SECTION 1:

RECOVERY CONTEXT

THE CURRENT STATUS OF PUGET SOUND AND CLIMATE CHANGE PROJECTIONS

Cover photo: Creative Commons, courtesy of Ken Smith on Flickr.

Recovery Context: The Current Status of Puget Sound and Climate Change Projections

"Healthy" ecosystems are both functioning and resilient. A functioning ecosystem serves the needs of fish and wildlife and of human populations. When ecosystem conditions are stressed, such as through pollution or resource depletion, it can become more difficult to meet all of these needs. Resilient means that the ecosystem is flexible or adaptable to changes over time that may be caused by humans or natural circumstances. Having some redundancy of species and habitats in the ecosystem (e.g., species live in multiple locations), as well as a representative sample of the species and habitats that were historically present in the ecosystem, can improve the resiliency of the ecosystem.

So what does this mean for Puget Sound? Based on the statutory goals, a healthy Puget Sound supports our well-being and quality of life, the health of our communities, and a thriving economy in the Northwest, both now and in the future. In a healthy Puget Sound, native species are abundant and diverse, and have the habitat they need to thrive. Moreover, Puget Sound waters are also clean and plentiful enough to fully support drinking water and recreational uses, fish and shellfish harvest, and other activities, without causing health concerns or posing environmental risks for fish or wildlife. While we don't expect Puget Sound to return to conditions before European settlers first arrived, we do want to derive many of the same benefits offered them, from a healthy, vibrant Puget Sound in the 21st century and beyond.

PRESSURES ON PUGET SOUND

Recovery targets consider both indicators of the statutorily-established Puget Sound goals and the pressures on the Puget Sound ecosystem that may make recovery difficult. Ecosystem pressures identify human activities that may impact the physical, structural, and ecological processes and functions in the ecosystem. Many of these human activities also may provide direct and indirect benefits to the ecosystem and/or may be relatively neutral to the ecosystem but provide benefits in terms of human quality of life. The goal is not to eliminate human pressures on Puget Sound, but to understand and manage them towards ecosystem protection and recovery.

Current Status of the Ecosystem

The Partnership has adopted indicators for the statutorily-established goals and recovery targets for 18 of the chosen indicators. These indicators and targets are presented on the Puget Sound Vital Signs.

The Vital Signs are updated annually. The State of the Sound, a performance report reviewing the ecological health of the Sound, the funding for the Sound, and the status of the Action Agenda implementation, is updated every two years. The next update is set for November 2012. The Vital Signs are next scheduled for updating in September 2012 as part of the State of the Sound process.

The table below presents the indicators, recovery targets and current status as reported on the current Vital Signs (unless otherwise noted). The current status information is helpful in developing the strategies and actions needed to reach 2020 targets and recovery goals.

