PUGET SOUND INSTITUTE

UNIVERSITY of WASHINGTON

Puget Sound Institute workshop on

Advancing the role of science in coastal ecosystem recovery

14 &15 May 2013

UW Tower, Seattle

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University of Washington / Puget Sound Institute **workshop on**

Advancing the role of science in coastal ecosystem recovery

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This document describes the concept, rationale, goals, and program of the workshop. Focal themes that have been selected for discussion are also defined, as is the process used to select them. Information about the venue, times and locations of meals, a map of the area, and the names, affiliations and contacts of all participants are appended.

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Concept, Rationale, and Goal

Restoring and managing ecosystems large enough to include terrestrial-to-marine environments, urban-to-wilderness land uses, and the spectrum of human endeavors present challenges relating to scope, complexity and cost that do not apply at smaller, simpler scales. Resolving these challenges is, by definition, mandatory for a sustainable future. Science is expected to contribute to recovery, but defining the role of science is itself challenging. The dynamics of these systems, and how they are affected by humanity, are too intricate to understand fully, or monitor comprehensively. Application of science's most powerful device – controlled experimentation – is typically ruled out by cost and complexity. The science of recovery advances more by description, comparison, and simulation, but at a pace that is usually much slower, and a scale much smaller than management would prefer. How should science contribute most effectively to recovery?

Problem solving in this context has been referred to as 'evolutionary', a cumulative process of comparing, selecting, and adapting practices that seem to work. Anderson et al. (2003)* described evolutionary problem solving as "*especially appropriate when multiple goals are incommensurable (i.e., lacking a common measure or basis of comparison). … [A]s information is gathered and disseminated, quantitative and qualitative results may be supplemented by a narrative sharing of experiences. The evolutionary approach thus takes advantage of people's ability to make decisions and solve problems by gathering cases and stories from experience…"* This workshop presents an opportunity to progress by a narrative sharing of experiences.

Workshop Goal: We expect to learn how science can better serve the recovery of complex ecosystems, by comparing practices and sharing experiences among leading scientists and practitioners from seven coastal regions in the USA. The represented ecosystems are Chesapeake Bay, Everglades, Long Island Sound, San Joaquin / Sacramento Delta, Columbia River Estuary, Louisiana Coast, and Puget Sound. All are large, coastal, heavily populated, badly degraded, and subject to decades of restoration effort under the same national governance. More than 40 leading scientists and practitioners, all well versed in applying science to recovery in complex and uncertain settings, will convene to compare their experiences, share lessons, and draw conclusions about how science can better inform strategies, policies, and practices for restoration and management of complex ecosystems. Their experiences have accumulated within each system independently enough for us to expect that such a comparison will yield novel insights.

Products from the workshop will include a multi-authored (all contributors) manuscript to be submitted for publication that captures and compares the assumptions and successful practices of these groups, and synthesizes their recommendations for improvement. We will also write a summary for managers, policy makers, and the public. The workshop will strengthen communication among scientists engaged in complex ecosystem recovery. A steering committee will coordinate implementation of the workshop's conclusions and recommendations in Puget Sound.

*Anderson, J. et al. 2003. Chapter 9 *in* RC Wissmar and PA Bisson, editors. Strategies for restoring river ecosystems: sources of variability and uncertainty in natural and managed systems. American Fisheries Society, Bethesda, Maryland.

Focal Themes and Panelists

Selection of Focal Themes and Panelists: Science plays many roles in ecosystem recovery, but in two short days we have time to focus on only four themes relating to 'the role of science'. Each theme will be the subject of a separate discussion panel on the first day of the workshop. Selection of these themes (by Joel Baker and Nick Georgiadis) was based on responses from each of the seven participating ecosystem groups to a questionnaire that attempted to discover the roles of science in each recovery strategy considered to be a) most challenging, b) most successful, c) potentially most instructive to other ecosystems, and d) worthy of attention in this workshop. All responses are reproduced on the following pages (original wording and structure are retained). In making our selections, we attempted to feature the stated preferences for discussion (answers to question d), but were also guided by 'what you are struggling with' (question a).

Subsequently, Carol Mitchell (Everglades NP) suggested an informal addition to the program, addressing how to communicate science to decision makers. Responses have been strong enough to warrant inserting a fifth panel discussion after lunch on the second day.

We have suggested panelists for each theme, based on their responses and what we know about their strengths.

Objectives of panel discussions are to:

- Clarify, examine, and expand issues relating to each focal theme arising from questionnaire responses, panel members, and other participants;
- Share lessons, impressions, experiences, and successes related to each theme;
- Most important: set explicit agendas for breakout group discussions on Day 2, which will focus on the same four themes, and attempt to develop solutions, plan actions, define principles and document conclusions arising in response to agenda items.

Description of Focal Themes and suggested panelists

Panel 1: Setting priorities in the face of uncertainty

We believe that recovery will follow from a long sequence of good decisions. The vast majority, however, are made under severe uncertainty: how certain are we that recovery goals are correct (optimized), and that selected actions will 'work'? How can science help us to reduce uncertainty? For that matter, how do we set priorities for science *that is intended to reduce* uncertainty and support decision-making? What are acceptable levels of uncertainty, and how do we propagate acceptance of uncertainty? Science plays diverse roles in reducing uncertainty: how can we better define and apply those roles?

Suggested Panel members:

- Ken Currens, Puget Sound (Chair)
- Mark Tedesco, Long Island Sound
- Gary Johnson, Columbia River Estuary
- Kurt Reinhart, Louisiana Coast

- Recorder: Richard Anderson (UW Puget Sound Institute)

Panel 2: Making management adaptive

A majority of respondents listed adaptive management as a challenge, recognizing the necessity of a measured approach to recovery – and having experienced the difficulty of achieving science-informed change. Others cited the challenge of linking stressors to responses, selecting indicators and targets, managing expectations given long time lags between recovery actions and ecosystem responses, and questioning the assumption that change is reversible. We need to know that we are progressing, but often lack resources to find out: when and how is it appropriate to apply an adaptive approach to recovery?

