January 23, 2007

INTERAGENCY EFFORT TO SELECT ENVIRONMENTAL INDICATORS FOR THE ACTION AGENDA OF THE PUGET SOUND PARTNERSHIP

SCOPE, OBJECTIVES AND APPROACH
NOAA-WDFW Inter-agency Personnel Agreement (IPA)

Background

In July 2007 the Puget Sound Partnership (Partnership) was formed (ESSB 5372), with a mandate to create a healthy Puget Sound ecosystem by 2020 by fulfilling 6 specific goals:

- Fresh and marine waters and sediments of a sufficient quality so that the waters in the region are safe for drinking, swimming, shellfish harvest and consumption, and other human uses and enjoyment, and are not harmful to the native marine mammals, fish, birds, and shellfish of the region.

- An ecosystem that is supported by ground water levels as well as rivers and stream flow levels sufficient to sustain people, fish, and wildlife, and the natural functions of the environment.

- A healthy Puget Sound where freshwater, estuary, nearshore, marine, and upland habitats are protected, restored and sustained.

- Healthy and sustaining populations of native species in Puget Sound, including a robust food web.

- A healthy human population supported by a healthy Puget Sound that is not threatened by changes in the ecosystem.

- A quality of human life that is sustained by a functioning Puget Sound ecosystem.

These goals were developed by the 2006 Partnership (Puget Sound Partnership, 2006) through a series of forums and workshops designed to identify ecosystem values that were broadly supported by the public, the scientific community and policy makers. Currently, an Action Agenda is being developed by the Partnership that will identify measurable parameters and target values that represent full achievement of each ecosystem goal associated with a healthy Puget Sound as well as, the necessary strategies and management activities to achieve those targets by 2020. Defining these quantitative measures for each of the ecosystem goals will require considerable resources and time. In the meantime, environmental indicators will be used to assess whether the health of Puget Sound is improving and whether the Action Agenda is moving towards achieving the Partnership goals.

Rationale for Using Environmental Indicators

Environmental indicators are attributes associated with specific ecosystem elements (e.g., water, plants, animals and people) that are used to characterize and communicate the condition of the ecosystem. The 2006 Partnership defined an environmental indicator as "a physical, biological, or chemical measurement, statistic or value that provides a proximate gauge or evidence of, the state of the condition of Puget Sound" (ESSB 5372). Indicators will both engage the public in understanding the ongoing health of the ecosystem and also inform decision-makers about the ecosystem to be restored.

Environmental indicators can inform us about 1) the current or evolving state of key ecosystem elements (e.g., releases of nutrients, concentrations of contaminants in fish, levels of dissolved oxygen, sea level rise, changes in eelgrass coverage, closure of shellfish beds due to fecal contamination), and 2) indirect processes or mechanisms that may drive ecosystem health (e.g., climate change, population growth) or 3) societal responses to perceived changes in environmental quality or policies implemented to improve environmental quality (e.g., percent increase in cars with catalytic converters; rate of increase in recycling).

In addition to such individual indicators, synthetic or index-type indicators (e.g., index of native species diversity) can be used to report on individual ecosystem components (i.e., freshwater water quantity, water quality, habitat, species and food webs, human health and human well-being) or the whole ecosystem. Additionally, higher-order indicators more reflective of ecosystem function (e.g., net primary production, carbon storage) may provide information on the ability of the ecosystem to sustainably provide goods and services.

Within a whole-ecosystem based management approach, good environmental indicators provide core tools for managing human activities to achieve ecosystem health. Environmental indicators should be used to:

1) inform policy makers about environmental problems and their level of urgency,
2) support policy development and priority setting by identifying key issues pressuring the environment, and
3) assess the effects of policy responses.

Once appropriate environmental indicators are selected and implemented they can be used to assess progress towards ecosystem goals and then, principles of adaptive management can be used to alter strategies and management activities to better meet ecosystem goals. Thus, management decisions based on good environmental indicators increase the likelihood of achieving ecosystem goals. This means indicators must be scientifically sound and they must resonate with the public and decision-makers. However, what constitutes a "good" environmental indicator and how many are needed to adequately inform management and policy is often unclear.

To ensure their value and utility, environmental indicators should be based on clearly defined goals, objectives and important elements in the conceptual models that define key structures and functions for the ecosystem of interest. Environmental indicators should be developed and selected in a logical, structured selection process that is scientifically rigorous and transparent, but also cost effective. Achieving broad regional agreement on the indicator selection criteria and a common framework for development and selection of indicators will require a substantial commitment of time but is essential to their successful implementation and use of environmental indicators.

