Synopsis of Priority Monitoring and Science Support Studies of the PSEMP Stormwater Work Group Pertaining to Ecosystem Indicators of Puget Sound

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1 INTRODUCTION

The purpose of this document is to provide a synopsis of the priority monitoring gaps and science support needs identified by the Puget Sound Ecosystem Monitoring Program (PSEMP) Stormwater Work Group (SWG) that pertain to the selection of ecosystem attributes and indicators of condition of Puget Sound. **We summarized monitoring and science support studies identified by the SWG using the ecosystem framework developed by O'Neill et al. (in prep), with the intent of providing the PSEMP Steering Committee with a common framework to present monitoring priorities and gaps across all PSEMP Work Groups.** The effort is part of an ongoing effort by the Puget Sound Partnership to select robust set of indicators to assess the overall health of Puget Sound.

This ecosystem framework presented by O'Neill et al. (in prep) is an amalgamation of three frameworks: (1) a generalized "causal chain/network framework" that is used to link drivers and pressures of ecosystem health with (2) a framework for assessment of the condition of Puget Sound's biophysical system with (3) a framework of the condition of human well-being (HWB) system, along with conservation strategies necessary for recovery and long-term protection for ecosystem health (Figure 1).

- Causal chain framework: establishes linkages between human activities that place pressures on selected key environmental states, HWB, and measures (i.e., responses) to manage these pressures and improve conditions. Assessing a complete array of condition and pressure indicators aides the analysis of the causal mechanism underlying ecosystem condition.
- Biophysical framework: dissects Puget Sound into domains and components that describe the major ecological units of this ecosystem (Figure 2), and incorporates conceptual models that describe how ecological attributes and candidate indicators are structurally and functionally linked to collectively describe the structure and processes that maintain ecosystem function in each domain. This biophysical framework and associated conceptual models allows users to identify the key ecosystem attributes and indicators for particular topic area or region of interest.
- HWB framework: dissects the HWB system into components that describe major categories of human well-being and incorporates a conceptual model demonstrating the central role of HWB in ecosystem-based management, broadly characterizing the interrelationships between HWB, human behaviors, components of the ecosystem addressed by conservation strategies, ecosystem services, and the strategies themselves. In this framework, HWB is recognized as an outcome of biophysical condition and a driver of biophysical condition, and that its many components are differentially affected by, and can affect, conservation outcomes.

Guidance on the selection of ecosystem attributes necessary to assess the condition of the Puget Sound biophysical system was based on a biophysical-condition framework proposed by USEPA (2002). EPA's biophysical-condition framework ensures that a sufficiently large set of Essential Ecosystem Attributes (EEAs) of ecosystem structures (i.e., pattern) and processes are selected indicators to fully assess the biophysical condition of the Puget Sound ecosystem. The EEA categories and sub-categories were adapted to be Puget Sound-specific with guidance from various PSEMP work groups. This approach was consistent with previous approaches to select attributes and indicators of the condition of Puget Sound (Levin et al. 2010, James et al. 2012, and Kershner et al. 2012) and was recommended for consideration by the Partnership by O'Neill et al. (2008) and the WSAS (2012).

