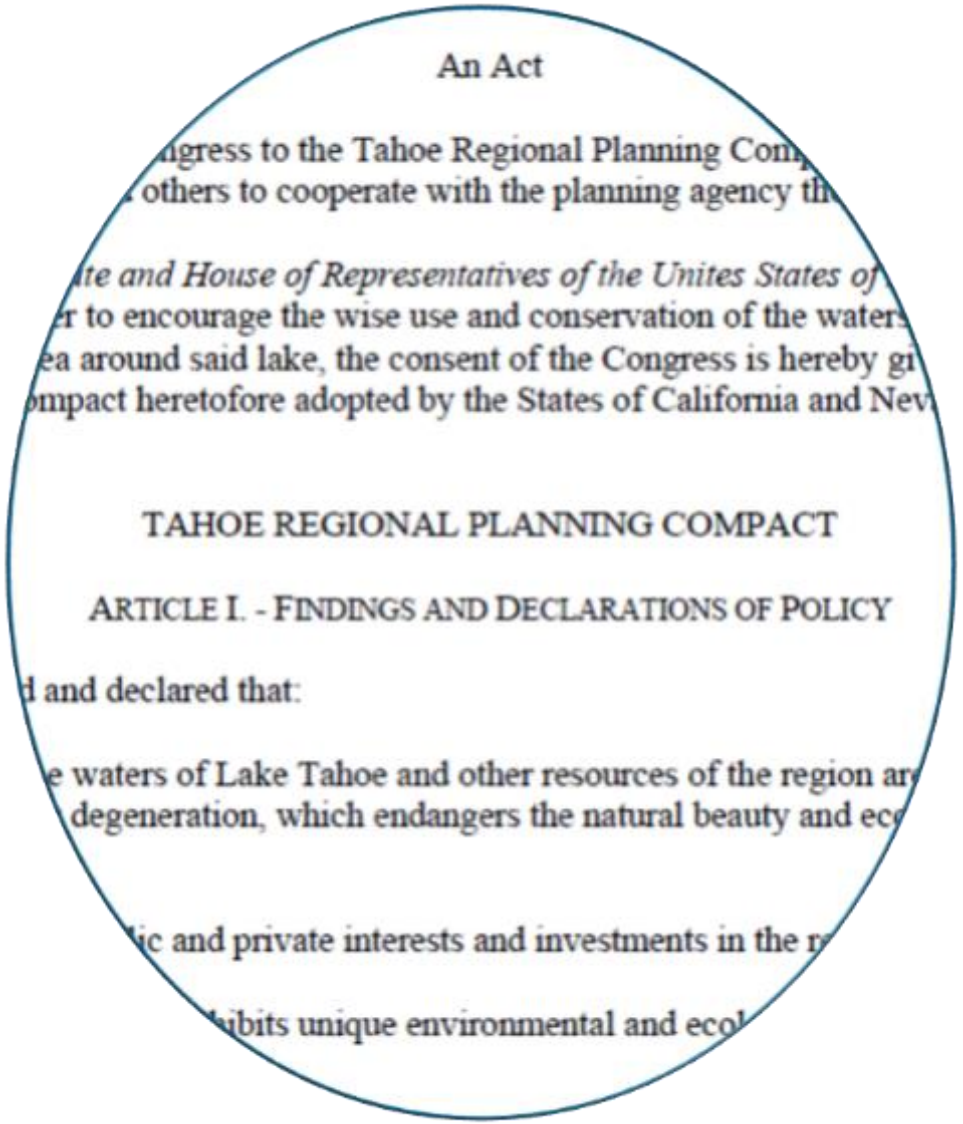
July Meeting of the Threshold Update Initiative Stakeholders Working Group

July 13, 2022

Bi State Compact



An Act

ngress to the Tahoe Regional Planning Com
others to cooperate with the planning agency th

te and House of Representatives of the Unites States of
r to encourage the wise use and conservation of the water
ea around said lake, the consent of the Congress is hereby gi
mpact heretofore adopted by the States of California and Nev

TAHOE REGIONAL PLANNING COMPACT

ARTICLE I. - FINDINGS AND DECLARATIONS OF POLICY

d and declared that:

e waters of Lake Tahoe and other resources of the region ar
degeneration, which endangers the natural beauty and ec

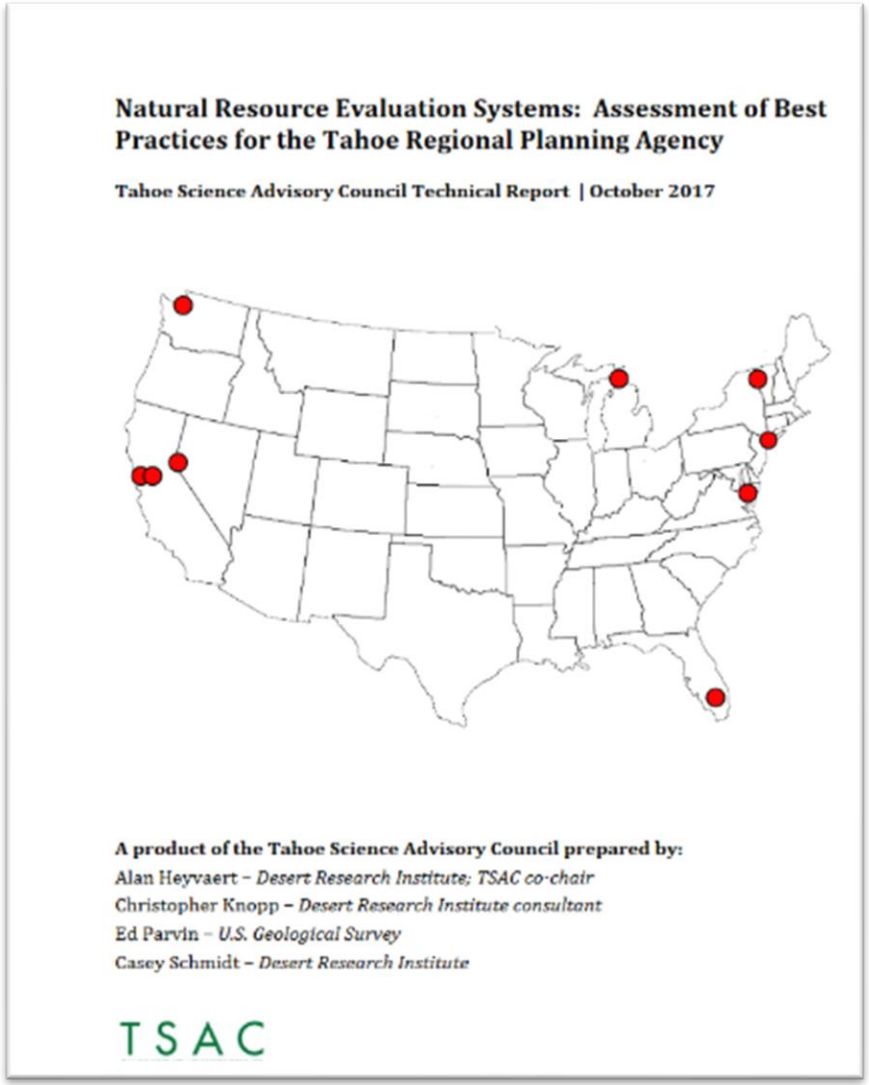
ic and private interests and investments in the r

ibits unique environmental and ecol

Article (II) (i) "***Environmental threshold carrying capacity***" *means 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..*

Article (V) (b) *The agency shall develop, in cooperation with the States of California and Nevada, environmental threshold carrying capacities for the region. The agency should request the President's Council on Environmental Quality, the U. S. Forest Service and other appropriate agencies to assist in developing such environmental threshold carrying capacities*

Tahoe Science Advisory Council



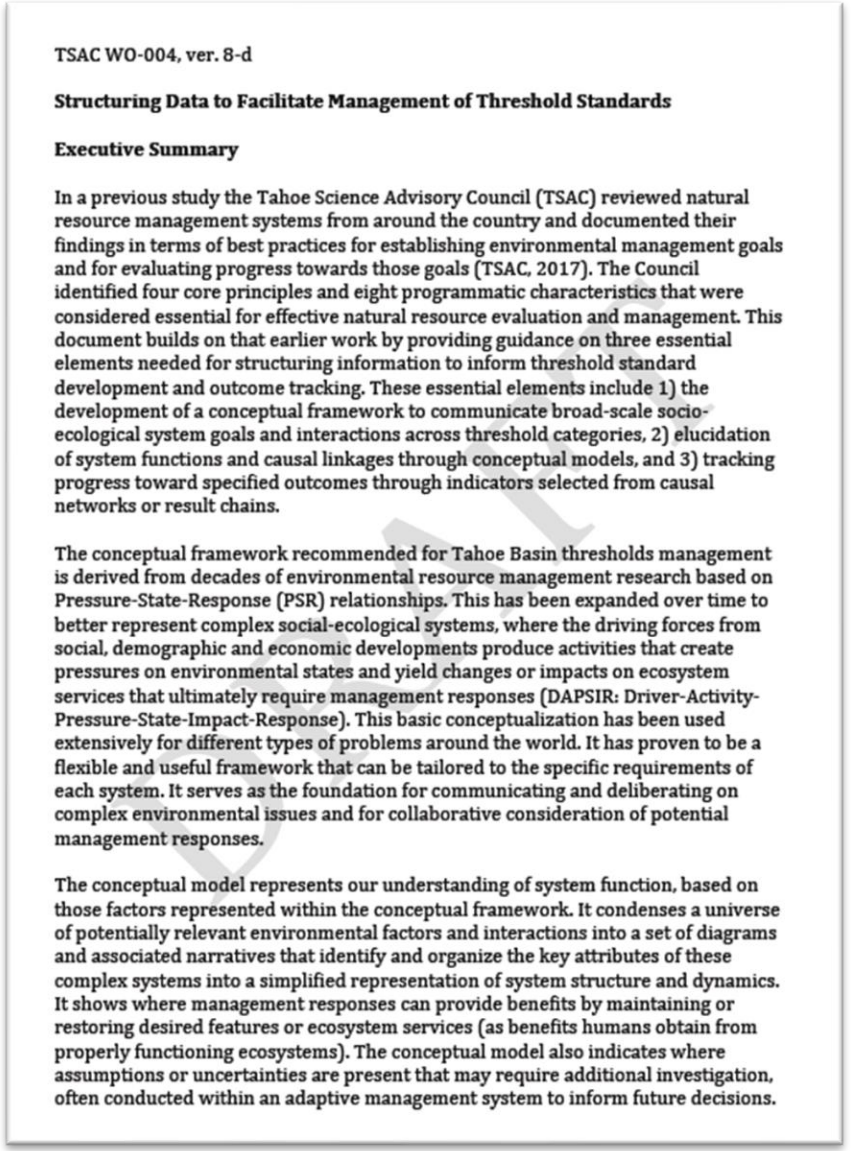
Natural Resource Evaluation Systems: Assessment of Best Practices for the Tahoe Regional Planning Agency

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



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.

DRAFT

Science-Based Adaptive Management Structure

Conceptual Model

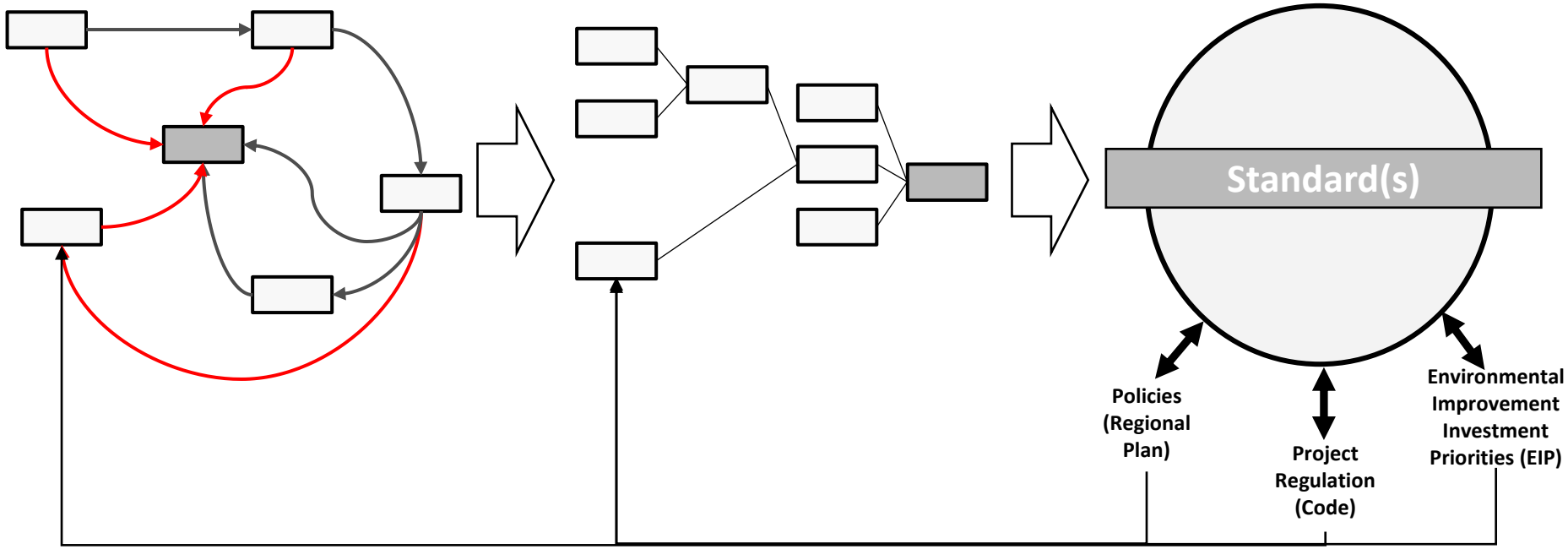
Scientific understanding of the processes and drivers that influence the state of the system (Science Groups)