Scope

Restoring the health of Puget Sound will require a holistic ecosystem approach to management that provides a comprehensive framework for resource decision making such that a wider-range of relevant ecological, environmental, and human factors bearing on societal choices regarding resource use are considered.

Environmental indicators will be one component of a larger Integrated Ecosystem Assessment (IEA), a critical element in an ecosystem approach to management that holistically address policy questions associated with competing ecosystem goals. An IEA is a synthesis and quantitative analysis of information on relevant physical, chemical, ecological and human processes in relation to specified ecosystem management objectives. NOAA Fisheries is currently developing an IEA for Puget Sound that can be used by the Partnership.

The IEA for Puget Sound has four major Phases as detailed below:

Policy questions	**IEA step**
What does a healthy ecosystem look like? How can we measure progress?	Identify ecosystem goals, indicators, and targets
What is the current health of PS? How much improvement in ecosystem elements is needed to meet targets? What are the biggest impediments to indicator health? Where should we focus our strategies first?	Conduct risk analysis: current status and key threats for indicators
What actions should be considered (e.g. priority toxic sources to limit/abate, nearshore protection sites and approaches, stormwater approaches)?	Generate alternative management strategies
What should we do, at what level of effort, and where?	Evaluate strategies and resulting ecosystem status

The IEA will eventually be developed for the whole system, including all major ecosystem components, but initially NOAA will focus analyses on a limited number of ecosystem components and major management strategies. Initial quantitative analyses will be conducted in a subset of the basins of the Sound. A more qualitative analyses will be used to identify and where possible, fill in steps in the IEA for the entire Sound. Because of existing analytical tools, the simulation modeling efforts will be focused on the state of the marine portion of the ecosystem. Statistical models in other components of the ecosystem (e.g., in freshwater or

terrestrial systems) will allow links to be made between risks, threats and management actions in these systems to changes in the structure and function in the marine environment.

At the start of an IEA, environmental indicators are selected to better define key ecosystem attributes that are scientifically sound and highly valued by society. The risk analysis defines the major threats to these key ecosystem attributes. The IEA then models ecosystem changes, with and without management strategies. This modeling effort will provide predictions on how specific ecosystem attributes (i.e. environmental indicators) may be affected by multiple management strategies. Based on predictions from multiple management strategies, policy makers will have to decide which sets of strategies provide the best trade-offs for meeting multiple ecosystem goals that are neither independent, nor necessarily positively correlated. Once management strategies have been implemented, environmental indicators are monitored to assess the effectiveness of the strategies, and the IEA process is repeated. Additionally, through the IEA quantitative process, ecosystem models can be used to generate a list of environmental indicators that best reflect ecosystem processes and function. These indicators will further assist the Partnership with identifying whether strategies and management activities in place are likely to be effective at achieving the desired goals.

Given the short timeline for the development of the Action Agenda, and the anticipated lengthy period needed to develop and select scientifically sound environmental indicators that are customized to the ecological health of Puget Sound but also resonate with policy makers and the general public, a tiered two-phase process will be needed to inform policies and management actions, both immediately (within the next year –Phase 1) and in the longer term (over the next several years and beyond – Phase 2). This two-phased approach can be summarized as follows:

Phase 1 = evaluation of currently available environmental indicators, and selection of a list of 'provisional' indicators;
Phase 2 = revision of provisional indicators to include development of new, customized, or synthetic environmental indicators

Phase 1: NOAA will support one full time staff member funded for 12 months, through an Interagency Personnel Agreement (IPA) with Washington Department of Fish and Wildlife (WDFW) to lead an inter-agency effort to select the provisional list of environmental indicators for the six ecosystem goals outlined by the Partnership. A short-term qualitative process that solicits and organizes expert judgment from the scientific community will be used to evaluate and select a list of environmental indicators from sets of available indicators that have been proposed, are currently in use, or have been used in the past in Puget Sound. The indicator work being conducted under this IPA draws upon the draft scoping paper *Developing measures of ecosystem health: Outcomes and benchmarks and indicators* (Draft Scoping Document, May 2007) developed by a small team representing several agency and organization perspectives. Indicator selection criteria and a common framework for development and selection of environmental indicators will be developed and will then be applied to existing indicators to develop a set of provisional indicators. Narrative outcomes defined by the 2006 Partnership will be used to frame the types of environmental indicators that will be selected, although thresholds or quantifiable targets for environmental indicators will not be determined in this phase. Opportunities for review and vetting of the process for selecting provisional environmental indicators will be available to the broader scientific community, federal, tribal, state, local governments, NGOs and the general public will be available. However, a more iterative dialogue between science and policy will be needed in Phase 2 to finalize the list of environmental indicators. A sub-set of

these provisional indicators may be used to develop be a "report card" list of indicators, however, development of an indicator "report" card is beyond the scope of this IPA.

