APPENDIX B: INVENTORY OF RECENTLY COMPLETELY AND ON-GOING RESEARCH

Inventory of Recently Completed/Ongoing Scientific Studies

Ref #	Ecosystem Component	Primary Pressure	Action Area	Study Title	Date	Author(s) or Study Contact	Supporting Agency	General Study Design/Methods	Study Results	Weblink	Journal Citation (if applicable)
C0340	All	Climate Change	All	A high-resolution climate model for the U.S. Pacific Northwest: Mesoscale feedbacks and local responses to climate change	2008	Salathé, E.P., R. Steed, C.F. Mass, and P. Zahn	UW Climate Impacts Group	Present-day (1990-1999) and future (2020-2029, 2045-2054, and 2090-2099) conditions are simulated at high resolution (15-km grid spacing) using the MM5 model system and forced by ECHAM5 global simulations. Simulations use the IPCC Special Report on Emissions Scenarios (SRES) A2 emissions scenario, which assumes a rapid increase in greenhouse gas concentrations.	Simulations of future climate scenarios produced with a high-resolution climate model show markedly different trends in temperature and precipitation over the Pacific Northwest than in the global model in which it is nested, apparently due to mesoscale processes not resolved at coarse resolution. Simulations of future climate scenarios produced with a high-resolution climate model show markedly different trends in temperature and precipitation over the Pacific Northwest than in the global model in which it is nested, apparently due to mesoscale processes not resolved at coarse resolution	http://cses.washington.edu/db/pubs/allpubs.shtml#Year2008	Journal of Climate 21(21): 5708–5726,
C0341	All	Climate Change	All	The Washington Climate Change Impacts Assessment	2009	M. McGuire Elsner, J. Littell, and L. Whitely Binder (eds)	UW 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)	The Washington Climate Change Impacts Assessment (WACCIA) involved developing updated climate change scenarios for Washington State and using these scenarios to assess the impacts of climate change on the following sectors: agriculture, coasts, energy, forests, human health, hydrology and water resources, salmon, and urban stormwater infrastructure. Adaptation in each of these sectors was also discussed.	see specific chapters for results	http://cses.washington.edu/db/pubs/allpubs.shtml#Year2009	Sections of the WACCIA were also published in a 2010 issue of Climatic Change 102(1-2)
C0342	All	Climate Change	All	Future climate in the Pacific Northwest	2009	Mote, P.W., and E.P. Salathé	UW Climate Impacts Group	Chapter 1 in The Washington Climate Change Impacts Assessment: Evaluating Washington's Future in a Changing Climate, Climate Impacts Group, University of Washington, Seattle, Washington.	Climate models used in the IPCC AR4 project increases in annual temperature of, on average, 1.1°C (2.0°F) by the 2020s, 1.8°C (3.2°F) by the 2040s, and 3.0°C (5.3°F) by the 2080s, compared with the average from 1970 to 1999, averaged across all climate models. Rates of warming range from 0.1 to 0.6°C (0.2° to 1.0°F) per decade. Projected changes in annual precipitation, averaged over all models, are small (+1 to +2%), but some models project an enhanced seasonal cycle with changes toward wetter autumns and winters and drier summers.	http://cses.washington.edu/db/pubs/allpubs.shtml#Year2009	Climatic Change 102(1-2): 29-50, doi: 10.1007/s10584-010-9848-z.
C0343	Nearshore - Species & Food Webs	Invasives - Marine	All	Recent trends in paralytic shellfish toxins in Puget Sound, relationships to climate, and capacity for prediction of toxic events	2008	Moore, S.K., N.J. Mantua, B.M. Hickey, and V.L. Trainer	UW Climate Impacts Group	Temporal and spatial trends in paralytic shellfish toxins (PSTs) in Puget Sound shellfish and their relationships with climate are investigated using long-term monitoring data since 1957.Analyses were limited to the shellfish species Mytilus edulis at 20 sites from 1993 to 2007.	Using blue mussel data only, we find no robust evidence to suggest that the frequency, magnitude, duration, or geographic scope of PST events in Puget Sound increased between 1993 and 2007. However, there is a significant basin-wide trend for closures to occur earlier in the year. There are no significant correlations between annual indices of mussel toxicity and aspects of the local and large-scale climate.	http://cses.washington.edu/db/pubs/allpubs.shtml#Year2008	Harmful Algae Feb2009, Vol. 8 Issue 3, p463
C0344	Terrestrial - Species & Food Webs	Climate Change	All	Impacts of climate change on key aspects of freshwater salmon habitat in Washington State	2009	Mantua, N.J., I. Tohver, and A.F. Hamlet	UW Climate Impacts Group	Chapter 6 in The Washington Climate Change Impacts Assessment: Evaluating Washington's Future in a Changing Climate, Climate Impacts Group, University of Washington, Seattle, Washington	The combined effects of warming stream temperatures and altered streamflows will very likely reduce the reproductive success for many salmon populations in Washington watersheds, but impacts will vary according to different life history-types and watershed-types. Salmon populations having a stream type life history with extended freshwater rearing periods (i.e. steelhead, coho, sockeye and stream-type Chinook) are predicted to experience large increases in hydrologic and thermal stress in summer due to diminishing streamflows and increasingly unfavorable stream temperatures. Salmon with an ocean-type life history (with relatively brief freshwater rearing periods) are predicted to experience the greatest freshwater productivity declines in transient runoff watersheds where future warming is predicted to increase the magnitude and frequency of winter flooding that reduces egg-to-fry survival rates.	http://cses.washington.edu/db/pubs/allpubs.shtml#Year2009	Climatic Change 102(1-2): 187-223, doi: 10.1007/s10584-010-9845-2
C0345	Terrestrial - Species & Food Webs	Climate Change	All	Potential responses to climate change in organisms with complex life histories: Evolution and plasticity in Pacific salmon	2008	Crozier, L.G., A.P. Hendry, P.W. Lawson, T.P. Quinn, N.J. Mantua, J. Battin, R.G. Shaw, and R.B. Huey	UW Climate Impacts Group	We present a conceptual model of how changing environmental conditions shift phenotypic optima and, through plastic responses, phenotype distributions, affecting the force of selection. Our predictions are tentative because we lack data on the strength of selection, heritability, and ecological and genetic linkages among many of the traits discussed here	We know little about ocean migration pathways, so cannot confidently suggest the potential changes in this life stage. Climate change might produce conflicting selection pressures in different life stages, which will interact with plastic (i.e. nongenetic) changes in various ways.	http://cses.washington.edu/db/pubs/allpubs.shtml#Year2008	Evolutionary Applications 1(2): 252–270, doi:10.1111/j.1752-4571.2008.00033.x.
C0346	Terrestrial - Water	Climate Change	All	Climate change impacts on water management in the Puget Sound region, Washington, USA	2009	Vano, J.A., N. Voisin, L. Cuo, A.F. Hamlet, M.M. Elsner, R.N. Palmer, A. Polebitski, and D.P. Lettenmaier	UW Climate Impacts Group	Chapter 3.2 in The Washington Climate Change Impacts Assessment: Evaluating Washington's Future in a Changing Climate, Climate Impacts Group, University of Washington, Seattle, Washington	We extend ongoing efforts in the Puget Sound basin cities of Everett, Seattle, and Tacoma to characterize differences between historic and future streamflow and the ability of the region's water supply systems to meet future demands. Over the next century, under average conditions, all three water supply systems (Everett, Seattle, and Tacoma) are projected to experience a decline and eventual disappearance of the springtime snowmelt peak in their inflows. How these shifts impact water management depends on the specifics of the reservoir system and their operating objectives, site-specific variations in the influence that reductions in snowmelt have on reservoir inflows, and the adaptive capacity of each system. Without adaptations, average seasonal drawdown of reservoir storage is projected to increase in all of the systems throughout the 21st century. The reliability of the three water supply systems in the absence of demand increases is, however, generally robust to climate changes through the 2020s, and in the 2040s and 2080s reliability remains above 98% for the Seattle and Everett systems. With demand increases, however, system reliability is progressively reduced by climate change impacts.	http://cses.washington.edu/db/pubs/allpubs.shtml#Year2009	Climatic Change 102(1-2): 287-317, doi: 10.1007/s10584-010-9856-z
C0347	Terrestrial - Water	Climate Change	All	Precipitation extremes and the impacts of climate change on stormwater infrastructure in Washington State	2009	Rosenberg, E.A., P.W Keys, D.B. Booth, D. Hartley, J. Burkey, A.C. Steinemann, and D.P. Lettenmaier	UW Climate Impacts Group	Chapter 9 in The Washington Climate Change Impacts Assessment: Evaluating Washington's Future in a Changing Climate, Climate Impacts Group, University of Washington, Seattle, Washington	We examined both historical precipitation records and simulations of future rainfall to evaluate past and prospective changes in the probability distributions of precipitation extremes across Washington State. Few statistically significant changes in extreme precipitation were observed in the historical records, with the possible exception of the Puget Sound. RCM simulations generally indicate increases in extreme rainfall magnitudes throughout the state, but the range of projections is too large to predicate engineering design, and actual changes could be difficult to distinguish from natural variability. Nonetheless, the evidence suggests that drainage infrastructure designed using mid-20th century rainfall records may be subject to a future rainfall regime that differs from current design standards.	http://cses.washington.edu/db/pubs/allpubs.shtml#Year2009	Climatic Change 102(1-2): 319-349, doi: 10.1007/s10584-010-9847-0.
C0348	Terrestrial - Habitats	Climate Change	All	Forest ecosystems, disturbance, and climatic change in Washington State, USA	2009	Littell, J.S., E.E. Oneil, D. McKenzie, J.A. Hicke, J.A. Lutz, R.A. Norheim, and M.M. Elsner	UW Climate Impacts Group	Chapter 7 in The Washington Climate Change Impacts Assessment: Evaluating Washington's Future in a Changing Climate, Climate Impacts Group, University of Washington, Seattle, Washington	We address the role of climate in four forest ecosystem processes and project the effects of future climatic change on these processes: 1) In areas where Douglas-fir is not water-limited, future growth will continue to vary with interannual climate variability, but in places where Douglas-fir is water-limited, growth is likely to decline due to projected increase in summer potential evapotranspiration. 2) By the mid 21st century, some areas of the interior Columbia Basin and eastern Cascades are likely to have climates poorly suited to pine species that are susceptible to mountain pine beetle, and if these pines are climatically stressed, they may be more vulnerable to pine beetle attack. 3) Regional area burned is likely to double or even triple by the end of the 2040s, although Washington ecosystems have different sensitivities to climate and thus different responses to climatic change. 4) Host tree vulnerability is closely related to vapor pressure deficit (VPD), and future projections support the hypothesis that summer VPD will increase over a significant portion of the range of host tree species. Due to the increased host vulnerability, MPB populations are expected to become more viable at higher elevations leading to increased incidence of MPB outbreaks.	http://cses.washington.edu/db/pubs/allpubs.shtml#Year2009	Climatic Change 102(1-2): 129-158, doi: 10.1007/s10584-010-9858-x.
C0349	Humans - Health	Climate Change	All	Public health impacts of climate change in Washington State: projected mortality risks due to heat events and air pollution	2009	Jackson, J.E., M.G. Yost, C. Karr, C. Fitzpatrick, B. Lamb, S.H. Chung, J. Chen, J. Avise, R.A. Rosenblatt, and R.A. Fenske	UW Climate Impacts Group	Chapter 10 in The Washington Climate Change Impacts Assessment: Evaluating Washington's Future in a Changing Climate, Climate Impacts Group, University of Washington, Seattle, Washington	Study examined the historical relationship between age- and cause-specific mortality rates and heat events at the 99th percentile of humidex values in the greater Seattle area (King, Pierce and Snohomish counties), Spokane County, the Tri-Cities (Benton and Franklin counties) and Yakima County from 1980 through 2006; the relative risk of mortality during heat events compared with more temperate periods were then applied to population and climate projections for Washington State to calculate number of deaths above the baseline (1980-2006) expected to occur during projected heat events in 2025, 2045 and 2085. In the greater Seattle area, the largest number of excess deaths in all years and scenarios was predicted for persons aged 65 and above. Under the middle scenario, this age group is expected to have 96 excess deaths in 2025, 148 excess deaths in 2045 and 266 excess deaths in 2085 from all non-traumatic causes.	http://cses.washington.edu/db/pubs/allpubs.shtml#Year2009	Climatic Change 102(1-2): 159-186, doi: 10.1007/s10584-010-9852-3.