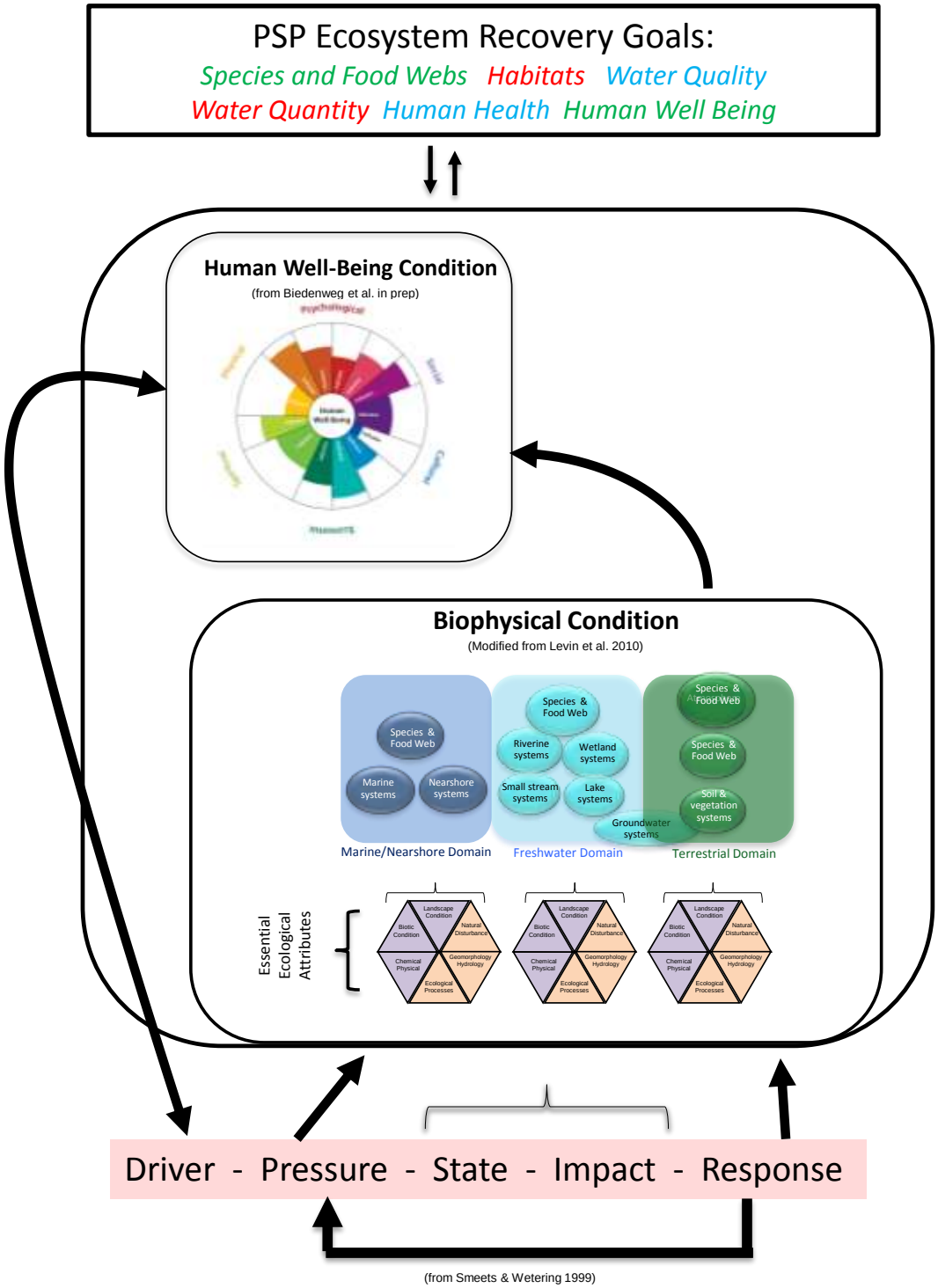

Figure 1. The Puget Sound ecosystems recovery framework to guide selection of essential ecosystem attributes and indicators of the condition of the Puget Sound ecosystem (from O'Neill et al., in prep). See text for details.