Phase 2 (not covered by IPA): The selection criteria and a common framework for development and selection of environmental indicators developed will continue to be used in Phase 2. A series of workshops will be necessary to continue a dialogue between policy and science that will finalize the list of environmental indicators determine desired thresholds or benchmarks for their performance. This iterative dialogue should provide information that answers key management questions needed by decision makers and the public. New indicators will need to be developed to address gaps and limitations in indicator use identified during the evaluation and selection of the Phase 1 provisional environmental indicators. The development of new indicators could include new individual indicators, synthetic or index-type indicators for individual ecosystem components or the whole ecosystem, and higher-order indicators more reflective of ecosystem processes.

Phase 1 Objectives

The primary objective is to select a provisional list of environmental indicators for the Puget Sound ecosystem that can be used by the Puget Sound Partnership to characterize and communicate the condition of the ecosystem. First, criteria and a framework for indicator selection will be developed. The criteria and framework will then be applied to former, current and proposed indicators for the Puget Sound ecosystem to select the most suitable indicators. This resulting list of indicators will be used to assess all 6 components of the Puget Sound ecosystem (water quality, water quantity, habitat and processes, species and food webs, human health, and human socio-economic and cultural well being) and address the goals and narrative outcomes identified by the Partnership.

Phase 1 Approach

To select environmental indicators, 4 major tasks were identified:

1. Develop criteria and a framework to be used for selecting environmental indicators.

2. Create conceptual models that define key structures and functions of the Puget Sound ecosystem components.

3. Identify, compile, and summarize former, current and proposed indicators for the Puget Sound ecosystem.

4. Select and evaluate the most suitable environmental indicators based on criteria/framework and conceptual model.

Task 1: Develop criteria and framework to be used to select environmental indicators.
The scientific criteria for choosing indicators are diverse but they must be scientifically sound and reflect regional issues. Higher-level indictors associated with ecosystem function should be based on well-understood and accepted conceptual models of the ecosystem (National Research Council 2000). Criteria will include practical constraints to using particular indicators (e.g., availability of

data, financial support for the indicator) and scientific/policy criteria (e.g., ability to assess changes in ecological processes, statistical properties). A framework or process to apply criteria will also be developed. Causal chains linking indicators to desired goals (e.g. the driving force-pressure-state-response) are commonly used frameworks. Literature reviews and will be used to identify potential criteria and potential frameworks to be used for selection of environmental indictors.

A Technical Working Group (TWG) will be formed to determine criteria and develop framework for the selection of environmental indicators. The TWG will consist of people that generate data that have been used for environmental indicators, or have developed environmental indicators. Members will include 2 – 4 representatives from each of the 6 ecosystem components plus NOAA staff. Small group interviews will be held with subsets of TWG members to identify concerns for specific ecosystem components. A workshop will be held with the full TWG to reach consensus on the criteria to be used to define good environmental indicators and to develop a framework to apply criteria to available indicators.

Task 2. Create conceptual models that define key structures and functions of the Puget Sound ecosystem components.

Conceptual models can be an effective tool to communicate key structures and functions for the ecosystem among managers, the public and scientists. Through conceptual models these different groups, often with very different perspectives, can build a common knowledge base to better define connections between science and policy.

The TWG will build upon a conceptual model for the whole of Puget Sound that is currently being used by the Partnership. Subgroups of the TWG will create conceptual models for each ecosystem component (water quality, water quantity, species, habitat, human health, and human well being). Once the draft conceptual models are created, the whole TWG will meet to provide comments. The Conceptual Model subgroups will then refine their models and present the final conceptual models to the TWG.

