated health risks.

Measures

- Quantitative measures of pathogens in beach areas is performed using indicator organisms (e. g., fecal coliform) in the water column. In addition, quantification of pathogens in sediment and development of sediment quality criteria for pathogens are needed. Measures of toxic contaminants in sediments (e.g., on a μg contaminant per g sediment basis) provide an estimate of potential exposure through ingestion and / or dermal contact in the overlying water and direct ingestion of sediment (e.g., by children).

Information and Date Sources

- Sediment quality criteria for pathogens is available for a number of other locations (e.g., Boston Harbor, Southern California) and can serve of a basis for establishing appropriate limits for NY-NJ Harbor and adjoining waterways. Sediment quality criteria for toxic exposure from swimming, wading, etc. could be determined from risk based calculations.

Assumptions, Unknowns, Problems Posed

22. Contained storm water runoff

Developed by: Riparian Zone – Land Water Interface - Group A

Short Title: Capture and Re-Use of Storm Water

Definition: Reduce the storm water flow in to the City's sewer system.

Justification

Technical Merit -

- Reduction of storm water into sewer system will reduce overflows into NY Harbor with sewage and debris issues.
- Restoring freshwater into City natural water table and freshwater (streams, rivers) system.

Policy and Management Relevance -

- Stabilize flow of tributaries.
- Meeting TMDL requirements.
- Increase O2 in Water.
- Improving fish habitat.
- Urban Stream restoration
- Plant succession
- Fish pops
- Invertebrates, etc..

Practicality -

- Localized opportunities:
- Using natural settings
- Creation of artificial and reversed "French drains"

Measures

- Reduction of current storm water outflow – 60%

Information and Data Sources

- Oakland Ravine Project
- Bronx River Project
- Blue Belt Project, SI

Assumptions, Unknowns, Problems Posed

23. Minimal hypoxic waters

Developed by: Pelagic Zone – Water Column in Deep Areas - Group C

Short Title: Hypoxia

Definition: Enhance seasonal hypoxic sites to acceptable water quality through local actions (circulation enhancement, CSO controls, and harbor wide).

Justification:

Technical Merit -

Policy and Management Relevance -

Practicality -

Measures

Information and Date Sources

Assumptions, Unknowns, Problems Posed

Aim is at cultural induced hypoxia.

APPENDIX C

Advance Workshop Material

Setting Targets for Restoration of the Hudson-Raritan Estuary An Interdisciplinary Workshop at the Hudson River Foundation

Purposes: Develop candidate target ecosystem characteristics to guide restoration planning in the Hudson-Raritan Estuary and assess program progress.

Duration: 2 consecutive half-days
Date: Lunch-afternoon October 25th through Lunch on the 26th
Location: Hudson River Foundation, New York, NY

Participant Work: Small group work on idea generation for targets followed by a small group work on performance measures paired with targets. Final revision of target and measures with a session of individual work with one or a few target-measures sets.

Workshop products: Written report with the notes of the workshop and all target ideas generated by the participants with recommended performance measures. Included will be key workshop planning documents and briefing materials on the approach being used for target setting. A draft workshop report will be reviewed by the Independent Technical Review Team to obtain their perspective on the workshop output and the review team comments will be included in the final report. All reporting by organizers using workshop material attributed to participants.

TUESDAY 25th

Noon to 1:00 pm: Optional pre-workshop lunch

1:00 Welcome and orientation to management need: Dennis Suzkowski
1:10 Restatement of purpose and method: Mark Bain
1:20 Logistics and breakout group plan: Jim Lodge
1:30 Breakout Groups to Identify Targets
Idea generation, habitats and biotic support

A - Land-water interface (riparian zone) B - Shallow illuminated waters (littoral zone)
C - Water column in deep areas (pelagic zone) D - Bottom layer in deep areas (benthic zone)

2:45 BREAK
3:00 Whole Group Discussion of Progress and Problems
4:00 Breakout Groups Round II on Targets (same groups)
Allocation by HRE zone, draft statements

