

2. Decision Analysis for a Sustainable Environment, Economy, and Society (DASEES): A tool for better decision-making by integrating community values with scientific understanding

Symposium 8: Integrating Human Health with Ecosystem Services – Research to Provide Practical Tools for Healthier and More Resilient Communities

Brian Dyson, Timothy J. Canfield, Teri Richardson, John Carriger
Office of Research and Development
National Risk Management Research Laboratory

2019 ESA Annual Meeting
Louisville, KY
August 14, 2019

Disclai *Disclaimer*

The views expressed in this presentation are those of the authors and do not necessarily represent the views or policies of the U.S. Environmental Protection Agency.

Values-Science Integration in DASEES



Values → Objectives → Measures → Options

- Options are developed in response to and evaluated against value-based objectives and their measures
- Science is used to assess consequences of options

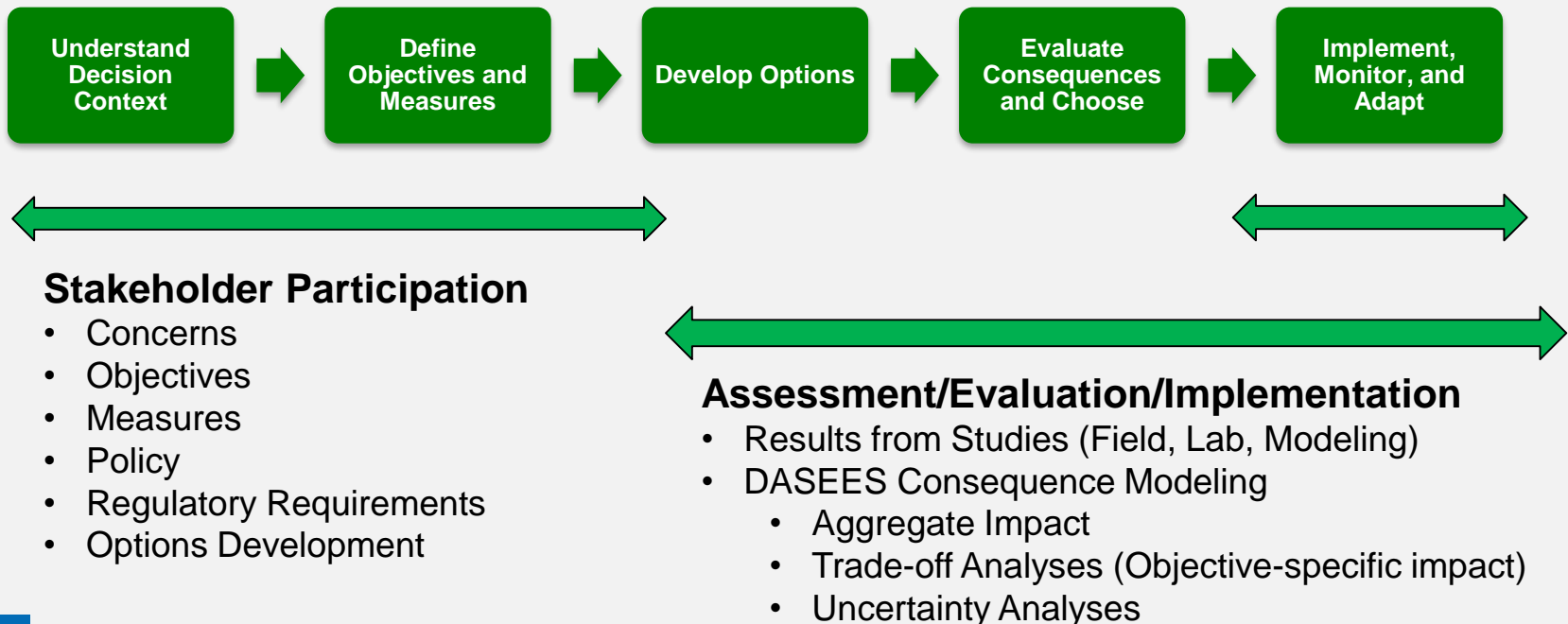
**Prescribed
Options**



**Predicted/Assessed
Measure**

DASEES Function and Philosophy

- ❖ Web-based framework supporting stakeholder-driven group decision-making
- ❖ Organizes use of tools/data/information needed for decision
- ❖ Includes stakeholder perspectives and tools for analysis and evaluation



DASEES Home Screen

Apps

DASEES

Decision Analysis for a Sustainable Environment • Economy • Society 1.0.8

dyson.brian@epa.gov

Structured Decision

Island Local Integrating Organization

Quick Start

DecisionViz

1 Context

Background

System Sketch

Map

2 Objectives

Brainstorm

Define Objectives

Preferences

3 Options

Define Options

Scenarios

4 Consequences

Consequence Table

Bayesian Network

5 Take Action

Adaptive Management

Parking Lot

Quick Start

DecisionViz

DASEES implements a 5 step Structured Decision Making (SDM) approach:

1. Understand Context
2. Define Objectives
3. Define Options
4. Evaluate Consequences
5. Take Action

Each Step in this SDM process provides information for subsequent Steps while the SDM process is designed to be an iterative, learning process. Revisiting and updating any particular Step may impact subsequent Steps. DASEES is designed to guide you through this process.