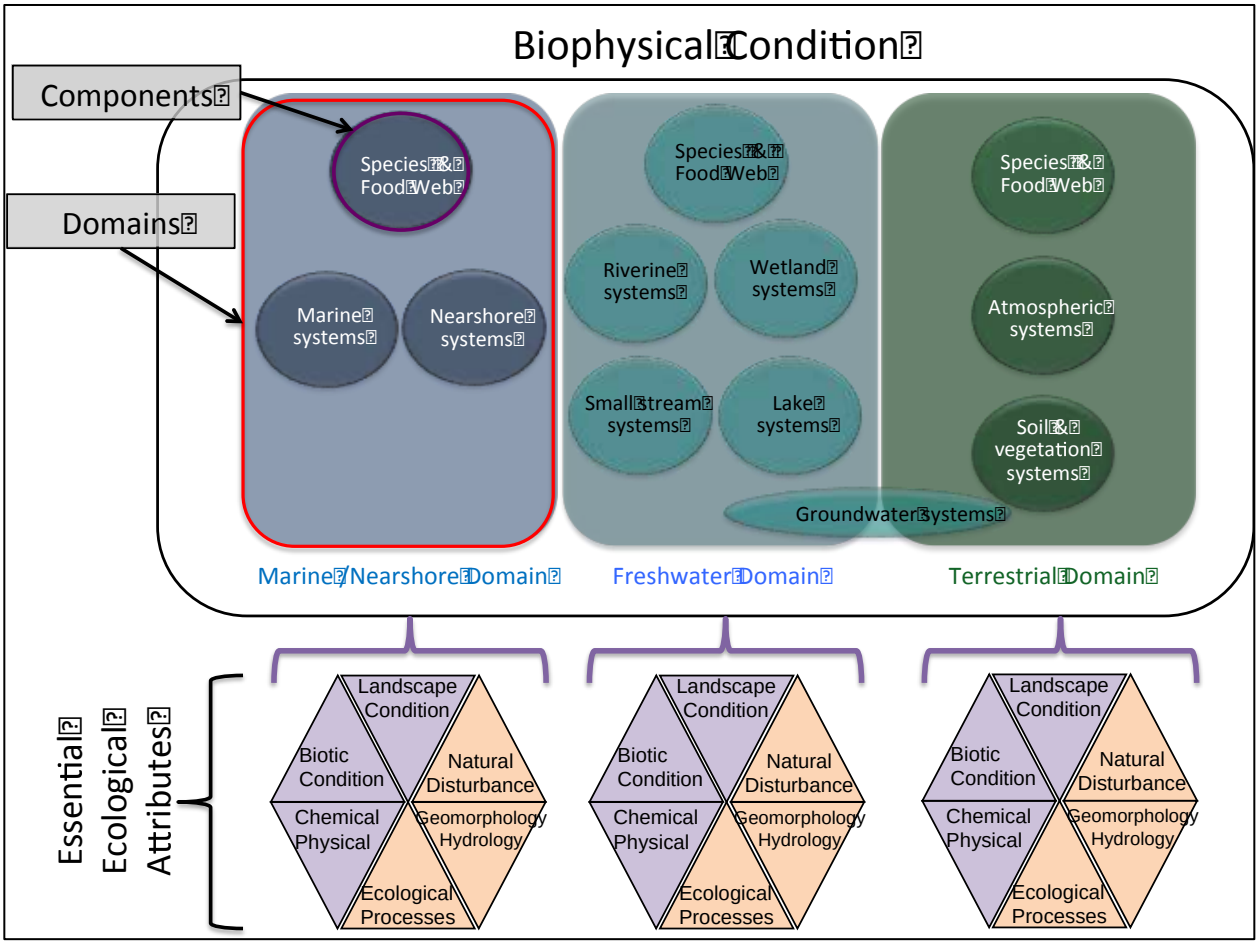

Figure 2. The biophysical condition framework for the Puget Sound Ecosystem (from O'Neill et al., in prep).

In this report we summarize:

- the scope of the SWG (Section 2),
- the prioritization process to identify monitoring gaps and priorities and science support needs for stormwater (Section 3),
- long-term status and trends monitoring to assess the condition of Puget Sound potentially impacted by stormwater (Section 4),
- science support (i.e., source identification and diagnostic monitoring short-term (Section 5), and
- project-specific effectiveness studies Section 6).

2 Scope

The goal of the SWG is to develop and carry out a strategy that improves how stormwater is managed in Puget Sound and provides decision makers with critical information to help them make more informed, more successful decisions (SWG 2010a). A key component of this strategy is a Stormwater Assessment

and Monitoring Program for Puget Sound (SWAMPPS) focused on stormwater-related impacts from urban and urbanizing land uses. The SWG recommended that initially SWAMPPS focus on small streams, nearshore areas, and the full spectrum of urbanizing lands but eventually should include all water bodies and land uses.

Priority water bodies for status and trends monitoring or other regional assessment by the SWG include:

- Small, wadeable streams in Puget Lowlands
- Marine nearshore

Stormwater impacts to lakes and groundwater were not part of the RSMP proposed by the SWG (SWG 2010b).

3 Process to Identify Gaps and priorities

The (SWG) prioritized monitoring needs as part of completing the *2010 Stormwater Monitoring and Assessment Strategy for the Puget Sound Region*. (SWG 2010a). They then identified a subset of those priorities to be conducted as part of a Regional Stormwater Monitoring Program (RSMP) funded by municipal stormwater NPDES permittees in Puget Sound (SWG 2010b). Most recently they identified other priority monitoring efforts that are important to continue because they provide context to the RSMP (SWG 2013), as well as preliminary list of priority effectiveness studies (2013b).

The SWG (2010a) developed a conceptual mode for stormwater (Figure 3) that detailed the types of stressors that should be considered, the pathways by which those stressors are transmitted, and how the outcomes of our management efforts should be assessed, using a Driver-Pressure-State-Impact-Response(DPSIR) conceptual model approach. The State and Impacts portions of the conceptual model reflect the condition of the Puget Sound relative to biological endpoints and beneficial uses in receiving water and aquatic systems.

