TAHOE REGIONAL PLANNING AGENCY

Mail
PO Box 5310
Stateline, NV 89449-5310

Location
128 Market Street
Stateline, NV 89449

Contact
Phone: 775-588-4547
Fax: 775-588-4527
www.trpa.org

MEMORANDUM

Date: June 27, 2018

To: Threshold Update Initiative Stakeholders Working Group

From: TRPA Staff

Subject: Threshold Update Initiative: Threshold Standard System Structure and Vegetation Preservation

---

Background:

Peer reviewers of the last two threshold evaluations have noted that the threshold standard system and threshold reporting reflect a siloed world view and would benefit from greater integration across threshold categories. As part of the Threshold Update Initiative, the Governing Board asked staff to look at the overall structure of the system and consider alternatives that better reflect modern ecosystem-based management.

To support this process, the Tahoe Science Advisory Council (Council) reviewed data management approaches from 10 large natural resource management agencies around the county and provided a suite of best practice recommendations for improving TRPA's systems. The Council documented the findings of that review in a reported entitled "Natural Resource Evaluation Systems: Assessment of Best Practices for the Tahoe Regional Planning Agency (Attachment D)." Following the release of those initial recommendations, TRPA engaged the Council to develop guidance to operationalize the recommendations.

The Council and TRPA begin working on an approach to implement the recommendations earlier this year. The Council's recommendations (Attachment E) and TRPA's direction to implement the Council's conclusions (Attachment F) provide a template for modernizing the threshold standard system.

The commitment to the open flow of information and adaptive management is key to the proposed system structure. The recommended system draws heavily from best practice and integrates three primary elements; (1) Standards are supported by conceptual models that detail the scientific understanding of system function. (2) Results chains that link management actions to desired outcomes (standards). (3) Connections between the individual standards and categories are documented in underlying system diagrams, grounded in the widely applied Drivers – Actions – Pressures – State Change – Impacts – Response model. These diagrams are used to identify inter-dependencies between resource areas and break down silos.

The recommended system structure can be built iteratively over time as the threshold update initiative works through priority areas. The team designed the structure to complement what's currently in place. Implementation of the new structure will provide stakeholders with a clearer picture of the Region's goals and how the actions of the partnership in the Basin contribute to attainment of those goals.

Also at the working group meeting, TRPA's Dr. Christina Restaino will share the latest work on the vegetation preservation threshold standards.

Contact Information: If you have any questions regarding this agenda item please contact Dan Segan, Principal Natural Resource Analyst, at dsegan@trpa.org, (775) 589-5233.

Attachments:

A. Agenda for June 27, 2018 Meeting of the Threshold Update Initiative Stakeholders Working Group
B. Draft Meeting Summary - Threshold Update Initiative Stakeholders Working Group March 28, 2018 Meeting
C. Draft Meeting Summary - Threshold Update Initiative Stakeholders Working Group April 18, 2018 Meeting
D. Tahoe Science Advisory Council report entitled "Natural Resource Evaluation Systems: Assessment of Best Practices for the Tahoe Regional Planning Agency"
E. Tahoe Science Advisory Council draft report entitled "Structuring Data to Facilitate Management of Threshold Standards"
F. Threshold Update Initiative Report on Threshold System Structure
G. Vegetation preservation threshold standards adopted in Resolution 82-11 as amended May 23, 2018.

Attachment A.
Threshold Update Initiative Stakeholder's Working Group Meeting #3 Agenda.

THRESHOLD UPDATE INITIATIVE STAKEHOLDER'S WORKING GROUP

MEETING # 3

DATE: Wednesday, June 27th, 2018 | 2:00PM - 4:30PM

LOCATION:

North Tahoe Events Center, 8318 N Lake Blvd Kings Beach, CA 96143

Goto Meeting:

Online: https://global.gotomeeting.com/join/327660333

Phone: +1 (646) 749-3122 Access Code: 327-660-333

TAHOE REGIONAL PLANNING AGENCY

Threshold Update

AGENDA

TIME	TOPIC	PREPARATION	LEAD
2:00 pm	**Welcome, Agenda Review**	None	All
2:05 pm	**Approval of Meeting Summaries (Meetings 1&2)**	Review summaries from meetings 1&2	
2:10 Pm	**Science Council Report on Structuring Data for Adaptive Management** Objectives: *(1) Elements of the proposed system structure, (2) Role and utility of individual elements*	Structuring Data to Facilitate Management of Threshold Standards	Alan Heyvaert, Tahoe Science Advisory Council
2:40 pm	**Proposed System Structure** *Objective: (1) Feedback and direction on development of system structure*	Review system structure memo	Dan Segan, TRPA
4:00 pm	**Update on Vegetation Preservation Standard Review** *Objectives: (1) Common understanding of existing vegetation preservation standards (2) direction on stakeholder engagement and process*	None	Christina Restaino, TRPA
4:30 pm	***Adjourn***		

Attachment B.
Draft Meeting Summary - Threshold Update Initiative Stakeholders Working Group March 28, 2018 Meeting.

Threshold Update Initiative Stakeholders Working Group Meeting # 1 | March 28, 2018

Draft Meeting Summary

ATTENDEES

Threshold Update Initiative Stakeholders Working Group Members: Brendan Ferry (El Dorado County), Jennifer Carr (Nevada Division of Environmental Protection), Jesse Patterson (League to Save Lake Tahoe), Robert Larsen (Lahontan Regional Water Quality Control Board), Jim Lawrence (Nevada Division of Environmental Protection), Bill Yeates (RPIC)

Absent DRWG Members: Teresa McClung (US Forest Service), Jason Drew (Tahoe Chamber of Commerce)

Tahoe Regional Planning Agency (TRPA) Staff: Joanne Marchetta, John Marshall, John Hester, Ken Kasman, Jeanne McNamara, Julie Regan, and Dan Segan

Tahoe Science Advisory Council: Mark Hausner

Members of the public: Jennifer Quashnick (Friends of the West Shore), John Vitenscz (Placer County resident)

MEETING PURPOSE & GOALS

- Present Science Council finding and recommendations on Technical Clean-up of overlap of existing Threshold Standards
- Present TRPA application of the Science Council findings on overlap typology
- Discuss proposed alternatives for addressing overlap
- Working group direction on next steps for technical clean-up

MEETING OUTCOMES

- ✓ The Tahoe Science Advisory Council assessed the degree of overlap with the existing threshold standards. The council presented the five identified unique types of overlap and discussed the sources of each, the relative harm caused by the various types, and potential strategies to avoid or resolve that type of overlap.

- ✓ TRPA staff reviewed non-technical corrections for selected water quality and stream environment zone standards.
- ✓ The DRWG members agreed with the structure of the standard changes but would like more comprehensive tracking of what happens to each individual standard.

MEETING SUMMARY

I. Welcome, Introductions, Group Orientation and Agenda Review

II. Administrative Clean-up Project overview

A. Threshold assessment findings
B. Scope of Tahoe Science Council engagement

III. Science Council Findings and Recommendations

A. What is the technical cleanup? What is overlap?
B. Science Advisory Council presentation on technical cleanup
    a. Five types of overlap
        i. Complete Overlap
        ii. Wholly Encompassing Standards
        iii. Competing Targets
        iv. Indirect Overlap
        v. Policy Statements as Standards
    b. Priorities for addressing overlap
        i. Maintain equivalent levels of protection
        ii. Reduce uncertainty and potential conflicts between regulated parties and TRPA
        iii. Reduce uncertainty and duplication of effort in TRPA's internal operations.
    c. Evaluating Solutions
        i. Priorities for addressing overlap
        ii. Must consider feasibility, timelines, and technical questions
        iii. Potential paths to resolution

IV. Alternative paths forward Science Council findings

A. TRPA application of the Science Council typology
    a. Review of attachment C- Overlap framework applied to the threshold standards
    b. Potential restructuring of current water quality load target standards to a separate sub category. See handouts 1 and 2.
    c. Potential restructuring of non-degradation of stream environment zones.
B. Next steps for the technical clean-up

NEXT STEPS

- TRPA staff to create cross walk documents - Provide a numbering system from the original text of 82-11 onto the spreadsheet that breaks out the existing standards (Attachments C and D), linking attachment C and handout 1-2, and provide information to show where the overlap exists.
- Meet briefly over the phone to approve the new documents to be sent to the APC

ATTACHMENT: DRWG DISCUSSIONS

The following provides a record of DRWG discussions specific to agenda topics notated by the project team during the March 2018 meeting.

John Hester reviews the Agenda and goals of the group. Work plan was taken to the board. General work plan contents: clean up current thresholds. Role of the group is as a stakeholder group to comment on if the proposal is workable and are the necessary stakeholders involved.

II. Administrative Clean-up Project overview

Dan Segan gives context as to how we arrived at technical cleanup as part of the work plan of the threshold update initiative. The 2015 threshold evaluation identified the review of existing standards against best practice for development of standards as something that should be done. Worked with advisory council and brought that to APC and GB. 43 standards were flagged that potentially overlapped with another standards. Overlap erodes the power of individual standards and causes confusion amongst staff and regulating parties as to what the ultimate goals are. Overlap means functional equivalence from a regulatory perspective. Worked with Science council to categorize, overlap, identify root causes of overlap, and recommend solutions and prevention.

III. Science Council Findings and Recommendations

Mark Hauser (Desert Research Institute, Tahoe Science Advisory Council) Presents on guidance of technical clean-up of the existing standards. Identified 5 types of overlap, brief assessment of relative harm, and suggests potential solutions. The five types of overlap identified: 1. Complete Overlap - two different standards regulate the same constituent with the same numerical target, 2. Wholly encompassing standard- Achievement of one standard would necessarily entail achievement of another standard, 3. Competing Targets-Two or more standards address the same constituent in different ways, 4. Indirect overlap-One standard regulates an overarching category, while subsequent standards regulate constituents of that category, 5. Policy statements and standards- Vague statements, more aspirational than feasible, that are unlikely to be realistically achieved. Examples of each type of overlap from the threshold evaluation were given.

Priorities for finding solutions when addressing overlap: Maintain equivalent levels of protection, reduce uncertainty and potential conflicts between regulated parties and TRPA, and reduce uncertainty and duplication of effort in TRPA's internal operations.

Potential paths to resolution: Eliminate one redundant standard (complete overlap, wholly encompassing standards), Eliminate the less stringent standard (competing targets), Refine focus of one standard (wholly encompassing, competing targets, indirect overlap), Numerically define baseline (competing targets, indirect overlap), SMART- Specific, Measurable, Achievable, Relevant, and Time bound criteria (especially for policy statements).

Questions about the scope of this group and meeting

Dan Segan clarifies that technical clean-up is narrowly defined as things that will make the intent of the standards more clear but not result in a change in policy. Policy statements would need a policy decision to change the statement. This group will in the future be making policy based decisions.

IV. Alternative paths forward Science Council findings

A. TRPA application of the Science Council typology

Dan Segan reviews contents of Attachment C – the application of the overlap typology. Currently in 82-11 standards are not numbered. They have been assigned a number as a way to discuss and track their movement through this process. There are 51 overlapping standards identified. Over 350 individual standards overlapping connections, many standards have overlap with multiple standards.

The 51 standards that are broadly overlapping fit into two broad categories. The first is non-policy technical corrections which are relatively short-term fixes that can be made without modifying the level of protection that will increase the clarity and intent of the standards. The second category are standards including either policy decision and or additional technical research to identify appropriate resolution per the science council.

33 standards are topics for discussion today – water quality and non-degradation of stream environment zones. Overview of the current water quality standards structure. Existing standards are organized by category and within those are a set of loading targets creating confusion. We're talking about pelagic lake Tahoe but within that discussion are 10 loading targets that don't necessary relate to the lake but relate to our goals relative to pelagic lake Tahoe. Potential solution is restructuring load targets as a separate sub category within water quality – see handouts. Hand out 1 is crosswalk with the existing structure of resolution 82-11 for the water quality section, each standard has a number in red. Hand out 2 is the proposed restructuring with corresponding number from handout 1.

Questions and clarifications on the numbering of the standards: Existing standard numbers do not match up to the numbering in handouts 1 and 2.

Robert Larsen asked if this is the proposed text of the new resolution. Adds that this provides a solid platform to discuss the thresholds while also addressing the overlap.

Joanne Marchetta responds that this is an equivalent reorganization that takes 53 water quality standards and consolidates them into 34 standards.

Dan Segan explains to just modify the text and not reorganize, it wasn't possible to maintain equivalent levels of protection and not increase or decrease. Pulling the loading targets out separately and then referencing back to the subcategories maintains equivalent levels of protection.

Bill Yeates asks for clarification of the numbering system in handouts 1 and 2: Hand out 1 is essentially the water quality language from resolution 82-11, which then has been pulled out to match the policy numbers that we have in the handouts.

Jesse Patterson asks what was the rationale for removing the 19 thresholds. What type of overlap are they?

Dan Segan answers that they fall into different categories, but most are competing target overlap***.***

Bill Yeates asks for more clarification on the where the numbers come from, and what exactly is numbered. Points out that the standards in the threshold evaluation were not previously numbered. Reviews that we are taking the resolution, pulled out the water quality standards and rewrote that policy.

Joanne Marchetta explains that the thresholds standards were numbered in an effort to track their movement and consolidation during the reorganization.

Robert Larsen and Jesse Patterson state that it would be useful to show what the overlap between standards is and why they were consolidated.

Dan Segan asks would the best way to be to bring the overlap to attachment C?

Group agrees attachment C isn't the best location because the numbers don't match handouts #1 and 2.

Joanne Marchetta explains that today's task clarifies what is actually contained in 82-11.

Robert Larsen states that there is potential for 2 numberings, an old and a new. The old, existing 82-11 numbers, and then relate it to the new numbering system in a table that links attachment C to handout 1. This will make a numbering system that is easy to communicate and follow the flow of standards. Link handout 1 to attachment C and then crosswalk that numbering system to handout 2 that shows where we are going and how the overall number of standards has been reduced.

Group agreement that we need a system that shows more clearly what happened with the consolidation of the overlap types.

Public comment:

Jennifer Quashnick Agrees with organization and general direction of the proposal.

Dan Segan addresses overlap within non-degradation SEZ standards that relate to vegetation and wildlife as well as the additional standards within wildlife and vegetation. Restoration standards that also apply to SEZs have overlap but is outside the scope of today's meeting.

Proposed solution is to acknowledge that the way we apply our standards is protection from one category, no matter which overlapping category is listed.

Jennifer Carr asks what happened to deep water plants in the reduction of the standards from deciduous trees, wetlands, and meadows.

Dan Segan responds that the 2 uncommon plant communities that are not wetlands maintain are retained in the standard. Non-numbered standards on the handouts are retained in their original location. The linkage to attachment C should help clarify this.

Bill Yeates There needs to be a key that shows us where the reductions took place.

John Hester responds that can we go back to 82-11 and everywhere we made a change, we put a number, and that can go to a key that explains what we did. Then if we can, we can build a new numbering system.

B. **Next Steps for Technical Clean-up**

Agreement for a need for a crosswalk from 82-11 to appendix C and D and handouts 1 and 2 to track the movement of standards. Provide a numbering system that reaches from the original text of 82-11 onto the spreadsheet that breaks out the existing standards (attachment C and D), and linking handouts 1 and 2, and also provide information to show where the overlap exists.

Jennifer Carr Asks that if by taking an action today on handout 2, are we saying that the approach is good or are we saying that we agree with the content of handout 2. There hasn't been the opportunity to digest whether the overlaps that are consolidated are wholly appropriate. Are we verifying that the approach is moving in the right direction?

John Marshall responds that we are looking for a recommendation on the substance, there are ample opportunities to review the content in the future.

Jesse Patterson Suggests that it needs to clearer what happened to the individual standards and where they sit in the typology.

John Hester proposes that in an effort to continue to move the process along, the new numbering cross walk is formed, then the group will have the opportunity to review the content and decide whether to move it forward before it goes to the APC.

Bill Yeates Suggests the group holds a conference call to review the content of the material before moving forward.

Jim Lawrence Agrees with the suggestion for another call to review and suggests that prior to bringing it to the APC and GB it would be good to have a working group recommendation on substance of the proposal.

Decision made to review new documents before sending this to the APC.

Group discussion that the next meeting will give the needed opportunity to review and discuss the types of overlap of the affected standards and how the structure of the standards has been changed. The result of the meeting would be the agreement with the substance of the consolidations as well as a working group recommendation to the APC and the Governing Board.

Opportunity for Public Comment

Joanne Marchetta clarifies that the group is working toward the recommendation from this working group so that at the May APC and Governing Board meetings, something can be brought forward.

Jennifer Carr clarifies that progress with be shown on 82-11 and that it is not being rewritten.

Robert Larsen responds it will be a proposed change with the already existing associated environmental documents.

Brendan Ferry reaffirms that the plan is to formally amend resolution 82-11 at the May Governing Board.

Attachment C.
C. Draft Meeting Summary - Threshold Update Initiative Stakeholders Working Group April 18, 2018 Meeting.

Threshold Update Initiative Stakeholders Working Group Meeting # 2 | April 18, 2018

Draft Meeting Summary

ATTENDEES

Threshold Update Initiative Stakeholders Working Group Members: Robert Larsen (Lahontan Regional Water Quality Control Board), Jim Lawrence (RPIC), Bill Yeates (RPIC), Brendan Ferry (El Dorado County), Zack Bradford - Alternate (League to Save Lake Tahoe), Jason Drew (Tahoe Chamber of Commerce)

Absent Threshold Update Initiative Stakeholders Working Group Members: Jennifer Carr (Nevada Division of Environmental Protection), Jesse Patterson (League to Save Lake Tahoe), Teresa McClung (US Forest Service)

Tahoe Regional Planning Agency (TRPA) Staff: John Marshall, John Hester, Ken Kasman, Jeanne McNamara, Julie Regan, and Dan Segan

Members of the public: Jennifer Quashnick (Friends of the West Shore)

MEETING PURPOSE & GOALS

- Review the proposed reorganization and technical corrections to 82-11 and the associated materials that provide the bridge to current version.

MEETING OUTCOMES

- ✓ Motion to bring the proposed reorganization and technical corrections to 82-11 (as presented in attachment D) and the associated materials to the APC for review and recommendation to the governing board.
- ✓ Discussion of the need for additional input on what kind of document the thresholds should be in and where it should live.
- ✓ Update on Lake Tahoe Info

MEETING SUMMARY

I. Questions and comments on the purpose of the proposed reorganizational changes or any further clarification of the attachments that bridge 82-11 to the current version.

A. Concerns over what type of document the thresholds should be and how it will fit in with the code and regional plan but still be living and breathable. Agreement that these are important concerns to be discussed at a later time.
B. Discussion on the need to display removed information from the standards and track changes in an easy to see way despite the radical changes.

II. Motion to bring the proposed reorganiziation and technical corrections to the 82-11 and the associated materials to the APC.

A. Motion unanimously carried

III. Update on Lake Tahoe Info: new monitoring programs are live on the monitoring dashboard including information on bike and pedestrian, tahoe yellow cress, traffic volume, and transit ridership.

IV. Discussion about how the thresholds could live in a setting like LTinfo.

DISCUSSION NOTES

The following provides a record of discussions specific to agenda topics notated by the project team during the April 2018 meeting.

Discussion on 1. A Comments and Questions

Bill Yeates asked about Jennifer Carr's absence and asked if she had had the opportunity to comment in advance. Expressed a desire for the thresholds to be part of a living document rather than part of the code.

John Marshall responds that this is worthy of a good discussion at a later time. There is some flexibility to figure out where exactly the thresholds should live. Somewhere appropriate for not only regulatory, but also for communicating messages, being responsive to new science.

John Hester said Jennifer Carr's will be able to weight in formally as part of the APC review.

Dan Segan reviews goals for today: Recommendation to take this forward to propose to the APC at which point they will have the time to weigh in on the proposal. The APC would then review and make recommendations to the Governing Board at the end of May about whether these changes were appropriate and consistent. Will follow up with Jennifer Carr.

Bill Yeates states that as we proceed and review thresholds and reorganize, we ought to figure out where to put it in the hierarchy whether it's its own separate document or whether we are going to put it in the regional plan. Resolution, attachment to the resolution, those are narratives reflecting the knowledge of 1982.

Dan Segan responds that the structure and its relation to the system is being worked on with the science advisory council for future discussion with this group.

Jennifer Quashnick Asks an organizational question on numbering 1-178 and numbered categories in the 82-11 proposal.

Dan Segan explains that there is numbering within each category as well as for the whole system. Open to suggestions.

Discussion on 1. B Concerns on tracking changes

Jennifer Quashnick and Dan Segan Discuss on how to displayed removed information. Want to ensure that it is a living breathing document, lineage and tracking what has happened to the standards is an important task. Looking for suggestions on how to do that moving forward.

Bill Yeates responds that using strikeouts and underlines could be an option.

Bob Larsen responds that could get messy due to the number of corrections. Attachment G connects previous 82-11 standards and references in the technical proposal. It is the anchor to see changes.

Jim Lawrence: maybe can take a paired down version of applicable changes to APC.

Discussion on II. Motion

Robert Larsen: Are we comfortable moving forward with the organizational structure and information before us right now to move forward to APC at this time?

Bill Yeates moves whats been put together by these first 2 meetings to send to APC for review and recommendation by the governing board as shown in attachment D and E.

Robert Larsen: All in favor of that motion, none opposed. Motion carries unanimously.

Discussion on III. Update on Lake Tahoe Info

Jeanne McNamara talks about the new monitoring programs on the monitoring dashboard. Information on bike and pedistraion monitoring- overview, individual stations and daily activity, Tahoe Yellow cress, traffic volume, and transit ridership. Most of that data is on Open data hub, raw data on GIS file and displayed on the monitoring dashboard.

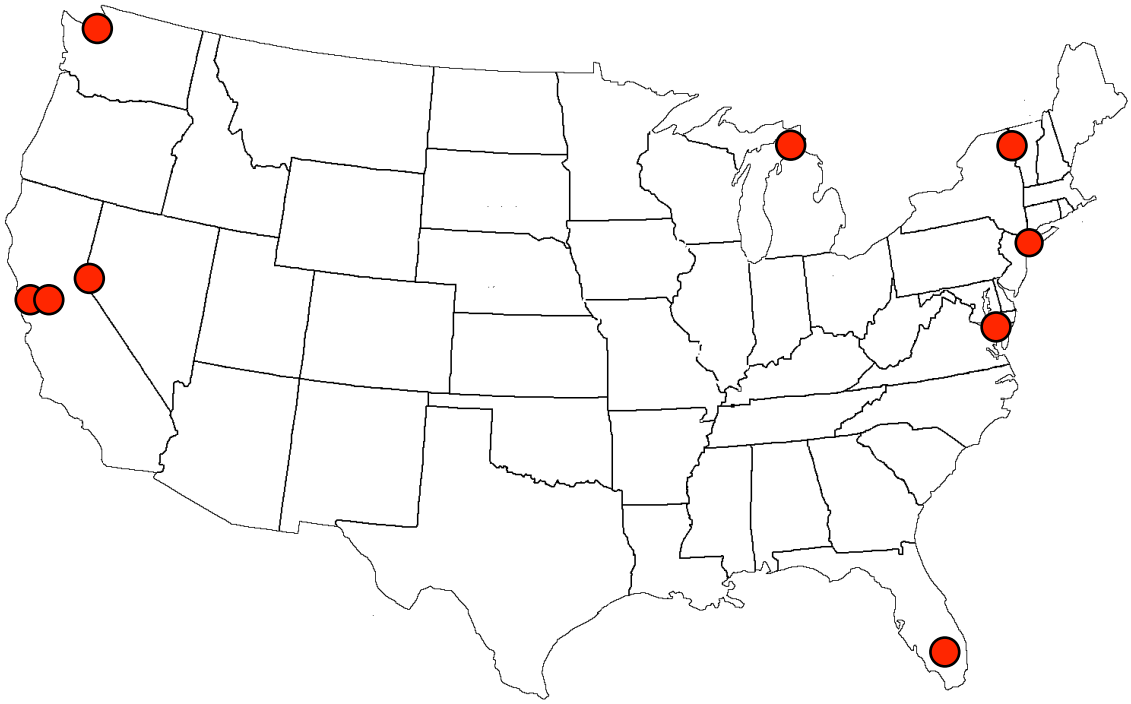
John Marshall adds that if we can have the thresholds live in a place where they make direct connections quickly and easily, it places less emphasis on what device we use to adopt and amend them and where they officially live.

Robert Larsen discusses broader vision on where the thresholds live. If the thresholds live on Lake Tahoe info and are directly linked to the associated monitoring data and performance metrics for different programs so you can look at how a particular action is influencing a desired outcome and how it ultimately roles up to a threshold.

Attachment D.
Tahoe Science Advisory Council report entitled "Natural Resource Evaluation Systems: Assessment of Best Practices for the Tahoe Regional Planning Agency."

Natural Resource Evaluation Systems: Assessment of Best Practices for the Tahoe Regional Planning Agency

Tahoe Science Advisory Council Technical Report | October 2017



A product of the Tahoe Science Advisory Council prepared by:

Alan Heyvaert – *Desert Research Institute; TSAC co-chair*

Christopher Knopp – *Desert Research Institute consultant*

Ed Parvin – *U.S. Geological Survey*

Casey Schmidt – *Desert Research Institute*

TSAC
TAHOE SCIENCE ADVISORY COUNCIL

Acknowledgements

This assessment of natural resource management systems is the result of a collaborative effort on the part of many individuals that contributed materials, useful edits and thoughtful reviews.

We recognize the contributions from members of the Tahoe Science Advisory Council:

Matt Busse – *U.S. Forest Service, Pacific Southwest Research Statio*n
Sudeep Chandra – *University of Nevada, Reno*
Alan Heyvaert – *Desert Research Institute, TSAC Co-chair*
Zach Hymanson – *CA Natural Resources Agency*
Pat Manley – *U.S. Forest Service, Pacific Southwest Research Station*
John Melack – *University of California, Santa Barbara*
Max Moritz – *University of California, Berkeley*
Ramon Naranjo – *U.S. Geological Survey*
My-Linh Nguyen – *Nevada Division of Environmental Protection*
Ed Parvin – *U.S. Geological Survey*
Marc Pitchford – *Desert Research Institute*
Steve Sadro – *University of California, Davis*
Geoffrey Schladow – *University of California, Davis; TSAC co-chair*
Scott Tyler – *University of Nevada, Reno*

Project assistance, comments and review were also provided by Dan Segan and Julie Regan at the Tahoe Regional Planning Agency. Additional program information was provided by representatives contacted at each program reviewed in this document. We appreciate their contributions, candor and patience during this effort. Any errors, omissions or misinterpretations are the responsibility of the TSAC authors.

This report is available at the Tahoe Science Advisory Council website:
https://www.tahoesciencecouncil.org/.

Preferred Citation:
Tahoe Science Advisory Council (TSAC). 2017. Natural Resource Evaluation Systems: Assessment of Best Practices for the Tahoe Regional Planning Agency. TSAC Technical Report, October 2017. Incline Village, NV.

For more information contact:
Alison Toy
Tahoe Science Advisory Council
291 Country Club Dr., Suite 320
Incline Village, NV 89451
775-881-7566
natoy@ucdavis.edu

Executive Summary

The Tahoe Regional Planning Agency (TRPA) has started working with Tahoe basin stakeholders in review and assessment of the existing threshold standards and reporting requirements. As part of an overall Threshold Update Initiative, they are also interested in evaluating how well the TRPA threshold system achieves its intended purpose and whether other natural resource management programs around the country have developed practices that would be instructive or useful for application at Tahoe. Toward that goal, the Tahoe Science Advisory Council (TSAC) has undertaken a review of resource management programs to identify best practices and methodologies that could serve to advance the TRPA environmental threshold system.

The authors contacted program managers, assembled background materials, reviewed commonalities and differences in approach, and then summarized the main findings relevant to evaluating or updating the TRPA threshold evaluation system.

There are many similarities among the natural resource evaluation and management systems reviewed, including adoption of adaptive management principles. Distinctive approaches tend to reflect unique or constraining characteristics of the system under management, as well as motivating factors for public concern, funding levels, and historical legacy, among other factors. As at Lake Tahoe, many of these programs have been grappling with an over-abundance of objectives or indicators that are difficult or expensive to track, and not directly linked to management actions or specific objectives. Like the TRPA, these programs are also in the process of refining tracking requirements and finding more efficient ways to understand the consequences of existing policies and management strategies.

Core Principles

- **Develop Focused Goals:** Identify goals that are specific, measurable, achievable, relevant and time-based. Effective examples include the San Francisco Estuary Partnership and the Chesapeake Bay Program.
- **Use Conceptual Models:** Describe linkages between program goals and important system components that demonstrate cause and effect relationships. Effective examples include the Delta Stewardship Council and the Chesapeake Bay Program.
- **Select Goal-Related Indicators:** Good indicators meet the criteria of being measurable, precise, consistent and sensitive. Effective examples include the Chesapeake Bay Program and the Everglades Restoration Program.
- **Implement and Commit to Adaptive Management:** This is essential for transferring information from monitoring and applied research to evaluate outcomes and inform future management actions. Effective examples include the Delta Stewardship Council and the Puget Sound Partnership.

Four core principles emerged as the basis for effective implementation and adjustments to natural resource evaluations programs. These are summarized in the adjoining text box. We believe the TRPA has already taken steps to implement each of these principles, although continued refinement to incorporate the details provided in this report would be beneficial to the threshold system.

In addition to the four core principles, we identify eight essential characteristics common to effective natural resource evaluation, management and reporting programs, as listed below. Some of these have been addressed in part by the TRPA, but continued development would enhance the performance and results of the threshold evaluation system.

- *Target key indicators.* Many programs deal with more indicators than they can afford to track and report on a regular basis. Ultimately, they tend to focus on a sub-set of key indicators to communicate their progress in detail, with other indicators or sub-indicators providing a supporting role or ancillary information for monitoring and evaluation purposes.

- *Use consistent terminology.* Terminology must be defined, accessible and consistent among stakeholders and the public for productive discussions and outreach communication. This can be particularly important when scientific terms or concepts are translated into planning and communications documents. Avoid jargon, and define new terminology for consistency across disciplines and documents.

- *Develop prioritization processes.* Limitations in funding and program capacity mean that choices must be made in selection of potential management actions. Different programs have developed various approaches to identify priorities among these options, and that transparently and explicitly link selected actions to indicators. A few examples are provided, but most rely in part on conceptual models and a decision support framework to inform prioritization and to provide documentation of the process.

- *Use monitoring to assess progress.* The iterative cycle of adaptive management requires monitoring, analysis, and reporting to inform management decisions. It is essential for tracking outcomes and for making adjustments to program indicators, objectives and trajectories. Monitoring has to be designed and integrated as part of an evaluation program that links to management decisions. Conceptual models are useful to inform the design. Such monitoring programs are not static, and should be subjected to regular review/revision to ensure the intended purposes are being achieved in a changing environment.

- *Incorporate independent scientific guidance.* Ecosystem management to sustain desirable functions and services is complex, working across specialized

disciplines and sometimes producing unexpected results. Using the best-available science and integrating information across disciplines establishes a credibility that stakeholders collectively support. Independent scientific guidance and peer-review can objectively inform progress toward desired outcomes, selection of appropriate indicators, and identification of emerging issues.

- *Develop diversified funding sources.* Funding for monitoring, data analysis, and reporting is often vulnerable, and generally difficult to restore. Several programs have established funding groups or committees to develop additional sources of revenue to help stabilize the funding base for outcome tracking and reporting.

- *Distribute the reporting responsibility.* Assembling outcome implementation teams of committed stakeholders to develop monitoring plans, assemble and analyze the data, and report on progress can distribute the burden of responsibility and produce broader public support for the program. With each team focused on a specific outcome, they can apply a more specialized perspective and analysis of the results, and identify progress and adjustments needed to continue on desired trajectories.

- *Implement structured collaborative frameworks.* These are formalized agreements that document how multiple agencies and organizations will work collaboratively to achieve common goals and objectives of the program. They would be used, for example, to set up goal implementation teams or similarly targeted groups, and should be updated regularly as the objectives, responsibilities and support levels evolve. This prevents unnecessary overlap, facilitates communication, and creates broader stakeholder participation in the program.

Additional details are subsequently provided in this document to inform the application of these general principles and the essential characteristics of a resource management program. We explain the tenets of adaptive management in some detail because it is central to these efforts and most programs are still struggling to implement it in a cost-efficient manner. It should be acknowledged, however, that amongst all these programs the TRPA threshold evaluation system is somewhat unique in its regulatory authority, and the responsibilities it entails. We recognize this will create additional caution and constraints on the part of the TRPA as it seeks to modernize and streamline the structure and processes of its program during the Threshold Update Initiative.

TABLE OF CONTENTS

Introduction

The purpose of this report is to evaluate a set of natural resource management programs from around the country for information relevant to updating threshold standards in the Lake Tahoe Basin. Management of natural resources to sustain ecosystem functions and services is complex. The interacting components that work at different temporal and spatial scales within ecosystems often produce unexpected responses. Desirable components of these systems can be affected by internal or external factors that may not be well understood or under the direct control of managers. The assemblage of stakeholders, agencies and other parties involved often represent perspectives that are not well aligned.

Yet strong public interest to conserve and restore natural resources with the functions and services they provide is indicated by the billions of dollars spent throughout the United States. These programs are generally charged with working through the complexities to 1) identify goals and the specific projects that will support those goals; 2) allocate funding across program areas; 3) quantify the outcomes and determine their effects; and in some cases 4) develop and implement regulations based on assessments. This document presents the results from an assessment of several natural resource management programs to determine the methods and practices used by these programs. The primary aim is to identify best practices and methodologies that could serve to advance the TRPA threshold evaluation system.

One of the more important factors that will contribute to the success of these programs is how science and management practices are integrated into an overall natural resources management program. In the face of challenges that resource management programs confront, various approaches have been developed to reduce uncertainty, inform decision-making, increase collaboration and test management options. Each of the programs reviewed in this document, including the TRPA, use some form of an adaptive management process to help guide decisions, but they each take a somewhat different approach in how they structure and manage their programs. This examination will highlight some of the important practices that seem to work well, which should help inform modifications to the Tahoe Regional Planning Agency (TRPA) Environmental Threshold System.

Several of the program representatives we contacted during this review indicated their interest in Tahoe's Environmental Threshold system. In some cases, they had previously investigated Tahoe as they developed their own approaches, or they had incidentally adopted similar practices into their programs. Indeed, similarities among natural resource evaluation and management systems were common, indicating general adoption of adaptive management principles as well as dissemination of ideas among groups as they continue to search for effective management methods that will efficiently address their specific goals and objectives.

Background

The TRPA Threshold Update Initiative is one of seven strategic priorities set by the TRPA Governing Board in 2015. It was followed by the 2015 Threshold Evaluation Report that set the stage for implementation of this initiative, with the goal of reviewing and updating the environmental threshold system to 1) ensure a representative, relevant, and scientifically rigorous set of standards; 2) establish a cost-effective, feasible and informative monitoring and evaluation plan to support the standards; and 3) develop a robust and repeatable process for review of standards in the future.

Threshold standards are defined as standards "necessary to maintain a significant scenic, recreational, educational, scientific or natural value of the region or to maintain public health and safety within the region." There are at present 178 different threshold standards, and the majority of them were adopted in 1982, based on best-available science at that time (Dan Segan, pers. comm.). There is a consensus among Tahoe basin stakeholders that it is time to review and update these standards and the monitoring systems that support them.

Toward that goal, the TRPA has started working with Tahoe basin stakeholders in review and assessment of the existing threshold standards and reporting requirements. Simultaneously, the Tahoe Science Advisory Council (TSAC) has undertaken a review of other national or international resource management programs to identify best practices and methodologies that could serve to advance the TRPA environmental threshold system.

The challenge of setting, evaluating, and reporting on benchmarks for environmental quality and resource condition is not unique to the Tahoe Basin. Across the country and around the world, government agencies and stakeholder groups are engaged in similar activities. In this examination of natural resource evaluation systems, TSAC representatives contacted program managers, assembled background materials, reviewed commonalities and differences in approach, and then summarized the main findings relevant to updating the TRPA threshold standards and the threshold evaluation system.

The resulting summary of relevant findings provided below is followed by a set of narrative program descriptions, along with answers to ten assessment questions addressed in the TSAC review of each program. In Appendix A we have compiled the responses to a questionnaire that was sent to each program manager.

The summary of findings and supporting materials presented in this document are intended to provide an overview and initial assessment of program characteristics that the TRPA may wish to consider as it begins to address its Threshold Update Initiative. We believe that more can be learned from a continued examination of the program features documented here, and invite interested readers to further explore the

individual programs summarized below and as represented in their corresponding program websites.

Summary of Findings

Various approaches have been taken by different regional programs to evaluate natural resource conditions and assess progress toward restoration. The distinctive approaches that develop tend to reflect the complexity and size of the system, the number and types of partners involved in management and assessment, the motivating factors for public concern, funding levels available, historical legacy when building on previously existing agreements or programs, and the degree of external oversight. They often began with ambitious objectives that grew over time to ultimately encompass a large number of targeted outcomes and indicators that were difficult or expensive to track and not directly linked to management actions or specific objectives. Many of these programs are now winnowing their tracking requirements down to a more concise set of primary objectives and indicators and finding ways to more closely link their decisions and management actions to desired results.

In the context of the current TRPA Threshold Update Initiative, there are some general principles that emerge as a basis for effective implementation and adjustments to these programs.

Core Principles

- Develop Focused Goals: A deliberative approach is required to achieve complex environmental restoration goals. Rather than general statements of vision, these should be developed as outcome-based goals, using all five SMART management criteria (Specific, Measurable, Achievable, Relevant and Time-based).

- Use Conceptual Models: Describe linkages between program goals and important system components with conceptual models that portray the most important cause and effect relationships, as currently understood. These models should represent dominant assumptions as well as known relationships for each linkage pathway, often with some indication of relative uncertainty. Conceptual models are used as tools to integrate knowledge, engage stakeholders, inform indicator selection, communicate management options, and guide the development of action plans.

- Select Goal-Related Indicators: Use results chains to link specific management actions through expected outcomes to desired impacts or goals. Results chains, also called logic models or theories of change, map out the known interactions and assumptions from conceptual models in a series of causal ("if – then") statements that link expected short-term or intermediate outcomes to long-term goals. Good indicators meet the criteria of being *measurable, precise, consistent,* and *sensitive* and should be tied explicitly to outcomes (objectives) at different

stages in the result chain, which will lead to the desired impact (goal). Use this approach to clearly demonstrate how specific management actions will lead to desired outcomes as the basis for determining what needs to be measured and what indicators should be used.

- Implement and Commit to Adaptive Management: Adaptive management frameworks allow for efficient incorporation of new evidence into management decisions. A meaningful, outcome-based, iterative adaptive management process should be an integral part of a comprehensive environmental evaluation program. The adaptive management process must support the transfer of information from science efforts (i.e., monitoring and applied research) to active forums for interpretation of outcomes and determination of future management actions.

Essential Characteristics

Here we describe eight characteristics of effective natural resource evaluation, management and reporting programs. All of the characteristics are considered essential, and therefore of equal priority.

Target Key Indicators – Indicators are a core component of any natural resource evaluation system. Indicators are generally a numerical expression of a resource condition (e.g., 100 ft of lake clarity) or living resource (e.g., X acres of late succession forest habitat). Most programs have ultimately focused on a few key indicators, with names such as vital signs, apex indicators, the elegant few, or outcomes. The Everglades Restoration Program, for example, has focused on 11 strictly biological indicators responsive at different time scales to demonstrate short and long-term effects of resource management. The Chesapeake Bay Program links 31 desired outcome measurements to ten goal statements, and reports progress on each of the outcomes. The Great Lakes Water Quality Agreement (GLWQA) has identified nine high level indicators (Vital Signs) linked to nine GLWQA objectives, with 44 sub-indicators and 56 or more corresponding metrics.

Use Consistent Terminology – Consistent and practical terminology is an important factor in developing resource evaluation programs that: 1) link data obtained from monitoring to indicators; 2) translate well in assessment of management actions; and 3) communicate progress toward goals. Perhaps the weakest link in terminology is transitioning from what is measured directly (a metric) to the different levels or types of aggregation that ultimately lead to a reported indicator (sometimes called a measure, a sub-indicator, or an index). We show some examples of definitions for common terminology in the attached glossary (Appendix B).

Develop Prioritization Processes – Several of the programs examined have developed some method to prioritize management actions that link to indicators. Limitations in funding or program capacity, and emergence of new issues or changing policies mean that choices must be made in deciding future actions. Decision support systems that

include conceptual models and explicit information on system attributes and functions are valuable in developing rational, well-supported priorities. In the absence of adequate peer-reviewed literature, the Puget Sound Partnership developed the Puget Sound Pressures Assessment (PSPA) approach to evaluate relationships between stressors and endpoints, based on the assumption that understanding the largest stressors and most vulnerable ecosystem components (endpoints) is an important consideration for recovery planning. The PSPA used an expert elicitation method to rank the relative impacts of stressors on important ecosystem endpoints.

Use Monitoring to Assess Progress – Monitoring is an essential component of a natural resource evaluation program. Monitoring and associated analyses provide the data and results to inform future decisions. Effective monitoring identifies the target audience, the required knowledge, and the level of rigor needed to satisfy these needs. This monitoring should help validate assumptions, track objective (outcome) achievements, and provide information that can be integrated into current and future iterations of conceptual or quantitative models that may be used to determine the status of an indicator.

Incorporate Independent Scientific Guidance – All programs reviewed acknowledge reliance on the "best-available science," and most have a science group integrated into the overall program structure. The science group may be external to the official program organization or it may be internal, but the strongest programs seem to have both (such as the Chesapeake Bay Program), with an internal group providing support for day-to day operations and reporting, while the external group provides independent scientific guidance, technical service, science collaboration and peer-review.

Develop Diversified Funding Sources –Funding for monitoring, data analysis, and reporting is often the most vulnerable, and generally difficult to restore. Several programs have established funding groups to develop additional sources of revenue for a more diversified and stable funding base and to find new efficiencies within existing programs for monitoring, evaluation and outcome reporting.

Distribute the Reporting Responsibility – Most programs have some form of periodic report card or indicator assessment that informs the public and stakeholders on progress toward achieving goals. This document can have many formats that provide differing levels of detail (e.g., high-level concise summary, or detailed technical report), and which are geared to different audiences (e.g., elected officials, the public, stakeholders, or government representatives). Assembling this information and interpreting results appropriately on a recurring basis is a considerable effort. The Chesapeake Bay Program has developed a set of Goal Implementation Teams, one for each outcome. These teams, formed across agencies and NGOs, are responsible for developing the monitoring plan, analyzing the data, producing the graphics that are used in reporting progress, and making data available. This occurs on a biennial cycle and keeps everything up to date for continued science-based assessment and evaluation, without placing excessive demand on the resources of the Program staff

alone. This also facilitates stakeholder engagement and buy-in to the process and the products.

Implement Structured Collaboration Frameworks – Many programs have representative bodies, as well as science networks that comprise multiple agencies and organizations. Developing a formalized written structure for collaborative responsibilities and relationships is a key tenet of many programs. These structures can assist with distribution of labor, minimize gaps and overlap, and allow for a diversity of input in to each program, while concentrating final decision making in executive agencies/bodies. In the Everglades, thorough cooperation agreements were drafted from the beginning of the program, and are updated regularly.

Suggestions for the TRPA Threshold Update Initiative

The following sections summarize additional factors learned from review of existing evaluation programs that we consider relevant to the primary objectives of the TRPA Threshold Update Initiative. Because adaptive management has emerged as one of the best tools available for managing complex ecosystems in the presence of uncertainty (Westgate et al., 2013), we present this first and explain it in more detail than the other sections. Subsequent sections simply aggregate a wide range of additional factors, in no particular order and the categorization is loosely applied. Similarities to findings previously summarized usually present some additional detail or highlight different aspects that are relevant.

A) Apply the adaptive management cycle.

Adaptive management is "a systematic approach for improving resource management by learning from management outcomes" (Williams et al., 2009). It is a structured, iterative process that supports decision-making while attempting to reduce uncertainty over time via monitoring and analysis. Despite the intuitive approach represented by this description, there are considerable variations in its application by different programs and large differences in perceived success from implementation (Gregory et al., 2006). Complications in adaptive management occur because the timeframes for monitoring and assessment do not match decision-making requirements or because key data is lacking due to incomplete or incorrect monitoring.

Each program in this review, including the TRPA, has applied some form of adaptive management as part of its strategy for guiding management decision-making in the presence of ongoing uncertainty and changing conditions. First developed as a science-based approach for natural resource management (Holling, 1978, Walters 1986), adaptive management was intended to reduce uncertainty over time through an iterative approach that evaluates response to selected actions or projects to ensure improvement in management planning and implementation directed at achieving specified objectives. The application of adaptive management can vary among programs, reflecting specific ecosystem characteristics and the management

requirements or constraints for each particular case. Identified steps in the process can range from as few as three to more than twelve.

As summarized by Westgate et al. (2013), with slight modification here, the adaptive management cycle includes these following steps:

1. Identification of management goals in collaboration with stakeholders.
2. Specification of multiple management options, one of which can be 'do nothing'.
3. Creation of a rigorous evaluation process for interpreting how the system responds to management interventions. This stage typically involves creation of quantitative conceptual models and/or rigorous experimental design.
4. Implementation of management action(s).
5. Monitoring of system response to management actions (preferably on a regular basis).
6. Adjust management practice in response to results from monitoring and update the underlying conceptual model(s) to reflect these changes in practice and understanding of system behavior.

In Appendix C we show selected examples of the adaptive management cycles used by programs reviewed in this document. Each program is struggling to close the loop of the adaptive management iterative cycle in a cost-efficient manner.

Some authors distinguish between passive and active forms of adaptive management (Walters and Holling, 1990), although the usual case lies somewhere along the spectrum between these two types. Passive adaptive management may be appropriate when management constraints limit the testing of alternative actions, but then hypothesis testing is not as rigorous and the pace of learning can be slower. Active adaptive management develops and tests competing hypotheses regarding anticipated impacts of management actions, usually with several types of actions tested sequentially or in parallel. These generally require a larger investment of resources, but can often provide statistically testable information in a shorter period (Gregory, 2006).

The Puget Sound Partnership has made extensive use of the Open Standards for the Practice of Conservation (CMP, 2013) in its recovery planning and implementation of adaptive management. We recommend review of this same document by staff, scientists and stakeholders engaged in thresholds standards review and updating. Additional useful information related to adaptive management, indicator selection and ecosystem assessment approaches can be found in a document produced for the Delta Stewardship Council (Delta Independent Science Board, 2016) and in a technical report for the Puget Sound Partnership (McManus et al., 2014).

Clear governance structures, collaborative management, and open and effective communication are all critical elements for successful implementation of adaptive management programs (Berkes, 2009; Armitage et al., 2009; Hopkinson et al. 2017). Amongst the other programs addressed in this review, however, the Tahoe Threshold system is unique in that it forms the basis of a regulatory responsibility enjoined on the

TRPA. The success and broad acceptance of any future Environmental Threshold system for the Lake Tahoe basin will likely depend upon a transparent and collaborative management approach.

B) Link science-based indicators with management action.

- Although ultimate responsibility for setting Threshold Standards belongs to the TRPA, the engagement of other stakeholder groups in this process is critical to broad acceptance and support. See the description below on how the Chesapeake Bay Program uses Goal Implementation Teams to set work plans, develop management strategies and report on progress. These teams do not set the goals or desired outcomes, but they work collaboratively to achieve them.

- One has to recognize inherent differences between how standards, goals and policies are developed, compared to how plans for monitoring, evaluation and reporting are completed. Although linked, ideally, through the adaptive management cycle, they arise from different motivations and responsible parties. High-level governance structures give rise to standards, goals and policies, while working groups with scientific collaboration typically develop plans for monitoring, evaluation and reporting.

- Prioritization of indicators must focus limited resources on essential characteristics of the system. Initial screening should be based on formal evaluations using specific criteria (e.g., *measurable, precise, consistent, sensitive)* and coordinated stakeholder input. This should be followed by the application of a vetted and proven decision support system, or some alternative approach designed for the prioritization of these types of decisions, such as the expert solicitation process used by the Puget Sound Partnership.

- Conceptual models are essential tools used to describe our understanding of a system or resource and the factors affecting it. They are most useful when framed around program goals, and the appropriate indicators and metrics are integrated. Development (and ongoing update) of conceptual models is an essential underpinning to a logical and well-supported decision support system.

- It should be recognized that management objectives and policy priorities of natural resource systems do not remain static. Threats and opportunities change over time, especially in the face of increasing technology, population and climate change. The adaptive management cycle provides a mechanism for dealing with change when the iterative loop is successfully implemented.