The **Understand Context** Step includes tools to

- document the Decision Landscape,
- define Stakeholders,
- define the scientific setting in **SystemSketch** and
- visualize the geographical context.

Note: The **Decision Context** Step is the only Step that doesn't feed directly into subsequent Steps.

The **Define Objectives** Step is based on the concept of **Value-Focused Thinking** and includes tools to

- collect stakeholder values and organize them into an **Objectives** hierarchy,
- define **Measures** associated with the **Objectives**
- define **Value Functions** associated with the **Measures** and
- define **Preference Weights** for the **Objectives**.

Note: Structuring stakeholder values in an **Objectives** hierarchy is a key SDM Step and the foundation for subsequent Steps.

The **Define Options** Step includes tools to

- define **Options** to achieve stakeholder preferences and
- collect **Options** into **Scenarios** which will be evaluated based on the **Measure Consequences**.

Note: **Options** are defined after stakeholder preferences and values are structured. This **Value-Focused Thinking** approach is fundamentally different from an alternatives focused approach.

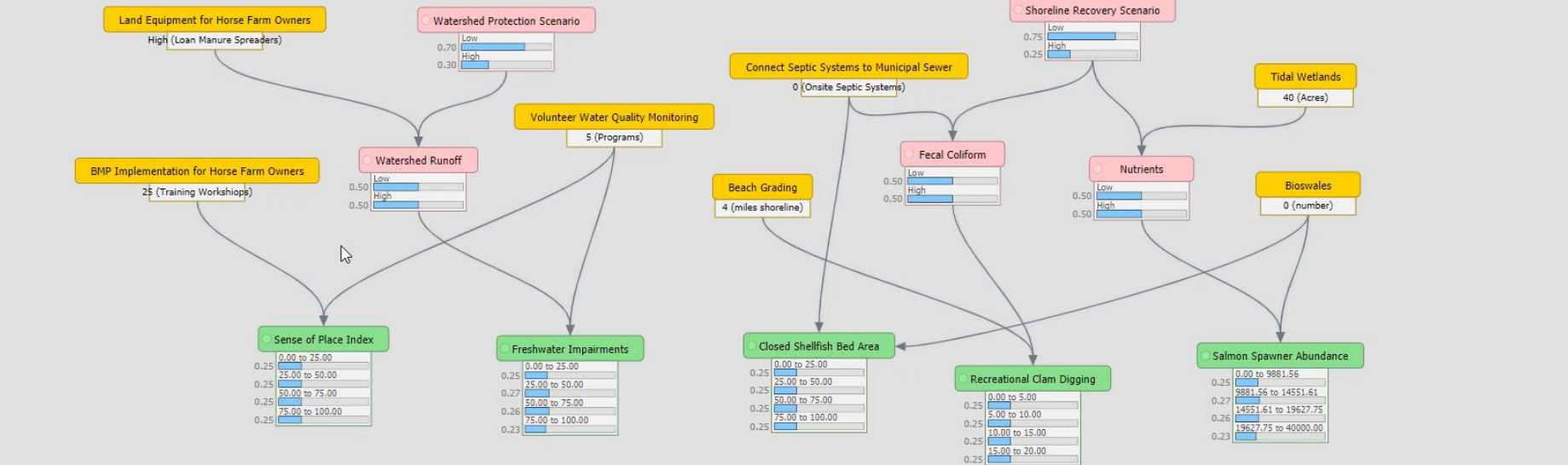
The **Evaluate Consequences** Step includes

- Consequence Table** to quickly screen **Scenarios** by ignoring uncertainty and



Consequence Table Take Action

Scenario Comparison



Integrating Human Well-Being and Ecological Indicators With DASEES in Puget Sound

Local Integrating Organizations (LIOs) in Puget Sound work to align local priorities, develop, and implement actions that contribute to the protection and recovery of the local ecosystem.