Suggested Panel members:
- Ronnie Best, Everglades (Chair)
- Denise Reed, Louisiana Coast
- Phil Levin, Puget Sound
- Peter Goodwin, San Joaquin Delta

- Recorder: Kari Stiles (PSI)

Panel 3: Institutional structure of recovery science: coordinating research, monitoring, and modeling in support of management

We sometimes hear that "no amount of money spent on science will bring about recovery". Yet reading your responses to question b (*what are the greatest scientific successes of your recovery strategies?*) affirms that recovery would not have advanced far without science (especially modeling, evidently). In medicine we have institutions (such as teaching hospitals) that foster discovery *and* learning *and* recovery. In restoration, our institutions tend to foster only one or two of these roles. MT stated that *true interdisciplinary and synthetic science applied to restoration is an institutional challenge with barriers operating in the scientific and management sectors. It is a challenge to engage the breadth of the scientific "community" in scientific assessments, synthesis, identifying gaps and priority needs, and truly integrating science across projects and themes*. In this climate of shrinking budgets, we must learn how to do more with less. There are inefficiencies in how we harness science to recovery: what are they, and how do we reduce them?

Suggested Panel members:
- Joel Baker, Puget Sound (Chair)
- Blaine Ebberts, Columbia River Estuary
- Jim Latimer, Long Island Sound
- Rich Batiuk, Chesapeake Bay

- Recorder: Andy James (PSI)

Panel 4: Science and Society

It is often said that "people are the problem, and thus the solution" to ecosystem recovery. Yet the key role of social sciences has been emphasized only latterly, mainly because natural scientists were the first to act on their concerns about impacts of humanity on nature. Several respondents stressed the under-representation of social sciences in ecosystem recovery: in changing minds and behaviors; in communicating benefits of healthy ecosystems and the value of ecosystem services; and in achieving equity and responsibility across sectors of society. What are the principal roles of social science in ecosystem recovery, and how can we realize them?

Suggested Panel Members:
- Ann Swanson, Chesapeake Bay (Chair)
- Trina Wellman, Puget Sound
- Larry Swanson, Long Island Sound
- Carol Mitchell, Everglades

- Recorder: Kelly Biedenweg (PSI/Natural Capital Project)

Panel 5: Communicating science to decision-makers

If a decision-maker actually understands a scientific result and the relevance it has to their decision, then they are more likely to use science as part of their decision-making process. So... how do scientists best communicate results and scientific knowledge to decision-makers, from the land-manager level to the level of Congress? This is really where the rubber hits the road in terms of science getting into the decision-making process: when a decision-maker has a decision to make, and you as a scientist are given time with this person, what do you give to him/her? How do you give it? How do you explain the potential scientific/ecological consequences of a particular decision?

Suggested Panel Members:

- Carol Mitchell, Everglades (Chair)
- Ann Swanson, Chesapeake Bay
- Martha Kongsgaard, Puget Sound
- John Stein, Puget Sound

- Recorder: TBA

Capturing the learning

a) Role of panelists:

i. Deliver a summary of their perspectives on the focal theme, with suggestions for promising threads for discussion (10 minutes modest use of Powerpoint if desired);
ii. Help to catalyze discussion, highlight implications, draw conclusions, and identify agenda items for breakout groups.
iii. The chair will moderate discussion, field questions, and be responsible for delivering the agenda for breakout groups.

b) Role of panel chairs:

i) facilitate discussion and maintain its focus on the theme;
ii) identify and record issues, problems, challenges, and items relating to the focal theme that would be candidates for inclusion in an agenda to be addressed by breakout groups the following day. Breakout groups are tasked with proposing solutions to these problems.
iii) in collaboration with the recorder, be responsible for production of the written agenda, by the start of the proceedings on the second day (preferably sooner).
iv) moderate questions and discussion from the floor.

c) Role of panel recorders:

i) record the thread and salient points of discussion.
ii) in collaboration with the chair, be responsible for production of the written agenda by the start of the program on the second day.
iii) write an edited summary of the discussion and submit to Nick Georgiadis.

d) For breakout discussions, group members will appoint a chair and a recorder, who will record the thread and salient points of discussion, operate the recording device (e.g. iphone), take photos of whiteboards etc. A designated group member (e.g. the chair) will verbally report a summary of proceedings to the plenary. After a suitable interval (two weeks) the chair and recorder are responsible for producing a written summary of discussion, edited to a degree suitable for inclusion of the salient points in a manuscript, and sent to Nick Georgiadis by email.

d) For "What I heard" sessions, presenters will write a summary of the main points, and submit them to Nick Georgiadis within two weeks.

e) Anyone presenting powerpoint slides please submit annotated copies to Nick Georgiadis.

Questionnaire Responses

1) Long Island Sound (Mark Tedesco)

a) Which role of science has proved most challenging to bring to bear on recovery of your ecosystem (what are you struggling with most), and why?

The link between stressors and response is complex, and may be non-linear. For example, nutrient reduction targets have been established to attain water quality standards for dissolved oxygen. However, the relationship between nutrients and DO is filtered by other system attributes that modulate the response. Simplistic predictions of the level and timing of response may reduce program credibility or obscure the need for more holistic management approaches.

Related to the challenge above is the resulting need to set clear priorities for science necessary to reduce uncertainties and support decision-making. Very clear hypotheses need to be developed, prioritized, and tested. Resources should be applied where uncertainty is large and the consequences from that variability are significant.

True interdisciplinary and synthetic science applied to restoration is an institutional challenge with barriers operating in the scientific and management sectors. It is a challenge to engage the breadth of the scientific "community" in scientific assessments, synthesis, identifying gaps and priority needs, and truly integrating science across projects and themes.

Science concepts important to management need to be communicated to the public and to decision-makers in an understandable format.

b) What is the most important way by which science has contributed to recovery in your ecosystem (the greatest scientific success of your strategy), and what is its significance to recovery?

Scientific knowledge incorporated into models has integrated data across disciplines. Despite limitations in the science underpinning the models, they have provided a tool to synthesize pollutant loading, ecosystem state, processing, and response. They also set priorities for research and monitoring. For example, a key science need for Long Island Sound was to determine the relative contribution of nitrogen from the East River (a tidal strait connecting the Sound to New York Harbor) and the Connecticut River to hypoxia in western Long Island Sound. This led to studies on circulation and transport. It has also led to research to better understand weather and climatology affecting the expression of hypoxia.

c) What are the top two lessons you have learned about the role of science in your ecosystem's recovery that have most to contribute to other ecosystems, and why?