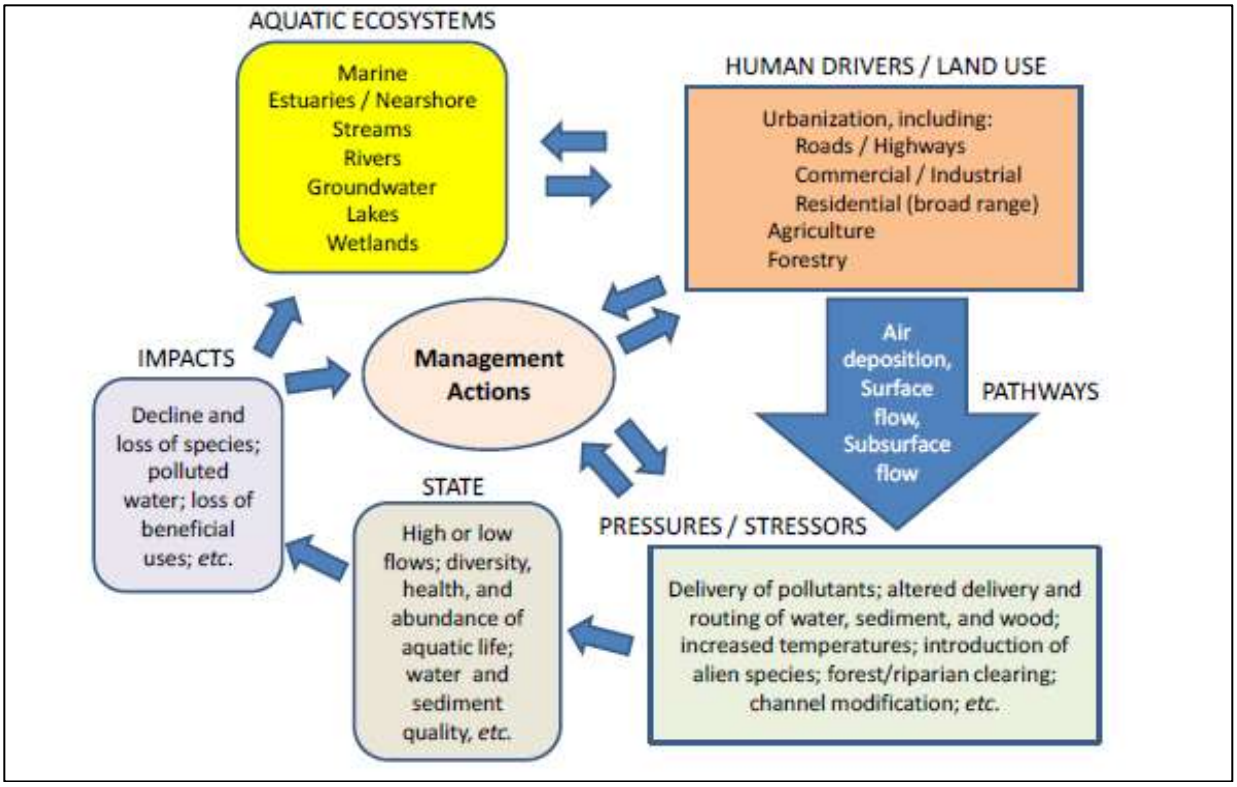

Figure 3. Conceptual Driver-Pressure-State-Impact-Response (DPSIR) model showing the complex interactions of land use and management actions on stressors impacting biological endpoints and beneficial uses in receiving waters and aquatic ecosystems(From SWG 2010a)

The SWG generally set priorities by consensus unless specifically noted. Priorities for RSMP for wadeable streams were based first on a series of 5 assessment questions (Table 1; SWG 2010b) and the appropriate scales most important for the initial launch of the PSMP: all of Puget Sound, only the Puget Sound lowlands, or the WRIAs. By consensus, they agreed that this initial effort should focus on understanding urban and rural areas of the Puget Sound lowlands streams at the regional scale.

Priorities for RSMP for marine nearshore were based on … complete – check with Karen.

Priorities for effectiveness studies were based on … complete – check with Karen.