- Understand how LIOs function (structure, membership)
- Integrate human wellbeing indicators with ecological indicators for LIO decision-making

Integrated Evaluation of Near-Term Actions (NTAs) for the Island and Snohomish LIOs

- Whidbey Island (Penn Cove)
 - City of Coupeville
- Camano Island (Port Susan)
 - Joint Effort with Snohomish/Stillaquamesh LIO



Puget Sound Partnership <https://www.psp.wa.gov/LIO-overview.php>

LIO Island Ecosystem Recovery Plan
https://www.islandcountywa.gov/Health/DNR/ILIO/Documents/Island_LIO_Plan_2017-06-20_%20FINAL.pdf

NTA Descriptions

Coupeville

Downgraded Shellfish Beds

- Fecal coliform and nutrient loading
- Affects commercial and residential harvest of Shellfish and Chinook Habitat

Water Quality Impairment

- Degraded onsite septic system (OSS)
- Undertreated stormwater

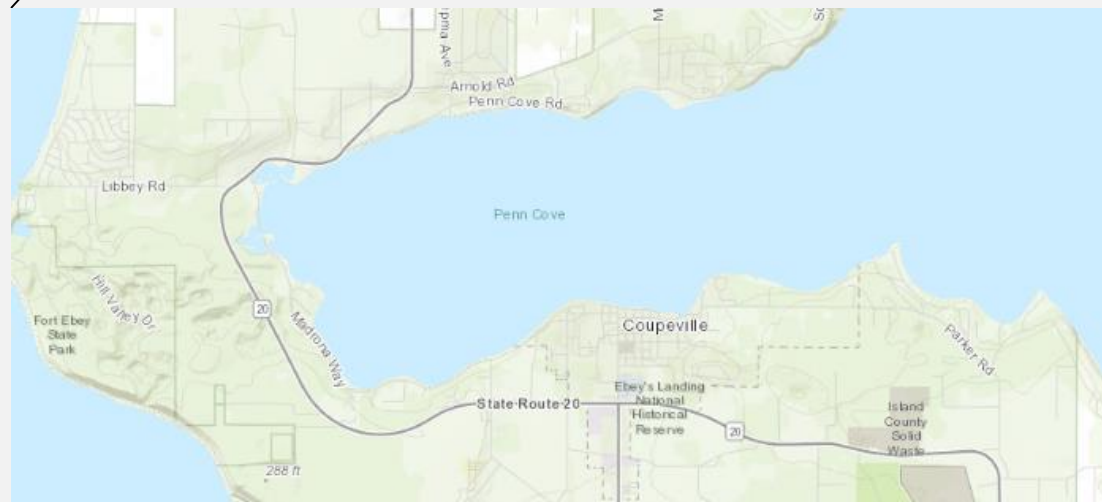
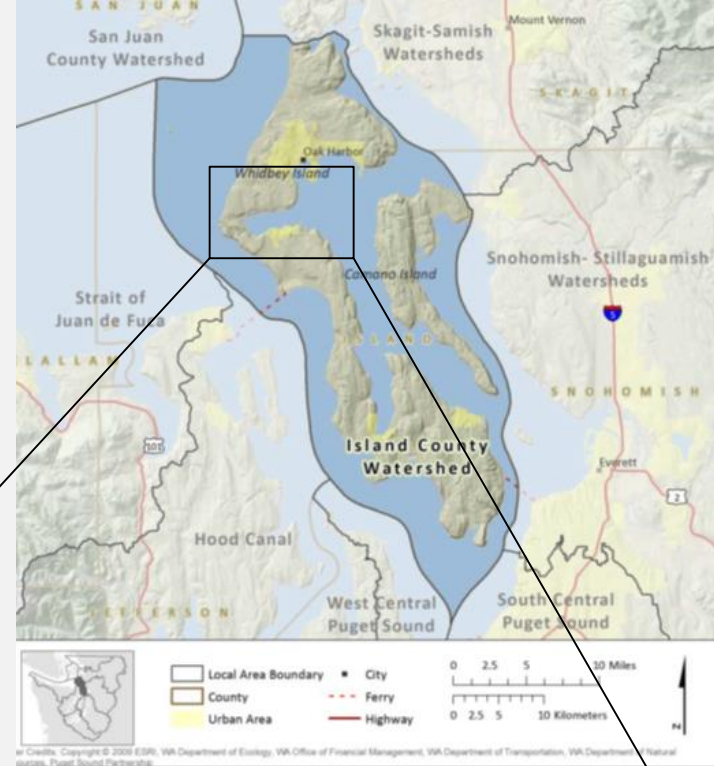
Options

Green Infrastructure (SW)