C0350	Terrestrial - Habitats	Residential, Commercial, Port & Shipyard Development	All	Effects of a century of land cover and climate change on the hydrology of Puget Sound basin	2009	Cuo, L., D.P. Lettenmaier, M. Alberti, and J.E. Richey	UW Climate Impacts Group	Using a spatially distributed hydrology model (the Distributed Hydrology-Soil-Vegetation Model, DHSVM) the concurrent effects of changing climate (primarily temperature) and land cover in the basin are deconvolved, based on land cover maps for 1883 and 2002, and gridded climate data for 1915-2006	It is found that land cover and temperature change effects on streamflow have occurred differently at high and low elevations. In the lowlands, land cover has occurred primarily as conversion of forest to urban or partially urban land use, and here the land cover signal dominates temperature change. In the uplands, both land cover and temperature change have played important roles.	http://cses.washington.edu/db/pubs/allpubs.shtml#Year2009	Hydrological Processes 23: 907-933
C0351	Terrestrial - Water	Climate Change	All	Assessing the impacts of global warming on snowpack in the Washington Cascades	2009	Casola, J.H., L. Cuo, B. Livneh, D.P. Lettenmaier, M. Stoelinga, P.W. Mote, and J.M. Wallace.	UW Climate Impacts Group	The decrease in mountain snowpack associated with global warming is difficult to estimate in the presence of the large year-to-year natural variability in observations of snow water equivalent. A more robust approach for inferring the impacts of global warming is to estimate temperature sensitivity λ of spring snowpack and multiply it by putative past and future temperature rises observed across the Northern Hemisphere.	Considering various rates of temperature rise over the Northern Hemisphere, it is estimated that spring snow water equivalent in the Cascades portion of the Puget Sound drainage basin should have declined by 8-16% over the past 30 years due to global warming and it can be expected to decline by another 11-21% by 2050.	http://cses.washington.edu/db/pubs/allpubs.shtml#Year2009	Journal of Climate 22:2758-2772
C0352	Terrestrial - Water	Climate Change	All	Has spring snowpack declined in the Washington Cascades?	2008	Mote, P.W., A.F. Hamlet, and E.P. Salathé	UW Climate Impacts Group	Analysis of long term records of 49 snow survey locations in Washington's Cascades and Olympics.	Our best estimates of 1 April snow water equivalent (SWE) in the Cascade Mountains of Washington State indicate a substantial (roughly 15–35%) decline from mid-century to 2006, with larger declines at low elevations and smaller declines or increases at high elevations.	http://cses.washington.edu/db/pubs/allpubs.shtml#Year2008	Hydrology and Earth System Sciences 12: 193-206
C0353	Nearshore - Habitats	Shoreline Armoring	All	Puget Sound Shorelines and the Impacts of Armoring— Proceedings of a State of the Science Workshop, May 2009	2011	Shipman, H., Dethier, M.N., Gelfenbaum, G., Fresh, K.L., and Dinicola, R.S., eds.	US Geological Survey	Results of scientific workshop in May 2009	22 papers within five topics (some papers are summaries of scientific papers published in journals; those relevant to this inventory are listed separately along with journal citation)	http://pubs.usgs.gov/sir/2010/5254/	
C0354	Marine - Water	Non-Point Source Loading & Runoff	All	Control of Toxic Chemicals in Puget Sound, Phase 2: Pollutant Loading Estimates for Surface Runoff and Roadways	Nov-08	Enviro Vision, Herrera, Ecology	Washington Department of Ecology	Literature Review, GIS analyses, Computation of loading estimates for 17 toxic chemicals of concern	For the entire Puget Sound Basin, total loading estimates were generally greatest for residential land use, which was the largest source for 14 of the 17 toxic chemicals of concern. Forest/field/other areas were the largest source for three toxic chemicals of concern (arsenic, mercury, and DDT and metabolites). For 10 of the toxic chemicals considered, highways had the lowest total loading estimates of all the land use categories. The total contribution of toxic chemical loadings from highways was between less than 1 percent to 14 percent of the total loading from surface runoff to Puget Sound, depending on the specific chemical.	http://www.ecy.wa.gov/biblio/0810084.html	

Inventory of Recently Completed/Ongoing Scientific Studies

Ref #	Ecosystem Component	Primary Pressure	Action Area	Study Title	Date	Author(s) or Study Contact	Supporting Agency	General Study Design/Methods	Study Results	Weblink	Journal Citation (if applicable)
C0355	Terrestrial - Water	Non-Point Source Loading & Runoff	King County	Vashon-Maury Island 2009 Water Resources Data Report	2010	King County	King County	This study is evaluating the role of nitrogen in the risk of low oxygen events in Quartermaster Harbor, to recommend policy changes in the 2012 King County Comprehensive Plan update for nitrogen management on Vashon-Maury Island, and to assess management options for implementing the recommended policy changes. This report summarizes the monitoring activities completed during the water year 2009 for the Water Resource Evaluation (WRE) Project.	The difference in total precipitation between water year 2008 and 2009 varied across the island from a 4.8 inch to 3.8 inch decrease. Stream gauging activities recorded decreases in stream flow at four out of the five sites when comparing water year 2009 to water year 2008. Bacteria data show two large spikes not seen in previous water years. Overall, the water quality of the groundwater on VMI is very good as compared to drinking water standards.	http://www.kingcounty.gov/environment/waterandland/groundwater/management-areas/vashon-maury-island-gwma/vashon-island/WRE-data-report.aspx	
C0356	Terrestrial - Water	Agriculture & Livestock Grazing	San Juan/Whatcom	Quality Assurance Project Plan: Effects of Conventional versus Minimum Tillage on Groundwater Nitrate at a Manured Grass Field	2009	Carey, B.	Washington Department of Ecology	This is the study plan for effects of conventional versus minimum tillage on groundwater nitrate at a manured grass field.	The field has been divided in half for the 2009-11 study, with three shallow monitoring wells in each half. One half received conventional tillage, and the other half minimum tillage. Groundwater monitoring will be conducted four times per year for both years.	http://www.ecy.wa.gov/biblio/0903126.html	
C0357	Terrestrial - Water	Agriculture & Livestock Grazing	San Juan/Whatcom	Nitrate Trends in the Central Sumas-Blaine Surficial Aquifer	2008	Redding, M.	Washington Department of Ecology	This groundwater quality monitoring study was designed to determine nitrate trends and to establish the framework for a long-term groundwater monitoring network in the central Sumas-Blaine surficial aquifer in Whatcom County. During 2003-05, groundwater was sampled for nitrate-nitrogen every other month for two years from 35 wells.	The results of this study reinforce findings from previous studies: groundwater contains elevated nitrate concentrations, with concentrations as high as 43 mg/l. Additionally, it was determined that there is an increasing nitrate trend at a rate of 0.46 mg/l per year.	http://www.ecy.wa.gov/biblio/0803018.html	
C0358	Marine - Water	Wastewater Treatment Plant Discharge & CSOs	All	Control of Toxic Chemicals in Puget Sound, Phase 2: Improved Estimates of Loadings from Dischargers of Municipal and Industrial Wastewater	Nov-08	Enviro Vision, Herrera, Ecology	Washington Department of Ecology	Refine the initial toxic chemical loading estimates from the Phase 1 project and to incorporate additional information on toxic chemical loadings from permitted dischargers of wastewater.	The primary conclusion from this Phase 2 analysis is that the contributions of toxic chemicals from wastewater dischargers were small relative to the total loadings from all of the major loading sources to Puget Sound (including, for example, atmospheric deposition and surface runoff). For those pollutants with sufficient data, the estimated portion of the total loadings from wastewater dischargers ranged from 1.4 to 7.0 percent of the total loading to Puget Sound. Surface runoff has been the largest contributing source of toxic chemicals to Puget Sound. With the exception of chloroform and mercury, municipal wastewater treatment plants discharged significantly more toxic chemicals than did industrial dischargers.	http://www.ecy.wa.gov/biblio/0810089.html	
C0359	Terrestrial - Water	Water Withdrawals & Diversions	San Juan/Whatcom	Quality Assurance Project Plan: Sumas-Blaine Surficial Aquifer Long-Term Ambient Groundwater Monitoring	2009	Redding, M.	Washington Department of Ecology	This study is designed to build on the previous monitoring efforts in order to provide an annual assessment of the status of the groundwater quality. Additionally, this monitoring program can assist in identifying new groundwater problems which may arise. Thirty-five wells will be sampled annually for nitrate, chloride, and bromide in March beginning in 2009. This project will continue as long as funding is available.	Each study conducted by the Washington State Department of Ecology (Ecology) must have an approved Quality Assurance Project Plan. The plan describes the objectives of the study and the procedures to be followed to achieve those objectives. After completion of the study, a final report describing the study results will be posted to the Internet.	http://www.ecy.wa.gov/biblio/0903111.html	
C0360	Terrestrial - Water	Non-Point Source Loading & Runoff	San Juan/Whatcom	Lake Whatcom Watershed Total Phosphorus and Bacteria Total Maximum Daily Loads: Water Quality Study Findings	2008	Pickett, P. and S. Hood	Washington Department of Ecology	Ecology conducted this technical study to set Total Maximum Daily Loads (cleanup plans) for these pollutants. Based on 2002 and 2003 data, a CE-QUAL-W2 lake model and an HSPF watershed model were developed. Land uses in the watershed model were adjusted to evaluate Lake Whatcom's response to phosphorus. Loading capacities for total phosphorus and for developed acres were calculated to protect dissolved oxygen in the lake.	Bacteria levels in 11 tributaries did not meet standards. Bacteria concentration and reduction targets were calculated.	http://www.ecy.wa.gov/biblio/0803024.html	
C0361	Marine - Water	Onsite Sewage Systems	San Juan/Whatcom	Addendum to Quality Assurance Project Plan: Drayton Harbor Watershed Fecal Coliform Total Maximum Daily Load	2008	Mathieu, Nuri	Washington Department of Ecology	Quality Assurance Project Plan: sets protocol for monitoring Fecal Coliform Total Maximum Daily Load.	This is the addendum to Quality Assurance Project Plan: Drayton Harbor Watershed Fecal Coliform Total Maximum Daily Load.	http://www.ecy.wa.gov/biblio/0803105add1.html	
C0362	Marine - Water	Onsite Sewage Systems	San Juan/Whatcom	Quality Assurance Project Plan: Drayton Harbor Watershed Fecal Coliform Total Maximum Daily Load: Phase 1 Water Quality Study Design	2008	Mathieu, N., and D. Sargeant	Washington Department of Ecology	This Quality Assurance (QA) Project Plan describes Phase 1 of the technical study that will monitor levels of fecal coliform bacteria in Drayton Harbor, as well as California and Dakota Creeks. It forms the basis for a bacteria TMDL.	Each study conducted by Ecology must have an approved QA Project Plan. The plan describes the objectives of the study and the procedures to be followed to achieve those objectives. The Phase 2 plan will be presented in an addendum. After completion of the study, a final report describing the study results from both phases will be published.	http://www.ecy.wa.gov/biblio/0803105.html	
C0363	Terrestrial - Water	Agriculture & Livestock Grazing	All	Surface Water Monitoring Program for Pesticides in Salmonid-Bearing Streams, 2009 Data Summary	2011	Sargeant, D., D. Dugger, P. Anderson, and E. Newell	Washington Department of Ecology	This report presents 2009 pesticide results for two urban basins, Thornton Creek (Cedar-Sammamish basin) and Longfellow Creek (Green-Duwamish basin), as well as four agricultural basins: lower Skagit-Samish basin, lower Yakima basin, and the Wenatchee and Entiat basins	A triennial review of pesticide data collected from 2007-09 is included for the Wenatchee-Entiat basins. During 2007-09 few pesticides were detected at the Wenatchee-Entiat basin sites with the exception of Brender Creek. Brender Creek endosulfan levels indicate potential chronic health effects to aquatic life during mid-March through May	http://www.ecy.wa.gov/biblio/1103004.html	
C0364	Marine - Water	Onsite Sewage Systems	Whidbey	Quality Assurance Project Plan: Skagit Bay Fecal Coliform Bacteria Loading Assessment	2010	Kardouni, J.	Washington Department of Ecology	This is the quality assurance project plan for the study, Skagit Bay Fecal Coliform Bacteria Loading Assessment. The goal of this study is to help reduce FC contamination to the bay. The objective of this study is to evaluate FC concentrations, surface water discharge, and general water quality parameters within the watershed during 2010-2011.	Data collected will form the basis for calculating FC contaminant loads to the bay. After completion of the study, a final report describing the results will be posted to the Internet.	http://www.ecy.wa.gov/biblio/1003121.html	
C0365	Terrestrial - Water	Non-Point Source Loading & Runoff	All	Quality Assurance Project Plan for Phase 3: Characterization of Toxic Chemicals in Puget Sound and Selected Major Tributaries	2009	Randy Coots and David Osterberg	Washington Department of Ecology	Existing data were used to estimate chemical loadings during Phase 1 of the PSTLA. Phase 2 efforts included development of the Puget Sound Toxics Box Model to simulate chemical fate, transport, and bioaccumulation. For the present study, the Washington State Department of Ecology (Ecology) will collect seasonal water samples (June, September, and December of 2009) at three oceanic boundary sites, in four Puget Sound basins, and at the mouths of the five largest rivers discharging to the Sound.	The Puget Sound Partnership identified the control and reduction of toxic chemicals entering Puget Sound as vital to the ecosystem's recovery and maintenance. In a multi-phase effort to develop source-control strategies for toxic contaminants, the Puget Sound Toxics Loading Analysis (PSTLA) will quantify concentrations within, and loadings to, Puget Sound, ultimately guiding management decisions.	http://www.ecy.wa.gov/pubs/0903118.pdf	
C0366	Terrestrial - Water	Wastewater Treatment Plant Discharge & CSOs	All	Quality Assurance Project Plan for Control of Toxic Chemicals in Puget Sound, Phase 3: Priority Pollutant Scans of Ten POTWs	2009	Ecology and Environment Inc and Herrera	Washington Department of Ecology	This Quality Assurance Project Plan (QAPP) is provided for monitoring pollutants not routinely monitored in wastewater treatment effluent from 10 publicly owned treatment works (POTWs). The ten selected facilities represent various types of wastewater discharges in the Puget Sound Watershed.	Washington State Department of Ecology (Ecology) goals for this project are to (1) improve loading estimates for certain toxic chemicals, and (2) screen representative discharges for toxic chemicals not routinely monitored.	http://www.ecy.wa.gov/biblio/0910001.html	
C0367	Marine - Water	Air Pollution & Atmospheric Deposition	All	Control of Toxic Chemicals in Puget Sound, Phase 3: Study of Atmospheric Deposition of Air Toxics to the Surface of Puget Sound	Jul-10	Brandenberger, J.M., P. Louchouarn, L-J Kuo, E.A. Crecelius, V. Cullinan, G.A. Gill, C. Garland, J. Williamson, and R. Dhammapala	Washington Department of Ecology	this study provided revisions to prior estimates or first reported atmospheric deposition fluxes of polycyclic aromatic hydrocarbons (PAHs), polybrominated diphenyl ethers (PBDEs), and select trace elements for Puget Sound. Samples representing bulk atmospheric deposition were collected during 2008 and 2009 at seven stations around Puget Sound spanning from Padilla Bay south to Nisqually River including Hood Canal and the Straits of Juan de Fuca. Revised annual loading estimates were calculated for each of the toxics and demonstrated an overall decrease in the atmospheric loading estimates except for PBDEs and total mercury (THg).	In summary, four major conclusions are derived from this study: 1) the depositional fluxes of a majority of the selected toxic elements (trace metals) and compounds (PAHs) in the urban/industrial area of Tacoma have decreased significantly (close to an order of magnitude for most) in the last ~20 years, 2) deposition fluxes directly to the waters of Puget Sound are spatially homogenous except in industrial regions and are not necessary representative of watershed deposition rate over a large range of land use and land cover classifications, 3) direct atmospheric deposition of trace elements and PAHs on the Puget Sound surface contributes only 1-5% of total inputs to sedimentary repositories, and 4) first-order estimates of sedimentary fluxes of Pb and PAHs in the Puget Sound system suggest that revised annual surface runoff estimates may be appropriate based on the sedimentary fluxes representing the last decade of inputs.	http://www.ecy.wa.gov/biblio/1002012.html	