We better understand the general circulation patterns that govern the transport of nutrients and relative import of different geographic sources to water quality impairments. Recent work has increased understanding of how water circulation and mixing in the Sound is affected by seasonal wind direction and force. As a result, processes affecting hypoxia and observed trends are better understood. This has been shown to be important in Chesapeake Bay as well.

The Long Island Sound Study supports a Long Island Sound Research Program that has engaged the scientific community. Entering its 13th year, the program has funded 33 investigations, resulted in numerous publications, and improved knowledge upon which to base management of Long Island Sound. The program, along with a revitalized Science and Technical Advisory Committee, has increased engagement of the academic community and improved credibility of the program initiatives.

d) What are your top 4 preferences for focal themes in this workshop?

i. Prioritization: There are more "science" needs or interests than can be accommodated by any program. Clear science priorities to support ecosystem management challenges must be set, leaving some research or academic fields aside.
ii. Decision-making: Institutional structures can hamper or aid the decision-making process. There are institutional, cultural, and logistical barriers to engaging scientists in the development of a science plan.
iii. Adaptive Management: Most programs do not truly incorporate adaptive management of implementation.
iv. Research/Modeling/Monitoring: Coordination of these three elements as part of an overall science effort.

2) Columbia River Estuary (Gary Johnson)

a) Which role of science has proved most challenging to bring to bear on recovery of your ecosystem (what are you struggling with most), and why?

- Adaptive management – Institutional responsiveness to implement a science-based, adaptively-managed restoration program is a challenge, because it takes time for institutions/agencies to adjust course and translate broad legal mandates into program implementation.
- Prioritization -- Development of models to accurately predict effects of various restoration actions is a challenge, because basic ecological relationships for key linkages are not well known. Action effectiveness data, noted above, are needed to validate predictive models.
- Decision-making -- The desire for statistical certainty and natural conservatism in science is a challenge, because management needs to make decisions today.
- Monitoring -- Empirical effectiveness data on how well the ecosystem restoration actions are working to benefit juvenile salmon growth and survival, i.e., data to answer the question: how well are the restoration actions are working is a challenge, because such data are difficult to collect.
- Monitoring – Implementation of a comprehensive monitoring program is a challenge, because budget constraints affect funding priorities and long-term commitments. Effectiveness monitoring remains a general issue in most (all) restoration programs in the PNW.
- Monitoring – Keeping scientists focused on the problem at hand can be a challenge, because scientists are creative and inquisitive by nature. Furthermore, coordinating restoration activities and action effectiveness monitoring can be a challenge, because planning and integration are required across a large program.

b) What is the most important way by which science has contributed to recovery in your ecosystem (the greatest scientific success of your strategy), and what is its significance to recovery?

i. Application of an *ecosystem-based approach* to ecosystem restoration that is implemented within an institutionalized adaptive management process is one scientific success because it provides the foundation for program strategy and implementation. For example, science has helped clarify which restoration actions are likely most effective.
ii. Science represented through an *expert panel*, which includes most of the main regional research organizations, has been a success in applying "best professional judgment/knowledge" to inform decision-makers and influence the restoration program.
iii. Another success has been the level "applied research," i.e., identifying ahead of time specific data and how will it be used in management decision making.

c) What are the top two lessons you have learned about the role of science in your ecosystem's recovery that have most to contribute to other ecosystems, and why?

i. Application of lines of evidence, including causal criteria analysis, to evaluate the cumulative effects of multiple restoration actions. Given the need to roll up effectiveness monitoring data, this type of analysis proved very useful in drawing comprehensive conclusions regarding actions despite the lack of empirical data on action effectiveness.
ii. It is one thing to develop an adaptive management framework, and quite another to successfully implement it; the lesson is to be consistent and persistent in engaging stakeholder participation on a routine, cyclic basis year after year. It took longer than ideal for us to develop the Columbia Estuary Ecosystem Restoration Program, but use of an adaptive management system to drive the program and the RM&E to support it have been worth the significant effort.

d) What are your top 4 preferences for focal themes in this workshop?

i. Adaptive management – It's easier said than done. How does experience and learning get translated to benefit subsequent decision-making and program design?
ii. Expert opinion – Expert opinion can be a bridge between scientific findings and management decisions. That is, when science has not addressed or poorly addressed a specific need, managers often look to "expert opinion." What role does expert opinion play in various recovery programs?
iii. Disseminating and communicating scientific findings – Dissemination and communication of scientific findings to a wide audience (managers, non-scientists, public) is so very important, yet scientists are not always the best communicators. Are there ways to disseminate and communicate science more effectively?
iv. Predictive numerical models of ecosystem and population responses to restoration actions – Models can integrate and synthesize various science elements to predict an outcome. While we all appreciate the limitations of models, they can serve a useful purpose. This is especially true for predicting ecosystems responses, but such modeling can be difficult because underlying data (science) are poor or lacking. How have other recovery programs used predictive numerical models of ecosystem and population responses to program actions?

3) San Joaquin Delta (Peter Goodwin)

a) Which role of science has proved most challenging to bring to bear on recovery of your ecosystem (what are you struggling with most), and why?