GOAL	INDICATOR	~~YEAR~~ 2020 RECOVERY TARGET	~~IMPORTANCE TO PUGET SOUND RECOVERY~~CURRENT STATUS
1. Healthy human population	**On-site sewage**	There are two targets for managing on-site sewage systems: • Inventory and fix all on-site sewage systems in marine recovery areas and other designated sensitive areas and be current with inspections at 95 percent. • Extend this work to cover 90 percent of Puget Sound's unsewered marine shorelines.	Local health jurisdictions and the Department of Health are gathering and mapping data for on-site sewage system inspections. Initial results will be available in 2012 and semi-annually thereafter.
	Swimming beaches	All monitored beaches – currently about 70 locations – meet health standards for what is called enterococcus, a type of fecal bacteria.	Almost half of routinely monitored beaches (about 70 locations) consistently met the standards between 2004 and 2010; another third met the standard except for one or two years. However, in any given year from 2004 - 2010, 7 to 15 beaches failed to meet standards, resulting in the issuance of health advisories to the public.
	Shellfish beds reopened	The target for shellfish beds is to have a net increase of 10,800 acres of harvestable shellfish beds, of which 7,000 acres must be from beds presently classified as prohibited.	Around Puget Sound, there are an estimated 190,000 acres of classified commercial and recreational shellfish beds. According to the State Department of Health, about 36,000 acres – approximately 19 percent – are closed due to pollution sources (primarily fecal bacteria from humans, livestock and pets).
2. Human quality of life	**Puget Sound quality of life index**	The index and targets are being developed with anticipated adoption in 2012-2013. The quality of life index will address aesthetics, recreation, culture, and the economy.	Indicator in development.
	Puget Sound behavior index	The Sound Behavior Index will be a measure of two elements: the public's changing behavior to reduce human impacts on Puget Sound, and social capital. Social capital represents the bonds that bring groups of people and organizations together; it can be measured, and correlates to a variety of social indicators including health, civic participation, and educational achievement. The index is under development.	Data will be available in 2012.
	Recreational fishing permit sales	The ~~governing board of the Puget Sound Partnership, the~~ Leadership Council~~,~~ chose not to set a target for recreational fishing licenses at this time. Desired future conditions will be reflected in the quality of life index.	This indicator is the number of recreational angling and crabbing license holders.
	Commercial fisheries harvest	The ~~governing board of the Puget Sound Partnership, the~~ Leadership Council~~,~~ chose not to set a target for commercial fisheries harvest at this time. Desired future conditions will be reflected in the quality of life index.	This indicator is pounds of all salmon caught in commercial harvest.
3. Species and food web	**Chinook salmon**	Stop the overall decline and start seeing improvements in wild Chinook abundance in two to four populations in each biogeographic region.	Data to be available in 2012.
	Orcas	Achieve an end-of-year census of southern resident killer whales of 95 individuals, which would represent a 1 percent annual average growth rate from 2010 to 2020.	The historic population of Southern Resident Orcas may have numbered around 200 individuals, but by mid-2011, the population totaled fewer than 90 whales. There are currently 17 female orcas capable of bearing young, and orcas generally wait three to five years between pregnancies. Also, about three orcas disappear from

GOAL	INDICATOR	~~YEAR~~ 2020 RECOVERY TARGET	~~IMPORTANCE TO PUGET SOUND RECOVERY~~CURRENT STATUS
			the population every year; generally their fates are unknown.
	Pacific herring	• Achieve increased spawning biomass for each genetic grouping to a minimum of: • 5,000 tons for Cherry Point stock • 880 tons for Squaxin Pass stock • 13,500 tons for all other stocks combine	Overall, the number of herring in Central and Southern Puget Sound has been relatively stable for the past 40 years. However, the population of one large and important stock of Pacific herring, the Cherry Point stock in North Puget Sound, has declined by 90 percent since 1973.
	Birds	The Leadership Council has not yet set a target for this indicator.	
4. Protect and restore habitat	**Shoreline armoring**	The target has three parts: • The amount of armoring removed is greater than the amount of new armoring added, for a net decrease in total armored shoreline. • Efforts should be focused on feeder bluffs (highly erodible bluffs that supply sediment to beaches). • Jurisdictions should require the use of "soft shore" techniques for all new and replacement armoring wherever feasible.	Currently, more than a quarter of all the shoreline around the Sound is armored with bulkheads and seawalls affecting important shoreline processes such as sediment supply and transport. To reduce the total amount of armoring, it will be necessary to minimize the need for new armoring by properly locating new structures and strategically remove existing armoring in key locations. Additionally, using "soft shore" designs for new and replacement armoring will reduce some of the impacts associated with traditional hard armoring.
	Eelgrass	Increase the acres of eelgrass in Puget Sound by 20 percent from the 2000 to 2008 baseline period - an increase from about 53,100 acres to about 63,700.	Though some larger Puget Sound eelgrass beds are stable or possibly increasing in size, many of the smaller more widely dispersed beds are in decline.
	Land development and cover	The target has three parts: • The proportion of basin-wide growth occurring within Urban Growth Areas is at least 86.5% (equivalent to all counties exceeding goal by 3%) and all counties show an increase over their 2000-2010 percentage. • Average annual loss of forested land cover to developed land-cover in non-federal lands does not exceed 1,000 acres per year and 268 miles of riparian vegetation are restored or restoration projects are underway • Basin-wide, loss of vegetation cover on indicator land base over a 5-year period does not exceed 0.15% of the 2011 baseline land area.	The rate of forest conversion to developed land-cover from 2001-2006 was 2,176 acres/year. For the riparian corridor aspect, the footnotes under the target options note that 13,000 riparian acres (equivalent to 268 stream miles) are currently in medium or high density development and 2,100 acres (equivalent to 43.3 stream miles) were converted from vegetated to developed from 1996 to 2006. The 2001-2006 rate of change from vegetative to developed land was 0.26% of the indicator base lands for a six county area (named in the footnote on p. 15); 83 percent of the basin-wide new growth from 2000-2010 occurred within Urban Growth Areas.
	Floodplains	There are two targets for floodplains: • Restore, or have projects underway to restore, 15 percent of Puget Sound floodplain areas. • Have no net loss of floodplain function, in any watershed (for example, due to conversion for development).	Data will be available in 2012. Based on other studies, the National Oceanic and Atmospheric Administration (NOAA) estimates that almost three quarters of wetlands have been lost in Puget Sound, the vast majority of which occurred in floodplains. Floodplains have been lost through a combination of shoreline armoring, levees, and residential, commercial, industrial, and agricultural development.