- Bioswales
- Restore Tidal Wetland

Water Treatment

- Connect OSS to Sewer line



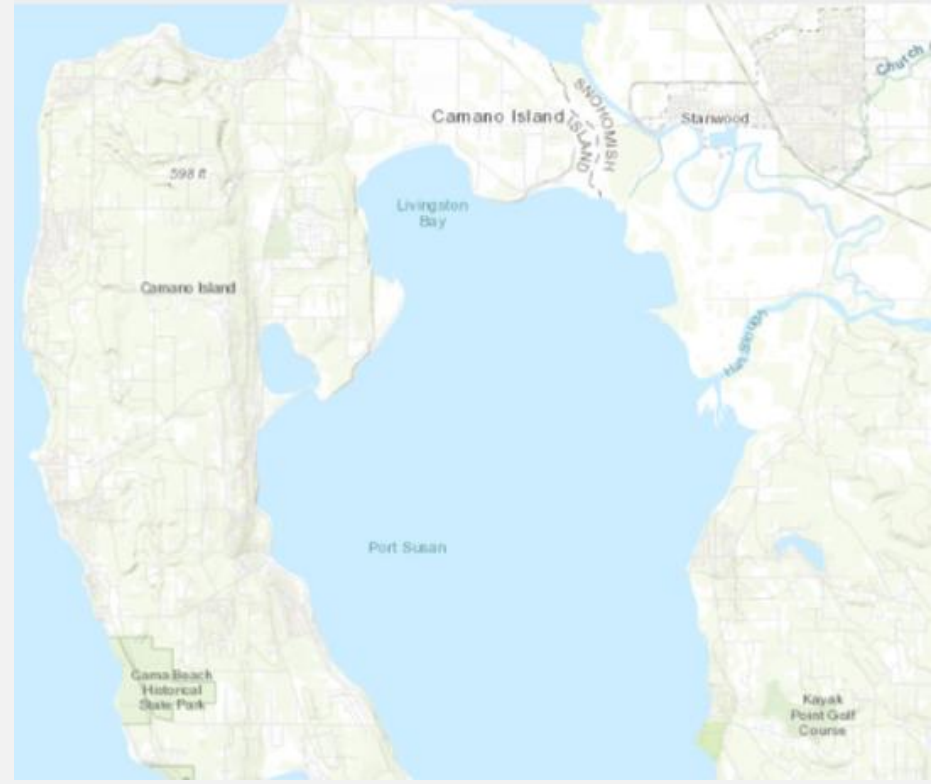
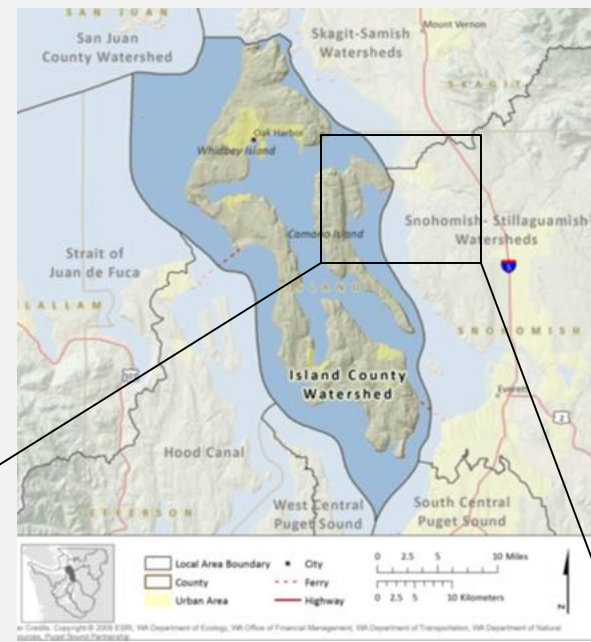
NTA Descriptions

Joint Island/Snohomish LIO Horse Farm Land Management

- Poor soil and manure management
- Impaired waterways 303(d)
- Impact shellfish beds

Options

- Training/engagement for BMP implementation
- Loan land management equipment
- Voluntary WQ monitoring programs