Coordination and Communication of 'Best Available Science' to Inform Policy Decisions and Management Actions. With over 200 interested entities (agencies and stakeholders), 29+ programs with some element of adaptive management, Biological Opinions with conflicting demands of a scarce water resource, a catastrophic flooding potential and billions of dollars at stake for municipal water supply and agriculture – it is a challenge to channel fractionated science programs toward a focused advice for management or policy decisions.

b) What is the most important way by which science has contributed to recovery in your ecosystem (the greatest scientific success of your strategy), and what is its significance to recovery?

i. Broad acceptance of the importance of rigorous peer review of publications, projects and programs.
ii. A recent NRC report points to the importance of "approximately 60 years of aquatic monitoring in the system, led since 1970 by the Interagency Ecological Program" as a significant accomplishment and a vital element for recognition of the threatened status of species in the system.
iii. Focused initiatives with broad participation to address well-defined problems. Recognition of the importance of the inter-dependence of multiple major system stressors.

c) What are the top two lessons you have learned about the role of science in your ecosystem's recovery that have most to contribute to other ecosystems, and why?

i. The value of an independent Science Program to play the role of "honest broker" and an Independent Science Board with the respect and attention of policy makers.
ii. The importance of fostering a community of scientists that can build bridges between scientists, managers and policy makers and facilitate networking (through Science Conferences, workshops, seminars, and the Science Fellow program). This has been demonstrated in the Delta science modeling community with conceptual and deterministic models. These models encapsulate current understanding of a complex and dynamic system and are useful tools for helping prioritize actions and enables communication among scientists and from scientists to policymakers, managers and the broader public.

d) What are your top 4 preferences for focal themes in this workshop?

i. **Adaptive Management at the Landscape Scale**. With multiple entities conducting adaptive management and many adaptive management 'experiments' underway, how do you effectively integrate individual implementation efforts and understand the response of specific actions? How do you make the AM effective and responsive on appropriate time-scales at the project, programmatic and regional scales – rather than being a cumbersome administrative structure that inhibits innovation and creativeness?
ii. **Measurement of Success**. What are appropriate performance measures and timelines for guiding science planning and project implementation, management and evaluation?
iii. **'Best Available Science' to inform policy and management decisions**. Is the collective community of science knowledge being used? What is an effective science-policy interface? How do you move away from piece-meal actions that are permit related to satisfy individual agency requirements or short-term political agendas to a more holistic 'what is best for the ecosystem' perspective?
iv. **Community models, shared data repositories and web services for data retrieval.**

4) Chesapeake Bay (Rich Batiuk)

a) Which role of science has proved most challenging to bring to bear on recovery of your ecosystem (what are you struggling with most), and why?

- **Integrating social science has proved the most challenging**. Regardless of the fact that we have some of the best scientists in the world and are considered to be the most studied estuary on earth, we continue to have difficulty persuading nonscientists to understand and buy into our beliefs. Until we can better relate to how nonscientists make decisions, and somehow get science incorporated subliminally and intentionally into those decisions, we will not progress at the desired pace. No matter how compelling the data can be, decisions will be made based on other seemingly more important parameters.
- *Uncertainty* also factors into this. When data is not absolutely certain (which it rarely is), or if the information is derived from modeling or Best Professional Judgment (also uncertain), that vagueness is viewed by nonscientists as flawed, instead of having an acceptable level of uncertainty. We must find ways to better communicate that some level of variability is acceptable.
- A significant challenge also relates to creating fiscal responsibility and equity in meeting load reduction targets. Even more challenging is communicating the concepts of equity and responsibility to stake holders which begins to cross over to social sciences and effective communication strategies.

b) What is the most important way by which science has contributed to recovery in your ecosystem (the greatest scientific success of your strategy), and what is its significance to recovery?

The Chesapeake Bay Program's success is the fact that it has been based on science from the beginning and that a widely cooperative program that involved multiple levels of government and stakeholders evolved in parallel as the science emerged. Painstaking efforts were made to bring decision-makers along during every process of the study for nearly thirty years. As a result, even though fiscal realities and political decision making are ever-present, the role of science has been so integrated that it is always looked to for input. It is almost a given that science will at least be considered, if not become the driver. Finally, accountability to continued consideration of new scientific findings and data in management decision making has been fully institutionalized within the advisory, oversight and peer review roles played by the Chesapeake Bay Program Partnership's independent Scientific and Technical Advisory Committee.

c) What are the top two lessons you have learned about the role of science in your ecosystem's recovery that have most to contribute to other ecosystems, and why?

i. <u>Establish and maintain robust, core long term monitoring networks</u> focused on tracking and understanding key elements of the ecosystem's response to restoration, designed to address well defined goals, but with the ability to adapt as new management needs emerge. Use the results from those cross-jurisdictional networks to management-oriented data and information on the status, trends, and responsiveness of the ecosystem to restoration efforts as well as to support the continued evolution of environmental models and other decision support tools.

ii. <u>Have the guts to change course as new science and knowledge suggests more appropriate and often new directions</u>. Define both short terms (e.g., two-year milestones) and long term (by 2025…) goals and continually develop the scientific basis for supporting the political willingness to change direction when necessary based on the best available information put in the context of these goals. Tackle the challenges with application and communication of adapting the use of environmental models in the face of emerging science, working to manage stakeholder expectations while maintaining engagement and support of the process.

iii. <u>You need some "Big Translators"</u> In order for the science to become properly imbedded into the minds of stakeholders and ultimately state and federal policy, you need to have translators. These are strong communicators that have the trust of their audiences – some should be scientists while others can be leaders of constituencies and elected officials. For a restoration effort to work, you need to engage the highest levels of leadership possible and ensure, to the maximum degree possible, that they are at least somewhat familiar with the science. To do this you must help them to access science at a distilled and salient level.

d) What are your top 4 preferences for focal themes in this workshop?

i. Integrating and taking fuller advantage of the **social sciences** in large scale ecosystem restoration, because, in the end, it's all about changing the behavior of our fellow humans. Specifically, tackle the issue of c*ommunicating the economic, social and ecological benefits of a healthy ecosystem and the recognition that clean water is not free, it has a cost.*

ii. **Adapting science and management** to a changing environment socially, scientifically and economically

iii. **Factoring in lag times in ecosystem recovery**—"what can we expect by when" and "how long do we wait for a response before taking even further action"

5) Louisiana Coast (Denise Reed)

a) Which role of science has proved most challenging to bring to bear on recovery of your ecosystem (what are you struggling with most), and why?

One of the most difficult things for us is the role of uncertainty. There are no historic (only geologic) precedents for the type of change we are trying to achieve so model validation is limited. Perhaps this can best be captured in terms of the expectations of science – people want/expect exact predictions of what will happen when an action is taken which is unrealistic. The scale of the changes means that some potential adverse changes cannot be taken care of by adaptive management – the changes could be irreversible.

b) What is the most important way by which science has contributed to recovery in your ecosystem (the greatest scientific success of your strategy), and what is its significance to recovery?

