An Ecosystem Framework for use in Recovery and Management of the Puget Sound Ecosystem: Linking Assessments of Ecosystem Condition to Threats and Management Strategies

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Speaker
Sandra M. O'Neill, Constance Amanda Sullivan, Scott B. Redman, Kari A. (Kari Ann) Stiles, Kelly Biedenweg, and Tracy K. Collier

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An Ecosystem Framework for use in Recovery & Management of the Puget Sound Ecosystem: Linking Assessments of Ecosystem Condition to Threats and Management Strategies

Sandie O’Neill, Connie Sullivan, Scott Redman, Kari Stiles, Haley Harguth, Kelly Biedenweg, Tracy Collier

Washington Department of Fish and Wildlife
Puget Sound Partnership
Puget Sound Institute
Puget Sound Partnership is using environmental indicators to track the recovery of Puget Sound

Science Panel has legislative assignment “to identify environmental indicators measuring the health of Puget Sound” (RCW 90.71.280(3)). Approved vital sign in 2010.

Leader Council adopted vital sign in 2010/2011 as surrogates of the status of the ecosystem.
Environmental indicators are tools to manage ecosystems...

What’s happening? (condition)

Why is it happening? (pressures)

What can be done? (management response)

Did we fix it?

INDICATOR: CHINOOK SALMON
Vital Sign Indicators

• Includes indicators of condition, pressures, and management and societal responses

• Initially, intended for communication

• Now, also used for understanding and management
Recommendations to Improve Indicators

- Develop a **conceptual framework of the ecosystem** that summarizes its major **attributes**, both structural elements and processes.
- Develop **new indicators** for missing attributes of ecosystem condition.
- Refine existing indicators

WA State Academy of Science Review
Orians et al. 2012
Stepwise Procedure for Selecting Indicators

1. Develop ecosystem conceptual model and frameworks.
2. Select key ecological attributes (KEAs).
3. Identify candidate indicators that represent each KEA.
4. Evaluate reliability of each indicator & metric (criteria).
5. Select a balanced indicator portfolio.
Step 1

Develop ecosystem conceptual model & frameworks
Integrated Ecosystem Recovery Conceptual Model + DPSIR

- Human Behaviors
  - Ecosystem Services
    - Produce
      - Support
      - Engage
        - Informs
          - Drive
            - Benefit
              - Pressure
                - Human Wellbeing Condition
                  - D
                    - External Drivers
                      - Driver
    - Deliver
      - Recover
        - Impact (+/-) Benefit
          - Response
            - Ecosystem Recovery Actions
              - Informs
                - Influence
                  - Pressure
                    - Biophysical Condition
                      - S/I
                        - State/Impact
                          - Contain
Integrated Ecosystem Recovery Conceptual Model

- Human Behaviors
  - Ecosystem Services
    - Ecosystem Recovery Actions
      - External Drivers

For more information, contact Haley Harguth
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Step 2

Select key ecological attributes
Biotic Condition “Menu”

• Ecosystems and Communities
  - Community Extent
  - Community Composition
  - Trophic Structure
  - Community Dynamics
  - Physical Structure

• Species and Populations
  - Population Size
  - Genetic Diversity
  - Population Structure
  - Population Dynamics
  - Habitat Suitability

• Organism Condition
  - Physiological Status
  - Symptoms of Disease or Trauma
  - Signs of disease
What are the key ecological attributes to track the condition and recovery of Puget Sound?