C0368	Marine - Water	Wastewater Treatment Plant Discharge & CSOs	All	Pharmaceuticals and Personal Care Products in Municipal Wastewater and Their Removal by Nutrient Treatment Technologies	2010	Lubliner, B., M. Redding, and D. Ragsdale	Washington Department of Ecology, Environmental Protection Agency	In August 2008, the Washington State Department of Ecology (Ecology) and the U.S. Environmental Protection Agency (EPA) conducted a one-day screening study to characterize pharmaceuticals and personal care products (PPCPs) at five municipal wastewater treatment plants (WWTPs) in the Pacific Northwest. Wastewater influent, secondary effluent, tertiary effluent, and biosolids were sampled.	In the study, PPCPs were found in all samples at concentrations comparable to those found in the literature. Secondary treatment alone achieved high removals for hormones and steroids. Approximately 21% of the 172 analytes were reduced to below reporting limits by conventional secondary treatment, whereas 53% were reduced to below reporting limits by at least one advanced nutrient-removal technology. Roughly 20% of the 172 analytes (mainly polycyclic aromatic hydrocarbons) were found only in the biosolids and not the wastewater samples. Some analytes were clearly concentrating in the biosolids.	http://www.ecy.wa.gov/biblio/1003004.html	
C0369	Nearshore - Species & Food Webs	Point Source Pollution	All	Polybrominated Diphenyl Ethers In Outmigrant Juvenile Chinook Salmon From The Lower Columbia River And Estuary And Puget Sound, WA	2010	C. A. Sloan, B. F. Anulacion, J. L. Bolton, D. Boyd, O. P. Olson, S. Y. Sol, G. M. Ylitalo, L. L. Johnson	NOAA, Northwest Fisheries Science Center	We present the concentrations of PBDEs measured in gutted bodies and stomach contents of outmigrant juvenile Chinook salmon collected at six sites in the LCR&E and four sites in Puget Sound. For comparison, we also analyzed gutted bodies of juvenile Chinook salmon from eight hatcheries in the LCR&E as well as samples of the hatchery fish feeds.	The mean PBDE concentrations measured in bodies of juvenile Chinook salmon from the different sites ranged from 350 to 2800 ng/g lipid weight, whereas those in stomach contents ranged from less than the quantitation limit (<2 ng/g wet weight) to 39 ng/g wet weight. The levels of PBDEs in the hatchery fish were significantly lower than those measured in the salmon samples collected from the LCR&E and Puget Sound. These results show that outmigrant juvenile Chinook salmon in the LCR&E and Puget Sound have been exposed to PBDEs in the environment and that these chemicals are bioaccumulating in their tissues; thus, the potential effects of PBDEs on these salmon should be further investigated.	http://www.nwfsc.noaa.gov/publications/displayallinfo.cfm?docmetadataid=6970	Archives of Environmental Contamination and Toxicology, Volume 58, Issue 2, Pages 403-414
C0370	Humans - Health	Climate Change	All	Recent trends in paralytic shellfish toxins in Puget Sound, relationships to climate and capacity for prediction of toxic events	2009	S. K. Moore, N. Mantua, V. L. Trainer, B. M. Hickey	NOAA, Northwest Fisheries Science Center	Temporal and spatial trends in paralytic shellfish toxins (PSTs) in Puget Sound shellfish and their relationships with climate are investigated using long-term monitoring data since 1957. Data are selected for trend analyses based on the sensitivity of shellfish species to PSTs and their depuration rates, and the frequency of sample collection at individual sites.	Using blue mussel data only, there was no robust evidence to suggest that the frequency, magnitude, duration, or geographic scope of PST events in Puget Sound increased between 1993 and 2007. However, there is a significant basin-wide trend for closures to occur earlier in the year. There are no significant correlations between annual indices of mussel toxicity and aspects of the local and large-scale climate. Case studies of daily variations in local environmental factors leading up to exceptionally toxic events identify a combination of conditions that generally precedes most closures from 1993 to 2007. These results suggest that periods of warm air and water temperatures and low streamflow on sub-seasonal times cales may facilitate toxin accumulation in mussels. No relationships were found between water residence times in the surface layer and either streamflow or mussel toxicity. Recommendations are made for future monitoring to improve forecasting of PST risks in Puget Sound.	http://www.nwfsc.noaa.gov/publications/displayallinfo.cfm?docmetadataid=6857	Harmful Algae. 8: 463-477
C0371	Terrestrial - Water	Point Source Pollution	All	Perflourinated Compounds in Washington Rivers and Lakes	2010	C. Fuir and C. Meredith	Washington Department of Ecology	The study represents an exploratory effort seeking information on 13 perfluorinated compounds (PFCs) statewide in surface waters, wastewater treatment plant effluents, and fish tissues. Surface water and effluent samples were collected during periods of low and high flows.	Generally speaking, total PFC concentrations in all matrices recorded as part of the study were within or below the range of values recorded at other United States locations.	http://www.ecy.wa.gov/biblio/1003034.html	
C0372	Terrestrial - Water	Non-Point Source Loading & Runoff	All	Control of Toxic Chemicals in Puget Sound: Characterization of Toxic Chemicals in Puget Sound and Major Tributaries, 2009-10	2011	Gries, T. and D. Osterberg	Washington Department of Ecology	Ecology conducted this 2009-2010 study to address data gaps identified by the Puget Sound Toxics Box Model. Samples were collected from the marine water column and 5 major rivers discharging to Puget Sound and analyzed for various toxic chemicals. Many were present in low concentrations but others were seldom if ever detected.	Marine water concentrations were used to evaluate exchange of toxic chemicals between Puget Sound and the ocean. Most chemicals, except for cadmium, appeared to be exported from Puget Sound. River water concentrations and flows were used to calculate daily loads of toxic chemicals. Additional monitoring for fewer target chemicals, especially in suspended particulate matter, was recommended	http://www.ecy.wa.gov/biblio/1103008.html	

Inventory of Recently Completed/Ongoing Scientific Studies

Ref #	Ecosystem Component	Primary Pressure	Action Area	Study Title	Date	Author(s) or Study Contact	Supporting Agency	General Study Design/Methods	Study Results	Weblink	Journal Citation (if applicable)
C0373	Terrestrial - Species & Food Webs	Point Source Pollution	All	An Assessment of the PCB and Dioxin Background in Washington Freshwater Fish, with Recommendations for Prioritizing 303(d) Listings	2010	Johnson, A., K. Seiders, and D. Norton	Washington Department of Ecology	In order to prioritize the state's TMDL resources, a study was conducted to measure PCB and dioxin levels in fish from freshwater background areas. The results are used to recommend approaches for prioritizing 303(d) listings for these compounds.	The results are used to recommend approaches for prioritizing 303(d) listings for these chemicals, with the intent of accelerating cleanup actions across the state.	http://www.ecy.wa.gov/biblio/1003007.html	
C0374	Terrestrial - Species & Food Webs	Agriculture & Livestock Grazing	Whidbey	Skagit-Samish Basin Intensive Surface Water Sampling for Pesticides in Salmon-Bearing Streams, 2009	2010	Sargeant, D. and P. Anderson	Washington Department of Ecology	Pesticide results from three sampling regimes during 2009 were compared: daily sampling for seven consecutive days; weekly sampling; and continuous sampling using a continuous low-level aquatic monitor (CLAM).	Results compared pesticides detected during the current weekly sampling regime to seven days of consecutive sampling. The study results indicate that prior knowledge of the pesticide-use practices is needed to target specific pesticides. The current regime of weekly sampling throughout the application season captures a variety of pesticide detections. CLAM results showed inconsistent pump rates throughout the placement period; the device did provide information on the presence or absence of selected pesticides	http://www.ecy.wa.gov/biblio/1003043.html	
C0375	Terrestrial - Species & Food Webs	Agriculture & Livestock Grazing	All	Surface Water Monitoring Program for Pesticides in Salmonid-Bearing Streams, 2006-2008 Triennial Report	2010	Sargeant, D., D. Dugger, E. Newell, P. Anderson, and J. Cowles (WSDA)	Washington Department of Ecology	This report presents results of a multi-year study to characterize pesticide concentrations in salmon-bearing surface waters. Monitoring occurred in five basins: one urban basin (Thornton Creek in the Cedar-Sammamish) and four agricultural basins (lower Skagit-Samish, lower Yakima, Wenatchee, and Entiat).	During 2006-2008, 71 pesticides were detected. Seven of these failed to meet an assessment criterion: permethrin; chlorpyrifos; diazinon; azinphos-methyl; malathion; endosulfan; and total DDT. Pesticide concentrations found likely do not directly affect salmonids, but at some sites may affect aquatic invertebrate populations. During 2010, an anomaly in the 2006-2009 analytical method for carbamates was found. This anomaly caused the false positive identification of the degradate compounds 1-naphthol, aldicarb sulfone, and aldicarb sulfoxide. The corrected report and appendices were posted on October 22, 2010.	http://www.ecy.wa.gov/biblio/1003008.html	
C0376	Terrestrial - Species & Food Webs	Invasives - Freshwater	All	Blue-Green Algae Toxins in Washington Lakes: Screening Fish Tissue for Microcystins and Anatoxin-a	2010	Johnson, A.	Washington Department of Ecology	The Washington State Department of Ecology conducted a screening survey to assess the presence of microcystins and anatoxin-a in muscle and liver tissue from fish in six Western Washington lakes that had blue-green blooms in 2008.	Microcystins were detected in all samples, with higher concentrations in liver than muscle. Anatoxin-a was not detected.	http://www.ecy.wa.gov/biblio/1003011.html	
C0377	Marine - Water	Non-Point Source Loading & Runoff	All	A Toxics-Focused Biological Observing System for Puget Sound	2010	Lyndal Johnson, Sandie O'Neill, Mark S. Myers, Gina Ylitalo, Nathaniel Scholz, Tracy Collier, NOAA Fisheries Northwest Fisheries Science Center; Claudio Bravo, University of California at Davis; James West, WA Department of Fish and Wildlife	Washington Department of Fish & Wildlife	The report explores the background of and need for toxics-focused biological monitoring and recommends approaches.	The report recommends a biologically-based ecosystem-wide monitoring program for toxics called a toxics-focused biological observing system (TBiOS).	http://wdfw.wa.gov/publications/pub.php?id=01129	
C0378	Nearshore - Species & Food Webs	Point Source Pollution	All	Marine distribution, life history traits, and the accumulation of polychlorinated biphenyls in chinook salmon from Puget Sound, Washington	2009	O'Neill, S. M., and J. E. West	Washington Department of Fish & Wildlife	Polychlorinated biphenyl (PCB) levels and the factors affecting PCB accumulation in subadult and maturing Chinook salmon Oncorhynchus tshawytscha from Puget Sound were characterized. Specifically, the study (1) determined PCB levels in Chinook salmon from Puget Sound and compared them with levels in Chinook salmon from other West Coast populations, (2) determined whether PCB accumulation mainly occurred in the freshwater or marine habitats, and (3) quantified the relative importance of fish age, fish size (fork length), lipid content, and saltwater age (the number of winters spent in saltwater) on PCB concentration.	The average PCB concentration measured in skinless muscle tissue samples of subadult and maturing Chinook salmon collected from Puget Sound was 53 ng/g (wet weight), which was 3–5 times higher than those measured in six other populations of Chinook salmon on the West Coast of North America. We hypothesized that residency in the contaminated Puget Sound environment was a major factor contributing to the higher and more variable PCB concentrations in these fish. This hypothesis was supported with an independent data set from a fishery assessment model, which estimated that 29% of subyearling Chinook salmon and 45% of yearling out-migrants from Puget Sound displayed resident behavior.	http://depts.washington.edu/tribalws/Resources/O'Neill_and_West_2009.pdf	Transactions of the American Fisheries Society 138:616-632
C0379	Marine - Species & Food Webs	Point Source Pollution	South Central Puget Sound	Dioxins, furans, and other contaminants in surface sediment and English sole collected from greater Elliott Bay (Seattle)	2008	Sloan, J., and Gries, T	Washington Department of Ecology	For this 2007 study, contaminants were measured in surface sediments and tissues of English sole from greater Elliott Bay.	Median levels of dioxins/furans in sediments of 2 depths were 7.7 and 5.9 ng/kg Toxic Equivalents (TEQ). English sole whole-body tissue and skinless fillet samples had 0.99-1.71 and 0.26-0.57 ng/kg (wet weight) TEQ dioxins/furans, respectively. Tissue preparation influenced levels more than where fish were collected. Levels of most organic contaminants in 0-2 and 0-10 cm sediment samples did not differ, but most trace metals and PCBs were significantly lower in 0-2 cm samples. Sediment contaminant levels at 5 of 30 stations may represent area background conditions.	http://www.ecy.wa.gov/biblio/0803017.html	
C0380	Marine - Species & Food Webs	Point Source Pollution	All	Control of Toxic Chemicals in Puget Sound - Phase 2: Sediment Flux/Puget Sound Sediments, Bioaccumulation Model - Derived Concentrations for Toxics - Final Summary Technical Report	May-09	Ecology and Environment Inc. Contact: Chance Asher	Washington Department of Ecology	The model used in this study is based on a bioaccumulation model developed by Condon in 2007. Condon's model evaluates PCB accumulation in biota of the Strait of Georgia, which is adjacent to Puget Sound and within the same major watershed. Modified to evaluate Puget Sound toxics, the model showed how several toxic compounds move (flux) from sediment to biota.	The model identified some instances where toxics concentrations at the SQS level exceeded criteria derived to protect both human and wildlife receptors. While the model's predictions appear to be reasonable based on available verification, caution should be exercised when interpreting these results and applying them to regulatory issues because of the uncertainty associated with the model's assumptions.	http://www.ecy.wa.gov/biblio/0909069.html	
C0381	Marine - Species & Food Webs	Point Source Pollution	South Puget Sound	Mercury in Sediment, Water, and Biota of Sinclair Inlet, Puget Sound, Washington, 1989-2007	2010	Anthony J. Paulson, Morgan E. Keys, and Kelly L. Scholting	US Geological Survey	Total mercury concentratoins in various biota species were compared among geographical locations and included data of composite samples, individual speciments, and caged mussels.	Mercury concentrations in muscle and liver of English sole from Sinclair Inlet ranked in the upper quarter and third respectively of Puget Sound locations. For other species, concentrations from Sinclair Inlet were within the mid-range of locations. Total mercury concentrations in rockfish from Sinclair Inlet were highest in Puget Sound.	http://pubs.usgs.gov/of/2009/1285/pdf/ofr20091285.pdf	
C0382	Nearshore - Species & Food Webs	Point Source Pollution	South Puget Sound	More than 100 Years of Background-Level Sedimentary Metals, Nisqually River Delta, South Puget Sound, Washington	2011	Takesue, Renee K.; Swarzenski, Peter W.	US Geological Survey	The goal of this study was to determine whether there were historical trends in contaminant metals in Nisqually Delta sediment.	Five shallow sediment cores were collected at low tide from the Nisqually tidal flats in August 2009 (fig. 1; table 1). Total metal contents of sediment were examined in the core that had the best-preserved sediment record, as derived from downcore excess 210Pb profiles.	http://pubs.er.usgs.gov/publication/ofr20101329	