Modeling. Our ability capture key processes in both high fidelity and lower resolution models has really moved things forward.

c) What are the top two lessons you have learned about the role of science in your ecosystem's recovery that have most to contribute to other ecosystems, and why?

i. Low resolution modeling is fine for many decisions. Researchers sometimes want the best possible – managers often want things like long term predictions that higher fidelity tools can't provide.
   Research models that university folks develop for research on how systems work do not always work for management. However scientifically they may be considered better (reflect more processes explicitly for example). The model which is best scientifically in terms of reflecting how the system works may not provide the kinds of things that managers want (like long term predictions). This is particularly true for hydrodynamic models in my experience.
ii. Modeling pays off over time. There was a huge investment in monitoring over a decade ago and now we have some longer term data across the area we can really show people how it helps us understand the systems as well as detect change.

d) What are your top 4 preferences for focal themes in this workshop?

i. decision support
ii. modeling for management
iii. expanding the knowledge base, bringing in research from universities: How can we help managers make use of the types of work university researchers do which isn't obviously management oriented? Understanding fish physiology for instance. Managers may not care about physiology but they might care about that the net response of the species to changing environmental conditions (mediated by physiological response).
iv. the role of scientists vs the knowledge/findings they produce.

6) Everglades (Ronnie Best)

a) Which role of science has proved most challenging to bring to bear on recovery of your ecosystem (what are you struggling with most), and why?

[blank]

b) What is the most important way by which science has contributed to recovery in your ecosystem (the greatest scientific success of your strategy), and what is its significance to recovery?

i. Sharing Knowledge/Communication is Key: Regardless of the specifics of the science, what is key is the process of sharing knowledge and communication among/between scientists, resource managers and decision makers. For example, at the first Greater Everglades Ecosystem Restoration Conference(s) (GEERs) held in 2000 (GEERs have been held generally every other year), we held a special session on "sheet flow" (a unique identifying feature of the Greater Everglades). This special session lead to a white paper which identified the need for broader, unrestricted sheet-flow throughout the Greater Everglades, ultimately leading to the justification to bridge a long segment of the Tamiami Trail … by the way, the 1st 1 mile bridge, of the proposed about 7 miles of bridging was completed in 2013. GEER-2000 solidified the concept of 'sheet flow' which eventually lead to more directed science to better understand the significance of the concept relevant to restoring the Greater Everglades. Then, the decision makers had the information necessary to justify bridging Tamiami trail.

ii. So, how 'wet' was the historically unaltered Greater Everglades? If we knew the answer to that challenging question, then we would know how much water would be needed to restore the ecosystem. We knew through hydrologic modeling how much water was 'available', but it appeared that if we captured the amount of 'available' water and distributed that water through a restored Everglades, then today's Everglades would apparently be too wet? Paleoecological studies (recent 150 years history) of freshwater marshes and coastal salinity, when coupled with model estimates of freshwater flow, gave rise to the fact that the historical Greater Everglades was 'wetter' than envisioned and planned for in restoration. Based on this science (which again, emerged as a special session at a GEER conference), the CERP is being modified to capture more water.

c) What are the top two lessons you have learned about the role of science in your ecosystem's recovery that have most to contribute to other ecosystems, and why?

i. Science has to be relevant, timely and communicated in an understandable and usable format. The science needs to have the 'solidity' of quality, peer reviewed work (i.e., credibility), yet the results and/or implications of the science needs to discussed, communicated, simplified, and then discussed some more.

ii. Recurring (every two years) Conferences with opportunities for special sessions (emerging topics, challenging issues, synthesis) and much time/opportunity for conversations. Between years, opportunity for Topical Workshops. Ensure resource managers and decision makers are integral parts of the conferences and workshops.

d) What are your top 4 preferences for focal themes in this workshop?

i. Targets and Indicator(s) … Targets: Where do we want to go? Indicators: How do we know we are on the 'right path' and when we 'get there'? … Indicator species, indicators of change (hydrology) using a simple 'report card' of status of indicators.

ii. Concepts, Models, Experimental Research and Monitoring: Conceptual Models helps us understand in a general sense 'what' has changed, perhaps 'why', and may point to 'how' to correct (restore) the system. In addition, Conceptual Models help identify where we have the need for a 'better understanding' to help decrease uncertainty. However, Conceptual Models have limited capacity to help link ecosystem dynamics into 'forecasting' models. Monitoring (coupled with baseline) allows us to observe change; experimental (research) allows us to understand change; modelling, especially when coupled with monitoring and experimental science, allows us to forecast change. Forecasting change is necessary for developing a recovery/restoration plan.

iii. Prognosticators: Anticipating what information may be needed before it is necessary for the decision process. In other words, a 'big picture perspective' of what may be on the forefront of information needs. It takes time to do 'science', and we will never have all the answers, but we need to be far enough of the 'need' to be able to provide meaningful direction to resource managers and decision makers.

7) Puget Sound (Ken Currens et al.)

a) Which role of science has proved most challenging to bring to bear on recovery of your ecosystem (what are you struggling with most), and why?

i. Three survey respondents identified the role of science in prioritization, but gave very different examples. For example: Species listed under the ESA assume highest priority once they are listed, but other ecological attributes or ecosystem components generally lack political horsepower to gain attention even if science go help prevent future listings. Two elements could change that dynamic, getting wide-scale public support and/or getting support from the affected stakeholder(s). Getting support from stakeholders often requires strong leadership.
ii. Prioritization of recovery actions (presumably for funding) – e.g., how to balance between biological effectiveness of actions (science focus) and fairness (policy focus) transparently
iii. How to use social science to understand decision making and behavior change. (This presumably could relate to the "fairness" point above).
iv. Identifying which policy decisions need more science to advance or improve decision making. (This could be thought of as a science prioritization answer but it may also be a comment about the difference between what level of certainty policy makers need to act versus what scientists think is appropriate).

b) What is the most important way by which science has contributed to recovery in your ecosystem (the greatest scientific success of your strategy), and what is its significance to recovery?