Results Chains

Explanation of management actions and their expected influence on the processes and drivers of the system, and ultimately the desired outcome (Policy Groups)

Management Actions

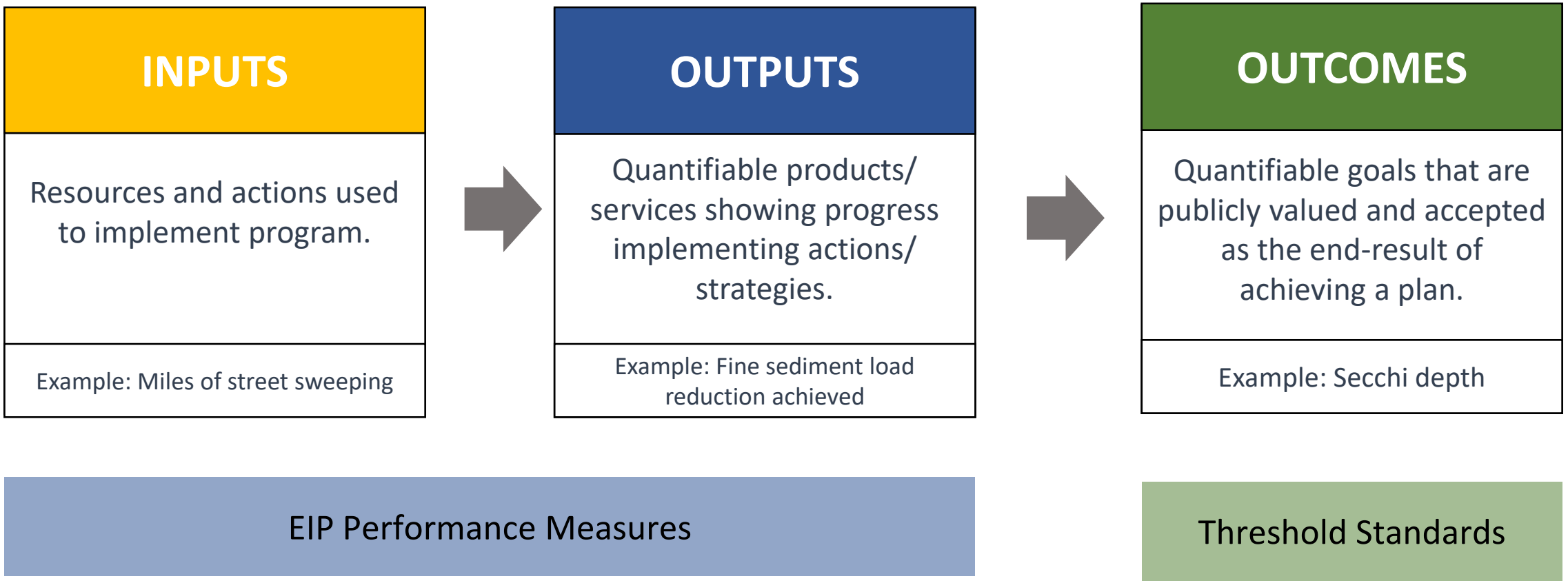
Management of system to achieve desired outcomes through standards expressed in policy, regulations, and investment priorities (Stakeholders)



Monitoring, Evaluation, and Learning

lake tahoe INFO

Framework


INPUTS
Resources and actions used to implement program.
Example: Miles of street sweeping
OUTPUTS
Quantifiable products/ services showing progress implementing actions/ strategies.
Example: Fine sediment load reduction achieved
OUTCOMES
Quantifiable goals that are publicly valued and accepted as the end-result of achieving a plan.
Example: Secchi depth
EIP Performance Measures
Threshold Standards

Threshold Standards

1	Specific	The standard establishes a specific numeric target, and benchmark/baseline values are documented where necessary.
2	Measurable	The standard has clearly defined indicator(s) that link to the standard, and there are practical ways to objectively and accurately measure progress towards attainment
3	Outcome-based	Standards establish a desired condition for an environmental end state. Standards do not establish a means to achieve the desire outcome.