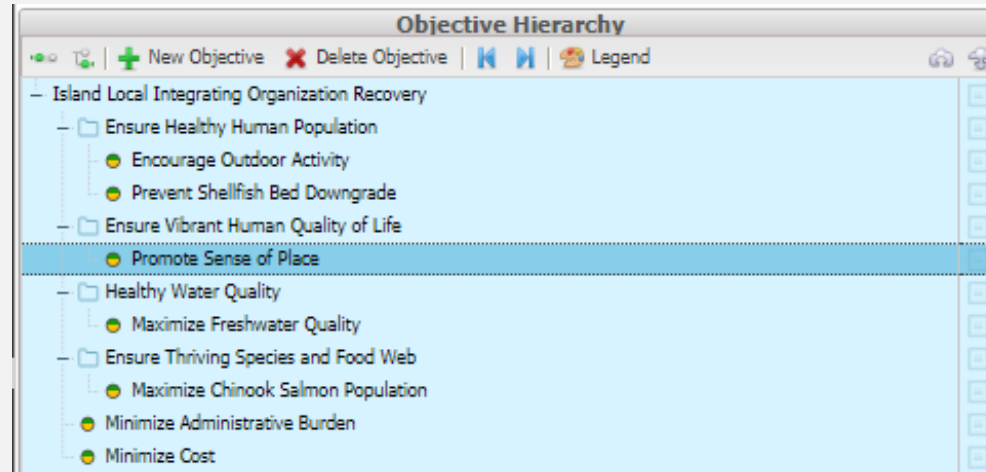


Objectives

Human Well-Being Components



Bio-physical Components



Structuring Objectives and Integrating Science

Normalizing Results

Define Objectives

Save Reload Help

Objective Hierarchy

New Objective

Delete Objective

Legend

- Island Local Integrating Organization Recovery
 - Ensure Healthy Human Population
 - Encourage Outdoor Activity
 - Prevent Shellfish Bed Downgrade
 - Ensure Vibrant Human Quality of Life
 - Promote Sense of Place
 - Healthy Water Quality
 - Maximize Freshwater Quality
 - Ensure Thriving Species and Food Web
 - Maximize Chinook Salmon Population
 - Minimize Administrative Burden
 - Minimize Cost

Objective Measures

New Measure Delete Measure

Objective Linked	Measure	Units
	Cost	100K Dollars
	Freshwater Impairments	% 303(d) listings
	Level of Oversight	# of Approving Agencies
	Recreational Clam Digging	Days/Month
	Salmon Spawner Abundance	Population Geometric Mean
	Sense of Place Index	% Strongly Agree

Sense of Place Index (% Strongly Agree)