- Various aspects of natural systems and management systems operate at different time scales. Indicators and monitoring should be designed to provide information on progress toward both short and long-term outcomes. As described below, the Everglades Restoration Program tracks a suite of indicators

designed to respond at different time scales. Program goals (and the associated indicators) must take this into account, and progress from management actions must be tracked at both scales.

- Responsiveness is an important criterion for successful management, and should always be considered when setting up the management structures and processes. Bureaucratic inertia must be considered and addressed so that appropriate levels of responsiveness can occur in the case of emerging threats, as recently exemplified by response to wildfire and aquatic invasive species threats in the Tahoe basin, for example.

- Document changes in management actions and policies to strengthen links to adaptive management. The development of restoration goals and changes in goals over time must document decisions based on the best available evidence, and should include revised objectives, corresponding actions, and expected outcomes. This should be accompanied by an organized approach to evaluate performance, measure progress and incorporate new information in an adaptive management cycle that supports continued programmatic evolution and progress.

Examples:

1) The Chesapeake Bay Program (CBP) negotiates all goals and outcomes through the Chesapeake Executive Council. Individual Goal Implementation Teams are responsible for meeting the outcomes of their particular goal area, and every two years must report to the Management Board on their work plans, management strategies and progress. If a goal or outcome needs to be changed, it is communicated to the Principals' Staff Committee, which acts as policy advisor to the Executive Council and elevates suggested changes for consideration by the Council, with public input. Indicators are developed and assessed by workgroups and the Goal Implementation Teams, with science review provided by the Scientific and Technical Assessment and Reporting (STAR) team. The reason for change would be identified through the periodic evaluation process, using an adaptive management framework.

2) In the Everglades, conceptual models and the best available science are used to select indicators that respond to management actions or environmental perturbations at different time-scales, and across different ecosystem attributes. This can provide information on both short-term and long-term management actions, helps decipher 'noise' from longer-term changes to the system, and allows more rapid response to environmental perturbations. The selected indicators are designed to have some overlap so when system-wide improvements occur they should manifest in multiple indicators.

C) Implement an informative and cost-effective monitoring plan.

- To the extent feasible, goal-specific implementation teams or designated working groups should be made responsible for the selection, monitoring and reporting of key indicators. This distributes the responsibility and the burden of indicator monitoring and reporting across multiple stakeholder groups and agencies. It also generates a diversity of perspectives and approaches, as well as engaged consensus with the process and findings.

- The adaptive management framework should distinguish between effectiveness (performance) monitoring and implementation monitoring, both of which are essential for completing the adaptive management cycle. Effectiveness monitoring indicates the results or outcomes of management actions, while implementation monitoring tracks the accomplishment of management actions as outputs. Both the Delta Stewardship Council and the Puget Sound Partnership, for example, use the terms "output" and "outcome" to distinguish between measures of management actions and measures of ecosystem consequences, respectively.

- The Puget Sound Partnership links outcome statements to output statements in setting specific incremental goals. Thus, both the environmental health goal, and the management goal are monitored empirically and evaluated, which gives information on progress towards the goal and the efficacy of the management action.

- Over time, through adaptive management cycles, the inherent uncertainties associated with initial aspects of conceptual model components and linkages should diminish as the models are used to guide targeted research and monitoring that then makes them increasingly explicit and capable of predicting changes in response to management actions. Uncertainties will be reduced by designing research and monitoring programs around evaluating the response linkages to specified actions or conditions.

- Science contributions are generally orchestrated through one or more research institutions that are commonly represented by an independent science board, committee or council. The Science Advisory Board of the Great Lakes Water Quality Agreement for, example, provides advice, analysis and review or support on science priorities, assessment of progress, and science reports, opinions or updates on current and emerging water quality issues as well as coordinating the cooperation, communication and collaboration needed to achieve integrated monitoring on GLWQA objectives and metrics.

- Contributions from the science community should be carefully integrated with management actions and evaluations as part of the adaptive management process. This integration is facilitated when there is frequent organized interaction between the external science community and program technical staff. The Chesapeake Bay Program supports this approach with close

communication between internal technical staff and an independent external science body.

Examples:

1) The Puget Sound Partnership uses a pressures assessment approach to inform its monitoring design. In this approach they identify pressures from human action that give rise to stress on the ecosystem. An intrinsic vulnerability analysis explores the expected ecological response to stressor-endpoint pairs. This intrinsic vulnerability evaluation produces a model-based, assumption-bounded, estimate of vulnerability and allows the comparison of potential for harm when stressors act directly on endpoints. Stressors or endpoints that have high uncertainty indices are considered when research and monitoring priorities are set.

2) The Great Barrier Reef integrates science, research and monitoring at multiple scales in a program called "Paddock (agricultural field) to reef." Models are developed by carefully evaluating the impacts of management and improved practices at the paddock and catchment scale. The relative impact on the reef of adopting that management or practice at a larger-scale is inferred from models. This process can be informative for creating and updating conceptual models and for guiding programs.

D) Periodically review and report on program goals.

- A formal reporting cycle is critical for communicating progress and return on investment. Many programs have changed the period of their reporting cycle over time, but they generally range from 2 to 5 years between in-depth reports.

- Staggered in-depth evaluation reporting will sometimes focus on specific aspects of the program, like the sequence of individual lakes evaluated by the Great Lakes Water Quality Agreement, where the burden of more frequent or comprehensive assessment is not supported by available resources. During interim periods, short informative videos and brief news releases can keep the program fresh and in the public eye pending the next detailed and comprehensive assessment.

- Most of the monitoring and scientific reporting should be peer-reviewed before publication, either internally or through a formal external process. Sometimes, evaluation reports on management progress are also peer-reviewed. There is a difference between whether the progress evaluation reports are peer-reviewed versus whether indicators and monitoring results are peer-reviewed. Appropriate peer-review of indicators and outcome expectations must be addressed whenever these change, as should be expected to happen on occasion within an adaptive management structure.

- Reporting and reports that are provided in a nested fashion can speak to different groups of stakeholders, whereby a reviewer or interested party can engage at appropriate levels by accessing more detailed information provided in supporting documents. Transparency and public participation is critical for designing this function so it can achieve its objectives. As discussed previously, the use of specialized terminology or jargon can be a barrier to effective communication. Therefore, terms and context must be described in detail and available to all stakeholders so there is a basis of shared understanding that supports engaged discussion.

- Many programs struggle with matching their reporting to initial evaluation goals of the program, often due to funding shortfalls, emergent issues, political or staffing changes, and missing or inadequate program documentation. Some successful programs divide their reporting into separate categories that include an essential focus on a small number of key attributes, indicators, and thresholds, and then reporting on peripheral aspects of the program. As funding waxes and wanes, there is a guarantee that core aspects will be evaluated thoroughly with the available funding, and peripheral evaluations will be conducted subject to time and funding constraints.

- Many programs are attempting to develop web-based data repositories that support the periodic evaluation reports. The more successful to date, use high-level data summaries and assessment for key indicators in an easy to understand format suitable for communicating progress to the interested public and associated stakeholders.

- The strength of linkage between indicators and goals or objectives varies within and between programs. How these are used to report progress varies accordingly. The Puget Sound Partnership uses outcome and output statements to focus on incremental or interim targets, where output statements are direct measurements of actions that affect outcomes. This provides two levels of progress reporting, one on an environmental health goal and the second on associated progress toward a management goal. The Chesapeake Bay Program links 31 desired outcome measurements to ten goal statements, and reports progress on each of the outcomes.

- Anticipating the linkages between management actions and environmental results is critical to an adaptive management cycle. These linkages should be explained by conceptual models that succinctly convey the dynamic interrelationships and strength of interactions between important environmental factors, system attributes and management options. Ultimately, these conceptual models help communicate decisions and progress to interested stakeholders and to the public.

- Outreach and education are important aspects of communicating management efforts and progress to the public. An educated populace is better equipped to support science-based policy decisions when they understand the concepts, processes, and linkages between management actions and desired results.

Examples:

1) Ecological reporting for the San Francisco Estuary Partnership is focused on five subject areas: Water, Habitat, Wildlife, Process, and People. These subjects are described with 32 general metrics in the State of the Estuary report 2015, aimed at providing the public with a broad perspective of the Estuary's health. Each of these general areas is subsequently described in more comprehensive scientific terms for those readers wanting more detail. This effort provides an excellent distillation of what would otherwise be an overly complex array of results. The Estuary News is also published four times a year with general interest topics. Short videos highlight special interest topics. These are available on the Partnership's website. There is a Partnership Newsletter that describes single topic issues. The State of the Estuary Report is published every 5 to 6 years.

2) The Chesapeake Bay Program (CBP) Management Board established an Indicators Framework to organize information and communicate progress toward achieving the Watershed Agreement Outcomes. This decision framework identifies three types of information needed to support an adaptive management approach for each of their 31 outcomes: 1) what key influencing factors can be controlled to achieve the desired outcome; 2) has output matched the work plan and management strategies; and 3) do performance measures indicate progress toward achieving the outcome? Operating in an adaptive management cycle, this framework seeks to refine key assumptions on influencing factors and the desired outcomes. Each outcome is evaluated on a two-year cycle, and results are communicated to the public and to stakeholders in an annual Bay Barometer report. The corresponding Chesapeake Progress web site contains additional information on progress for the CBP oversight group and interested parties.

Cited References

Armitage, D.R., R. Plummer, F. Berkes, R.I. Arthur, A.T. Charles, I.J. Davidson-Hunt, A.P. Diduck, N.C. Doubleday, D.S. Johnson, M. Marschke, P. McConney, E.W. Pinkerton, and E.K. Wollenberg. 2009. Adaptive co-management for social-ecological complexity. Frontiers in Ecology and the Environment. 7(2): 95-102.

Berkes, F. 2009. Evolution of co-management: Role of knowledge generation, bridging organizations and social learning. Journal of Environmental Management, 90: 1692-1702.

Conservation Measures Partnership. 2013. Open Standards for the Practice of Conservation. Version 3.0, April 2013.

Delta Independent Science Board. 2016. Improving Adaptive Management in the Sacramento-San Joaquin Delta. A report to the Delta Stewardship Council, January 2016.

Gregory, R., D. Ohlson, and J. Arval. 2006. Deconstructing adaptive management: Criteria for applications to environmental management. Ecological Applications, 16(6): 2411-2425.

Holling, C.S. (Ed.). 1978. Adaptive Environmental Assessment and Management. John Wiley & Sons, Chichester, UK.

Hopkinson, P., A. Huber, D.S. Saah, and J.J. Battles. 2017. A word to the wise: Advice for scientists engaged in collaborative adaptive management. Environmental Management, 59: 752-761.

McManus, E., K. Jenni, M. Clancy, K. Ghalambor, I. Logan, S. Redman, B. Labiosa, K. Currens, T. Quinn, W. Landis, K. Stiles, J. Burke. 2014. The 2014 Puget Sound Pressures Assessment. Puget Sound Partnership. Publication # 2014-04. Tacoma, WA.

Segan, Dan. Principal Environmental Specialist, Tahoe Regional Planning Agency, Stateline, NV. Personal communication, March 2017.

Walters, C.J. 1986. Adaptive Management of Renewable Resources. Mc Graw Hill, New York, NY.

Walters, C.J., and C.S. Holling. 1990. Large-scale management experiments and learning by doing. Ecology, 71: 2060–2068.

Westgate, M.J., G.E. Likens, and D.B. Lindenmayer. 2013. Adaptive management of biological systems: A review. Biological Conservation, 158:128-139.

Williams, B.K., R.C. Szaro, and C.D. Shapiro. 2009. Adaptive Management: The U.S. Department of the Interior Technical Guide. Adaptive Management Working Group, U.S. Department of the Interior, Washington DC.

Programs Reviewed

Chesapeake Bay Program (CBP)
(http://www.chesapeakebay.net)

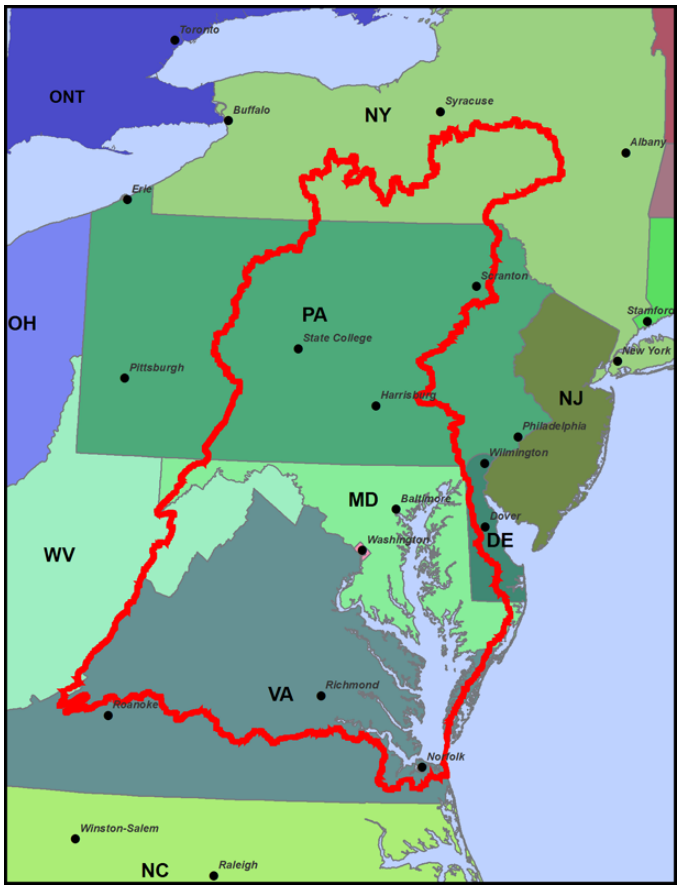
Chesapeake Bay is the largest estuary in North America and was the first congressionally targeted for integrated watershed ecosystem restoration. Its watershed comprises 64,000 square miles, 150 major rivers and streams, six states, along with the District of Colombia, and is home to over 17 million residents.

Massive fish kills in the 1970s resulted in a $27 million, congressionally funded, five-year U.S. EPA study that identified excess nutrient pollution as the main cause of water-column hypoxia leading to rapid loss of aquatic life. The Chesapeake Bay Commission was established in 1980 to coordinate policy across state lines between Maryland and Virginia. Pennsylvania was added in 1985 to form a tri-state legislative assembly that promotes intergovernmental cooperation and coordination for resource planning. The Commission is a signatory to the Chesapeake Bay Agreement of 1983, signed by the governors of Maryland, Pennsylvania and Virginia, as well as the mayor of the District of Columbia, and the administrator of the U.S. EPA. The Chesapeake Bay Commission now serves a legislative function on the Executive Council of the Chesapeake Bay Program formed by the Agreement of 1983.

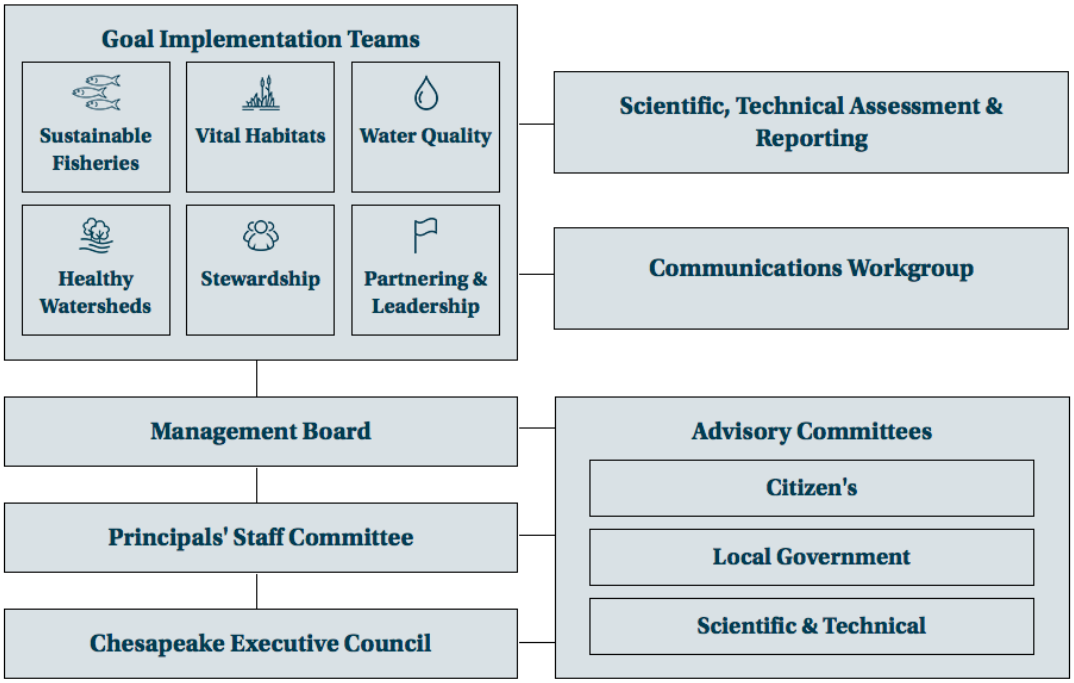
The 1987 Chesapeake Bay Agreement set numeric goals to reduce pollution and restore the Bay ecosystem. It was followed by Chesapeake 2000, a comprehensive agreement that established 102 goals to reduce pollution, restore habitat, promote appropriate land use practices, and to engage the public in restoration over a ten-year period through 2010. Governors from the headwater states of Delaware, New York and West Virginia have also officially committed to these goals.

In 2010 the EPA established the Chesapeake Bay TMDL, where each of the seven Bay jurisdictions was charged with creating their own jurisdiction specific Watershed Implementation Plans to meet pollution load cap goals by 2025. Most recently, in 2014, the six states, Washington DC, the Chesapeake Bay Council and the EPA signed a Chesapeake Bay Watershed Agreement that established science-based goals to guide the work of the Chesapeake Bay Program. This agreement established 10 goals and 31 outcomes for Chesapeake Bay restoration. The Chesapeake Bay Program currently lists 41 environmental indicators that are updated regularly to gauge success of restoration.

The focus has been on regional management organization and interstate cooperation, recognizing since earliest days of the Chesapeake Bay Program partnership that the initiative to clean the Bay has to come from the states to be successful. The Federal partnership, led by the EPA, helps to ensure coordination, facilitation, and oversight of this multi-state effort. Engagement of regional partners through the Chesapeake Bay Program under an adaptive management process, adopted in 2011, assures continued stakeholder engagement through Goal Implementation Teams.



Chesapeake Bay watershed map.



Chesapeake Bay Program organizational chart.

What is the major driver of the program or prioritization of main goals?
Environmental concerns emerged in the 1970s over eutrophication and damage to key habitats. Important aquatic species in the Bay were affected, resulting in threats to both commercial and recreational activities. The Chesapeake Bay Program now operates under the Chesapeake Bay Watershed Agreement of 2014, which established ten goals for collaborative management and restoration. The Agreement recognizes that these goals tend to be interrelated. For example, excess nutrients from many sources fuel algae growth in the water column, blocking sunlight to underwater grasses and damaging habitats, while excessive algae decomposition depletes dissolved oxygen and kills aquatic organisms and fish. The Chesapeake Bay Total Maximum Daily Load (TMDL of 2010) established limits for nutrient and sediment discharges into the Bay. There does not appear to be an established hierarchy for the ten goals of the Chesapeake Bay Program, although sustainable fisheries is generally listed first in Program websites and documentation.

How are indicators organized to provide an integrated evaluation system?
The Chesapeake Bay Watershed Agreement goal statements are supported by desired outcomes to restore the Bay, its tributaries and the lands that surround them. Forty-one associated indicators are used to assess progress toward these outcomes. Several of the outcomes are oriented toward achieving time-bound measurable targets. The ten goal statements are for: sustainable fisheries (with five outcome specifications), vital habitats (eight outcomes), water quality (three outcomes), toxic contaminants (two outcomes), healthy watersheds (one outcome), stewardship (three outcomes), land conservation (three outcomes), public access (one outcome), environmental literacy (three outcomes), and climate resiliency (two outcomes). Data are acquired and analyzed for each indicator to assess status and trends for reporting on progress toward desired outcomes.

How are management actions linked to indicator evaluations?
Management strategies and work plans are developed by Goal Implementation Teams. These management strategies indicate how Bay Program partners propose to achieve each outcome by 2025, as well as how they will monitor, assess and report progress. The strategies are further supported by successive two-year work plans summarizing participating partners, specific commitments, short-term actions, monitoring progress, data gaps and resources required for success. There are management strategies listed and two-year work plans developed for each of the 31 desired outcome statements. Furthermore, each of the seven Bay watershed jurisdictions have developed Watershed Implementation Plans (WIPs) that detail how and when each will meet their pollution-reducing goals (mainly associated with the 2010 Chesapeake Bay TMDL). Agreeing to achieve numeric goals within set deadlines has been a hallmark of the restoration approach taken by this Program since its Agreement of 1987.

What role do science partnerships play in establishing program goals and supporting the monitoring and evaluation of progress toward those goals?
The Chesapeake Bay Program has used a series of science-based goals to guide restoration work since 1984, when the Scientific and Technical Advisory Committee

(STAC) was established to provide scientific and technical guidance to the Chesapeake Bay Program (CBP) on measures to restore and protect the Chesapeake Bay. STAC provides independent scientific and technical advice through independent scientific peer reviews, scientific and technical workshops, technical reports and position papers, discussion groups, assistance in organizing merit reviews of CBP programs and projects, technical workshops, and interaction between STAC members and the CBP. STAC serves as a liaison between the region's scientific community and the CBP. Through professional and academic contacts and organizational networks of its members, STAC ensures close cooperation among and between the various research institutions and management agencies represented in the Bay watershed. Working with the STAC the CBP's Scientific, Technical Assessment and Reporting (STAR) Team facilitates collaboration between science providers and Goal Implementation Teams to support CBP priorities and assist with management decision-making. STAR is responsible for updating and delivering data on the status and trends (indicators) of ecosystem conditions and for communicating these results to support the CBP decision framework. STAR provides internal day-to-day support for Goal Implementation Teams, while STAC is intended to provide an independent, external source of scientific and technical advice to the CBP. The STAC Chair is a non-voting member of the CBP Management Board.

What are the data requirements for the evaluation system?

Data requirements for outcomes are outlined in the biennial work plans of each Goal Implementation Team. Tracking factors contributing to 31 outcomes is a relatively data intensive effort. Each outcome is reported separately in the CBP biennial progress reports and on their website. The Chesapeake Information Management System (CIMS) is the CBP's ongoing cooperative approach to ensuring all environmental data funded and generated by the partnership and its partners are made publically accessing for supporting management, decision-making, and communicating Chesapeake Bay and watershed information. ChesapeakeStat is currently accessible on the Chesapeake Bay Program website as a data sharing and warehousing website. ChesapeakeDecisions, currently in development, is supported by a series of internationally recognized models and collections of data for progress runs, as well as scenario builder tools that support multi-million dollar decisions.

How are evaluation results communicated?

Assessment of progress for indicators and watershed-wide restoration is issued as an annual CBP publication, the "Bay Barometer". In addition, the framework for a CBP Tracking Tools website has been developed as part of ChesapeakeStat. A separate ChesapeakeProgress website has been established by the CBP to document progress toward goals and outcomes of the Chesapeake Bay Watershed Agreement. Linked to annual updates of the Bay Barometer report it functions as a public report card on progress toward each of the outcomes and provides access to data, methods and summary graphics.

How are evaluation results used to make changes to the program?

The Chesapeake 2000 document signed by Bay Program partners establishing more than 100 goals to reduce pollution, restore habitats and achieve other objectives. In 2009 ongoing evaluations indicated that restoration needed to accelerate, so short-term two-year restoration milestones were established that year and are now updated biennially for the water quality outcomes, and two-year workplans are developed for the remaining 31 desired outcomes by their corresponding Goal Implementation Team. As signatories of the Chesapeake Bay Watershed Agreement identify new opportunities and concerns, goals or outcomes may be adopted or modified. The Principals' Staff Committee can approve changes or additions to outcomes, although significant changes or additions must be raised to the Executive Council for approval. Proposed changes to goals and outcomes or suggested addition of new ones will be open for public input before being finalized.

What are the main successful attributes of the program?
The annual Bay Barometer report documents progress toward each of the ten Chesapeake Bay Program goals and associated 31 desired outcomes. Because these goals and outcomes are generally based on quantitative time-based targets, they can demonstrate significant progress toward meeting several of these. The ChesapeakeProgress website is very well organized and executed, providing evidence-based results toward for the public and other stakeholders. Organization of the Chesapeake Bay Program Executive Council includes each of the state governors and the chair of the long-standing Chesapeake Bay Commission, as well a representative from the EPA. A variety of state and federal agencies participate as well as academic partners and NGOs are engaged in producing capital projects and in gathering data for assessing progress. These are organized in a responsive governance structure based on Goal Implementation Teams, which are a set of active working groups focused separately on each of the desired outcomes. The biennial reporting provides a timely feedback process for the adaptive management approach adopted by the CBP. The director of the CBP is an appointed representative from the USEPA. This assures accountability and focus among the many jurisdictional partners and agency representatives.

What are perceived weaknesses of the program?
The program started with many goals, but has reduced these over time. The CBP is highly dependent on federal funding to continue their restoration work and monitoring. This makes them susceptible to changes in federal budget priorities. Efforts are currently underway to diversify the funding sources, and to develop funding streams that will continue to support monitoring when budgets change and funding sources shift. The CBP website is slow and does not link directly to the ChesapeakeProgress website.

Estimate of funding used to keep the program operational.
A total of $536.4 million was invested by federal agencies in environmental restoration in the Chesapeake Bay watershed in fiscal 2016. The Office of Management and Budget (OBM) estimates that state and federal partners invested $1.8 billion for environmental

restoration that year, with much of it directed to support efforts for achieving the TMDL.

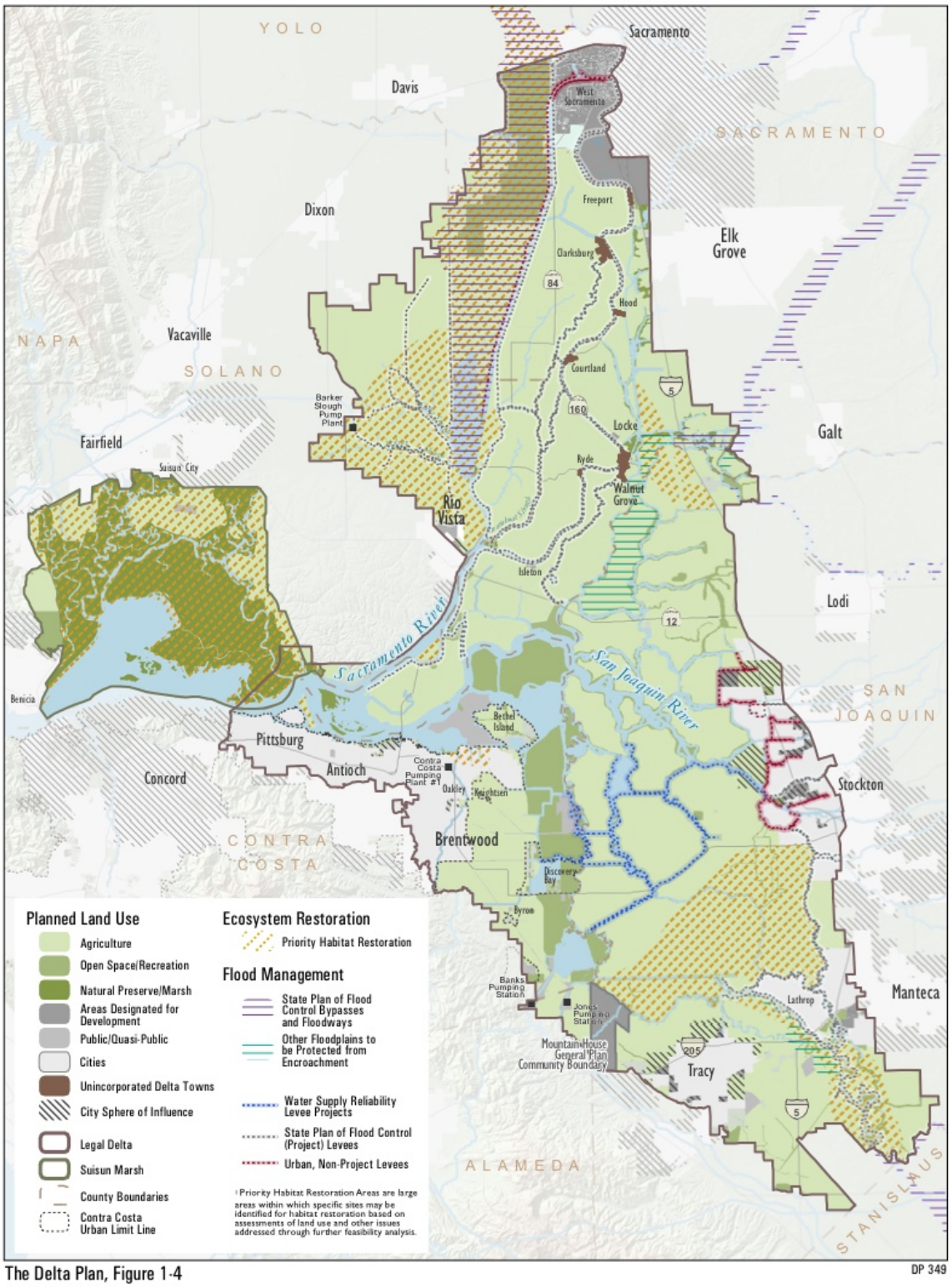
Delta Stewardship Council (DSC)
(http://deltacouncil.ca.gov)

The Sacramento-San Joaquin River Delta is a legally defined area of approximately 1,300 square miles. It represents the most upstream extent of the San Francisco Bay estuary. It supplies California with 8% of its freshwater needs (but disproportionately provides southern California with 25% of its needs), and is the largest estuary in the western hemisphere providing essential habitat for 100 wildlife, 140 plant, and 13 taxa of fish listed as special emphasis species. It is also home to 11 historic communities, with 1335 miles of levees protecting 800,000 acres of land and infrastructure. Water supply, dependent species and local communities are all at risk due to their competing demands and the dynamic and changing water supply resulting from climate change.

Managing this is the responsibility of more than 18 primary agencies. In 2008, the State legislature established the Delta Stewardship Council (DSC) to regulate development and coordinate agency efforts to meet co-equal goals of providing a reliable supply of water and protecting and restoring the ecology of the Delta while preserving the Delta as a place. Health of the upper Delta is described in a 2015 Bay Estuary report as poor.

The concept the DSC represents is to regulate and limit development within the legally defined Delta, to coordinate applicable agency efforts to achieve co-equal goals, and to steer the process with unimpeachable science. The DSC implements its strategies through 73 Delta Plan *Recommendations* and 14 legally enforceable *Policies* that pertain to regulatory issues addressed by the Delta Plan. *Recommendations* effect tasks being done or to be done by other agencies that the Council believes are essential to attainment of the co-equal goals. Actions the recommendations engender are tracked in an online database, organized by relevant state and federal agency. Recommendations are further monitored via *performance measures* designed to capture important trends and to address whether interagency actions are producing expected results. The Delta Plan is currently being modified to update the performance measures. *Policies* are legal requirements that anyone undertaking a significant project in the Delta must meet.

The process the DSC uses is intended to be adaptive, utilizing best available science and objective decision making in an environment historically awash with conflicting science. To achieve credible, "best science", the DSC includes a robust science team, and an Independent Science Board composed of 8 nationally acclaimed scientists selected from universities across the country. The head of the DSC's science team is also a nationally known figure who generally serves a four-year term. The purpose of the Delta Science Program is to serve as an unbiased arbiter for current science for all agencies and to initiate and fund research on key topics to facilitate the coequal goals. Monitoring results and evaluation of performance measure data is accomplished or coordinated through the Interagency Ecological Program and the science team. Results are shared with an Interagency Implementation Committee who recommends changes to the Plan its policies and recommendations or its performance measures which completes the adaptive management cycle.



The Delta Plan, Figure 1-4

Map of the legally defined Delta illustrating water delivery and ecological restoration work. This area represents the upper end of the San Francisco bay Estuary, and demonstrates an overlapping authority.

What is the major driver of the program or prioritization of main goals?
The main driver for the Delta Stewardship Council's (DSC) management plan is to coordinate state and federal agencies to resolve the long standing conflict for water use in the Sacramento and San Joaquin rivers. The conflict arises because agricultural interests and southern California communities require very large volumes of water to function which takes water out of the river system, depriving dependent fish and wildlife populations the fresh water they need to survive.

How are indicators organized to provide an integrated evaluation system?
The Council's Delta Plan includes 160 performance measures in three categories: Administrative performance measures (118) are used to track various actions recommended by the Delta Plan. Output performance measures (21) are used to track results of administrative action (what happened as a result of the project or program?). Finally, outcome measures (21) are included for tracking the impacts of those actions (did the project or program achieve the desired results?).
Staff monitors the progress of the 118 actions tracked by the Delta Plan's administrative measures. Of these, 100 have either been completed or are in the process of being completed.

Delta Plan performance measures have been placed into three general classes:

1. Administrative performance measures describe decisions made by policy makers and managers to finalize plans or approve resources (funds, personnel, projects) for implementation of a program or group of related programs.
2. Output (also known as "driver") performance measures evaluate the factors that may be influencing outcomes and include on-the-ground implementation of management actions, such as acres of habitat restored or acre-feet of water released, as well as natural phenomena outside of management control (such as a flood, earthquake, or ocean conditions).
3. Outcome performance measures evaluate responses to management actions or natural outputs. Core Output/Outcome Performance Measure Criteria

Performance measures are further broken down and evaluated as follows.

- Metrics define the unit(s) of measure and other characteristics for tracking aspects of performance over time.
- Baselines are standards or historical reference conditions for comparing with the current condition.
- Targets are the desired future conditions or trends.

How are management actions linked to indicator evaluations?
The Delta Vision Foundation (an outside group) annually prepares a report on the state of the Delta. The San Francisco Bay Delta Estuary Partnership prepares a Bi annual report on the state of the Delta, of which the DSC manages about a fifth of the estuary, and the Council prepares an annual report on the state of its efforts to achieve the co-equal goals. Project evaluations are accomplished by interagency partners, except at a larger scale typical of an annual report.

What role do science partnerships play in establishing program goals and supporting the monitoring and evaluation of progress toward those goals?
The Delta Science Plan coordinates interagency science efforts in the Delta. The Interagency Ecological Program (state and federal agencies) coordinates the broader San Francisco Bay Estuary monitoring including the Delta. Both organizations share individuals (the Ecological Program lead is a member of the Delta Science team), and have a productive collaborative working relationship.

What are the data requirements for the evaluation system?
Data collection and management is coordinated by the Interagency Ecological Program and by individual participating agencies. Data requirements are established by the Delta Science Team and the Interagency Ecological Program, although individual agencies currently store their own data. The DSC Science program is the proposed repository for models, although individual agencies would perform model development in most cases. The Science program oversees the broader process, emphasizing the evolution of data into knowledge. See following diagram.

How are evaluation results communicated?
Evaluations are tracked and communicated by:

1) An on line tracking database that follows agency progress with "recommendations listed in the Delta Plan.
2) Semi annual state of the Delta reports.
3) Delta Newsletter (Monthly)
4) Public Council Meetings (Monthly)
5) Videos of meetings and informational, subject specific videos
6) Science forums (annually), with explicit discussions of policy changes engendered by recent science.

How are evaluation results used to make changes to the program?
The science team evaluates monitoring data and can directly or in combination with the Council staff recommend actions to the Council. The Council can also request review of issues from the Independent Science Board. Action can be taken at regular Council Board meetings based on staff recommendations, Science Team Recommendations or Independent Science Board recommendations. In addition, the Council can choose to advance issues to the Interagency Implementation Committee for review and/or action.

What are the main successful attributes of the program?
The DSC's Plan has been effective in coordinating multiple state and federal programs to improve their overall effectiveness and efficiency. The Interagency Implementation Committee has also provided a forum for face to face communication and exchange of ideas among agency leaders.

What are perceived weaknesses of the program?
Some believe the agency exerts too much control over Delta activities and development. Others believe the agency should offer explicit targets that are legally required. The

Court in a recent ruling against the Council highlighted the latter issue as a deficiency of the Delta Plan.

Many of the controversial issues regarding water management were tied to the Bay Delta Conservation Plan. Since the fate of the BDCP is uncertain now, this may put additional pressure on the Delta Plan to provide the missing leadership.

Estimate of funding used to keep the program operational.
Funding is primarily received through State appropriations (27 million). Grant dollars are also received through various programs. The State limits the DSC's authority to accept outside funding to approximately 7 million dollars annually. Funding has been relatively stable. Other agencies provide the bulk of project funding.

The DSC has approximately 64.5 permanent employees; approx. 12 on the science team and 52 on the management team. The 2016-2017 budget is:

General administration	$5,490,000
Planning & Performance Mgmnt	$6,040,000
Science Program Salary & admin	$7,575,000
Independent Science Board	$675,000
Research funds	$7,000,000[1]
Interagency Ecological Program Lead	$200,000
Total projected funding	$26,776,000.[2]

[1] In addition to the 7 million dollars of allocated funding for research, an additional 7.2 million dollars of authority to accept outside funding for research is authorized.
[2] The Interagency Ecological Program is an interagency effort to coordinate multiple agency monitoring budgets intended to reduce duplication and increase the value of state funded monitoring in the Delta. The Interagency Ecological Program's annual budget is approximately $22,840,000.

Everglades Restoration Program
(http://www.evergladesrestoration.gov)

Known as a river of grass, shallow freshwater marshes and tree islands dominate in the Everglades. Additionally, within the 18,000-square mile ecosystem there are four unique regions including a major lake, the riparian and estuarine system, mangrove and open ocean, and the iconic marsh. The basin covers all of South FL and contains over 6 million people, and significant agricultural land-use (sugar cane, citrus, cattle). The hydrology is heavily managed for flood-control, drainage, and ecosystem health. Man-made structures channel 1.7 billion gallons of water daily to the ocean.

Beginning in the 1950's, the Army Corps of Engineers (ACOE) began a process of flood control and drainage that resulted in a complete hydrological modification of what was once a continuous 'river of grass'. In addition to hydrological fragmentation, agriculture has increased the nutrient load resulting in significant shifts in vegetation and TMDLs. To restore natural flow, manage nutrients, and provide flood control for the growing populace, the US congress enacted the largest hydrological restoration project in the US called the Comprehensive Everglades Restoration Plan (CERP) in 2000, underneath the Water Resources Development Act of 2000 (WRDA). Defined by WRDA, a 14-member task force composed of local, state, federal and tribe members with the Secretary of the Interior as the Chair was created and a Science Coordination Group was established.

The Science Coordination Group was tasked with carefully selecting an 'elegant few' organisms that serve as indicators of system-wide ecosystem response. Considerations for these indicators include organisms that are responsive at various time scales (e.g. periphyton to crocodiles), most strongly linked to ecosystem disturbances and restoration actions (e.g. flood timing, salinity), cost-effectiveness and feasibility of monitoring, and ease of communication to decision makers. The indicators are designed to have a large degree of overlap so that when systemwide improvements occur, multiple indicators should respond, and the differential response among indicators can allow for the reevaluation of models. Based on this assessment, 11 strictly biological indicators were selected. It is difficult to compare these biologically-based indicators to other programs directly. The indicators are most comparable to individual Tahoe *standards*, although some of the Everglades indicators may have more than one standard. However indicators are counted, it is clear that this biologically-based indicator program, composed of a small number of indicators is unique.

The federal/state partnership between the ACOE, National Parks Service, and the South Florida Water Management District is an investment of over $10.5 billion dollars over 30+ years. Cooperation agreements were developed thoughtfully at the beginning of the program in WRDA, and are updated frequently. Fourteen stakeholders represented by the Task Force give input, although one state and one federal agency make the final decisions. Data is reported in a nested approach so engagement can occur at many levels. Systemwide science reports solely include the 11 system-wide indicators evaluated for each of the four regions, and then broader monitoring of many more standards is incorporated in to reports centered around each specific region.

Everglades Restoration Program area map.

What is the major driver of the program or prioritization of main goals?
Balancing the water needs of an expanding population with the needs of the ecosystem. Ecosystem protection includes the preservation of a variety of species and unique habitats, (oysters, seagrass, aquatic vegetation, wading birds, tree island, ridge and slough habitat). Hydrology is a significant driver in this ecosystem and therefore water stage, flows, and salinity are a primary concern. Additionally, managing the residual and current nutrient loading from agriculture is a significant component of this program.

How are indicators organized to provide an integrated evaluation system?
Indicators consist of 11 carefully chosen organisms that are known from science and monitoring to respond directly to changes in ecosystem components, and which are representative of different time-scale responses. Through the evaluation of these indicators, short and long-term responses to management actions, and ecosystem degradation across a wide array of biogeochemical, hydrological, and ecological attributes can be evaluated. The indicators are chosen specifically because they represent unique attributes, but also so there is a large degree of overlap. Resulting from these commonalities, it is expected that multiple indicators should react simultaneously. This allows for confirmation of improvements, and a reevaluation of models when responses aren't synchronized. The Everglades has four major regional ecosystems, and key indicators are utilized to evaluate the health of each specific region. A systematic evaluation of the indicators and monitoring results takes place every 5 years. The number of indicators has declined over time but not as a result of a scientific assessment, but resulting from funding limitations.

How are management actions linked to indicator evaluations?
Indicators are chosen so they have direct responses to ecosystem attributes that can be affected by restoration and management. Through indicator evaluation, changes in salinity due to management of the lake can be described by oyster counts; the timing of controlled flooding can be evaluated through wading bird counts for instance for instance. As discussed previously, the strong overlap between indicators allows for the evaluation of system-wide responses to management over the short and long term.

What role do science partnerships play in establishing program goals and supporting the monitoring and evaluation of progress toward those goals?

Collaboration is a significant part of the Everglades restoration and the leadership group has one representative from each agency involved. Significant planning and documentation has been used to structure these collaborative relationships from the beginning, and they have been updated regularly. Two main agencies (ACOE and South Florida Water Management District) make the final science decisions, although there is input and collaboration from over 12 agencies. Monitoring is done by principal investigators, and regional coordinators who are leaders in the region are chosen to oversee these programs.

What are the data requirements for the evaluation system?
(Not available.)

How are evaluation results communicated?
Results are communicated in a nested fashion. Large-scale results are communicated every five years for 11 indicators in System Status Reports to the public. Additionally, the results of more broad monitoring are reported within each of the four unique regions of the Everglades. The data is not available to the public generally, although they can be made available upon request. Generally this data is only available to key stakeholders. Lastly, they have hired a group from the University of Maryland for their upcoming report to improve communication.

How are evaluation results used to make changes to the program?
This process is primarily driven by conceptual ecosystem models. These models are used to predict changes, and evaluate management actions. These models are in the process of being updated for the first time in about a decade. As described previously, the 11 indicators were chosen to allow for an assessment of programmatic changes, and the updating of models. Given the expectation of an integrated and correlated response between indicators, any deviations in these responses are informative to models and the program more broadly.

What are the main successful attributes of the program?
The healthy collaborative relationships between many agencies and stakeholders, the size and complexity of the restoration program, and the scientific and engineering rigor are all known as strong attributes of this program. The most significant positive attribute is the methodology and the thought that went in to creating a small number of elegant indicators. The planners of the program understood that too many indicators can confuse results reporting and so they developed a method to decipher ecosystem response and management with a small number of indicators.

What are perceived weaknesses of the program?
Indicators have been reduced in scope not as a result of a science-based program evaluation, but as a result of limited funding. The restoration plan is far behind schedule, and the pace of capital investments has been limited. The program doesn't stress emerging threats (i.e. climate change, invasive species) in a significant manner.

Estimate of funding used to keep the program operational.
Actual funding fluctuates annually as a result of property tax revenue to the South Florida Water Management District, and modifications to state funding. Additionally, land acquisition is a big part of this program, which creates years of high spending when large parcels are purchased. In FY2016 the adopted state budget includes a cost of $750 million, with $523 million in revenue from the SFWMD. Federal funding in FY2016 is approximately $200 million for a total of $950 million. The population in the basin is approximately 6 billion and the land- area is approximately 18,000 square miles. Normalized metrics of cost per person and cost per area are thus $58 per person, and $19,444 per square mile

Approximately 73% of the program budget goes towards capital improvement projects, while the remaining portion is used for 'adaptive assessment and monitoring, program coordination, and in-kind work'.

Given the price tag of $10.5 billion over 30 years, an annual estimate of project spending can be calculated. The population in the basin is approximately 6 million and the land- area is approximately 18,000 square miles. Normalized metrics of cost per person and cost per area are thus $158.33 per person, and $52,778 per square mile.

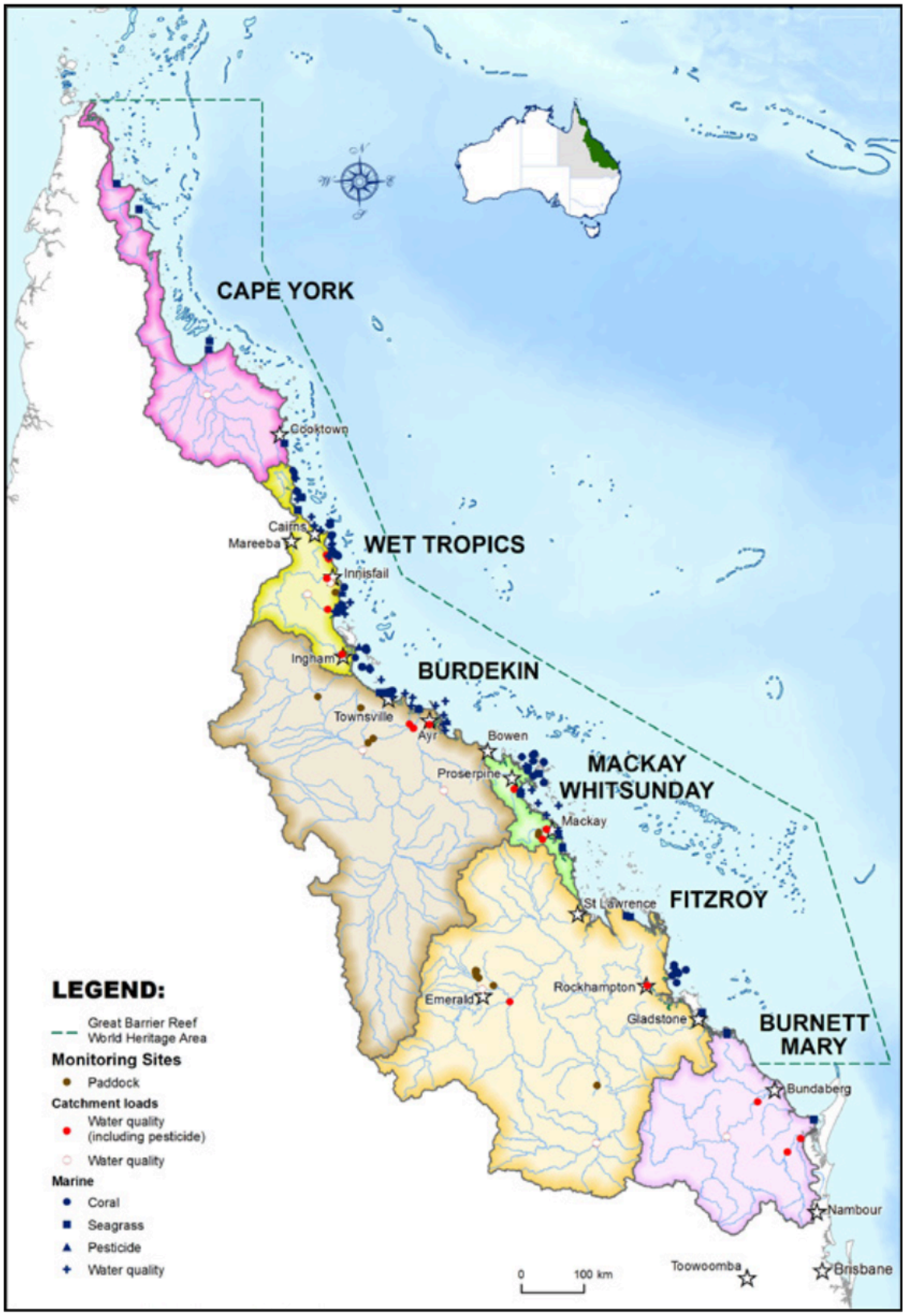
Great Barrier Reef Plan
(http://www.reefplan.qld.gov.au)

The Great Barrier Reef is a world heritage site bordering the state of Queensland in Australia that consists of approximately 3,000 reefs stretching over 130,000 sq mi. Thirty-five major streams discharge in to the reef from a 164,000 square mile catchment, and the water quality of the reef is therefore intricately linked to land-use. Cattle is the predominant agricultural land-use (77%), although there are extensive sugarcane fields (1.4%), horticultural crops (0.2%) and other agriculture. The population in the basin is expected to reach approximately 1.6 million by 2026.