Science Council Process

1

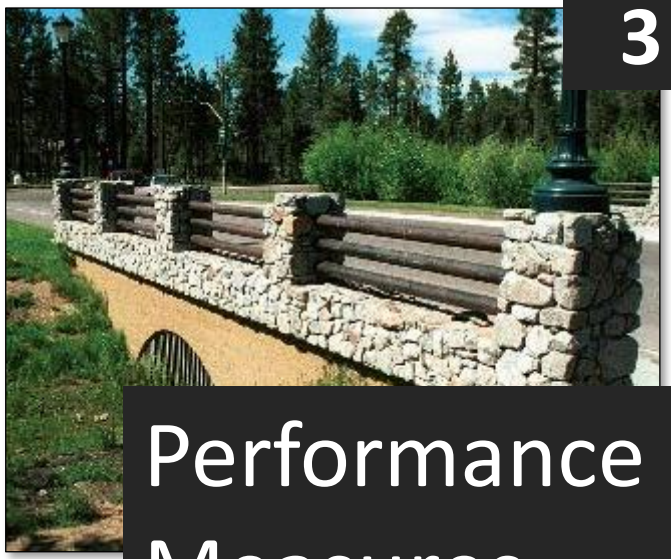
Goal / Value

Restore Clarity

2

Threshold Standard

98.4 ft of Clarity



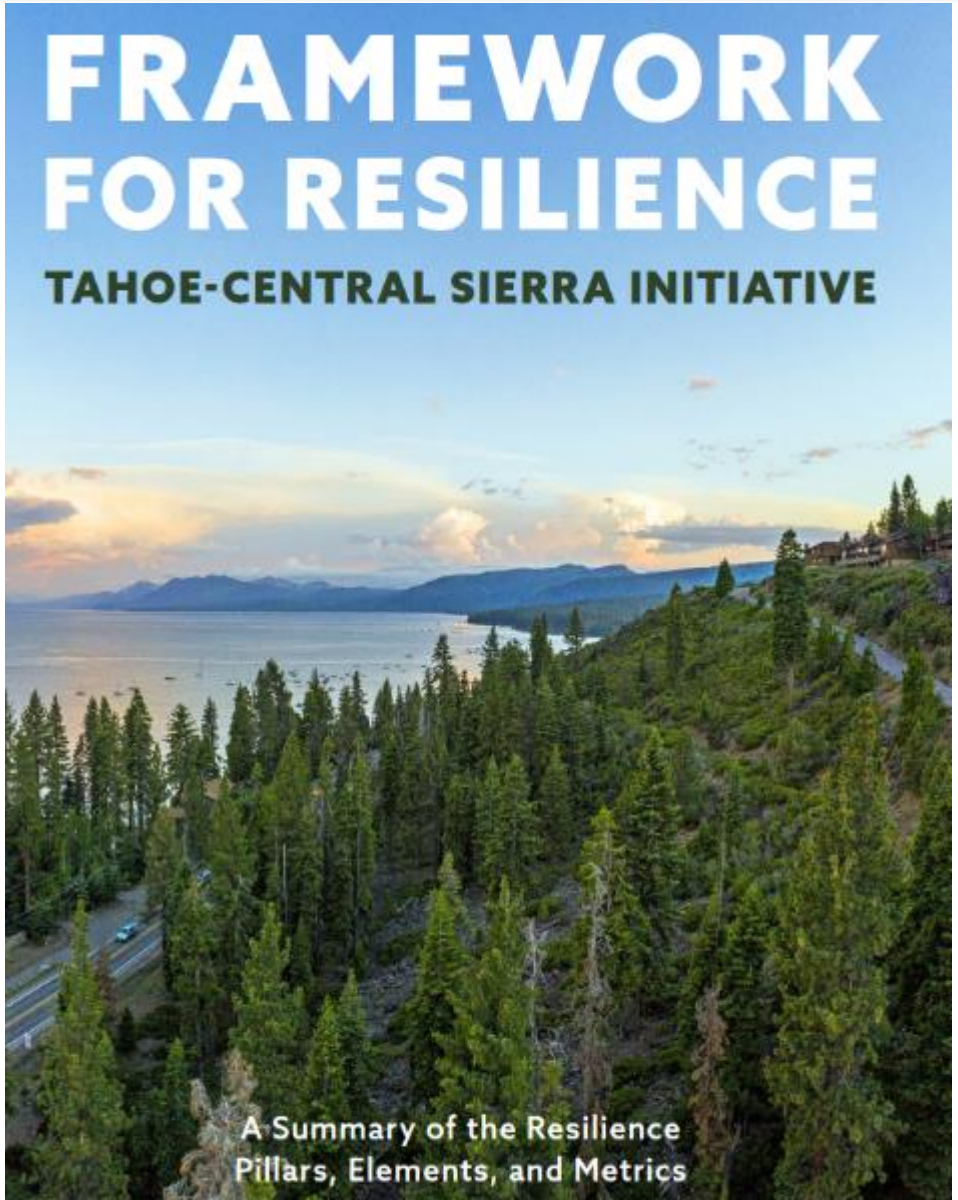
3

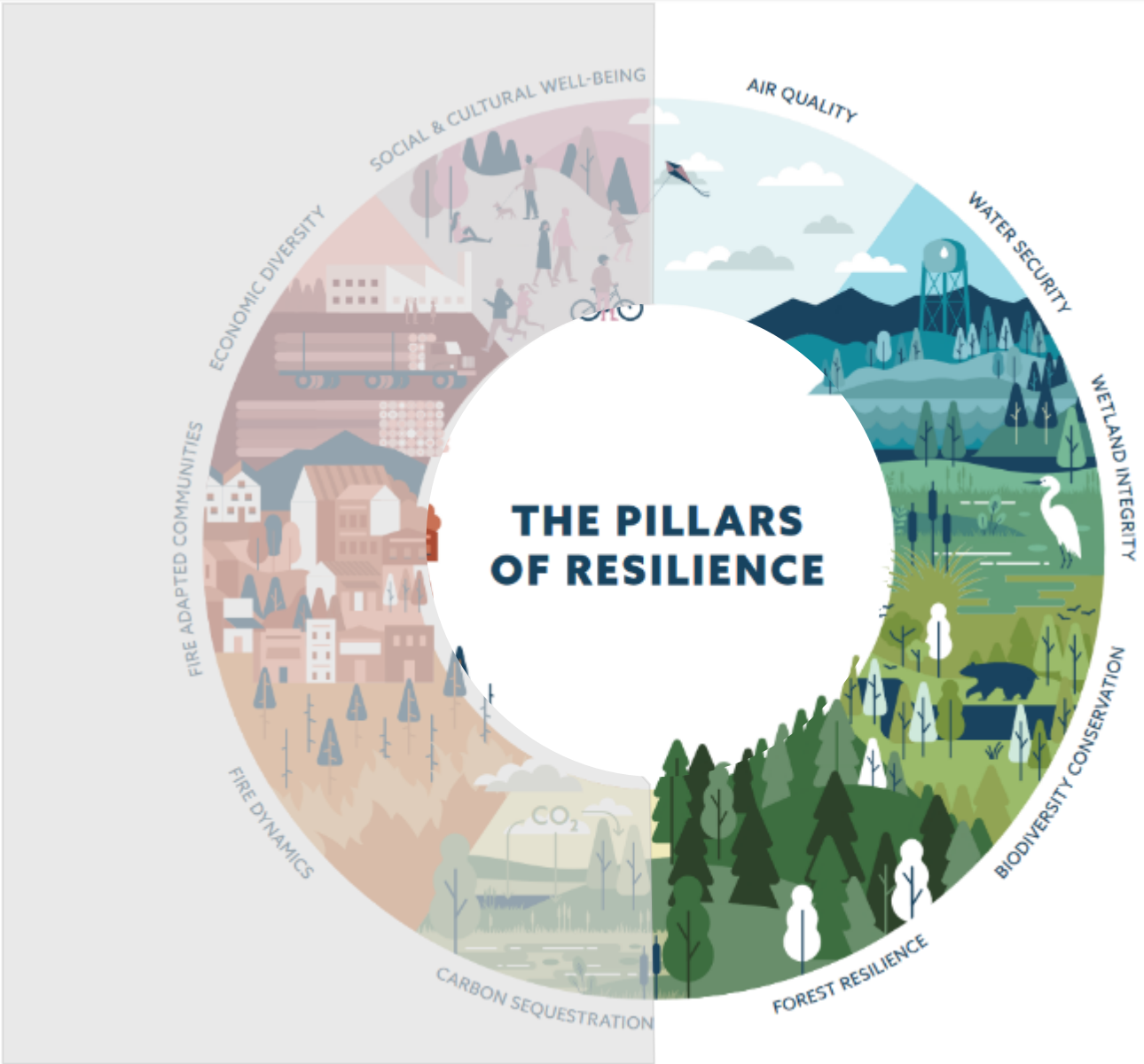
Performance Measures

Area treated
FSP Reduced

Standard Outline

Threshold & EIP Performance Measures Update Scope

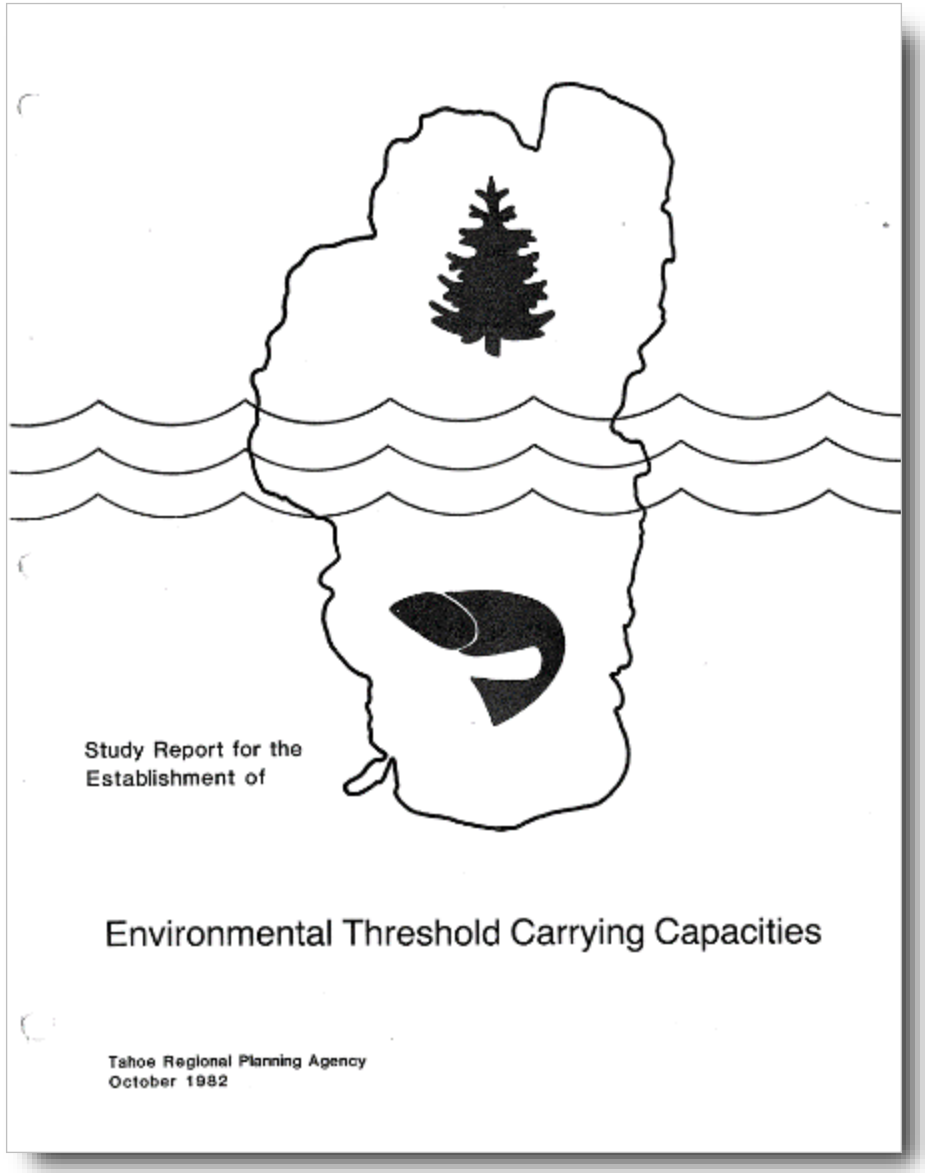




What's included

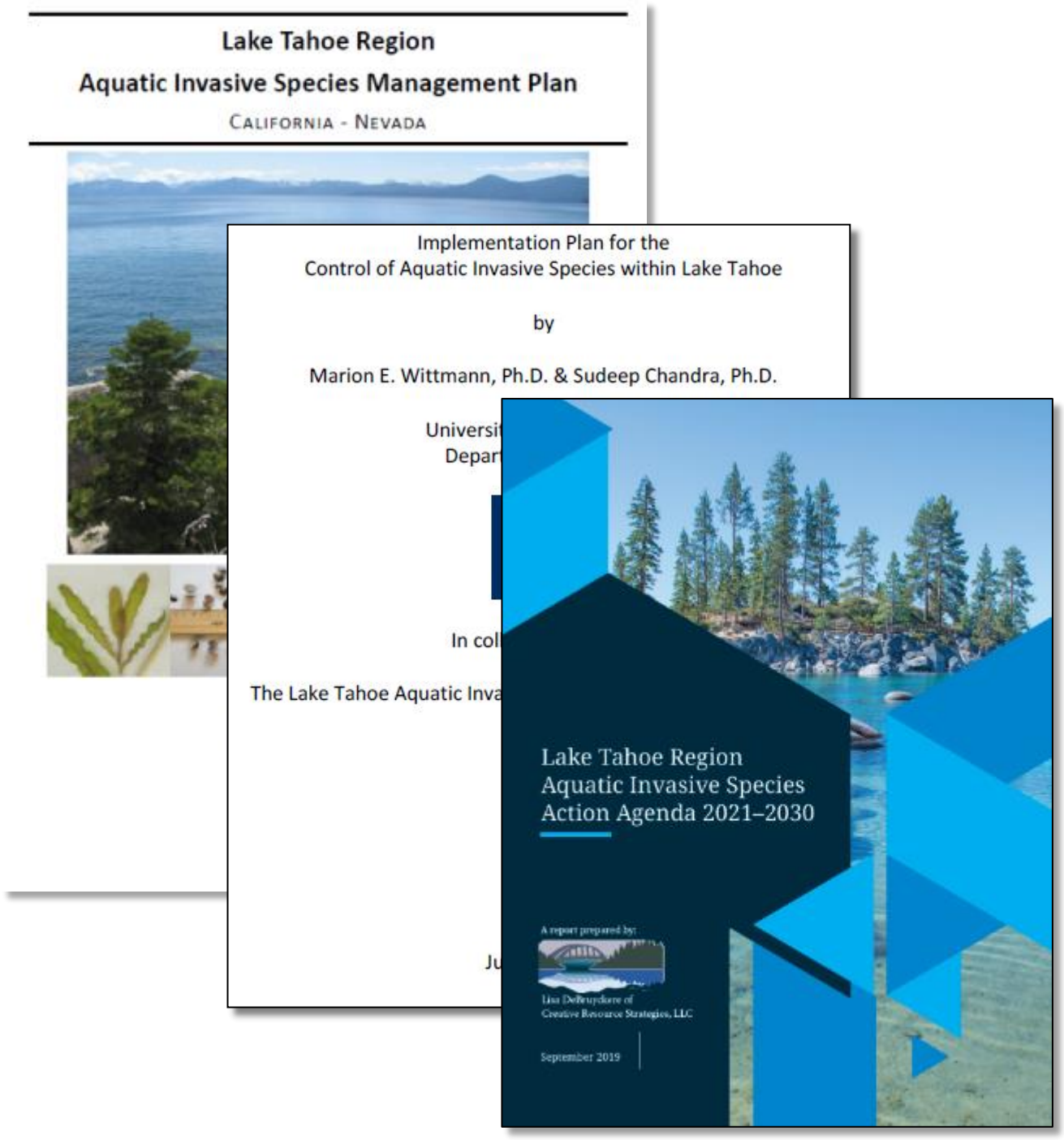
Categories

- Air Quality
- Water Quality
- Fisheries
- Wildlife
- Vegetation
- Soil Conservation
- Scenic Resources
- Recreation
- Noise
- Transportation and Sustainable Communities



Outline Development

The Lake Tahoe Aquatic Invasive Species Coordination Committee is comprised of representatives from the following organizations:



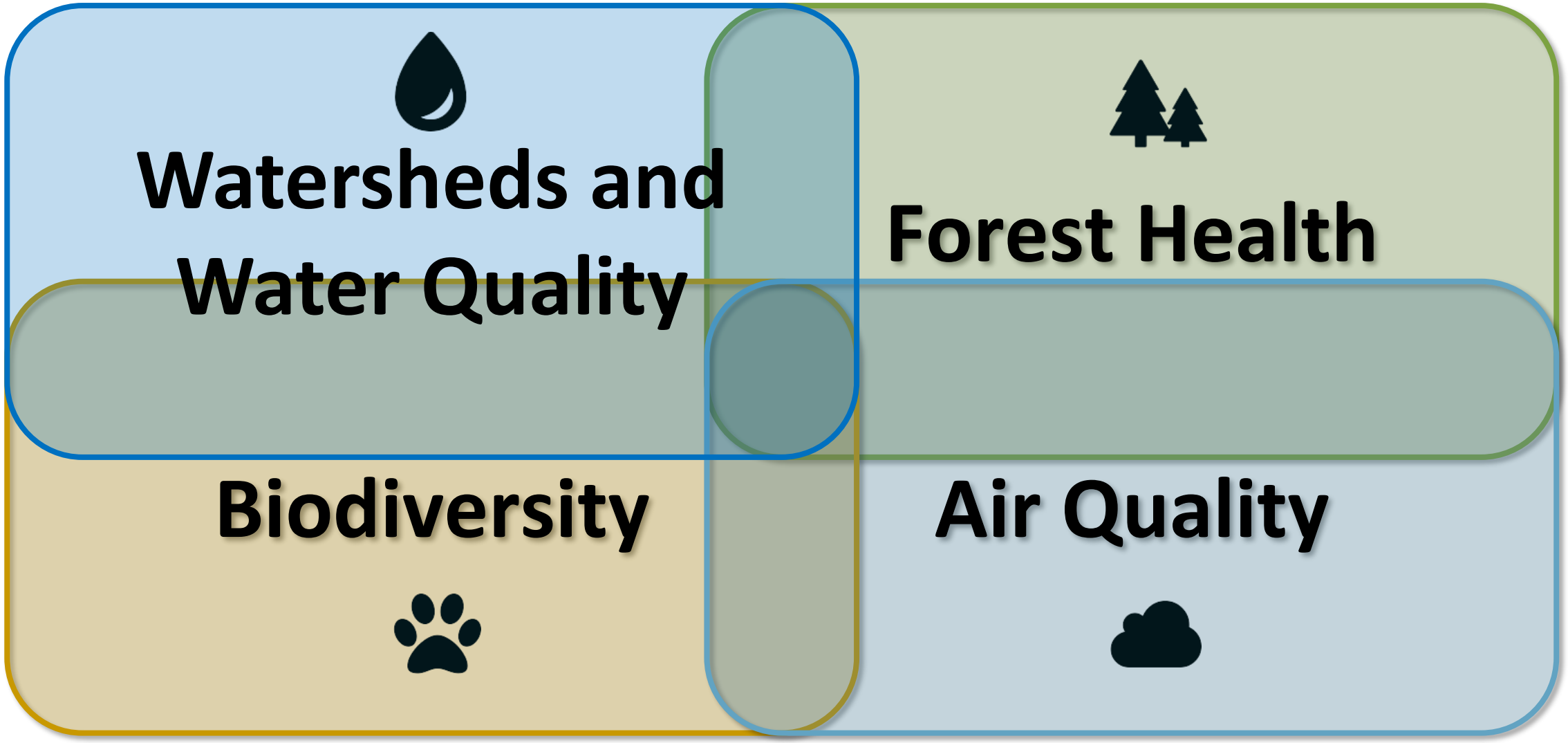
Outline Organization

Watersheds and Water Quality

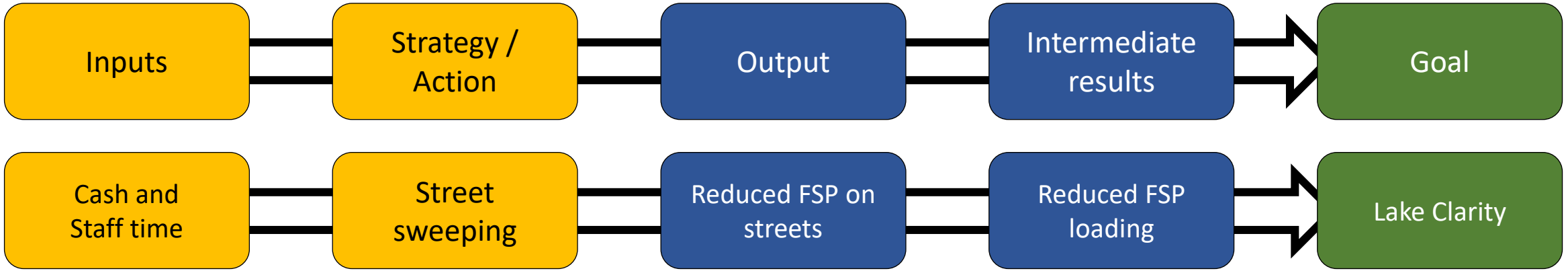
Forest Health

Biodiversity

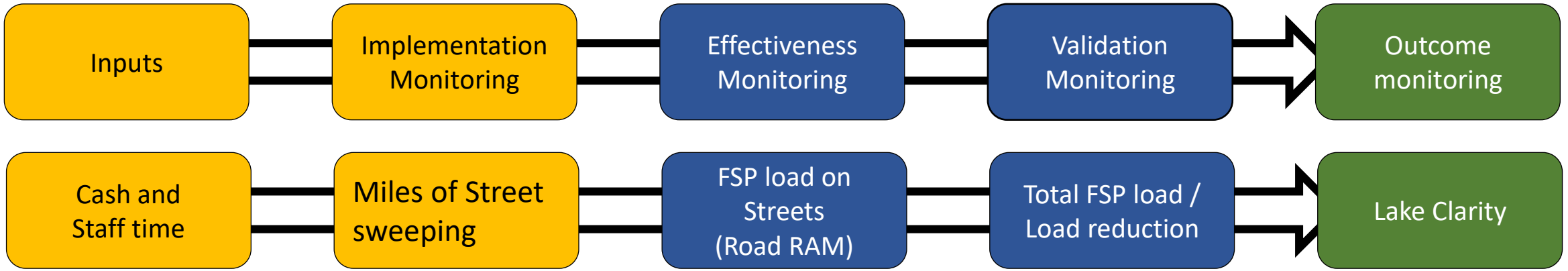
Air Quality


Watersheds and Water Quality
Forest Health
Biodiversity
Air Quality

From outline to standard



What would to monitor?