A - Land-water interface (riparian zone) B - Shallow illuminated waters (littoral zone)
C - Water column in deep areas (pelagic zone) D - Bottom layer in deep areas (benthic zone)

5:15 Whole Group Discussion of Progress and Plan for next day
5:45 BREAK and Free Discussion [overflow time]
6:00 Dinner; provided at the Foundation offices

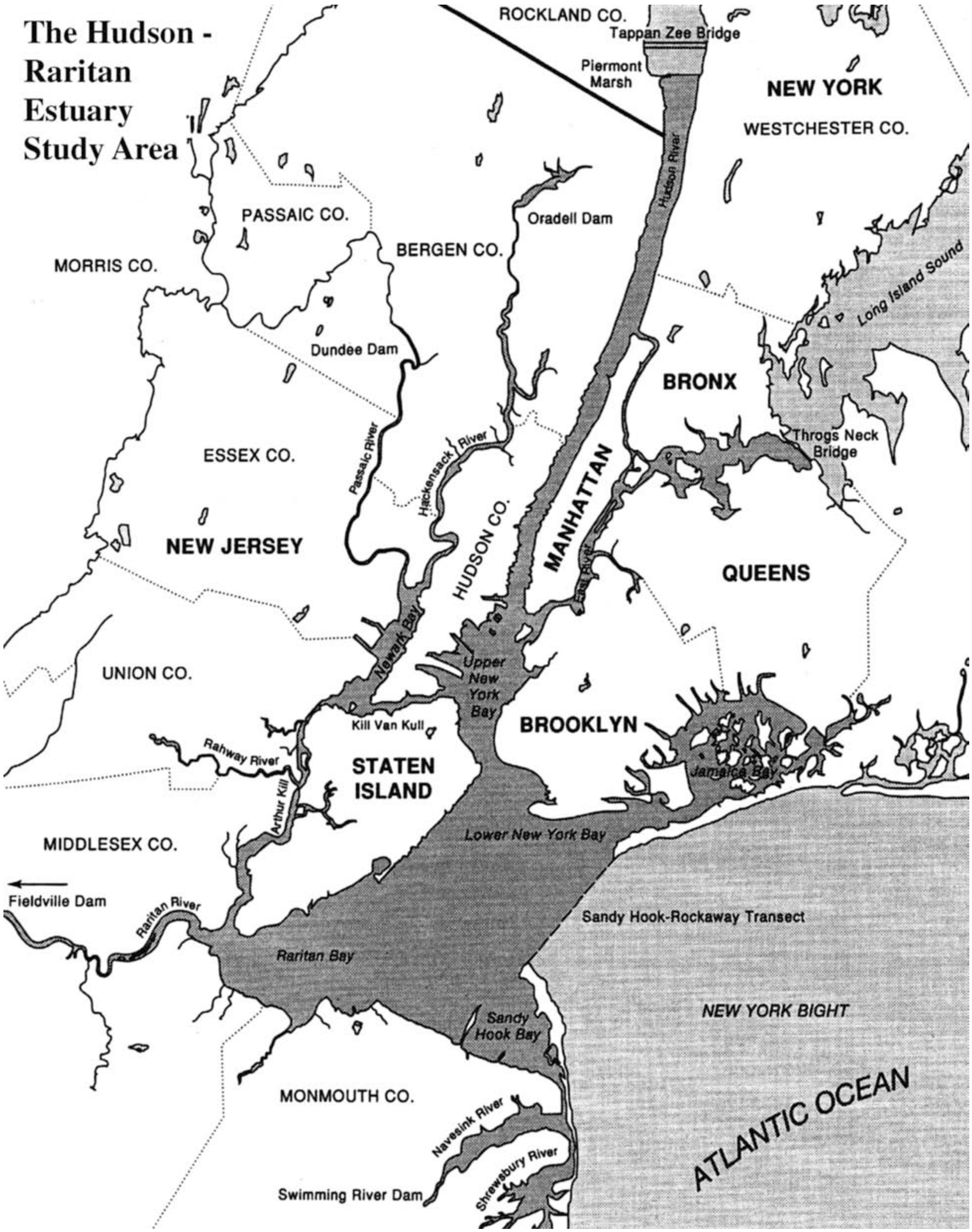
WEDNESDAY 26th

8:00 Breakfast
8:30 Introduction to Day 2: Mark Bain
8:45 Breakout Groups on Performance Measures (compiled by organizers)
Draft statements, list of criteria and assumptions, data and information needs