The motivation for the environmental assessment came from the World Heritage Committee's recommendation in 1981 protect the *Outstanding Universal Value* of the reef. In 2001, the Great Barrier Reef Marine Park Authority released a report on the decline in water quality in the reef, and an independent panel of scientists produced a report linking land-use to water quality degradation. It was observed that water quality is declining primarily due to nutrient, and sediment loads from diffuse non-point sources. The reef water quality protection plan was created in 2003, and updated in 2009, and 2013 based on inputs from an independent science panel. The main changes were driven by a slow adoption of BMPs, and declining water quality. The first report card was produced in 2009, and has been produced annually ever since.

The main focus of the program is on reducing diffuse non-point pollutant loads from streams, which benefits the reef directly and increases resilience towards climate change. Therefore, much of the focus of this program is on implementing, monitoring, and modelling best management practices in an adaptive process. This is strongly informed by direct experiments, precise monitoring, and field to catchment models and monitoring. The environmental health indicators are concise and consist of four management indicators centering around BMP implementation, a ground cover indicator, and three standards of nitrogen, sediment, and pesticide loading.

The assessment is managed by the Australian government and the State of Queensland, with partners ranging from research institutions, academics, farmers, private consultants, and traditional owners. The governments of Australia, and Queensland have committed $278 million over the next five years. The data is reported in report cards that rank progress towards 2018 goals. The importance of the indicators are weighted, and the scores are listed as academic scores (i.e., A, B, C, D, F)



Great Barrier Reef Plan area map.

What is the major driver of the program or prioritization of main goals?
The major driver of the program is declining water quality in the Great Barrier Reef from diffuse non-point pollution. There are 35 catchments discharging to the reef, and there is a significant amount of agriculture in the basin. Nitrogen runoff from fertilizer causes outbreaks of coral eating crown-of-thorns starfish; suspended sediment from various sources attenuates light and leads to seagrass and inshore reef loss; and climate change is causing large-scale bleaching events. The goal of the program is to decrease nutrient, sediment, and pesticide loading by implementing Best Management Practices. This will improve coral health and increase the resiliency of the reef to climate change.

How are indicators organized to provide an integrated evaluation system?
Monitoring data is collected at multiple scales from the paddock (field), to catchment to reef (Paddock to reef program). Monitoring at each scale informs the whole. Field-scale experiments on BMPs at the field level are evaluated, the data is modelled for the entire catchment to provide predictive results, and the water quality of the reef is evaluated.

How are management actions linked to indicator evaluations?
The major management in the basin is the application of BMPS in agriculture. The indicators themselves are composed of four management actions, which are simply the percent application of best management practices in four types of agriculture. Based on field-scale experiments this is modelled to the catchment scale. Monitoring at the catchment scale is used to assess management and modelling.

What role do science partnerships play in establishing program goals and supporting the monitoring and evaluation of progress toward those goals?
Science partnerships have been significant from the very beginning. The original reef plan was spearheaded by a group of scientists. An independent science panel was created in 2009. The program is regularly re-evaluated in a holistic manner and this has resulted in frequent updates to the programs. The reef program has been updated twice since 2003 based on the slow adoption of BMPs and a continued decline in water quality

What are the data requirements for the evaluation system?
(Not Available.)

How are evaluation results communicated?
The results are communicated via a report card that provides weights to the given indicators, and lists the results as academic scores (i.e. A, B, C, D, F).

How are evaluation results used to make changes to the program?
It is clear that this program has been in a state of flux since it's inception. The program has been updated twice since 2003. This has been based directly on the evaluation results and the contribution of the independent science panel. Based on observations of slow BMP adoption, and declining water quality the plans have been updated.

What are the main successful attributes of the program?

The program has a strong focus on BMP implementation and capital improvement projects to reduce stream loading. There is a strong emphasis on science and research, that is manifested in experiments, field-scale evaluations, and modelling. The program has a strong record of reevaluation. This is both a positive and negative attribute as these reevaluations were driven partly by program failures.

What are perceived weaknesses of the program?
Based on available information this program is overly simplistic, disorganized, and lacks clear goals and indicators. This is especially true in comparison to the other programs evaluated. It has been difficult to find clear and concise information about details of the program, beyond simple statements of goals, and a simple report card. It is uncertain if this is from limited reporting to the public on the plan, or if the plan itself is limited. The funding appears to be small for such a large, and significant watershed.

Estimate of funding used to keep the program operational.
The Australia and Queensland government is spending $278 million over five years to run the program. Normalized to population and area, the costs are $34.75 per person and $339 per square mile respectively.

Great Lakes Water Quality Agreement (GLWQA)
(http://www.ijc.org/en_/Great_Lakes_Water_Quality)

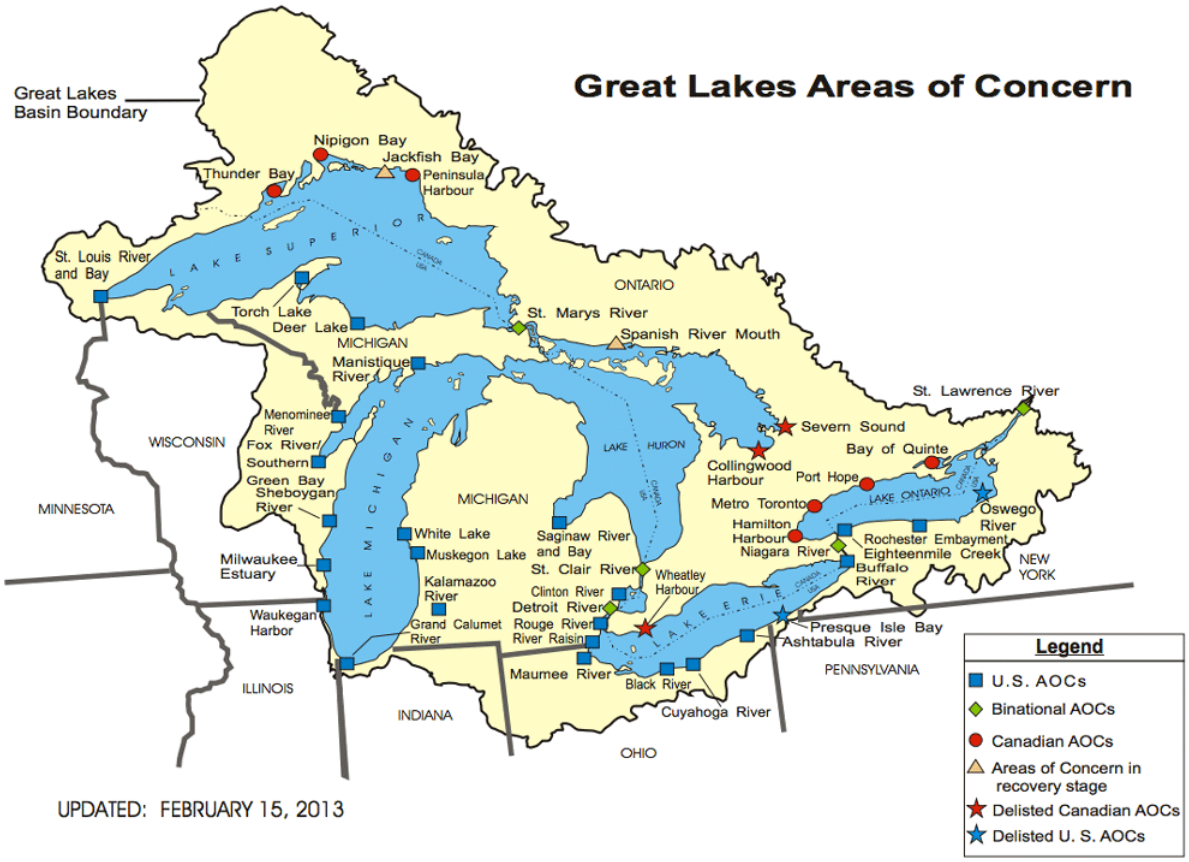
The Great Lakes of North America formed about 14,000 years ago at the end of the last glacial period. This group of lakes contains over 20% of the world's total surface fresh water by volume. Surface area of the five main lakes is greater than of the United Kingdom, about 94,250 square miles, and its drainage extends to more than 200,000 square miles (not including lake surface). This watershed crosses jurisdiction of two countries and eight U.S. states, with over 30 million people living in the Great Lakes Basin.

The International Joint Commission (IJC) was established in 1909 to address U.S. and Canadian transboundary water resource issues, primarily related to water use, diversion or obstruction. The Great Lakes Water Quality Agreement (GLWQA) was added in 1972 to address water quality issues resulting from pollution that caused excessive algal growth and bacterial contamination. This agreement established the Great Lakes Water Quality Board and the Research Advisory Board to advise the IJC. As new issues emerged over time, several GLWQA amendments were added to identify and address threats with renewed commitments to "science governance and action that will help restore and protect the Great Lakes water quality and ecosystem health." This includes preventing environmental threats before they cause ecological harm.

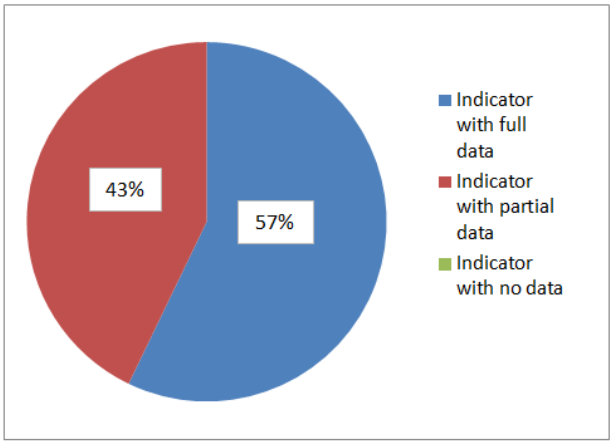
The GLWQA amendment of 1987 established Lakewide Management Plans and Remedial Action Plans for Areas of Concern. The purpose of these action plans was to restore and maintain the chemical, physical and biological integrity of the Great Lakes Basin ecosystem, with a focus on Areas of Concern (AOC) that had at least one beneficial use impairment. The 16th and final Biennial Report on Great Lakes Water Quality was published in 2013. It identified a set of three Apex Indicators (Ecosystem, Human Health, and Response) that summarized trends over time from available data on 16 separate indicators: seven on chemical integrity, two on physical conditions, five on biological integrity, and two indicators of performance on AOC restoration.

The 2013 report acknowledged that although approximately 80 indicators were reviewed, most suffered from data gaps and short-term records. Specifically, the IJC recommended that "even in a time of budget austerity, the governments should allocate sufficient resources to monitor a core set of indicators," and that targets, goals or standards be developed for each of the core indicators and resources provided to achieve the goals. A subsequent 2014 Great Lakes Ecosystem Indicator Project Report identified 41 individual measures (or metrics) that would support triennial assessment and reporting on the 16 key indicators.

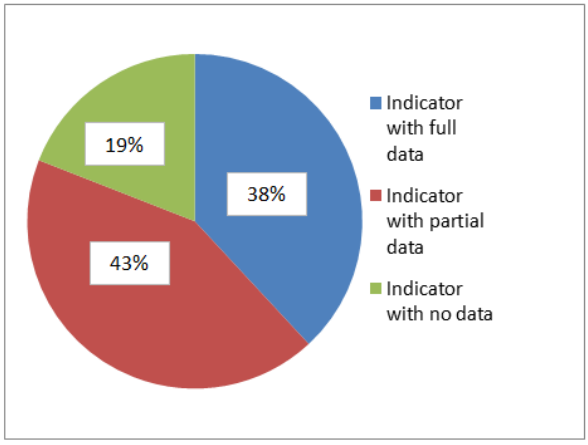
The IJC is required to issue an Assessment of Progress Report, which will be informed by its current advisory boards: the Water Quality Board, the Science Advisory Board, and the Health Professionals Advisory Board. This report will be issued every three years based on the Progress Report of the Parties, the State of the Great Lakes Report, the advisory board reports, its own reports and extensive public consultation..



Great Lakes Basin (North America) and Areas of Concern (AOC) map.



Data availability for calculating indicator status



Data availability for assessing trends of indicators

Percentages of IJC indicators that have full, partial and no data for indicator calculation and detecting trends (from Great Lakes Science Advisory Board Research Coordination Committee, 2016).

What is the major driver of the program or prioritization of main goals?
Primary issues have evolved over the years, beginning with water use and allocation in the early 1900s, to phosphorus reductions in the early 1970s, persistent toxic substances and ecosystem approaches subsequent to that, and aquatic invasive species, harmful algae and climate change more recently. Overall, current goal is to restore and maintain the chemical, physical, and biological integrity of the waters of the Great Lakes Basin Ecosystem. The 2012 GLWQA amendment placed priority on monitoring and scientific assessment to evaluate progress of Great Lakes programs. There are currently nine GLWQA general objectives, related to restoring beneficial uses, with associated indicators and measures (metrics). International treaty and agreements provide legal structure for coordination and decision-making.

How are indicators organized to provide an integrated evaluation system?
As issues evolved over the decades, so have indicators. Ultimately, the sheer number of indicators became so large that despite being comprehensive it was difficult to assess and communicate progress. This led to a series of IJC workshops to evaluate the role and number of indicators, which had grown to approximately 80 by 2011. These workshops proposed a reduced set of 21 key indictors with 51 measures divided into two categories: one focused on factors that affect human health and the other focused on health of the ecosystem. A more recently updated approach identifies nine high level indicators (Vital Signs) linked to nine GLWQA objectives, with 44 sub-indicators and 56 or more corresponding metrics.

How are management actions linked to indicator evaluations?
Under Annex 2 of the GLWQA each of the Great Lakes must develop and then update a Lakewide Action and Management Plan (LAMP) every five years. These plans will address the nine General Objectives of the GLWQA but should also evaluate a set of Lake Ecosystem Objectives (LEOs) that are currently in development. It is anticipated that LEOs will be used as a systematic approach among the Lakes to specify interim and long-term ecological conditions needed to achieve the General Objectives, while being flexible enough to accommodate unique characteristics and challenges faced by each lake. The management actions and projects described in these reports are organized to address the LEOs. If not lake-wide, these actions are often directed at specific Areas of Concern (AOC) with the goal of achieving AOC delisting.

What role do science partnerships play in establishing program goals and supporting the monitoring and evaluation of progress toward those goals?
The Lakewide Action and Management Plans use data derived from recent State of the Great Lakes Reports as well as from Cooperative Science and Monitoring Initiatives. Science and monitoring priorities are identified through lake-wide management discussions, with input opportunities available to all stakeholders and the interested public. These recommendations are then aligned with the GLWQA general objectives and the Lake Ecosystem Objectives to develop five-year priority plans for research and monitoring. At a higher level, the Great Lakes Science Advisory Board (SAB) reports directly to the IJC and orchestrates much of the binational research and monitoring that results in triennial Assessment of Progress on Great Lakes Water Quality and the

development of the triennial State of the Great Lakes Report. The SAB provides advice, analysis and review or support on science priorities, assessment of progress, and science reports, opinions or updates on current and emerging water quality issues. The binational research and monitoring program involves an intensive, management-related scientific examination of each Great Lake, on a staggered five-year rotational basis. The SAB helps coordinate the cooperation, communication and collaboration needed to achieve integrated monitoring on GLWQA objectives and LEOs. These are the core indicators for which monitoring and research is needed to provide the public and policy makers with scientifically sound information that help them make better monitoring, management and restoration decisions. There is an increasingly closer link between identification of management objectives, the selection of appropriate indicators, and coordination of metric monitoring that supplies the scientific information needed for progress evaluation. These links are supported by the SAB through a series of annual work plans, products from standing committees, science workshops, working groups and various reports.

What are the data requirements for the evaluation system?
It is recognized that ideally targets, goals or standards should be developed for each of the core indicators and that resources should be provided for the monitoring and restoration actions needed to achieve each of these goals. As described above, a core set of high level (apex) indicators have been selected for communicating progress to the public and associated stakeholders. These apex indicators are typically composed of several components (i.e., sub-indicators, measures and metrics) that are ultimately combined into one indicator. This requires individual datasets necessary for calculating each ecosystem indicator measure or metric and evaluated approaches for calculating the measures and reporting on indicator progress. Simply identification of the needed datasets was a major step towards implementation of these indicators within the Great Lakes Water Quality Agreement framework. The next step of identifying accessibility, integrating, and compiling the existing data into a dataset that can be used for calculating each measure is still a work in progress to assess the utility of the indicators and to identify data gaps. Additional indicators, beyond the core set, can be valuable for research and resource management purposes, provided the resources are available for addressing the needs of the core indicators first..

How are evaluation results communicated?
The governments of Canada and the U.S. must report to the public on progress in achieving objectives of the GLWQA through the Progress Report of the Parties, the State of the Great Lakes Report, and the Lakewide Action and Management Plans. Specifically, the large number of existing indicators was perceived as interfering with assessing status or trends and communicating progress to the public and stakeholder constituencies. Therefore, recent government efforts have focused on indicators tied to the 9 General Objectives of the Agreement. In addition, the IJC has developed a set of 8 “Vital Signs” based partly on a report from its Science Advisory Board and other advisory reports that identified a group of key measures of chemical biological and physical indicators (Vital Signs). These Vital Signs are considered indicators that most clearly and concisely communicate progress under the GLWQA, based on scientific

measurement of key parameters of ecosystem and human health. While any limited set of indicators will not measure all parameters desired to address progress, they should be sufficient to tell the story of progress and of problems in the ecosystem. This messaging about conditions and trends must be accessible to the general public and readily understandable. The first draft IJC triennial report on progress (2017) links SOGL Indicators to each specific GLWQA objective, then provides a narrative overview on that objective and associated indicator(s), some background, an assessment of status and trend with a summary graphic (when available) and discussion of management action efficacy, followed by a brief conclusion and identification of data gaps or other needs. Although not aligned yet in terms of release timing with the IJC report on progress, it is expected that the triennial State of the Great Lakes Report will communicate details of scientific data, results of analysis, and recommendations for indicator assessment. Ultimately, making these data publicly accessible data will not only increase the efficiency, consistency and transparency of the assessment of progress, but will also enhance the effectiveness of information delivery for public awareness and science based policy and management decision-making.

How are evaluation results used to make changes to the program?
The IJC, as well as representatives of the two governments have been through many rounds of program evaluation, indicator assessment, and metric analysis since the nine GLWQA objectives were formalized in 2012. During that time there has been a concerted effort to coordinate monitoring and assessment between groups for consistency and ecosystem scale coverage. There has also been a drive to develop a process for selecting a smaller set of indicators and metrics that can tell meaningful and compelling stories to the public. Selection factors have included completeness of data, relevance to ecological function, data quality, measurement error, discriminatory power, links to thresholds, and linkage to management actions. The IJC Science Advisory Board now recommends that this process be repeated on a regular basis as lake conditions, public interest and data availability change over time. Also, by adopting Lake Ecosystem Objectives, the program is evolving to incorporate lake-specific factors and threats that are not necessarily represented by system-wide GLWQA objectives. Great emphasis has been placed on the role of monitoring and assessment, along with peer-reviewed science so that wiser management decisions can target limited resources to help protect environmental resources worth billions of dollars.

What are the main successful attributes of the program?
Coordination between jurisdictional partners has been well supported under auspices of the IJC and GLWQA. In addition, there is strong support for the role of monitoring and assessment to help the public understand whether the integrity of the Great Lakes basin is improving or deteriorating. Specifically, the IJC recommends that "even in a time of budget austerity, the governments should allocate sufficient resources to monitor a core set of indicators, enable scientific diagnosis of causes of adverse trends and undertake remediation and prevention actions that are needed to achieve objectives." Communication and outreach has been key in garnering support for the program.

What are perceived weaknesses of the program?

The Great Lakes are each different, so one size does not fit all in terms of developing priorities, standards and indicators. Terminology for tracking objectives and indicators has been confusing and variable (indicators, sub-indicators, measures, metrics, etc.) Also, the GLWQA restoration effort has largely supported by national funding sources (United States Environmental Protection Agency, and the Environment and Climate Change Canada), which are subject to the vagaries of national politics and sole source funding streams.

Estimate of funding used to keep the program operational.
The Great Lakes Restoration Initiative (GLRI) was launched in 2010 to help protect and restore this ecosystem. The Canada-Ontario Agreement (Canadian) and the Great Lakes Restoration Initiative (US) have been instrumental in achieving progress, especially since 2010. Sustainable funding is a key factor to success. Led by the USEPA from 2010 through 2014, the GLRI has provided approximately $300M USD per year following the first year, which was approximately $450 M. Subsequently, GLRI Action Plan II has been submitted to continue these programs for FY15-19.

Lake Champlain Basin Program
(http://www.lcbp.org/)

Lake Champlain is the eighth largest natural freshwater lake in the United States. It occupies a valley between the Green Mountains of northwestern Vermont and the Andirondack Mountains of northeastern New York. In addition to straddling the border of these two states, this 500 square mile lake also crosses into Quebec, Canada and ultimately drains into the St. Lawrence River. The watershed covers 8,234 square miles, with most of its western portion in Adirondack Park. Champlain Valley is the most heavily populated region of Vermont. More than 600,000 people live in the basin and about 250,000 people get drinking water from the lake, which has a 3-year hydraulic residence time.

The Lake Champlain Basin Program (LCBP) was created by congressional act in 1990 as part of an effort to develop a lake basin management plan that would protect and enhance the environmental integrity and social and economic benefits of the Lake Champlain Basin. The resulting plan "Opportunities for Action: An Evolving Plan for the Lake Champlain" was issued in 1996, and signed by the governors of New York and Vermont, as well as by Regional Administrators of the U.S EPA. That plan was updated in 2003, at which time the Premier of Quebec signed on as well. Then the plan was updated again in 2010.

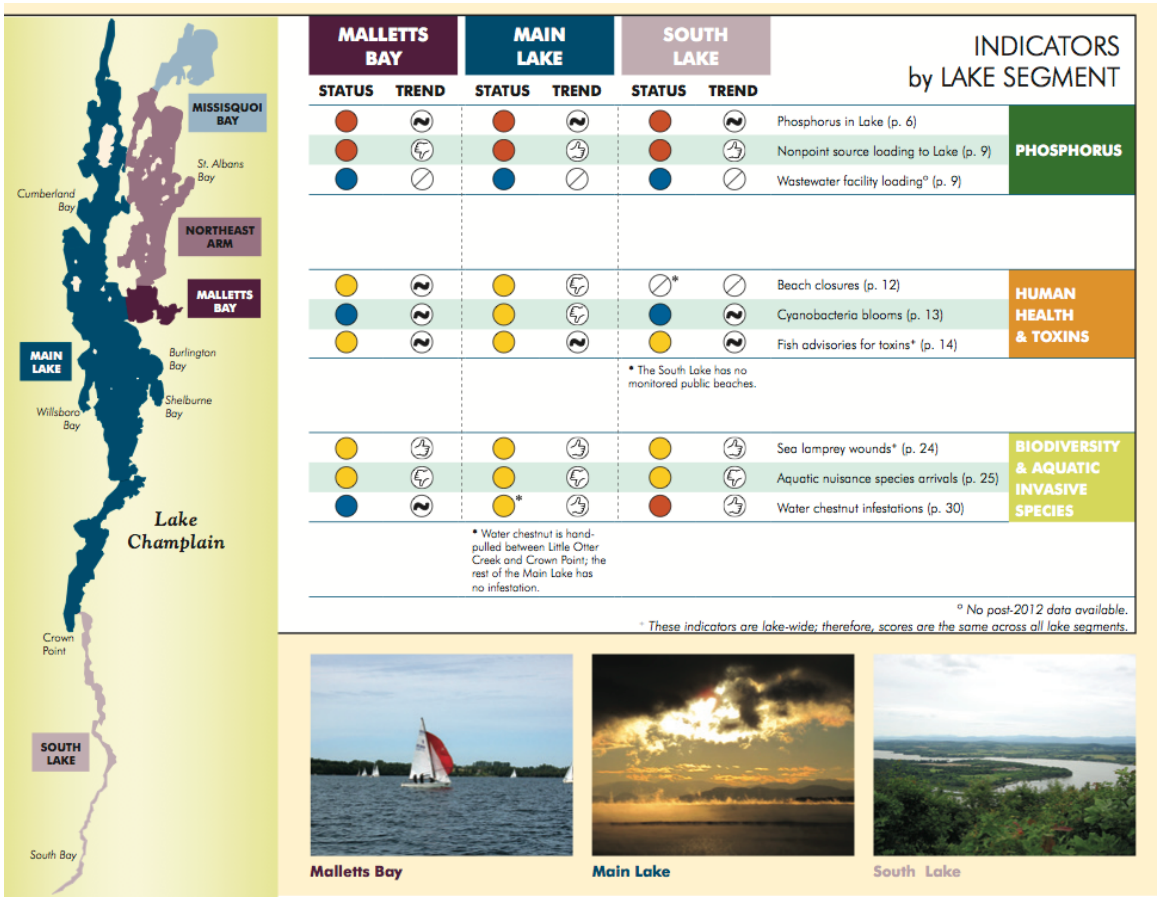
The Lake Champlain Steering Committee is the formal, international, government-based institution that coordinates state and provincial policies and programs for the LCBP management plan. It meets quarterly. Membership includes senior staff from state and provincial governments, from seven US federal agencies, and the chairs for the specific committees (Citizens Advisory Committee, Technical Advisory Committee, Heritage Area Program Advisory Committee and Education and Outreach Committee), as well as a Lake Champlain Sea Grant Representative.

Recognized as a model for interstate and international cooperation, the primary goals of LCBP are to reduce phosphorus inputs to Lake Champlain, reduce toxic contamination, minimize the risks to humans from water-related health hazards, and control the introduction, spread, and impact of non-native nuisance species. Over the years, most of the funding for the program has been provided by the U.S. EPA, which has been administered by LCBP through a local grants program.

Agricultural and urban runoff from the watershed is recognized as the primary source of excess phosphorus, which exacerbates harmful algae blooms of cyanobacteria. Both Vermont and Quebec have agreed to reduce their inputs by 60% and 40%, respectively. Runoff from developed land and suburbs is estimated to contribute about 46% of the phosphorus runoff basin-wide to Lake Champlain, and agricultural lands contributed about 38%. The LCBP uses a Pressure-State-Response framework for data collection to assist decision-makers, and a series of Ecosystem Indicator Scorecards to communicate progress.

Lake Champlain Basin Program

Lake Champlain watershed map.



Lake Champlain Basin Program indicators reporting example.

What is the major driver of the program or prioritization of main goals?

Since 1991, Lake Champlain's ecosystem issues have changed over time including concerns with invasive species and cyanobacteria, but high phosphorus levels have remained a constant. Each iteration of Opportunities for Action has evolved as new concerns emerge. The Congressional legislation for the LCBP also highlights the regional connection to our unique cultural heritage and lake recreational opportunities and this, too, is reflected in Opportunities for Action.

How are indicators organized to provide an integrated evaluation system?

The 2017 draft LCBP Opportunity for Action (OFA) has four goals. The four goals are a consolidation of the eight specific goals from 2010 LCBP OFA.

- Clean Water - Improving the water quality of Lake Champlain and its watershed is critical in achieving progress towards a healthier environment. Strategies in this section focus on maintaining the current monitoring network, understanding the risk of toxic pollutants, and reducing nutrient inputs to water bodies.
- Healthy Ecosystems- Wetland and upland habitat, in particular riparian and shoreland habitat areas must be identified, prioritized, protected and restored in each sub-watershed. Native species must be conserved while the impact of aquatic invasive and non-native species is reduced through improved management strategies.
- Thriving Communities - As part of the Champlain Valley National Heritage Partnership, strategies in this section focus on preserving the rich cultural heritage of the watershed and connecting people to their landscape.
- Informed and involved Public - main tenet of the Lake Champlain Basin Program is providing valuable education to the public. This goal outlines ways to improve communication, scientific literacy, and cultural guidance to communities, partners, the media, K-12 educators and children.

Management plan breaks down the four goals into objectives, strategies, task areas and anticipated outcomes. The task areas will be reviewed on an annual basis to determine if progress was made or to identify areas of additional work.

The LCBP has divided Lake Champlain into 5 lake segments; Missisquoi Bay, Northeast Arm, Malletts Bay, Main Lake and South Lake. Missisquoi Bay, Main Lake and Northeast Arm are further divided into sub regions. Each region segment is monitored for 9 indicators divided into 3 categories.

- Phosphorus
- Human Health and Toxins
- Biodiversity and Aquatic Invasive Species

Phosphorus has three indicators including Phosphorus in the lake, Non-point source loading to the lake and Waste Water facility loading. Human Health and Toxins addresses Beach closures, Cyanobacteria blooms and Fish advisories for toxins. Biodiversity and aquatic invasive species address sea lamprey, aquatic invasive species and water chest nut infestation.

How are management actions linked to indicator evaluations?

The State of the Lake (SOL) report is a triennial report that utilizes an indicator score card to present the current status and the trends the data is indicating. The state of the Lake report appears to drive changes to the LCBP OFA, which is updated every 7 years.

What role do science partnerships play in establishing program goals and supporting the monitoring and evaluation of progress toward those goals?

The LCBP program has 12 full time staff and 4 supporting scientists from regulatory agencies from New York, Vermont, US EPA, and Quebec. Additionally, the LCBP has 5 committees addressing five areas; Steering, Citizen advisory, Technical advisory, Heritage Area program, and Education and outreach.

The LCBP's 25 member Technical Advisory Committee (TAC) composed of professional from academia, management and science agencies from Vermont, New York and Canada. The TAC presents the steering committee with technical information to be used for decision-making. The TAC also facilitates the technical aspects of the implementation projects, interprets monitoring program data, and advises the steering committee of emerging issues and prepares research or action to address those issues.

What are the data requirements for the evaluation system?

Measurement of mercury in ambient precipitation began in Underhill Center, VT in 1992. Event-based sampling and analyses have continued at this location since that time, making this site what is believed to be the longest continuous event-based record for mercury in precipitation in the world. The NADP/MDN program is currently funded through 2016 by a joint agreement between the Vermont Agency of Natural Resources and the LCBP.

Since 2004 the Lake Champlain Committee has trained citizens to distinguish algae from other lake phenomena and report on the presence and absence of blue-green algae blooms on a weekly basis during the summer. The LCC provides critical data on where and when blooms are happening and is relied on by municipal and state agencies to assess whether the water is safe for swimming.

The Long-Term Water Quality and Biological Monitoring Project for Lake Champlain began in 1992 and is conducted by the Vermont Department of Environmental Conservation and the New York State Department of Environmental Conservation with

funding provided by the LCBP and the two states. This program also conducts zebra mussel monitoring.

The Lay Monitoring Program of the Vermont Department of Environmental Conservation has used citizen volunteers to monitor eutrophication-related parameters at approximately 20 Lake stations during the summer season each year since 1979. Through use of consistent methods, the Lay Monitoring Program has provided a valuable long-term database with secchi depth readings and levels of total phosphorus and chlorophyll a.

In 2010, the VT DEC Watershed Management Division released the Vermont Surface Water Management Strategy to describe the management of pollutants and stressors that affect the uses and values of Vermont's surface waters. This strategy presents goals, objectives and approaches for the protection and management of Vermont's surface waters, and will help to guide future decision-making efforts to ensure efficient, predictable, consistent and coordinated management actions.

How are evaluation results communicated?

The State of the Lake (SOL) report is a triennial report that utilizes an indicator score card to present the current status and the trends the data is indicating. The LCBP web sites publishes or links to the various monitoring projects and data.

Lake Champlain basin program excels at involving and conveying information to the public. LCBP has an invasive species and Lake Exhibit at the ECHO Leahy Center for Lake Champlain. Echo sits on Burlington Water front at Lake Champlain in a heavily traveled area. The LCBP resource room at Echo sees 160,000 visitors per year.

How are evaluation results used to make changes to the program?

The LCBP is updated every 7 years utilizing data from the previous state of the lake reports. The LCBP also considers emerging issues for inclusion of the updated management plans.

Management plan breaks down the four goals into objectives, strategies, task areas and anticipated outcomes. The task areas will be reviewed on an annual basis to determine if progress was made or to identify areas of additional work.

What are the main successful attributes of the program?

Between 2011 and 2015 the LCBP has funded 330 projects ranging from curriculum development and cultural heritage recognition, aquatic invasive species recognition and nutrient reduction programs. The highlights of the LCBP accomplishments are the long term water quality monitoring program, cyanobacteria monitoring program, water chestnut harvesting and the boat launch steward program. The LCBP's SOL report indicates that Phosphurous loading has had a net change of -27 metric tons per year,

water chestnut infestations are reducing, as are the occurrence of lamprey wounds in resident fish populations and fish advisories for toxins have remained steady.

What are perceived weaknesses of the program?

The LCBP SOL report does show that ground has been lost in Cyanobacteria blooms and beach closures. Harmful algal blooms are specifically addressed in the 2017 draft LCBP OFA Strategy 1.B.1: Control sources of contamination and is a listed extensively as a priority under the Clean water goal.

The numbers of indicators are few but are considered the major impacts of the lake. A focused approach of the monitored indicators is not necessarily a weakness. This approach of focusing on a handful of indicators is probably best suited for a large basin such as Lake Champlain with a diverse array of industry, agriculture, business and recreation.

The Lake Champlain Basin program is a non-regulatory program. Vermont, New York and Quebec determine their own TMDLs as approved by the USEPA or Provincial agencies. The LCBP role is to coordinate with regulatory agencies to develop and implement projects that will allow the States and Quebec to achieve those TMDL goals. It is unclear whether the lack of regulatory role hampers the LCBP ability to conduct their work.

Estimate of funding used to keep the program operational.

The LCBP has funded 12.72 million in technical projects including 3.98 million for monitoring between 2011 and 2015. Additionally the LCBP has funded $489,057 in education and outreach programs and $388,678 to the Champlain National Heritage Program.

Long Island Sound Study (LISS)
(http://www.longislandsoundstudy.net)

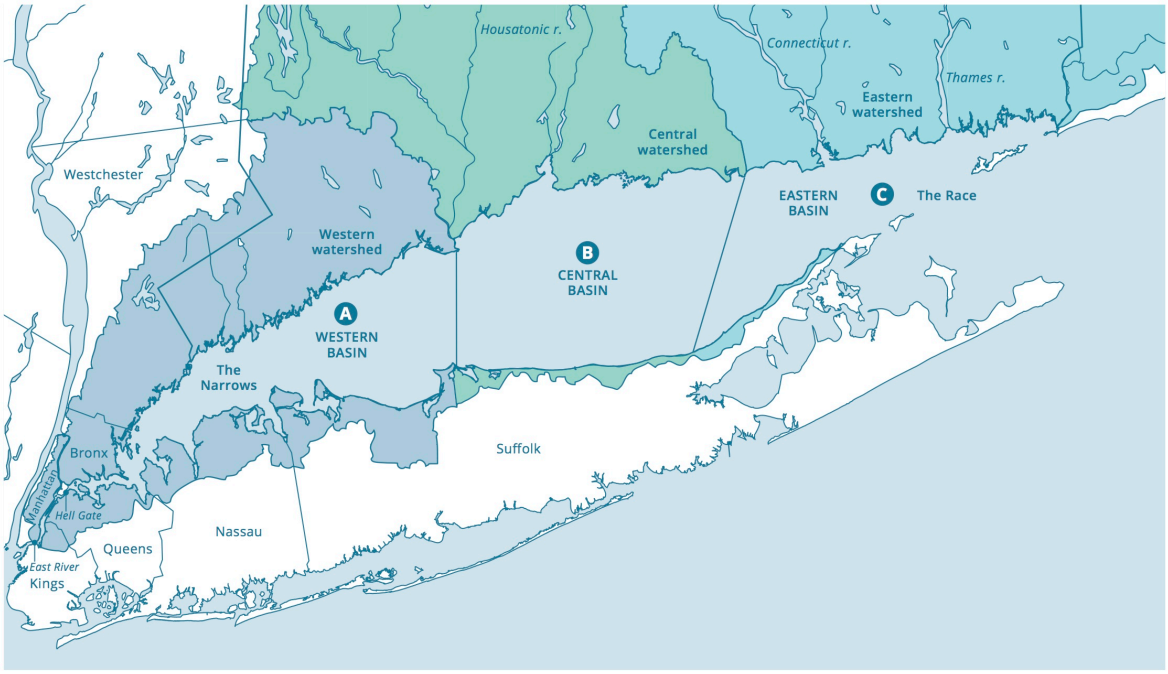
The Long Island Sound watershed is a 16,820 square mile area. The sound itself is 1,320 square miles with an average depth of 63 feet. Approximately 23 million people live within 50 miles of the sound, which has an economic value of 9.4 billion dollars annually. The sound is home to over 120 species of fish. The impacts of New York City and other urban areas have adversely affected the water quality of the sound resulting in hypoxic conditions over broad areas.

The Long Island Sound Management Conference was formed in March 1988. Its membership is composed of EPA, the States of Connecticut and New York and numerous other state, interstate and local agencies and universities. The first Comprehensive Conservation and Management Plan (CCMP) was completed in 1994. Agency scientists provide basic scientific input to the Conference. Science oversight rests with the Science and Technical Advisory Committee that provides objective scientific and technical guidance to the Management Committee, working to synthesize research results, identify priority science needs, and support collaboration among the region's scientists. Its members are engineers and scientists from government agencies, academia, industry, and private organizations, who represent a cross section of backgrounds and areas of expertise that are important to understanding and managing Long Island Sound.

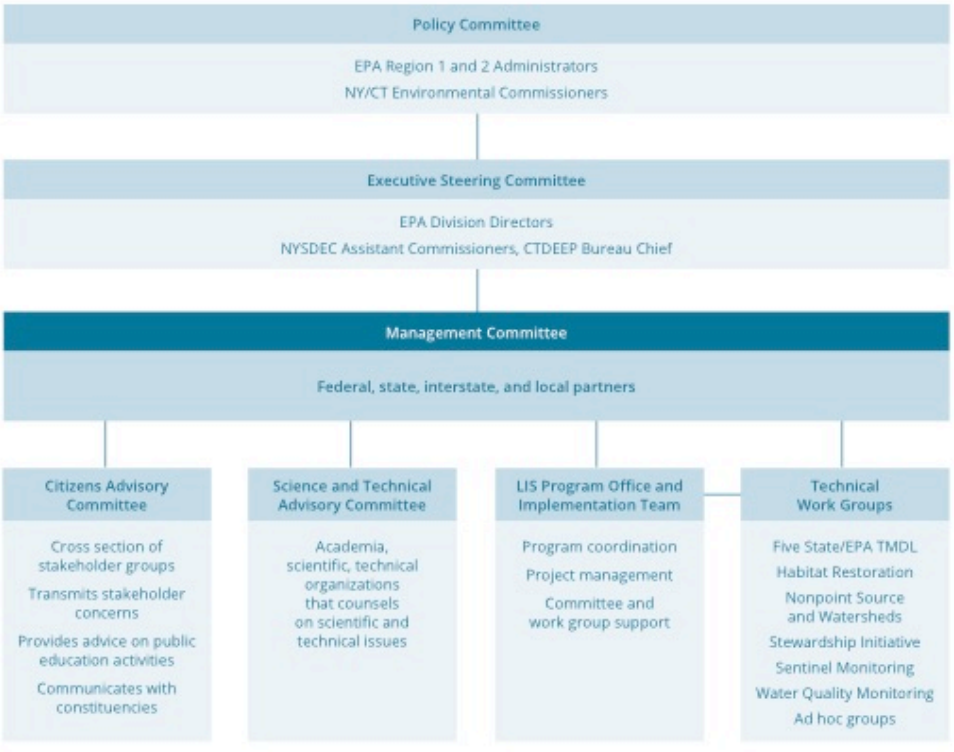
In 2015 the Comprehensive Conservation and Management Plan was updated with the following goals in mind;

- Re-energize and broaden the current Management Conference around updated shared goals and cross- jurisdictional management;
- Set measurable ecosystem targets and management outcomes;
- Use strong science, ecosystem service concepts, and environmental indicators to adapt and refine management;
- Incorporate new areas such as sustainability, climate change resiliency, and environmental justice; and
- Expand public engagement and collaboration.

An example of one of the updates is the use of more understandable indicators. Indicators reflect the following themes: Water Quality, Climate Change, Habitats, Land Use and Population, and Marine and Coastal Animals. Each theme is described by multiple indicators, which in turn may represent aggregations of discrete metrics.



Long Island Sound Study management area.



Long Island Sound Study organizational chart.

What is the major driver of the program or prioritization of main goals?
The Comprehensive Conservation and Management Plan (CCMP) has four themes. Each theme has an overall goal. Those themes and associated goals are:

- Clean Waters and Healthy Watersheds – Improve water quality by reducing contaminant and nutrient loads from the land and the waters impacting Long Island Sound.
- Thriving Habitats and Abundant Wildlife – Restore and protect the Sound's ecological balance in a healthy, productive, and resilient state for the benefit of both people and the natural environment.
- Sustainable and Resilient Communities – Support vibrant, informed, and engaged communities that use, appreciate, and help protect Long Island Sound; and.
- Sound Science and Inclusive Management – Manage Long Island Sound using sound science and cross-jurisdictional governance that is inclusive, adaptive, innovative, and accountable

The primary driver for the program is to reduce hypoxic (low oxygen at depth) conditions in the Sound.

How are indicators organized to provide an integrated evaluation system?
The 2015 CCMP sets ambitious, but achievable, long-term targets for the Sound. These ecosystem targets are intended to drive progress toward attaining CCMP goals. Measuring, tracking, and reporting environmental indicators of each ecosystem target will provide information to assess progress and refine and adapt management as needed. The ecosystem targets are environmental indicators for which condition outcomes have been set. Supporting environmental indicators for which no outcome conditions has been set will continue to be evaluated to provide insight into the drivers of and responses to ecosystem change.

Water quality indicators, for example, are divided into four categories, each of which has been identified by the program as a priority area of concern. The categories include hypoxia (low dissolved oxygen) and nutrients; toxic contaminants; pathogens; and floatable debris. These indicators help resource managers assess recent and historical water quality trends, and management efforts to improve conditions. The water quality index is a calculation that combines several water quality measurements to rate overall water quality in Long Island Sound on an annual basis.

The EPA's National Coastal Assessment (NCA) index has been used to evaluate water quality trends in Long Island Sound over the last two decades. The NCA index is based on five chemical and biological measures:

- Nitrogen (Dissolved inorganic nitrogen in surface waters)
- Phosphorus (Phosphate, or PO4, in surface waters)
- Chlorophyll a (in surface waters)

- Dissolved Oxygen (in bottom waters)
- Water Clarity (Secchi disk depth)

Good water quality is defined here as water containing low concentrations of nitrogen, phosphorus and chlorophyll a, high concentrations of dissolved oxygen and high water clarity. The NCA Index Thresholds (click "Show/Hide Table Data" to view) rate each measurement as good, fair or poor based on the following thresholds:

How are management actions linked to indicator evaluations?
A team of federal, state and private stakeholders developed the CCMP's goals and targets. Periodic review of monitoring data determines trends and the need for adjustments to the targets or actions. The interagency team produces an annual Plan of Work that outlines each specific project and its purpose.

What role do science partnerships play in establishing program goals and supporting the monitoring and evaluation of progress toward those goals?
The LISS supports a science coordinator whose job is to lead and integrate science among the many scientists and organizations at work in the LIS watershed. The position is responsible for assisting in the development and management of technical projects and programs of the LISS, and developing and maintaining professional, scientific, and technical contacts among the LISS partners. The LISS Science Coordinator acts as science liaison between the LISS and federal, state, and local scientists and managers, and works with the external Science and Technical Advisory Committee (STAC) to prioritize LIS research needs and apply research results into LISS management actions. The STAC is comprised of around 35 scientists and engineers from government, universities, and NGOs. The STAC is headed by two co-chairs, one from Connecticut and one from New York. The STAC is advisory only and is not responsible for program tasks.

What are the data requirements for the evaluation system?
Data collection is dispersed among many different organizations. Funding is distributed by EPA to various agencies (about $2 million per year) to conduct the monitoring. Quality control is the responsibility of the collecting agency.

How are evaluation results communicated?
Biennial Reports. Comprehensive look at each CCMP theme. Hierarchical organization of information, from simplified results to comprehensive monitoring results.

Sound Health: Annual publication. Mostly simplified results. General audience. Long Island Sound Study's Year in Review: 2016

"By the Numbers" quick perspective of overall health. Part of annual Sound Health.

Implementation Tracking reports This report summarizes the continuing work of the LISS Management Conference partners in carrying out the Comprehensive Conservation and Management Plan.

Miscellaneous reports These are usually single issue reports like "Nitrogen study". It also includes annual Plan of Work.

How are evaluation results used to make changes to the program?
The 2015 CCMP include 139 implementation actions. The CCMP recommends that the implementation actions be reviewed and formally updated every five years. planned. More immediate changes can occur as a result of monitoring data or research showing a need, and the interagency team approving a desired change. The change would be reflected in the annual Plan of Work.

What are the main successful attributes of the program?
A clear translation and presentation of what hypoxia is, where it occurs and trends. The document is very understandable to the general public yet retains the technical details behind the simplification and attractive pictures.

What are perceived weaknesses of the program?
The lack of a centralized data management and GIS team impedes comprehensive analysis and presentation of data.

Estimate of funding used to keep the program operational.
The LISS budget is organized into the four Program Elements outlined below; the FY2016 LISS budget breakdown by Program Element is:

Program Element Amount
Coordination and Reporting of Actions/Results.....$447,245 (9.6%)
Public Outreach, Information and Education.....$600,129 (13.0%)
Monitoring, Modeling and Research $2,078,444 (45%)
CCMP Implementation, Technical Assistance/Regulatory Support.....$1,502,302 (32.4%)

(from the 2016 Plan of Work)

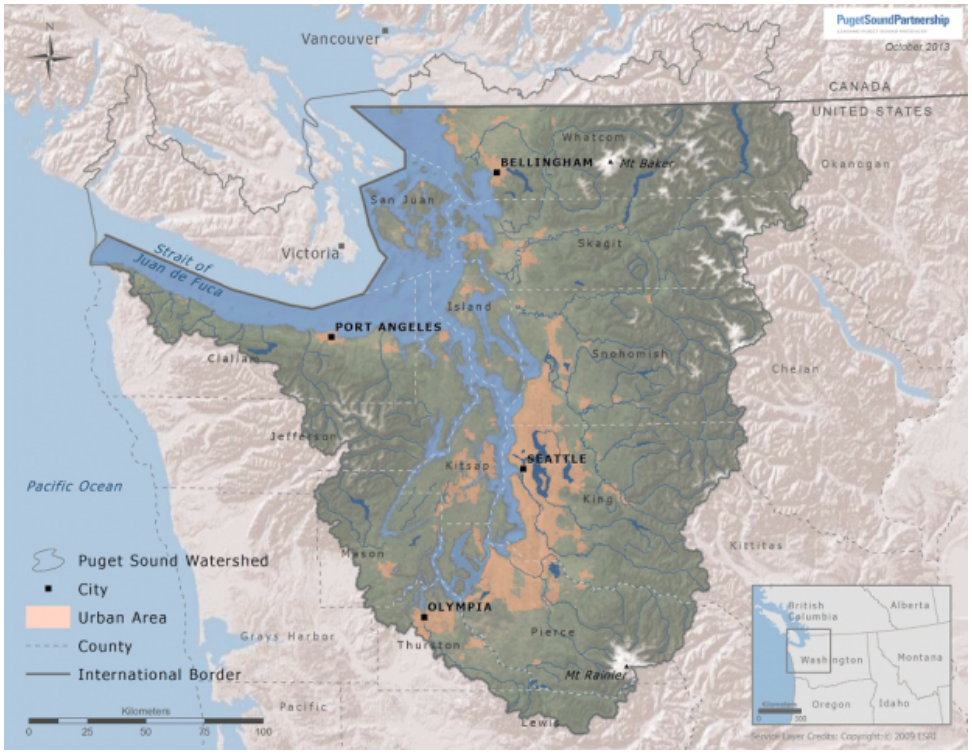
Puget Sound Partnership (PSP)
(http://www.psp.wa.gov)

Puget Sound is the largest estuary by volume in the contiguous US. Carved by glaciers, it is a physically, biologically and chemically complex system of fjords, bays, flooded valleys, with 2,800 streams and a watershed exceeding 12,000 sq mi. There are over 4.7 million people in bordering counties (68% of the population of Washington State), and the region is expected to add 2 million people over the next 25 years.