4 Key Ecosystem Attributes and Indicators- Gaps and Priorities for Monitoring and Science Support Studies

To identify the key ecosystem attributes and indicators for the Puget Sound, we mapped ecosystem characteristics (i.e., ecosystem attributes) described in the stormwater conceptual models, and priority status and trend monitoring and indicators identified in the SWAMPPS and RMP (SWG 2010a, 2010b) onto the biophysical framework of the Puget Sound ecosystem framework described in Figure 2. As the focus of the SWG is on stormwater, not all components and EEAs are applicable. A modified biophysical framework indicating the focus components and EEAs for the SWG are shown in Figure 4.

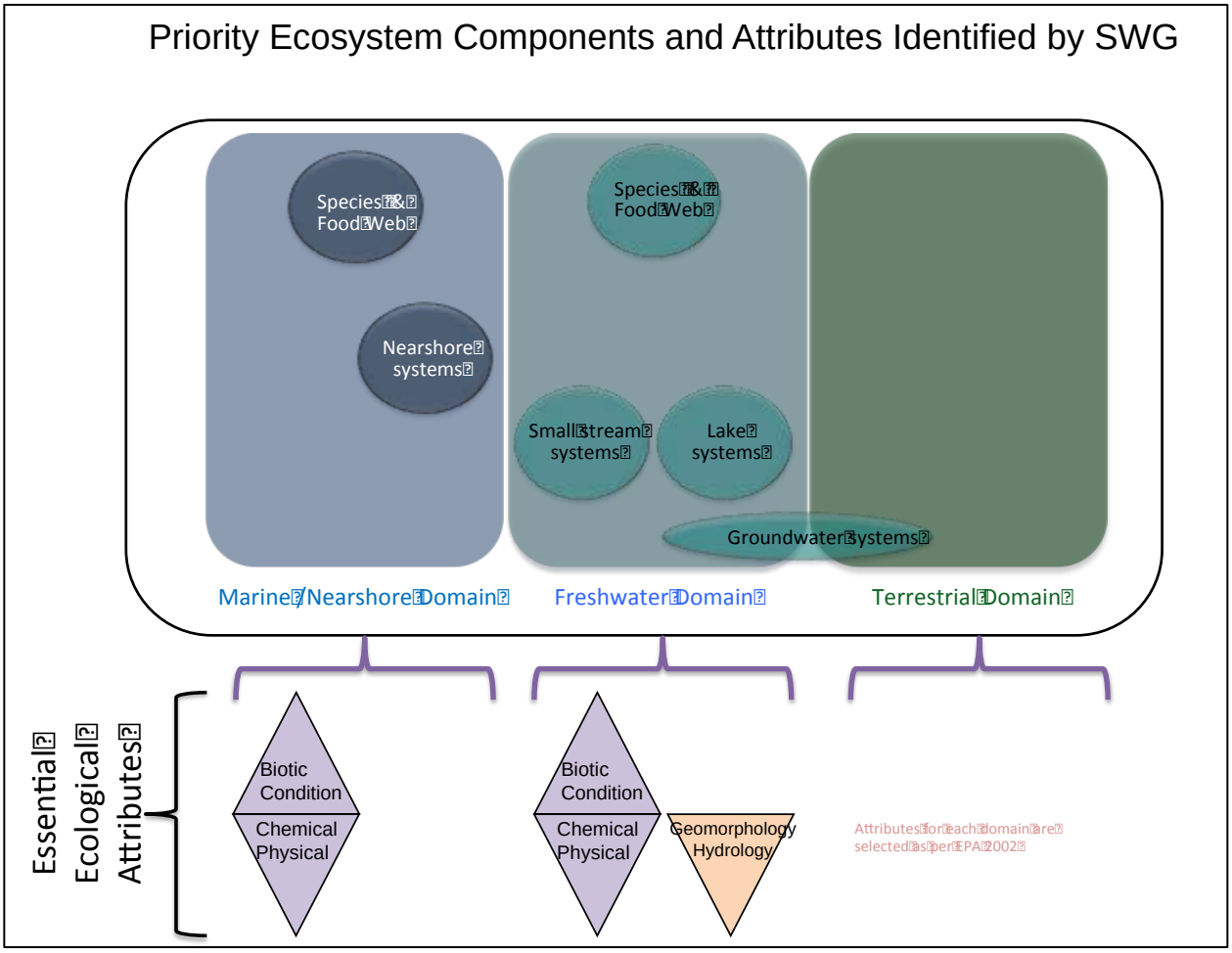

Figure 4.The subset of the biophysical condition framework of interest to the PSEMP SWG. The scope of priority monitoring extends to the marine/nearshore and freshwater domains subset of all components. Only three of the six essential ecosystem attributes (EPA 2002) are included.