i. Science identifying the negative consequences of inaction in confluence with strong, progressive leadership of affected stakeholders was very important for progress in forested environments
ii. History of research by universities, federal research labs, and to a more limited extent state agencies located within the region provided a strong foundation for ESA listings of endangered species and recovery plans
iii. Assisted with ecosystem monitoring
iv. Given confidence to policy makers willing to make hard choices

c) What are the top two lessons you have learned about the role of science in your ecosystem's recovery that have most to contribute to other ecosystems, and why?

i. The role of scientists in decisions: Scientists and conservation biologists in this region were among the first in the conservation biology literature to define the line between personal advocacy and the need for policy-neutral science that is necessary in democratic decision making. This promotes trust.
ii. Scientists need policy maker allies that understand how to empower scientists to speak beyond the data and to address the policy implications (bigger picture) in a safe forum. A safe forum is one that does not penalize scientists for offering their points of view. Change happens when that understanding of the bigger picture messaging is carried by good leaders back to political forums.
iii. That the science-policy link requires constant two-way communication
iv. That asking for money without specifying how it will be spent or how the results will benefit ecosystem restoration is fruitless. You won't get any money and you probably don't deserve it until you know this.
v. The role of policy makers: Science and policy makers need to identify where science makes a difference (policy relevance) to the outcome of well-defined problems. Scientist need to repeatedly push on having policy define those problems

d) What are your top 4 preferences for focal themes in this workshop?

i. Successful policy/science interactions or structures (4 answers)
ii. Use of quantitative decision analysis tools (2 answers) answers
iii. How much data (or money to fund science) is enough (2 answers)
iv. How to incorporate and use social sciences and applied tools, such as education, outreach, social marketing, behavior change, in additional to physical and biological sciences (2 answers)

Program

The program features panel discussions (Day 1) and breakout group sessions (morning of Day 2), and concludes with summaries, interpretations, and a session on policy implications (afternoon of Day 2). The proposed timing of these sessions is as follows:

Tue, May 14: PANEL DISCUSSIONS		Wed, May 15: BREAKOUT GROUPS	
Time	**Activity**	**Time**	**Activity**
8:30-8:45	Opening remarks	**8:30-8:45**	Objectives and Organization
8:45-9:15	Introduction & Objectives	**8:45-11:15**	Breakout Discussions 1-4
9:15-10:45	Panel 1: Prioritization under Uncertainty	**11:15-11:30**	Break
10:45-11:00	Break	**11:30-12:30**	Summary Reports and Questions
11:00-12:30	Panel 2: Making management adaptive	**12:30-1:00**	Lunch
12:30-1:30	Lunch	**1:00-2:30**	Panel 5: Communicating science to decision-makers
1:30-3:00	Panel 3: Institutional structure of recovery science	**2:30-3:15**	"What I heard": Interpretation
3:00-3:15	Break	**3:15-3:30**	Break
3:15-4:45	Panel 4: Science and Society	**3:30-4:30**	"What I heard": Policy implications
		4:30-	Conclusions and Next Steps

Explanation

In **Introductions and Challenges** lead scientists from each system will, in 4 minutes or less, introduce themselves and their colleagues, and relate their answer to the question: *Which role of science has proved most challenging to bring to bear on recovery of your ecosystem (what are you struggling with most), and why?*

Panel discussions, each lasting 90 minutes, will focus on the 4 focal themes described above. Each panel will consist of 3 panelists plus a chair. The purpose of these panels is to compare approaches to shared goals relating to focal themes. An important objective of panel discussions is to set explicit agendas for breakout group discussions on Day 2, which will focus on the development of solutions.

Breakout discussions on the morning of Day 2 will continue to focus on the same four focal themes featured in panel discussions on Day 1, but with a more prospective outlook. Participants will have 3 hours to address and define solutions to the principal challenges to that were identified the previous day, including conceptual and institutional structures most likely to deliver results.

In the session on **'Summary reports and questions'** reporters from each breakout group will summarize to all participants the thread of discussion and principal conclusions, leaving time for questions.

'What I heard': Interpretation two panelists will summarize what they heard over the course of two days that had the greatest significance to the theme of the workshop (20 minutes each). In the second part, two panelists will assess policy implications of our findings.

'Next steps' allows time to discuss how best to report on proceedings, including the content and structure of a manuscript, and assess potential for further workshops of this type.

Relevant Information

Transportation: if you are arriving by air, best option from SEATAC airport to the hotel is by Shuttle Express, $19.00 per adult. Please note that advanced reservations are required at http://www.shuttleexpress.com.

Accommodation: All visiting participants will stay at the Watertown hotel (4242 Roosevelt Way North East Seattle; http://www.watertownseattle.com/; 1.866.866.7977).

Parking for hotel residents is provided in their underground garage, accessed down a ramp off Roosevelt Ave. Use the intercom to the front desk to gain entry, saying you are participating in the PSI workshop). For non-resident participants, including local commuters, the hotel has kindly offered free parking in their garage, **space permitting**. To save space, participants from PSI and PSP please pick up free daily parking permits from Dustin at PSI (they will be available from about 8 May). These permits are valid for UW lots, but you must fill in the blanks (date etc.).

Venue: The workshop will be held in the UW Tower building near the UW campus in NE Seattle (4333 Brooklyn Ave NE, Seattle). **You will need a photo ID** to enter the building and must sign in and out. UW Tower is a 6-minute walk from the hotel (suggested route on the map below). On the first day we will meet in the auditorium on the mezzanine floor (M in the elevator). On the second day we will also start in the auditorium then split into breakout rooms on the top floor. We will convene again in the auditorium after lunch for the remainder of the day.