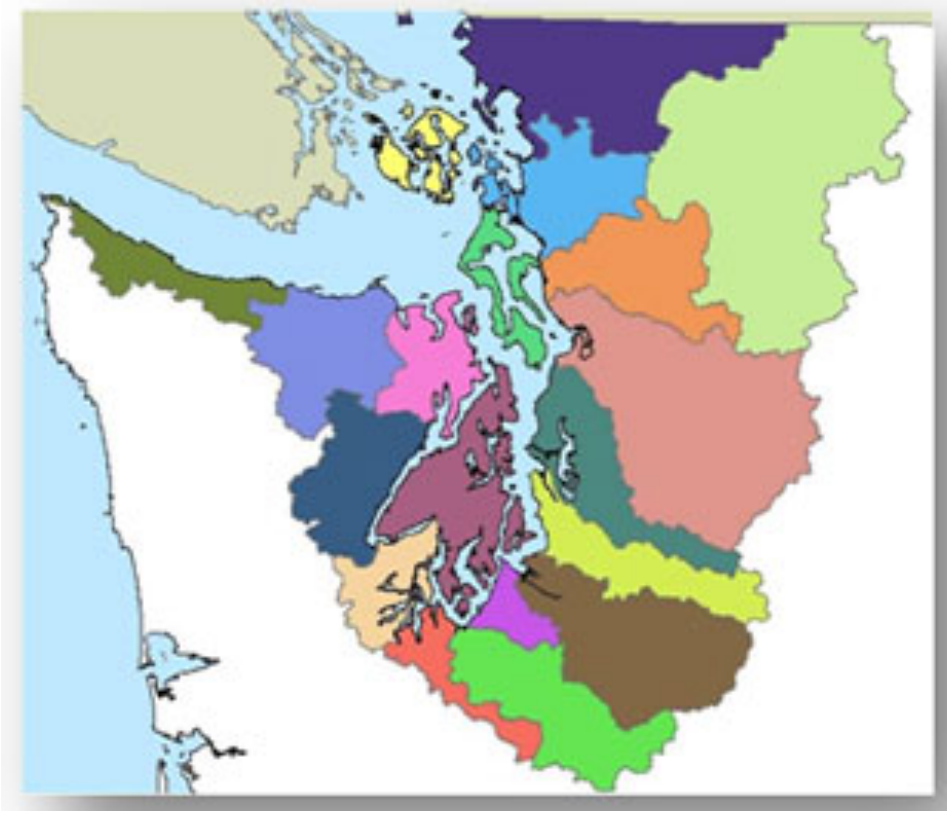
The environmental health monitoring of the Sound is driven by a superfund listing, over 500 waterbodies requiring TMDLs, the listing of salmonids and orcas as endangered, NPDES stormwater permitting, and the WA State Legislatures creation of the Puget Sound Partnership (PSP) program in 2007. The PSP is a collaborative body that sets goals based on science and public priorities, stewards the collaboration of tribes, NGOs, NOAA, universities, and local and state agencies by focusing on a science-driven funding prioritization system to catalyze environmental restoration and health monitoring. Funding for the program is provided through the National Estuary Program. The legislatorial initiative required biennial reporting on recovery, monitoring, and environmental health, and the restoration of the sound to a healthier condition by 2020.

The assessment is driven by 6 recovery goals explicitly defined by state legislation to provide scientifically sound surrogates for ecosystem attributes that are relevant to management concerns, predictably responsive to management actions, linkable to a baseline condition, supported by available, high-quality data and understood by the public and policymakers. Progress towards these goals are measured using quantitative milestones categorized as 25 Vital sign categories (e.g. water quality, quantity, species & food web), and approximately 49 specific measurable indicators that are used to track goals (e.g. eelgrass acreage, # of resident killer whales). This monitoring is defined by 'outcome' statements (e.g. Orca counts), and 'outputs' that are measurable actions related to these targets (e.g. Boat traffic in Orca habitat after regulation). Focused on 2020 goals, the PSP is in the process of using adaptive management to decipher how monitoring data can be linked to management to guide this long-term restoration.

The partnership encompasses numerous organizations and for each indicator, a specific named individual and agency is listed for primary, secondary and tertiary leads, which serves to sub-divide responsibility in an explicit and distributed manner. Each monitoring unit is responsible for developing science-based approaches to the indicator including providing the data and interpreting the results. The Puget sound partnership is responsible for integrating and reporting the results to Washington Dept. of Ecology and the legislature and in the state of the sound report.



Puget Sound watershed as defined by the Washington State Legislature.


Puget Sound international watershed map.

What is the major driver of the program or prioritization of main goals?
The main goals were defined legislatively as six recovery goals including Healthy Human Population, Vibrant Quality of Life, Thriving Species and Food Web, Protected and Restored Habitat, Abundant Water Quantity, and Healthy Water Quality. Much of this was driven by a rapid growth in population in the basin, declining water quality, and the listing of salmonids on the endangered species list.

How are indicators organized to provide an integrated evaluation system?
The six recovery goals are a general statement of outcomes. Based on these goals, the Puget Sound Partnership (PSP) has created 25 Vital sign categories. These vital signs cover a broad range of ecosystem attributes. Within each of these vital signs are specific indicators that are measured to track progress, and link management actions to results, which results in 49 indicators.

How are management actions linked to indicator evaluations?
Indicators are evaluated for trends over time with a focus towards interim targets that which provide a roadmap towards achieving 2020 goals. The interim targets are explicitly defined by their linkage to management. The targets are composed of 'outcome' and 'output' statements. Outcome statements are specific incremental goals for one aspect of the environment. Output statements are direct measurements of actions that can affect the outcome. An example of an 'outcome' statement would be '89 orcas counted in the end of year census by 2020', and an example of an output statement would be 'evaluation of post-regulation vessel behavior completed'. In this manner both the environmental health goal, and the management goal are monitored empirically and evaluated. This gives information on progress towards the goal and the efficacy of the management action.

What role do science partnerships play in establishing program goals and supporting the monitoring and evaluation of progress toward those goals?
The Technical and Scientific experts who collect the monitoring data are responsible for assuring the quality, and for providing the interpretation of the results. These results are collated by the Puget Sound partnership in to biennial reports. The partnerships consist predominantly with universities, state environmental agencies (WA Dept. of F&W, Ecology), the PSP, and consultants. One component of leadership is a Science Panel that develops a science-based plan to restore the Puget Sound, selects the indicators, gives input on project implementation, and defines information needs and research goals. The panel consists of members from NOAA, tribal fisheries, university professors, private timber company executives, and more.

In order to utilize expert guidance to determine program goals, an EPA-funded Puget Sound Pressures Assessment was completed that is worth elaborating on. Given the fact that sometimes there is no peer-reviewed literature on a given topic, or there is limited time to research, they utilized a published method called the 'expert elicitation' method. This is a defined methodology for using the input of lots of experts as objectively as possible, and analyzing the results in a scientifically-justifiable manner. Numerous

experts were asked to rank the relative impact of pairs of stressors, and to rank the most important 'end-points' (e.g. key species, habitat). Based on these pairs the experts were asked the sensitivity of the stressor-endpoint pair, the recovery time when exposed to a stressor, and the resiliency of the endpoint to the stressor. Furthermore, these pairs were categorized by the experts based on a probabilistic determination of their confidence in their answers. The results of this particular study created prioritized ecosystem components to evaluate, and impacts to manage that seemed intuitive.

What are the data requirements for the evaluation system?
(Not Available)

How are evaluation results communicated?
Evaluation results are reported in three summarized formats to the community, state politicians, and comprehensively in a biennial state of the sound report. The results are also shown on a detailed website.

How are evaluation results used to make changes to the program?
Changes to the program are made through a variety of different means. The science panel evaluates the program to track progress towards 2020 goals, evaluates the completion of programs, and the linkages between recovery efforts and ecosystem status. After this review, suggestions are provided. As with many programs, adaptive management is a key component of the program, although it's implementation has been inconsistent. Conceptual models are used to understand the connection between recovery actions and ecosystem responses. The PSP holds 'report card forums' where the practitioners of recovery efforts are brought together to discuss, and share implementation strategies. Lastly, the PSP creates an effectiveness assessment to evaluate project implementation before the next round of recovery efforts. Based on this report, fact sheets are prepared for each type of restoration effort (e.g. shellfish restoration, removing shoreline armoring) that detail what works and what doesn't.

What are the main successful attributes of the program?
There are several successful attributes of the program. One novel component of this program is the inclusion of a human well-being category. For such a complex ecosystem with such a diverse population, the number of indicators is low. As described above, it is clear that there is a good structure for evaluating the program from the science panel, and recovery practitioners. One of the most significant positive aspect of the program is the Pressures Assessment briefly described above. This is a method that allows for a prioritization of program goals when knowledge gaps are present.

What are perceived weaknesses of the program?
It is clear that the current goals of the program exceeds the current funding available. This has resulted in an inadequate implementation of adaptive management strategies, a lack of program goals in many areas, and insufficient monitoring results. Over 70% of the indicators don't have short-term targets (2018), 30% have no long-term target (2020), and 55% of the indicators have no data currently. Many of the vital signs haven't changed and are even deteriorating so it is clear that more is necessary.

Estimate of funding used to keep the program operational.
Based on the report of the PSP finance committee successful implementation of the program would cost $906-$1,184 million, the programs are funded at a level of $52-$708 million, which represents a gap of $295-$661 million. Normalized to program area and population respectively, the cost estimate of program funding is $193-$252/person and $75,000-$98,000 per square mile..

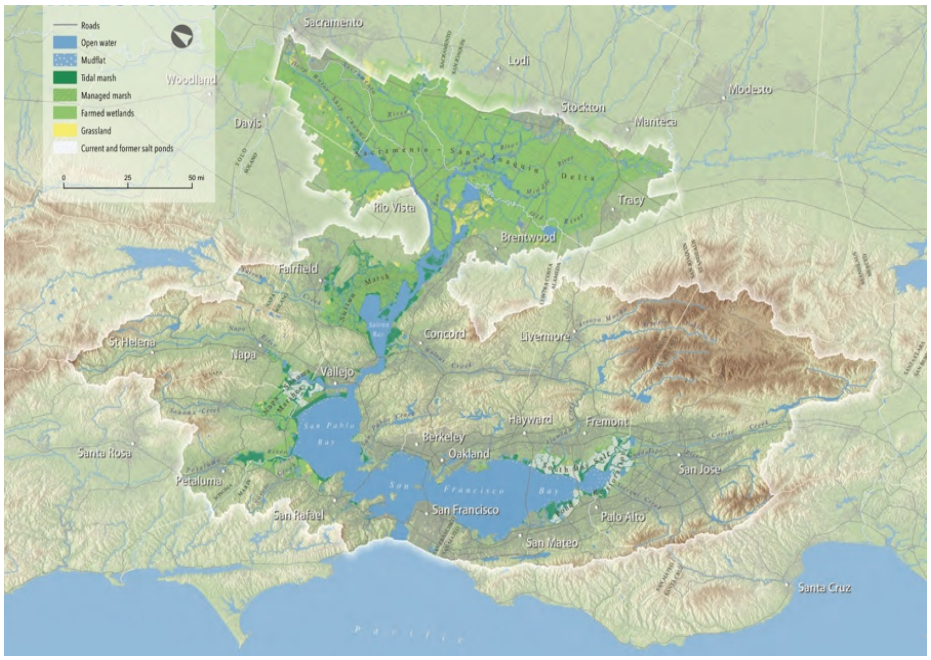
San Francisco Bay Estuary Partnership
(http://www.sfestuary.org)

The San Francisco Estuary Partnership is a coalition of resource agencies, non-profits, citizens, and scientists working to protect, restore, and enhance water quality and fish and wildlife habitat in and around the San Francisco Bay Delta Estuary. The Partnership manages over $100 million in regional restoration, water quality and climate resiliency projects. The Estuary Partnership's host entity is the Association of Bay Area Governments. Like the Delta Stewardship Council, both agencies depend on a strong science component. The Estuary Partnership relies primarily on the expertise of its partners, and scientists from a wide variety of agencies who have worked to provide the metrics for the 2015 State of the Bay report and the Comprehensive Conservation and Management Plan (CCMP).

The guiding document for the Estuary Partnership is the 2016 CCMP. The plan includes 32 actions to be carried out over five years, (down from over 200 in the 2007 CCMP) connected to 35-year goals and objectives. By focusing on a more manageable number of priority actions, and updating priorities every five years, the Partnership believes they will be more responsive and adaptable in the face of uncertain and changing environmental conditions. While general on the surface, the metrics selected give a very good presentation of the health of the estuary (including the upper delta). They differ from the Delta Stewardship Council's (DSC) metrics by being primarily outcome-based measures while the DSC's are primarily Administrative and project tracking measures. This may be a moot point since the DSC is currently updating their measures to better match the San Francisco Bay Estuary's (in part).

Ecological monitoring and reporting for the Estuary Partnership is focused on 5 subject areas: Water, Habitat, Wildlife, Process, and People. These subjects are described with 32 general metrics, (in the State of the Estuary report 2015) aimed at providing the public with a broad perspective of the Estuary's health. Each of these general areas is subsequently described in more comprehensive scientific terms for those readers wanting more detail. This effort provides an excellent distillation of what would otherwise be an overly complex array of results. It follows similar examples provided by the Healthy Land and Water Project of Eastern Queensland, Australia (hlw.org, not formally reviewed here), and the Long Island Sound Study (longislandsoundstudy.net).

The San Francisco Bay Estuary Partnership has done a commendable job in tackling the difficult problem of simplifying its indicators and providing an understandable analysis.



San Francisco Bay estuary map.

CCMP GOAL 1
Sustain and improve the Estuary's habitats and living resources

OBJECTIVES

a. Protect, restore, and enhance ecological conditions and processes that support self-sustaining natural communities

b. Eliminate or reduce threats to natural communities

c. Conduct scientific research and monitoring to measure the status of natural communities, develop and refine management actions, and track progress towards management targets

CCMP GOAL 2
Bolster the resilience of Estuary ecosystems, shorelines, and communities to climate change

OBJECTIVES

d. Increase resilience of tidal habitats and tributaries to climate change

e. Increase resilience of communities at risk from climate change impacts while promoting and protecting natural resources

f. Promote integrated, coordinated, multi-benefit approaches to increasing resiliency

CCMP GOAL 3
Improve water quality and increase the quantity of fresh water available to the Estuary

OBJECTIVES

g. Increase drought resistance and water efficiency and reduce reliance on imported water

h. Improve freshwater flow patterns, quantity, and timing to better support natural resources

i. Reduce contaminants entering the system and improve water quality

CCMP GOAL 4
Champion the Estuary

OBJECTIVES

j. Build public support for the protection and restoration of the Estuary

k. Strengthen regional leadership in support of Estuary health

l. Promote efficient and coordinated regional governance

San Francisco Bay Estuary Partnership goals.

What is the major driver of the program or prioritization of main goals?
The CCMP strives to restore vibrant, healthy habitats to some parts of the Estuary, and in turn help recover endangered species. In addition, despite population growth, we can still conserve water, grow wetlands, green cities, and protect wildlife.

How are indicators organized to provide an integrated evaluation system?
The SF Bay Estuary CCMP starts with 4 basic Goals, each with several Objectives. The Goals and Objectives are then linked to specific Actions that often are related to several Objectives (San Francisco Bay Estuary Partnership, 2016 CCMP). The State of the Estuary Report (http://www.sfestuary.org/about-the-estuary/soter/) includes 32 indicators of health that are monitored and will be reported on every 5-6 years. More may be added as data are collected and as the Estuary Blueprint exposes gaps (San Francisco Bay Estuary Partnership, 2016 CCMP).

The 32 Actions are further broken down into a number of specific Tasks. Actions are tracked by measuring programmatic progress as well as tracking the corresponding environmental Indicators within the 2015 State of the Estuary Report, where applicable.

Programmatic outputs reflect the work of many partners who have carefully provided input to develop outputs that are both achievable and that reflect a larger, ambitious vision for the Estuary. Each task in the CCMP links to a milestone with a year assigned for completion. In addition, tasks are linked to "owners" in the document. Owners are entities convening, stewarding, tracking, or implementing an action. "Collaborating partners" include entities working to support and sometimes implement tasks.

How are management actions linked to indicator evaluations?
As an EPA program, there are frequent and multiple reporting requirements. The Partnership must report on the progress of the CCMP to EPA, semi-annually, and have in depth program evaluations every 5 years by EPA. We also report on habitat acres restored, $ spent, leverage $, etc. to EPA every year. The Blueprint also supports other regional planning and policy docs that guide implementation, monitoring, etc (such as the SF Bay Joint Venture's Implementation Plan, the Baylands Ecosystem Habitat Goals, the Subtidal Habitat Goals, and others) (Personal communication, Caitlin Sweeney).

What role do science partnerships play in establishing program goals and supporting the monitoring and evaluation of progress toward those goals?
We rely almost entirely on our partners for generating the science that we base our programmatic considerations on. We do not have an established "science team", but instead a network of science partners that we work with. We rely on partners to help us report on regional progress as we act as more a clearinghouse of partners and partner work. Same for program goals and indicator reviews – both the Estuary Blueprint and the State of the Estuary Report involve extensive partner participation (Personal communication, Caitlin Sweeney).

What are the data requirements for the evaluation system?
We are not the central repository for data. The Estuary lacks a central repository, though it is certainly a topic of conversation among partners. Data collection and storage is the responsibility of the collecting agency (Personal communication, Caitlin Sweeney).

How are evaluation results communicated?
Some examples of communication of the programs progress are as follows. The Estuary News is published 4 times a year with general interest topics. Special edition publications using well know local authors to explain difficult issues. John Hart has been used for this purpose both with the San Francisco Bay Estuary Partnership and the Delta Stewardship Council. The Partnership also produces short videos highlight special interest topics. These are available on the Partnership's website (sfestuary.org). The Partnership also may produce brochures on single topic issues such as green infrastructure. (sfestuary.org). The State of the Estuary Report is published every 5 to 6 years. (the last publication date was 2015) and the Partnership hosts the biennial State of the Estuary Conference (to date, twelve conferences have been held)

What are the main successful attributes of the program?
This most recent CCMP (released Sept 2016) provides a collaborative comprehensive regional vision for the future of the Estuary. It is both visionary and strategic, with clear, manageable, and trackable actions

What are perceived weaknesses of the program?
The Partnership needs to diversity funding sources even more – can't depend on federal funding. Would like to better integrate with local communities, and with land use and transportation planning.

Estimate of funding used to keep the program operational.
Foundational seed money for the San Francisco Bay Estuary Partnership comes through EPA as authorized by the National Estuary Program (Section 320). On average EPA allocates about $600,000 per year to each of the 28 National Estuary Programs. This money is then leveraged with matching funds from non-federal sources by at least 16.5 times. The Partnership's leverage rate has recently been as high as 1:68.

Source: (https://www.epa.gov/sites/production/files/2015-09/documents/2007_07_13_estuaries_anniversaryfactshett.pdf)

Conservation Measures Partnership
(http://conservationmeasures.org)

The Conservation Measures Partnership is a coalition or collaboration among over 30 organizations intended to facilitate global conservation by improving communication and sharing experiences to speed implementation of cutting edge conservation management.

Its membership is made up of 31 international members. One of its primary products is a tool called the Rosetta Stone. The Rosetta Stone application is a way to decipher differences among various approaches to ecosystem management which allows more effective communication among groups following seemingly dissimilar paths. It compares approximately 20 different organization's structures for ecosystem and adaptive management.

The other tool CMP provides is their Open Standards. It does not offer a list of preferred metrics, organizational structures needed to manage an ecosystem, or likely budget requirements. It primarily represents a way to interpret multiple approaches and to best fit that information into effective solutions for new problems. It does provide a forum for these discussions to occur and the breadth of the membership ensures a robust, well informed discussion.

With this in mind, the Conservation Measures Partnership (CMP) has worked over the past fifteen years to combine principles and best practices in adaptive management and results-based management from conservation and other fields to create the Open Standards for the Practice of Conservation. The Open Standards bring together common concepts, approaches, and terminology in conservation project design, management, and monitoring in order to help practitioners improve the practice of conservation.

The Open Standards are meant to describe the general process necessary for the successful implementation of conservation projects.3 They are not a recipe that must be followed exactly. Rather, they are meant primarily to guide programmatic decisions in project management (i.e., determining the best interventions for conservation success). Also, they are not designed to fully address administrative processes and functions related to, for example, budgets, contracts, and human resource management.

In the context of the Lake Tahoe Thresholds, the Rosetta Stone communication approach and the Open Standards template for evaluating and planning solutions may be too elemental, however, the resources the partnership provides present a gateway to draw new people in to share their experiences and to lead the Tahoe program into new areas of exploration and refinement. Their experience is global. The full potential of the Partnership's approach is difficult to judge without greater involvement in their process.

Conservation Measures Partnership recommended open standards approach.

Appendix A. Questionnaire Responses from Program Managers.

Name of program: Chesapeake Bay Program (CBP)

Please provide short answers to the following six statements: strongly agree, agree, neutral, disagree, strongly disagree, not applicable, or your can provide a different qualified answer.

1) Our plan or program has a clearly stated purpose with tiered goals, objectives and actions to deliver the purpose of the plan.
   Strongly Agree – Through our most recent *2014 Chesapeake Bay Watershed Agreement*. We have a vision, 10 goals, and 31 measurable outcomes in the Agreement. We have long-term management strategies for each outcome, and two-year workplans.

2) The program strives to be accountable for achieving its goals and must monitor relevant aspects of the environment to demonstrate status and progress.
   Strongly agree – we have indicators of progress, a web site dedicated to monitoring progress (ChesapeakeProgress) and a system of review of outcomes, management strategies, and workplans.

3) The best available science is regularly integrated into program assessments.
   Strongly Agree – the majority of the goals and outcomes of the Agreement specifically require the use of "best available science" to establish goals and assess progress.

4) Our plan utilizes an adaptive management process to direct research and management actions based on monitoring and/or modeling results.
   Strongly agree – We have been using adaptive management with our water quality goals for several years, the current Agreement calls for adaptive management on all other goals and outcomes, and we are putting monitoring and tracking programs in place, along with the previously mentioned strategy review process to use adaptive management process to manage actions for the rest.

5) As part of being accountable, progress towards achieving the plan goals is communicated objectively and regularly.
   Strongly Agree – we have indicators of progress that we use, we communicate through ChesapeakeProgress, annually through Bay Barometer, and do press releases throughout the year as indicators are updated.

6) Results must be expressed in terms understandable to the public and decision-makers, but the underlying data is available and easily accessible to all stakeholders.
   Strongly agree. We use ChesapeakeProgress for a more informed public and stakeholders, while our primary website offers news blogs that translates impacts into more layman's terms.

This next set of questions can be answered briefly, or in longer form if you wish to provide context or more information (use as much room as needed).

7) What would you list as the primary set of prioritized goals and associated environmental indicators for your program? (This does not need to be an exhaustive or complete listing.)

10 goals

Sustainable fisheries – indicators include

- Blue crab abundance and management
- Oyster restoration

Vital habitats – Indicators include

- Fish passage miles
- Wetlands restored
- **Submerged aquatic vegetation**
- Forest buffers restored
- Tree Canopy planted.

Water Quality – Indicators include:

- **water quality standards achievement** for tidal waters,
- **pollution reduction indicators for N, P, and sediment**.

Toxic Contaminants

Healthy Watersheds

Stewardship

- Diversity

Land Conservation – Indicators Include:

- Land conserved

Public Access – indicator includes:

- Public access

Environmental Literacy

- Students involved in meaningful watershed experience
- Sustainable schools

8) What criteria do you use to select indicators or metrics of system condition? (For example, responsiveness, ease and cost of data collection, repeatability, public understanding, strength of linkage, etc.)

Because of the varied nature of our outcomes in the Chesapeake Bay Watershed Agreement, the Chesapeake Bay Program has not yet adopted a set of criteria that every new indicator must meet. In proposing and accepting new indicators, the Chesapeake Bay Program first looks for relevance to the Agreement outcomes and fit of the proposed indicator within the Indicator Framework that relates categories of indicators to outcomes in the Agreement. Furthermore, it is crucial to consider the adaptive management needs of Goal Implementation Teams—what information do they need to adaptively manage? What information will be most meaningful to associated teams and workgroups and inform their management actions? The Program also considers more general characteristics considered best practice, such as data availability, including

baseline information and future reporting; ability to show change and trends over time; public understanding of the issue; responsiveness to change; clarity in value; and appropriate scale.

9) Collaboration among State and Federal agencies can be challenging to achieve. How important is interagency collaboration for your program and what are key factors that lead to a productive collaborative program? How are the unique perspectives of different individual agencies integrated when establishing or revising program goals?

The Chesapeake Bay Program negotiates all goals and outcomes through the Chesapeake Executive Council (EC), which includes the governors of the 6 states in the watershed, the mayor of Washington, D.C., the chair of the Chesapeake Bay Commission (a tri-state legislative body) and EPA on behalf of the Federal Government. The Program works through agreements signed by the EC and the most recent *Chesapeake Bay Watershed Agreement*, signed in 2014, lays out the vision of the CBP partnership, the 10 goals and 31 outcomes, and it lays out a process by which the Program develops management strategies and two-year workplans. Therefore, all goals of the Program are the goals of the "signatories" of the Agreement. Once a year, the EC gets together to renew their commitment to the Program and the partnership. In addition, Goal Implementation Teams (GITs), made up of the federal and state reps as well as various stakeholders, are responsible for meeting the outcomes for their particular goal area (e.g. the Sustainable Fisheries GIT is responsible for the coordination of activities that implement the outcomes under the Sustainable Fisheries goal in the Agreement. There is a Management Board whose responsibility is to manage across the GITs and identify policy issues that would need to be raised to the EC or their Principals' Staff Committee (PSC), and there are Advisory Committees for citizens, scientists, and local governments that advise the EC.

10) To what extent is the decision-making and management centralized for project implementation, program monitoring, research, evaluation and reporting, and how is this work coordinated among agencies and other stakeholders?

A crucially important aspect of the Program is that setting goals, monitoring, modeling, communication, and accountability are centralized. What is not centralized is how each state or stakeholder achieves the goals. Specifically, each state may have a unique approach, according to the way the state works, its laws, its regulations, and its relationship with the local governments, to achieve a goal or outcome and that is not going to be prescribed centrally. However, reporting on and managing progress to meet the goal is centralized through workgroups, GITs, the Management Board, the PSC, and the EC (the full organizational structure). The work is coordinated through this organizational structure.

11) How often are formal program evaluation reports conducted, including assessment of program goals and indicators? Among program participants, who conducts these evaluations, and how is leadership assigned? Are the results as objective as you would like? Is there independent oversight or peer-review of the evaluation reports?

For our water quality goal and outcomes, we have an extensive accountability system that includes a Total Maximum Daily Load (TMDL) for all tidal waters in the Chesapeake Bay for dissolved oxygen, clarity/submerged aquatic vegetation (SAV), and chlorophyll~*a*, individual jurisdiction Watershed Implementation Plans (WIPs) to complete actions that will reduce nutrients and sediment pollution by 2025 to meet the water quality standards, and two-year milestones each of the seven jurisdictions (six states and D.C.) commit to. Formal evaluations of the two-year milestones are done by EPA using modeled progress runs of the reductions each jurisdiction made. Evaluations are completed every year (one interim and one final evaluation for each two-year period). A midpoint assessment is being completed for the whole process in 2017, and adjustments will be made to the WIPs based on the midpoint assessment.

For the remaining goals and outcomes, a formal evaluation process has just been initiated, where each outcome is evaluated every two years through a process that involves the workgroup and GIT assigned to that outcome and the Management Board and workplans and management strategies are updated to reflect adjustments based on that evaluation.

The Chesapeake Bay Accountability and Recovery Act (CBARA) calls for an independent evaluator for the Chesapeake Bay restoration effort that is nominated by the EC and appointed by the EPA Administrator. The EC has yet to nominate the independent evaluator, but it is envisioned they would have a role in this process.

12) What are the roles and responsibilities of the various participating stakeholders such as agency representatives, the science community, and public stakeholder groups in 1) regular reporting, 2) program goal review, and 3) indicator review?

The agency representatives of the nine signatories of the *Chesapeake Bay Watershed Agreement* are involved at each level of the CBP partnership, from the EC (governor/administrator level), PSC (state secretaries/regional administrator level), to the workgroup level (subject matter experts), the scientific community and the public are involved through the advisory committees, and through open meetings and membership on GITS and workgroups. For regular reporting, it is done through workgroups and GITs to the Management Board. The Agreement calls for biennial reporting to the EC on implementation of the management strategies. Advisory committees are involved mainly at the Management Board, PSC, and EC levels, and all meetings are open to the public and all documents are available on the websites. Program goal review is done at the Management Board level through the Strategy Review System described above. If a goal or outcome needs to be changed, it would be elevated to the PSC and the EC with public input. Indicators are developed in the workgroups and GITs but have science review under the Scientific and Technical Assessment and Reporting (STAR) team. Indicators are used to report to the public as well as to help manage the outcomes and goals.

13) Are the results of periodic evaluation reports used to adjust program goals, indicators or standards, and if so what is the process for adopting those changes? Has the trend been toward simplification over time, or toward increased complexity with more indicator tracking? What types of reports are produced on a regular basis (e.g., implementation activity, effectiveness evaluation, status and trend, etc.)?

The *Chesapeake Bay Watershed Agreement* outlines a process for changing goals. If an outcome or a goal needs to be changed, it must go through a public process and be approved by the EC. It is intended the reason for a change would be identified through the periodic evaluation process using an adaptive management framework. The trend seems to be toward increased complexity rather than simplification and reports tend more toward progress in meeting the outcomes through indicators and through activity reporting. The water quality monitoring program provides periodic work on status and trends, and the Bay Barometer (annual) is like a report card to the public. Again, ChesapeakeProgress is the web site that provides information on progress to our oversight group.

14) What are key considerations for incorporating and delivering the best science for your program? How is leadership for your science team determined and how large or extended is the participating science community? Do agency and public stakeholders generally perceive the science team as an independent and reliable source of information?

The science needs of the Chesapeake Bay Program partnership are driven by the consensus-based decision-making by the partners in support of work towards achieving the goals and outcomes under the *Chesapeake Bay Watershed Agreement* and prior similar agreements dating back to 1983.

CBP's Scientific and Technical Advisory Committee (STAC) directly helps the partnership in both setting scientific and research priorities as well as the synthesis of existing scientific finding and technical data for application to management using a combination of quarterly meetings, partnership request independent scientific peer reviews, proactive and reactive scientific workshops, and independent evaluation by STAC itself.

STAC is composed of three sets of members: 14 members appointed by the states' governors and the District of Columbia's mayor (two per each of the seven jurisdictions); 21 members selected by STAC to fill specific areas of expertise to match with Chesapeake Bay Program partners' priorities; and six federal agency scientists appointed by the CBP's Federal Office Directors Workgroup.

The partners and stakeholders involved in Chesapeake Bay and watershed restoration have long perceived STAC as an independent and reliable source of information given the members and leadership have taken significant steps to ensure that independence by following clear protocols for keeping a degree of separation between STAC and the remainder of the larger CBP partnership.

15) Are conceptual models utilized, and if so, how often are they updated? Are other types of models used in your program? For example, are models used to test management options, estimate the status of an indicator, identify research needs, select restoration projects for funding, or to assign restoration credits? Has modeling been an effective tool for your program? Does your program include efforts to validate and update the models?

Conceptual models have been utilized in different parts of the Chesapeake Bay Program partnership in one form or other since the partnership was formed more than three decades ago. Within the partnership, models are used extensively to support a range of collaborative decision making, a linked series of airshed-watershed-estuarine hydrodynamic-water quality-lower biological resources models to fisheries population models.

These models are used by the partnership to support the range of decisions and more—for developing and then populating indicators, targeting what to do where to support Bay and watershed restoration, and in estimating pollutant load reductions based on implementation of specific sets of best management practices.

In helping formulate Bay-wide and basinwide policies, goals, commitments and strategies directed towards reducing nitrogen, phosphorus and sediment pollutant loads, the partnership has applied a suite of models and other decision support tools since the 1980s. Within the CBP partnership, responsibilities for model development, calibration, validation, independent peer review, and approval for management application are distributed across several groups within the management structure, including the Modeling Workgroup (model development, calibration, validation), STAC (independent peer review) and the Water Quality GIT (approval for management application).

16) Are program monitoring and evaluation data centrally managed and periodically updated for stakeholder use? In general terms, how is multi-agency data coordinated, stored, quality assured and distributed or otherwise made available?

Oversight and management of the Chesapeake Bay Program partnership's monitoring networks have always been assigned to a specific multi-agency/multi-institutional group within the CBP's management structure. Decision making about the networks and their operation, from field and laboratory methodologies to quality assurance to data management and shared data analysis has always been nested within the partnership.

Based on both stakeholder feedback as well as CBP senior agency managers' requests, the partnership has periodically undertaken comprehensive reviews of and adjustments to individual monitoring programs or entire networks. Over the past 30+ years of the operation of these shared monitoring networks, there have been at least

four formal monitoring network reviews, several undertaken in concert with STAC to ensure an independent perspective.

Millions of data points collected every year through the partnership's monitoring networks are managed, undergo quality assurance and are shared online through the CBP partnership's website following an established set of agreed to data management procedures. Following a common set of procedures are re-enforced through funding agreements (e.g., grant and cooperative agreement conditions) and a program-wide quality assurance program. Within the CBP management structure, there are specific workgroups charged within responsibility for reaching agreement on and then carrying out common and consistent data analysis and interpretation

17) What are your major funding source categories (e.g., ongoing government funding, funding from the regulated community, private contributions). Roughly, what are average annual allocations to: a) project planning and implementation, b) monitoring and research, c) programmatic evaluation and reporting, and d) general program management, staff and operations? Are collaborations with other agencies or groups a significant source of funding or in-kind support for the program? Is your funding stable?

We have federal funding under appropriations from Section 117 of the Clean Water Act as amended in 2000 to coordinate, facilitate, and leverage activities that would help implement the *Chesapeake Bay Watershed Agreement*. However, all of our federal, state, and local partners contribute funds toward meeting our goals. The CBARA calls for us to report annually on federal and state funding activities. Funding under Section 117 is categorized in the CBARA reporting as follows:

- Program Operations and Support
- Partnership and data management support
- Water Quality Monitoring Grants
- TMDL implementation and Analysis
- Reporting and accountability
- Permit review and rule development, guidance, and implementation
- Enforcement
- Small Watershed Grant Program
- Innovative Nutrient and Sediment Reduction Grnats
- State Implementation Grants

18) If you have a TMDL in effect is it integrated into the management plan and performance reporting? What might be improved? Does the TMDL limit the evolution of your program?

In December 2010, the Chesapeake Bay TMDL was published by EPA, but developed working directly and cooperatively with all seven watershed jurisdictions. Prior to publication of the Bay TMDL, in 2008 the EC agreed to adopt an accountability system based on development of two-year milestones by each of the seven jurisdictions along

with the federal agency partners and public reporting on progress towards each of the two-year milestones and underlying commitments.

As part of the Bay TMDL, the partners agreed to conduct a midpoint assessment of progress in 2017, the midpoint between 2010 and the agreed to 2025 end date for getting all the practices on the ground necessary to reach each jurisdictions' Bay TMDL goals and commitment. The Bay TMDL has brought a regulatory focus within a voluntary partnership, which has caused some concerns, but at the same time it has resulted in reduction of millions of pounds of nutrient and sediment from reaching Bay tidal waters.

19) Is your conservation plan recognized as excelling in some area, and what is it?

We believe the Chesapeake Bay Program partnership has been nationally and internationally recognized for our strong shared decision-making governance structure, well into its fourth decade, for making significant reductions in nitrogen, phosphorus and sediment pollutant loads from a wide array of source sectors, for progress on restoration of fish passage to oyster reefs to underwater bay grasses, to permanent land conservation of millions of acres watershed-wide to adding hundreds of new public access locations throughout the watershed and along the Bay's tidal shorelines.

20) What do you see as areas to improve upon? Do you have funding and program capacity to make these improvements?

There are always areas to improve upon, and the midpoint assessment for the water quality goal, as well as the Strategy Review System, will continue to identify areas to improve. In addition, we are looking to improve our capacity for socio-economic issues, including developing indicators, optimizing tools and targeting based on multiple outcomes and return-on-investment. It is unclear moving forward whether we will have funding or program capacity because the Fiscal Year 2018 (FY18) President's proposed budget currently zeroes out funding for the EPA Chesapeake Bay Program Office and much of the other functions of the partnership. However, since Congress has not acted yet on the FY18 appropriations, funding for this improvement is unclear.

Name of program: Delta Stewardship Council

Please provide short answers to the following six statements: strongly agree, agree, neutral, disagree, strongly disagree, not applicable, or your can provide a different qualified answer.

1) Our plan or program has a clearly stated purpose with tiered goals, objectives and actions to deliver the purpose of the plan. Strongly agree.

2) The program strives to be accountable for achieving its goals and must monitor relevant aspects of the environment to demonstrate status and progress. Strongly agree. The Delta Plan is implemented in large part by agencies other than the Delta Stewardship Council, and likewise, the Council relies on monitoring performed by those agencies as well as our own.

3) The best available science is regularly integrated into program assessments. Strongly agree. The Delta Reform Act requires the Delta Stewardship Council to use best available science in developing and implementing the Delta Plan.

4) Our plan utilizes an adaptive management process to direct research and management actions based on monitoring and/or modeling results. Agree. The Delta Reform Act (Water Code 85308(f)) requires the Delta Plan to "include a science-based, transparent, and formal adaptive management strategy for ongoing ecosystem restoration and water management decisions." The Delta Plan details a three-phase, nine-step adaptive management framework that is referenced in the Delta Plan governance regulation (GP 1), and is therefore required for projects deemed "covered actions." We are also adaptively managing the Delta Plan itself by following the adaptive management framework for the review of the Delta Plan as required by the Delta Reform Act to occur at least one every five years. In addition, the Delta Independent Science Board (ISB) is required to review all of the "scientific research, monitoring, and assessment programs that support adaptive management of the Delta." Truly implementing adaptive management is challenging as outlined by the Delta ISB (http://deltacouncil.ca.gov/docs/final-delta-isb-adaptive-management-review-report), and we are also working with others to break down the barriers to adaptive management.

5) As part of being accountable, progress towards achieving the plan goals is communicated objectively and regularly. Agree. The Council's Performance Management unit has developed a dashboard showing the status of Delta Plan administrative performance measures as well as an online project tracking tool, Delta View. The Performance unit is also working with other agencies and stakeholder groups to refine all Delta Plan performance measures (administrative, output and outcome), including clearly identifying metrics, baselines, targets and data availability. Each year the Council publishes a progress report on the implementation of the Delta Plan that highlights the work of the Council's staff as well as the work of the Council's partner agencies, whose efforts help implement the

Delta Plan and advance the State's coequal goals of water supply reliability and Delta ecosystem restoration.

6) Results must be expressed in terms understandable to the public and decision-makers, but the underlying data is available and easily accessible to all stakeholders.
Agree. The Delta Stewardship Council is currently working with the California Water Quality Monitoring Council as well as DWR, DFW and SWRCB to support implementing the 2016 Open and Transparent Water Data Act (AB 1755), which requires collection and sharing of water data, including the data supporting Delta Plan performance measures.

This next set of questions can be answered briefly, or in longer form if you wish to provide context or more information (use as much room as needed).

7) What would you list as the primary set of prioritized goals and associated environmental indicators for your program? (This does not need to be an exhaustive or complete listing.)

The overall goals for the Delta Stewardship Council and Delta Plan are the coequal goals as described in our authorizing statute, the Delta Reform Act: "…the two goals of providing a more reliable water supply for California and protecting, restoring, and enhancing the Delta ecosystem. The coequal goals shall be achieved in a manner that protects and enhances the unique cultural, recreational, natural resource, and agricultural values of the Delta as an evolving place." (CA Water Code §85054).

The broad policy objectives to meet the coequal goals are:

- A More Reliable Supply of Water for California
- Protect, Restore, and Enhance the Delta Ecosystem
- Protect and Enhance the Unique Cultural, Recreational, Natural Resource and Agricultural Values of the California Delta as an Evolving Place
- Improve Water Quality to Protect Human Health and the Environment
- Reduce Risk to People, Property and State Interests in the Delta

These are followed by strategies, policies and recommendations, and performance measures.

Delta Plan performance measures are in three general classes:

- Administrative performance measures
- Output (also known as "driver") performance measures and
- Outcome performance measures.

These are measured by:

- Metrics that reflect the performance measure to be quantified, its unit(s) of measure and other characteristics for tracking aspects of performance over time.

- Baselines are standards or historical reference conditions for each metric comparing with the current condition, and
- Targets, which are the desired future conditions or trends stated in terms of specific metrics.

8) What criteria do you use to select indicators or metrics of system condition? (For example, responsiveness, ease and cost of data collection, repeatability, public understanding, strength of linkage, etc.)

Several screening criteria and responses to a fit/gap assessment guided initial refinement of the original 2013 Delta Plan performance measures. See http://deltacouncil.ca.gov/docs/process-refinement-and-update-delta-plan-performance-measures, http://deltacouncil.ca.gov/docs/delta-stewardship-councils-response-delta-independent-science-boards-process-review, and http://deltacouncil.ca.gov/docs/delta-stewardship-councils-response-delta-independent-science-boards-process-review for more information. For information on the current effort to further refine the Delta Plan's performance measures, please see http://www.deltacouncil.ca.gov/docs/delta-stewardship-council-april-27-28-2017-meeting-agenda-item-9-update-regarding-draft-delta.

9) Collaboration among State and Federal agencies can be challenging to achieve. How important is interagency collaboration for your program and what are key factors that lead to a productive collaborative program? How are the unique perspectives of different individual agencies integrated when establishing or revising program goals?

Plan goals and objectives, from necessity, fit into a web of legislated authority and existing authorities of other agencies. Delta Plan implementation is promoted through the 17-member Delta Plan Interagency Implementation Committee (DPIIC; http://www.deltacouncil.ca.gov/delta-plan-interagency-implementation-committee-3), which serves as a forum to discuss, consider and orchestrate the timely and orderly implementation of actions consistent with the policies and recommendations outlined in the Delta Plan. The Delta Stewardship Council, DPIIC and the Delta Science Program promote the "One Delta, One Science " approach outlined in the Delta Science Plan to enhance current multiagency collaborative approach research and monitoring collaboration. Collaboration is an art, requires interpersonal skills, and a good knowledge of what other groups are contributing in order to have others pull together for a larger cause.

10) To what extent is the decision-making and management centralized for project implementation, program monitoring, research, evaluation and reporting, and how is this work coordinated among agencies and other stakeholders?

Decision-making stays within each individual agency's authority, but coordination and collaboration among the agencies is promoted through DPIIC and through the collaborative approaches taken by the Council and Science Program.

11) How often are formal program evaluation reports conducted, including assessment of program goals and indicators? Among program participants, who conducts these evaluations, and how is leadership assigned? Are the results as objective as you would like? Is there independent oversight or peer-review of the evaluation reports?

The Council prepares an annual report on the state of interagency efforts to achieve the coequal goals. See this link for the 2016 Annual Report (http://deltacouncil.ca.gov/docs/2016-annual-report-0). The Council is currently considering amendments to the Delta Plan in three areas: refining the Delta Plan performance measures as described above, incorporating the Delta Levees Investment Strategy (DLIS) and incorporating changes addressing conveyance, storage and the operations of both. The amendment process is open, transparent and inclusive, involving public Council meetings and workshops, stakeholder listening sessions, as well as independent science review or Delta Independent Science Board review. In 2017, the Council is preparing for its 2018 review of the Delta Plan as required by the Delta Reform Act.

12) What are the roles and responsibilities of the various participating stakeholders such as agency representatives, the science community, and public stakeholder groups in 1) regular reporting, 2) program goal review, and 3) indicator review?

Agency representatives serve as members of the Delta Plan Interagency Implementation Committee (DPIIC) and regularly participate in monthly Council meetings. DPIIC, Council and Delta Independent Science Board meetings are webcast and allow for public comment. Council members and staff meet regularly with agency, scientific community and stakeholder representatives as part of routine Council activities. Most technical review occurs in interagency meetings and in formal processes associated with the Delta Science Program and its products. Delta Plan review and amendment processes include public meetings and workshops that include involvement of all interested parties.

13) Are the results of periodic evaluation reports used to adjust program goals, indicators or standards, and if so what is the process for adopting those changes? Has the trend been toward simplification over time, or toward increased complexity with more indicator tracking? What types of reports are produced on a regular basis (e.g., implementation activity, effectiveness evaluation, status and trend, etc.)?

Sections of the Delta Plan are currently being amended based on new or updated information as described above. The five-year review of the Delta Plan called for in the Delta Reform Act is being planned in 2017 for implementation in 2018.

14) What are key considerations for incorporating and delivering the best science for your program? How is leadership for your science team determined and how large or extended is the participating science community? Do agency and public stakeholders

generally perceive the science team as an independent and reliable source of information?

The Delta Lead Scientist who leads the Delta Science Program is selected through a competitive process to serve up to two terms of up to three years each. The Delta Science Program is composed of 18 staff including scientists and engineers. The Delta Independent Science Board of 10 nationally- and internationally-renowned scientists and engineers is appointed by the Delta Stewardship Council and is charged with providing oversight of the scientific research, monitoring, and assessment programs that support adaptive management of the Delta through periodic reviews of each of those programs. The science community served by these groups is composed of several hundred directly involved agency, academic, consultant and stakeholder scientists and many others who express an interest. The Delta Science Program and Delta Independent Science Board are perceived as reliable sources of independent scientific information within the agency and stakeholder communities.

15) Are conceptual models utilized, and if so, how often are they updated? Are other types of models used in your program? For example, are models used to test management options, estimate the status of an indicator, identify research needs, select restoration projects for funding, or to assign restoration credits? Has modeling been an effective tool for your program? Does your program include efforts to validate and update the models?

The use of conceptual and quantitative computer models is promoted by the Council's three-phase, nine-step adaptive management framework. Both types of models are used to support at least some of most agencies' science and management efforts. The importance of community models, integrated models and structured decision making has been recognized through recent reports from the Delta Modeling Summit (http://www.deltacouncil.ca.gov/docs/agenda-item-4attachment-45integratedenvironmentalmodelingpolicybrief) and DPIIC Science Enterprise Workshop (http://www.deltacouncil.ca.gov/docs/agenda-item-4attachment-44complete-proceedings-report-science-enterprise-workshop), which both recommend enhancements to current modeling efforts..

16) Are program monitoring and evaluation data centrally managed and periodically updated for stakeholder use? In general terms, how is multi-agency data coordinated, stored, quality assured and distributed or otherwise made available?

Data are not currently managed in a central location. The Interagency Ecological Program (IEP) coordinates and provides Estuary and Delta aquatic ecosystem monitoring information, and the California Water Quality Monitoring Council is developing portals that provide access to water quality data and information. The USGS, DFW, SWRCB and DWR all provide access to various types of water data. Overall access to data is expected to improve with implementation of the recently-passed 2016 Open and Transparent Water Data Act (AB 1755) which requires collection and sharing of water data.

17) What are your major funding source categories (e.g., ongoing government funding, funding from the regulated community, private contributions). Roughly, what are average annual allocations to: a) project planning and implementation, b) monitoring and research, c) programmatic evaluation and reporting, and d) general program management, staff and operations? Are collaborations with other agencies or groups a significant source of funding or in-kind support for the program? Is your funding stable?

Funding is primarily received through State General Fund appropriations ($19 million), a small amount of special funding ($0.8M) and authority to accept funding through reimbursable agreements with state (up to $4.5M) and federal (up to $2.8M) agencies. . Funding has been relatively stable. Other agencies provide the bulk of funding for implementing Delta Plan policies and recommendations.

The DSC has approximately 69 employees.

18) If you have a TMDL in effect is it integrated into the management plan and performance reporting? What might be improved? Does the TMDL limit the evolution of your program?

No specific TMDL drives Delta Plan implementation.

19) Is your conservation plan recognized as excelling in some area, and what is it?

The Delta Plan is only four years old but has been recognized for its integrative nature as well as its strong reliance on science to guide policy.

20) What do you see as areas to improve upon? Do you have funding and program capacity to make these improvements?

The Council has been working on refining the Delta Plan performance measures to make them more quantitative; however, data collection and availability are areas to improve upon. There is some funding to address this issue, but it is insufficient. It will require a collaborative effort across government agencies to collect, access, and analyze the data needed to support all Delta Plan performance measures.

Name of program: Everglades Restoration Program

Please provide short answers to the following six statements: strongly agree, agree, neutral, disagree, strongly disagree, not applicable, or your can provide a different qualified answer.

1) Our plan or program has a clearly stated purpose with tiered goals, objectives and actions to deliver the purpose of the plan. Strongly agree

2) The program strives to be accountable for achieving its goals and must monitor relevant aspects of the environment to demonstrate status and progress. Strongly agree

3) The best available science is regularly integrated into program assessments. Strongly agree

4) Our plan utilizes an adaptive management process to direct research and management actions based on monitoring and/or modeling results. Strongly agree

5) As part of being accountable, progress towards achieving the plan goals is communicated objectively and regularly. Strongly agree, regularly but only 1x/5yrs. in a comprehensive manner.