GOAL	INDICATOR	~~YEAR~~ 2020 RECOVERY TARGET	~~IMPORTANCE TO PUGET SOUND RECOVERY~~CURRENT STATUS
	Estuaries	There are two targets for restoring large river estuaries and the salmon that depend on them: • Meet the 10-year salmon habitat recovery goals in the Nisqually, Skagit, Stillaguamish, Skokomish and Elwha river deltas. More information about those goals can be found at the Washington State Salmon Recovery homepage. • Restore 7,380 acres of river delta marsh and swamp throughout Puget Sound, about 20 percent of the total restoration need.	A number of efforts are now under way to restore estuarine habitat because it is believed to be a bottleneck to the recovery and success of wild salmon and other species. Local groups working with the support of state and federal partners are working hard, watershed by watershed to set local acreage targets, find willing landowners, work through intense local politics, and restore habitat as part of their salmon recovery planning process (see the Habitat Work Schedule). These efforts are technically complex, and require public-private partnerships in a complex landscape. Strong local and state organization is necessary to lay the groundwork to leverage and maintain federal investment.
5. Water quantity	**Summer stream flows**	This indicator has the following river-specific targets: • Maintain stable or increasing flows in highly regulated rivers: Nisqually, Cedar, Skokomish, Skagit, Green. • Monitor low flow in the Elwha River after dam removal. • Maintain stable flows in unregulated rivers that currently are stable: Puyallup, Dungeness, Nooksack. • Restore low flows to bring the Snohomish River from a weakly decreasing trend to no trend. • Restore low flows to bring the Deschutes River, North Fork Stillaguamish River, and Issaquah Creek from a strongly decreasing trend to a weakly decreasing trend.	Low stream flows affect salmon runs, wildlife, and our water supply. Summers in the Puget Sound region are often glorious, with comfortable temperatures and little rain. One result of this great weather is that the flow of water from rivers and streams around the Sound also declines, affecting salmon runs, wildlife, and our water supply. There are other man-made reasons for lower summer stream flows, such as new wells that tap ground water and new buildings and development that cover up the ground and decrease seepage – reducing the amount of water that would reach the stream in summer.
6. Water quality	**Marine water quality**	The Leadership Council adopted the Marine Water Condition Index as an indicator to determine if the overall water quality of Puget Sound is getting better or worse over time. However, they only set a target for one of the 12 components of the index: dissolved oxygen levels, specifically related to how much humans are contributing to dissolved oxygen problems. The target for improved water quality in the Sound is to keep dissolved oxygen levels from declining more than 0.2 milligrams per liter in any part of Puget Sound *as a result of human inputs.*	Because dissolved oxygen concentrations are a result of many natural and human influences, we cannot simply measure dissolved oxygen and understand how much humans contribute directly. This target requires a combination of monitoring data, studies on the sources of nitrogen and sophisticated mathematical models to determine whether human inputs are contributing to a decline in dissolved oxygen. The Washington Department of Ecology and others are currently working on such studies. Initial results will be available sometime in late 2012. At that time we will understand whether humans contribute to low levels of dissolved oxygen and what management actions may be necessary to address them. In the future we will update these results using better models and more recent estimates of nitrogen loads coming into Puget Sound.