Meals for hotel residents: PSI will provide all meals for hotel residents, from a reception on the evening of May 13 to breakfast on May 16, as follows:

- The reception will be from 6:30-8:30pm in Watertown hotel's conference room on the ground floor.
- Breakfast for residents will be served in the hotel cafeteria from 7-8am each morning, also on the ground floor.
- Dinner on 14 May will be provided for hotel residents at Ivar's Salmon House at 6:30pm (401 NE Northlake Way; marked on the map below), 0.6 miles from the hotel.
- Dinner on 15 May: residents are welcome to sample local restaurants. Some recommendations:

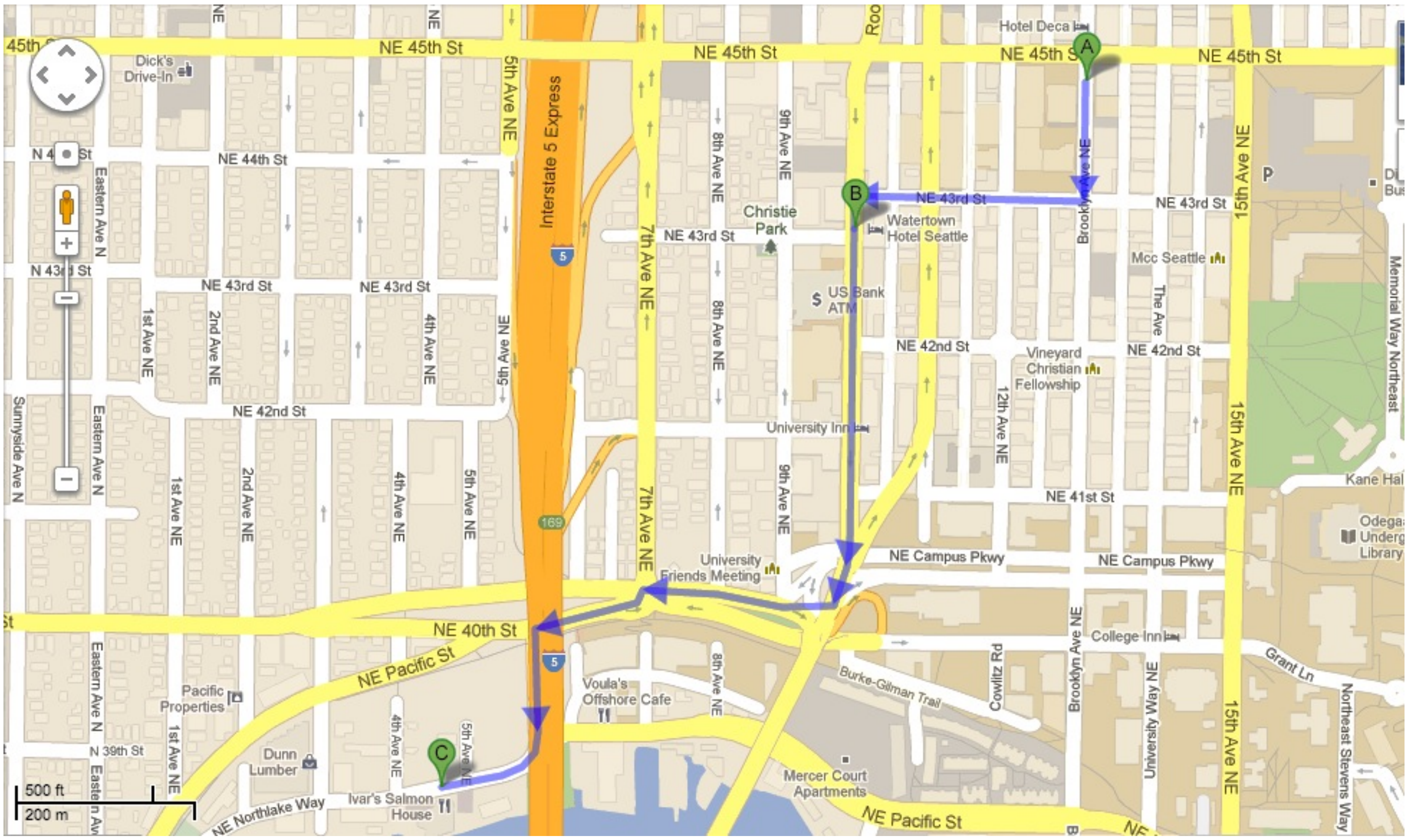
Portage Bay Cafe	**Agua Verde Cafe & Paddle Club**	**Cedars Restaurant**	**Big Time Brewery & Alehouse**	**Guanaco's Tacos**	**Thai Tom***
4130 Roosevelt Way NE	1303 Northeast Boat Street	1319 Northeast 43rd Street	4133 University Avenue	4106 Brooklyn Ave NE #102	4543 University Way NE
(206) 547-8230	(206) 545-8570	(206) 632-7708	(206) 545-4509	206-547-2369	206-548-9548
http://www.portagebaycafe.com	www.aguaverde.com	http://www.cedarsseattle.com	http://www.bigtimebrewery.com		*CASH ONLY

Lunch, and mid-morning and afternoon refreshments will be served for all workshop participants in the auditorium at UW Tower. You can eat there, or sit in the cafeteria on the same floor, which has an outdoor balcony, weather permitting.

Reimbursement: You will be reimbursed at a per diem rate for any meals that we are not covering. Airfare, and other travel expenses over $75, must be accompanied by an original receipt. Save all receipts and submit them to Dustin Annis by mail at 326 East D. Street, Tacoma WA 98421.

Map

…showing the western part of UW campus, Seattle and environs, with walking routes between UW Tower(A),Watertown hotel (B), and Ivar's House of Salmon (under the raised highway).