6) Results must be expressed in terms understandable to the public and decision-makers, but the underlying data is available and easily accessible to all stakeholders. Strongly agree

This next set of questions can be answered briefly, or in longer form if you wish to provide context or more information (use as much room as needed).

7) What would you list as the primary set of prioritized goals and associated environmental indicators for your program? (This does not need to be an exhaustive or complete listing.)

The general goal is restoration, preservation and protection of the S. Florida Ecosystem while providing for other water-related needs of the region, including water supply and flood control. Environmental indicators include but are not limited to; oysters, seagrass, benthic infauna, pan fish, cyanobacteria, SAV, EAV, wading birds, prey fish, cray fish, tree islands, ridge and slough, spotted seatrout, WQ. Other hydrologic indicators include water stage, duration and flows and salinity.

8) What criteria do you use to select indicators or metrics of system condition? (For example, responsiveness, ease and cost of data collection, repeatability, public understanding, strength of linkage, etc.)

We look for key indicators of the health of the unique regions of the Everglades system. Other considerations include those above but those are secondary.

9) Collaboration among State and Federal agencies can be challenging to achieve. How important is interagency collaboration for your program and what are key factors that lead to a productive collaborative program? How are the unique perspectives of different individual agencies integrated when establishing or revising program goals?

Collaboration is at the heart of everything we do. The CERP and RECOVER program is made up of 12 Federal and State Agencies including the Miccosukee and Seminole Tribes of Florida, many local agencies are also involved. All input is taken in, discussed but if needed the two main agencies (USACOE and SFWMD) will make a final call on a decision. What helps is our well thought out framework, guidelines, program management plans, programmatic regulations (in WRDA 2000, 2007) and GCM's (Corp guidance memos). There was a lot of planning and thought that went into the process of this program 17+ yrs ago, and this initial effort has been updated and expanded as time went by.

10) To what extent is the decision-making and management centralized for project implementation, program monitoring, research, evaluation and reporting, and how is this work coordinated among agencies and other stakeholders?

As mentioned above the two funding agencies (ACOE and SFWMD) are the main decision making agencies but input is taken from all others as well as stakeholders. RECOVER has a Leadership group with one rep. form each agency, an Executive Committee and regional coordinators who all have responsibilities in moving forward the process. If more detail is needed let me know and I can send a copy of our PMP (program management plan) that spells this out in more detail.

11) How often are formal program evaluation reports conducted, including assessment of program goals and indicators? Among program participants, who conducts these evaluations, and how is leadership assigned? Are the results as objective as you would like? Is there independent oversight or peer-review of the evaluation reports?

Once every five years we produce our System Status Report which is a comprehensive accounting of the newest monitoring data, modeling and project construction and operation reporting. Teams include Principle Investigators who are under contract to collect and report on our ecological indicators, other SF scientists, RECOVER regional coordinators, for each SSR leaders from the ACOE and SFWMD are assigned to organize and facilitate the production. The results are objective, but in an attempt to improve our communication to a variety of audiences for our next report (2019) we have hired a group form the University of Maryland, Center for Environmental Science, Integration and application Network who produce "Report Cards" all around the world to help us. We do not do an independent peer review of the SSR.

12) What are the roles and responsibilities of the various participating stakeholders such as agency representatives, the science community, and public stakeholder groups in 1) regular reporting, 2) program goal review, and 3) indicator review?

The first two are involved to some extent to all 3, each agency is invited but some have more participation then others depending on the agency focus and resource availability. Public Stakeholders have input but do not work as directly on the above, they give comment which is welcome.

13) Are the results of periodic evaluation reports used to adjust program goals, indicators or standards, and if so what is the process for adopting those changes? Has the trend been toward simplification over time, or toward increased complexity with more indicator tracking? What types of reports are produced on a regular basis (e.g., implementation activity, effectiveness evaluation, status and trend, etc.)?

The SSR is out main document that tracks ecological indicators. We have had to cut back on indicators over time due to budget constraints not due to scientific findings. The SSR strives to report on trend, discuss stressors and drivers in the system (why are things happening), and inform adaptive management at both the planning and implementation and operational levels.

14) What are key considerations for incorporating and delivering the best science for your program? How is leadership for your science team determined and how large or extended is the participating science community? Do agency and public stakeholders generally perceive the science team as an independent and reliable source of information?

As mentioned before our science is governed by the RECOVER leadership team and we have participation at some level from the 12 agencies and 2 tribes. The structure mentioned above guides the management of our work and the additional scientists under contract that do our monitoring. I think the plan and our assessments of data are generally perceived as top-notch (we hire the best experts in the field who in many cases have spent their entire careers on Everglade science) and reliable.

15) Are conceptual models utilized, and if so, how often are they updated? Are other types of models used in your program? For example, are models used to test management options, estimate the status of an indicator, identify research needs, select restoration projects for funding, or to assign restoration credits? Has modeling been an effective tool for your program? Does your program include efforts to validate and update the models?

CEM's are used and were the basis for much of the original Monitoring and Assessment Plan (MAP). They were originally published in 2005 and are currently being updated for the first time. The program uses many other models in our evaluations and planning, hydrologic, hydrodynamic and ecological modeling tools are used in future predictions to guide project planning and to forecast out how a given indicator might

respond to a restoration activity. They are both very large system-wide models, regional and some site specific.

16) Are program monitoring and evaluation data centrally managed and periodically updated for stakeholder use? In general terms, how is multi-agency data coordinated, stored, quality assured and distributed or otherwise made available?

Data is centrally managed. We use what we call CERPzone which is accessible to anyone who has a password. There is a process to get a password and not all public can get one. It is more for people working directly on our monitoring and assessment activities. Our reports such as the SSR and others are widely available on the web. We have QA/QC protocols in place.

17) What are your major funding source categories (e.g., ongoing government funding, funding from the regulated community, private contributions). Roughly, what are average annual allocations to: a) project planning and implementation, b) monitoring and research, c) programmatic evaluation and reporting, and d) general program management, staff and operations? Are collaborations with other agencies or groups a significant source of funding or in-kind support for the program? Is your funding stable?

All funding comes from the federal (ACOE) budget under the WRDA bills and from the State of Florida. Some other agencies contribute in-kind with staff time. I refer you to page 54 of the NAS report on Progress Toward Restoring the Everglades 2016 report for many more details as well as funding levels.
https://www.nap.edu/catalog/23672/progress-toward-restoring-the-everglades-the-sixth-biennial-review-2016

18) If you have a TMDL in effect is it integrated into the management plan and performance reporting? What might be improved? Does the TMDL limit the evolution of your program?

The state of Florida has TMDL's for many water bodies all over the state. CERP does integrate this into our work per say, but is greatly influenced by the WQ consent decree for phosphorus levels into ENP.

19) Is your conservation plan recognized as excelling in some area, and what is it?

It is a restoration plan not really a conservation plan. It is widely recognized for it size, complexity, scientific and engineering rigor but the slow pace of restoration progress is a problem (once again see the NAS report for more…)

20) What do you see as areas to improve upon? Do you have funding and program capacity to make these improvements?

More money should/could be spent on science and modeling to incorporate new major stressors such as climate change and exotic species. Monitoring has been reduced from what we thought was our optimal plan (MAP 2009). Additional active adaptive management field scale experiments would be very helpful to tackle some key engineering and scientific uncertainties. We currently do not have the funding to make these and other improvements in our science and AM program.

Name of program: **Great Barrier Reef Plan**

(Response to questionnaire not received.)

Name of program: Great Lakes Water Quality Agreement

Please provide short answers to the following six statements: strongly agree, agree, neutral, disagree, strongly disagree, not applicable, or your can provide a different qualified answer.

1) Our plan or program has a clearly stated purpose with tiered goals, objectives and actions to deliver the purpose of the plan. Yes, the purpose is stated in the Great Lakes Water Quality Agreement (GLWQA) however the goals are not tiered or described in great detail.

2) The program strives to be accountable for achieving its goals and must monitor relevant aspects of the environment to demonstrate status and progress. Yes, but the IJC-GLRO monitors the progress of the parties using monitoring data that is collected by other organizations.

3) The best available science is regularly integrated into program assessments. Yes, often contracted or contributed by expert advisory boards, task forces and reference groups.

4) Our plan utilizes an adaptive management process to direct research and management actions based on monitoring and/or modeling results. The IJC has created a Great Lakes Adaptive Management committee to assist its boards of control.

5) As part of being accountable, progress towards achieving the plan goals is communicated objectively and regularly. Triennial reports of progress.

6) Results must be expressed in terms understandable to the public and decision-makers, but the underlying data is available and easily accessible to all stakeholders. Yes

This next set of questions can be answered briefly, or in longer form if you wish to provide context or more information (use as much room as needed).

7) What would you list as the primary set of prioritized goals and associated environmental indicators for your program? (This does not need to be an exhaustive or complete listing.)

Protection and restoration of the chemical, physical and biological integrity of the Great Lakes. 9 general objectives of the GLWQA, Great Lakes "Vital Signs" and SOGL indicators and sub-indicators.

8) What criteria do you use to select indicators or metrics of system condition? (For example, responsiveness, ease and cost of data collection, repeatability, public understanding, strength of linkage, etc.)

"Vital Signs" were selected by the Science Advisory Board as a small set of indicators that could effectively communicate progress and conditions to the general public. Other indicators are effectively indices of relevant environmental data. See publications and material available on www.ijc.org for more details. IJC makes recommendations to the governments of the U.S. and Canada on ways to more effectively achieve and measure progress on the general and specific goals of the GLWQA. The IJC uses expert advisory panels to inform its advice to governments.

9) Collaboration among State and Federal agencies can be challenging to achieve. How important is interagency collaboration for your program and what are key factors that lead to a productive collaborative program? How are the unique perspectives of different individual agencies integrated when establishing or revising program goals?

IJC advisory boards are amalgamated from representatives of a diverse collection of US and Canadian agencies and organizations. Applied science and "pure" academically oriented interests must be represented by members of boards. One board is more policy oriented, whereas others are science and management oriented.

10) To what extent is the decision-making and management centralized for project implementation, program monitoring, research, evaluation and reporting, and how is this work coordinated among agencies and other stakeholders?

Boards submit work plans to the IJC and commissioners approve projects. Members communicate with networks of peers to assure that proposals add to the knowledge base and avoid duplication of efforts.

11) How often are formal program evaluation reports conducted, including assessment of program goals and indicators? Among program participants, who conducts these evaluations, and how is leadership assigned? Are the results as objective as you would like? Is there independent oversight or peer-review of the evaluation reports?

The President and Prime Minister appoint IJC Commissioners. Representatives of the governments meet semi-annually (at a minimum) to discuss activities and progress. Although the IJC is an independent bi-national commission, the governments hold the "power of the purse." The IJC depends on science based advice, transparency and public consultation. The IJC will on occasion have contracted reports peer-reviewed, but often uses expert consultations/workshops to ground-truth advice developed by its boards and other advisors. This is primarily a collaborative, consultative process, not an overly-prescriptive, formal process.

12) What are the roles and responsibilities of the various participating stakeholders such as agency representatives, the science community, and public stakeholder groups in 1) regular reporting, 2) program goal review, and 3) indicator review?

Representatives of stakeholder organizations serve as board members in an advisory capacity. Public consultation is conducted on draft reports. Work groups provide input on programs and indicators.

13) Are the results of periodic evaluation reports used to adjust program goals, indicators or standards, and if so what is the process for adopting those changes? Has the trend been toward simplification over time, or toward increased complexity with more indicator tracking? What types of reports are produced on a regular basis (e.g., implementation activity, effectiveness evaluation, status and trend, etc.)?

Sometimes IJC reports have an impact on governments, sometimes they are ignored, but they are all publically available.

14) What are key considerations for incorporating and delivering the best science for your program? How is leadership for your science team determined and how large or extended is the participating science community? Do agency and public stakeholders generally perceive the science team as an independent and reliable source of information?

Experience and expertise. Co-chairs and staff are selected by panels and approved by commissioners. Advisory board members serve in their "personal and professional" capacity and are generally perceived as independent and reliable sources. The IJC is also generally perceived as independent and reliable.

15) Are conceptual models utilized, and if so, how often are they updated? Are other types of models used in your program? For example, are models used to test management options, estimate the status of an indicator, identify research needs, select restoration projects for funding, or to assign restoration credits? Has modeling been an effective tool for your program? Does your program include efforts to validate and update the models?

Not really.

16) Are program monitoring and evaluation data centrally managed and periodically updated for stakeholder use? In general terms, how is multi-agency data coordinated, stored, quality assured and distributed or otherwise made available?

Not by IJC

17) What are your major funding source categories (e.g., ongoing government funding, funding from the regulated community, private contributions). Roughly, what are average annual allocations to: a) project planning and implementation, b) monitoring and research, c) programmatic evaluation and reporting, and d) general program management, staff and operations? Are collaborations with other agencies or groups a significant source of funding or in-kind support for the program? Is your funding stable?

Federally funded. See IJC annual reports to get a grasp of allocations. Budgets are public records. Budgets have remained flat while personnel costs have risen and costs have inflated. Funding is reasonably stable in comparison to most programs. IJC received some GLRI funds for studies where it claimed no overhead and personnel hours were all an in-kind contribution. The volunteer experts on advisory boards provide "free" consultation to the IJC and in turn, governments, so it is a relatively good return on investment. The GLRO budget is approximately $3M.

18) If you have a TMDL in effect is it integrated into the management plan and performance reporting? What might be improved? Does the TMDL limit the evolution of your program?

N/A

19) Is your conservation plan recognized as excelling in some area, and what is it?

N/A

20) What do you see as areas to improve upon? Do you have funding and program capacity to make these improvements?

Public awareness and education; yes.

Name of program: Lake Champlain Basin Program

Please provide short answers to the following six statements: strongly agree, agree, neutral, disagree, strongly disagree, not applicable, or your can provide a different qualified answer.

1) Our plan or program has a clearly stated purpose with tiered goals, objectives and actions to deliver the purpose of the plan. Agree

2) The program strives to be accountable for achieving its goals and must monitor relevant aspects of the environment to demonstrate status and progress. Agree

3) The best available science is regularly integrated into program assessments. Strongly agree

4) Our plan utilizes an adaptive management process to direct research and management actions based on monitoring and/or modeling results. Agree

5) As part of being accountable, progress towards achieving the plan goals is communicated objectively and regularly. Strongly agree

6) Results must be expressed in terms understandable to the public and decision-makers, but the underlying data is available and easily accessible to all stakeholders. Agree

This next set of questions can be answered briefly, or in longer form if you wish to provide context or more information (use as much room as needed).

7) What would you list as the primary set of prioritized goals and associated environmental indicators for your program? (This does not need to be an exhaustive or complete listing.)

Goal 1: Clean water –
Indicator: Frequency of harmful algal blooms
Healthy Ecosystems
Indicator: frequency of new aquatic invasive species
Thriving Communities
Indicator: access to Lake Champlain
Informed & Involved Public
Indicator: none – to be developed.

8) What criteria do you use to select indicators or metrics of system condition? (For example, responsiveness, ease and cost of data collection, repeatability, public understanding, strength of linkage, etc.)

- Ease & cost of data collection

- Data longevity – are historic data available, and will these data be available going forward with current monitoring efforts
- Ability to interpret data to public
- Scale at which we can infer trends from data - e.g. farm level or subwatershed level?

9) Collaboration among State and Federal agencies can be challenging to achieve. How important is interagency collaboration for your program and what are key factors that lead to a productive collaborative program? How are the unique perspectives of different individual agencies integrated when establishing or revising program goals?

- Interagency collaboration is critical – this is the reason the Lake Champlain Basin Program was created – to ensure cooperation and collaboration among the different jurisdictions of Lake Champlain (US federal, the States of New York and Vermont, the Province of Quebec, local municipalities)
- All partners are at the table when the Lake Champlain Management plan is updated (most recently, June 19, 2017) and the plan is developed with an inclusive approach to provide all partners opportunities to inform priorities in the new plan

10) To what extent is the decision-making and management centralized for project implementation, program monitoring, research, evaluation and reporting, and how is this work coordinated among agencies and other stakeholders?

The Lake Champlain Steering Committee, via the Lake Champlain Basin Program, is charged with ensuring coordination of efforts across the multiple jurisdictions managing Lake Champlain. The Steering Committee makes all decisions regarding application of funding from several US agencies, including the EPA, Great Lakes Fishery Commission and National Park Service. The LCBP also serves as a central point of communication for all partners working within the Lake Champlain watershed.

11) How often are formal program evaluation reports conducted, including assessment of program goals and indicators? Among program participants, who conducts these evaluations, and how is leadership assigned? Are the results as objective as you would like? Is there independent oversight or peer-review of the evaluation reports?

- We update the Lake Champlain State of the Lake and Ecosystem Indicators report every 3 years. This is the responsibility of the Lake Champlain Basin Program, with advice and feedback from all partners we work with.

12) What are the roles and responsibilities of the various participating stakeholders such as agency representatives, the science community, and public stakeholder groups in 1) regular reporting, 2) program goal review, and 3) indicator review?

Roles and responsibilities vary among organizations providing funding to certain programs and those who do not. The LCBP is constructed in a way to allow for different stakeholder groups to provide advice and input at many different levels. We have the Lake Champlain Steering Committee, which sets the annual budget priorities for the LCBP (approximately $5 million). The Steering Committee is represented by about 6 different US federal agencies, 4 different branches of government each in NY, VT, and Quebec, scientists, culture & heritage, education & outreach, and three citizen representatives representing VT, NY, Quebec. We also have advisory committees (to the Steering Committee) providing feedback from each of these perspectives for annual reporting, program goals and indicators.

13) Are the results of periodic evaluation reports used to adjust program goals, indicators or standards, and if so what is the process for adopting those changes? Has the trend been toward simplification over time, or toward increased complexity with more indicator tracking? What types of reports are produced on a regular basis (e.g., implementation activity, effectiveness evaluation, status and trend, etc.)?

The indicators have not been adjusted since an initial basin-wide survey was conducted ca. 2002 to develop indicators that are useful and important to both resource managers and the general public. This is something that we need to work on updating for Lake Champlain, and intend to do so in fall 2017. http://sol.lcbp.org/

14) What are key considerations for incorporating and delivering the best science for your program? How is leadership for your science team determined and how large or extended is the participating science community? Do agency and public stakeholders generally perceive the science team as an independent and reliable source of information?

Key considerations include the quality and repeatability of the data to be used for informing indicators. Our science team (Technical Advisory Committee) currently consists of about 25 people representing state and federal agencies and academic institutions. We do occasionally have members representing NGOs in the watershed as well, but none at this time due to staff transitions. Membership on this committee is determined by an individual's area of expertise, not who they work for. We have three standing seats on this committee who serve as official representatives for VT, NY and Quebec. The Chair is selected by nomination, and approval by the Lake Champlain Steering Committee. Historically, Chairs of this committee have been associated with local academic institutions, not government agencies.

15) Are conceptual models utilized, and if so, how often are they updated? Are other types of models used in your program? For example, are models used to test management options, estimate the status of an indicator, identify research needs, select restoration projects for funding, or to assign restoration credits? Has modeling been an effective tool for your program? Does your program include efforts to validate and update the models?

Conceptual models are not heavily utilized in this program. We frequently support research studies that do build and develop predictive models, however. Utility of recently supported models has ranged from identification of "critical source areas" of phosphorus within a subwatershed to economic models to begin to determine the "value" of Lake Champlain to the region.

Models have been an effective tool, if used with caution. We do need to do a better job of following up on modeling projects after their funding is complete to determine if the outcomes of the models were realized. Other research programs have used models that we built with LCBP funds and updated them via other funding (e.g. NSF).

16) Are program monitoring and evaluation data centrally managed and periodically updated for stakeholder use? In general terms, how is multi-agency data coordinated, stored, quality assured and distributed or otherwise made available?

For the Lake Champlain Long-Term Monitoring program and our Cyanobacteria monitoring program, yes. The State of Vermont, with LCBP funding, currently coordinates data, QA, and distribution for these two programs on behalf of all jurisdictions.

For other short-term projects, not at the moment – we are actually building this capacity this summer.

17) What are your major funding source categories (e.g., ongoing government funding, funding from the regulated community, private contributions). Roughly, what are average annual allocations to: a) project planning and implementation, b) monitoring and research, c) programmatic evaluation and reporting, and d) general program management, staff and operations? Are collaborations with other agencies or groups a significant source of funding or in-kind support for the program? Is your funding stable?

We are currently 100% federally funded. In FY16, Approximately 20% of our budget supports program management and staffing, 20% supports long-term monitoring programs, 25% supports research, and the remainder supports on-the ground implementation or outreach projects.

The State of Vermont provides our required non-federal match (approximately $1million) for our EPA funding.

Our funding is as stable as can be expected with the current federal administration.

18) If you have a TMDL in effect is it integrated into the management plan and performance reporting? What might be improved? Does the TMDL limit the evolution of your program?

The phosphorus TMDLs for Lake Champlain are not integrated into the management plan and performance reporting. This is the responsibility of the States of Vermont and New York.

19) Is your conservation plan recognized as excelling in some area, and what is it?

The new plan has been approved for 24 hours, so a little too early to tell yet. The previous plan, in effect from December 2010 to yesterday, was extremely comprehensive, to the point where it did not serve as a useful tool for establishing annual priorities in our budget process. http://www.lcbp.org/about-us/opportunities-for-action/

20) What do you see as areas to improve upon? Do you have funding and program capacity to make these improvements?

We need to find useful ways to document progress. Many of our goals are long-term goals, and more short-term goals would be helpful to use to report back to the public on progress. This is something I hope to work on this fall.

Name of program: Long Island Sound Study

Please provide short answers to the following six statements: strongly agree, agree, neutral, disagree, strongly disagree, not applicable, or your can provide a different qualified answer.

1. Our plan or program has a clearly stated purpose with tiered goals, objectives and actions to deliver the purpose of the plan. STRONGLY AGREE

2. The program strives to be accountable for achieving its goals and must monitor relevant aspects of the environment to demonstrate status and progress. STRONGLY AGREE

3. The best available science is regularly integrated into program assessments. AGREE

4. Our plan utilizes an adaptive management process to direct research and management actions based on monitoring and/or modeling results. AGREE

5. As part of being accountable, progress towards achieving the plan goals is communicated objectively and regularly. AGREE

6. Results must be expressed in terms understandable to the public and decision-makers, but the underlying data is available and easily accessible to all stakeholders. AGREE

This next set of questions can be answered briefly, or in longer form if you wish to provide context or more information (use as much room as needed).

7) What would you list as the primary set of prioritized goals and associated environmental indicators for your program? (This does not need to be an exhaustive or complete listing.)

The Long Island Sound Comprehensive Conservation and Management Plan (CCMP) contains an overall vision "The vision for the Sound is of waters that are clean, clear, safe to swim in, and charged with life. It is a vision of waters nourished and protected by extensive coastal wetlands, by publicly accessible, litter-free beaches and preserves, and of undeveloped islands. It is a vision of abundant and diverse wildlife, of flourishing commercial fisheries, of harbors accessible to the boating community, and of a regional consciousness and a way of life that protects and sustains the ecosystem."

The CCMP has four themes. Each theme has an overall goal. Those themes and associated goals are:

- Clean Waters and Healthy Watersheds – Improve water quality by reducing contaminant and nutrient loads from the land and the waters impacting Long Island Sound.

- Thriving Habitats and Abundant Wildlife – Restore and protect the Sound's ecological balance in a healthy, productive, and resilient state for the benefit of both people and the natural environment.
- Sustainable and Resilient Communities – Support vibrant, informed, and engaged communities that use, appreciate, and help protect Long Island Sound; and.
- Sound Science and Inclusive Management – Manage Long Island Sound using sound science and cross-jurisdictional governance that is inclusive, adaptive, innovative, and accountable

The CCMP included 20 ecosystem targets. These are indicators for which a specific measurable outcome was set. The list of ecosystem targets is available at http://longislandsoundstudy.net/about/our-vision/

The program tracks additional environmental indicators that support evaluation of the ecosystem targets. While our website is being updated, the current list of support indicators is available at http://longislandsoundstudy.net/research-monitoring/long-island-sound-environmental-indicators/

8) What criteria do you use to select indicators or metrics of system condition? (For example, responsiveness, ease and cost of data collection, repeatability, public understanding, strength of linkage, etc.)

The CCMP includes a technical background and explanation of the quantitative ecosystem targets. Explanation is provided for each target on how and why the given metric and specific target were chosen and how progress toward the target will be measured (e.g., what the baseline value is, clarification of specific terms, what datasets will be used, etc.). The targets were selected based on all the factors listed in the question, but particularly availability of data and relevancy to meetings goals and objectives.

9) Collaboration among State and Federal agencies can be challenging to achieve. How important is interagency collaboration for your program and what are key factors that lead to a productive collaborative program? How are the unique perspectives of different individual agencies integrated when establishing or revising program goals?

This is a critical aspect of plan development. A team of federal, state, and private stakeholders developed the CCMP, goals, and the ecosystem targets. In addition, the plan went through extensive agency review and sign off, in additional to open public review.

10) To what extent is the decision-making and management centralized for project implementation, program monitoring, research, evaluation and reporting, and how is this work coordinated among agencies and other stakeholders?

The Long Island Sound Study uses a distributed management structure. While the U.S. EPA provides overall administrative support through a program office, program funding is provided to state and other agencies for coordination, implementation, science, monitoring, etc. The multi-agency team meets regularly to communicate and coordinate efforts.

11) How often are formal program evaluation reports conducted, including assessment of program goals and indicators? Among program participants, who conducts these evaluations, and how is leadership assigned? Are the results as objective as you would like? Is there independent oversight or peer-review of the evaluation reports?

The EPA Office of Water conducts a formal program evaluation approximately every five years, most recently in 2015. The LISS has also supported independent evaluation of some program elements. For example, the Long Island Sound Futures Fund, a competition to fund local implementation projects was independently evaluated by an external consultant. External model evaluation groups have also been used to provide input to complex technical projects with regulatory and policy implications.

This program evaluation is different from regular evaluations and reports on the "state of the ecosystem" or "implementation progress" reports. These are internal program products that get input from program participants but are not independently peer-reviewed.

12) What are the roles and responsibilities of the various participating stakeholders such as agency representatives, the science community, and public stakeholder groups in 1) regular reporting, 2) program goal review, and 3) indicator review?

See answer to question 4. The multi-agency team provides overall program coordination. We also support an external Science and Technical Advisory Committee and Citizen Advisory Committee. These groups provide independent evaluation and input on science and policy.

13) Are the results of periodic evaluation reports used to adjust program goals, indicators or standards, and if so what is the process for adopting those changes? Has the trend been toward simplification over time, or toward increased complexity with more indicator tracking? What types of reports are produced on a regular basis (e.g., implementation activity, effectiveness evaluation, status and trend, etc.)?

Our trend has been toward simplification in both the number of actions contained in the plan and in focusing on key ecosystem indicators with targets. This is partly a consequence of resource limitations requiring that we focus our tracking and evaluation of what matters most.

14) What are key considerations for incorporating and delivering the best science for your program? How is leadership for your science team determined and how large or extended is the participating science community? Do agency and public stakeholders

generally perceive the science team as an independent and reliable source of information?

The LISS supports a science coordinator whose job is to lead and integrate science among the many scientists and organizations at work in the LIS watershed. The position is responsible for assisting in the development and management of technical projects and programs of the LISS, and developing and maintaining professional, scientific, and technical contacts among the LISS partners. The LISS Science Coordinator acts as science liaison between the LISS and federal, state, and local scientists and managers, and works with the external Science and Technical Advisory Committee (STAC) to prioritize LIS research needs and apply research results into LISS management actions. The STAC is comprised of around 35 scientists and engineers from government, universities, and NGOs. The STAC is headed by two co-chairs, one from Connecticut and one from New York. The STAC is advisory only and is not responsible for program tasks.

15) Are conceptual models utilized, and if so, how often are they updated? Are other types of models used in your program? For example, are models used to test management options, estimate the status of an indicator, identify research needs, select restoration projects for funding, or to assign restoration credits? Has modeling been an effective tool for your program? Does your program include efforts to validate and update the models?

The LISS program early on invested in research, monitoring, and technical support to develop water quality and circulation models of Long Island Sound (1990). These models were fundamental to the development of nitrogen reduction targets for LIS (See #12 below). Later, the regulated community (New York City) expanded and refined the models, supporting additional data collection (2000), calibration, and validation. Now LISS is evaluating the need for the next generation of modeling tools to support eutrophication management.

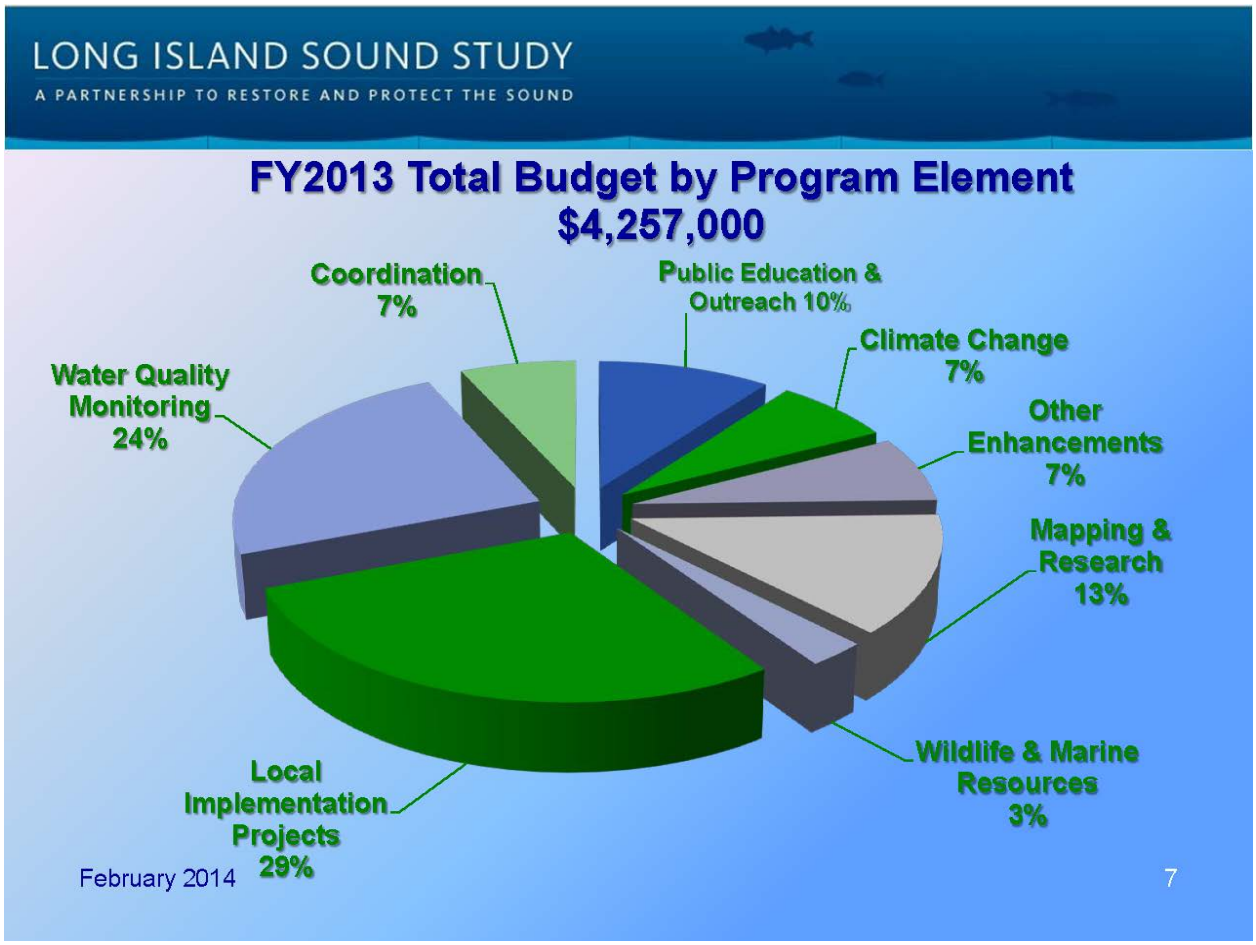
16) Are program monitoring and evaluation data centrally managed and periodically updated for stakeholder use? In general terms, how is multi-agency data coordinated, stored, quality assured and distributed or otherwise made available?

As discussed in #4, the LISS uses a distributed management structure. Data storage, quality assurance, and distribution is the responsibility of the data collector. Assistance agreements require development of quality assurance program plans for all data collection. LISS staff then work to access and assess data necessary for program evaluation and reporting, and to foster interagency efforts. Lack of a centralized data management and GIS team does impede the comprehensive analysis and presentation of data (Better data management and GIS implementation are important needs of the program.)

17) What are your major funding source categories (e.g., ongoing government funding, funding from the regulated community, private contributions). Roughly, what are average annual allocations to: a) project planning and implementation, b) monitoring

and research, c) programmatic evaluation and reporting, and d) general program management, staff and operations? Are collaborations with other agencies or groups a significant source of funding or in-kind support for the program? Is your funding stable?

The LISS is funded through a federal appropriation that has been steady the past five years at approximately $4.5 million/year. State and local funds match the federal awards. The chart below shows the general breakdown of funds for 2013 but is applicable through 2016. EPA generally covers program administrative costs (leasing office space, EPA staff) with a portion coming from the coordination and PIE categories. Detailed work plans with budget breakdowns and descriptions are available on line. For example, see http://longislandsoundstudy.net/2017/03/2016-work-plan/.



18) If you have a TMDL in effect is it integrated into the management plan and performance reporting? What might be improved? Does the TMDL limit the evolution of your program?

The LISS was fundamental to the research, monitoring, modeling, and policy development that led to New York and Connecticut developing the *2000 Total Maximum Daily Load to Achieve Water Quality Standards for Dissolved Oxygen in Long Island Sound*

(TMDL) to address summertime bottom water hypoxia conditions in the main stem of Long Island Sound. The LISS subsequently has supported implementation of the TMDL, tracked progress, evaluated ecosystem response, and recommended refinements in implementation strategies. Most recently, EPA has announced a new Nitrogen Reduction Strategy with a greater focus on local waters and is working with the states on its implementation. Our emphasis is on Sound-wide issues; local TMDLs to address local issues are developed independently of the program.

19) Is your conservation plan recognized as excelling in some area, and what is it?

The LISS has focused on two areas: 1) eutrophication impairments to water quality, particularly open water hypoxia, and 2) habitat restoration and protection. The program has also invested in public involvement, outreach, and education.
I think you could highlight the likely hypoxia reduction in response to the N reductions as well as some of the land acquisition for habitat protection.

20) What do you see as areas to improve upon? Do you have funding and program capacity to make these improvements?

Improving technical tools for assessing and managing eutrophication is a key science priority. An attached file shows recommendations in this area resulting from a recent STAC meeting. Partnerships with the regulated community will be necessary to fully meet these needs.

Name of program: Puget Sound Partnership

Please provide short answers to the following six statements: strongly agree, agree, neutral, disagree, strongly disagree, not applicable, or your can provide a different qualified answer.

1) Our plan or program has a clearly stated purpose with tiered goals, objectives and actions to deliver the purpose of the plan.

Agree – qualification in that the plan does not describe actions needed to achieve clearly stated "targets" (though such plans are in development).

2) The program strives to be accountable for achieving its goals and must monitor relevant aspects of the environment to demonstrate status and progress.

Strongly agree – we report on progress toward recovery using our Vital Signs and targets we have set (desired future conditions). Reporting is on psp.wa.gov and in biennial State of the Sound reports.

3) The best available science is regularly integrated into program assessments.

Agree – though we struggle to assess even the subset of conditions we have adopted as Vital Signs, much less other "ancillary" measures that would provide a richness to our understanding of conditions and the contributions of recovery efforts.

4) Our plan utilizes an adaptive management process to direct research and management actions based on monitoring and/or modeling results.

Agree – see above re: limitations of monitoring and also note that a 2-year planning cycle has impeded our ability to consistently integrate learning from monitoring and research into successive iterations of our recovery plan.

5) As part of being accountable, progress towards achieving the plan goals is communicated objectively and regularly.

Strongly agree – see comment above for question 2.

6) Results must be expressed in terms understandable to the public and decision-makers, but the underlying data is available and easily accessible to all stakeholders.

Strongly agree – our Vital Signs were adopted by our Leadership Council which gave significant consideration to the communication merits of proposed/possible measures; our reports are very brief but psp.wa.gov Vital Signs pages provides links to underlying data.

This next set of questions can be answered briefly, or in longer form if you wish to provide context or more information (use as much room as needed).

7) What would you list as the primary set of prioritized goals and associated environmental indicators for your program? (This does not need to be an exhaustive or complete listing.)

See 6 goals in Washington State statute at RCW 90.71.

See Vital Signs adopted to represent these goals. And targets adopted to specify desired future conditions for these Vital Signs and their indicators. Information available at psp.wa.gov.

8) What criteria do you use to select indicators or metrics of system condition? (For example, responsiveness, ease and cost of data collection, repeatability, public understanding, strength of linkage, etc.)

An Indicators Action Team (IAT), an interdisciplinary group of primarily scientists, proposed a "Dashboard of Vital Signs" for adoption by a Leadership Council. The criteria used by the IAT included current availability, technical merits, communication merits, etc.

A review panel under the auspices of the Washington State Academy of Sciences critiqued this approach and recommended that we first "qualify" indicators based on technical considerations and then apply social and feasibility considerations to select from among the technically qualified indicators. We have commissioned a report to attempt this approach; revisions are being made to address comments from peer review.

Copies of these materials for details about criteria and recommendations are available on request

9) Collaboration among State and Federal agencies can be challenging to achieve. How important is interagency collaboration for your program and what are key factors that lead to a productive collaborative program? How are the unique perspectives of different individual agencies integrated when establishing or revising program goals?

Interagency collaboration including state, federal, local governments and tribes is VERY important to our program. Institutional structures that ensure engagement of partners from various caucuses are key tool for us. Our Ecosystem Coordination Board has multiple seats for members of the Federal Caucus, State Caucus, Local Government Caucus, and tribes. The Steering Committee of the PS Ecosystem Monitoring Program likewise has allocated seats for members from these (and other) caucuses.

Overall program goals are established in state statute – the stakeholder engagement in legislative deliberation and action would be the primary avenue for revision to overall goals.

Vital Signs to represent our goals and targets to express desired future conditions are science-informed policy decisions. Our stakeholder bodies have been invited to share their perspectives on alternative Vital Signs and target statements and these perspectives have been considered as a non-representational Leadership Council makes the organization's decisions.

10) To what extent is the decision-making and management centralized for project implementation, program monitoring, research, evaluation and reporting, and how is this work coordinated among agencies and other stakeholders?

Project implementation – dispersed to a variety of entities who "own" actions; as of 2016 actions are included in the plan via responses to solicitation of actions where the solicitation declares regional priorities.

Program monitoring 1: monitoring of action implementation is centralized at the Puget Sound partnership, with action owners asked to self-report on progress semi-annually

Program monitoring 2: ecosystem monitoring investigations and reporting are dispersed to lead organizations (primarily government agencies) with coordination via a PS Ecosystem Monitoring Program, which includes participation from a number of partner organizations (described above for Steering Committee)

Effectiveness evaluation: mix of dispersed to programs that evaluate themselves and centralized at PS Partnership/PSEMP where data are "mined" to develop assessments through analysis of existing information

Research: dispersed to entities in the region with resources to conduct or commission studies (state agency science programs, federal agency centers and programs, local government science programs, Sea Grant, private efforts such as SeaDoc Society); the PS Partnership's Science Panel prepares a "science work plan" that identifies priority science work actions but this merely lists items that "should" be done but does not provide/direct resources to these efforts

Reporting: mix – see above for description of centralized State of the Sound and Vital Sign reporting but also note that science programs and PSEMP work groups also develop their own reporting. Another centralized effort: Salish Sea stories published by Puget Sound Institute as partner group at University of Washington.

11) How often are formal program evaluation reports conducted, including assessment of program goals and indicators? Among program participants, who conducts these evaluations, and how is leadership assigned? Are the results as objective as you would like? Is there independent oversight or peer-review of the evaluation reports?

External evaluations have been occurring since the PS Partnership was established in 2007:

- Washington State Legislature's joint legislative audit and review committee (JLARC) reviewed PS Partnership in 2011 and again in 2016
- Washington State Academy of Sciences conducted an early evaluation of the Partnership – focused on our identification of ecosystem indicators – in 2013
- EPA review of the PS Partnership as a participant in the National Estuary Program (CWA Section 320) has occurred on about a 3-year cycle, most recently in 2014.

Except for WSAS, these did not assess the quality/nature of our goals or indicators.

Internal evaluations occur routinely, especially in the production of the State of the Sound report which includes comments from the Science Panel on progress in implementing the recovery plan.

12) What are the roles and responsibilities of the various participating stakeholders such as agency representatives, the science community, and public stakeholder groups in 1) regular reporting, 2) program goal review, and 3) indicator review?

Regular reporting – partners self-report the status of the activities they "own," Indicator leads (principal investigators, typically at partner organization) provide reports on Vital Sign indicators including interpretation of progress toward recovery.

Program goal review – for overall goals, this is generally reserved for the legislature but the Science Panel has begun discussion of alternative frames for recovery re: resilience indicators for complex systems. For Vital Signs and their targets see answers above.

Indicator review – see answer above re: assessment of goals and indicators for role of WSAS. Other key participants are representatives of partner organizations who participate in (1) the topical work groups of the PS Ecosystem Monitoring Program and (2) interdisciplinary teams for Implementation Strategy development and (3) advisory teams for Strategic Initiatives. PS Partnership provides staff support for the PSEMP work groups. Partner organization provide the staff support and other infrastructure for Implementation Strategies and Strategic Initiatives

13) Are the results of periodic evaluation reports used to adjust program goals, indicators or standards, and if so what is the process for adopting those changes? Has the trend been toward simplification over time, or toward increased complexity with more indicator tracking? What types of reports are produced on a regular basis (e.g., implementation activity, effectiveness evaluation, status and trend, etc.)?

Critique of and recommendation for improvements to our indicators and targets comes up routinely in our reporting on Vital Signs, in our State of the Sound reports, and in the planning of successive iterations of our recovery plan (Action Agenda). For the most part, we have not adapted our indicators in response to these critiques and recommendations preferring instead to offer stability in the measurement system up through our upcoming milestone of (recovery by) 2020.

One key exception is that we adopted revised human wellbeing indicators in 2015 in response to an indicator development effort that built from watershed scale up to Puget Sound-wide measures.

14) What are key considerations for incorporating and delivering the best science for your program? How is leadership for your science team determined and how large or extended is the participating science community? Do agency and public stakeholders generally perceive the science team as an independent and reliable source of information?

A strategic science plan (2010) describes science-policy engagement through the steps of integrated ecosystem assessment (IEA) and the adaptive cycle as described in the Open Standards for the Practice of Conservation. These are further detailed in the Partnership's Adaptive Management Framework (2013).

Leadership for our science team comes in 3 primary forms:

(1) Science Panel established as part of the Partnership, assigned to provide advice, synthesis, and science program development – members nominate themselves, vetting is through the Washington State Academy of Sciences, and (non-representational) appointments are made by the governor-appointed Leadership Council.
(2) Chief scientist is on the staff of the agency that operates under the direction of an Executive Director. In recent years this appointment has shifted to the Science & Evaluation Director with additional (sometimes) support from a Senior Science Advisor.
(3) Puget Sound Institute – a joint program of (primarily) University of Washington and (secondarily) PS Partnership and U.S. EPA; director is ex officio member of Science Panel and institute is key collaborator of PS Partnership science & evaluation program

Engagement with the science community extends into academia, private sector, and additional agencies but not to the extent desired/imagined. Science Panel membership brings some of this extension (e.g., Canadian federal agency science leader; UBC social scientist, retired private sector scientist, multiple faculty members from Washington's public universities). PSEMP work groups and Steering Committee accomplish some additional extension. Planning and participation in biennial Salish Sea Ecosystem Conference is also a key tool in engagement of the science community.

15) Are conceptual models utilized, and if so, how often are they updated? Are other types of models used in your program? For example, are models used to test management options, estimate the status of an indicator, identify research needs, select restoration projects for funding, or to assign restoration credits? Has modeling been an effective tool for your program? Does your program include efforts to validate and update the models?

Yes, we use conceptual models extensively especially in the sense of situation mapping and results chain development in the Open Standards for the Practice of Conservation. Uses include: development and selection of management options, selection of indicators and explanation of the findings of indicator monitoring, identification of uncertainties to address by research or monitoring investigation.

Quantitative modeling has not been broadly used in PS recovery. The Science Panel has identified this as a key issue – a science service that is not well developed or used. A question for us to address: what is the decision-making culture in PS and how would it be served or improved by development/use of additional (more quantitative) models.

16) Are program monitoring and evaluation data centrally managed and periodically updated for stakeholder use? In general terms, how is multi-agency data coordinated, stored, quality assured and distributed or otherwise made available?

Data are not centrally managed. We have a vision of "portals" to provide access to distributed data but have not actively developed or encouraged use of such portals.

We have a few good tools that could be better used: NANOOS data visualization, monitoring tools.org, MiradiShare

17) What are your major funding source categories (e.g., ongoing government funding, funding from the regulated community, private contributions). Roughly, what are average annual allocations to: a) project planning and implementation, b) monitoring and research, c) programmatic evaluation and reporting, and d) general program management, staff and operations? Are collaborations with other agencies or groups a significant source of funding or in-kind support for the program? Is your funding stable?

The Puget Sound Partnership provides backbone functions for the collective recovery effort. The Partnership is supported by ongoing government funding from (1) state appropriations (general fund, aquatic lands enhancement account, and state toxics account) and (2) federal awards (primarily EPA's CWA Section 320 NEP funds and Puget Sound Geographic Funds and NOAA Fisheries' Pacific Coast Salmon Recovery Funds.

The Partnership receives roughly $5.5M/year from federal sources and $3.75M/year from state for:

- Recovery planning (links to project planning, but doesn't not fully fund project planning)
- Coordination of monitoring and research, including support for some monitoring studies and a few other scientific investigations
- Programmatic evaluation and reporting
- General program management, staff and operations (which includes the above efforts as well as coordination of nested scales of recovery, coordination of salmon recovery in the Puget Sound region, and coordination of stewardship programs)

Collaborations are key as partner investments are (1) the primary source of funding for project and program implementation (including implementation of scientific investigations) and (2) provide in-kind participation in efforts to collectively plan and evaluate recovery.

State and federal funding have been stable at level far below our articulated need for backbone function and project and program implementation. For example, we describe a funding gap of $300M/yr for habitat protection and restoration, $40M/yr for shellfish bed protection and restoration, and > $100M/yr for stormwater management.

18) If you have a TMDL in effect is it integrated into the management plan and performance reporting? What might be improved? Does the TMDL limit the evolution of your program?

We have multiple TMDLs and TMDL-like "clean up plans" in effect as the Puget Sound ecosystem encompasses hundreds of "water bodies."

One of our measures of freshwater quality is the number of water quality impairments (303d listings), many of which are addressed by development of TMDL or similar plans.

We also have a measure of marine water quality related to human-caused (e.g., via excess nutrients) depletion of dissolved oxygen. A TMDL-type approach is getting underway to address this issue.

TMDL and TMDL-like tools seem well positioned to help address water quality concerns in the Puget Sound region.

19) Is your conservation plan recognized as excelling in some area, and what is it?

I think we are recognized in two areas (both of which could be improved):

(1) Setting targets as science-informed policy statements of desired future conditions for our indicators of ecosystem health.
(2) Engagement of social sciences in supporting ecosystem recovery.

20) What do you see as areas to improve upon? Do you have funding and program capacity to make these improvements?

"Mainstreaming" Puget Sound recovery and protection issues and approaches into existing programs, investment decisions, and citizen behaviors. Puget Sound's needs from state and local management of population growth and shoreline development are not clearly and uniformly addressed by local government programs or by the land development proposals put forward by the private sector and governments. We have insufficient program capacity to make such an improvement.

Using information from prior implementation to improve decisions about approaches to best achieve recovery and long-term protection. Our adaptive management philosophy assumes shared learning across the diversity of implementers but data collection, knowledge generation, and sharing of learning are all quite limited. We have insufficient program capacity to make such an improvement.

Name of program: San Francisco Estuary Partnership

Please provide short answers to the following six statements: strongly agree, agree, neutral, disagree, strongly disagree, not applicable, or your can provide a different qualified answer.