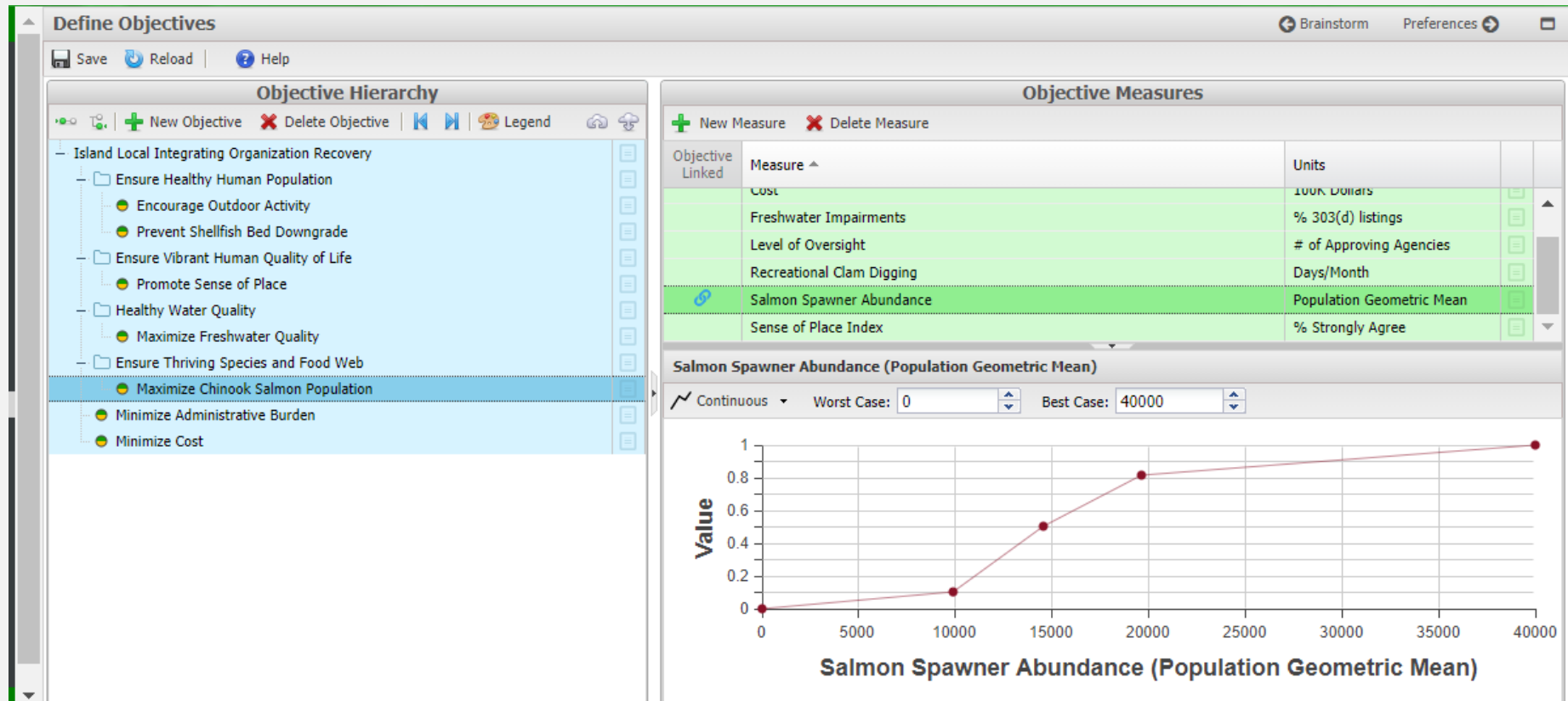
Continuous

Worst Case: 0

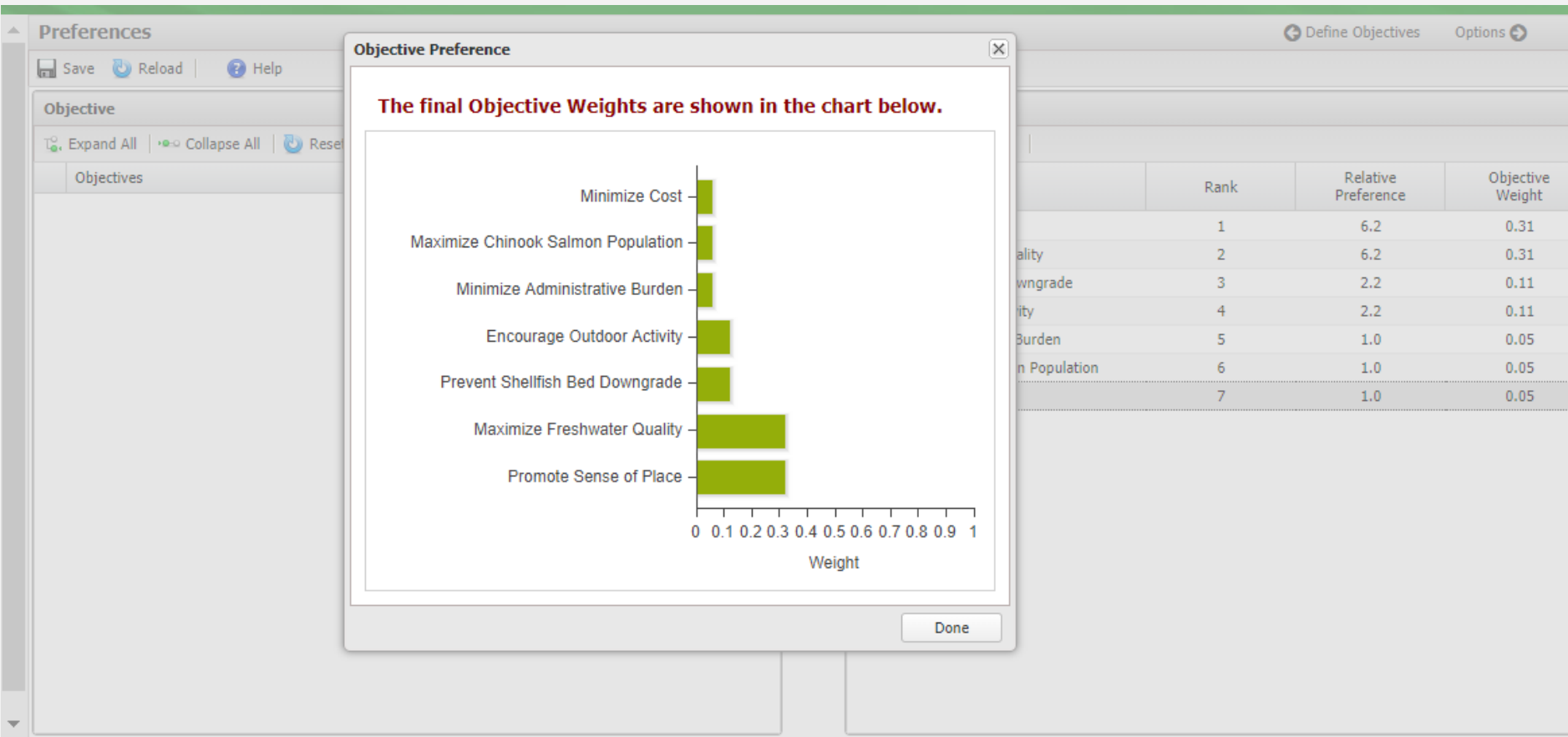
Best Case: 100

Sense of Place Index (% Strongly Agree)	Value
0	0.0
25	0.25
50	0.5
75	0.75
100	1.0