PSI Workshop Participants

No.	Participant name	Ecosystem represented	Title	Affiliation	*Email address*
1	Rich Batiuk	Chesapeake Bay	Associate Director for Science, Analysis and Implementation	EPA	*batiuk.richard@epa.gov*
2	Lee Currey	Chesapeake Bay	Director, Technical Services Administration	Maryland Department of the Environment	*lcurrey@mde.state.md.us*
3	Ann Swanson	Chesapeake Bay	Executive Director	Chesapeake Bay Commission	*aswanson@chesbay.us*
4	G. Ronnie Best	Everglades	Coordinator, Greater Everglades Science Program	USGS, Fort Lauderdale FL	*ronnie_best@usgs.gov*
5	Carol Mitchell	Everglades	Science Lead	Everglades National Park	*carol_mitchell@nps.gov*
6	Mark Tedesco	Long Island Sound	Director, Long Island Sound Office	EPA	*tedesco.mark@epa.gov*
7	Jim Latimer	Long Island Sound	Scientist	National Health and Environmental Effects Research Laboratory	*latimer.jim@epa.gov*
8	Larry Swanson	Long Island Sound	Associate Dean	School of Marine and Atmospheric Sciences, Stonybrook University	*larry.swanson@stonybrook.edu*
9	Gary Johnson	Columbia River Estuary	Scientist	Pacific Northwest National Laboratory Marine Sciences Laboratory	*Gary.Johnson@pnnl.gov*
10	Blaine Ebberts	Columbia River Estuary	Fishery Biologist	Portland Corps of Engineers	*blaine.d.ebberts@usace.army.mil*
11	Catherine Corbett	Columbia River Estuary	Science Director	Lower Columbia River and Estuary Partnership	*ccorbett@estuarypartnership.org*
12	Peter Goodwin	San Joaquin Delta	Lead Scientist	Delta Stewardship Council	*peter.goodwin@deltacouncil.ca.gov*
13	Sam Harader	San Joaquin Delta	Program Manager	Delta Stewardship Council	*sam.harader@DeltaCouncil.ca.gov*
14	Chris Enright	San Joaquin Delta	Delta Science Program	Delta Stewardship Council	*cenright@deltacouncil.ca.gov*
15	Lindsay Correa	San Joaquin Delta	Environmental Scientist	Delta Stewardship Council	*lcorrea@deltacouncil.ca.gov*
16	Kirk Reinehart	Louisiana Coast	Director of Planning and Research	Coastal Protection andl Restortion Authority	*Kirk.Rhinehart@LA.GOV*
17	Denise Reed	Louisiana Coast	Chief Scientist	Water Institute of the Gulf	*dreed@thewaterinstitute.org*
18	Joel Baker	Puget Sound	Director / Professor	Puget Sound Institute / UW Tacoma	*jebaker@u.washington.edu*
19	Bill Labiosa	Puget Sound	Research Scientist	USGS	*blabiosa@usgs.gov*
20	Scott Redman	Puget Sound	Senior Science Program Specialist	Puget Sound Partnership	*scott.redman@psp.wa.gov*
21	Ron Thom	Puget Sound	Research Scientist	Pacific Northwest National Laboratory	*ron.thom@pnnl.gov*
22	Tracy Collier	Puget Sound	Science Program Director	Puget Sound Partnership	*tracy.collier@psp.wa.gov*
23	Si Simenstad	Puget Sound	Research Professor	University of Washington	*simenstd@u.washington.edu*
24	Nick Georgiadis	Puget Sound	Research Scientist	Puget Sound Institute	*nicogeo@uwashington.edu*
25	Ken Currens	Puget Sound	Hatchery Genetics Manager	Northwest Indian Fisheries Commission	*kcurrens@nwifc.org*
26	Trina Wellman	Puget Sound	Associate Marine Environmental Economist	Northern Economics	*Katharine.Wellman@norecon.com*
27	Joe Gaydos	Puget Sound	Director and Chief Scientist	SeaDoc Society, Orcas Island Office	*jkgaydos@ucdavis.edu*
28	Phil Levin	Puget Sound	Program Manager, Ecosystem Science	Northwest Fisheries Science Center	*phil.levin@noaa.gov*
29	Andy James	Puget Sound	Research Scientist	Puget Sound Institute	*jamesca@u.washington.edu*
30	Tessa Francis	Puget Sound	Research Scientist	Puget Sound Institute	*tessa@uw.edu*
31	Angela Bonifaci	Puget Sound	Performance Management, Puget Sound Team Lead	EPA Region 10	*bonifaci.angela@epa.gov*
32	Diana Gale	Puget Sound	Senior Lecturer Emeritus and Leadership Council, PSP	Evans School of Public Affairs, University of Washington	*dianagale3@gmail.com*
33	Guy Gelfenbaum	Other	Oceanographer	USGS Pacific Coastal and Marine Science Center, Santa Cruz	*ggelfenbaum@usgs.gov*
34	John Stein	Puget Sound	Science and Research Director	NOAA Fisheries' Northwest Fisheries Science Center	*john.e.stein@noaa.gov*
35	Kari Stiles	Puget Sound	Research Scientist	Puget Sound Institute	*kstiles@uwashington.edu*
36	Kelly Biedenweg	Puget Sound	Visiting Scientist	Puget Sound Institute	*kellybiedenweg@gmail.com*
37	Martha Kongsgaard	Puget Sound	President	Kongsgaard-Goldman Foundation	*martha@kongsgaard-goldman.org*
38	Tim Quinn	Puget Sound	Chief scientist of the WDFW's habitat program	Washing Department of Fish and Wildlife	*Timothy.Quinn@dfw.wa.gov*
39	Tom Eaton	Puget Sound	Director	EPA Region 10 Washington Operations	*eaton.thomas@epa.gov*
40	Bob Johnstone	Puget Sound	Senior Scientist	US Navy Support Office	*johnston@spawar.navy.mil*
41	Dave Ward	Puget Sound	Regional Stewardship Manager	Puget Sound Partnership	*dave.ward@psp.wa.gov*
42	Fran Wilshusen	Puget Sound	Habitat Services Manager	Northwest Indian Fisheries Commission	*fwilshus@nwifc.org*
43	Jan Newton	Puget Sound	Principal Oceanographer	Applied Physics Laboratory, University of Washington	newton@apl.washington.edu
44	John Stark	Puget Sound	Professor	Department of Entomology, WSU	*starkj@wsu.edu*
45	Tom Leschine	Puget Sound	Director	UW School of Marine Affairs	*tml@u.washington.edu*
46	Alana Knaster	Puget Sound	Deputy Director	Puget Sound Partnership	*alana.knaster@psp.wa.gov*
47	Richard Anderson	Puget Sound	Research Scientist	Puget Sound Institute	*rmanders@uw.edu*
40	Amy Snover	Puget Sound	Assistant Dean, Applied Research, and Director	Climate Impacts Group, University of Washington	*aksnover@uw.edu*