C0383	Terrestrial - Species & Food Webs	Point Source Pollution	All	Measuring Mercury Trends in Freshwater Fish in Washington State, 2009 Sampling Results	2010	Meredith, C., C. Furl, and M. Friese	Washington Department of Ecology	Mercury levels were measured in 50 individual bass and 25 fish composites during the fifth year of a long-term monitoring program to assess mercury levels in fish tissues across Washington State. Previous Department of Ecology studies identified elevated mercury levels which led to fish consumption advisories.	Mercury concentrations in individual bass ranged from 40 - 907 ppb, with a median of 163 ppb. Four percent of bass (2 of 50 samples) exceeded Washington's water quality standard of 770 ppb. Seven individual bass and one composite sample were above the EPA recommended criterion guidance of 300 ppb.	http://www.ecy.wa.gov/biblio/1003058.html	
C0384	Terrestrial - Species & Food Webs	Point Source Pollution	All	Measuring Mercury Trends in Freshwater Fish in Washington State: 2007 Sampling Results	2008	Furl, C. and C. Meredith	Washington Department of Ecology	Mercury concentrations were measured in 60 individual fish and 32 composite samples as part of the third year of long-term monitoring of mercury in fish tissues across Washington State.	A total of 73% of individuals and 28% of composites sampled had mercury concentrations higher than the EPA's recommended water quality criterion of 300 ppb. A single four-year-old female bass from Lake Ozette contained a concentration of 1800 ppb. This sample was the highest mercury concentration recorded in a largemouth bass during the first three years of this long-term study.	http://www.ecy.wa.gov/biblio/0803027.html	
C0385	Marine - Water	Climate Change	All	Local and large-scale climate forcing of Puget Sound oceanographic properties on seasonal to interdecadal timescales	2008	Moore, S.K., N.J. Mantua, J.P. Kellogg, and J.A. Newton	UW Climate Impacts Group	The influence of climate on Puget Sound oceanographic properties is investigated on seasonal to interannual timescales using continuous profile data at 16 stations from 1993 to 2002 and records of sea surface temperature (SST) and sea surface salinity (SSS) from 1951 to 2002	The influence of climate on Puget Sound oceanographic properties is investigated on seasonal to interannual timescales using continuous profile data at 16 stations from 1993 to 2002 and records of sea surface temperature (SST) and sea surface salinity (SSS) from 1951 to 2002	http://cses.washington.edu/db/pubs/allpubs.shtml#Year2008	Limnology and Oceanography 53(5): 1746-1758
C0386	Marine - Water	Wastewater Treatment Plant Discharge & CSOs	South Puget Sound	South Puget Sound Dissolved Oxygen Study	2011	Teizeen Mohamedali, Mindy Roberts, Brandon Sackmann, Anthony Whiley, Andrew Kolosseus	Washington Department of Ecology	DOE is conducting a water quality study on low dissolved oxygen levels in South Puget Sound. As part of this effort, water quality data were collected from July 2006 through October 2007 from a number of wastewater treatment plants (WWTPs), rivers, and streams within South and Central Puget Sound. These field data, however, were collected at monthly intervals. A statistical method called multiple linear regression was applied to the field data to develop continuous daily loads of nutrients into South and Central Puget Sound for the years 2006 and 2007. This statistical approach relates concentrations to seasons of the year and streamflow patterns using a best fit to monitoring data. The resulting daily loads provide a better fit to monitoring data than simply using monthly or annual averages.	The purpose of this study is to determine determine whether human sources of nitrogen contribute to low levels of dissolved oxygen. One critical step is to identify nutrient loads to South Puget Sound. The study also involves developing a hydrodynamic and water quality model to assess alternative management scenarios. Rivers and WWTPs are both significant sources of nitrogen, particularly dissolved inorganic nitrogen (DIN; sum of ammonium and nitrate + nitrite). DIN concentrations and loads from WWTPs are generally greater than those from rivers. River DIN loads vary with the seasons such that 77% of river DIN loading to South and Central Puget Sound occurs during the wetter months of November through March. In contrast, DIN loads from WWTPs are relatively constant throughout the year, but contribute to 90% of watershed DIN load in the summer when rivers loads are much lower. Watershed DIN loads into Central Puget Sound (north of Tacoma Narrows) are 3.8 times greater than those into South Puget Sound.	http://www.ecy.wa.gov/pubs/1103001.pdf	
C0387	Marine - Species & Food Webs	Non-Point Source Loading & Runoff	Hood Canal	The Effects of Hypoxia on Marine Fish Populations in Southern Hood Canal, Washington	2008	Palsson, W. A., R. E. Pacunski, T. R. Parra, and Beam.J.	Washington Department of Fish & Wildlife	By correlating ambient oxygen concentrations with fish abundance and by relating fish kills to oxygen concentrations, we are developing a model for predicting when fish will avoid or be killed by low oxygen events.	Copper rockfish Sebastes caurinus avoid oxygen concentrations below 2 mg/L but can tolerate concentrations to 1 mg/L. Other marine fish species show similar responses, but smaller fish and species appear to be affected more than larger ones. Fish kill events are not consistent between years, affecting rockfish in one instance and lingcod in another. Differences in behavior and lethality during hypoxic conditions may relate to the magnitude and duration of exposure, temperature, past experience, and physiology. Recent and past fish kill events have resulted in long-term impacts reducing populations of rockfish and lingcod at Sund Rocks by one-third. Based on our results, continued efforts to minimize other population stressors are warranted.	http://md1.csa.com/partners/viewrecord.php?requester=gs&collection=ENV&recid=8452668&q=The+effects+of+hypoxia+on+marine+fish+populations+in+Southern+Hood+Canal%2C+Washington&uid=790718227&setcookie=yes	American Fisheries Society Symposium [Am. Fish. Soc. Symp.]. no. 64, pp. 255-280. 2008
C0388	Marine - Species & Food Webs	Non-Point Source Loading & Runoff	Hood Canal	Nekton distribution and midwater hypoxia: a seasonal, diel prey refuge?	2009	Parker-Stetter, J. L. and J. K. Horne	Hood Canal Dissolved Oxygen Program through a Naval Sea Systems Command contract	Using acoustics, we quantified vertical distribution of nekton at two sites (Hoodsport and Duckabush) before (July) and after (September) OML development.	Both Hoodsport and Duckabush had strong OML between 10 and 35 m in September, with lower (minimum 0.63 mg L_1) oxygen levels at Hoodsport compared to Duckabush (1.58 mg L_1). The OML did not affect daytime distribution of fish or invertebrates, with both occupying depths >60 m. At night in July, with no OML, invertebrates migrated into waters <20 m and fish dispersed to within 15 m of the surface at both sites. In the presence of the September OML, invertebrates migrated into waters <20 m, but the upper limit of fish vertical distribution stopped at the base of the OML (35 m) at Hoodsport. Fish vertical distribution at Duckabush was less pronounced within and above the OML (10–35 m) than it had been in July. Our results suggest that the OML did not affect invertebrate vertical distribution, but did affect fish vertical migration, and may provide a seasonal, diel prey refuge.	http://www.acoustics.washington.edu/pubs/2008%20parker-stetter%20horne%20and%20langness%20ECSS.pdf	Estuaries and Coasts 81:13-18
C0389	Marine - Species & Food Webs	Non-Point Source Loading & Runoff	Hood Canal	The influence of midwater hypoxia on nekton vertical migration	2009	Parker-Stetter, S. L., J. K. Horne, and M. M. Langness	Hood Canal Dissolved Oxygen Program through a Naval Sea Systems Command contract	Using acoustics (38 and 120 kHz), the 2007 night DVM patterns of nekton were quantified before (June, August) and during (September) an OML.	All months had similar precrepuscular distributions (>50-m depth) of fish and invertebrates. During the September evening crepuscular period, a zooplankton layer migrated upwards (>1.5 m min−1), but the layer's rate of ascent slowed to <0.5 m min−1 when it reached the lower edge of the OML. The bottom edge of the layer then moved below the OML and remained there for 13 minutes before moving through the OML at >1.0 m min−1. As in June and August, fish in September followed the upward migration of the zooplankton layer to the surface, crossing through the OML. Our results suggest that the 2007 OML did not affect zooplankton or fish vertical distributions.	http://icesjms.oxfordjournals.org/content/66/6/1296.full	ICES Journal of Marine Science 66:1296-1302

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Ref #	Ecosystem Component	Primary Pressure	Action Area	Study Title	Date	Author(s) or Study Contact	Supporting Agency	General Study Design/Methods	Study Results	Weblink	Journal Citation (if applicable)
C0390	Marine - Species & Food Webs	Non-Point Source Loading & Runoff	Hood Canal	Quantifying hypoxia impacts on an estuarine demersal community using a hierarchical ensemble approach	2010	Essington, TE and Paulsen, CE	UW - Fisheries	Applied conventional and hierarchical ensemble analyses to evaluate the weight of evidence in support of hypoxia impacts on local densities of individual and groups of demersal fish and invertebrate species in Hood Canal, WA, which is subject to seasonal hypoxia in its southern reaches. Central to approach was a sample design and analysis scheme that was designed specifically to consider multiple alternative hypotheses regarding factors that dictate local species' densities.	The hierarchical ensemble analysis improved the precision of species-specific effect sizes, and also allowed us to make inferences about the response of aggregated groups of species. The estimated mean density reductions during hypoxic events (dissolved oxygen ~2 mg/l) ranged from 73 to 98% among mobile invertebrates, benthic, and benthopelagic fishes. The large reduction in benthic and benthopelagic species suggests substantial effects of hypoxia in Hood Canal even at oxygen levels that were marginally hypoxic.		Ecosystems Volume 13, Number 7, 1035-1048
C0391	Terrestrial - Water	n/a	South Puget Sound	Incorporation of Fine-Grained Sediment Erodibility Measurements into Sediment Transport Modeling, Capitol Lake, Washington	2008	Stevens, Andrew W.; Gelfenbaum, Guy; Elias, Edwin; Jones, Craig	US Geological Survey	Fifteen cores were collected at several sites throughout Capitol Lake and measured for erodibility using Sedflume.	n/a	http://pubs.usgs.gov/of/2008/1340/	
C0392	Nearshore - Habitats	Point Source Pollution	San Juan/Whatcom	Assessment of Sediment Toxicity near Post Point (Bellingham Bay)	2008	Gries, T.	Washington Department of Ecology	Sediments were collected from 8 locations in September 2007 and tested using 4 bioassays. Sulfide levels in sediment, porewater, and during bioassays were also measured.	Only 2 samples had minor toxicity, but they were among the highest sulfide levels measured, and a dose-response relationship was suggested. Sulfides levels near Post Point were not different from levels in other inner Bellingham Bay areas.	http://www.ecy.wa.gov/biblio/0803016.html	
C0393	Terrestrial - Habitats	n/a	All	Baseline Characterization of Nine Proposed Freshwater Sediment Reference Sites, 2008	2009	Sloan, J. and N. Blakley	Washington Department of Ecology	The Department of Ecology collected and analyzed three sediment samples from nine proposed freshwater reference areas during the summer of 2008.	Target chemical analyses included total organic carbon, percent solids, grain size, sulfides, ammonia, semi-volatile organic compounds, polychlorinated biphenyls, polycyclic aromatic hydrocarbons, chlorinated pesticides, and metals. The bioassays suite included 20-day Midge (Chironomus tentans), 28-day Amphipod (Hyalella azteca), and Microtox.	http://www.ecy.wa.gov/biblio/0903032.html	
C0394	Nearshore - Habitats	Non-Point Source Loading & Runoff	San Juan/Whatcom, Strait of Juan de Fuca	Sediment Quality Assessment of the Bays and Inlets of the San Juan Islands, Eastern Strait of Juan de Fuca, and Admiralty Inlet, 2002-2003	2008	Long, E., S. Aasen, M. Dutch, K. Welch, and V. Partridge	Washington Department of Ecology	During 2002 and 2003, a sediment quality survey was conducted in the bays and inlets of the San Juan Islands, Eastern Strait of Juan de Fuca, and Admiralty Inlet as part of the Puget Sound Assessment and Monitoring Program. Sediment chemistry, toxicity, and invertebrate community structure were measured.	Measurement of sediment chemistry, toxicity, and invertebrate community structure indicated that: Highest sediment quality was measured in Admiralty Inlet (67% of area); The majority of the sediments measured in the San Juan Islands and the Eastern Strait of Juan de Fuca (70 and 71% of each area, respectively) were of intermediate quality; No sediments were of degraded quality in any of the three regions.	http://www.ecy.wa.gov/biblio/0803030.html	
C0395	Nearshore - Habitats	Point Source Pollution	South Central Puget Sound	Urban Waters Initiative, 2007; Sediment Quality in Elliott Bay	2007	Partridge, V., Weakland, S., Long, E., Welch, K., Dutch, M., and Jones, M	Washington Department of Ecology	As part of the Urban Waters Initiative, the Department of Ecology's Environmental Assessment Program is assessing sediment quality throughout urban bays in Puget Sound, beginning with Elliott Bay and adjoining waterways of the lower Duwamish River in 2007. These bay-scale assessments assist environmental managers in determining whether collective localized cleanups and source control improve conditions over a wider area.	Comparisons of the 2007 survey results with similar data collected in 1998 show bay-wide decreases in sediment contamination by numerous toxics, especially PAHs and PCBs. Spatial extent of toxicity decreased significantly from 1998 to 2007, and some measures of benthic infaunal community health improved.	http://www.ecy.wa.gov/biblio/0903014.html	
C0396	Terrestrial - Water	Water Withdrawals & Diversions	South Puget Sound	Channel-Conveyance Capacity, Channel Change, and Sediment Transport in the Lower Puyallup, White, and Carbon Rivers, Western Washington	2010	Czuba, Jonathan A.; Czuba, Christiana R.; Magirl, Chistopher S.; Voss, Frank D.	US Geological Survey	The report documents an analysis of the historical trends in channel-conveyance capacity of the lower Puyallup River system, describes sediment transport through the system, and evaluates the potential effects of different river-management strategies on these factors. The study included river cross-sections, a hydraulic model, and a sediment transport model.	The greatest rates of aggradation since the 1980s were in the Nisqually River near National (5.0 inches per year) and the White River near Auburn (1.8 inches per year). Less pronounced aggradation was measured on the Puyallup River and the White River just downstream of Mud Mountain Dam. The largest measured rate of incision was measured in the Cowlitz River at Packwood (5.0 inches per year). Channel-conveyance capacity estimated using a one-dimensional hydraulic model decreased in some river reaches since 1984. The hydraulic model showed that setback levees would provide greater flood protection than gravel-bar scalping.	http://pubs.usgs.gov/sir/2010/5240/	
C0397	Marine - Water	n/a	All	A descriptive analysis of temporal and spatial patterns of variability in Puget Sound oceanographic properties	2008	Moore, Stephanie; Mantua, Nathan J.; Newton, Jan A.; Kawase, Mitsuhiro; Warner, Mark J.; Kellogg, Jonathan P.	NOAA Climate Program Office	Temporal and spatial patterns of variability in Puget Sound's oceanographic properties are determined using continuous vertical profile data from two long-term monitoring programs; monthly observations at 16 stations from 1993 to 2002, and biannual observations at 40 stations from 1998 to 2003.	Climatological monthly means of temperature, salinity, and density reveal strong seasonal patterns. Water temperatures are generally warmest (coolest) in September (February), with stations in shallow finger inlets away from mixing zones displaying the largest temperature ranges. Salinities and densities are strongly influenced by freshwater inflows from major rivers during winter and spring from precipitation and snowmelt, respectively, and variations are greatest in the surface waters and at stations closest to river mouths. Vertical density gradients are primarily determined by salinity variations in the surface layer. Strong tidal stirring and reflux over sills at the entrance to Puget Sound generally removes vertical stratification. Mean summer and winter values of oceanographic properties reveal patterns of spatial connectivity in Puget Sound's three main basins; Whidbey Basin, Hood Canal, and Main Basin.	http://www.treesearch.fs.fed.us/pubs/35300	Estuarine, Coastal and Shelf Science 80: 545-554