Biophysical Objective/Measure/Value Function



Construction of Preference *Objective Weighting*



Objectives, Measures, Options

Analysis for a Sustainable
Development • Economy • Society 1.0.8

dyson.brian@epa.gov



Define Options

Options Scenarios

Save Reload Help

Objective Hierarchy



Management Options

+ New Option - Delete Option

Objective Linked	Option Name ^	Type	Units
	Beach Accessibility	Continuous	Beach Grading
	Bioswales	Continuous	number
	Co-ordinate LIO Agencies	Categorical	Meetings
	Connect Septic Systems to Municipal Sewer	Continuous	Onsite Septic Systems
	Encourage Best Management Practice implementation for Horse Own...	Continuous	Training Workshops
	Federal Grants	Continuous	\$(x100,000)
	Technical Assistance to Horse Owners	Categorical	Loan Manure Spreaders
	Tidal Wetlands	Continuous	Acres
	Volunteer Water Quality Monitoring	Continuous	Programs

Option

Volunteer Water Quality Monitoring

This is an optional action that will affect the decision outcome.

Affects the objectives:

- Promote Sense of Place
- Maximize Freshwater Quality

Affect measured by:

- Sense of Place Index
- Freshwater Impairments

Develop Management Scenarios

DASEES

Decision Analysis for a Sustainable
Environment • Economy • Society 1.0.8

dyson.brian@epa.gov

Structured Decision

Island Local Integrating Organization

- Quick Start
- DecisionViz
- Context
 - Background
 - System Sketch
 - Map
- Objectives
 - Brainstorm
 - Define Objectives
 - Preferences
- Options
 - Define Options
 - Scenarios
- Consequences
 - Consequence Table
 - Bayesian Network
- Take Action

Scenarios

Save Reload Scenario: New Delete Edit Duplicate Compact View

Status Quo

This scenario represents the existing levels for each option.

- Beach Accessibility
0 Beach Grading
- Bioswales
0 number
- Co-ordinate LIO Agencies
Low Meetings
- Connect Septic Systems to Municipal Sewer
0 Onsite Septic Systems
- Encourage Best Management Practice implementation for Horse Owners
0 Training Workshops
- Federal Grants
0 \$(x100,000)
- Technical Assistance to Horse Owners
Low Loan Manure Spreaders
- Tidal Wetlands
0 Acres
- Volunteer Water Quality Monitoring
0 Projects

Coupeville Water Quality

Connect Onsite Sewage Systems to Municipal Sewer Line. Install Stormwater Bioswales.

- Beach Accessibility
5 Beach Grading
- Bioswales
15 number
- Co-ordinate LIO Agencies
Low Meetings
- Connect Septic Systems to Municipal Sewer
60 Onsite Septic Systems
- Encourage Best Management Practice implementation for Horse Owners
0 Training Workshops
- Federal Grants
12 \$(x100,000)
- Technical Assistance to Horse Owners
Low Loan Manure Spreaders
- Tidal Wetlands
20 Acres
- Volunteer Water Quality Monitoring
1 Projects

Joint ILO Horse Farm Management

Provided Training, Support, and Land Management Equipment to Horse Farm Owners to control Manure and Mud.

- Beach Accessibility
10 Beach Grading
- Bioswales
0 number
- Co-ordinate LIO Agencies
High Meetings
- Connect Septic Systems to Municipal Sewer
0 Onsite Septic Systems
- Encourage Best Management Practice implementation for Horse Owners
20 Training Workshops
- Federal Grants
3 \$(x100,000)
- Technical Assistance to Horse Owners
Medium Loan Manure Spreaders
- Tidal Wetlands
40 Acres
- Volunteer Water Quality Monitoring
5 Projects

Option

Technical Assistance to Horse Owners
This is an optional action that will affect the decision outcome.

Affects the objectives:

- Maximize Freshwater Quality

Affect measured by:

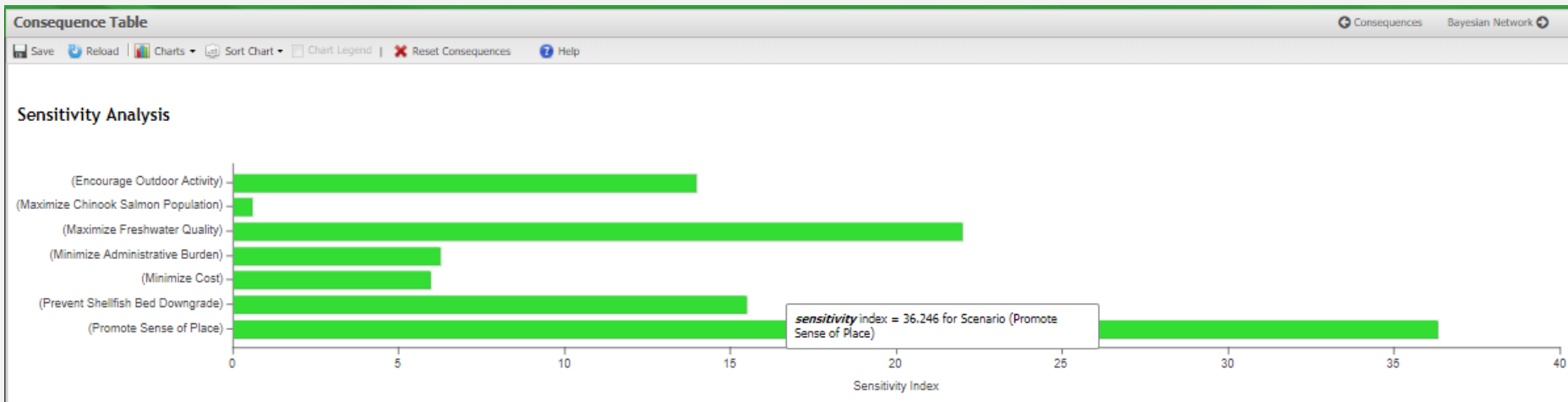
- Freshwater Impairments

Consequence Table

Rapid Analysis/Low Uncertainty



Measure Sensitivity Analysis





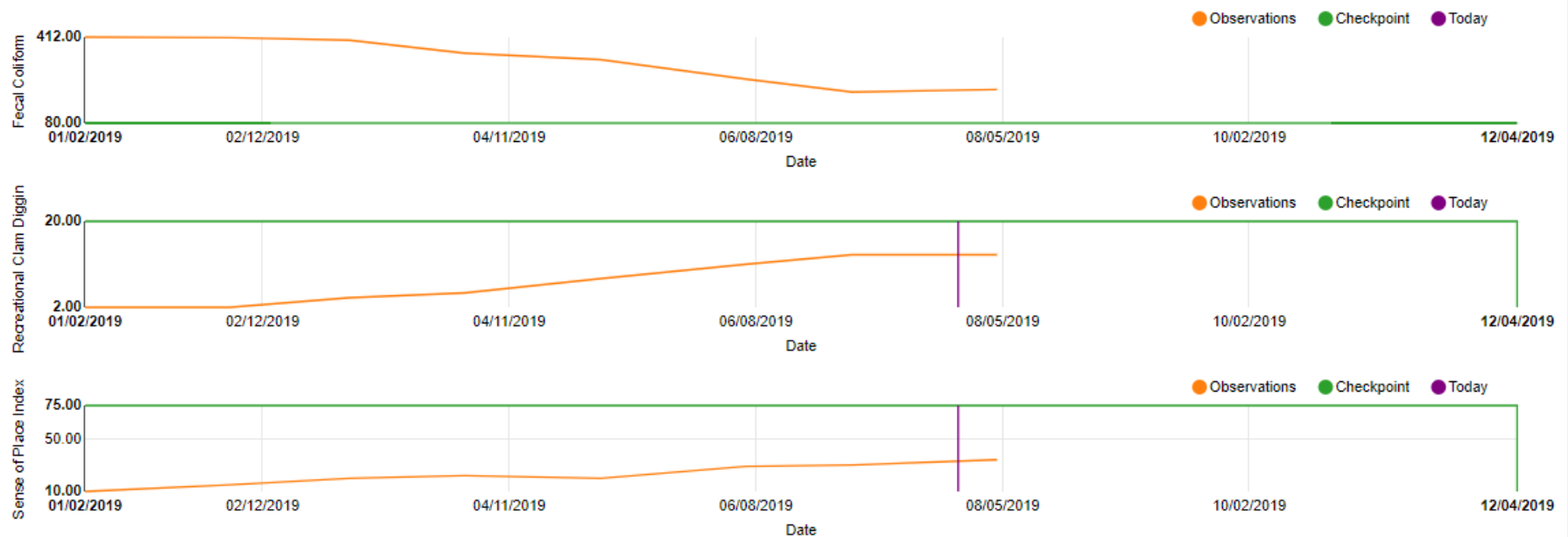
Adaptive management

Adaptive Management

Take Action

Save | Reload | Help

Define Checkpoints | **Summary**



- Continued engagement with LIO and community stakeholders
 - Further structure decision problem (objectives, measures, options)
 - Refine Bayesian Network (causal mechanisms)
 - Identify experts, modeling, and study designs necessary for generation/prediction of data for assessment