GOAL	INDICATOR	~~YEAR~~ 2020 RECOVERY TARGET	~~IMPORTANCE TO PUGET SOUND RECOVERY~~CURRENT STATUS
	Freshwater quality	To improve the quality of freshwater that flows into Puget Sound, the Leadership Council established three major targets: • At least half of all monitored streams should score 80 or above on the fresh water quality index. • Reduce the number of "impaired" waters. • Protect (i.e. allow no degradation of) any small streams that are currently ranked "excellent" for biological condition, and improve water quality in streams ranked "fair" so their average scores become "good".	**Fresh Water Quality Index:** A score of 80 or higher (out of 100) indicates that water quality is generally meeting our goals for sediments, nutrients, temperature, dissolved oxygen, fecal coliform bacteria, and other conventional pollutants (the index does not address toxic contaminants for a number of technical reasons). In general, fresh water quality index scores for the major rivers in Puget Sound have slowly improved since the index was first established in 1995 and now average in the mid-70's range. Scores in small urban streams are lower. **Impaired Waters:** Washington's most recent complete list of impaired waters (2008) shows 1,272 "listings" on 501 different rivers and streams in Puget Sound (an individual stream may be listed as impaired for more than one pollutant or impaired in more than one location). Since 2008, 54 listings (about 4.2 percent) have been addressed by formal Clean-Up Plans. An additional five listings were removed for other reasons. Since about 1998, a total of 570 listings in Puget Sound have been addressed (about 31 percent) by formal Clean-Up Plans. **Biological Condition:** Scientists studying small streams have developed a way to summarize the overall condition of the aquatic biological community using a measure called the Benthic Index of Biological Integrity, or "B-IBI" for short. Data for this measure are more sparse than for conventional water pollutants, but King County recently reported that, for small wadeable lowland streams, 37 percent of sites ranked "good" or "excellent" and 63 percent ranked "fair or poor."
	Marine sediment quality	The Puget Sound Partnership has defined a "functioning, resilient ecosystem to include sediment quality that supports functioning, healthy communities of sediment dwelling invertebrates." This is a clear goal, but determining specific numerical targets is very complex. Accordingly, the Leadership Council adopted several different measures based on accepted scientific methods for assessing marine sediment quality. All Puget Sound regions and bays should: • Have sediment chemistry measures reflecting "minimum exposure", as defined by having a Sediment Chemistry Index (SCI) score of >93.3. • Have combined measures of sediment chemistry, toxicity, and the health of bottom-dwelling marine life reflecting "unimpacted" conditions, as defined by	This status report focuses only on the second target - the Sediment Quality Triad index (SQTI), as an overall summary of sediment quality in Puget Sound. Eight regions were sampled between 1997 and 2003 in Puget Sound (Hood Canal, Strait of Georgia, Whidbey Basin, Central Sound, South Sound, San Juan Islands, Strait of Juan de Fuca, and Admiralty Inlet). Four of the eight regions met or exceeded the target value for sediment quality. Of the three regions re-sampled between 2004 and 2012, two (Hood

GOAL	INDICATOR	~~YEAR~~ 2020 RECOVERY TARGET	~~IMPORTANCE TO PUGET SOUND RECOVERY~~CURRENT STATUS
		having a Sediment Quality Triad Index (SQTI) score of >83. • Have no chemistry measurements exceeding the Sediment Quality Standards set in Washington State	Canal and Strait of Georgia) showed declining SQTI scores due to poor biological community values; the other, Whidbey Basin, showed an improvement. Results are not yet available for the remaining regions either because they are being analyzed or will be sampled.
	Toxics in fish	The Leadership Council (LC) adopted several different sets of targets related to reducing toxic contaminants in fish. They include: • Reducing levels of PCBs and related compounds in salmon, herring, and English sole (a bottom-dwelling flatfish) below: • a threshold related to fish health, and • a threshold related to human health. • Reducing concentrations of two other classes of toxic contaminants (abbreviated as PAHs and EDCs), in herring and English sole below several different thresholds for harmful effects in fish. The Vital Signs report focuses only on one chemical in the first target (PCBs) as it relates to the fish health threshold. *As data become available for the other targets, those results will be added to the report.*	Results are mixed. In recent years, four of the five species of salmon were almost always below the threshold. But 15% of adult Chinook salmon that were sampled, and 100% of juvenile Chinook exceeded the threshold. This is most likely because Puget Sound Chinook salmon spend more time in Puget Sound close to PCB sources and are more likely to eat contaminated prey (e.g. herring). The other four species of salmon tend to spend more of their life in the Pacific Ocean where PCB levels are lower. For Pacific herring, from 30-82% of sampled fish exceeded the threshold levels for contamination, with herring from Puget Sound's most urbanized basin showing the highest levels. Nearly all (95%) of English sole from urban bays exceeded the threshold, compared to only 30% which exceeded the threshold in rural bays (still above the target).