Task 3: Identify, compile, and summarize existing indicators that have been proposed, are currently being used, or have been used in the past for the Puget Sound ecosystem.
A regional set of available indicators will be identified, inventoried, and summarized to provide a common knowledge base of the potential list of indicators available for selection using the criteria and framework in Task 1. The sets of indicators to be inventoried will include those developed by PSAT (including the Puget Sound Assessment and Monitoring Program), the Governor's Forum on Monitoring, Puget Sound Georgia Basin Trans-boundary Indicator Workgroup, Sustainable Seattle, The Nature Conservancy, Biodiversity Council, and others. This summary will include indicators for the whole ecosystem: terrestrial ecosystems, freshwater and marine environments, species diversity, and human well-being (i.e., health, socio-economic, cultural). Major gaps from the breadth of indicators compiled from regional set of indicators will be identified. As time allows, national or non-Puget Sound regional indicators that may be suitable to fill these gaps will be proposed.

Task 4: Select and evaluate environmental indicators based on criteria and framework.
Indicators will be classified and binned in tables based on the criteria identified in Task 1. Selected indicators will be linked to Partnership goals and narrative outcomes. An effort will be made to identify and cross-link indicators with other reporting efforts to ensure that policy makers are not inundated with indicators from all directions.

Once the environmental indicators are selected, the overall quality of selected list will be evaluated to identify completeness (i.e. identify gaps) and their overall utility to assess changes in the health of the Puget Sound ecosystem. Additional screening of published indicators used outside the Puget Sound region or nationally (see Task 3) may be conducted to fill gaps as time allows. Monitoring and research gaps for selected indicators will also be identified.

New indicators may need to be developed to fully assess the health of the Puget Sound ecosystem and the effectiveness of the Action Agenda. Although Phase 2 indicator-development is not covered in the scope of this IPA, recommendations for the next steps to improve the quality of the environmental indicators will be outlined.

Phase 1 Review and Vetting Process

A Steering Committee (SC) will be formed to provide guidance and review of the proposed scope/objectives and approach used to select environmental indicators, and to ensure broad scientific feedback throughout the process. The SC will consist of 8-10 people, including at least one expert for each of the 6 ecosystem components, 1-2 representatives from the Partnership and 1-2 experts in indicator development. The SC will review scope, objectives and approach on the Phase 1 selection of environmental indicators, provide guidance with selection of TWG members, reviews the sets of indicators to be evaluated, along with proposed criteria and framework, reviews proposed list of indicators and recommendations.

The Leadership Council and the Ecosystem Coordination Board will be briefed at the start of the process on the 1) the scope, objectives and approach to select the provisional environmental indicators.

The Science Panel will review and provide guidance on 1) the scope, objectives and approach to select environmental indicators, 2) the list of indicators to be evaluated, along with the proposed criteria and framework and 3) the draft list of selected indicators and recommendations for future indicator development.

Opportunities for vetting and review throughout the broader scientific community, local governments and the general public will be available. The Partnership staff will engage federal, state, tribal and local agencies and NGOs by circulating to them final scope, objectives and approach for selection of environmental indicators plus the list of SC and TWG members. The intent of this distribution is to inform regional scientists, agencies, and the general public on the process, solicit feedback, and identify opportunities for involvement. When the TWG selects the set of draft provisional indicators, the list and the selection criteria and framework that were used will be circulate to the aforementioned groups to solicit their input. The Partnership will host a several large workshops to solicit comments about the overall indicator selection process and list of selected indicators and recommendations for future work. The workshop will include sessions for the science community and educators and local government.

The Leadership Council and the Ecosystem Coordination Board will also be briefed at the end of the process once comments from the Science Panel, the broader scientific community, local and local governments and the general public have been incorporated.

Phase 1 Sequence of Events and Estimated Timeline

1. **NOAA staff** develops draft scope, objectives and an approach to select indicator environmental indicators with input from Partnership staff, *October 22- November 30, 2007.*

2. **NOAA staff** forms a Steering Committee [SC]. *November 13 – December 7, 2000.*

3. **SC** reviews draft scope, objectives and approach, *December 7- 14, 2007.*

4. **NOAA staff** modified scope, objectives and approach based on SC comments, *December 17- 26th, 2007*.

5. **NOAA staff** finalizes potential members of the Technical Working Group [TWG] and send invitational letters, *December Dec 17-21, 2007*.