Process

1
Outline Development
2
Outline Refinement
3
Standard development
4
Adaptive management Framework
5
Framework Refinement
6
Formal Adoption

Watersheds and Water Quality

Watersheds and Water Quality

THRESHOLD STANDARD	SYSTEM TAGS
1) DEEP LAKE CLARITY – TAHOE TMDL TARGET FOR LAKE CLARITY	
2) NEARSHORE ALGAE – TARGET FOR ALL NEARSHORE ALGAE (METAPHYTON/PERIPHYTON)	
3) NO NEW AIS – RETAIN CURRENT STANDARD	
4) AIS CONTROL GOAL – TARGET FOR REDUCTION IN THE ABUNDANCE AND DISTRIBUTION OF AIS FROM AIS ACTION PLAN	
5) TRIBUTARY HEALTH – SEZ CONDITION INDEX / BIOASSESSMENT SCORE	
6) MEADOW AND STREAM RESTORATION – USE SEZ CONDITION INDEX TO ESTABLISH A NEW RESTORATION GOAL FOR THE REGION	

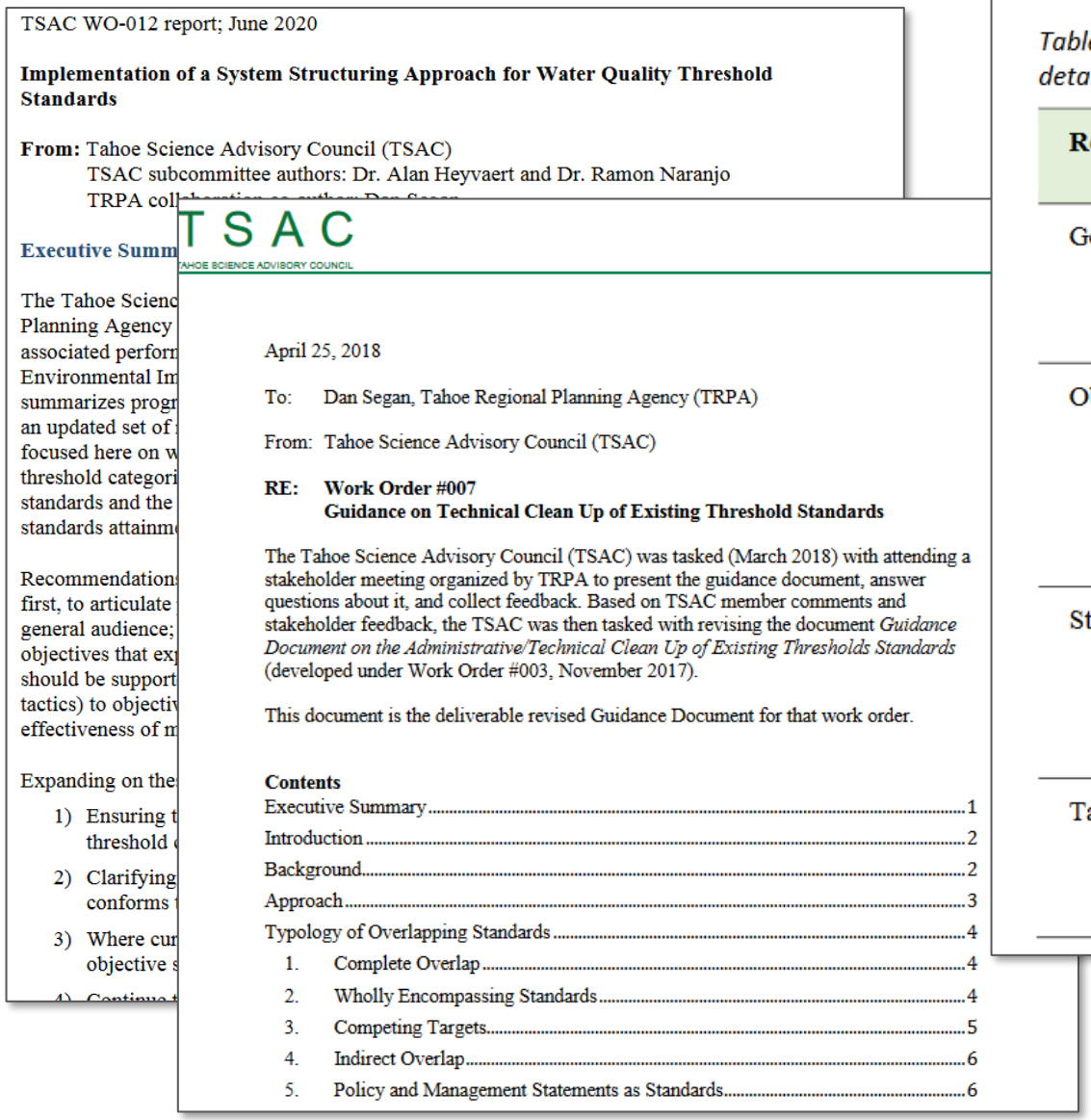
Threshold Standards

1	Specific	The standard establishes a specific numeric target, and benchmark/baseline values are documented where necessary.
2	Measurable	The standard has clearly defined indicator(s) that link to the standard, and there are practical ways to objectively and accurately measure progress towards attainment
3	Outcome-based	Standards establish a desired condition for an environmental end state. Standards do not establish a means to achieve the desire outcome.

Assessment Findings

- No standard received a perfect score
- 39% (69 of the 178) were found to be both specific and measurable
- 28% (49 of the 178) were found to be specific, measurable and based on settled/solid science

Water Quality Review



TSAC WO-012 report; June 2020

Implementation of a System Structuring Approach for Water Quality Threshold Standards

From: Tahoe Science Advisory Council (TSAC)
TSAC subcommittee authors: Dr. Alan Heyvaert and Dr. Ramon Naranjo
TRPA col

Executive Summ

The Tahoe Scienc
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Recommendation
first, to articulate
general audience;
objectives that ex
should be support
tactics) to objecti
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Expanding on the

1) Ensuring t
threshold
2) Clarifying
conforms
3) Where cur
objective s
4) Continue t

TSAC
TAHOE SCIENCE ADVISORY COUNCIL

April 25, 2018

To: Dan Segan, Tahoe Regional Planning Agency (TRPA)

From: Tahoe Science Advisory Council (TSAC)

RE: Work Order #007
Guidance on Technical Clean Up of Existing Threshold Standards

The Tahoe Science Advisory Council (TSAC) was tasked (March 2018) with attending a stakeholder meeting organized by TRPA to present the guidance document, answer questions about it, and collect feedback. Based on TSAC member comments and stakeholder feedback, the TSAC was then tasked with revising the document *Guidance Document on the Administrative/Technical Clean Up of Existing Thresholds Standards* (developed under Work Order #003, November 2017).

This document is the deliverable revised Guidance Document for that work order.

Contents

Executive Summary 1
Introduction 2
Background 2
Approach 3
Typology of Overlapping Standards 4
1. Complete Overlap 4
2. Wholly Encompassing Standards 4
3. Competing Targets 5
4. Indirect Overlap 6
5. Policy and Management Statements as Standards 6

Table 1. Functional relationships between goals, objectives, strategies and tactics. Note the difference in detail levels and whether they address "what" is desired or "how" the desired outcomes will be achieved.

Role	Description	Purpose	Water Quality Example	Link to EIP Program
Goal	High-level "what"	Broad, high-level ultimate outcome that supports a collective vision.	Restore the historic clarity and exceptional water quality of Lake Tahoe.	EIP focus area goals
Objective	Detailed "what"	Specific (SMART) result representing desired conditions for a goal or an intermediate outcome.	Restore lake clarity to a depth of 97.4 feet by 2076 (Lake Tahoe Clarity Commitment).	Threshold standard
Strategy	High-level "how"	An overall approach or actionable plan taken to achieve the objectives linked to primary goals.	Reduce urban fine sediment particle loading. The TMDL jurisdictional pollutant load reduction plan.	EIP Action Priority (output performance measure, FSP load reduced)
Tactic	Detailed "how"	A discrete set of actions taken to execute the strategy.	Street sweeping.	EIP action performance measure (miles of street swept)

Water Quality Review

TSAC WO-012 report; June 2020

Implementation of a System Structuring Approach for Water Quality Threshold Standards

From: Tahoe Science Advisory Council (TSAC)
TSAC subcommittee authors: Dr. Alan Heyvaert and Dr. Ramon Naranjo
TRPA collaboration co-author: Dan Segan

Executive Summary

The Tahoe Science Advisory Council (Council) has been working with the Tahoe Regional Planning Agency (TRPA) to develop specific recommendations for threshold standards and associated performance measures to ensure they formally link to appropriate metrics for the Environmental Improvement Program (EIP) and for thresholds progress reporting. This report summarizes progress toward that goal through diverse efforts over the last few years, including an updated set of recommendations for implementation of a system structuring approach, focused here on water quality threshold standards to serve as a model for similar reviews in other threshold categories. System structure in this context represents general organization of threshold standards and the reporting framework that supports decision-making on actions to promote standards attainment and maintenance.

Recommendations for structuring the threshold standards system comprise three key elements: first, to articulate program goals in clear language that communicates a collective purpose to a general audience; second, each goal statement should be supported by one or more specific objectives that explicitly define success, which are the threshold standards; third, objectives should be supported by result chains that link management actions (strategies and individual tactics) to objectives and clearly identify how implementation will be tracked and how the effectiveness of management actions will be evaluated.

Expanding on these key features, recommendations for structuring threshold standards include:

1) Ensuring that each threshold standard fits under a broad aspirational goal statement for its threshold category;
2) Clarifying that threshold standards are framed as objectives, and that each objective conforms to SMART criteria (specific, measurable, attainable, relevant and time-framed);
3) Where current threshold standards articulate a goal instead of an objective, a specific objective should be defined as the threshold standard for that goal;
4) Continue to reduce or eliminate sources of overlap between standards;

Table 2. Role identification for WQ threshold standards. All are TRPA threshold standards at present, with VEC added as an existing state standard. N/A indicates a role was not identified within the system structure. See Appendix A for narrative definitions associated with each threshold standard.