Climate Change Projections in Puget Sound

Climate change is key part of Puget Sound recovery context. The climate is already changing, and we will increasingly experience the effects of climate change. In 2012 and 2013, the Puget Sound Partnership and the Puget Sound Institute are working with UW Climate Impacts group to synthesize and update the growing body of climate change science that has emerged since publication of *Uncertain Future: Climate Change and Its Effects on Puget Sound* in 2005[1]. This new information will become part of the *Puget Sound Science Update.* The climate change pressures summary below is drawn from the 2010 *Puget Sound Science Update* (Chapter 3), with additional review by the Climate Impacts Group.

Climate change pressures in Puget Sound include:

- **Changes in streamflow timing and volume**. Watersheds with streamflow based mostly or partially on snowmelt are projected to have the greatest hydrological shifts associated with climate change. Impacts to streamflow include earlier peak streamflows, decreasing runoff in late spring and summer, and increasing runoff in fall and winter.

- **Temperature changes.** Over the last century (1900-2000), average air temperature in the Puget Sound region increased 2.3°F[2]. Average annual and seasonal temperature is expected to increase over the coming century, although natural climate variations will continue to cause substantial variability between years and decades. Relative to 1970-1999, average annual temperature in the Pacific Northwest is projected to increase about 2°F by the 2020s (range: 1.1°F to 3.4°F), 3.2°F by the 2040s (range: 1.6°F to 5.2°F), and 5.3°F (range: +2.8°F to +9.7°F) by the 2080s[3]. Most models project an enhanced seasonal precipitation cycle with wetter winters and drier summers, although the region's large natural variations in precipitation will make it difficult to distinguish the influence of climate change on Northwest precipitation in the next few decades[4].

- **Loss of snowpack and glacial retreat.** The loss of snowpack and glacial retreat are one of the most far-reaching impacts of rising temperature, affecting water availability for both people and wildlife. Under a moderate warming scenario (the A1B greenhouse emissions scenario), average spring snowpack in Washington State is projected to decrease 29% by the 2020s, 44% by the 2040s, and 65% by the 2080s, relative to the average for 1916-2006[5].

  This decline in snowpack contributes to lower spring runoff in snow-fed rivers and streams and lower summer streamflows. Warmer spring temperatures also reduce late spring and summer streamflows by shifting the timing of peak snowmelt runoff earlier into the spring season.

[1] Snover, A.K., P.W. Mote, L.C. Whitely Binder, A.F. Hamlet, and N.J. Mantua. 2005. *Uncertain Future: Climate Change and Its Effects on Puget Sound*. Climate Impacts Group, Center for Science in the Earth System, Joint Institute for the Study of the Atmosphere and Oceans, University of Washington. Available at: http://cses.washington.edu/db/pdf/snoveretalpsat461.pdf

[2] Source: Snover, A.K., P.W. Mote, L.C. Whitely Binder, A.F. Hamlet, and N.J. Mantua. 2005. *Uncertain Future: Climate Change and Its Effects on Puget Sound*. Climate Impacts Group, Center for Science in the Earth System, Joint Institute for the Study of the Atmosphere and Oceans, University of Washington.

[3] Mote, P.W., and E.P. Salathé. 2010. Future climate in the Pacific Northwest. *Climatic Change* 102(1-2): 29-50, doi: 10.1007/s10584-010-9848-z.

[4] Mote and Salathé 2010 (see previous)

[5] Elsner, M.M., L. Cuo, N. Voisin, J. Deems, A.F. Hamlet, J.A. Vano, K.E.B. Mickelson, S.Y. Lee, and D.P. Lettenmaier. 2010. Implications of 21st century climate change for the hydrology of Washington State. *Climatic Change* 102(1-2): 225-260, doi: 10.1007/s10584-010-9855-0.