6. **NOAA staff** meets with TWG to outline scope, objectives and approach and solicit assistance with literature review, *January 14-18, 2008.*

7. **Science Panel** reviews the scope, objective and approach and (January 14th - 24th, 2008) and provides guidance and input, *January 25th, 2008.*

8. **NOAA staff** brief Leadership Council on scope, objectives and approach for selection of environmental indicators and modifies as necessary. (*January 28, 2008*)

9. **NOAA staff** brief Ecosystem Coordination Board on scope, objectives and approach for selection of environmental indicators (*February 8th*) and modifies draft as necessary.

10. **Partnership staff** circulates scope, objectives and approach for selection of environmental indicators, plus the list of SC and TWG members to federal, state, tribal and local agencies and NGOs to inform them of the process, solicit feedback, and identify opportunities for their involvement, *February 8-22nd, 2008*.

11. **NOAA staff** revises scope, objectives and approach for selection of environmental indicators based on comments from broader scientific community, *February 25-29th, 2008.*

12. **NOAA staff and TWG** identifies and inventories sets of current, former, and proposed indicators lists for this region [e.g. Puget Sound-Georgia Basin Indicators, State of the Sound Indicators, Sustainable Seattle Indicators, etc.] to be evaluated, *January 23rd - March 17, 2008.*

13. **NOAA staff and subset of the TWG** create conceptual models for ecosystem components, *January 30t - March 17th, 2008.*
    a. form subgroups of TWG members to do create conceptual models for ecosystem components that identify key elements of for each ecosystem components.
    b. host a workshop with all TWG members to reach final consensus on the conceptual models, *March 17-18, 2008.*

14. **NOAA staff and subset of TWG** develops criteria and framework to be used for selection of environmental indictors, *January 23rd– March 17th.*

a. form subgroups of TWG members to do literature review to identify specific criteria /concerns for specific ecosystem components.
b. host a workshop with all TWG members to reach final consensus on the selection criteria and framework, *March 17-18, 2008*

15. **NOAA staff** brief the SC on the indicators to be evaluated, along with proposed criteria and framework to solicit input on completeness of the proposed set of indicator lists to be evaluated and if necessary, over-looked indicators will be added, *March 20-21, 2008.*

16. **NOAA staff** brief the Science Panel on the indicators to be evaluated, along with proposed criteria and framework to solicit input on completeness of the proposed set of indictor lists to be evaluated and if necessary, over-looked indicators will be added, week of *March 24- 28, 2008.*

17. **TWG** applies criteria/framework to select draft provisional indicators and evaluates quality of draft list to identify completeness (i.e. identify major gaps), utility and make recommendations for next steps (Phase 2) to improve quality of list of environmental indicators, *April 1-April 30, 2008.*
a. Host workshops for subgroups of TWG members select provisional indicators for each ecosystem component, *April 8-10, 2008*.
b. host a workshop with all TWG members to reach final consensus on the selection of provisional indicators, *Apri1 21, 2008*

18. **SC** reviews draft indicators/ recommendations and if necessary, **NOAA staff** make modifications, *May 5-9th, 2008.*

19. **Science Panel** reviews draft indicators/ recommendations the week of *May 19th –23rd, 2008* and if necessary, **NOAA staff** make modifications the week of *May 27- 30th, 2008*.

20. The **Partnership staff** prepares summary of indicator selection process and list of selected indictors /recommendations to be mailed out for broad public, scientific and policy review, *first week of June.* Indicator selection process and list of provisional indicators /recommendations is also sent to Ecosystem Coordination Board at this time.

21. The **Partnership staff** hosts a several large workshops to solicit comments on selected provisional indictors /recommendations from broader scientific community, and the general public, the *week of June 23 - 30, 2008.*

22. **NOAA staff** summarizes results of workshop comments, *June 30th- July 3rd, 2008*.

23. **Partnership staff** conducts policy review through the Ecosystem Coordination Board, *July 7 – 18th, 2008.*

24. **NOAA staff** brief Leadership Council on provisional environmental indicators and recommendations for Phase 2, week of *July 22th- 23st, 2008.*

Bibliography

Draft Scoping Document (2007). *Developing measures of ecosystem health: Outcomes and benchmarks and indicators.* May 21, 2007 scoping document in support of the Puget Sound Partnership.

NRC (National Research Council). 2000. Ecological indicators for the nation. Washington, DC: National Research Council.

Puget Sound Partnership (2006). *Sound Health, Sound Future: Protection and Restoring Puget Sound. Puget Sound Partnership Recommendations.* December 2006.