C0398	Marine - Water	Wastewater Treatment Plant Discharge & CSOs	South Central Puget Sound, Whidbey	2005 - 2007 Water Quality Status Report for Marine Waters	2008	Stark, K., S. Mickelson, and S. Keever	King County	This report provides a summary of water quality data collected between 2005 and 2007 as part of King County's ambient and outfall marine monitoring program. The monitoring program contains elements of baseline sampling to assess background conditions (ambient monitoring) and also sampling to assess conditions around the County's marine outfalls (point source monitoring). Data are assessed at three secondary wastewater treatment plant (TP) marine outfalls (West Point TP, South TP, and Vashon TP), three combined sewer overflow (CSO) treatment facilities (Alki TP, Carkeek TP, and Elliott West TP), and selected CSO outfalls as part of the point source monitoring program.	Various findings for water quality, sediment, shellfish tissue.	http://green.kingcounty.gov/marine/reports/Marine-Report-2005-2007.aspx	
C0399	Terrestrial - Water	Water Withdrawals & Diversions	San Juan/Whatcom	Nooksack Watershed Planning Area (WRIA 1): Prediction of Gaged Streamflows by Modeling	2010	Kett.P	Washington Department of Ecology	The Washington State Department of Ecology (Ecology) has operated 14 streamflow gaging stations in Water Resource Inventory Area (WRIA) 1. WRIA 1 includes the Nooksack River watershed and other neighboring watersheds that drain to Puget Sound and the Fraser River. This study developed regression tools for the Ecology gages for the period of record ending in September 2009. These regressions were based on other Ecology and United States Geological Survey (USGS) gages using power relationships and a hydrograph separation method. Regressions were also developed for two USGS gages on the mainstem Nooksack River. The quality of these regressions was assessed using statistical tools. Regression quality was better for the gages on the Nooksack River mainstem and forks and poorer for tributary gages.	Recommendations were made regarding the discontinuation or retention of the gages based on study results. Useful regressions were found between Ecology and USGS gages in the Nooksack River mainstem and forks, in lowland Nooksack tributaries, and in coastal tributaries. This suggests that some of these stations are redundant for many purposes.	http://www.ecy.wa.gov/biblio/1003023.html	
C0400	Terrestrial - Water	n/a	All	Flow variability and the biophysical vitality of river systems	2008	Naiman, R. J., J. J. Latterell, N. E. Pettit, and J. D. Olden	Andrew W. Mellon Foundation, U.S. National Science Foundation, U.S. Forest Service Pacific Northwest Research Station, and Weyerhaeuser Company	Literature review.	We illustrate the fundamental importance of fluctuations in natural water flows to the long-term sustainability and productivity of riverine ecosystems and their riparian areas. Natural flows are characterized by temporal and spatial heterogeneity in the magnitude, frequency, duration, timing, rate of change, and predictability of discharge. These characteristics, for a specific river or a collection of rivers within a defined region, shape species life histories over evolutionary (millennial) time scales as well as structure the ecological processes and productivity of aquatic and riparian communities.	http://linkinghub.elsevier.com/retrieve/pii/S1631071308000266	Comptes Rendus Geoscience 340:629-643
C0401	Terrestrial - Water	Water Withdrawals & Diversions	Whidbey	Numerical Simulation of the Groundwater-Flow System in Tributary Subbasins and Vicinity, Lower Skagit River Basin, Skagit and Snohomish Counties, Washington	2011	Kenneth H. Johnson and Mark E. Savoca	US Geological Survey	A groundwater-flow model was developed to evaluate the effects of potential groundwater withdrawals and consumptive use on streamflows in tributary subbasins of the lower portion of the Skagit River basin.	Model simulations were conducted to demonstrate model performance and to provide representative examples of how the model may be used to evaluate the effects of potential changes in groundwater withdrawals, consumptive use, and recharge on groundwater levels and tributary stream baseflows.	http://pubs.usgs.gov/sir/2010/5184/	
C0402	Terrestrial - Water	Point Source Pollution	North Central Puget Sound	Selected Natural Attenuation Monitoring Data, Operable Unit 1, Naval Undersea Warfare Center, Division Keyport, Washington, 2007 and 2008	2009	Dinicola, R.S., and Huffman, R.L.,	US Geological Survey	Report contains results of long-term monitoring for natural attenuation by two hybrid poplar plantations on the landfill (planted in spring 1999) to remove and to control the migration of chlorinated VOCs in shallow groundwater.	Multiple results listed in report	http://pubs.usgs.gov/of/2009/1141/	
C0403	Terrestrial - Water	Water Withdrawals & Diversions	Whidbey	Shallow Groundwater Movement in the Skagit River Delta Area, Skagit County, Washington	2009	Savoca, M.E., Johnson, K.H., and Fasser, E.T., 2009	US Geological Survey	Water levels were measured in 47 wells on a quarterly basis (August 2007, November 2007, February 2008, and May 2008). Measurements from 34 wells completed in the shallow groundwater system were used to construct groundwater-level and flow-direction maps and perform a linear-regression analysis to estimate the overall, time averaged shallow groundwater-flow direction and gradient.	Water levels rise from October through March, when precipitation is high, and decline from April through September, when precipitation is lower. Groundwater levels in wells along the eastern margin of the study area also are likely influenced by stage on the Skagit River. Water levels in these wells remained elevated through April, and did not seem to begin to decline until the end of May in response to declining river stage. Groundwater levels in a well equipped with a continuous water-level recorder exhibited periodic fluctuations that are characteristic of ocean tides.	http://pubs.usgs.gov/sir/2009/5208/	
C0404	Terrestrial - Species & Food Webs	Residential, Commercial, Port & Shipyard Development	South Puget Sound	Priority Habitats and Species Management Recommendations: Mazama Pocket Gopher	2011	Washington Department of Fish & Wildlife	Washington Department of Fish & Wildlife	The Washington Department of Fish and Wildlife (WDFW) is providing these management recommendations to inform local government permit reviewers, applicants, consultants, and landowners working on projects with potential impacts to Mazama pocket gopher, a state-listed threatened species.	WDFW provides three recommendations that are not regulatory, but are based on best available science for avoiding, minimizing, and mitigating impacts to gophers and their habitat, which is primarily located in South Puget Sound.	http://wdfw.wa.gov/publications/pub.php?id=01175	
C0405	All	n/a	All	Priority Habitats and Species List	2008	Washington Department of Fish & Wildlife	Washington Department of Fish & Wildlife	The PHS List is a catalog of habitats and species considered to be priorities for conservation and management. Priority species require protective measures for their survival due to their population status, sensitivity to habitat alteration, and/or recreational, commercial, or tribal importance.	There are 20 habitat types, 152 vertebrate species, 41 invertebrate species, and 10 species groups currently in the PHS List. These constitute about 17% of Washington's approximately 1000 vertebrate species and a fraction of the state's invertebrate fauna.	http://wdfw.wa.gov/publications/pub.php?id=00165	
C0406	Terrestrial - Habitats	Agriculture & Livestock Grazing	King County	A Study of Agricultural Drainage in the Puget Sound Lowlands to Determine Practices which Minimize Detrimental Effects on Salmonids	2008	Washington State University and the University of Washington	King County Department of Natural Resources and Parks	A multidisciplinary team of researchers from Washington State University and the University of Washington conducted a 5-year investigation of various practices related to agricultural watercourse maintenance. The primary focus of the investigation was related to how maintenance practices affect salmonid utilization in King County drainage systems. Four broad areas of study (fish biology, instream habitat, riparian, and sediment) were identified by KCDNPR staff during initial contract negotiations. Within each of these areas, two to four research questions were developed with methodologies and quality assurance procedures approved by King County in the project Sample Analysis Plan. Consequently, a total of twelve specific questions were addressed in this study.	Ditch maintenance is an important process for drainage and providing juvenile salmonid rearing habitat in King County. Post-maintenance water quality testing found significant improvements in dissolved oxygen levels; the temperature model predicted of temperature improvements as riparian buffers grow; and visual reports of salmonids using much larger sections of the Mullen Slough/Boscolo complex all strongly suggest that maintenance activities benefit the fish. Furthermore, reports also support the assumption that better drainage help the farmers by allowing better use of their lands. By following the general processes discussed in this report, farming and salmonids should be able to successfully co-exist.	http://www.kingcounty.gov/environment/waterandland/agriculture/drainage-assistance/agricultural-drainage-study.aspx	

Inventory of Recently Completed/Ongoing Scientific Studies

Ref #	Ecosystem Component	Primary Pressure	Action Area	Study Title	Date	Author(s) or Study Contact	Supporting Agency	General Study Design/Methods	Study Results	Weblink	Journal Citation (if applicable)
C0407	Terrestrial - Species & Food Webs	Unsustainable Fishing / Harvesting	All	Abundance, Stock Origin, and Length of Marked and Unmarked Juvenile Chinook Salmon in the Surface Waters of Greater Puget Sound	2010	Rice, C.A.,C.M. Greene, P. Moran, D.J. Teel, D.R. Kuligowski, R.R. Reisenbichler, E.M. Beamer, J.R. Karr, K.L. Fresh	NOAA, Northwest Fisheries Science Center	We measured the density, origin, and size of marked (known hatchery) and unmarked (majority naturally spawned) juveniles by means of monthly surface trawls at six river mouth estuaries in Puget Sound and the areas in between.	Results indicate more extensive use of estuarine environments by wild than by hatchery juvenile Chinook salmon as well as differential use (e.g., rearing and migration) of various geographic regions of greater Puget Sound by juvenile Chinook salmon in general. In addition, the results for hatchery-generated timing, density, and length differences have implications for the biological interactions between hatchery and wild fish throughout Puget Sound.		Transactions of the American Fisheries Society. Volume 140, Issue 1, 2011, pp170 - 189
C0408	Terrestrial - Species & Food Webs	n/a	All	Estimating Changes in Coho Salmon and Steelhead Abundance from Watershed Restoration: How Much Restoration is Needed to Measurably Increase Smolt Production?	2010	Philip Roni; George Pess; Tim Beechie; Sarah Morley	NOAA, Northwest Fisheries Science Center	Using existing data from evaluations of habitat restoration, we estimated the average change in coho salmon Oncorhynchus kisutch and steelhead O. mykiss parr and smolt densities for common in-channel (culvert removal, large wood placement, boulder placement, and constructed logjams) and floodplain restoration techniques (constructed side channels and reconnected floodplain habitats). We then used these numbers and a Monte Carlo simulation to predict changes in fish numbers in a model watershed for two restoration scenarios: (1) restoration of all accessible habitat within the watershed and (2) restoration of the average amount historically implemented in Puget Sound watersheds (8% of total restorable areas).	The percentage of floodplain and in-channel habitat that would have to be restored in the modeled watershed to detect a 25% increase in coho salmon and steelhead smolt production (the minimum level detectable by most monitoring programs) was 20%. However, given the large variability in fish response (changes in density or abundance) to restoration, 100% of the habitat would need to be restored to be 95% certain of achieving a 25% increase in smolt production for either species. Our study demonstrates that considerable restoration is needed to produce measurable changes in fish abundance at a watershed scale.		North American Journal of Fisheries Management Volume 30, Issue 6, 2010, Pages 1469 - 1484
C0409	Marine - Species & Food Webs	Unsustainable Fishing / Harvesting	All	Historical abundance of Puget Sound steelhead, Oncorhynchus mykiss, estimated from catch record data	2011	N. Gayeski, B. McMillan, P. Trotter	National Research Council of Canada	We used reported commercial catch data and historical information regarding unreported catches to estimate the abundance of winter steelhead, Oncorhynchus mykiss, in Puget Sound rivers in 1895, the year in which the peak commercial catch of steelhead occurred. We employed a Bayesian analysis to address the uncertainties associated with the estimation process and report abundance estimates for four large northern Puget Sound rivers and for the remaining aggregate of rivers and streams in Puget Sound.	Compared with the 25-year average abundance for all of Puget Sound of 22000 for the 1980-2004 period, our results show that current abundance is likely only 1%-4% of what it was prior to the turn of the 20th century		Canadian Journal of Fisheries and Aquatic Sciences, 2011, 68:498-510, 10.1139/F10-166
C0410	Marine - Species & Food Webs	Unsustainable Fishing / Harvesting	Hood Canal	Reproductive behavior and relative reproductive success of natural - and - hatchery - origin Hood Canal summer chum slamon (Oncorhynchus keta)	2009	B. A. Berejikian, D. M. Van Doornik, J. A. Scheurer, R. Bush	NOAA, Northwest Fisheries Science Center	This study compared the adult to fry reproductive success of natural-origin summer chum salmon (Oncorhynchus keta) with that of first- to third-generation hatchery-origin salmon in an experiment that included four replicate breeding groups.	Hatchery- and natural-origin chum salmon exhibited similar reproductive success. Hatchery- and natural-origin males obtained similar access to nesting females, and females of both types exhibited similar breeding behaviors and durations. Male body size was positively correlated with access to nesting females and reproductive success. The estimates of relative reproductive success (hatchery/natural = 0.83) in this study were similar to those in other studies of other anadromous salmonids in which the hatchery population was founded from the local natural population and much higher than those in studies that evaluated the lifetime relative reproductive success of nonlocal hatchery populations.	http://www.nwfsc.noaa.gov/publications/displayallinfo.cfm?docmetadataid=6987	Canadian Journal of Fisheries and Aquatic Sciences, Volume 66, Pages 781 789
C0411	Terrestrial - Species & Food Webs	Unsustainable Fishing / Harvesting	Hood Canal	Increases in Steelhead Redd Abundance Resulting from Two Conservation Hatchery Strategies in the Hamma Hamma River, WA	2008	B. A. Berejikian, T. Johnson, R. Endicott, J. Lee	NOAA, Northwest Fisheries Science Center	Focused on the influence of hatchery programs on redd abundance in Hamma Hamma River.	The conservation hatchery program for steelhead (i.e., sea-run rainbow trout, Oncorhynchus mykiss) evaluated in this study caused an increase in the number of redds in the supplemented Hamma Hamma River compared with the presupplementation period. Three control populations (nonsupplemented) either remained stable or declined over the same period. The increase in redds from hatchery-produced spawners did not reduce the redd production from natural-origin spawners. The strategy of rearing and releasing adult steelhead accounted for the greatest proportion of redd abundance increases. Environmentally induced differences in spawn timing between the adult release group and anadromous adults of hatchery and natural origin may explain why the adult release group and anadromous adults assortatively formed pairing combinations on the spawning grounds. Although captively reared adults produced the majority of redds in years they were released in substantial numbers, uncertainty regarding the relative reproductive success of this strategy suggests caution in recommending one strategy over the other. A demographic boost to the naturally spawning population was effeced while managing to minimize negative ecological consequences.	http://www.nwfsc.noaa.gov/publications/displayallinfo.cfm?docmetadataid=6643	Canadian Journal of Fisheries and Aquatic Sciences, Volume 65, Pages 754-764