The priority monitoring for status and trends as detailed by the SWG (2010a 2010b, 2013a) are classified according to the EEAs categories and sub-categories (Table 1) and will be used in conjunction with other priority monitoring identified by other PSEMP Work Groups to assess the condition of Puget Sound.

Table 1. Priority monitoring for ecosystem condition identified by the PSEMP Stormwater Work Group for major components of the freshwater and marine/nearshore domains of the Puget Sound biophysical system, classified according to the Essential Ecosystem Attribute (EEA) categories and sub-categories defined by EPA (2002). Blank cells denote low monitoring priorities for stormwater. NA = not applicable.

				Freshwater Domain			Marine/ Nearshore Domain
EEA	**EEA Category**	**EEA Sub-category**	**Indicator**	**Wadeable Streams**	**Lakes**	**Ground-water**	**Nearshore System**
Chemical and Physical Characteristics	Trace Organic and Inorganics; Other Chemical Parameters	Metal, Organic compounds; Organic carbon	Sediment Chemistry	RSMP[1] will monitor sediment chemistry for metals and PAHs at 100 sites (50 inside and 50 outside UGA[2] located near WQI and benthos sites).	GAP?		RSMP will monitor sediment chemistry at 30 - 50 sites within UGA (co-located with bacteria sites) once every five years. GAP in UGA. Collected data will be compared with Ecology's ongoing nearshore sediment monitoring data??
	Nutrient Concentrations; Physical Parameters; Other Chemical Parameters;	Nitrogen, Phosphorus, pH, Temperature, Dissolved O_2	Water Quality	RSMP will monitor water quality parameters at 100 sites (50 inside 50 outside UGA located near sediment and benthos sites). These data will be leveraged against Ecology's ongoing stream water quality monitoring program.	GAP?	GAP?	
	Trace Organic and Inorganics;	Metal and Organic Compounds	Pesticides	GAP	GAP?	GAP?	
Hydrology & Geomorphology	Surface and Groundwater Flows	Patterns of Surface Flow	Stream flow	Currently not monitored by RSMP plan but a study is planned to assess sampling design. Leveraged against Ecology's stream flow monitoring and several current active gages that are threatened	NA	NA	NA

Table 1 cont'd. Priority monitoring for ecosystem condition identified by the PSEMP Stormwater Work Group for major components of the freshwater and marine/nearshore domains of the Puget Sound biophysical system, classified according to the Essential Ecosystem Attribute (EEA) categories and sub-categories defined by EPA (2002). Blank cells denote low monitoring priorities for stormwater. NA = not applicable.

				Freshwater Domain			Marine/ Nearshore Domain
EEA	**EEA Category**	**EEA Sub-category**	**Indicator**	**Wadable Streams**	**Lakes**	**Ground-water**	**Nearshore System**
Biotic Condition	Ecosystems and Communities	Community Composition	Benthic Invertebrate Quality (?) B-IBI	RSMP will monitor stream benthos at 100 sites (50 inside and 50 outside UGA located near WQI and sediment sites). Data will be compared to stream benthos database.	GAP?		Gap not addressed; Data could be leveraged against Ecology's nearshore sediment monitoring program.
	Species and Populations	Population Condition	Fish Diversity and Abundance	Gap not addressed	GAP?		
		Population Condition?	Bacteria Levels				RSMP will monitor fecal coliform levels monthly in marine nearshore waters at 50 sites (co-located with sediment sites) within UGA. GAP outside UGA. Data intended for comparison with WDOH bacterial monitoring at shellfish sites but WDOH monitoring was lost in recent budget cuts.
	Organism Condition	Symptoms of Disease	Contaminants in Mussels				RSMP will monitor toxics in mussels at 30 - 50 sites located near stormwater outfalls. Data will be compared with ongoing NOAA/WDFW Mussel Watch programs that are in possible jeopardy.

5 EFFECTIVENESS STUDIES

Copy from Jim Simmonds letter to Ecology (SWG 2013b)

6 SCIENCE SUPPORT STUDIES

Priority science support studies identified in the RMP (2010b) and are summarize below:

Copy from SWG 2010a

Conduct literature review of source identification problems, approaches, and lessons learned in Puget Sound and elsewhere

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