E-Target set 1 F-Target set 2 G-Target set 3 H-Target set 4

10:15 BREAK
10:30 Whole Group Session on targets and measures
11:00 Targets and measures distributed across attendees for editing and revision (1-on-1 work)
11:45 Wrap Up, assessment of effort by all, discussion of next steps

12:15 Lunch and Departure


The Hudson - Raritan Estuary Study Area
ROCKLAND CO.
Tappan Zee Bridge
Piermont Marsh
NEW YORK
WESTCHESTER CO.
Hudson River
PASSAIC CO.
Oradell Dam
BERGEN CO.
MORRIS CO.
Long Island Sound
Dundee Dam
BRONX
Throgs Neck Bridge
ESSEX CO.
Passaic River
Hackensack River
HUDSON CO.
MANHATTAN
NEW JERSEY
QUEENS
East River
Newark Bay
Upper New York Bay
UNION CO.
Kill Van Kull
BROOKLYN
Rahway River
STATEN ISLAND
Jamaica Bay
Arthur Kill
MIDDLESEX CO.
Lower New York Bay
Fieldville Dam
Raritan River
Sandy Hook-Rockaway Transect
Raritan Bay
NEW YORK BIGHT
Sandy Hook Bay
MONMOUTH CO.
ATLANTIC OCEAN
Navesink River
Shrewsbury River
Swimming River Dam

Setting Targets for Restoration of the Hudson-Raritan Estuary

An Interdisciplinary Workshop at the Hudson River Foundation

25-26 October 2005
17 Battery Place, New York, NY 10004

Participation by invitation only

> *.....too few ecologists and managers spend enough time in collaborative efforts to unambiguously define the end points or desired conditions of the system being managed; in other words, coming to consensus on the job to be done and goals to be achieved.*   *K. Rogers in Conservation Ecology 1998*

Designing a future Hudson - Raritan Estuary is a challenge that demands creative applications of our knowledge and science. We believe you are someone who can make important contributions to our effort to make a better NY/NJ Harbor Estuary environment. The Hudson River Foundation and the Center for the Environment at Cornell University are hosting this workshop in support of the The Hudson - Raritan Estuary Environmental Restoration effort led by the U.S. Army Corps of Engineers, New York District with the Port Authority of New York and New Jersey. In 1992 the National Research Council defined ***environmental restoration*** as returning an ecosystem to its former, undisturbed state. True ecosystem restoration is not possible in an intensely human setting like the Hudson-Raritan Estuary. Acknowledging that raises a major conceptual impediment to restoration planning: ***what is the aim of efforts to make changes in the estuary?*** This workshop is focused on developing target ecosystem characteristics to guide restoration planning in the Hudson-Raritan Estuary.

We are using the term *Target Ecosystem Characteristics* (TEC) to mean precise and quantifiable conditions that are being promoted in restoration activities. This term and concept are similar to essential ecosystem components used in planning the Florida Everglades restoration. A TEC is a specific ecosystem property or feature that is related to ecosystem health (see box for examples). For a program oriented to habitat restoration, we expect our TECs will focus on biophysical properties of the estuary defined in precise terms indicating relevant measures of existence and quality.

We expect lively debate on what is important, desirable, achievable, and sustainable for the NY/NJ Harbor Estuary environment. Substantial public funds have been committed to improving this ecosystem, and it is very likely more support will follow. Elected officials, agency leaders, and others expect clear targets, measures of success, and expert input to keep restoration going.

Examples

Target Ecosystem Characteristics

1 - Shallow water habitat large enough to support species that specialize on littoral conditions at common abundances in each subregion.

2 - Offshore rock habitat in tidal currents capable of supporting sustained attached fauna within the photic zone in multiple locations by subregion.