ID No.	Reporting Category	Name of Standard	Role
State Standard	Deep Water (Pelagic) Lake Tahoe	Vertical Extinction Coefficient (VEC)	Objective
WQ-01	Deep Water (Pelagic) Lake Tahoe	Secchi Disk	Objective
WQ-02	Deep Water (Pelagic) Lake Tahoe	Phytoplankton Primary Productivity	Objective
WQ-03	Nearshore (Littoral) Lake Tahoe	Nearshore Turbidity (Stream Influence)	Objective
WQ-04	Nearshore (Littoral) Lake Tahoe	Nearshore Turbidity (No Stream Influence)	Objective
WQ-05	Nearshore (Littoral) Lake Tahoe	Nearshore Phytoplankton Primary Productivity	Objective
WQ-06	Nearshore (Littoral) Lake Tahoe	Nearshore Periphyton Biomass	Objective
WQ-07	Nearshore (Littoral) Lake Tahoe	Nearshore Attached Algae	Goal
WQ-08	Aquatic Invasive Species (AIS)	Aquatic Invasive Species Prevention	Goal
WQ-09	Aquatic Invasive Species (AIS)	Aquatic Invasive Species Abundance	Goal
WQ-10	Aquatic Invasive Species (AIS)	Aquatic Invasive Species Distribution	Goal
WQ-11	Aquatic Invasive Species (AIS)	Aquatic Invasive Species Ecological Impacts	Goal
WQ-12	Aquatic Invasive Species (AIS)	Aquatic Invasive Species Social Impacts	Goal
WQ-13	Aquatic Invasive Species (AIS)	Aquatic Invasive Species Economic Impacts	Goal
WQ-14	Aquatic Invasive Species (AIS)	Aquatic Invasive Species Public Health Impacts	Goal
WQ-15	Tributaries	Nitrogen Concentration (Tributaries)	Strategy
WQ-16	Tributaries	Phosphorus Concentration (Tributaries)	Strategy
WQ-17	Tributaries	Iron Concentration (Tributaries)	Strategy
WQ-18	Tributaries	Suspended Sediment Concentration (Tributaries)	Strategy
WQ-19	Surface Runoff	Nitrogen Concentration (Surface Runoff)	Strategy
WQ-20	Surface Runoff	Phosphorus Concentration (Surface Runoff)	Strategy
WQ-21	Surface Runoff	Iron Concentration (Surface Runoff)	Strategy
WQ-22	Surface Runoff	Suspended Sediment Concentration (Surface Runoff)	Strategy
WQ-23	Groundwater	Surface Discharge – Total Nitrogen	N/A

Water Quality Standards

41

7

Objectives

1

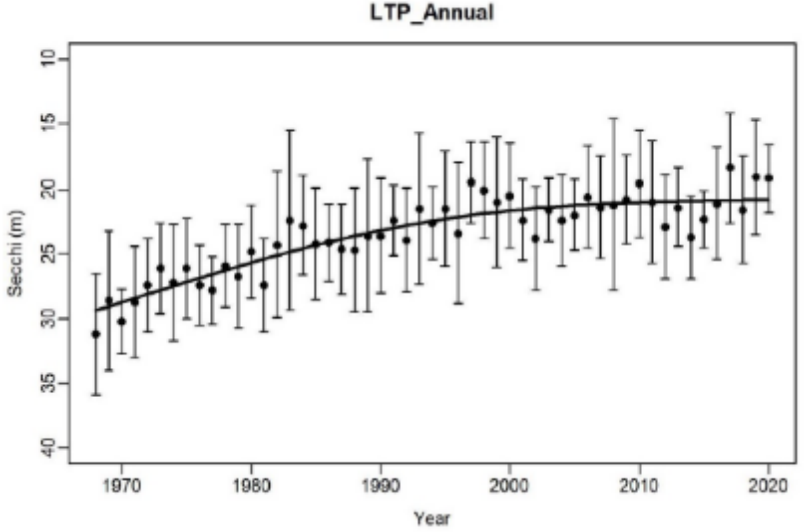
Specific & Measurable

1) DEEP LAKE CLARITY

Tahoe Science Advisory Council (TSAC)

Summary Science Report on Lake Tahoe Clarity and Associated Conditions, 2021

August 2021



Final

Lake Tahoe Total Maximum Daily Load Report

November 2010

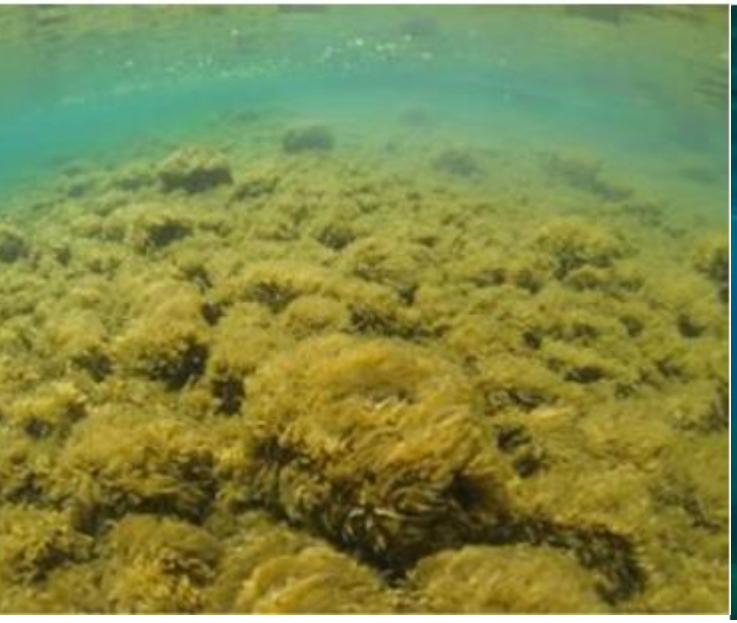
California Regional Water Quality Control Board, Lahontan Region
2501 Lake Tahoe Boulevard
South Lake Tahoe, California 96150

Nevada Division of Environmental Protection
901 South Stewart Street, Suite 4001
Carson City, Nevada, 89701-5249

2) NEARSHORE ALGAE

Variability in periphyton community and biomass over 37 years in Lake Tahoe (CA-NV)

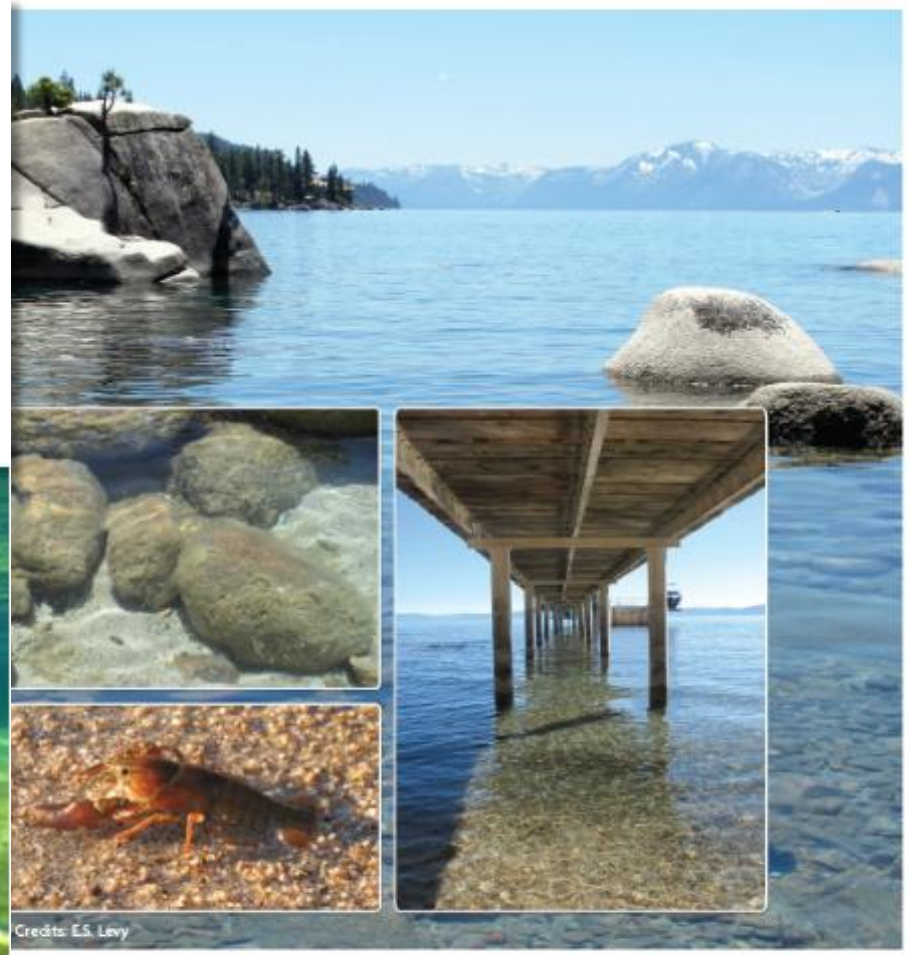
Karen S. Atkins · Scott H. Hackley · Brant C. Allen · Shohei Watanabe · John E. Reuter · S. Geoffrey Schladow