1) Our plan or program has a clearly stated purpose with tiered goals, objectives and actions to deliver the purpose of the plan.
   Strongly agree

2) The program strives to be accountable for achieving its goals and must monitor relevant aspects of the environment to demonstrate status and progress.
   Strongly agree (with partners)

3) The best available science is regularly integrated into program assessments.
   Strongly agree

4) Our plan utilizes an adaptive management process to direct research and management actions based on monitoring and/or modeling results.
   Strongly agree (as much as we can – correlating management actions and environmental responses at a high level is challenging)

5) As part of being accountable, progress towards achieving the plan goals is communicated objectively and regularly.
   Strongly agree

6) Results must be expressed in terms understandable to the public and decision-makers, but the underlying data is available and easily accessible to all stakeholders.
   Agree

This next set of questions can be answered briefly, or in longer form if you wish to provide context or more information (use as much room as needed).

7) What would you list as the primary set of prioritized goals and associated environmental indicators for your program? (This does not need to be an exhaustive or complete listing.)

Four primary goals: sustain and improve Estuary's habitats and living resources; bolster the resilience of Estuary ecosystems, shorelines and communities to climate change; improve water quality and increase the quantity of freshwater available to the Estuary; Champion the Estuary. Goals, Objectives, Actions and Tasks are described in the 2016 Estuary Blueprint (http://www.sfestuary.org/ccmp/).

The State of the Estuary Report (http://www.sfestuary.org/about-the-estuary/soter/) includes 32 indicators of health that are monitored and will be reported on every 5-6

years. More may be added as data are collected and as the Estuary Blueprint exposes gaps.

8) What criteria do you use to select indicators or metrics of system condition? (For example, responsiveness, ease and cost of data collection, repeatability, public understanding, strength of linkage, etc.)

Available data (for analysis of trends), ease and cost of data collection, repeatability.

9) Collaboration among State and Federal agencies can be challenging to achieve. How important is interagency collaboration for your program and what are key factors that lead to a productive collaborative program? How are the unique perspectives of different individual agencies integrated when establishing or revising program goals?

Extremely important. We are a federally mandated program under EPA, with a regional agency as our host entity (association of bay area governments), and a strong state partnership (SF Bay regional water quality control board). We have a 35 member "Implementation Committee" responsible for program direction and implementation of the Estuary Blueprint, consisting of govt agencies at all levels, business interests, nongovernmental environmental orgs, academia.

10) To what extent is the decision-making and management centralized for project implementation, program monitoring, research, evaluation and reporting, and how is this work coordinated among agencies and other stakeholders?

Priorities are centralized through collaborative vision of region - the Estuary Blueprint. Agreement among multiple partners on long term goals and near term priorities. The Blueprint also supports other regional planning and policy docs that guide implementation, monitoring, etc (such as the SF Bay Joint Venture's Implementation Plan, the Baylands Ecosystem Habitat Goals, the Subtidal Habitat Goals, and others).

11) How often are formal program evaluation reports conducted, including assessment of program goals and indicators? Among program participants, who conducts these evaluations, and how is leadership assigned? Are the results as objective as you would like? Is there independent oversight or peer-review of the evaluation reports?

As an EPA program, we have frequent and multiple reporting requirements. We must report on the progress of the Blueprint to EPA, semi-annually, and have in depth program evaluations every 5 years by EPA. We also report on habitat acres restored, $ spent, leverage $, etc to EPA every year.

12) What are the roles and responsibilities of the various participating stakeholders such as agency representatives, the science community, and public stakeholder groups in 1) regular reporting, 2) program goal review, and 3) indicator review?

We rely on partners to help us report on regional progress as we act as more a clearinghouse of partners and partner work. Same for program goals and indicator reviews – both the Estuary Blueprint and the State of the Estuary Report involve extensive partner participation.

13) Are the results of periodic evaluation reports used to adjust program goals, indicators or standards, and if so what is the process for adopting those changes? Has the trend been toward simplification over time, or toward increased complexity with more indicator tracking? What types of reports are produced on a regular basis (e.g., implementation activity, effectiveness evaluation, status and trend, etc.)?

We are not as integrated as we could be in this regard, though we are working towards it with a stronger connection between our state of the estuary report, our evaluations reports and the estuary blueprint. The trend is towards increased complexity in terms of monitoring of indicators.

14) What are key considerations for incorporating and delivering the best science for your program? How is leadership for your science team determined and how large or extended is the participating science community? Do agency and public stakeholders generally perceive the science team as an independent and reliable source of information?

We rely almost entirely on our partners for generating the science that we base our programmatic considerations on. We do not have an established "science team", but instead a network of science partners that we work with.

15) Are conceptual models utilized, and if so, how often are they updated? Are other types of models used in your program? For example, are models used to test management options, estimate the status of an indicator, identify research needs, select restoration projects for funding, or to assign restoration credits? Has modeling been an effective tool for your program? Does your program include efforts to validate and update the models?

We don't use conceptual models directly, but many of our partners do.

16) Are program monitoring and evaluation data centrally managed and periodically updated for stakeholder use? In general terms, how is multi-agency data coordinated, stored, quality assured and distributed or otherwise made available?

We are not the central repository for data. The Estuary lacks a central repository, though it is certainly a topic of conversation among partners.

17) What are your major funding source categories (e.g., ongoing government funding, funding from the regulated community, private contributions). Roughly, what are average annual allocations to: a) project planning and implementation, b) monitoring and research, c) programmatic evaluation and reporting, and d) general program

management, staff and operations? Are collaborations with other agencies or groups a significant source of funding or in-kind support for the program? Is your funding stable?

Yearly federal appropriation, federal grants, state grants, local funding. 90% of our income is passed through directly to our partners for on-the-ground projects and those projects may include implementation, monitoring, etc.

18) If you have a TMDL in effect is it integrated into the management plan and performance reporting? What might be improved? Does the TMDL limit the evolution of your program?

We work closely with the SF Bay Regional Water Quality Control board to support TMDL implementation with specific projects.

19) Is your conservation plan recognized as excelling in some area, and what is it?

This version is fairly new (released Sept 2016) but we've gotten positive feedback for it being clear, manageable, trackable, and reflecting key regional priorities.

20) What do you see as areas to improve upon? Do you have funding and program capacity to make these improvements?

Need to diversity funding sources even more – can't depend on federal funding. Would like to better integrate with local communities, and with land use and transportation planning.

Appendix B. Glossary of Common Terms Used in this Report.

The terminology used among programs reviewed in this document is not consistent, which often leads to frustration when trying to communicate ideas or even when trying to provide useful comparisons. TRPA management in the Lake Tahoe Basin uses some specific terminology that is unique to Tahoe as well as some terminology that is common to other programs. The Conservation Measures Partnership's (CMP) "Open Standards" program strongly recommends the use of consistent terminology and provides some definitions. We have assembled a preliminary list that borrows from the CMP and other programs to begin the process of assembling a standard terminology set for general use at Lake Tahoe.

Adaptive Management – Adaptive management (AM), also known as adaptive resource management (ARM) or adaptive environmental assessment and management (AEAM), is a structured, iterative process of robust decision making in the face of uncertainty, with an aim to reducing uncertainty over time via system monitoring. In this way, decision making simultaneously meets one or more resource management objectives and, either passively or actively, accrues information needed to improve future management. Adaptive management is a tool which should be used not only to change a system, but also to learn about the system. Because adaptive management is based on a learning process, it improves long-run management outcomes. The challenge in using the adaptive management approach lies in finding the correct balance between gaining knowledge to improve management in the future and achieving the best short-term outcome based on current knowledge. (From https://en.wikipedia.org/wiki/Adaptive_management.)

DPSIR Framework – Driver-Pressure-State-Impact-Response Framework. Drivers are factors that result in pressures that cause changes in the system. Pressures are factors that cause changes in state or condition. State variables describe the condition of the ecosystem. Impacts measure the effect of changes in state variables. Responses are the actions taken in response to predicted impacts.

Ecosystem Attribute – Ecosystem attributes are characteristics that define the structure, composition and function of the ecosystem that are of scientific and/or management importance, but insufficiently specific and/or logistically challenging to measure directly (Environmental Protection Agency, 2008). Indicators provide a practical means to judge changes in ecosystem attributes.

Conceptual Model – A narrative description or diagram that represents the relationships between key factors identified through situation analysis that are believed to impact or lead to one or more environmental management targets. A good model should link these targets to threats, opportunities, stakeholders, and key intervention points (factors – threats, opportunities, or targets) in a conceptual model where a team can develop strategies that will influence those factors. It should also indicate which factors are most important to monitor.

Goal – A formal statement detailing a desired impact of a project, such as the desired future status of a target. A good goal meets the criteria of being *linked to targets, impact oriented, measurable, time limited,* and *specific.* Goals combine societal values and scientific understanding to define a desired ecosystem condition.

Indicator – A measurable entity related to specific information needed such as the status of a target/factor/outcome, change in a threat, or progress toward an objective. A good indicator meets the criteria of being: *measurable, precise, consistent,* and *sensitive*. Ecosystem indicators are quantitative biological, chemical, physical, social, or economic measurements that serve as proxies of the conditions of attributes of natural and socio-economic systems (Environmental Protection Agency, 2008).

Note: as used in many of the natural resource management programs reviewed here, indicators are often a composite variable representing a broader aspect of environmental health, measured by individual metrics. A metric, as we use this term, is a solitary measurement with an established protocol for its collection.

Objective – A formal statement detailing a desired outcome of a project such as reducing a critical threat. A good objective meets the criteria of being: *results oriented, measurable, time limited, specific,* and *practical.* If the project is well conceptualized and designed, realization of a project's objectives should lead to the fulfillment of the project's goals and ultimately its vision. Compare to vision and goal.

Outcome *(Target, Standard)* – The desired future state of *an ecosystem component, structure or function)* threat or opportunity factor *(normally quantified).* An objective is a formal *(more general, not quantified)* statement of the desired outcome.

Note: "outcome" is often interchanged with "target", "attainment threshold", or "desired future condition". If the outcome is legally regulated, (specifically in the context of water quality) it's often referred to as a "standard". Most of the plans reviewed use the term "target" or "standard". Lake Tahoe uses "threshold standard", except when referring to the TMDL, (water quality) where "standard" is used.

Method *(Protocol)* – A specific technique used to collect data to measure an indicator. A good method should meet the criteria of being *accurate, reliable, cost-effective, feasible,* and *appropriate*.

Metric – A specific measurement variable with an established protocol for its collection. The Delta Stewardship Council, for example, distinguishes between the metric (what is specifically measured) and the indicator, which may represent some aggregate compilation of more than one metric.

Standard – Usually represents a numerical limit that's legally enforceable.

Strategy – A set of actions with a common focus that work together to achieve specific goals and objectives by targeting key intervention points, integrating opportunities, and limiting constraints. Often the strategy is driven by the evolving conceptual model. A good strategy meets the criteria of being: *linked, focused, feasible,* and *appropriate.*

Threshold Standard – This is a Tahoe-specific term that represents the nine categories for which the Tahoe Regional Planning Agency adopted environmental quality goals in 1982. Also known as Environmental Threshold Carrying Capacities, these nine Threshold Standard categories continue to encompass the highest level goals for environmental management at Lake Tahoe.

Threshold Standards:

1) Air Quality (AQ)
2) Fisheries (F)
3) Noise (N)
4) Recreation (R)
5) Scenic Resources (SR)
6) Soil Conservation (SC)
7) Water Quality (WQ)
8) Vegetation Preservation (V)
9) Wildlife (W)

Threshold Indicator – There are currently more than 170 Threshold Indicators (standards) under review by the TRPA. Each of these may include a specific numeric target, or a more general management objective, or sometimes may be simply expressed as a broad policy statement. These individual Threshold Indicators are organized into 34 indicator reporting categories that pertain to the nine TRPA Threshold Standards as shown below.

Threshold Standard - Indicator Reporting Categories:

1. Air Quality - Carbon Monoxide (CO)
2. Air Quality - Nitrate Deposition
3. Air Quality - Odor
4. Air Quality - Ozone (O3)
5. Air Quality - Regional Visibility
6. Air Quality - Respirable and Fine Particulate Matter
7. Air Quality - Sub-Regional Visibility
8. Fisheries - Instream Flow
9. Fisheries - Lahontan Cutthroat Trout
10. Fisheries - Lake Habitat
11. Fisheries - Stream Habitat
12. Noise - Cumulative Noise Events
13. Noise - Single Noise Events
14. Recreation - Fair Share Distribution of Recreation Capacity
15. Recreation - Quality of Recreation Experience and Access to Recreational Opportunities

16. Scenic Resources - Built Environment
17. Scenic Resources - Other Areas
18. Scenic Resources - Roadway and Shoreline Units
19. Soil Conservation - Impervious Cover
20. Soil Conservation - Stream Environment Zone
21. Vegetation - Common Vegetation
22. Vegetation - Late Seral/ Old growth Ecosystems
23. Vegetation - Sensitive Plants
24. Vegetation - Uncommon Plant Communities
25. Water Quality - Aquatic Invasive Species
26. Water Quality - Attached Algae
27. Water Quality - Deep Water (Pelagic) Lake Tahoe
28. Water Quality - Groundwater
29. Water Quality - Nearshore (Littoral) Lake Tahoe
30. Water Quality - Other Lakes
31. Water Quality - Surface Runoff
32. Water Quality - Tributaries
33. Wildlife - Habitats of Special Significance
34. Wildlife - Special Interest Species

Appendix C. Selected Examples of Adaptive Management Cycles.

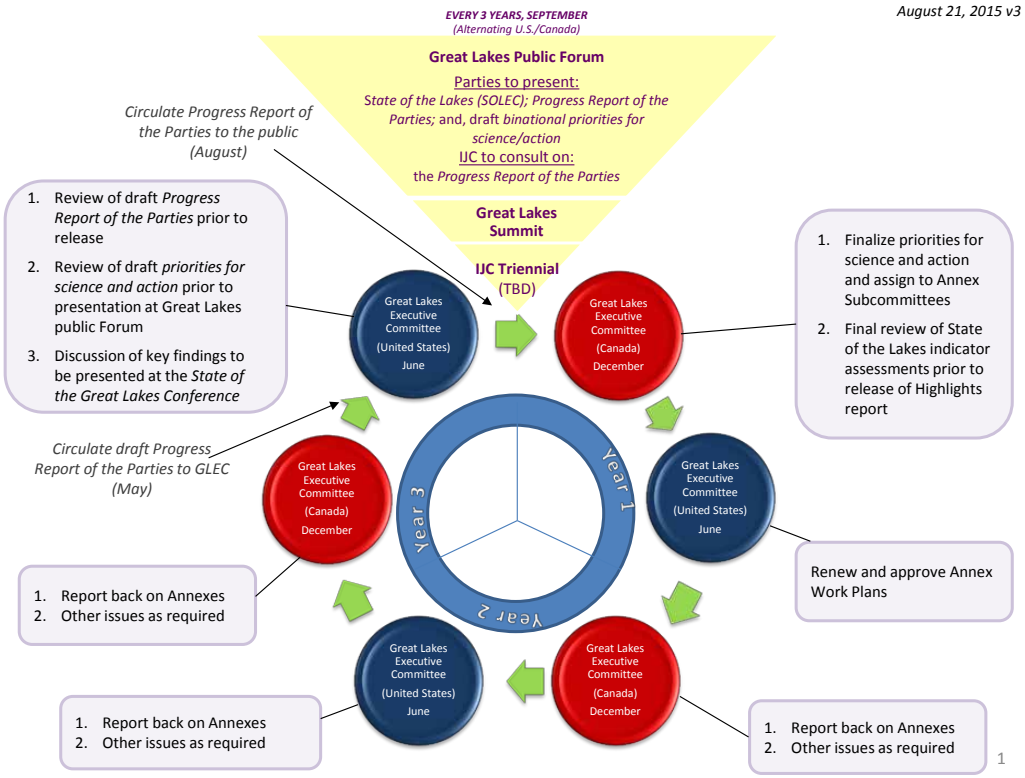


Figure C-1. The GLWQA Management and Reporting Cycle.

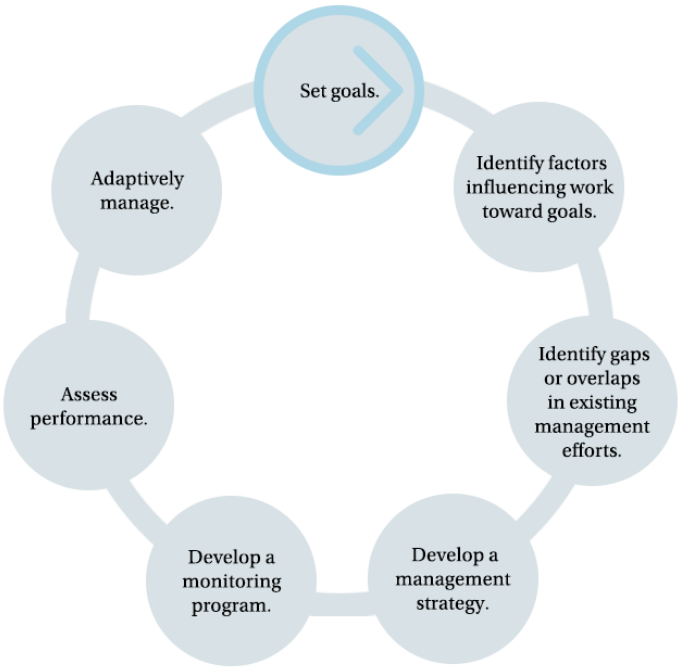


Figure C-2. The Chesapeake Bay Partnership Management Cycle.

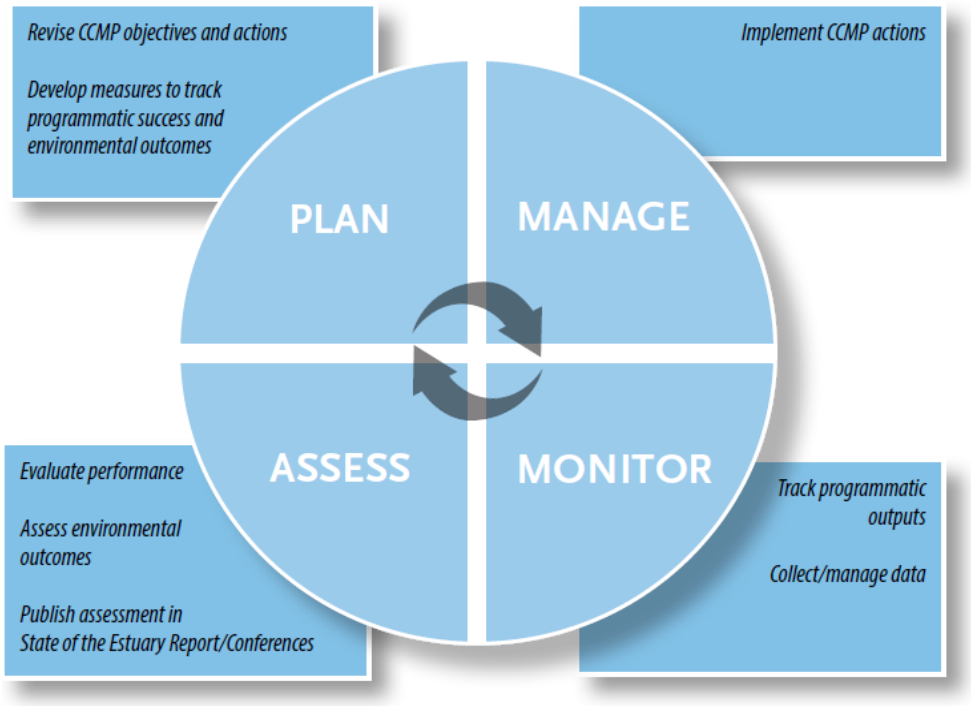


Figure C-3. San Francisco Bay Estuary Plan's Adaptive Management Cycle.

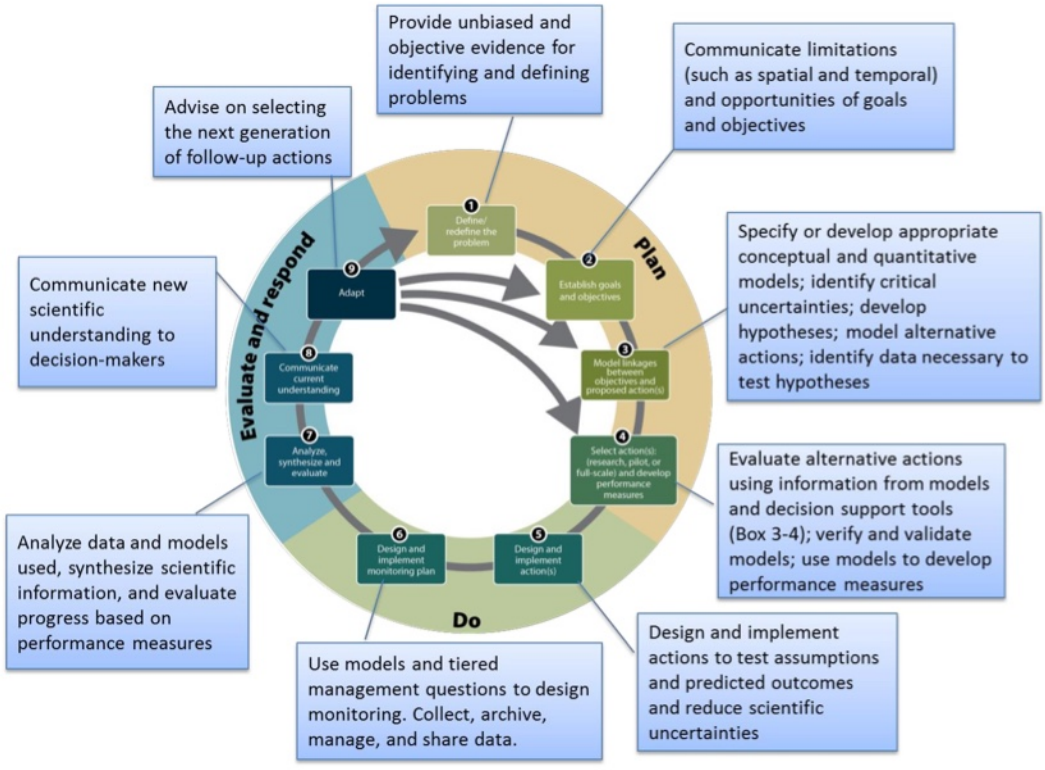


Figure C-4. Nine-step framework for adaptive management depicted in the Delta Plan.

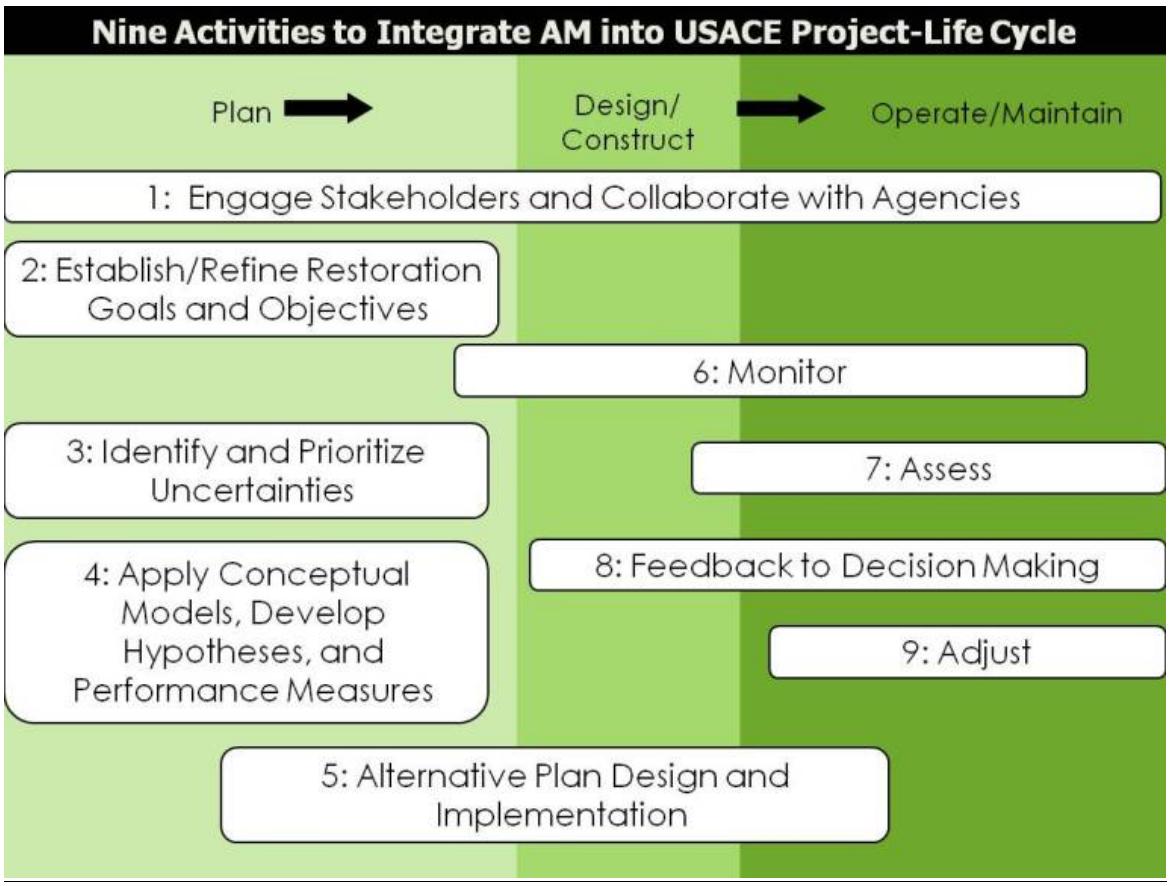


Figure C-5. Adaptive management strategy applied by the U.S. Army Corps of Engineers for projects of the Everglades Restoration Program.

Appendix D. Additional Program Graphics of Interest.

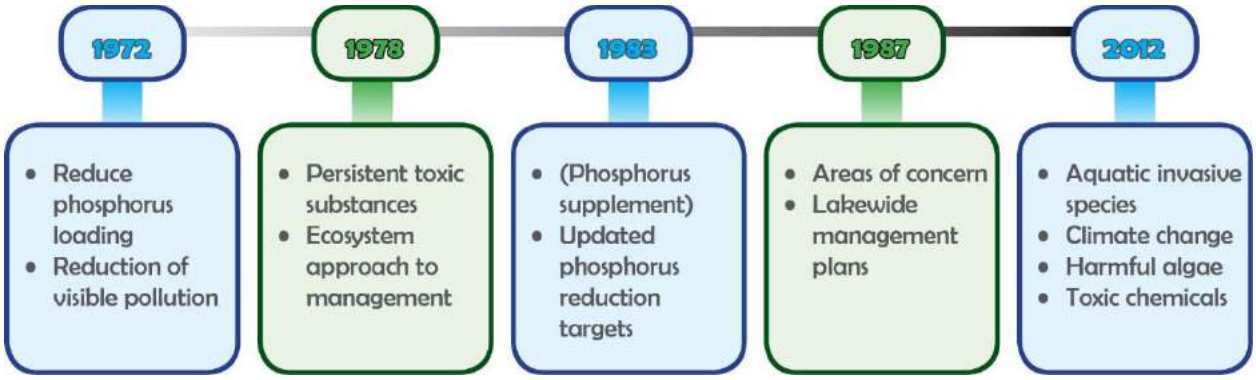


Figure D-1. Changes in GLWQA goals over time (*"Identifying Future Improvements to Great Lakes Ecosystem and Human Health Indicators", S. K. Sinha and R. Pettit, Environmental Consulting & Technology Inc. Report, 35 pp, April 2016.)*

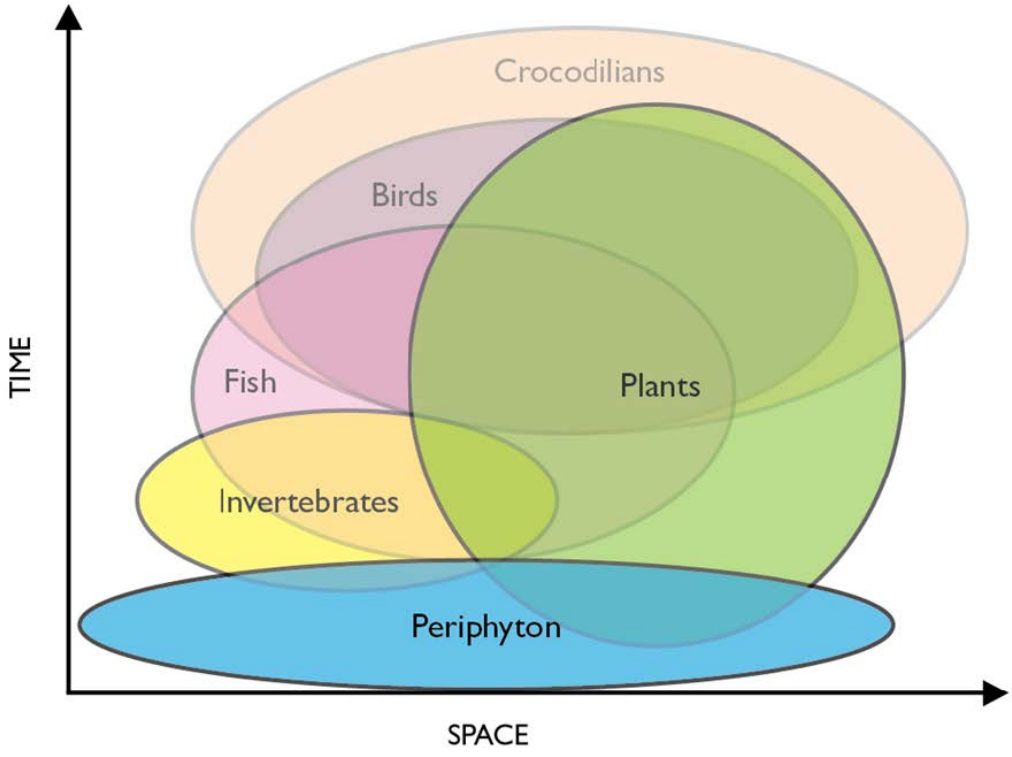


Figure D-2. Relationship between time and space scales for biological indicators selected by the Everglades Restoration Program.

	GOAL 1: Sustain and improve the Estuary's habitats and living resources.			GOAL 2: Bolster the resilience of Estuary ecosystems, shorelines, and communities to climate change.			GOAL 3: Improve water quality and increase the quantity of fresh water available to the Estuary.			GOAL 4: Champion the Estuary.		
OBJECTIVE	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**
ACTION												
1 Develop and implement a comprehensive, watershed-based approach to aquatic resource protection	●		●	●	●	●		●	●	●	●	●
2 Establish a regional wetland and stream monitoring program	●		●									●
3 Protect, restore, and enhance tidal marsh and tidal flat habitat	●			●	●							
4 Identify, protect, and create transition zones around the Estuary	●	●		●	●							
5 Protect, restore, and enhance intertidal and subtidal habitats	●	●		●	●							
6 Maximize habitat benefits of managed wetlands and ponds	●	●	●	●								
7 Conserve and enhance riparian and in-stream habitats throughout the Estuary's watersheds	●	●		●	●							
8 Protect, restore, and enhance seasonal wetlands	●	●										
9 Minimize the impact of invasive species		●	●									
10 Increase the efficacy of terrestrial predator management		●	●									
11 Develop processes for increasing carbon sequestration through wetland restoration, creation, and management	●		●	●		●						

OBJECTIVES

a. Protect, restore, and enhance ecological conditions and processes that support self-sustaining natural communities
b. Eliminate or reduce threats to natural communities
c. Conduct scientific research and monitoring to measure the status of natural communities, develop and refine management actions, and track progress towards management targets
d. Increase resilience of tidal habitats and tributaries to climate change
e. Increase resilience of communities at risk from climate change impacts while promoting and protecting natural resources
f. Promote integrated, coordinated, multi-benefit approaches to increasing resiliency
g. Increase drought resistance and water efficiency and reduce reliance on imported water
h. Improve freshwater flow patterns, quantity, and timing to better support natural resources
i. Reduce contaminants entering the system and improve water quality
j. Build public support for the protection and restoration of the Estuary
k. Strengthen regional leadership in support of Estuary health
l. Promote efficient and coordinated regional governance

Figure D-3. Relationships between goals, objectives and actions for the San Francisco Bay Estuary reported on in the 2015 State of the Estuary report and the 2016 Management Plan.

STATE OF THE ESTUARY 2015 INDICATORS AND THE CCMP

State Of The Estuary 2015 Indicator	CCMP Goals	CCMP Objectives	CCMP Actions
WATER			
Safe For Swimming	Goal 1, 3	Objective a, b, i	Action 26
Safe For Aquatic Life	Goal 1, 3	Objective a, b, i	Action 24, 25, 27, 30
Fish Safe to Eat	Goal 1, 3	Objective a, b, i	Action 25, 27, 28
Freshwater Inflow	Goal 3	Objective a, b, h	Action 18
HABITAT			
Open Water Habitat	Goal 3	Objective h	Action 26
Eelgrass	Goal 1, 2	Objective a, d, e	Action 1, 2, 4, 5, 9, 12, 15, 17
Tidal Marsh Extent	Goal 1, 2	Objective a, d, e	Action 1, 2, 3, 11, 15, 16
WILDLIFE			
Benthic Invertebrates	Goal 2	Objective a, e	Action 9
Fish	Goal 2, 3	Objective a, e, h	Action 1, 5, 6, 7, 9
Harbor Seals	Goal 2, 3	Objective a, e, i	Action 27, 28, 31
Winter Waterfowl	Goal 1, 2	Objective a, b, e	Action 3, 6, 8
Breeding Waterfowl	Goal 1, 2	Objective a, b, e	Action 3, 6, 8, 10
Shorebirds	Goal 1, 2	Objective a, b, e	Action 3, 6, 10
Herons & Egrets	Goal 1, 2	Objective a, b, e	Action 3, 6, 10
Tidal Marsh Birds	Goal 1, 2	Objective a, b, e	Action 3, 6, 9, 10, 12
Ridgway's Rail	Goal 1, 2	Objective a, b, e	Action 3, 6, 9, 10, 12
PROCESSES			
Migration Space	Goal 1, 2, 4	Objective a, b, d, f, k	Action 2, 3, 4, 13, 15, 16, 17
Beneficial Floods	Goal 2	Objective d, e	Action 12, 26
Zooplankton as Food	Goal 1, 3	Objective a, b, c, h	Action 9, 18
Feeding Chicks	Goal 1	Objective b, e	Action 3, 6, 10
PEOPLE			
Urban Water Use	Goal 3	Objective g	Action 18, 19, 20, 21, 22, 23, 24
Recycled Water Use	Goal 3	Objective g	Action 19, 22, 23
Public Access/Trail Access	Goal 4	Objective j, k, l	Action 31
State Of The Estuary 2015 Emerging Indicator	**CCMP Goals**	**CCMP Objectives**	**CCMP Actions**
Pervasive Pesticides	Goal 1, 3	Objective b, i	Action 7, 27
Oyster Beds	Goal 1, 2	Objective a, d, e	Action 5, 14, 29
Woody Riparian	Goal 1, 2	Objective a, e	Action 7
Watersheds	Goal 1	Objective a	Action 1, 2, 24
Managed Ponds	Goal 1	Objective a	Action 6
Sediment	Goal 1, 2	Objective a, d, e	Action 13, 24
Invasions	Goal 1, 3	Objective a, b, i	Action 9, 19

Figure D-4. Reporting on indicators in the San Francisco Bay Estuary 2016 Plan.

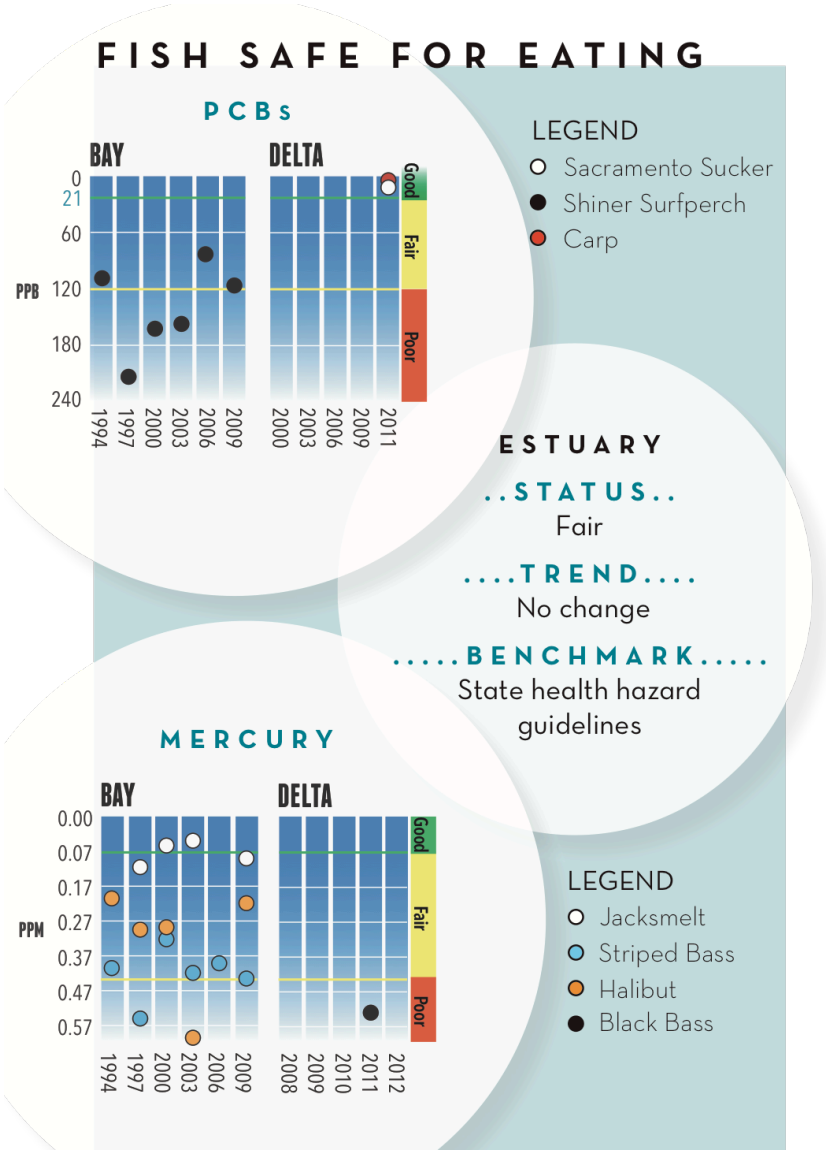


Figure D-5. Example of metric reporting to the public on San Francisco Bay Estuary health.

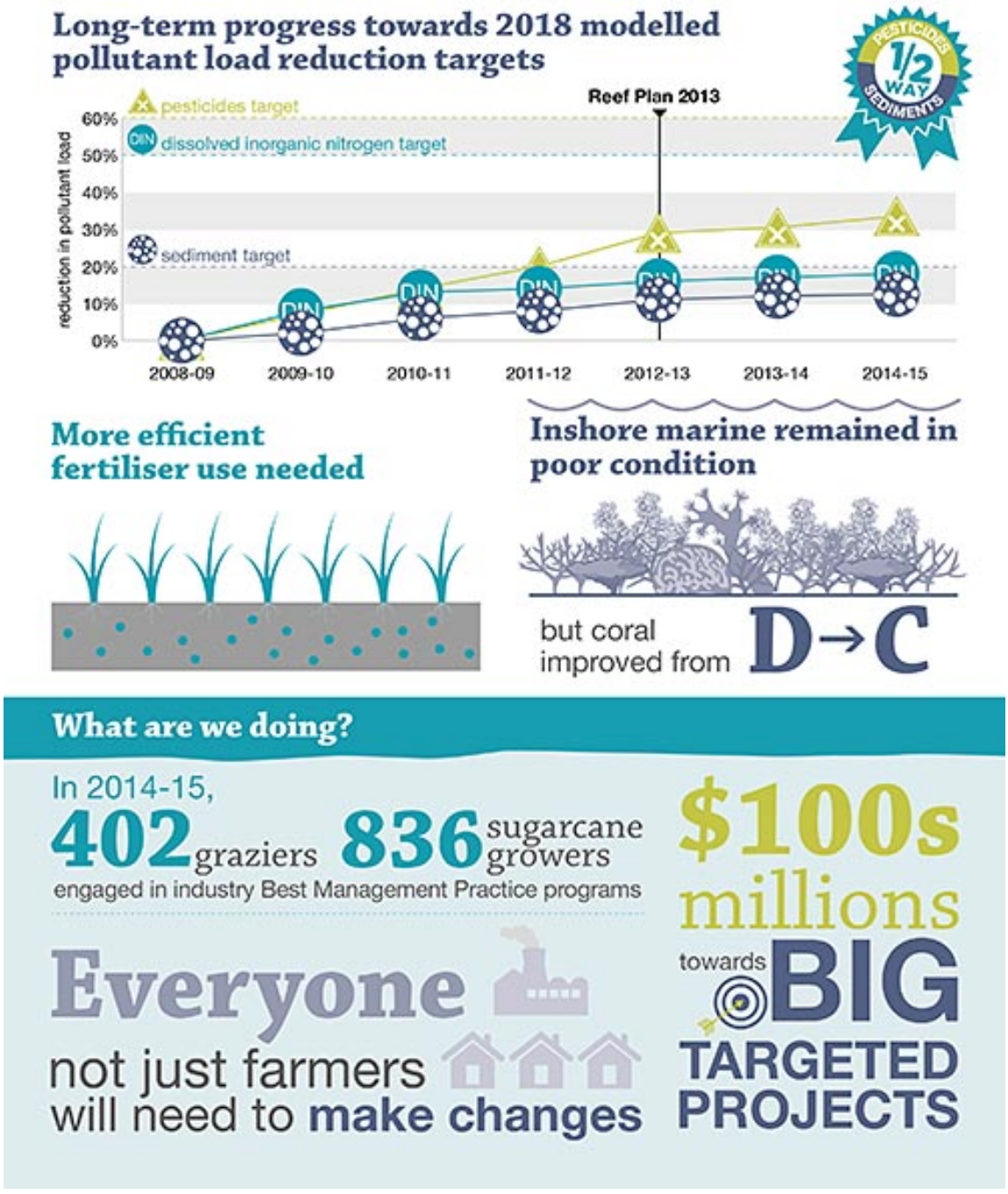


Figure D-6. Report card for the Great Barrier Reef Plan.

Attachment E.
Tahoe Science Advisory Council draft report entitled "Structuring Data to Facilitate Management of Threshold Standards."

TSAC WO-004, ver. 8-d

Structuring Data to Facilitate Management of Threshold Standards

Executive Summary

In a previous study the Tahoe Science Advisory Council (TSAC) reviewed natural resource management systems from around the country and documented their findings in terms of best practices for establishing environmental management goals and for evaluating progress towards those goals (TSAC, 2017). The Council identified four core principles and eight programmatic characteristics that were considered essential for effective natural resource evaluation and management. This document builds on that earlier work by providing guidance on three essential elements needed for structuring information to inform threshold standard development and outcome tracking. These essential elements include 1) the development of a conceptual framework to communicate broad-scale socio-ecological system goals and interactions across threshold categories, 2) elucidation of system functions and causal linkages through conceptual models, and 3) tracking progress toward specified outcomes through indicators selected from causal networks or result chains.

The conceptual framework recommended for Tahoe Basin thresholds management is derived from decades of environmental resource management research based on Pressure-State-Response (PSR) relationships. This has been expanded over time to better represent complex social-ecological systems, where the driving forces from social, demographic and economic developments produce activities that create pressures on environmental states and yield changes or impacts on ecosystem services that ultimately require management responses (DAPSIR: Driver-Activity-Pressure-State-Impact-Response). This basic conceptualization has been used extensively for different types of problems around the world. It has proven to be a flexible and useful framework that can be tailored to the specific requirements of each system. It serves as the foundation for communicating and deliberating on complex environmental issues and for collaborative consideration of potential management responses.

The conceptual model represents our understanding of system function, based on those factors represented within the conceptual framework. It condenses a universe of potentially relevant environmental factors and interactions into a set of diagrams and associated narratives that identify and organize the key attributes of these complex systems into a simplified representation of system structure and dynamics. It shows where management responses can provide benefits by maintaining or restoring desired features or ecosystem services (as benefits humans obtain from properly functioning ecosystems). The conceptual model also indicates where assumptions or uncertainties are present that may require additional investigation, often conducted within an adaptive management system to inform future decisions.

As scientific and management understanding improves, the preliminary conceptual models contribute to more sophisticated causal networks that represent key interactions, management options and optimal nodes for indicators of progress.

The results chain represents a specific pathway in the conceptual model that identifies a set of causal linkages leading from a management action to a desired outcome. This also identifies the indicators needed for tracking progress toward a desired outcome. It is structured to show the inputs needed to support a management response strategy that is then evaluated in terms of both outputs and outcomes as the measurements of progress toward achieving a specific target or goal.

The final component is a monitoring and evaluation plan that provides the protocols and the support necessary for indicator and status assessments to measure the effectiveness of management actions. This monitoring and evaluation approach is informed by conceptual models and by results chains that clearly represent cause-and-effect relationships between inputs from management actions and expected outcomes. In cases where outcomes can be framed as testable hypotheses, then specific actions should be implemented and evaluated as part of an adaptive management program.

In summary, four primary recommendations arise from this work that will improve the effectiveness of the threshold system and environmental quality in the Basin.

1. Adopt a conceptual framework (DAPSIR) that identifies the important social-ecological drivers of change, associated impacts and the resulting management responses. This serves as a high-level collaboration and communications tool that defines outcome-based goals and helps to integrate across threshold categories.
2. Develop conceptual models for each goal representing the key ecosystem attributes and linkages. These conceptual models should capture the current scientific thinking on interactions and processes along with administrative options for management actions (responses) that are expected to improve conditions of the key attributes.
3. Use the conceptual models to articulate causal-network based result chains that link management actions with their expected influence on the pressures and states (conditions) of the system and ultimately to desired outcomes.
4. Identify a limited set of indicators from the causal relationships to establish a monitoring and evaluation plan that tracks progress toward outcome-based goals, and evaluate response to management actions within an adaptive management framework.

Taken together these recommendations will yield a Tahoe threshold system that is adaptable, results oriented and responsive to social-environmental changes. It will provide structure to data and information that improves communication and

provides stakeholders with a coherent vision of how the threshold system is applied to manage environmental resources in the Tahoe Basin, and how management actions can be evaluated as part of an adaptive management process.

Introduction

The TRPA Threshold Update Initiative is one of seven strategic priorities set by the TRPA Governing Board in 2015. Followed by the 2015 Threshold Evaluation Report, this set the stage for comprehensive review of the environmental threshold system to 1) ensure a representative, relevant, and scientifically rigorous set of standards; 2) to establish a cost-effective, feasible and informative monitoring and evaluation plan to support threshold standards; and 3) to develop a robust and repeatable process for review of standards in the future.

Preliminary guidance was provided in the Tahoe Science Advisory Council's 2017 review of other natural resource evaluation and management systems from around the country (TSAC, 2017). This review suggested that outcome-based metrics are preferred over output measures, and that intermediate indicators can provide more timely feedback on response to management actions than long-term targets. The TRPA threshold standards currently include a mix of outcomes, outputs, inputs, and aspirational statements. These different types of standards and the lack of a consistent terminology creates confusion around intent. The terminology and evaluation methods used can be better organized to promote a more structured approach to threshold management.

This document provides guidance on how information and data can be structured within a management system using conceptual models and representations of causal linkages that connect actions to outcomes. This becomes useful when characterizing the factors relevant to choosing key attributes and associated indicators for tracking impacts resulting from management actions, and it clarifies how different types of information inform the environmental management system.

Background

Threshold standards at Tahoe are defined as the standards “necessary to maintain a significant scenic, recreational, educational, scientific or natural value of the region or to maintain public health and safety within the region” (PL 96-551; December 19, 1980). There are currently 173 threshold standards across nine resource categories administered by the TRPA. The Bi-State Compact that established TRPA instructed TRPA to develop the threshold standards in consultation with partners and to develop and enforce a regional plan to ensure the standards were attained and maintained.

The Council’s review of natural resource management programs from around the country found that management objectives tend to grow over time, ultimately encompassing large numbers of targeted outcomes and indicators that are difficult

or expensive to track and are not directly linked to management actions or specific objectives (TSAC, 2017). As a consequence, many of these programs are now seeking to reduce their tracking requirements to a more concise set of primary objectives and indicators that more closely link decisions and management actions to desired results. Some form of problem structuring method is generally adopted to guide this process and to focus efforts on key indicators and processes that inform policy decisions and management actions to achieve desired results.