C0412	Terrestrial - Species & Food Webs	Dams, Levees & Tidegates	South Central Puget Sound	Selection on breeding date and body size in colonizing coho salmon	2010	J. H. Anderson, P. Faulds, Will I. Atlas, G. R. Pess, T. P. Quinn	NOAA, Northwest Fisheries Science Center	We measured the form, direction, and strength of selection on body size and date of arrival to the breeding grounds over the first three cohorts (2003 2005) of a coho salmon (Oncorhynchus kisutch)population colonizing 33 km of habitat made accessible by modification of Landsburg Diversion Dam, on the Cedar River, Washington	Larger fish in both sexes produced more adult offspring, and the magnitude of the effect increased in subsequent years for males, suggesting that low densities attenuated traditional size-biased intrasexual competition. For both sexes, directional selection favoured early breeders in 2003, but stabilizing selection on breeding date was observed in 2004 and 2005. Adults that arrived, and presumably bred, early produced stream-rearing juvenile offspring that were larger at a common date than offspring from later parents, providing a possible mechanism linking breeding date to offspring viability. Comparison to studies employing similar methodology indicated selection during colonization was strong, particularly with respect to reproductive timing. Finally, female mean reproductive success exceeded that needed for replacement in all years so the population expanded in the first generation, demonstrating that salmon can proficiently exploit vacant habitat.	http://www.nwfsc.noaa.gov/publications/displayallinfo.cfm?docmetadataid=7071	Molecular Ecology, Volume: 19, Issue: 12, Pages: 2562-2573
C0413	Terrestrial - Species & Food Webs	Dams, Levees & Tidegates	South Central Puget sound	A genetic and phenetic baseline before the recolonization of steelhead above Howard Hanson Dam, Green River, Washington	2010	G. A. Winans, M. C. Baird, J. Baker	NOAA, Northwest Fisheries Science Center	Purpose of study was to provide data to help manage the stock of fish that are selected to recolonize the upper Green River and to track how resident rainbow trout above the dam respond genetically after 80 years of isolation. They characterized relevant gene pools in the upper Green River before fish transportation with 11 microsatellite loci to evaluate the genetic variability within and among collections.	Hatchery steelhead are clearly different from wild steelhead (FST = 0.037); genetic assignment tests correctly distinguished 91% of the steelhead. While there was no reduction in the amount of genetic variability in the resident rainbow trout above Howard Hanson Dam compared with that of wild steelhead collections below the dam, the two groups had low but statistically significant differences (FST = 0.03). The transport of juvenile and adult steelhead above the dam in the last 20 years may have affected these genetic results.	http://www.nwfsc.noaa.gov/publications/displayallinfo.cfm?docmetadataid=7052	North American Journal of Fisheries Management Volume: 30, Pages: 742-756
C0414	Terrestrial - Species & Food Webs	Unsustainable Fishing / Harvesting	South Central Puget Sound	Changes in fish communities following recolonization of the Cedar River, WA, USA by Pacific salmon after 103 years of local extirpation	2008	P. M. Kiffney, G. R. Pess, J. H. Anderson, K. Burton, P. Faulds, S. Riley	NOAA, Northwest Fisheries Science Center	Examination of the effectiveness of fish passage facility at Landsburg Dam in restoring coho (Oncorhynchus kisutch) salmon populations above the diversion, and whether reintroduction of native anadromous species affected the distribution and abundance of resident trout (O. mykiss and O. clarki).	Results suggest that barrier removal creates an opportunity for migratory species to re-establish populations leading to range expansion and potentially to increased population size.	http://www.nwfsc.noaa.gov/publications/displayallinfo.cfm?docmetadataid=6793	River Research and Applications, Volume 25, Issue 4, pages 438–452
C0415	Marine - Species & Food Webs	Unsustainable Fishing / Harvesting	Hood Canal	Movements of yearling Chinook salmon during the first summer in marine waters of Hood Canal, Washington	In press	J. Chamberlin, A. N. Kagley, K. L. Fresh, T. P. Quinn	NOAA, Northwest Fisheries Science Center	The objective of this study was to quantify the movements of yearling Chinook salmon smolts during their initial summer in Hood Canal, a long, narrow fjord in western Puget Sound, Washington. Fifty-eight yearling hatchery-reared smolts were tagged with acoustic transmitters and tracked during May–August 2008 with a network of 50 receivers placed throughout Hood Canal.	A total of 41 fish were detected during the study period; of these, 18 fish were still being detected in Hood Canal after 100 d. Fish initially congregated near the release site and gradually dispersed during summer; individual movement rates ranged between 0.44 and 1.52 body lengths/s. Fish movement occurred both with and against tidal currents, and nearly all fish showed some period of inactivity, especially as recorded on receivers near estuaries and tidal deltas. Eight fish (20%) were detected as leaving Hood Canal during the study, but seven of them later returned to Hood Canal. The extended use of Hood Canal as rearing habitat indicated the importance of such environments beyond their role as migratory corridors to the Pacific Ocean.	http://www.nwfsc.noaa.gov/publications/displayallinfo.cfm?docmetadataid=7627	Transactions of the American Fisheries Society, in press
C0416	Marine - Species & Food Webs	Unsustainable Fishing / Harvesting	All	The influence of hatchery rearing strategies on salmon migratory behavior: Is the tendency for Chinook salmon to remain within Puget Sund affected by size and date of release?	In press	J. Chamberlin, T. E. Essington, J. W. Ferguson, T. P. Quinn	NOAA, Northwest Fisheries Science Center	The objective of our study was to determine the effect of rearing conditions and hatchery location on the prevalence of this alternative pattern of marine distribution by hatchery-produced Chinook salmon in Puget Sound. We used coded wire tag recovery data to analyze the effect of release region, age, size, and date of release on the proportion of fish showing resident-type behavior, defined as recovery in Puget Sound fisheries outside the period when maturing salmon return from the coast.	Based on 226 different release groups from 26 hatcheries throughout Puget Sound from 1972 to 1993, 24% of the fish recovered were classified as residents, though this is not an actual estimate of the percentage of fish displaying this distribution pattern. The best single predictor of residency was release region, suggesting that where fish enter the marine environment had the largest influence on whether they adopted resident behavior or migrated directly to the ocean. The overall best model included an interactive effect between release region and size at release, revealing that the propensity of large fish to remain resident varied significantly among regions. The actual mechanisms that create the diversity of distribution patterns are still unknown, but the effects of rearing conditions and release location provide useful information for the management of these salmon populations.	http://www.nwfsc.noaa.gov/publications/displayallinfo.cfm?docmetadataid=7686	Transactions of the American Fisheries Society, in press
C0417	Marine - Species & Food Webs	Unsustainable Fishing / Harvesting	All	April 2010 Comprehensive Management Plan for Puget Sound Chinook: Harvest Management Component	2010	Puget Sound Indian Tribes and WDFW	Puget Sound Indian Tribes and WDFW	The Harvest Management Plan will guide the Washington co-managers in planning annual harvest regimes, as they affect listed Puget Sound Chinook salmon, for management years 2010 - 2014. Harvest regimes will be developed to achieve stated objectives for each of fifteen management units. The Plan describes how these guidelines are applied to annual harvest planning.	The abundance and productivity of all Puget Sound Chinook populations is constrained by habitat conditions. Recovery to substantially higher abundance is primarily dependent on restoration of habitat function. The plan sets Exploitation Rate ceilings and low abundance thresholds for each management unit.	http://wdfw.wa.gov/publications/pub.php?id=00854	
C0418	Marine - Species & Food Webs	Unsustainable Fishing / Harvesting	All	Comprehensive Management Plan for Puget Sound Chinook: Harvest Management Component - Annual Postseason Report 2008-09 Fishing Season	2009	Puget Sound Indian Tribes and WDFW	Puget Sound Indian Tribes and WDFW	This annual report on the Puget Sound Chinook Comprehensive Harvest Management Plan summarizes results of salmon fisheries occurring between May 1, 2008 and April 30, 2009. This includes comparisons of pre-season projections with actual catch in all commercial and some recreational fisheries. Chinook spawning escapement estimates for 2008 are reported for all Puget Sound populations, with details on escapement surveys and estimation methods. Comparisons are also made between pre-season projections of escapement, and actual results.	Commercial Chinook catch in Puget Sound pre-terminal areas was less than projected in all areas. Marine and freshwater landed recreational Chinook catch in the 2007-2008 season was estimated, from a combination of Catch Record Card and creel data, to be 64,300, higher than the pre-season projection of 52,100. Escapement varied by region. Coded-wire tag sampling of 2007 commercial fisheries achieved sampling rate above 20% in most, but not all marine and freshwater areas.	http://wdfw.wa.gov/publications/pub.php?id=00104	
C0419	Marine - Species & Food Webs	Unsustainable Fishing / Harvesting	All	Comprehensive Management Plan for Puget Sound Chinook: Harvest Management Component - Annual Postseason Report 2009-10 Fishing Season	2010	Kyle Adicks, Thom Johnson, Randy Cooper, Brett Barkdull, Andrew Fowler, Pete Verhey, Jennifer Whitney, Natasha Geiger, Aaron Bosworth, Larry Phillips, Mike Scharpf, Mark Baltzell, Laurie Peterson, Steve Thiesfeld, and Jeromy Jording	Puget Sound Indian Tribes and WDFW	This annual report on the Puget Sound Chinook Comprehensive Harvest Management Plan summarizes results of salmon fisheries occurring between May 1, 2009 and April 30, 2010. This includes comparisons of pre-season projections with actual catch in all commercial and some recreational fisheries. Chinook spawning escapement estimates for 2009 are reported for all Puget Sound populations, with details on escapement surveys and estimation methods. Comparisons are also made between pre-season projections of escapement, and actual results.	Commercial Chinook catch in Puget Sound pre-terminal net fisheries was less than projected in all areas. Marine and freshwater landed recreational Chinook catch in the 2008-2009 season was estimated, from a combination of creel and preliminary Catch Record Card data, to be 45,800, slightly less than the pre-season projection of 47,100. Spring Chinook escapement varied by region.	http://wdfw.wa.gov/publications/pub.php?id=00975	
C0420	Nearshore - Species & Food Webs	n/a	South Puget Sound	Pre-Restoration Habitat Use by Chinook Salmon in the Nisqually Estuary Using Otolith Analysis: An Additional Year	2009	Lind-Null, Angie, and Larsen, Kim	US Geological Survey	Otolith analysis was used to examine Chinook salmon life history, growth, and residence in the Nisqually Estuary. The purpose was to incorporate otolith microstructure analysis from 2005, to verify findings from 2004, and to evaluate between-year variation in otolith microstructure.	Results indicated no inter-annual variation in the appearance of the tidal delta check (TDCK) and delta-flats check (DFCK). A new life history type (fry migrant) was observed on samples collected in 2005. Fish caught in the tidal delta spent an average of 17 days in the tidal delta. There was a corresponding increase in growth rate as the fish migrated from freshwater (FW) to tidal delta to nearshore (NS) habitats. Fish grew 33 percent faster in the tidal delta than in FW habitat and slightly faster (14 percent) in the delta flats (DF) habitat compared to the tidal delta.	http://pubs.usgs.gov/of/2009/1106/	

Inventory of Recently Completed/Ongoing Scientific Studies

Ref #	Ecosystem Component	Primary Pressure	Action Area	Study Title	Date	Author(s) or Study Contact	Supporting Agency	General Study Design/Methods	Study Results	Weblink	Journal Citation (if applicable)
C0421	Nearshore - Species & Food Webs	n/a	South Puget Sound	Otolith Analysis of Pre-Restoration Habitat Use by Chinook Salmon in the Delta-Flats and Nearshore Regions of the Nisqually River Estuary	2010	Lind-Null, Angie, and Larsen, Kim	US Geological Survey	Otolith analysis was used to examine Chinook salmon life history, growth, and residence in the Nisqually River estuary.	Generally, freshwater mean increment width of unmarked fish, on average, was smaller compared to marked Chinook followed by tidal delta and DF/NS portions respectively. On average, the complete tidal delta growth rate was higher for marked Chinook compared to unmarked Chinook. The average DF/NS growth rate on unmarked Chinook was consistently lower than marked Chinook during all years; however, sample sizes were small during some years. Unmarked Chinook, on average, spent longer in the tidal delta compared to marked Chinook. Otolith microstructural analysis can be a valuable tool in establishing baseline information on the utilization of Nisqually River estuary habitats by juvenile Chinook salmon prior to the newly funded restoration efforts.	http://pubs.usgs.gov/of/2010/1238/	
C0422	Terrestrial - Species & Food Webs	Unsustainable Fishing / Harvesting	South Central Puget Sound	Evaluation of Downstream Migrant Salmon Production in 2008 from the Cedar River and Bear Creek	2009	Kelly Kiyohara and Mara Zimmerman	Washington Department of Fish & Wildlife	This report describes downstream juvenile migrations of five salmonid species emigrating from Cedar River and Bear Creek. Trapping is done annually. The study provides juvenile production estimates for sockeye and Chinook and outmigration estimates of coho, steelhead, and cutthroat smolts.	In addition to sockeye and Chinook, five salmonid species were captured as outmigrants of the Cedar River and three salmonid species were captured as outmigrants of Bear Creek. Egg to migrant survival of Chinook and sockeye on the Cedar River was higher in 2008 than any previous year when juvenile outmigrations have been evaluated.	http://wdfw.wa.gov/publications/00091/wdfw00091.pdf	
C0423	Terrestrial - Species & Food Webs	Unsustainable Fishing / Harvesting	South Central Puget Sound	Cedar River and Lake Washington Sockeye Salmon Biological Reference Point Estimates	2009	Scott McPherson and James Woodey	Washington Department of Fish & Wildlife	The subject of the report is the findings of an inquiry into appropriate biological reference points (BRPs) for Cedar River sockeye and for the Lake Washington sockeye stock complex as a whole. The goal is to estimate the appropriate BRPs for Cedar River sockeye with available data and to provide fishery managers insight into the options and risks of changing the management policy based on current biological measurements. Secondly, data from other stocks is analyzed for comparative purposes.	The report presents 16 conclusions and 5 recommendations that are specific to the Cedar River watershed and salmon runs.	http://wdfw.wa.gov/publications/pub.php?id=00778	
C0424	Terrestrial - Species & Food Webs	Unsustainable Fishing / Harvesting	All	2011 Wild Coho Forecasts for Puget Sound, Washington Coast, and Lower Columbia River	2011	Mara Zimmerman	Washington Department of Fish & Wildlife	Wild coho production estimates for each of the primary and secondary management units in Puget Sound were derived from results of juvenile trapping studies conducted by the Washington Salmon Production Evaluation Unit.		http://wdfw.wa.gov/publications/pub.php?id=01166	