Lake Tahoe Nearshore Evaluation and Monitoring Framework

FINAL

October 15, 2013

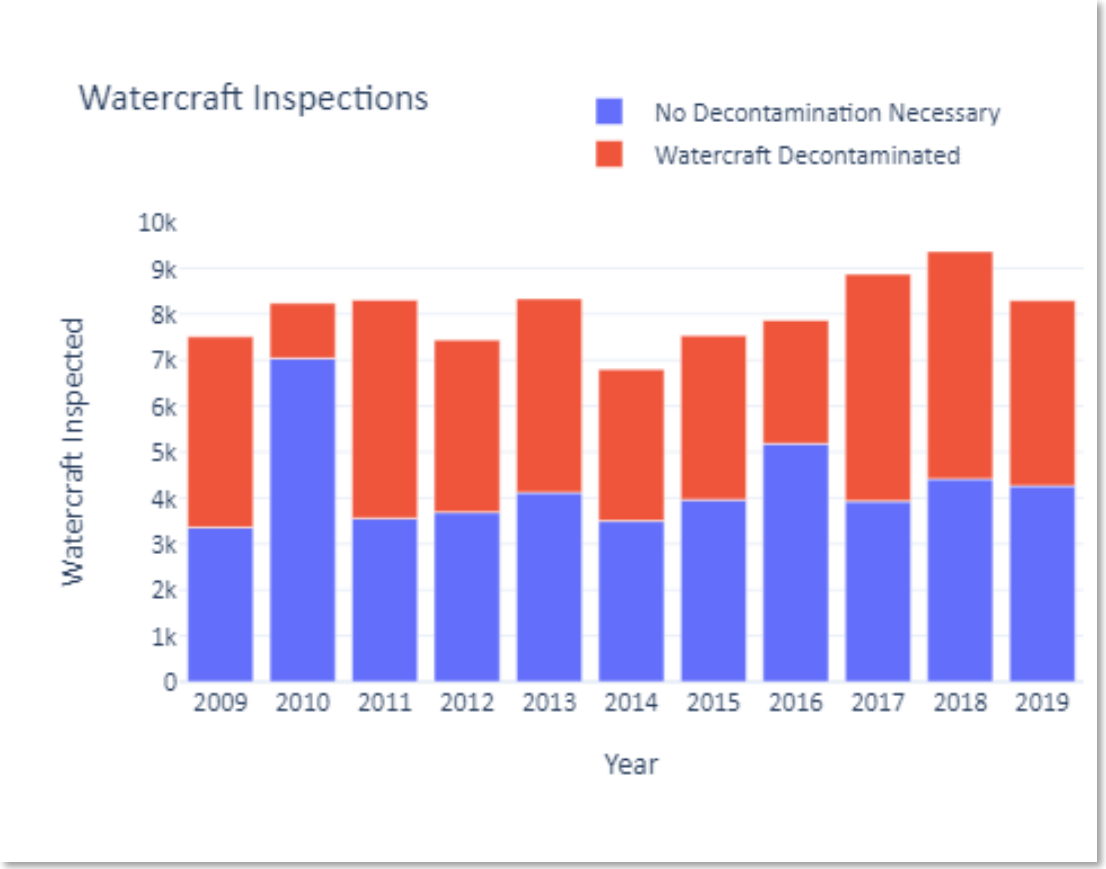


DRI Desert Research Institute

University of Nevada, Reno

UCDAVIS TAHOE ENVIRONMENTAL RESEARCH CENTER

3) NO NEW AIS


Watercraft Inspections
No Decontamination Necessary
Watercraft Decontaminated
Watercraft Inspected
10k
9k
8k
7k
6k
5k
4k
3k
2k
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2010
2011
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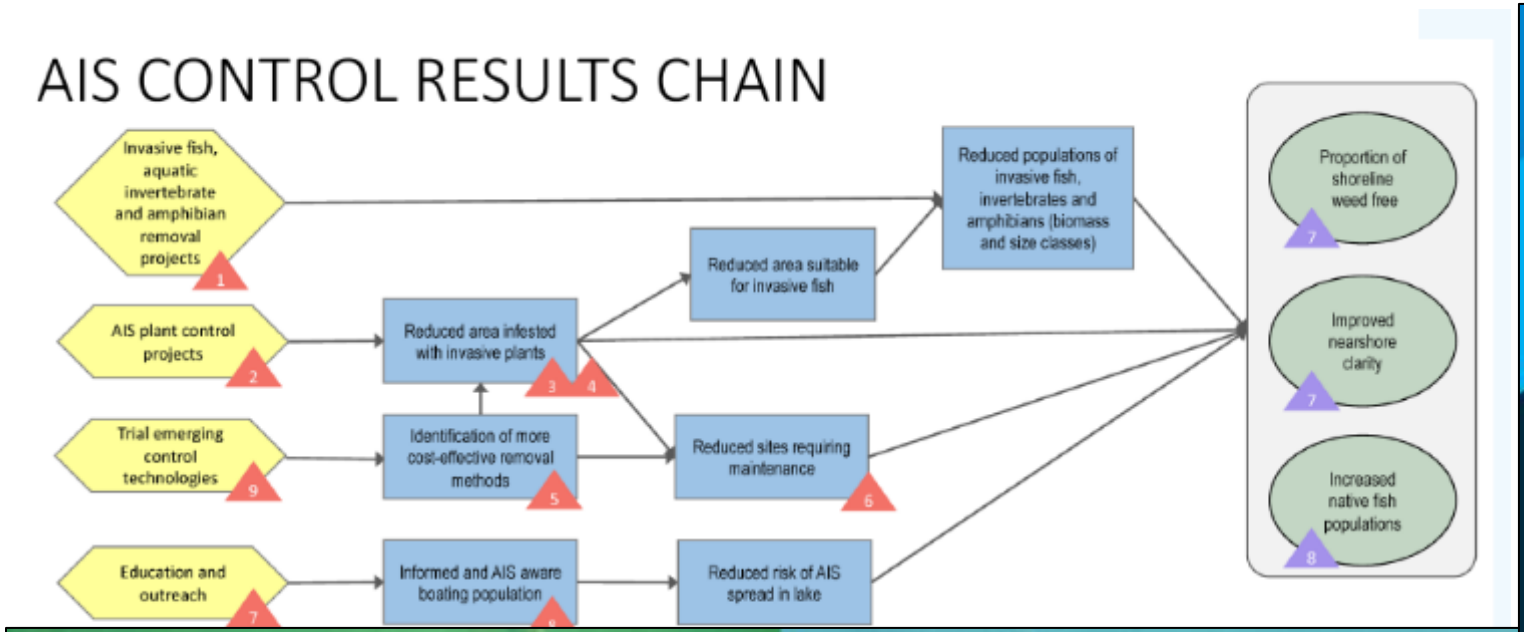
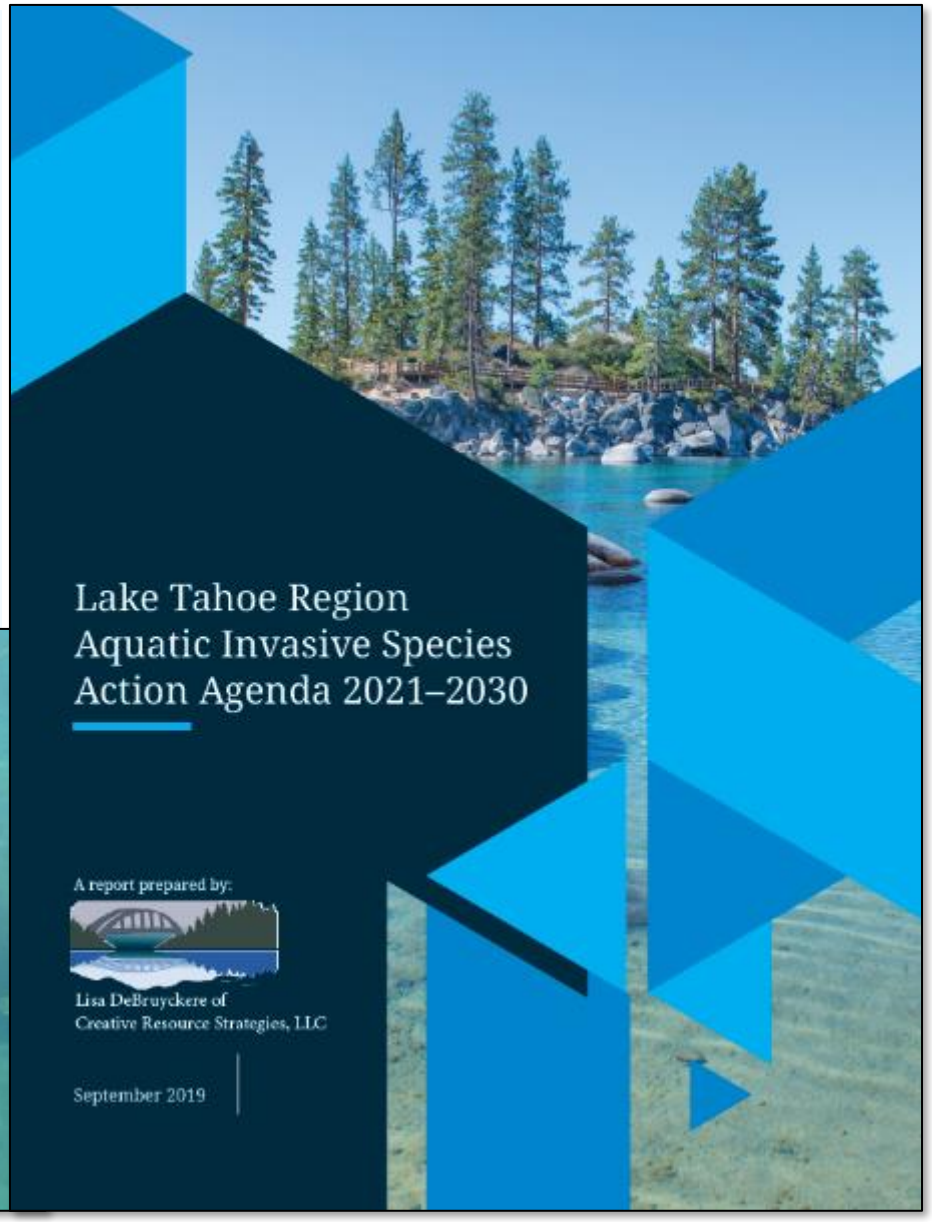
2017
2018
2019
Year

CROWNLINE
WATERCRAFT INSPECTOR

CF0027RC

4) AIS CONTROL

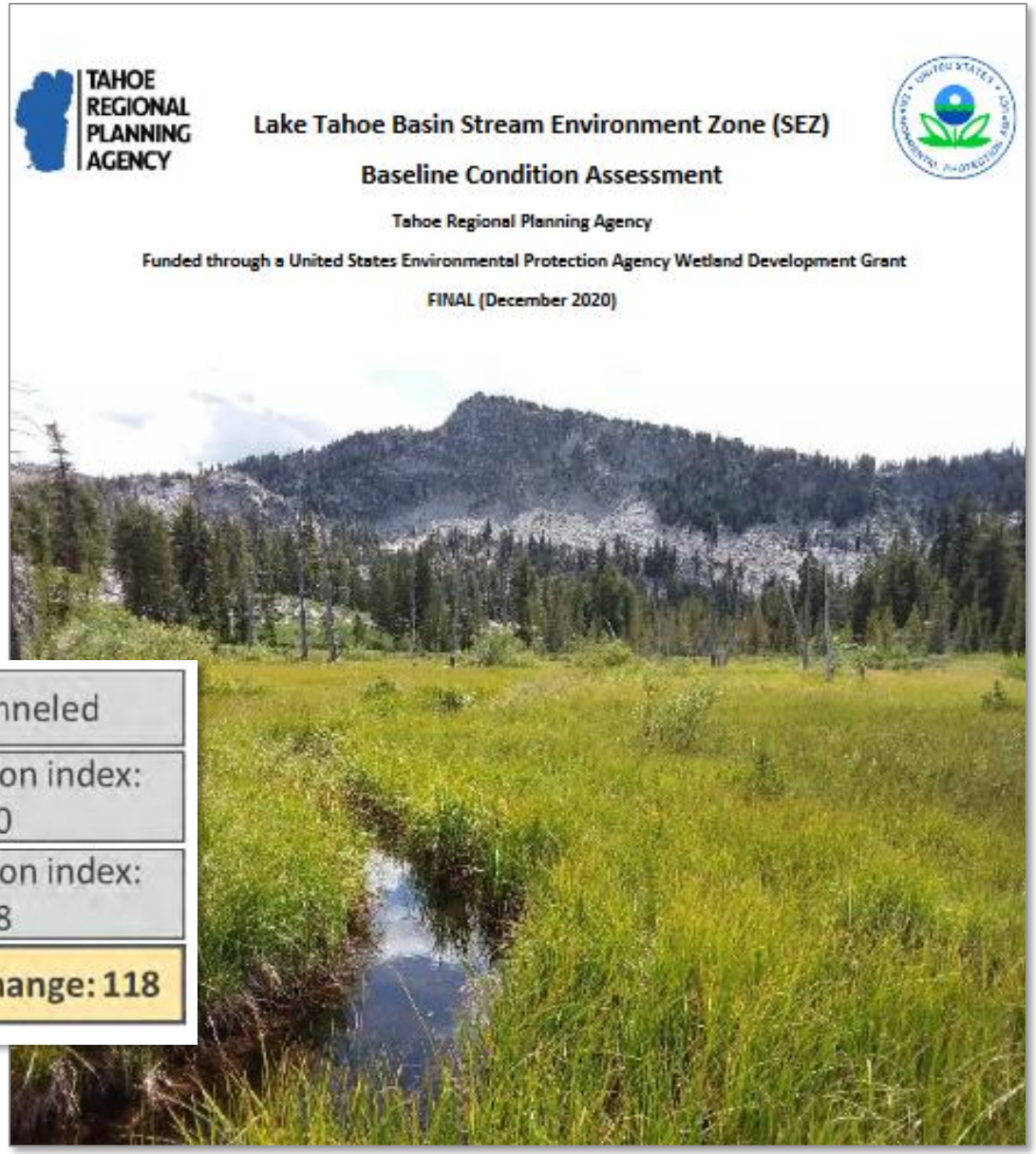




5) TRIBUTARY HEALTH

"In summary, the present approach to evaluating the condition and the improvement in SEZ's is an overly blunt instrument with no apparent scientific basis beyond "more is better." The science has truly advanced in the last 40+ years"

– 2015 Peer Reviewer



SEZ Area: Site A		SEZ Type: Meadow, Non-Channeled		
Year: 2014	SEZ quality: 67	× Acres: 10	=	SEZ condition index: 670
Year: 2018	SEZ quality: 75	× Acres: 10.5	=	SEZ condition index: 788
				SEZ index change: 118

6) MEADOW AND STREAM RESTORATION

SEZ Area: Site A			SEZ Type: Meadow, Non-Channeled		
Year: 2014	SEZ quality: 67	×	Acres: 10	=	SEZ condition index: 670
Year: 2018	SEZ quality: 75	×	Acres: 10.5	=	SEZ condition index: 788
					SEZ index change: 118

Air Quality

Bi-State Compact

Public Law 96-551
96th Congress

An Act

To grant the consent of the Congress to the Tahoe Regional Planning Compact, and to authorize the Secretary of Agriculture and others to cooperate with the planning agency thereby created.

Be it enacted by the Senate and House of Representatives of the Unites States of America in Congress assembled, That in order to encourage the wise use and conservation of the waters of Lake Tahoe and of the resources of the area around said lake, the consent of the Congress is hereby given to the Tahoe Regional Planning Compact heretofore adopted by the States of California and Nevada, which compact reads as follows:

TAHOE REGIONAL PLANNING COMPACT

ARTICLE I. - FINDINGS AND DECLARATIONS OF POLICY

(a) It is found and declared that:

(1) 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.

(2) The public and private interests and investments in the region are substantial.

(3) The region exhibits unique environmental and ecological values which are irreplaceable.

(4) By virtue of the special conditions and circumstances of the region's natural ecology, developmental pattern, population distributions and human needs, the region is experiencing problems of resource use and deficiencies of environmental control.

- *"The **regional plan** shall provide for attaining and **maintaining Federal, State, or local air and water quality standards**, whichever are strictest, in the respective portions of the region for which the standards are applicable. The agency may, however, adopt air or water quality standards or control measures more stringent than the applicable State implementation plan or the applicable Federal, State, or local standards for the region, if it finds that such additional standards or control measures are necessary to achieve the purposes of this compact."*

Crosswalk

Ambient Air Quality Standards

Pollutant	Averaging Time	California Standards [1]		National Standards [2]		
		Concentration [3]	Method [4]	Primary [3,5]	Secondary [3,6]	Method [7]
Ozone (O_3)[8]	1 Hour	0.09 ppm (180 µg/m^3)	Ultraviolet Photometry	—	Same as Primary Standard	Ultraviolet
	8 Hour	0.070 ppm (137 µg/m^3)		0.070 ppm (137 µg/m^3)		
Respirable Particulate Matter (PM10)[9]	24 Hour	50 µg/m^3	Gravimetric or Beta Attenuation	150 µg/m^3	Same as Primary Standard	
	Annual Arithmetic Mean	20 µg/m^3		—		
Fine Particulate Matter (PM2.5)[9]	24 Hour	—	—	35 µg/m^3	Same as Primary Standard	
	Annual Arithmetic Mean	12 µg/m^3	Gravimetric or Beta Attenuation	12.0 µg/m^3	15 µg/m^3	
Carbon Monoxide (CO)	1 Hour	20 ppm (23 mg/m^3)	Non-Dispersive Infrared Photometry (NDIR)	35 ppm (40 mg/m^3)	—	
	8 Hour	9.0 ppm (10 mg/m^3)		9 ppm (10 mg/m^3)	—	
	8 Hour (Lake Tahoe)	6 ppm (7 mg/m^3)		—	—	
Nitrogen Dioxide (NO_2)[10]	1 Hour	0.18 ppm (339 µg/m^3)	Gas Phase Chemiluminescence	100 ppb (188 µg/m^3)	—	
	Annual Arithmetic Mean	0.030 ppm (57 µg/m^3)		0.053 ppm (100 µg/m^3)	Same as Primary Standard	

OZONE

NUMERICAL STANDARDS

AQ3) Maintain ozone concentrations at or below 0.08 parts per million averaged over 1 hour.