One of the most common pitfalls in developing an effective resource management program is the failure to build a common understanding of how management actions are linked to desired outcomes. This understanding is best constructed through a problem structuring approach that defines the boundaries of relevant issues and brings together stakeholder perspectives and available information needed to link policy to action and evaluation. There is an extensive literature on problem structuring methods, and a diverse set of approaches have been developed for use in a variety of fields and disciplines. Examples from the business world include Strength, Weakness, Opportunity and Threat (SWOT) assessment and Strategic Options Development and Analysis (SODA) for more complex problems. The Pressure-State-Response (PSR) framework (OECD, 1991) is an example of a problem structuring method that has been used often in environmental resource management. More recently, the PSR approach has evolved into a Driving Forces-Pressure-State-Impact-Response (DPSIR) framework (EEA, 2003), which better represents human–environmental interactions and related information flows (Figure 1). Over time the DPSIR theme has been extended and revised in many ways to address different perceived requirements (Gari et al., 2015), but each of these variations has attempted to structure an approach for problem specification that recognizes the complex, interacting, dynamic, non-linear and multidisciplinary characteristics typical of ecosystem management.

We will focus on key aspects of the PSR and DPSIR frameworks here, since they are widely used and have an extended history of development and application as conceptual frameworks for representing complex social-ecological systems (Vugteveen et al., 2015). Most importantly, this approach can be adapted and customized as needed to meet the specific needs of TRPA and their associated stakeholders, which is how the Puget Sound Partnership used it for their program (TSAC, 2017). It is this continued adaptation and customization of the conceptual framework that will ultimately increase its utility and successful application at Tahoe.

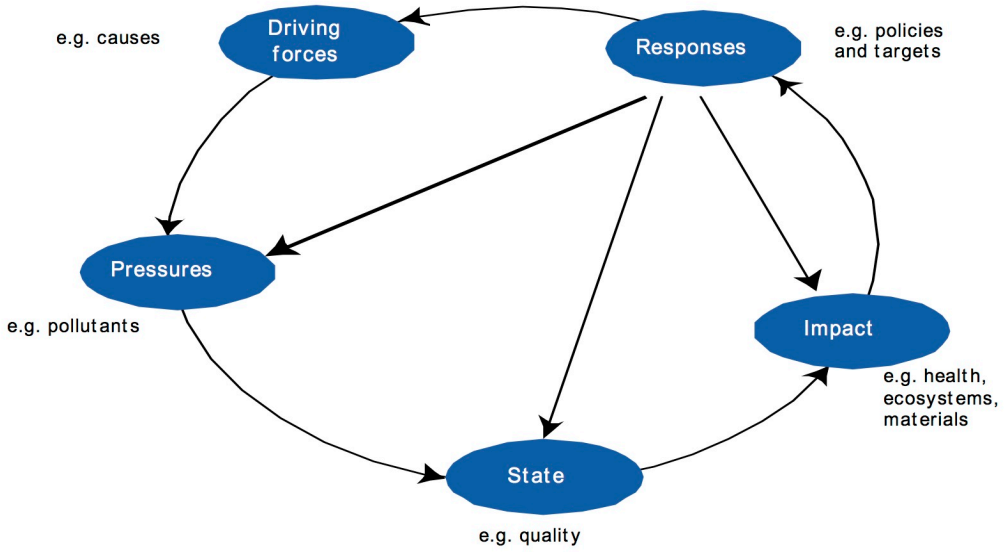


Figure 1. DPSIR framework for reporting on environmental issues (EEA, 2003). Note that management actions may affects multiple points in the framework, so indicators can be used for each of these.

Stem et al. (2005) noted that the conceptual framework is but one part of a two-component system that also must include effectiveness monitoring and evaluation. A traditional but simplistic approach for conducting environmental evaluations was to first define the indicators, then collect the data and analyze it, and ultimately write up the results. This is insufficient, however, since data are not usually evaluated in the context of project interventions or desired outcomes (Margoluis et al., 2009). As a result, it has been difficult to demonstrate solid evidence of success from management interventions or to learn from the implementation of specific actions.

Adaptive management provides a data-driven feedback and hypothesis-testing framework for the results of management actions. It structures the monitoring and evaluation approach into an evaluation-response cycle that promotes "learning while doing." Specifically, adaptive management attempts to reduce management uncertainty through an iterative approach that evaluates response to selected actions or projects directed at achieving specified objectives (see Appendix A). It may not be appropriate or applicable in all cases, but over time, and properly implemented, this iteration contributes to a continuous improvement in management planning and project implementation through a Plan, Do, Check or study, and Act or adjust (PDCA) cycle, originally developed for quality control methods in manufacturing and business (Deming, 1993).

The combination of these approaches has been discussed by Vugteveen et al. (2015), who emphasized the integrated roles of an information cycle and a capacity building cycle for environmental management. Figure 2 illustrates how the adaptive

management process is supported by both a technical information cycle (adaptive monitoring) and an institutional or social learning cycle (adaptive governance) that focuses on deliberation and planning steps to determine whether management actions perform as intended and should be continued or should be replaced or modified to achieve objectives. The intent of this iterative sequence of decision making, monitoring, and assessment is to increase technical management understanding and capacity, including innovations that achieve desired outcomes.

Two specific tools are fundamental to implementing a successful environmental management program in complex systems. The first of these is development of conceptual models that succinctly represent dominant characteristics and processes evident within the coupled human and natural system under study. The second is development of causal effect results chains that show how specific management actions are expected to manifest as desired outcomes in the context of integrated resource management.

A consortium of twenty-three conservation organizations working as the Conservation Measures Partnership collectively developed a set of recommended procedures for project design, management and monitoring that incorporate adaptive management practices (CMP, 2007). Significantly, conceptual models are fundamental to the adaptive management approach in Open Standards for the Practice of Conservation developed by CMP (2013). Results chains are used to communicate why specific outcomes are anticipated from management actions.

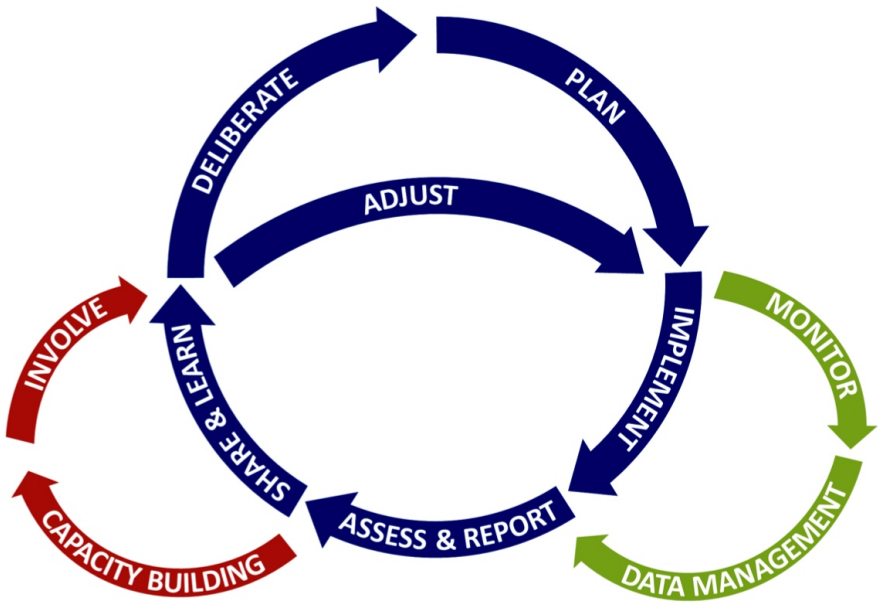


Figure 2. The overall environmental management process cycle (center, in blue) represents an adaptive management approach that involves an information cycle (right, in green) based on adaptive monitoring (right), and a capacity building cycle (left, in red) serving scientific and societal capacity building (left); from Vugteveen et al., 2015.

The Conceptual Framework

The conceptual framework organizes and communicates our general understanding of complex interactions within the coupled social-ecological system. The use of a conceptual framework ensures that a system-based approach is used in addressing environmental challenges. This approach acknowledges at the highest level that challenges in managing the system are interconnected and dynamic. The linkages captured in a conceptual framework diagram can be used to break down silos between resources areas, and to avoid myopic management interventions with negative unintended consequences.

The flexibility of a DPSIR framework and its adaptability make it a compelling approach for threshold management in the Tahoe Basin. Specifically, we recommend the DAPSIR conceptual framework from Elliot et al. (2017), which includes one additional term to represent the human activities (resulting from societal driving forces) that give rise to pressures on the ecosystem. This formulation (Figure 3) clarifies some ambiguities that became evident in application of the original DPSIR framework (Patricio et al., 2016). It shows that specific human activities resulting from driving forces cause the pressures, while responses are properly considered as measures that introduce prevention, mitigation or compensation for these activities and the resulting pressures (Elliot et al., 2017).

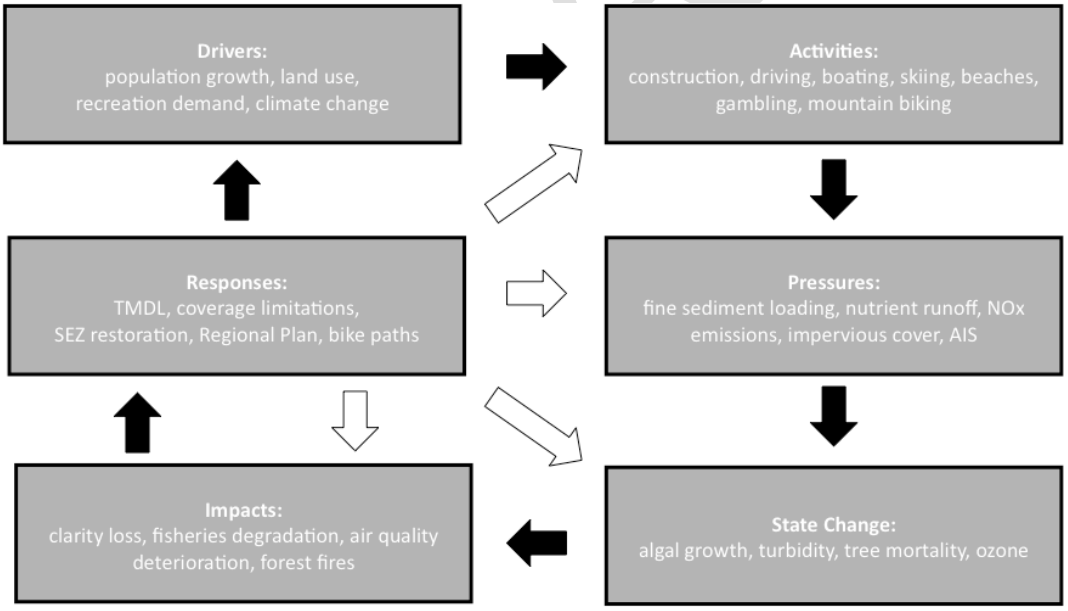


Figure 3. Outline of the categories represented in a DAPSIR conceptual framework at Tahoe. Each category would be developed in narrative detail for TRPA thresholds.

Given that terminology is fundamental to consistent and effective application of a conceptual framework and its associated tools, we provide some brief preliminary

definitions for DAPSIR components as they would be applicable to a Tahoe thresholds system. Over time the TRPA should work with their stakeholders to revise and update these definitions so they are customized for Tahoe and reflect the knowledge gained in application to thresholds.

- Driving Forces are considered the social, demographic, technologic and economic developments in society that motivate human activities to fulfill basic human needs. Examples of potential driving forces at Tahoe would be population growth in surrounding communities, decreased housing affordability, recreation demand, climate change and emergence of electric vehicles.

- Activities are derived from the driving forces that induce human behavior that cause changes in the environment. Examples would be increased boating, higher density development, more road traffic.

- Pressures result from human activities that use resources or cause direct environmental alterations, whether from land use, hydrologic modification, physical, chemical or biological emissions. Examples would be increased impervious area from development, atmospheric deposition of nutrients from automobiles, or introduction of aquatic invasive species (AIS) from recreational boating.

- State changes result from pressures on the ecosystem. Thus, changes in physical, chemical and biological processes resulting from pressures interact to affect different ecosystem and built environment characteristics that can be measured by their attributes. Algae concentrations in the lake change from nutrient loading, native foodweb changes occur with the introduction of AIS. Note that stressors are the components of state that are changed by pressures. Excess loading from impervious runoff is a stressor that causes a state change in lake water nutrient concentrations.

- Impacts on ecosystem services and human welfare is a consequence of changes in the quality and functioning of the ecosystem (state changes), including the production of ecosystem goods and services on which human well-being and economic resilience depend. Impacts include effects on obvious factors like clean water and air, as well as less obvious factors like water clarity, aesthetic scenic elements and cultural assets. Note that benefits can also be represented in this category, which shifts the perspective toward benefits humans derive from a healthy environment rather than a focus on negative effects of humans on the environment (Vugteveen et al., 2015).

- Responses are considered as measures or explicit actions that prevent, mitigate, compensate or adapt for changes in the state of environmental factors. Response measures taken by groups or individuals in society and

government can be implemented at any stage of the DAPSIR cycle, but generally operate on activities, pressures or impacts. The reduced application of winter traction sands, boat inspections for AIS, and storm-water infiltration are examples of management strategy responses at Tahoe.

With almost two hundred standards across nine threshold categories, the requirements for resource management in the Lake Tahoe Basin are sufficiently complex to benefit from a problem structuring approach, while also presenting an opportunity to demonstrate the benefits of its application across thresholds. The TRPA could develop a DAPSIR conceptual framework for each of the nine threshold areas. These efforts to define primary driving forces, activities, pressures, impacts, and management responses would inform the selection of goals and targets for conceptual model development and then the appropriate indicators. Some factors for each component term may be similar across thresholds, especially for driving forces. Note that the intent of response measures generally is not to manage natural variability and exogenous factors that operate outside of the system, but to affect change on selected factors within the system.

Although initial development of the conceptual framework can be completed relatively quickly, the resulting product should not be considered static. Instead, it should be examined and revised periodically to reflect ongoing changes in the environment and societal pressures along with corresponding evolution of knowledge about those factors and the continued examination of linkages and indicators from causal network modeling to inform responsive management actions.

Developing Conceptual Models

A conceptual model facilitates understanding the complex interaction of multiple variables across space and time. These models consist of diagrams and associated narratives that organize connections between key factors in complex systems and simplify our understanding of system structure, interactions and dynamics. When developed as part of multi-stakeholder collaborations they also contribute to a shared learning process that supports subsequent development of decision support tools, predictive mathematical models, performance indicators and results-based assessments (EPA, 2015).

Recommendations for developing conceptual models at the threshold category level should draw on work described by Margolis et al. (2009). Important elements of this approach have also been adopted by the Conservation Measures Partnership (CMP), an international consortium of twenty-three conservation organizations, in their Open Standards for the Practice of Conservation (CMP, 2002; 2013). Although the focus in their application is on conservation projects and biodiversity, these same principles and tools are broadly applicable. Indeed, some Tahoe studies have included conceptual models that reflect this structural approach in their development, as with the nearshore (Heyvaert et al., 2013) or for mid-lake clarity (citation needed). The overall approach recognizes several important steps and

specific elements that are used for constructing conceptual models (Margoluis et al., 2009; CMP, 2017).

At Tahoe this approach would be applied to development of a conceptual model for each of the nine threshold categories, following the general structure shown in Figure 4 and following steps shown below, adapted from Margoluis et al. (2009). These are intended to represent key attributes and interacting factors relevant to the dominant items and goals listed for terms in the conceptual framework.

(1) Define what the program for that threshold category intends to ultimately accomplish. This requires identification of scope (boundaries) and vision (goals and targets in Figure 4). The DAPSIR conceptual framework for each threshold category should inform this step, but if not yet available then a preliminary consensus among stakeholders would substitute. Limit the selection of primary goals and targets (desired outcomes) within each threshold category. Although the Nature Conservancy recommends no more than eight targets as a general rule of thumb (The Nature Conservancy, 2007), they are not simultaneously working across multiple thresholds in their project designs, so a lower number for each threshold category would be advisable.

(2) Moving from right to left in Figure 4, brainstorm the direct threats affecting the targets. Targets should be specific, measurable, achievable, relevant and time-based (SMART) representations of each goal. The model should include the main direct threats (pink boxes in Figure 4) and use arrows to indicate which threats are affecting which targets. Direct threats are the human actions (or conditions resulting from human activities) that directly degrade one or more of the specified targets or outcome-based goals.

(3) Add the main contributing factors (orange boxes in Figure 4, also referred to as drivers or underlying root causes (Wood et al., 2000)). Contributing factors typically include social, economic, cultural, political, and other behavioral variables. Use arrows to show the causal links among contributing factors, direct threats, and targets. It is important to limit represented variables to the primary direct threats and contributing or indirect factors that are affecting targets. If the model becomes overly large and convoluted it may obscure the more influential factors and lose its communication value. According to Margoluis et al. (2009) a coarse rule of thumb is to limit the number of contributing factors to approximately 25 or 30 in these conceptual models.

(4) Add management, policy or adaptation strategies and show what part of the conceptual model they are designed to influence. Strategies should directly influence one or more contributing factors to ultimately reduce a threat or to restore desired conditions. These strategies should each link to an objective, which is a specific statement detailing the desired accomplishments or outcomes of a strategy or project.

A good model should be as simple as possible while still including the most important details. At the scale of the threshold categories, these conceptual models will still be relatively coarse grained, but should include the most important details and factors needed to represent dominant sources of resource impacts, mitigation opportunities, constraints and strategies. As with the conceptual frameworks, these conceptual models would be built collaboratively by goal implementation teams or target working groups (TSAC, 2017). Ultimately, each model should be tested with key stakeholders outside of the project team to ensure it reflects a collective understanding, where areas of confusion or uncertainty are noted for further research, analysis or documentation (CMP, 2017). The real utility of a conceptual model is to show how managers expect interventions will influence existing conditions and lead to desired results. These are based on the causal links shown between strategies, factors, objectives and targets. A finer grained understanding of these causal linkages will be developed with results chains to document specific steps expected to achieve objectives and targeted goals.

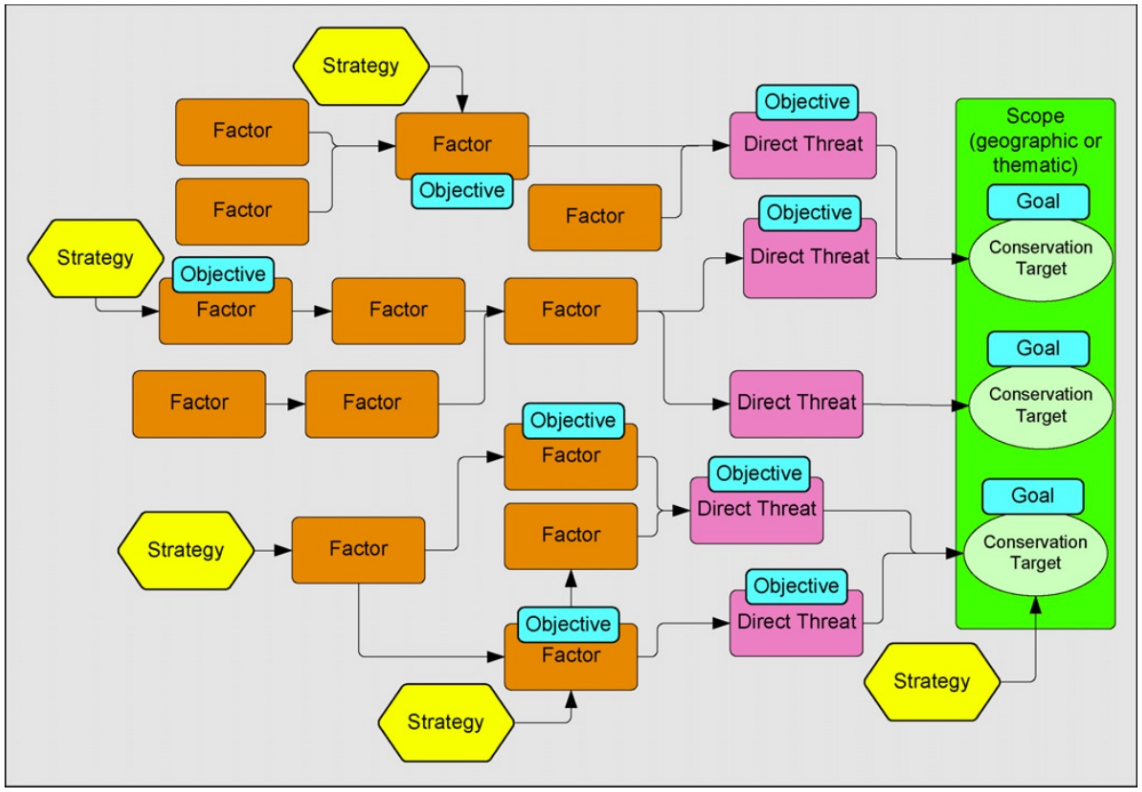


Figure 4. This generic structure for a conceptual model approach is recommended for each of the Tahoe thresholds; from Margoluis et al. (2009).

Constructing Results Chains

The results chain is a tool that identifies precisely how a system is expected to respond to specific management actions. Although similar to and generally derived

from previously developed conceptual models for system function, they show more detailed linkages between actions, outcomes and goals, along with any associated objectives and indicators at each step. The general characteristics of a results chain are demonstrated in Figure 5. It is composed of an activity or a strategy (group of activities) that leads through a set of desired outcomes to ultimately achieve the desired results on a particular focal component or target (Margoluis et al. 2013). In these results chains, the outputs are measures of management activities intended to achieve specific outcomes (e.g., acres of restored wetland), while outcomes are the measures of function or restored condition achieved (e.g., load reduction from wetland restoration), and goals are the primary targets for which the work is being done (e.g., lake clarity recovery). Tracking of intermediate outcomes becomes important when the final results or impacts represent longer-term goals that do not immediately manifest the expected benefits of management actions.

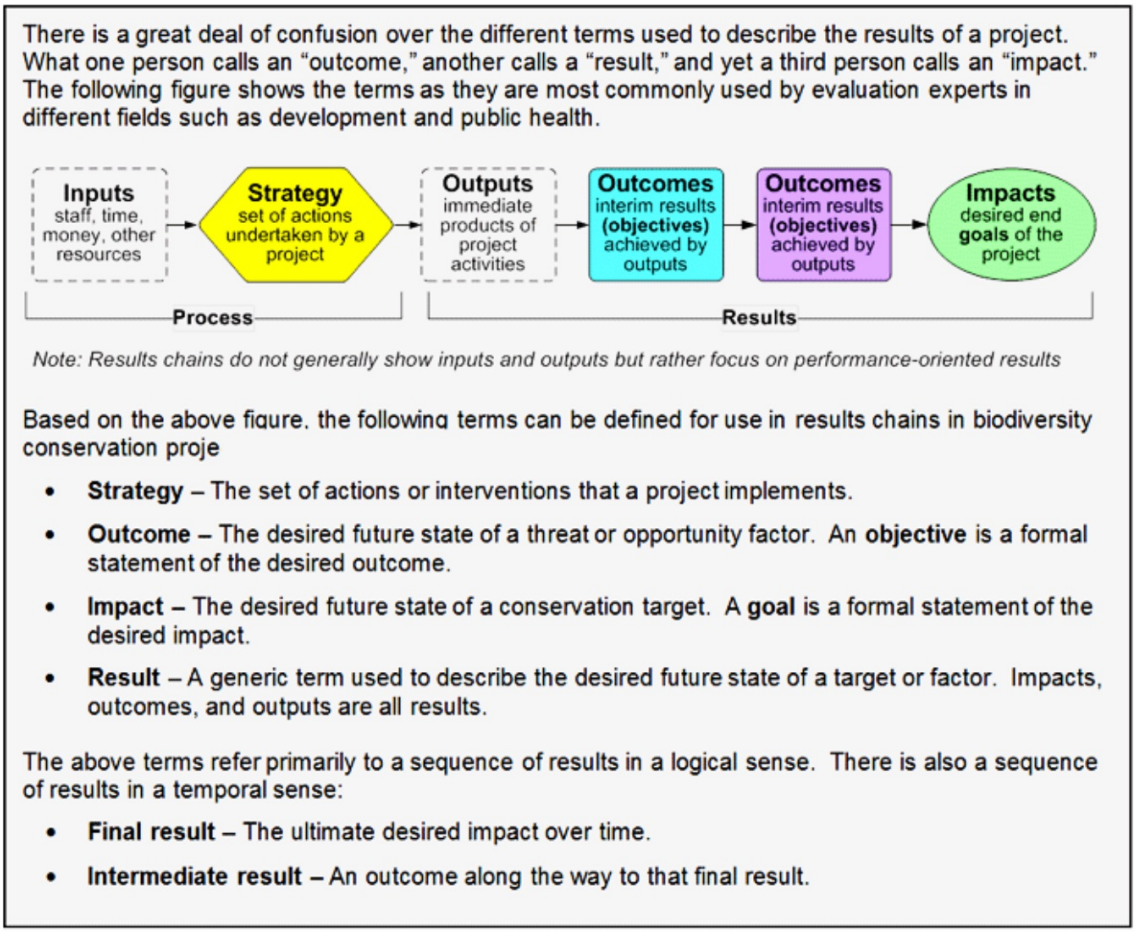


Figure 5. Basic components of a generic results chain; from Margoluis (2013).

Although linear results chains, as described above, provide a direct representation of expected outcomes, they generally do not adequately represent the convergence of multiple causality lines. A causal network-based approach, which is similar to the flowcharts of process-based simulation models, can better demonstrate the inter-

relationships between various causal chains (Niemeijer and de Groot, 2008). Over the longer-term a conceptual model would be expected to evolve toward a causal network representation of the ecosystem, as increasingly detailed information on direction and strength of multiple interactions is evaluated and incorporated. The linear results chain is a simplified representation of this complexity that reduces the details into a set of responses expected from proposed management actions to achieve a specific outcome. It is structured to show the inputs needed to support a management response strategy that is evaluated in both outputs and outcomes as measurements of progress toward achieving a specific target or goal. Even within the context of a causal network, these objectives are communicated most efficiently through a results chain series as described above.

As an example, the Sacramento–San Joaquin Delta Regional Ecosystem Restoration Implementation Plan (DRERIP) developed a conceptual modeling approach that linked actions to outcomes through a network of driver-linkage-outcome chains that clearly described actions to be evaluated, assessed the magnitude and certainty of anticipated outcomes, provided estimates of project worth and risk, evaluated reversibility of actions and identified opportunities for learning through adaptive management (DiGennaro et al., 2012). Developing causal networks from conceptual models can ultimately lead to more quantitative or semi-quantitative approaches that support higher-level analysis, as for example with structured equation modeling (Grace, 2006), expert elicitation methods (Slottje et al., 2008) or process-based models in some cases.

Selecting Appropriate Indicators

Each of the components for the threshold system described above recognize the essential role of information and data in developing management solutions. Environmental indicators are critical components of this process. They reflect the trends in environmental conditions and progress toward realizing policy targets. Given the number and diversity of potential indicators, however, it is necessary to develop an understanding of the structure within which those data and indicators serve. Most importantly, the relevance and utility of existing indicators must be understood by policy-makers and public stakeholders.

We are accustomed to seeing indicators used in many aspects of modern society; economics, medicine, weather, sports and other disciplines routinely apply different types metrics and indicators to communicate status and process. Ideally, indicators for an environmental management system are selected to represent each step in a conceptual framework, as recommended for the DPSIR framework (Appendix B).

More commonly, however, most of the initial focus is on state and impact indicators, which are preferable for identifying the seriousness of an environmental problem, while pressure and response indicators are used to evaluate how best to control the problem (Niemeijer and de Groot, 2008). In this context it is practical to distinguish between different types of indicators that serve specific purposes in assessment of

the conceptual framework, as described below (from EEA, 2003, see also Appendix B):

A. ***Descriptive Indicators*** *usually show the development of a variable over time. They are most commonly used as state, pressure or impact indicators.*

B. ***Performance Indicators*** *are connected with target or regulatory values. They provide a 'distance to target' assessment, and are typically state, pressure or impact indicators that clearly link to policy responses.*

C. ***Efficiency Indicators*** *relate drivers to pressures. They provide insight into the efficiency of management products and processes in terms of resources and output measures in monetary terms or physical output measures.*

D. ***Policy-effectiveness Indicators*** *relate the actual change of environmental variables to policy efforts. They link response indicators to state, driving force, pressure or impact indicators and are crucial in understanding the reasons for observed developments.*

Good indicators usually share a suite of characteristics that improve their utility. Outcome-based goals should conform to SMART criteria (Specific, Measureable, Attainable, Relevant, and Time-bound), as previously described in Council documentation (TSAC, 2017), so these typically apply to indicators as well. In addition to being measureable and having close correspondence with targets or goals, indicators should be repeatable and yield reliable measurements, sensitive and responsive to change in condition, and feasible. Beyond these critieria,, indicators should be match up to key nodes in the conceptual models or resulting causal networks and results chains derived from them. Niemeijer and de Groot (2008) recommend locating key nodes in the causal network, and identify three types: root-nodes, central nodes, and end-of-chain nodes. Root nodes are those nodes that have many dependent nodes or is a node that influences many other nodes, but is itself influenced by few if any nodes. Central nodes are those that influence and are driven by many other nodes. End-of-chain nodes typically are influenced by many nodes but influence very few nodes. The most useful indicators for understanding system behavior tend to be central nodes with a large number of intersecting linkages, while end-of-chain nodes are used to provide an overall of view on status toward achieving the final goal or target. Root node indicators are typically used to assess the source of environmental problems.

Final selection of indicators should focus on key attributes, or focal components, which are those major elements or features of an ecosystem that require some form of management intervention to ensure their continued viability (CMP, 2007; Rice and Rochet, 2005; Harwell et al., 1999). Considering the complexity of an ecosystem in terms of its focal components helps to organize the relevant information into a limited number of discrete, but not necessarily independent categories (Levin et al., 2014). Intermediate and final outcome targets in the results chains will typically have associated indicators that track progress toward identified outcomes. The Conservation Measures Partnership Open Standards documentation (CMP 2013)

makes several additional recommendations for effective and credible indicators (Appendix C).

As discussed previously, full development of an integrated threshold system will require both the conceptual framework along with a well-defined monitoring and evaluation approach (Stem et al. 2005) based on detailed conceptual models and causal results chains. The adaptive management cycle is closed ultimately by monitoring and evaluation of indicators that indicate effectiveness of management actions. Four different types of monitoring assessment have been identified by Fogueres (2017) in the course of landscape-scale planning for the Lake Tahoe West Restoration Partnership. These are representative of monitoring conducted within the Tahoe Basin:

1) Implementation monitoring is used to show whether the work was completed as designed.
2) Effectiveness or performance monitoring is conducted to determine whether projects or management actions are achieving desired outcomes.
3) Validation monitoring is used to determine whether models are producing accurate outputs.
4) Compliance monitoring is required to meet regulatory standards

Implementation indicators are used to describe or tally the work done to achieve policy or management objectives. These are often referred to as *output indicators*. They track whether management actions have been implemented as designed and to the scale intended. Tracking and reporting on these indicators is considered project implementation monitoring.

Effectiveness indicators are used to measure the change in key attributes of system behavior in response to management action or policy. These are generally referred to as *outcome indicators*. These are focus of result chains that link expected outcomes in terms of impacts on ecosystem services or conditions from management actions.

Intermediate indicators may be needed when the rates of change toward desired goals or targets are slow or less evident within the background noise of natural ecosystem variability. Status monitoring is useful only when indicators are linkage nodes that pertain to results chains for specified targets.

Assembling the Structural Components

Margoluis et al. (2009) identified two main types of complexity encountered by ecosystem management and conservation efforts: detail complexity that refers to the presence of a large number of variables within a system (Senge, 1990), and dynamic complexity that refers to unpredictable ways in which variables may

interact with one another (Salafsky et al., 2002). Integration of the three main structural elements described above as part of a modernized Tahoe threshold system will help address both types of complexity.

(1) DAPSIR conceptual framework — The DAPSIR conceptual framework provides a big-picture context within which stakeholders can work collaboratively to anticipate changes resulting from driving social forces and develop a shared understanding of how ecosystem-based management would best function for a complex social-ecological system like Tahoe, where the aim is to balance ecological, economic, and social objectives for sustainable development (Vugteveen et al., 2015).

(2) Conceptual models — Conceptual models are essential for the application of an adaptive management approach. They are a refinement on the more broadly based conceptual framework and serve to represent interacting factors and processes that effect change within a system. This is where specific goals, targets, objectives and potential management strategies are collectively established and documented. Both the conceptual framework and conceptual models serve to communicate current understanding of the social-ecological system, but conceptual models identify the dominant processes and focal components that can be manipulated to effect desired changes within the system.

(3) Results chains — The results chain specifies a sequence of causal linkages that extend management actions (output) directly to desired outcomes, either as final goals and targets or as intermediate objectives and outcomes (CMP 2013). For the Tahoe thresholds these should be based on causal networks that show expected interaction between factors in ecosystem function and the impact of specific management action on a particular outcome (goal). The associated narrative should represent current scientific understanding of key factors and processes, along with associated uncertainties, and an assessment of certainty for anticipated outcomes.

When these structural elements are combined in a nested series they provide context and detail across multiple scales. Each is a joint exercise between managers, scientists and public stakeholders. Policy and stakeholder engagement is particularly critical in development of the conceptual framework and preliminary conceptual models, while scientific input is especially important for developing causal networks and the associated suite of effectiveness indicators.

The conceptual framework could be developed as a whole for the Tahoe social-ecological system, or individually for each threshold category and then combined. Elliot et al. (2017) show how multiple DAPSIR representations can be functionally nested, for example, which would provide integrated management across thresholds (see Figure 6). Conceptual models and causal network development would normally follow in sequence, but are not necessarily dependent on having a conceptual framework in place first, as the process is iterative in any case. The conceptual framework should provide a coarse-grained contextual overview of each threshold category, or of the threshold system overall, while the conceptual models

and causal network chains are increasingly fine-grained representations of system function, linkages and outcome details.

Developing these structural elements for one or two threshold categories initially would be a judicious approach. They should be the focus of outcome (or threshold category) implementation teams or target working groups, consisting of committed stakeholders who would collectively develop the structural elements and then the resulting monitoring and evaluation plan for that threshold (TSAC, 2017). In some cases, it may be easier to have separate implementation teams focus on specific goals for a threshold category, similar to how working groups currently function for the Tahoe Interagency Executives Steering Committee (TIE-SC). In any case, developing these in sequence will create a staggered reporting cycle that avoids placing excessive demand on program resources, while also facilitating stakeholder engagement and buy-in during the process and for its products.

The goal is to implement a flexible but structured approach that supports an adaptive management cycle, which reduces uncertainty and unpredictability inherent to the dynamics and behavior of complex social-ecological systems. This promotes a systems approach, where information has specific roles defined by key attributes, expected outcomes, functional linkages, identified feedback loops, anticipated response times, and indicators of key focal components. The Tahoe threshold monitoring and evaluation approach that results should be adaptable, results oriented and responsive to social-environmental changes.

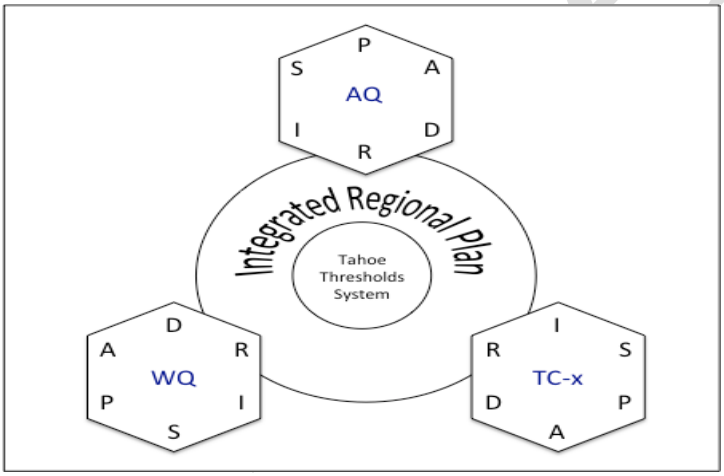


Figure 6. A nested DAPSIR conceptual framework for integrated management of Tahoe threshold categories (TC) for water quality (WQ), air quality (AQ), etc. (TC-x); modified from Elliott et al., (2017). Key for DAPSIR elements: D – driving forces; A – activities; P – pressures; S – state changes; I – impacts; R – responses. Regional plan represents the intersection and compilation of factors from each DAPSIR element for these thresholds.

Citations

Conservation Measures Partnership. 2007. *Open Standards for the Practice of Conservation.* Conservation Measures Partnership.

CMP Open Standards, 2013

CMP Open Standards, 2017

Conservation Science Partners, 2016

Delta Independent Science Board, 2016.

Deming, W.E. 1993.*The New Economics*. MIT Press. Cambridge, MA.

DiGennaro et al., 2012

EEA, 2003

Elliot et al., 2017

Fogueres, 2017

Gari et al. 2015

Grace, 2006

Gregory, 2006

Harwell et al. 1999

Heink and Kowarik 2010 (from Vugteveen et al., 2015)

Heyvaert et al. 2013, nearshore report

Levin et al. 2014

Margoluis et al., 2009

Margoluis et al., 2013

McManus et al., 2014

Niemeijer and de Groot, 2008

NOAA Fisheries, 2008 (and PSP, 2011)

OECD, 1991

Patricio et al., 2016

PL 96-551; December 19, 1980

PSP, 2011

Rice and Rochet, 2005

Salafsky et al., 2002 (from Margoluis et al. 2009)

Senge, 1990 (from Margoluis et al. 2009)

Slottje et al., 2008

Stem et al., 2005

Tahoe Science Advisory Council (TSAC). 2017. Natural Resource Evaluation Systems: Assessment of Best Practices for the Tahoe Regional Planning Agency. TSAC Technical Report #2017-01. Incline Village, NV

The Nature Conservancy CAP Handbook (TNC 2007)

Vugteveen et al., 2015

Walters and Holling, 1990

Wood et al., 2000

Appendix A. Application of adaptive management (from TSAC, 2017).

Each program in this review has applied some form of adaptive management as part of its strategy for guiding management decision-making in the presence of ongoing uncertainty and changing conditions. First developed as a science-based approach for natural resource management (Holling, 1978, Walters 1986), adaptive management was intended to reduce uncertainty over time through an iterative approach that evaluates response to selected actions or projects for continuous improvement in management planning and implementation directed at achieving specified objectives. The application of adaptive management can vary widely among programs, however, reflecting unique ecosystem characteristics and the management requirements or constraints for each particular case. Identified steps in the process can range from as few as three to more than twelve.

As summarized by Westgate et al. (2013), the adaptive management cycle includes these following steps:

1. Identification of management goals in collaboration with stakeholders.
2. Specification of multiple management options, one of which can be 'do nothing'.
3. Creation of a rigorous evaluation process for interpreting how the system responds to management interventions. This stage typically involves creation of quantitative conceptual models and/or rigorous experimental design.
4. Implementation of management action(s).
5. Monitoring of system response to management actions (preferably on a regular basis).
6. Adjust management practice in response to results from the monitoring.

While this is the general set of steps for an adaptive management cycle, each program tends to apply its own variation to this overall approach. In Appendix C we show selected examples of the adaptive management cycles used by programs reviewed in this document.

Some authors distinguish between passive and active forms of adaptive management (Walters and Holling, 1990), although the usual case lies somewhere along the spectrum between these two types. Passive adaptive management is more easily implemented and may be appropriate when management constraints limit the testing of alternative actions, but then hypothesis testing is not as rigorous and the pace of learning can be slower. Active adaptive management develops and tests competing hypotheses on anticipated impacts of management actions, usually with several types of actions tested sequentially or in parallel. These generally require a larger investment of resources and may involve greater risk, but in theory can provide statistically testable information in a shorter period (Gregory, 2006).

The Puget Sound Partnership has made extensive use of the Open Standards for the Practice of Conservation (CMP, 2013) in its recovery planning and implementation

of adaptive management. We recommend review of this same document by all staff, scientists and stakeholders engaged in thresholds standards review and updating. Additional useful information related to adaptive management, indicator selection and ecosystem assessment approaches can be found in a document produced for the Delta Stewardship Council (Delta Independent Science Board, 2016) and in a technical report for the Puget Sound Partnership (McManus et al., 2014).

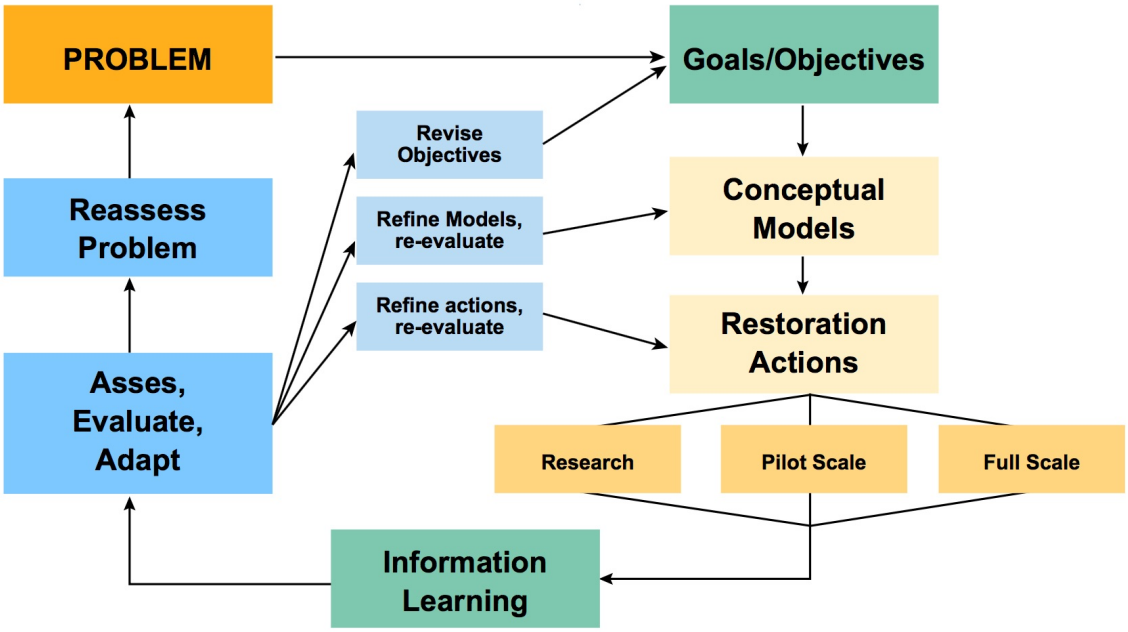


Figure A1. Adaptive management approach developed for the CALFED Bay-Delta Program (from DiGennaro et al., 2012).

Appendix B. Types of indictors recognized for use in the DPSIR conceptual framework.

Ideally, indicators would be identified for each step of the DPSIR framework such that the full portfolio of indicators could be used to assess ecosystem condition as well as the processes and mechanisms that drive ecosystem health. The following are descriptions used by the European Environment Agency for indicators within each category of the DPSIR chain (quoted from EEA, 2003).

*Indicators for **Driving forces** describe the social, demographic and economic developments in societies and the corresponding changes in lifestyles, overall levels of consumption and production patterns. Primary driving forces are population growth and developments in the needs and activities of individuals. These primary driving forces provoke changes in the overall levels of production and consumption. Through these changes in production and consumption, the driving forces exert pressure on the environment.*

***Pressure indicators** describe developments in release of substances (emissions), physical and biological agents, the use of resources and the use of land by human activities. The pressures exerted by society are transported and transformed in a variety of natural processes to manifest themselves in changes in environmental conditions. Examples of pressure indicators are CO2-emissions per sector, the use of rock, gravel and sand for construction and the amount of land used for roads.*

***State indicators** give a description of the quantity and quality of physical phenomena (such as temperature), biological phenomena (such as fish stocks) and chemical phenomena (such as atmospheric CO2-concentrations) in a certain area. State indicators may, for instance, describe the forest and wildlife resources present, the concentration of phosphorus and sulphur in lakes, or the level of noise in the neighborhood of airports.*

*Due to pressure on the environment, the state of the environment changes. These changes then have impacts on the functions of the environment, such as human and ecosystem health, resources availability, losses of manufactured capital, and biodiversity. **Impact indicators** are used to describe changes in these conditions. Although effects of human change in the environment occur in a sequence: air pollution may cause changes in the radiation balance (primary effect but still a state indicator), which may in turn cause an increase in temperature (secondary effect, also a state indicator), which may provoke a rise of sea level (tertiary effect, but still a state of the environment), it is only the last step: loss of terrestrial biodiversity, that should be called the impact indicator. It is the change in the availability of species that influences human use of the environment. In the strict definition impacts are only those parameters that directly reflect changes in environmental use functions by humans. As humans are a part of the environment, impacts also include health impacts.*

Response indicators *refer to responses by groups (and individuals) in society, as well as government attempts to prevent, compensate, ameliorate or adapt to changes in the state of the environment. Some societal responses may be regarded as negative driving forces, since they aim at redirecting prevailing trends in consumption and production patterns. Other responses aim at raising the efficiency of products and processes, through stimulating the development and penetration of clean technologies. Examples of response indicators are the relative amount of cars with catalytic converters and recycling rates of domestic waste. An often used 'overall' response indicator is an indicator describing environmental expenditures.*

Vugteveen et al. (2015) defined an indicator as "a component or a measure of environmentally relevant phenomena used to describe social-ecological conditions, evaluate system changes, or prescribe management goals (Heink and Kowarik 2010)." In the context of a DPSIR framework they link both research-driven and policy-driven monitoring focused on evaluations of effectiveness, performance and processes (Figure B1), where monitoring and evaluation efforts are required to be credible, legitimate, and salient.

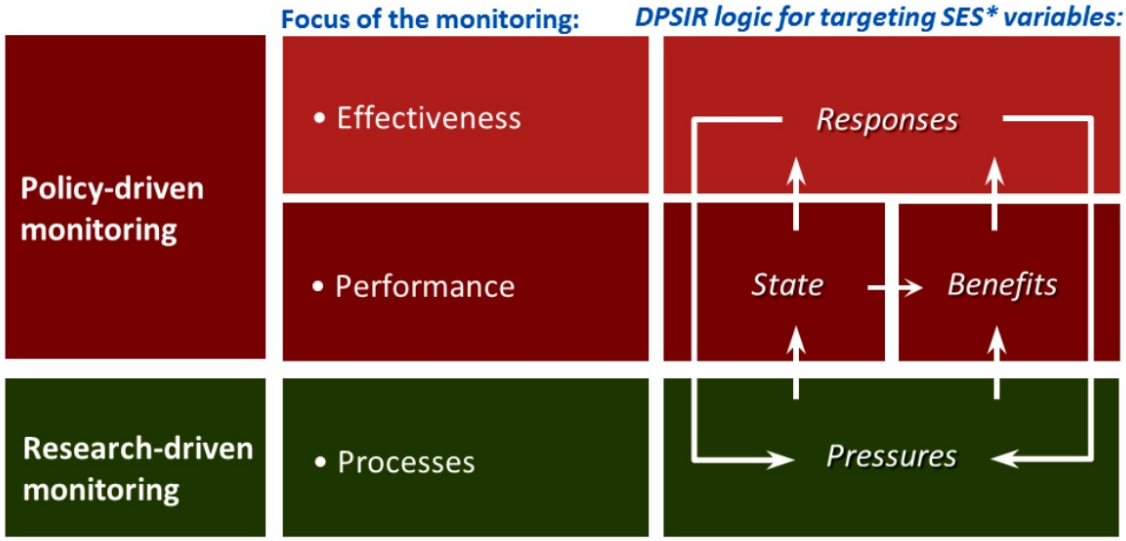


Figure B1. The use of response, pressure, state, and benefits (impacts) indicators for different monitoring foci; effectiveness, performance, or processes (from Vugteveen et al., 2015).

Appendix C. Characteristics of Useful Indicators.

Conservation Measures Partnership Open Standards documentation makes the following recommendations for effective and credible indicators (CMP 2013).

1. *Measurable: The indicator can be assessed in quantitative or discreet qualitative terms by some procedure that produces reliable, repeatable, accurate information.*
2. *Precise and Consistent: The indicator means the same thing to all people and does not change over time.*
3. *Specific: The indicator is unambiguously associated with the key attribute of concern and is not significantly affected by other factors.*
4. *Sensitive: The indicator shows detectible and proportional changes in response to changes in threats or conservation actions.*
5. *Timely: The indicator detects change in the key attribute quickly enough that you can make timely decisions on conservation actions.*
6. *Technically Feasible: The indicator is one that could be implemented with existing technologies, not one that must await some great conceptual or technological innovation.*

The most effective and credible indicators will also be:

7. *Cost-effective: The indicator should provide more or better information per unit cost than the alternatives.*
8. *Partner-based: The indicator should be one that works well for key partner institutions in the conservation effort and/or rests on measurements they can or already do collect.*
9. *Publicly Relevant: The indicator should be useful for publicly communicating conservation values and progress to the community.*

Five evaluation questions were used to assess potential indicators for the Puget Sound ecosystem (NOAA Fisheries, 2008):

- *Is the indicator conceptually valid?*
- *Do data exist?*
- *Can the indicator be feasibly implemented?*
- *Are the statistical properties understood and sufficient?*
- *Does the indicator fulfill management and reporting needs?*

For management purposes, one suite of indicators was selected to address key properties of the Puget Sound ecosystem, while another suite of indicators was selected to address the causal mechanisms underlying ecosystem functions.