C0425	Terrestrial - Species & Food Webs	Unsustainable Fishing / Harvesting	Whidbey	Migration of Anadromous Juvenile Bull Trout in the Skagit River, 1990-2009	2010	Mara Zimmerman and Clayton Kinsel	Washington Department of Fish & Wildlife	This report summarizes twenty years of biological information on anadromous juvenile bull trout in the Skagit River. The goal of this report is to characterize juvenile bull trout migration patterns and identify environmental variables that are associated with variation in these patterns.	Initial comparison of juvenile anadromy in the Skagit River with a previous study on the Hoh River indicates that both age structure and migration timing differs between these river systems. Further work in the Skagit River is needed to resolve the relative contributions of source populations to the anadromous life history form and validate assumptions regarding the age structure of juvenile migrants.	http://wdfw.wa.gov/publications/pub.php?id=01173	
C0426	Terrestrial - Species & Food Webs	Unsustainable Fishing / Harvesting	South Central Puget Sound	Green River Juvenile Salmonid Production Evaluation: 2009 and 2010 Annual Report	2011	Pete Topping and Mara Zimmerman	Washington Department of Fish & Wildlife	This report provides the 2009 and 2010 results from the juvenile salmonid monitoring study conducted on the Green River in central Puget Sound, Washington. The primary objective of this study was to estimate the juvenile abundance natural-origin Chinook in the Green River. Additional objectives were to estimate the juvenile migrants produced by other salmonid species and to describe life history characteristics of all juvenile migrants.	Egg-to-migrant survival of Green River Chinook for the 2009 outmigration (2008 brood) was estimated to be 2.1%, yielding a basin-wide production estimate of 269,277 juveniles. Egg-to-migrant survival of the 2010 outmigration (2009 brood) was estimated to be 5.7%, yielding a basin-wide production estimate of 263,466 juveniles. In 2009, fry (<45-mm fork length) represented 61% of all sub yearling migrants and peaked between March 30 and April 5, whereas parr migrants (45+ mm fork length) peaked between June 15 and 21. In 2010, fry migrants represented just 10% of total sub yearling migrants and peaked between March 29 and April 4. Parr migrants peaked between June 7 and 13 in 2010.	http://wdfw.wa.gov/publications/pub.php?id=01168	
C0427	Terrestrial - Species & Food Webs	Unsustainable Fishing / Harvesting	South Central Puget Sound	Evaluation of Juvenile Salmon Production in 2009 from the Cedar River and Bear Creek	2011	Kelly Kiyohara and Mara Zimmerman	Washington Department of Fish & Wildlife	This report describes downstream juvenile migrations of five salmonid species emigrating from two heavily spawned tributaries in the Lake Washington watershed: Cedar River and Bear Creek. The report provides production estimates of Chinook salmon, coho, steelhead, and cutthroat smolts.	A total of 52,691 natural-origin coho were estimated to have migrated from Cedar River in 2009. A total of 33,395 ± 6,555 (95% C.I.) natural-origin coho and 4,401 ± 1,751 (95% C.I.) cutthroat are estimated to have migrated from Bear Creek in 2009.	http://wdfw.wa.gov/publications/pub.php?id=01150	
C0428	Terrestrial - Species & Food Webs	n/a	All	Land Use Planning for Salmon, Steelhead and Trout: A land use planner's guide to salmonid habitat protection and recovery	2009	Katie Knight	Washington Department of Fish & Wildlife	This planner's guide to salmonid recovery is intended for local governments and includes information on state salmonid recovery efforts, sources of best available science, and model policies and development regulations for implementing salmonid recovery.	n/a	http://wdfw.wa.gov/publications/pub.php?id=00033	
C0429	Terrestrial - Species & Food Webs	Unsustainable Fishing / Harvesting	South Central Puget Sound	Functions of restored wetlands for juvenile salmon in an industrialized estuary	2011	Jeffery R Cordell; Jason D Toft; Aysha Gray; Gregory T Ruggerone; Michael Cooksey	Water Resource Inventory Area 9, the King Conservation District, and the Salmon Recovery Funding Board	We tested the function of restored sites in the Duwamish estuary for juvenile Chinook salmon by comparing fish densities from enclosure nets or beach seines at three paired restored/un-restored sites and by applying environmental and diet data to a bioenergetics model. We also examined temporal and diet overlap of wild juvenile Chinook salmon with other salmon species and with hatchery-reared Chinook salmon using non-metric multidimensional scaling (NMDS).	Our results suggest that restoration sites in the Duwamish estuary that have larger access openings and are located in brackish water may have increased function over other configurations.		Ecological Engineering Volume: 37 Issue: 2 Pages: 343-353
C0430	Marine - Species & Food Webs	Unsustainable Fishing / Harvesting	Hood Canal	Determination of independent populations and viability criteria for the Hood Canal summer chum salmon evolutionarily significant unit	2009	Sands, N. J., K. Rawson, K. P. Currens, W. H. Graeber, M. H. Ruckelshaus, R. R. Fuerstenberg, and J. B. Scott	NOAA, Northwest Fisheries Science Center	The analysis of the Hood Canal Summer Chum Salmon ESU was based on allozyme and microsatellite DNA variation, straying patterns, historical and present geographical distribution, and life history and ecological variations.	Based on multiple lines of evidence, we concluded that the ESU contains two independent populations. Since the Hood Canal Summer Chum Salmon ESU has only two independent populations, both the Strait of Juan de Fuca population and the Hood Canal population would need to be viable to have a viable ESU at low risk of extinction.	http://www.nwfsc.noaa.gov/assets/25/6991_09292009_133954_HoodCanalChumTM101WebFinal.pdf	
C0431	Marine - Species & Food Webs	n/a	All	Species composition and relative abundance of large medusae in Puget Sound, WA	2010	Reum, J., M. Hunsicker, and C. Paulsen	UW - Fisheries	We assessed species composition and relative biomass densities of large medusae (bell diameters larger than 4 cm) at four locations in Puget Sound, Washington, over two sampling periods (June and September). We specifically sampled sites in southern Hood Canal (near Hoodsport), northern Hood Canal (Hazel Point), southern Admiralty Inlet (Useless Bay) and Possession Sound using a bottom trawl as part of a larger survey of demersal fish and invertebrate community structure.	Our results indicate that jellyfish biomass changed markedly within and among locations, which has implications for modeling energy flows in Puget Sound and developing monitoring schemes that are able to capture interannual variability in jellyfish biomass. Given the abundance of jellyfish in our survey and their potential as sentinels of change in the marine environment we recommend that jellyfish populations be routinely monitored in Puget Sound.	http://www.bioone.org/doi/abs/10.3955/046.084.0202	Northwest Science.84(2):131-140. doi: 10.3955/046.084.0202
C0432	Marine - Species & Food Webs	n/a	All	Quantitative evaluation of marine ecosystem indicator performance using food web models	2009	Samhouri, J., P. Levin, and C. Harvey	NOAA, Northwest Fisheries Science Center	The study analyzed seven marine food web models to evaluate the performance of candidate indicators of ecosystem structure and function. The basic approach involved simulating fishing perturbations to each model, measuring the response of ecosystem attributes and candidate indicators to the perturbations, and testing the ability of the indicators to track changes in the values of the attributes.	Our analysis suggests that no single indicator is sufficient to describe all of the ecosystem attributes, but at the same time highlights broad, catch-all indicators (for example, detritivores, jellyfish) and distinguishes the strongest attribute– indicator relationships. Ecosystem indicators consisting of lower-trophic level, higher-productivity functional groups tended to perform particularly well. We also identified indicators that showed strong or weak associations with different attributes, but together captured changes in nearly all of them. Examples of such complementary indicators include phytoplankton, zooplanktivorous fish, piscivorous fish, and trophic level of the catch. Quantitative approaches such as this one will enable managers to make informed decisions about ecosystem-scale monitoring in the oceans.	http://www.springerlink.com/content/k3k81124v4x70p37/	Ecosystems 12:1283-1298
C0433	Marine - Species & Food Webs	Climate Change	Whidbey	Multiscale influence of climate on estuarine populations of forage fish: the role of coastal upwelling, freshwater flow and temperature	2011	Reum, J.C.P.,T.E. Essington, C.M. Greene, C.A, Rice, K.L. Fresh	NOAA, Northwest Fisheries Science Center	Data collected during surface trawls examined how local- and regional-scale environmental drivers affect patterns of abundance and recruitment in 2 abundant and ecologically significant forage fishes (Pacific herring Clupea pallasi and surf smelt Hypomesus pretiosus) in the Skagit River estuary	Results suggest that age-0 recruitment in these populations is synchronized by regional upwelling as opposed to estuary-specific environmental forcing related to river flows. The present study isolates a potential key process governing age-0 forage fish abundance in this system and highlights the importance of simultaneously evaluating patterns of variability across multiple spatiotemporal scales in order to identify the primary pathways through which climate may impact estuarine populations.		Marine Ecology Progress Series (0171-8630), 425, p. 203.
C0434	Marine - Species & Food Webs	n/a	Whidbey	Prevalence of Viral Erthrocytic Necrosis in Pacific Herring and Epizootics in Skagit Bay, Puget Sound, Washington	2009	P. K. Hershberger, N. Elder, C. A. Grady, J. L. Gregg, C. A. Pacheco, C. Greene, C. Rice, T. R. Meyers	NOAA, Northwest Fisheries Science Center	Measured epizootics of viral erythrocytic necrosis (VEN)in juvenile Pacific herring (Clupea pallasii) in Skagit Bay, Puget Sound, Washington, during 2005 2007	The persistence and recurrence of VEN epizootics indicate that the disease is probably common among juvenile Pacific herring throughout the eastern North Pacific Ocean, and although population-level impacts probably occur they are typically covert and not easily detected.	http://www.nwfsc.noaa.gov/publications/displayallinfo.cfm?docmetadataid=6954	Journal of Aquatic Animal Health Volume: 21 Pages: 1-7
C0435	Marine - Species & Food Webs	Unsustainable Fishing / Harvesting	All	Rockfish in Puget Sound: An Ecological History of Exploitation	2010	G. D. Williams, P. S. Levin, Wayne A. Palsson	NOAA, Northwest Fisheries Science Center	Presents a review of the local history of rockfish exploitation, focusing on the socioeconomic forces and management decisions which influenced the trajectory of landings.	Annual commercial and recreational harvests together peaked (almost 400. mt) in the early 1980s as anglers' attitudes changed, gear technology improved, rockfish became more familiar to the market, human population increased, and agency programs promoted fisheries to sustain employment. Rockfishes were generally not managed intensely or with conservation goals in mind until the late 1980s, in part due to scientific shortcomings and a lack of resources. By the time management actions were deemed necessary, the greatest harvest had already occurred	http://www.nwfsc.noaa.gov/publications/displayallinfo.cfm?docmetadataid=7573	Marine Policy Volume: 34 Pages: 1010-1020
C0436	Marine - Species & Food Webs	Unsustainable Fishing / Harvesting	All	The Biology and Assessment of Rockfishes in Puget Sound	2009	Wayne A. Palsson, Tien-Shui Tsou, Greg G. Bargmann, Raymond M. Buckley, Jim E. West, Mary Lou Mills, Yuk Wing Cheng, and Robert E. Pacunski	Washington Department of Fish & Wildlife	This technical literature review supports and is a source document for the Puget Sound Rockfish Conservation Plan.	The report summarizes the current knowledge of rockfish biology in Puget Sound (life history, habitat usage, and ecosystem linkages), provides an overview of the exploitation history of rockfishes, and examines their current stock status. The review also includes a series of recommendations to improve the understanding and management of rockfishes in Puget Sound.	http://wdfw.wa.gov/publications/pub.php?id=00926	
C0437	Marine - Species & Food Webs	n/a	All	2008 Washington State Herring Stock Status Report	2009	Kurt C. Stick and Adam Lindquist	Washington Department of Fish & Wildlife	This is the fourth edition of the Washington Department of Fish and Wildlife herring stock status report. Similar to previous editions, this document uses localized documented herring spawning grounds in Washington waters to represent discrete stocks.	The cumulative abundance of south and central Puget Sound herring stocks in recent years is comparable to that observed in the 1970's and 1980's, while the Cherry Point stock, and cumulative north Puget Sound (excluding the Cherry Point stock) and Strait of Juan de Fuca regional spawning biomasses are at low levels of abundance. For the 2007-08 period, less than half (47%) of Puget Sound herring stocks are classified as healthy or moderately healthy. This is the lowest percentage of individual stocks meeting these criteria since development of the stock status summary in 1994, although very similar to the status breakdown for the previous two-year periods (2003-04 and 2005-06).	http://wdfw.wa.gov/publications/pub.php?id=00928	
C0438	Marine - Species & Food Webs	n/a	San Juan/Whatcom	Estimating Acoustic Abundance of Forage Fish in Rosario Strait, Washington	2009	Darcy A. Wildermuth	Washington Department of Fish & Wildlife	Hydroacoustic-trawl surveys were conducted in June of 2008 to assess pelagic forage abundance and composition in Rosario Strait and Burrows Bay, Washington.	Pelagic forage species composition varied by area and survey date, but was dominated by juvenile Walleye Pollock (Theragra chalcogramma), (TL=60.9 mm) and pre-metamorphosed Pacific Herring (Clupea pallasii), (TL= 45.0 mm). From these results, 1,369 metric tons of pelagic forage, including 505 metric tons of juvenile pollock and 169 metric tons of pre-metamorphosed herring were estimated.	http://wdfw.wa.gov/publications/pub.php?id=00929	

Inventory of Recently Completed/Ongoing Scientific Studies

Ref #	Ecosystem Component	Primary Pressure	Action Area	Study Title	Date	Author(s) or Study Contact	Supporting Agency	General Study Design/Methods	Study Results	Weblink	Journal Citation (if applicable)
C0439	Terrestrial - Species & Food Webs	Residential, Commercial, Port & Shipyard Development	South Puget Sound	Olympic mudminnow (Novumbra hubbsi) in the Green Cove Creek Watershed, Thurston County, Washington: Distribution and Recommendations for Protection	2009	Molly Hallock and Jamie Glasgow	Washington Department of Fish & Wildlife	In response to the threat posed to mudminnow habitat by rapid urban development within the Green Cove watershed, WDFW initiated a systematic basin-wide survey to describe mudminnow distribution and habitat usage. Fish presence was ascertained using baited minnow traps, dipnets, and on rare occasion an electrofisher.	Olympic mudminnows were documented at 23 of the 31 sample sites throughout the drainage, including headwater ditches and ponds, wetlands, and lower stream reaches. In addition to describing observed and potential mudminnow distribution throughout the watershed, the report presents management recommendations to protect Olympic mudminnow habitat from further degradation.	http://wdfw.wa.gov/publications/pub.php?id=00002	
C0440	Nearshore - Species & Food Webs	Climate Change	All	Anticipated effects of sea level rise in Puget Sound on two beach-spawning fishes, *in* Shipman et al 2010	2010	Krueger, K.L., Pierce, Jr., K.B., Quinn, Timothy, and Penttila, D.E.,	Washington Department of Fish and Wildlife	To describe the geographic and temporal distribution of surf smelt and sand lance spawning occurrence we analyzed survey data collected by the WDFW since 1972, which included visual observation of egg presence, and plotted spawning sample results onto Washington ShoreZone Inventory beaches. Also did surveys of Camano Island 2007-2008 and intertidal distributional surveys at 28 beaches in Central PS in 2004-2005.	Our analyses suggest that addressing shoreline armoring effects on beach morphology and surf smelt and sand lance spawning habitat is an important and urgent management concern. Loss of beach spawning habitat as a result of sea‑level rise and shoreline armoring is likely to be widespread because much of the shoreline of Puget Sound is already armored and the desire to armor shorelines is expected to increase as additional shoreline is developed (Quinn, 2010) and as sea level rise speeds beach migration (Griggs and others, 1994; Johannessen and MacLennan, 2007). Further, the discontinuous geographic distribution of spawning occurrence and egg abundance suggest that loss of a relatively small number of spawning beaches might have a large detrimental effect on egg abundance.	http://pubs.usgs.gov/sir/2010/5254/	