AQ4) Maintain oxides of nitrogen (NOx) emissions at or below the 1981 level.

REGIONAL VISIBILITY[4]

NUMERICAL STANDARDS

AQ5) Achieve an extinction coefficient of 25 Mm^{-1} at least 50 percent of the time as calculated from aerosol species concentrations measured at the Bliss State Park monitoring site (visual range of 156 kilometer, 97 miles).

AQ6) Achieve an extinction coefficient of 34 Mm^{-1} at least 90 percent of the time as calculated from aerosol species concentrations measured at the Bliss State Park monitoring site (visual range of 115 kilometers, 71 miles).

SUBREGIONAL VISIBILITY[5]

NUMERICAL STANDARDS

AQ7) Achieve an extinction coefficient of 50 Mm^{-1} at least 50 percent of the time as calculated from aerosol species concentrations measured at the South Lake Tahoe

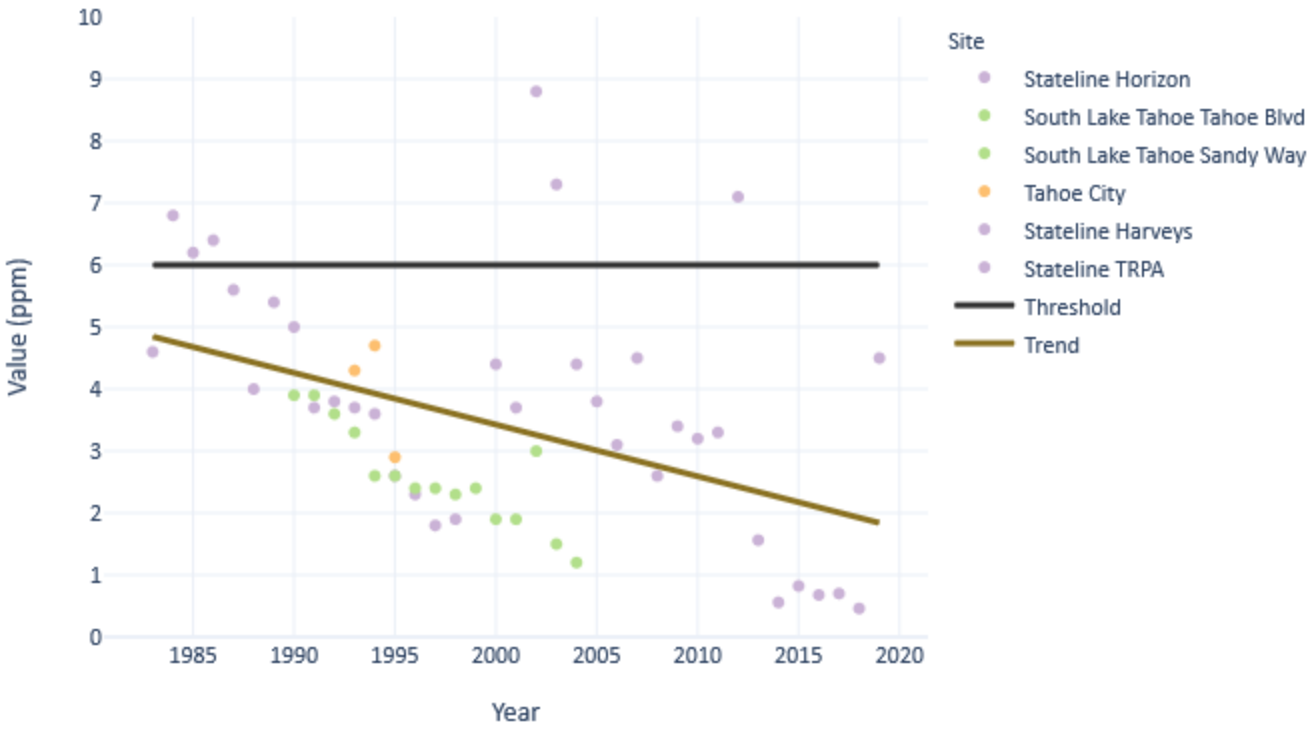
Proposed Standards

THRESHOLD STANDARD	SYSTEM TAGS
1) CARBON DIOXIDE - 8 HR AVERAGE – RETAIN CURRENT STANDARD	
2) OZONE – 1 HR STANDARD – RETAIN CURRENT STANDARD	
3) REGIONAL VISIBILITY – 50% STANDARD – RETAIN CURRENT STANDARD	
4) REGIONAL VISIBILITY – 90% STANDARD – RETAIN CURRENT STANDARD	
5) SUBREGIONAL VISIBILITY – 50% STANDARD – RETAIN CURRENT STANDARD	
6) SUBREGIONAL VISIBILITY – 90% STANDARD – RETAIN CURRENT STANDARD	

8 HR Carbon Monoxide

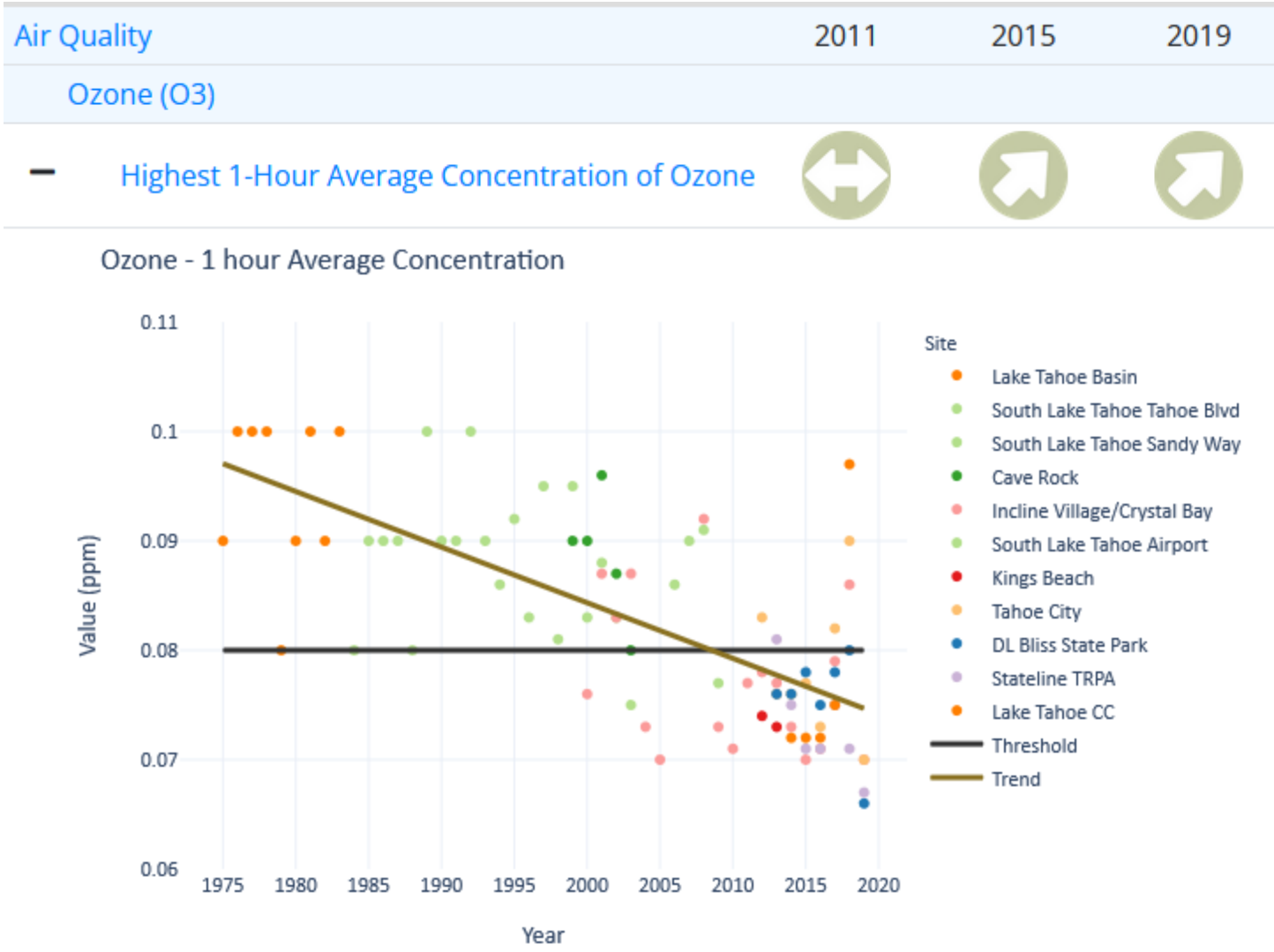
- State & Federal Standard: 9ppm
- Tahoe Standard: 6ppm

Air Quality	2011	2015	2019
Carbon Monoxide (CO)			
Highest 8-Hour Average Concentration of Carbon Monoxide	↑	↗	↗



1 HR Ozone

- State & Federal Standard: 0.09 ppm
- Tahoe Standard: 0.08 ppm



Visibility Standards

3) REGIONAL VISIBILITY – 50% STANDARD – RETAIN CURRENT STANDARD	☁
4) REGIONAL VISIBILITY – 90% STANDARD – RETAIN CURRENT STANDARD	☁
5) SUBREGIONAL VISIBILITY – 50% STANDARD – RETAIN CURRENT STANDARD	☁
6) SUBREGIONAL VISIBILITY – 90% STANDARD – RETAIN CURRENT STANDARD	☁

Air Quality Trends

Respirable and Fine Particulate Matter	2011	2015	2019
Highest 24-Hour PM10 Concentration	↗	↔	↘
Annual Average PM10 Concentration	◆	↗	↗
Highest 24-Hour PM2.5 Concentration	↘	↔	↘
Annual Average PM2.5 Concentration	↔	↔	↗

articles

A globally coherent fingerprint of climate change impacts across natural systems

Camille Parmesan* & Gary Yohe†

Biodiversity

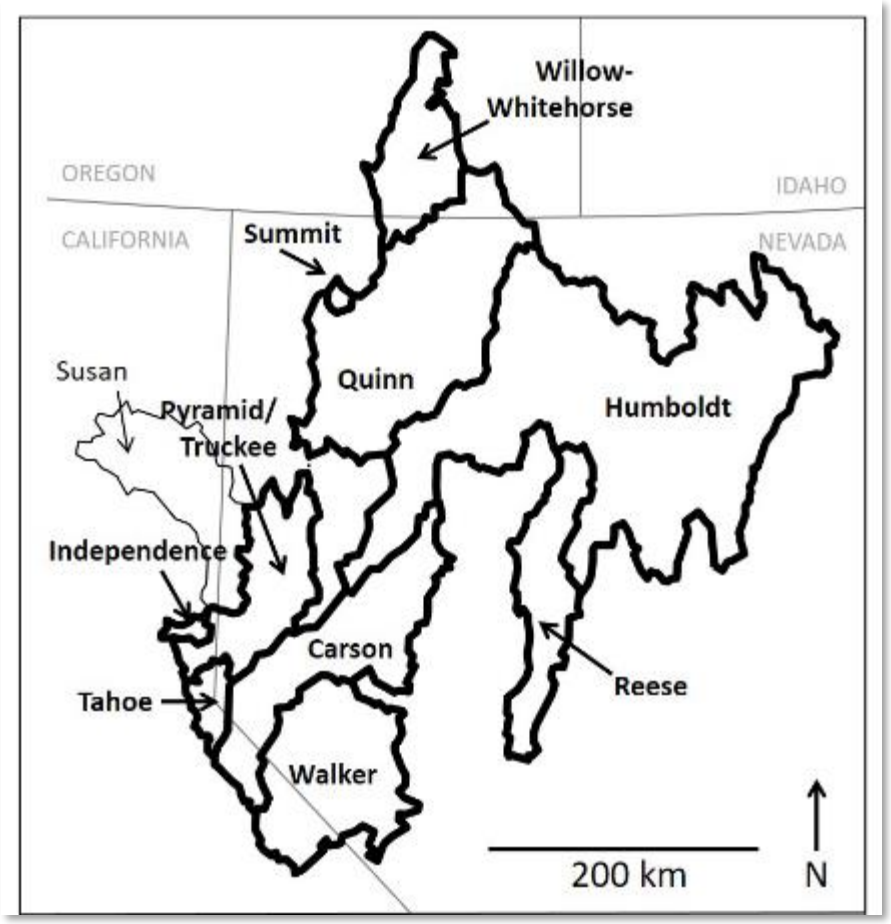
What is biodiversity?

Biological diversity is the variety of life on Earth.

THRESHOLD STANDARD	SYSTEM TAGS
1) INDEX OF BIRD DIVERSITY – SURROGATE OF ECOSYSTEM HEALTH, INCORPORATES POPULATION TRENDS OF A SUITE OF REPRESENTATIVE SPECIES	
2) PLANT (OR OTHER SPECIES) BIODIVERSITY INDEX – SURROGATE OF ECOSYSTEM HEALTH, INCORPORATES POPULATION TRENDS OF A SUITE OF REPRESENTATIVE SPECIES	
3) LAHONTAN CUTTHROAT TROUT – ALIGN WITH VISION OF RECOVERY ENDORSED BY THE LAHONTAN CUTTHROAT TROUT MANAGEMENT OVERSIGHT GROUP.	
4) TAHOE YELLOW CRESS – ALIGN TAHOE YELLOW CRESS GOAL WITH CONSERVATION STRATEGY.	
5) DEEPWATER COMMUNITIES – PROTECTION OF DEEPWATER ENDEMIC PLANTS/INVERTEBRATES OF LAKE TAHOE.	