Attachment F.
Threshold Update Initiative Report on Threshold System Structure

TAHOE REGIONAL PLANNING AGENCY

Threshold Update

THRESHOLD SYSTEM STRUCTURE

VERSION 1.3

JUNE 19, 2018

CONTENTS

THRESHOLD SYSTEM STRUCTURE

EXECUTIVE SUMMARY

The threshold standards establish the goals for environmental quality and express the shared aspiration for environmental restoration of the Tahoe region. The threshold system structure refers to how information related to those goals is managed and shared. As part of the threshold update initiative, TRPA and the Tahoe Science Advisory Council developed this recommendation for improving data management in system.

The threshold update team committed to science-based adaptive management as a driving principle for the recommended system structure. The proposed structure is founded on clearly articulated statements of goals that are specific and measurable. The recommended structure for the threshold standard system draws heavily from best practice and integrates three primary elements: (1) standards that are supported by conceptual models that detail the scientific understanding of system function, (2) results chains that link management actions to desired outcomes (standards), and (3) underlying system diagrams that detail the connections between standards or standard categories, grounded in the widely applied Drivers – Actions – Pressures – State Change – Impacts – Response (DAPSIR) model.

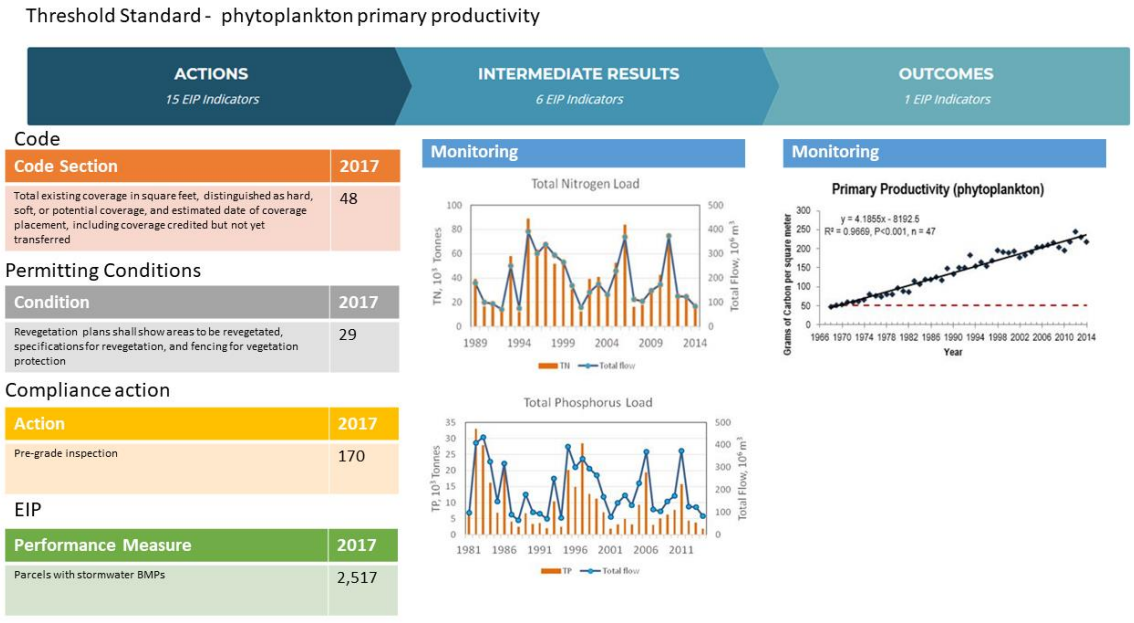


FIGURE 1: MOCKUP OF REPORTING CONTENT ENABLED BY THE THRESHOLD STANDARD SYSTEM

The proposed structure can be built iteratively over time as the threshold update initiative works through priority areas. The Tahoe Region will benefit from a clearer understanding of actions, intermediate results, and outcomes going forward as shown in Figure 1. The fully interconnected system serves multiple audiences. The system provides regulated parties with an explanation of what goal each rule serves. It provides funders and managers with the tools to assess return on investment for policies or projects and prioritize management strategies. It provides tracking of where the conditions in the basin stand relatives to its goals.

The design process considered six core objectives:

1. Achieve the Compact mandate for the threshold standards and support the Regional Plan.
2. Support for science-based adaptive management.
3. Promote data sharing and transparency.
4. Leverage new technologies to promote stakeholder awareness of the Region's shared goals and how the actions of TRPA and its partners contribute to those goals.
5. Facilitate collaboration and communication across resource areas to encourage systems-thinking and ecosystem-based management.
6. Be consistent with and complement the approaches of larger partnerships and initiatives to address similar challenges.

BACKGROUND AND CONTEXT

TRPA operates under the authority of the states of California and Nevada and the federal government through the Bi-State Compact, which was ratified by Congress and signed by the President of the United States. The revised Bi-State Compact (PL 96-551; December 19, 1980), signed nearly forty years ago, wrote “the waters of Lake Tahoe and other resources of the region are threatened with deterioration or degeneration, which endangers the natural beauty and economic productivity of the region (TRPA 1982)”. To ensure the natural beauty and economic productivity of the region would persist for generations to come, the Bi-State Compact directs TRPA to establish “environmental threshold carrying capacities”, defined as "an environmental standard necessary to maintain a significant scenic, recreational, educational, scientific or natural value of the region or to maintain public health and safety within the region." Environmental threshold carrying capacities (standards) establish goals for environmental quality and express the shared aspiration for environmental restoration of the Tahoe region. The standards shape the goals and policies of the Regional Plan and guide millions of dollars of public and private investment in the region through the Environmental Improvement Program.

The TRPA Governing Board identified the review and updating of the standards and performance measures as a strategic initiative for the agency. TRPA is leading the process to review and update these standards, as well as create an ongoing process to incorporate new scientific information, to ensure that the standards that guide management and investment in the region are representative, relevant, and scientifically rigorous. The goals of the initiative are:

- A representative, relevant, and scientifically rigorous set of threshold standards.
- An informative, cost-efficient, and feasible monitoring and evaluation framework to support adaptive management for threshold standard attainment.
- A robust and repeatable process for review of threshold standards in the future.

The initiative to update the standards includes three complimentary phases, where the third phase of the initiative is iterative:

- Technical Corrections and Reorganization: The assessment of the threshold standards identified multiple overlapping standards in the system. This process leveraged the Tahoe Science Advisory Council's work to identify and vet proposed changes to clarity the intent of the standard and address overlap while maintaining the same level of environment protection. It was completed in May 2018.
- System Structure: System structure is an umbrella term used to describe both the threshold standards and the reporting framework that supports decision making on actions that promote standard attainment and maintenance. The Tahoe Science Advisory Council's review of other natural resource management systems provided numerous recommendations for organizing and implementing the threshold standard system to better support adaptive management in the region and accelerate threshold standard attainment. The recommendations articulate where individual pieces of information fit into the system, framing the difference between standards and items that we monitor because they help inform management towards those goals. The task will leverage the Tahoe Science Advisory Council's prior work to guide the development of alternative organizational frameworks. The recommendations for structure of the standard system will be implemented as the review process iterates through all categories as described in the next phase. This system structure document is the product of this phase.

- Content Review: The thresholds system structure is comprised of individual standards that are grouped into logical categories (e.g. water quality, wildlife). The individual standards make up the heart of the threshold standard system. As new information, knowledge, and resources become available specific standards will be reviewed using a repeatable process. This process has been initiated for multiple standards.

Work on the first two phases was intended to proceed in parallel with work on the initial focus areas of the third phase.

COMPACT GUIDANCE

The Bi-State Compact (Compact) provides clear guidance on the role of the threshold standards in the governance of the region relative to other actions and responsibilities of Agency (Figure 2). The Compact empowered TRPA "to adopt and enforce a regional plan and implementing ordinances which will achieve and maintain such capacities (Standards) while providing opportunities for orderly growth and development consistent with such capacities (Standards)." The Compact specified that following standard adoption, TRPA "shall amend the regional plan so that, at a minimum, the plan and all its elements, as implemented through agency ordinances, rules and regulations, achieves and maintains the adopted environmental threshold carrying capacities." The Compact provides direction that the regional plan shall include, "a diagram, or diagrams, and text, or texts setting forth the projects and proposals for implementation of the regional plan." The Compact further directed that implementation of the regional plan shall include a set of required findings be made prior to approval of project in the region. The findings ensure the review of projects includes the impact of the projects on the environment and that the project will not cause exceedance of any of the adopted standards.

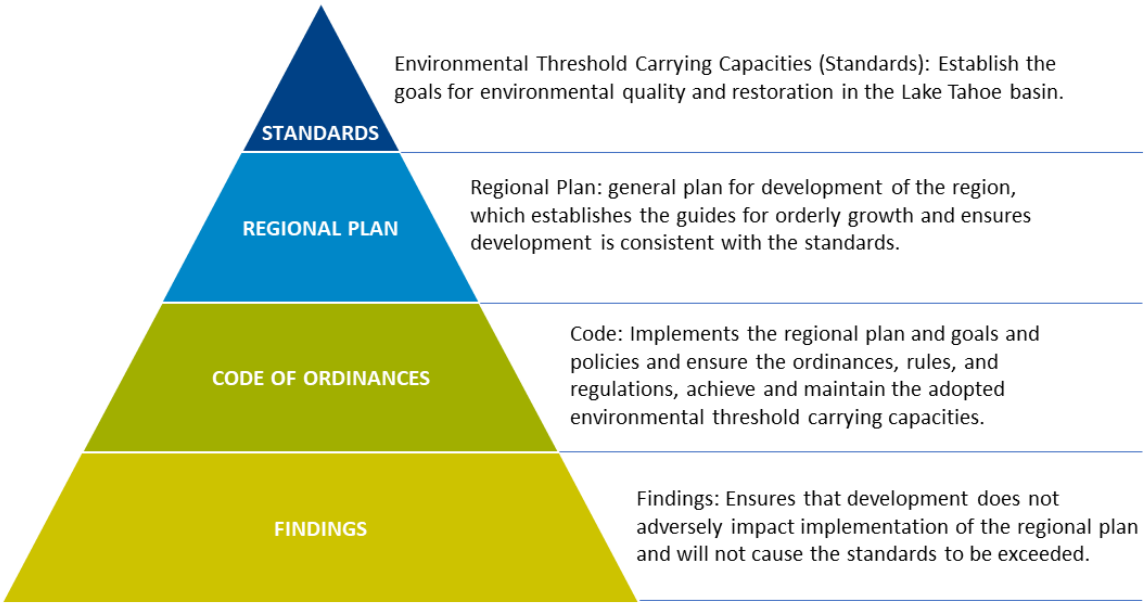
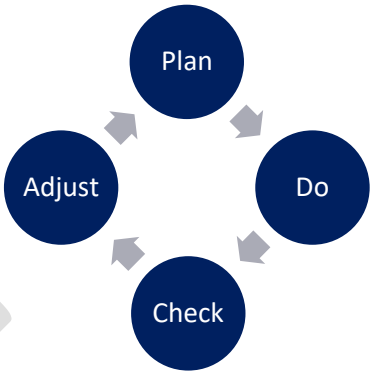


FIGURE 2: HIERARCHY OF THERSHOLD STANDARDS, REGIONAL PLAN, AND FINDINGS ARTICULATED IN THE COMPACT.

ADAPTIVE MANAGEMENT

TRPA has embraced the adaptive management or continuous improvement "plan-do-check-adjust" approach. The standards and regional plan represent the "plan" function. Completion of public and private projects and proposals corresponds to the "do" function. The "check" function is carried-out through monitoring and reporting which is then used on an ongoing basis to "adjust" by making "plan" changes. Support for this approach is the concept underlying the ongoing threshold evaluation and update process. That is, as new information, knowledge, and resources become available the thresholds and regional plan are updated.



THRESHOLD SYSTEM STRUCTURE

In addition to coupling straightforward outcome-based standards with an ongoing monitoring and reporting component, the thresholds system is designed to incorporate the best available scientific and program management information for each threshold category. This is achieved by including conceptual models and results frameworks components. These components are tied together across categories by identifying and ensuring consistency between common drivers and between outcomes from one category that may be drivers in another. The result is that the threshold system structure essentially represents a system of systems (i.e., it has an underlying system) that can be continually improved with new knowledge and resources. Each of these components is described in more detail below.

Threshold Standard System

The system itself contains two primary elements that are unified through a single management structure. The two primary elements are conceptual models that reflect scientific understanding of the system and results chains based on the conceptual models. The results chain explains how management action is intended to influence the system towards the desired goals.

Conceptual Model

Conceptual models document the current scientific understanding of the processes and drivers that influence the state of the system. Conceptual models provide a more detailed view of the system, relative to the high-level view captured in the underlying system. System understanding grows as science progresses and as projects are implemented and lessons are learned. As understanding of the system improves, the conceptual models are intended to be updated to reflect the most recent understanding of the processes at work. Conceptual models will be accompanied by documentation that explains the links in the conceptual model, how modification of individual drivers impacts other parts of the system, and where items in the conceptual model fit in the underlying system.

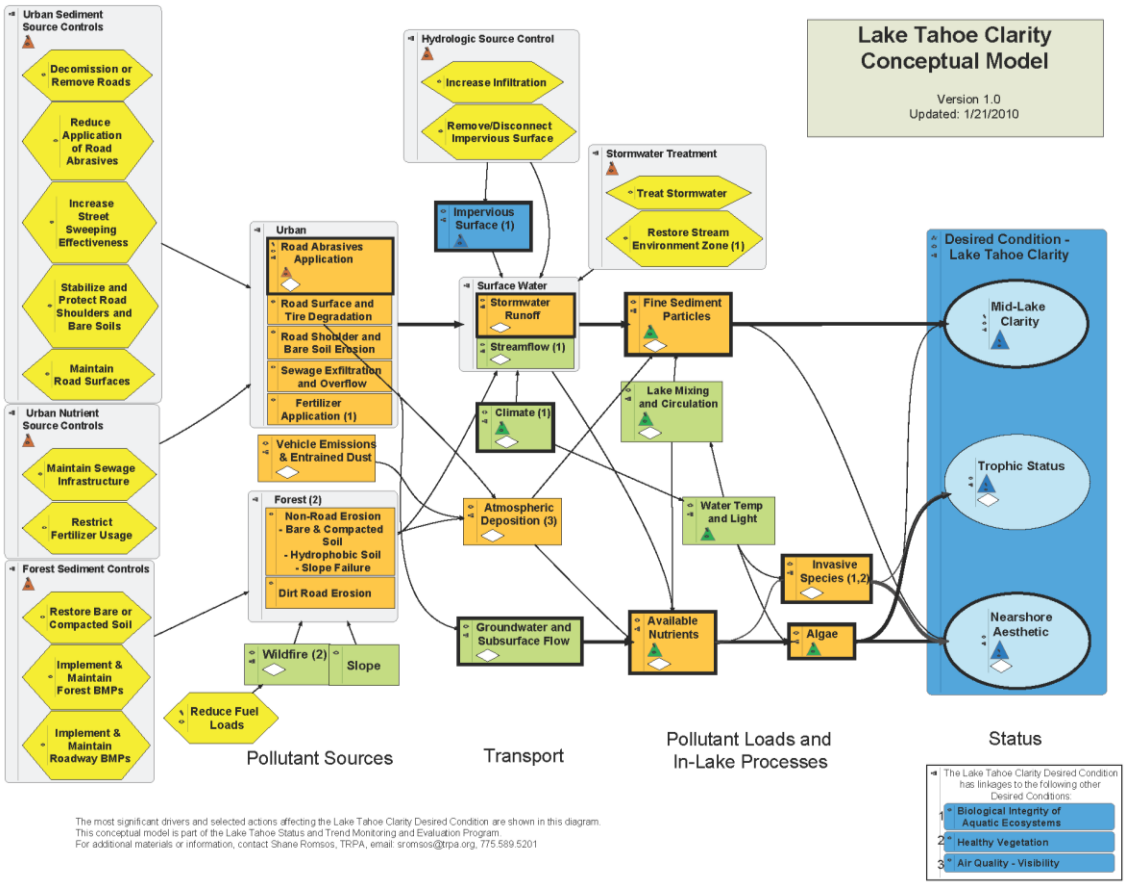


FIGURE 3: EXAMPLE CONCEPTUAL MODEL

Results Chain

Results chains provide straightforward explanations of how management actions are expected to influence the system to achieve the desired outcome. The results chains lay out the logic pathways that link our management actions and policies to the desired outcomes. They are organized around simple "If then" logic model. If I do this, I expect that to happen. They are intended to communicate to stakeholders how we anticipate the system to respond to management actions. Results chains are built on top of the conceptual models of how the system functions, with a focus on how particular management actions relate to the desired outcome articulated in the standard. The causal relationships and connections detailed in the results chain, will already be reflected in the conceptual model for the system. The results chains also serve as a set testable hypotheses that enable assessment of the efficacy of individual management interventions. Evaluating these hypotheses provides the information necessary to identify higher return on investment management interventions and adaptively manage the system. Results chains link elements of the regional programs and policies to the standards they support, as suggested in the Bi-State Compact.

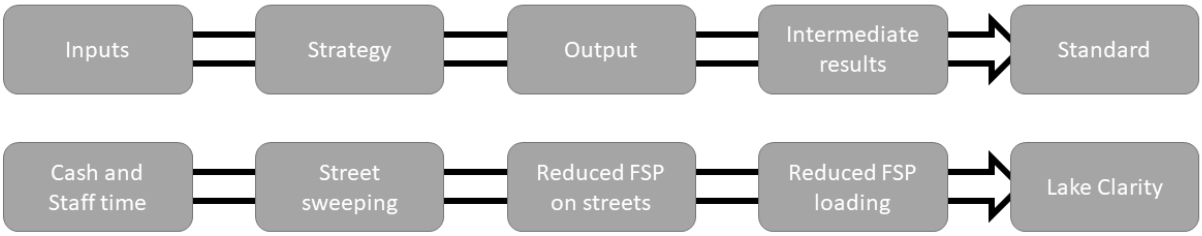


FIGURE 4: SIMPLE EXAMPLE RESULTS CHAIN FOR RESTORING LAKE CLARITY.

3. Management Tools

These are the methods or tools authorized through the TRPA Bi-State Compact consisting of adoption of threshold standards and the regional plan including regulations, projects, and proposals for implementation of the regional plan. The management tools bring the full system structure together. Figure 5 illustrates the interrelationship between the components of the system.

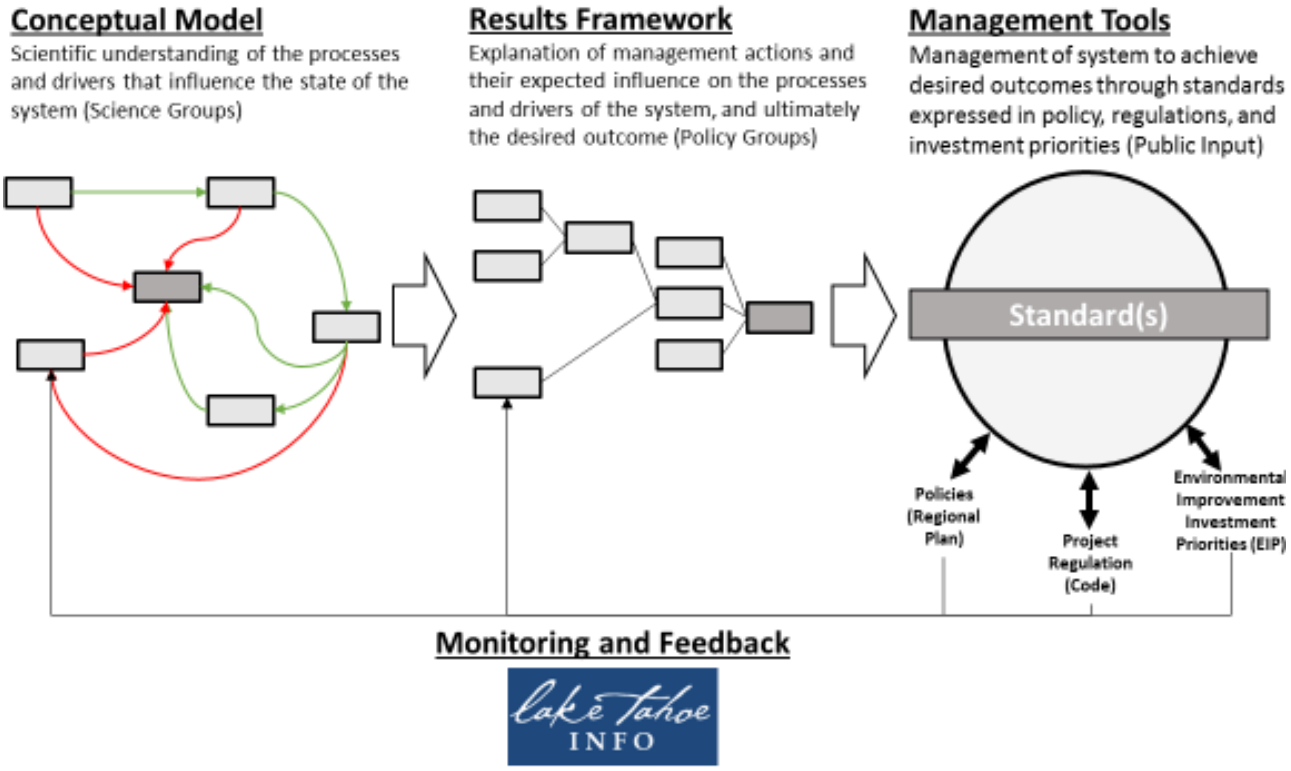


FIGURE 5: THRESHOLD COMPONENTS FOR A STANDARD OR CATEGORY

Underlying System

Consistency, linkages across threshold categories (air quality, water quality, etc.), and feedback are necessary components of a robust systems model. This means that common and consistent definitions, information, and assumptions (e.g., level of population) are used; the impacts across categories are recognized; and the results from ongoing monitoring are utilized to adjust the system. Often this concept is referred to as a "conceptual framework" of which there are many varieties that have been widely

utilized in environmental management, including the Driver-Linkage-Outcome (DLO) or Drivers-Activities Pressures-State-Impact-Response (DAPSIR) approach.

The underlying system provides a high-level view of the larger context within which each standard or standard categories is nested. They identify underlying Drivers (e.g. hunger) that causes population to engage in Activities (e.g. fishing), that place Pressure on ecosystems (e.g. extraction of fish) that alter the State of the system (e.g. fewer fish), that Impacts ecosystem function and delivery of ecosystem services (e.g. altered food webs), and the Response that human populations take to address the unwanted changes (e.g. fishing limits, permitting) (example modeled after Oesterwind et al. 2016). The underlying system diagrams for categories or individual standards are designed to be reviewed with the conceptual frameworks of other categories to look for commonalties and overlap between drivers, activities, or responses that are impacting multiple categories.

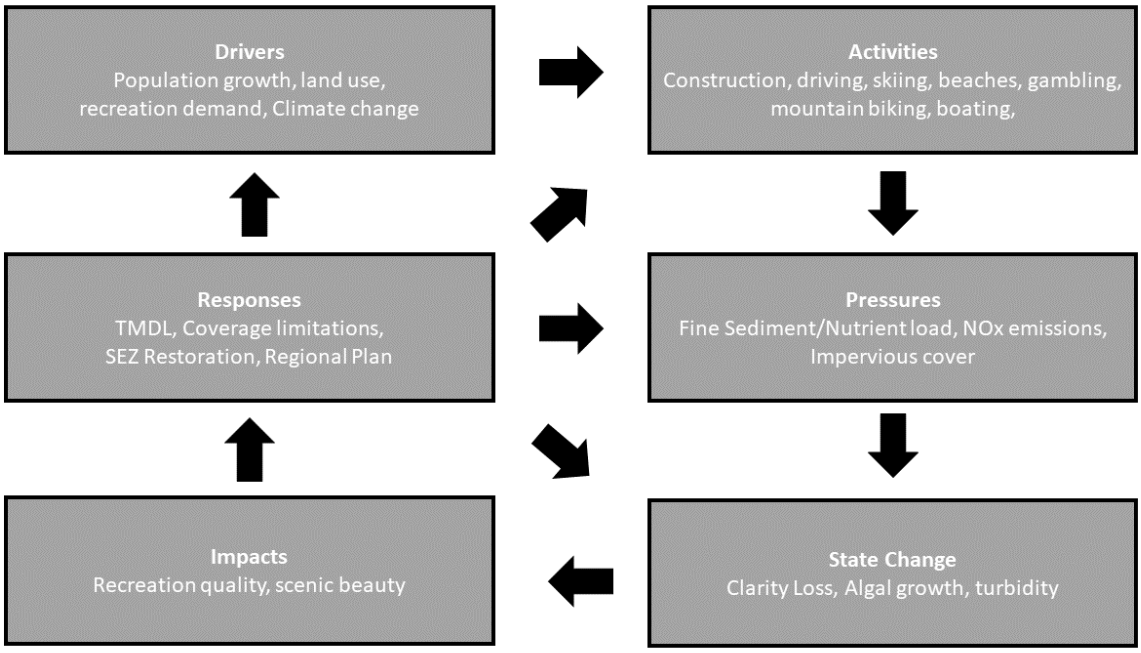


FIGURE 6: EXAMPLE DIAGRAM OF AN UNDERLYING SYSTEM DIAGRAM FOR WATER QUALITY

Development of the individual DAPSIR diagrams can be a relatively simple and straightforward exercise. As the components of each threshold category and their linkages are further developed, a better understanding of how the categories relate to one another emerges. Figure 7 illustrates this concept by showing the linkage between threshold categories. The implication of points of linkage between two categories means different things depending where the linkage between the categories occurs. Where categories share underlying drivers or are impacted by the same activity, the linkage suggests that management interventions focused on those drivers or activities will have multiple benefits. Where the linkage is between responses it suggests that the responses need to be designed to ensure the multiple potential benefits of those responses are delivered. The linkages between the pressures on the water quality and meadows, and between the responses to improve water quality and forest health help promote integrated resource management. Identifying these linkages promotes system level management that breaks out of the individual silos.

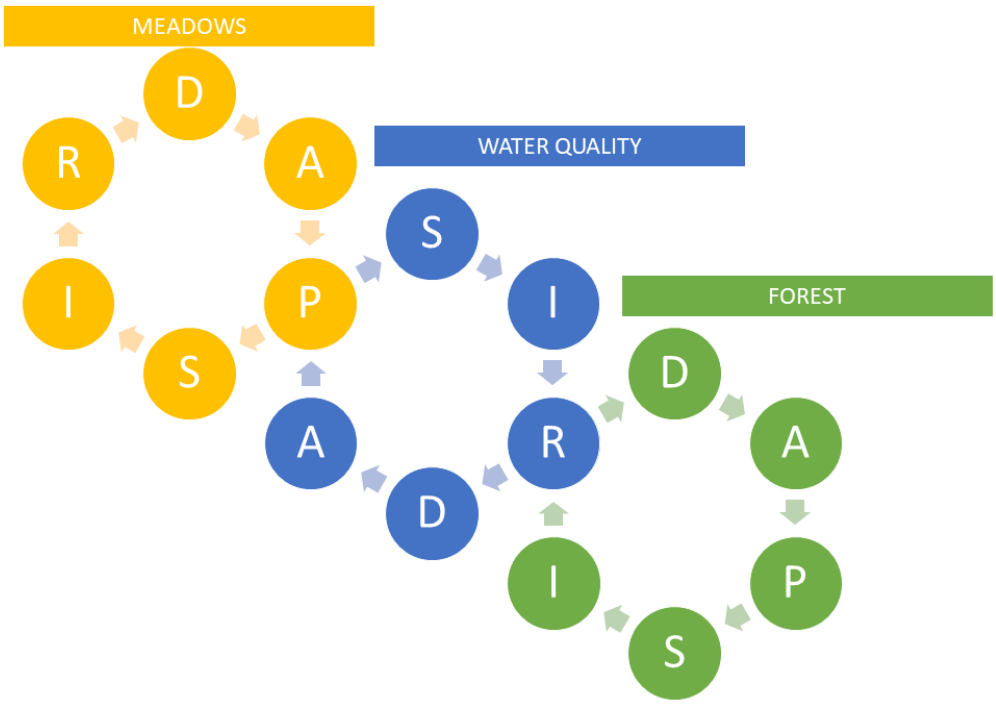


FIGURE 7: OVERLAPPING UNDERLYING SYSTEM DIAGRAMS USED TO IDENTIFY LINKAGES BETWEEN FOCUS AREAS.

To summarize, the threshold system structure is, at the most general level, a system of systems or an underlying system. At the threshold category level, it consists of a conceptual model, results framework, and management tools. At the most specific level it consists of the outcomes or goals and standards for a category, along with a description of any associated conceptual model(s), results framework(s), and the monitoring protocol(s) that have been created to support it.

THRESHOLD STANDARD TEMPLATE

The threshold standard template details the format that standardizes content for individual standards in the system.

Goal statement: Simple explanation of the overall goal of the threshold standard and importance of that goal. The goal statement should address how the actions of the agency and its partners can influence and attain the standard.

Threshold standard: A specific and measurable statement of the desired outcome. Desired outcomes will generally be expressed as a state of the system or a quantity of an ecosystem service.

Threshold indicator: The indicator provides a clear statement of the value(s) used to assess the status of the indicator relative to the desired state of the indicator as specified in the standard

Analytic guidance: Provides guidance on assessment of status and trend for the threshold standard.

Conceptual model: Reference to the conceptual model that documents the current understanding of system function.

Results chain: Reference to the location of the results chain that documents the linkages between actions (e.g. projects, investment priorities) and policies (e.g. code, regulations) of the partnership and their intended impact on the system.

Underling System: References the name of the underlying system or conceptual framework diagram that places individual threshold standard in the broader context of the basin's management system.

AVAILABILITY OF THRESHOLD INFORMATION

The proposed threshold standard system is designed to embrace and encourage transparency at all levels of the system. Transparency regarding where dollars are spent, transparency about how projects are selected, transparency about the expected impact of those investments, transparency about how the effects of projects are evaluated and how that information is incorporated into future project selection. TRPA fully embraces the concept of making the information and methods used open to the public. To achieve this level of openness, threshold data and systems will be provided using the following three vehicles:

1. Stand-alone document
2. Appendix to Regional Plan
3. Web page with links to all components (e.g., conceptual model, monitoring data, etc.)

IMPLEMENTATION

The proposed threshold standard system described in this document will not materialize overnight. Each element of the system and the architecture to link them will need to be developed. The development of the individual elements need not proceed in a linear fashion. Development can start at any level of the system. Development of the individual elements should acknowledge that management in the region is not a blank slate today. Existing management interventions are based implicitly on results chains that have not been formally articulated. Those results chains are built on an understanding or mental model of how the system works (conceptual model) and the underlying pressures and drivers (underlying system) that shape the system. Formally articulating and sharing individual elements will surface these previously undocumented mental models, provoke an opportunity to communicate about them, and spur development of the other elements of the system. These discussions will provide opportunities to bridge the gap between management and scientists and ensure the interventions are designed based on the current scientific understanding of the system and that researchers are focusing their work on areas with the greatest opportunity to influence management.

The intention of this document is to lay out a coherent vision for the future of the threshold standard system. The vision for the system is intended to provide the outline that will be filled in, populated, and refined over time as standards are reviewed and updated. In addition to the individual elements of the system that are specific to, and underpin, individual standards (e.g. conceptual framework, results chain, underlying system), realization of the full potential of the vision will also requires consideration and investment in how the elements can be integrated into a seamless system for stakeholder consumption.

The presentation of the information to stakeholders is as important to system's success as the underlying elements. The integration of the individual elements will likely require a web-based platform that links each of the elements in an intuitive manner. The web-based platform serves as a framework to display and navigate the standards and the linkages articulated in the associated conceptual models, results chains, and underlying systems. Development of the web-based platform begins with the logic embedded within the elements of the system, that link standards to code, policies, and projects, albeit in a slightly different form (Figure 8). The relationship between sections of code, permitting conditions, and other performance measures to standards will be one to many, because each serves multiple functions and contribute to maintaining and attaining multiple threshold standards. Completing the mapping of these relationships is the first step in aggregating the individual results chains.

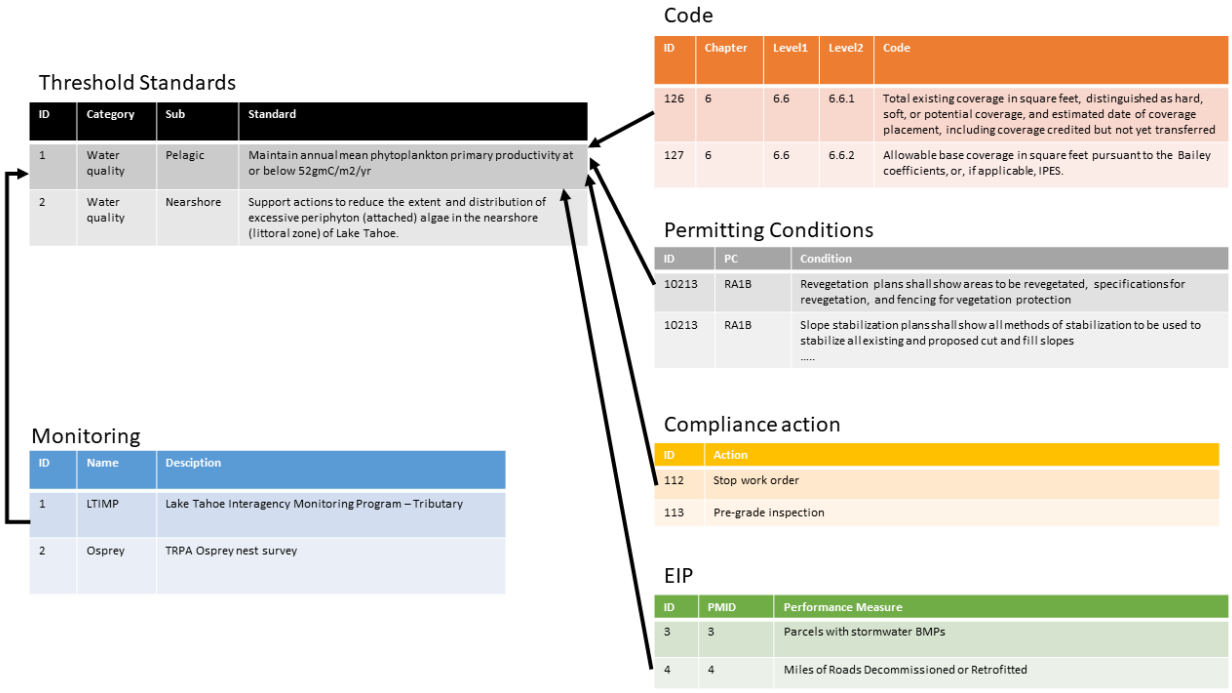


FIGURE 8: EXAMPLE OF THE BACKEND DATA STRUCTURE THAT LINKS TRPA ACTIONS TO THE THRESHOLD STANDARD THEY SUPPORT

The background linkages between the code of ordinances and the threshold standards serve multiple purposes. It promotes a deeper understanding of the purpose of individual ordinances. It identifies links and connections within the system. It also provides a database that simplifies reporting and evaluation of the efficacy of the individual actions. The aggregation of all elements in single platform will provide the public with greater information on the status and trends of environmental conditions in the region and provide managers with the information they need to adjust management priorities where necessary. The process will also facilitate generation of threshold evaluations and annual and quarterly reports that are higher quality.

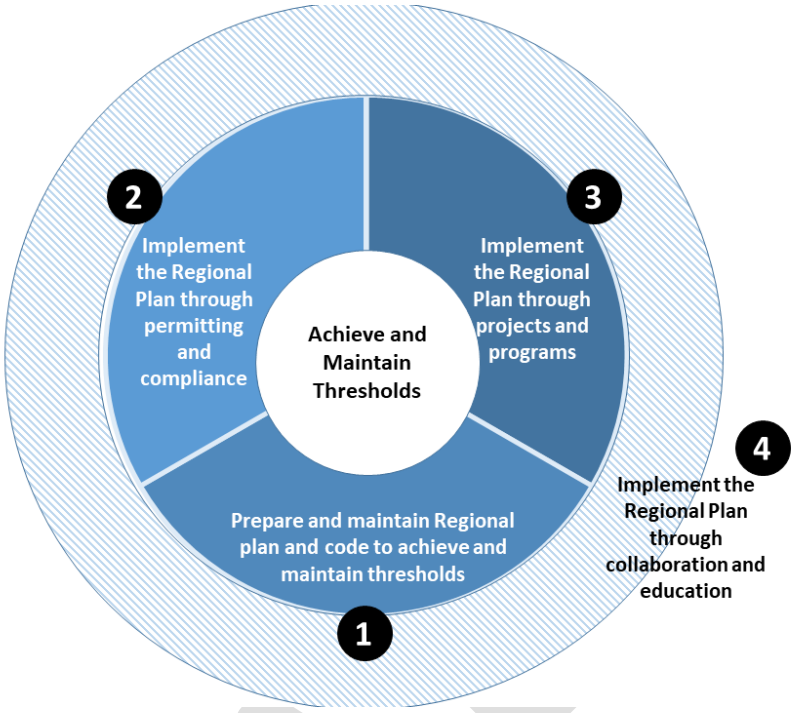


FIGURE 9: RELATIONSHIP BETWEEN AGENCY ACTIONS AND THE ACHIEVEMENT AND MAINTENANCE OF THRESHOLD STANDARDS

TRPA's work to attain and maintain the threshold standards can be broadly grouped into four categories, the effectiveness of each can be reported in the threshold dashboard and assessed as part of the threshold evaluation (Figure 9). Those elements include;

1. The preparation and maintenance of a Regional Plan that attains and maintains the thresholds
2. The implementation of that Plan through review of programs and projects
3. The implementation of the Plan through the coordination of the projects and proposals that comprise the Environmental Improvement Program
4. Implementation of the Regional Plan through collaboration with partners and education initiatives.

Actions under each of these can be tracked through the definition of discrete units to quantify and track the activities associated with those actions. The Environmental Improvement Program (EIP), already has an extensive tracking platform to report on the collective impact of implementing partners. That impact is captured in the EIP performance measures, which are available at https://eip.laketahoeinfo.org/EIPPerformanceMeasure/Index. Similar work occurs in the other categories and can also be summarized on Lake Tahoe Info, to provide greater transparency about the actions that contribute to attaining and maintaining the standards.

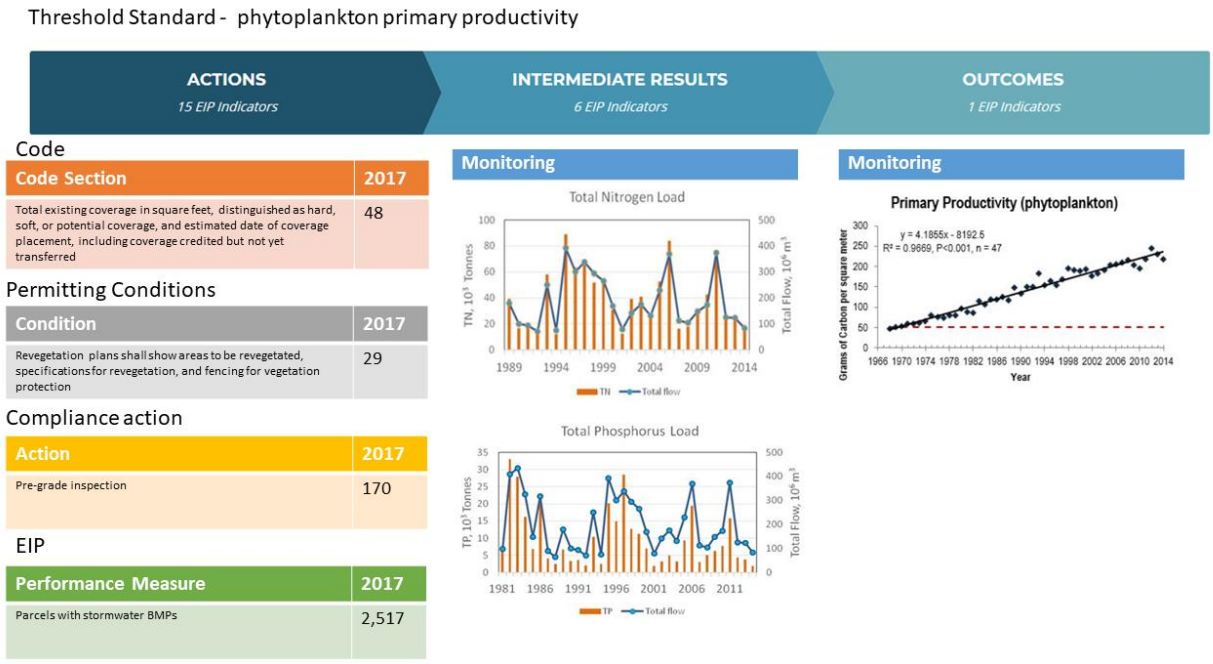


FIGURE 10: MOCKUP OF DASHBOARD REPORTING CONTENT ENABLED BY THE THRESHOLD STANDARD SYSTEM

Figure 10 provides a mockup of what a dashboard of activities and intermediate results related to a threshold standard could look like. A single standard (phytoplankton primary productivity) is displayed in conjunction with information about the actions of TRPA and its partners to attain the standard. Monitoring results from programs that track the indicators related to the goal are also displayed. The mockup collates the individual parts of the results chains that are measurable and presents them in a dashboard so that stakeholders can access information on a) how current conditions compare to the goal, b) what programs and polices contribute to attainment, and c) what short term indicators of success are tracked to understand how effective those programs and policies are?

The code section of the thresholds dashboard provides a summary of how often individual sections of code were utilized to ensure projects are design and implemented to support threshold standard attainment. The permitting conditions section summarizes how often specific conditions were applied to permits to ensure threshold attainment. The compliance action section of the page summarizes the compliance actions are taken to assure project conditions are in alignment with the permit requirements necessary to achieve the threshold standard. Finally, the EIP section (which is already implemented as the EIP project tracker at https://eip.laketahoeinfo.org/) summarizes the contributions of EIP projects to attaining and maintaining the threshold standard.

The findings of monitoring programs related to the threshold standard could also be summarized on each threshold standard page. For many standards the monitoring results will be split into two groups based on the results chain for the standard. The first set to focus on reporting more immediate outcomes or intermediate results. Monitoring intermediate results or shorter-term outcomes enables the assessment of the efficacy of the actions or programs implemented. The second set of monitoring results addresses the outcomes that are the focus of the standard. The integration of the two sets of monitoring results provides a framework to adaptively manage towards the goal through iterative

improvement of our understanding of the drivers of the systems and the how our actions influence those drivers.


TAHOE
REGIONAL
PLANNING
AGENCY
P.O. Box 5310
Stateline, NV 89449
fax 775-588-4527
www.trpa.org
imagine. plan. achieve.

Attachment G.
Vegetation preservation threshold standards adopted in Resolution 82-11 as amended May 23, 2018.

VEGETATION PRESERVATION

COMMON VEGETATION

MANAGEMENT STANDARDS

VP1) A non-degradation standard shall apply to native deciduous trees, wetlands, and meadows to preserve plant communities and significant wildlife habitat, while providing for opportunities to increase the acreage of such riparian associations to be consistent with the SEZ threshold.

VP2) Increase plant and structural diversity of forest communities through appropriate management practices as measured by diversity indices of species richness, relative abundance, and pattern.

VP3) Maintain the existing species richness of the Basin by providing for the perpetuation of the following plant associations:
Yellow Pine Forest: Jeffrey pine, White fir, Incense cedar, Sugar pine.
Red Fir Forest: Red fir, Jeffrey pine, Lodgepole pine, Western white pine, Mountain hemlock, Western juniper.
Subalpine Forest: Whitebark pine, Mountain hemlock, Mountain mahogany.
Shrub Association: Greenleaf and Pinemat manzanita, Tobacco brush, Sierra chinquapin, Huckleberry oak, Mountain whitethorn.
Sagebrush Scrub Vegetation: Basin sagebrush, Bitterbrush, Douglas chaenactis.
Deciduous Riparian: Quaking aspen, Mountain alder, Black cotton-wood, Willow.
Meadow Associations (Wet and Dry Meadow): Mountain squirrel tail, Alpine gentian, Whorled penstemon, Asters, Fescues, Mountain brome, Corn lilies, Mountain bentgrass, Hairgrass, Marsh marigold, Elephant heads, Tinker's penney, Mountain Timothy, Sedges, Rushes, Buttercups.
Wetland Associations (Marsh Vegetation): Pond lilies, Buckbean, Mare's tail, Pondweed, Common bladderwort, Bottle sedge, Common spikerush.
Cushion Plant Association (Alpine Scrub): Alpine phlox, Dwarf ragwort, Draba.

VP4) Relative Abundance - Of the total amount of undisturbed vegetation in the Tahoe Basin: Maintain at least four percent meadow and wetland vegetation.

VP5) Relative Abundance - Of the total amount of undisturbed vegetation in the Tahoe Basin: Maintain at least four percent deciduous riparian vegetation.

VP6) Relative Abundance - Of the total amount of undisturbed vegetation in the Tahoe Basin: Maintain no more than 25 percent dominant shrub association vegetation.

VP7) Relative Abundance - Of the total amount of undisturbed vegetation in the Tahoe Basin: Maintain 15-25 percent of the Yellow Pine Forest in seral stages other than mature.

VP8) Relative Abundance - Of the total amount of undisturbed vegetation in the Tahoe Basin: Maintain 15-25 percent of the Red Fir Forest in seral stages other than mature.

VP9) Pattern - Provide for the proper juxtaposition of vegetation communities and age classes by; 1. Limiting acreage size of new forest openings to no more than eight acres

VP10) Pattern –Provide for the proper juxtaposition of vegetation communities and age classes by; 2. Adjacent openings shall not be of the same relative age class or successional stage to avoid uniformity in stand composition and age.

VP11) Native vegetation shall be maintained at a maximum level to be consistent with the limits defined in the Land-Capability Classification of the Lake Tahoe Basin, California-Nevada, A

Guide For Planning, Bailey, 1974[1], for allowable impervious cover and permanent site disturbance.

POLICY STATEMENT

VP12) It shall be a policy of the TRPA Governing Board that a non-degradation standard shall permit appropriate management practices.

LATE SERAL AND OLD GROWTH FOREST ECOSYSTEMS[2]

NUMERICAL STANDARDS

VP13) Attain and maintain a minimum percentage of 55 percent by area of forested lands within the Tahoe Region in a late seral or old growth condition, and distributed across elevation zones. Standards VP 14, VP15, and VP16 must be attained to achieve this threshold.

VP14) 61 percent of the Subalpine zone (greater than 8,500 feet elevation) must be in a late seral or old growth condition. The Subalpine zone will contribute 5 percent (7,600 acres) of forested lands towards VP13.

VP15) 60 percent of the Upper Montane zone (between 7,000 and 8,500 feet elevation) must be in a late seral or old growth condition. The Upper Montane zone will contribute 30 percent (45,900 acres) of forested lands towards VP13.

VP16) 48 percent of the Montane zone (lower than 7,000 feet elevation) must be in a late seral or old growth condition; the Montane zone will contribute 20 percent (30,600 acres) of forested lands towards VP13.

UNCOMMON PLANT COMMUNITIES

NUMERICAL STANDARDS

VP17-VP18) Provide for the non-degradation of the natural qualities of any plant community that is uncommon to the Basin or of exceptional scientific, ecological, or scenic value. This threshold shall apply but not be limited to:

VP17) The deep-water plants of Lake Tahoe.

VP18) The Freel Peak Cushion Plant community.

SENSITIVE PLANTS

NUMERICAL STANDARDS

Maintain a minimum number of population sites for each of five sensitive plant species.

VP19) Maintain a minimum of 2 Lewisia pygmaea longipetala population sites.

VP20) Maintain a minimum of 2 Draba asterophora v. macrocarpa population sites.

VP21) Maintain a minimum of 5 Draba asterophora v. asterophora macrocarpa population sites.

VP22) Maintain a minimum of 26 Rorippa subumbellata population sites.

VP23) Maintain a minimum of 7 Arabis rigidissima v. demote population sites.

---

[1] See attachment B

[2] For standards VP13 - VP16: Forested lands within TRPA designated urban areas are excluded in the calculation for threshold attainment. Areas of the montane zone within 1,250 feet of urban areas may be included in the calculation for threshold attainment if the area is actively being managed for late seral and old growth conditions and has been mapped by TRPA. A maximum value of 40 percent of the lands within 1,250 feet of urban areas may be included in the calculation.