- Followed recommendations in the Puget Sound Science Update (2011)
- Added additional attributes recommended by the WSAS (2012)
- Confirmed proposed attributes using conceptual model and monitoring priorities identified by PSEMP work groups.
Step 3

Identify candidate indicator for key ecological attributes
Candidate Indicator must reflect major ecosystem components
Candidate Indicator must reflect PSP Recovery Goals

Habitats
- Landscape Condition
- Natural Disturbance
- Geomorphology
- Hydrology

Species & Food Webs
- Biotic Condition
- Chemical Physical
- Ecological Processes

Water Quality
- Habitats

Water Quantity
- Habitats
Step 4

Evaluate reliability of each indicator & metric (criteria).
Hierarchical Decision Tree for Indicator Selection
(modified from Kurtz et al. 2001)

Is the indicator conceptually valid and relevant to PSP goals?
- theoretically sound
- ecologically relevant to PSP goals
  - Yes
  - No

Unsuitable

Can the indicator be feasibly implemented?
- operationally simple
- cost benefit & cost effective
  - Yes
  - No

Unsuitable

Are the statistical properties of the indicator understood?
- responsive to change
- consistently measurable
- appropriate scale
  - Yes
  - No

Potential

Does the indicator meet management & reporting needs?
- easily understood
- linked to management responses; measurable targets;
- international compatibility; - timely
  - Yes
  - No

Potential

Good
Step 5

Select a balanced indicator portfolio.
Final Portfolio must include 6 Major categories of Indicators

Biophysical Condition

Species & Food Web
Nearshore Systems
Marine systems

Floodplain Channel systems
Wetland systems
Lake systems

Groundwater systems

Marine /Nearshore Domain
Freshwater Domain
Terrestrial Domain

Essential Ecological Attributes

Landscape Condition
Biotic Condition
Natural Disturbance
Chemical Physical
Geomorphology Hydrology
Ecological Processes

Modified from Levin et al. 2010)
## Attributes Assessed by Vital Signs

<table>
<thead>
<tr>
<th>Attribute Category</th>
<th>Domain</th>
<th>Marine/Nearshore</th>
<th>Freshwater</th>
<th>Terrestrial</th>
</tr>
</thead>
<tbody>
<tr>
<td>Landscape Condition</td>
<td></td>
<td></td>
<td>Floodplains</td>
<td>Land Cover (Forests)</td>
</tr>
<tr>
<td>Biotic Condition</td>
<td></td>
<td></td>
<td>Chinook salmon; B-IBI; Birds</td>
<td></td>
</tr>
<tr>
<td>Physical &amp; Chemical Characteristic</td>
<td></td>
<td>Marine Water Quality; Marine Sediment Quality</td>
<td>Freshwater Quality</td>
<td></td>
</tr>
<tr>
<td>Hydrology &amp; Geomorphology</td>
<td></td>
<td></td>
<td>Summer Stream Slows; Floodplains</td>
<td></td>
</tr>
<tr>
<td>Ecological Processes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Natural Disturbances</td>
<td></td>
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</tr>
</tbody>
</table>
Next Steps....

• Continue process for process of identifying candidate indicators.
• Evaluate the reliability of candidate indicators.
• Propose a more balanced portfolio of vital sign indicators.
• Peer review this summer.
Integrated Ecosystem Recovery Conceptual Model + DPSIR

- Human Behaviors
- Ecosystem Services
- Recovery Actions
- Human Wellbeing
- Biophysical Condition
- State/Impact
- Pressure (P)
- Response (R)
- External Drivers (D)
- Benefit (S/I)
- Drive (S/I)
- Informs (S/I)
- Influence (S/I)
- Deliver (S/I)
- Engage (S/I)
- Support (S/I)
- Impact (+/-) Benefit
- State/Impact (S/I)
- Recover
PSP Ecosystem Recovery Goals:
Species and Food Webs  Habitats  Water Quality  Water Quantity  Human Health  Human Well Being

Human Well-Being Condition
(from Biedenweg et al. in press)

Driver - Pressure - State - Impact - Response
(from Smeets & Wetering 1999)
PSP Recovery Goals & Ecological Attributes

Habitats
- Landscape Condition
- Natural Disturbance
- Geomorphology
- Hydrology
- Ecological Processes
- Chemical Physical
- Biotic Condition

Species & Food Webs
- Water Quantity
- Water Quality
- Habitats

Water Quantity Habitats

Water Quality Habitats

Species & Food Webs

Habitats

Habitats

Species & Food Webs