3) LAHONTAN CUTTHROAT TROUT

Updated Goals and Objectives
for the Conservation of Lahontan Cutthroat Trout
(*Oncorhynchus clarkii henshawi*)



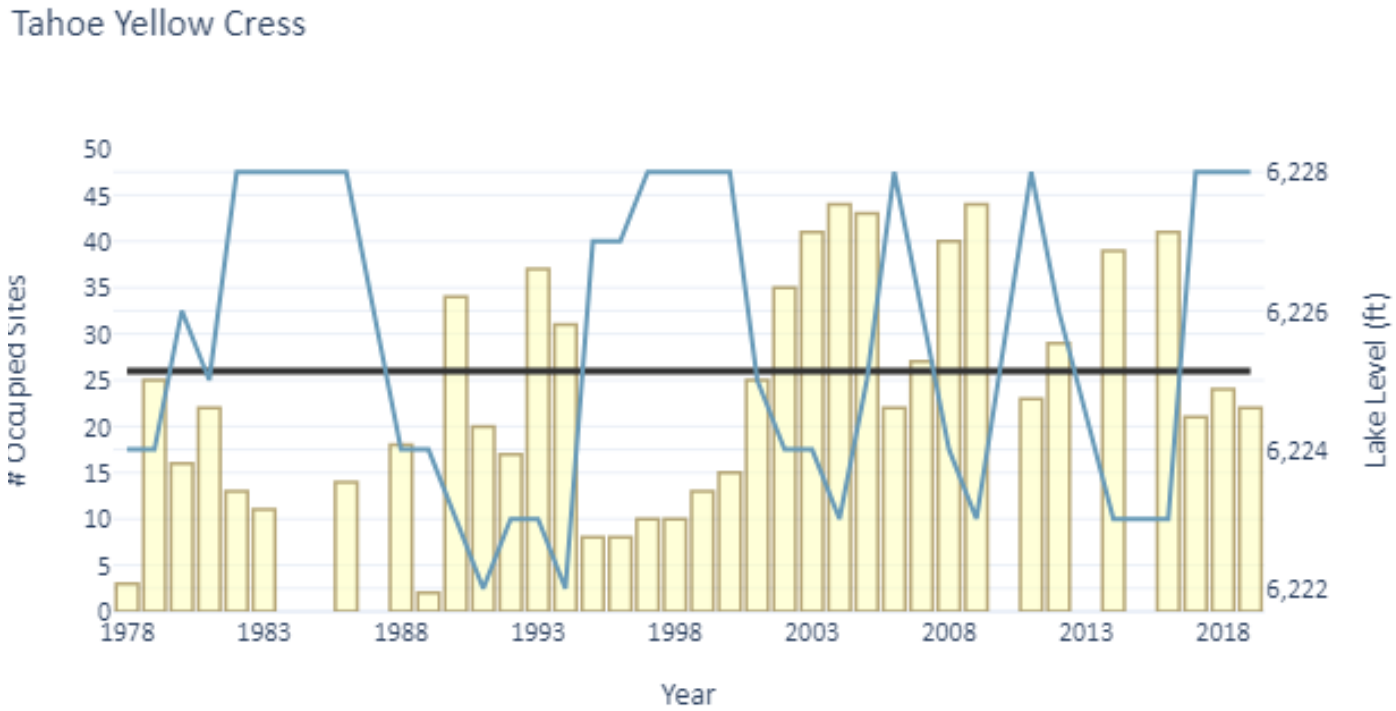
4) Tahoe Yellow Cress

Conservation Strategy for

Tahoe yellow cress (*Rorippa subumbellata*)

Prepared by
Alison E. Stanton
and the
Tahoe yellow cress
Adaptive Management Working Group
and
Executive Committee

For the
USDA Forest Service Pacific Southwest Research Station
Domestic Grant
13-DG-11272170-010



5) DEEPWATER COMMUNITIES

ECOLOGY

Vol. 48 LATE SUMMER 1967 No. 5

OBSERVATIONS ON DEEPWATER PLANTS IN LAKE TAHOE, CALIFORNIA AND NEVADA

TED C. FRANTZ AND ALMO J. CORDONE
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and
Inland Fisheries Branch, California Department of Fish and Game, Sacramento, California

(Accepted for publication April 5, 1967)

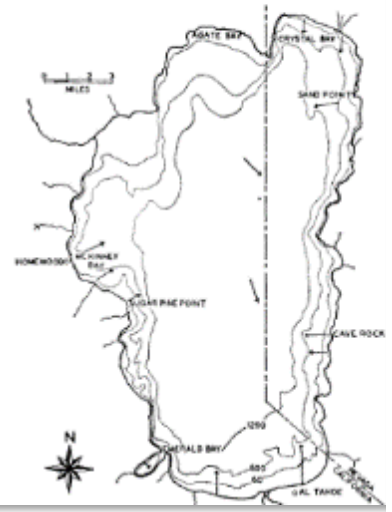
Abstract. Deepwater macroscopic hydrophytes in Lake Tahoe were found to a depth of 500 ft. They consist of algae, mosses and liverworts. Most were concentrated at depths from 200 to 350 ft. Only *Chara* occasionally invaded areas as shallow as 20 ft. Other deepwater hydrophytes were restricted to depths below 50 ft.

INTRODUCTION

Studies of fish and fish food organisms by the cooperative Nevada and California Lake Tahoe Fisheries Study yielded information on a remarkable zone of deepwater plant beds in Lake Tahoe. This information is summarized here because of its scientific interest and in the hopes that it will stimulate further study.

From many standpoints, Lake Tahoe is one of the most fascinating lakes in the world. Its morphometry and limnology are of particular interest. Although not unusually large at 123,300 surface acres, its maximum depth of 1,645 ft and average depth of 1,027 ft makes it tenth and fifth, respectively, of the world's lakes for these parameters (McGaubey et al. 1963, p. 59) (Fig. 1). Recent limnological investigations have revealed additional unique characteristics. Goldman and Carter (1965) describe the extreme light penetration and low primary productivity that place Lake Tahoe "among the ultra-oligotrophic lakes of the world." In a checklist of invertebrates found in Lake Tahoe, 10 new species and one subspecies are listed (Frantz and Cordone 1966).

We are indebted to the individuals who identified the plants: Elva Lawton, the mosses, assisted by H. S. Conard; and Paul Patterson, the liverworts. Algae were identified by Fay K. Daily and Francis Drouet. These individuals and by federal funds under the Dingell-Johnson program (Nevada Project F-15-R and California Project F-21-R).



Four decades of change: dramatic loss of zoobenthos in an oligotrophic lake exhibiting gradual eutrophication

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School of Natural and Social Sciences, Wayne State College, 1111 Main Street, Wayne, Nebraska 68787 USA

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1) INDEX OF BIRD DIVERSITY

EVALUATION OF A MULTIPLE-SPECIES APPROACH TO MONITOR
SPECIES AT THE ECOREGIONAL SCALE

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[2]*Pacific Southwest Station, USDA Forest Service, 1700 Bayview Drive, Arcata, California 9*
[3]*Pacific Southwest Station, USDA Forest Service, 800 Buchanan Street, Albany, California 9*

Abstract. Monitoring is required of land managers and conservation practit
assess the success of management actions. "Shortcuts" are sought to reduce m
costs, most often consisting of the selection of a small number of species that ar
monitored to represent the status of many associated species and environmental co
Assumptions associated with such shortcuts have been challenged, yet alternat
proaches remain scant. We evaluated an approach that departs significantly from
proach of selecting a few representative species. We explored two primary assertion
that a coordinated multiple-species monitoring effort that collects presence–absence
on a broad range of species is a robust alternative to a few intensive single-species effo
and (2) that the vertebrate species expected to be detected using this approach are numerou
and diverse enough to represent all vertebrate species. We simulated monitoring the ver-
tebrate species pool on an existing sample grid across the 7 million ha of public lands in
the Sierra Nevada (USA) ecoregion. Based on the use
protocols, we estimated the number of vertebrate speci
number of sample points within their range to detect ≥2
of points with detections between two points in time. W
would be obtained for 76% of the 465 vertebrate spec
of all mammals, 65% of all reptiles, and 44% of all am
among life-history and ecological groups, but >50% of
in every group with the exception of three groups: rare s
of concern (33%, 24%, and 47% of associated species
A multiple-species monitoring approach represents an
the challenges of large-scale monitoring needs by tar
data for a large number and breadth of species.

Key words: biological diversity; conservation strategies; management actions, assessing success of; monitoring; popul species monitoring, multiple-species approach; survey; verte

Table 7-5: Bird Species Assemblag **Wetland Integrity.**

Bird Assemblage	Common Name	Genus	Species
Detrimental	Brown-headed Cowbird	*Molotrus*	*ater*
	Common Raven	*Corvus*	*corax*
	European Starling	*Sturnus*	*vulgaris*
	Steller's Jay	*Cyanocitta*	*stelleri*
Songbirds	Lazuli Bunting	*Passerina*	*amoena*
	Lincoln's Sparrow	*Melospiza*	*lincolnii*
	Macgillivray's Warbler	*Oporornis*	*tolmiei*
	Warbling Vireo	*Vireo*	*gilvus*
	Willow Flycatcher	*Empidonax*	*trailii*
	Wilson's Warbler	*Wilsonia*	*pusilla*
	Yellow Warbler	*Dendoica*	*petechia*
Waterbirds	American Bittern	*Botaurus*	*lentiginosus*
	Eared Grebe	*Podiceps*	*nigricollis*
	Marsh Wren	*Cistothorus*	*palustris*
	Pied-billed Grebe	*Podilymbus*	*podiceps*
	Sora	*Porzana*	*carolina*
	Virginia Rail	*Rallus*	*limicola*
	Wilson's Phalarope	*Phalaropus*	*tricolor*
Waterfowl	Buffelhead	*Bucephala*	*albeola*
	Cinnamon Teal	*Anas*	*cyanoptera*
	Common Merganser	*Mergus*	*merganser*
	Northern Pintail	*Anas*	*acuta*
	Redhead	*Aythya*	*americana*
	Ring-necked Duck	*Aythya*	*collaris*
	Ruddy Duck	*Oxyura*	*jamaicensis*

2) PLANT BIODIVERSITY INDEX

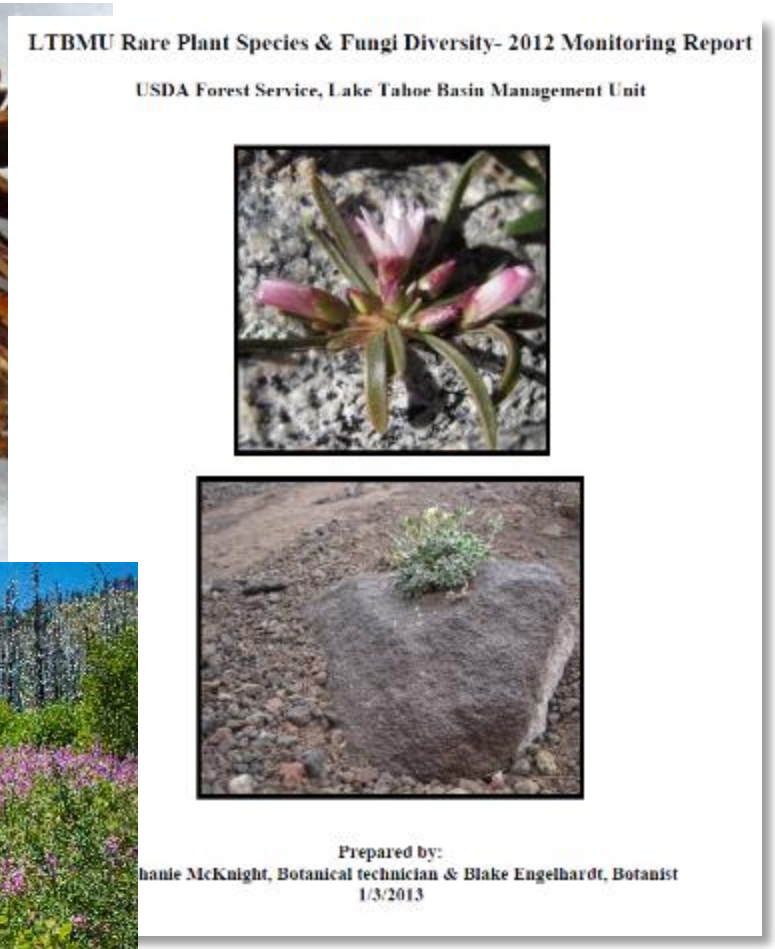

Photo credits: MacRae, T. C. 2009. Trees of Lake Tahoe. https://beetlesinthebush.com/