- **Sea Level Rise.** Global sea level is rising due to ocean thermal expansion and melting of land-based ice sheets. A medium estimate of sea level rise in the Puget Sound region is +6 inches (range of 3 to 22 inches) by 2050 and +13 inches (range of 6 to 50 inches) by 2100[6]. Changes at specific locations within Puget Sound will vary from these regional projections depending on local factors, including uplift or subsidence rates. Major impacts associated with sea level rise are likely to be inundation of low-lying areas, flooding, erosion and infrastructure damage, with the largest impacts occurring when storm and/or river flooding events converge with high tides. Shifts in or loss of coastal habitat types is another major concern associated with sea level rise.

- **Ocean Acidification.** As the global ocean absorbs atmospheric carbon dioxide, these increasing concentrations are reducing ocean pH and carbonate ion concentrations, resulting in ocean acidification. Impacts of ocean acidification include altered marine food web, loss of shellfish production, and impacts to the growing environment for sea grasses like eelgrass.

Climate change scenarios are modeled estimates of how climate change and related impacts may unfold in the Pacific Northwest in the coming decades. As such, climate change scenarios they are *projections*, not specific predictions. While scientists expect that the direction of trends (e.g., increasing or decreasing) in temperature, snowpack, sea level rise, and other important variables will remain consistent over the 21st century or longer, the specific values (e.g., specific temperature changes) will change over time as: modeling capabilities increase, greenhouse gas emissions change, and our understanding of global and regional sensitivity to climate change increases.

Puget Sound climate is also affected by large-scale patterns of natural variability, particularly the El Niño/Southern Oscillation (ENSO) and Pacific Decadal Oscillation (PDO). While it is not clear at this time how climate change will affect the frequency or intensity of ENSO or PDO, we should expect continued year-to-year and decade-to-decade variability in regional conditions even as the long-term mean around which we vary is affected by climate change.

Climate Change Impacts and Risks in Puget Sound

In the recently released, *Preparing for a Changing Climate: Washington State's Integrated Climate Response Strategy* (April 2012), risks and impacts across the state are summarized as presented below. Specific impacts to natural resources and Puget Sound communities will vary. Where local information is available, it is presented in the subject-specific parts of the Action Agenda or in the local profiles. Part of the work underway with the UW Climate Impacts Group will be to update and call out geographically-specific changes and risks.

[6] Mote, P.W., A. Petersen, S. Reeder, H. Shipman, and L.C. Whitely Binder. 2008. *Sea Level Rise in the Coastal Waters of Washington State*. Report prepared by the Climate Impacts Group, Center for Science in the Earth System, Joint Institute for the Study of the Atmosphere and Oceans, University of Washington, Seattle, Washington and the Washington Department of Ecology, Lacey, Washington.

- **Severe consequences to human health** from increased injuries and disease due to higher temperatures, heat waves, declining urban air quality, and smoke from more frequent wildfires. More frequent extreme storms are likely to cause river and coastal flooding that could lead to increased injuries and loss of life.

- **Increased damage costs and disruptions** to communities, transportation systems, and other infrastructure. Damage to roads, bridges, ports, rail, power and communication transmission systems, and communities due to extreme storms, flooding, erosion, landslides, sea level rise, and storm surges could occur. In Puget Sound counties, structures valued at $29 billion are located in flood hazard areas. Ports, rail, highways, wastewater treatment plans, and other infrastructure could require retrofits or relocation to accommodate rising sea levels and stronger coastal storms.

- **Reduced summer water supply**. Increasing temperatures will significantly reduce snowpack in the Cascade and Olympic Mountains. This will lead to reduced summer streamflows, reduced soil moisture, higher summer stream temperatures, and an increased risk of drought for Washington's water users, including agriculture, municipalities, and fish and wildlife. Increased water demand could increase the potential for conflict among users.

- **Loss of fish, wildlife, and natural systems**. Species will be forced to move northward or higher in elevation, and some will perish. Higher summer stream temperatures and reduced flows are projected to increase lethal stream conditions for salmon and other coldwater species. Increased forest fires will destroy habitat, leading to erosion and degraded water quality. Sea level rise is projected to eliminate valuable habitat, and increasing ocean acidity and upland runoff threatens shellfish aquaculture.

- **Losses to agriculture and forest industries.** Increased disease, pests, weeds, and fire, along with reduced summer water supplies, are already affecting Washington's farms and forests. Crops and yields are also likely to be impacted.