C0441	Marine - Species & Food Webs	Unsustainable Fishing / Harvesting	All	Trophic and fishery interactions between Pacific hake and rockfish: effect on rockfish population rebuilding times	2008	Harvey, C. J., K. Gross, V. H. Simon, and J. Hastie	NOAA, Northwest Fisheries Science Center	Several species of overfished Pacific rockfish (genus Sebastes) are incidentally caught in the fishery targeting Pacific hake *Merluccius productus* . Juvenile rockfish also comprise a small amount of Pacific hake diets. The study used 2-species, age-structured models to estimate how prey selectivity by Pacific hake, life history and population structure of rockfish, spatiotemporal overlap, and fishery closures might affect the time required to rebuild overfished rockfish populations to 40% of unfished spawning stock biomass.	As prey selectivity increased, rebuilding time increased moderately for widow rockfish S. entomelas and darkblotched rockfish S. crameri, and more sharply for canary rockfish S. pinniger. Darkblotched rockfish were the least sensitive to Pacific hake predatory selectivity, which was likely related to their rarity in Pacific hake diets, not their stochastic reproductive success. Spatiotemporal overlap between rockfish and Pacific hake also increased rebuilding times, primarily because of higher rockfish bycatch, not predation. Early fishery closures and Pacific hake predation had an interactive effect that prolonged widow and canary rockfish rebuilding times, partly as a function of model assumptions and partly because fishery closures led to increased predation on juvenile rockfish. Because an ecosystem-based approach to fisheries management involves considering the influence of ecological factors on fish populations, models that examine interactions between depleted species and predatory species are essential. In this case, it appears that overfished rockfish rebuilding times can be significantly affected by the dynamics of a key predator, but also that the predatory effect can be mitigated by effective bycatch control.	http://www.int-res.com/abstracts/meps/v365/p165-176/	Marine Ecology Progress Series 365:165-176
C0442	Nearshore - Species & Food Webs	Oil & Hazardous Spills	All	Cardiac Arrhythmia Is the Primary Response of Embryonic Pacific Herring (Clupea pallasi) Exposed to Crude Oil during Weathering	2009	Incardona, J.P., Carls, M.G., Day, H.L., Sloan, C.A., Bolton, J.L., Collier, T.K., and Scholz, N.L.	NOAA—Fisheries	Teleost embryos develop a syndrome characterized by edema when exposed to water that weathers substrates contaminated with crude oil. Previous studies using zebrafish demonstrated that crude oil exposure causes cardiogenic edema, and that the most abundant polycyclic aromatic hydrocarbons (PAHs) in weathered crude oils (tricyclic fluorenes, dibenzothiophenes, and phenanthrenes) are cardiotoxic, causing arrhythmia through a pathway that does not require activation of the aryl hydrocarbon receptor (AHR).	The study demonstrates for Pacific herring, a species impacted by the Exxon Valdez oil spill, that the developing heart is the primary target of crude oil exposure. Herring embryos exposed to the effluent of oiled gravel columns developed dose-dependent edema and irregular cardiac arrhythmia soon after the heartbeat was established. At a dose that produced cardiac dysfunction in 100% of exposed embryos, tissue levels of tricyclic PAHs were below 1 µmol/kg, suggesting a specific, high affinity target in the heart. These findings have implications for understanding the mechanism of tricyclic PAH cardiotoxicity, the development of biomarkers for the effects of PAH exposure in fish, and understanding the long-term impacts of oil spills and other sources of PAH pollution in aquatic environments.	http://pubs.acs.org/doi/abs/10.1021/es802270t	Environmental Science & Technology 43(1): 201-207
C0443	Marine - Species & Food Webs	n/a	All	Seasonal variation in guild structure of the Puget Sound demersal fish community	2008	Reum, J., and T. Essington	UW - Fisheries	The study analyzed guild structure of the demersal fish assemblage in Puget Sound, WA, a temperate estuarine system on the US west coast. Using diet information from 2,401 stomachs collected across three seasons (fall, winter, and summer), we identified guild membership for 21 fish species, examined seasonal guild switching, and tested for seasonal shifts in predation and for differences in the degree of diet overlap at the assemblage level.	Using cluster analysis and a permutation approach, we identified seven significant guilds that were typified by predation on benthic invertebrates, pelagic invertebrates, and piscivory. Of the 18 species with more than one season of diet information, six switched guilds (Pacific sanddab L, sturgeon poacher, Pacific tomcod S, speckled sanddab, rex sole, and rock sole S). At the assemblage level, we tested for seasonal differences in prey use between seasons by performing an analysis of similarities based on Bray–Curtis diet similarities and found no significant difference. However, diet overlap was significantly higher in the summer than the fall and winter (with summer>fall>winter) indicating that diets within the assemblage converged in the summer. These results indicate that analyses of guild structure and diet overlap can reveal seasonal variation in community trophic structure and highlight intra-annual food web variation in the Puget Sound demersal fish community.	http://www.springerlink.com/content/tlju0r8238337pq8/	Estuaries and Coasts 31:790-801
C0444	Marine - Species & Food Webs	Climate Change	All	Unconfounding the effects of climate and density dependence using 60 years of data on spiny dogfish (Squalus acanthias)	2009	Taylor, I. G., and V. F. Gallucci	NOAA, Northwest Fisheries Science Center	The report compares demographic parameters for spiny dogfish in the Northeast Pacific and analyzed changes using Leslie matrix analysis.	Over a 60-year interval, growth parameters changed significantly, with faster growth to a smaller size. These changes could lead to an increase in population growth rate of about 1%. The greatest change in demographic parameters occurred between the 1940s and 1970s. The implications for fishing on long-lived populations during times of rapid environmental change are explored.	http://www.nrcresearchpress.com/doi/pdf/10.1139/F08-211	Canadian Journal of Fisheries and Aquatic Sciences 66:351-366
C0445	Marine - Species & Food Webs	Unsustainable Fishing / Harvesting	All	Linking killer whale survival and prey abundance: food limitation in the oceans' apex predator?	2009	Ford, J. K. B., G. M. Ellis, P. F. Olesiuk, and K. C. Balcomb	Fisheries and Oceans Canada, the Vancouver Aquarium, the BC Wild Killer Whale Adoption Program and the Earthwatch Institute	The study examines 25 years of demographic data from two populations of fish-eating killer whales in the northeastern Pacific Ocean.	Population trends are driven largely by changes in survival, and that survival rates are strongly correlated with the availability of their principal prey species, Chinook salmon (Oncorhynchus tshawytscha). Results suggest that, although these killer whales may consume a variety of fish species, they are highly specialized and dependent on this single salmonid species to an extent that it is a limiting factor in their population dynamics. Other ecologically specialized killer whale populations may be similarly constrained to a narrow range of prey species by culturally inherited foraging strategies, and thus are limited in their ability to adapt rapidly to changing prey availability.	http://rsbl.royalsocietypublishing.org/content/6/1/139.full	Biology Letters 6:139-142
C0446	Marine - Species & Food Webs	Non-Point Source Loading & Runoff	All	Effects of age, sex and reproductive status on persistent organic pollutant concentrations in "Southern Resident" killer whales	2009	Krahn, M. M., M. B. Hanson, G. S. Schorr, C. K. Emmons, D. G. Burrows, J. L. Bolton, R. W. Baird, and G. M. Ylitalo	NOAA, Northwest Fisheries Science Center, Cascadia Research Collective	Twelve Southern Resident killer whales (two from J-pod, five from K-pod and five from L-pod) were biopsied in 2007. Each sample was analyzed for POPs, carbon and nitrogen stable isotopes and lipids in order to assess possible changes in the Southern Residents POP levels and diet.	Blubber biopsy samples from Southern Resident juveniles had statistically higher concentrations of certain persistent organic pollutants than were found for adults. Most Southern Resident killer whales, including the four juveniles, exceeded the health-effects threshold for total PCBs in marine mammal blubber. Maternal transfer of contaminants to the juveniles during rapid development of their biological systems may put these young whales at greater risk than adults for adverse health effects (e.g., immune and endocrine system dysfunction). Pollutant ratios and field observations established that two of the pods (K- and L-pod) travel to California to forage. Nitrogen stable isotope values, supported by field observations, indicated possible changes in the diet of L-pod over the last decade.		Marine Pollution Bulletin 58:1522-1529
C0447	Marine - Species & Food Webs	n/a	San Juan/Whatcom	Tidal influence on the haul-out behavior of harbor seals (Phoca vitulina) at a site available at all tide levels	2008	Patterson, J., and A. Acevedo-Gutierrez	Western Washington University	The study counted hauled-out Harbor Seals from sunrise to sunset on floatingwater-breakers at Semiahmoo Marina, Washington, to examine the effect of tides on haul-out behavior. Because haul-out behavior is affected by several factors, we conducted mixed-factor analyses that included tide level, tidal current, time of season, and time of day as fixed factors, and several meteorological variables as random factors.	The number of hauled-out Harbor Seals was significantly associated with tide level, time of season, and time of day. Results suggest that seal counts in Semiahmoo Marina should be made late in the pupping season and early in the afternoon at moderately positive tide levels to achieve the highest counts. They also indicate that tide was associated with seal numbers unrelated to site availability because seal numbers were positively related to tide height, a finding opposite to studies at tidal haul-out sites.	http://www.biol.wwu.edu/mbel/media/pdfs/NWNat2008_89.pdf	Northwestern Naturalist 89:17-23
C0448	Nearshore - Habitats	Shoreline Armoring	South Central	Shoreline Changes over 40 Years in the Seahurst Region, Central Puget Sound	2010	Dethier, M.N. and H.D. Berry	Washington Department of Natural Resources	Intensive biotic surveys at Seahurst Park in 2009 were compared with historic surveys completed by Kohn in 1971 and by Thom between 1982 and 1984. Additionally, more recent changes in the region were assessed using monitoring data collected by DNR and UW between 1999 and 2009.	We found substantial changes in both beach morphology and biota at all sites surveyed within Seahurst Park in 2009, as compared to the 1971 and 1983 surveys. Key findings listed in report	http://www.dnr.wa.gov/ResearchScience/Topics/AquaticHabitats/Pages/aqr_nrsh_publications.aspx	
C0449	Nearshore - Habitats	n/a	South, South Central	Restricted ranges in physical factors may constitute subtle stressors for estuarine biota	2010	Dethier, M.N., Ruesink, J., Berry, H., Sprenger, A.G., and Reeves, B.	University of Washington	Analysis of physical parameters of beaches to look for correlations with shallow gradients in nearshore wave energy, temperature, and salinity.	Variation in physical parameters on estuarine shorelines in Puget Sound is quite low compared to many other estuaries, but particular parameters nonetheless correlate with strong gradients in species richness and biomass.		Marine Environmental Research, v. 69, p. 240–247.
C0450	Nearshore - Habitats	n/a	All	Puget Sound intertidal biotic community monitoring—2008 monitoring report	2009	Dethier, M.N., and Berry, H.D.	Washington Department of Natural Resources	DNR has monitored biotic communities and assessed the condition of nearshore habitats since 1997 (in collaboration with UW). Monitoring methods characterize epibiota and infauna using quadrat and core samples.	Report addresses three research questions for Puget Sound through status and trends in intertidal biota at Admiralty Inlet, Possession Sound, and San Juan embayments.	http://www.dnr.wa.gov/ResearchScience/Topics/AquaticHabitats/Pages/aqr_nrsh_publications.aspx	
C0451	Nearshore - Habitats	Non-Point Source Loading & Runoff	San Juan/Whatcom	Decadal Changes in Shoreline Biota in Westcott and Garrison Bays, San Juan County	2008	Dethier, M.N. and H.D. Berry	Washington Department of Natural Resources	Intertidal biotic communities were censused at multiple tidal heights using quadrat and core sampling techniques, and compared current data to historical records ranging from 1974-1998	The purpose of the study was to determine whether there has been a similar radical change in intertidal biotic communities over 2001 and 2003 when virtually of the eelgrass (Zostera marina) disappeared for unknown reasons. The presence or absence of change in these communities, which are largely ecologically independent of eelgrass communities, could provide a key piece of data on the causes of the eelgrass decline. Virtually all of the species found in the 1990s were also found in 2007 suggesting that eelgrass loss in the early part of the decade was not indicative of a broader ecosystem-wide change in Westcott and Garrison Bays.	http://www.dnr.wa.gov/ResearchScience/Topics/AquaticHabitats/Pages/aqr_nrsh_publications.aspx	
C0452	Nearshore - Species & Food Webs	Shoreline Armoring	South, South Central, Whidbey	Effects of Shoreline Modifications on Supratidal Macroinvertebrate Fauna on Puget Sound, Washington Beaches	2010	Sobocinski, K.L., Cordell, J.R., and Simenstad, C.A.	Many (UW-Fisheries)	Paired and synoptic sampling regimes were employed to assess armoring effects on insects and benthic macroinvertebrates in the supratidal zone of Puget Sound beaches between 2000-2002	Where shoreline armoring lowers the land–sea interface, benthic infauna and insect assemblages are disrupted. Widespread shoreline modifications may decrease the availability of prey resources for fish and wildlife and decrease the contribution of organic material entering the nearshore ecosystem.		Estuaries and Coasts, v. 33, no. 3, p. 699–711
C0453	Marine - Species & Food Webs	n/a	San Juan/Whatcom, Strait of Juan de Fuca, Whidbey	Reevaluating Marine Diets of Surf and White-Winged Scoters: Interspecific Differences and the Importance of Soft-Bodied Prey.	2008	Anderson, E. M., J. R. Lovvorn, and M. T. Wilson	USFWS and others	Analyzed diets of Surf Scoters collected in northern Puget Sound, Washington during 2005–2006 using following alternative methods: collecting birds that are feeding, immediately preserving gut contents, excluding gizzard contents, averaging food-item percentages across birds versus pooling gut contents for all birds, and using energy or ash-free dry mass versus wet mass values of foods.	Found that the bivalve component of diet declining by over half and a near doubling of soft-bodied prey (i.e., crustaceans, polychaetes) compared to previous diet analysis methods. Also, relative to White-winged Scoters, Surf Scoters consume smaller bivalves, a smaller and more variable percentage of mollusk prey (including bivalves and gastropods), and a declining percentage of bivalves as winter progresses. Past diet studies for scoters may provide misleading guidelines to conservation efforts by implying that only standing stocks of bivalves require consideration when prioritizing critical foraging sites.		The Condor 110:285-295
C0454	Marine - Species & Food Webs	n/a	San Juan/Whatcom, Strait of Juan de Fuca, Whidbey	Changes in marine bird abundance in the Salish Sea: 1975 to 2007	2009	Bower, J. L.	Washington Sea Grant, Western Washington University	Compared results of four marine bird surveys to evaluate non-breeding bird abundance: The 1978/79 Marine Ecosystems Analysis (MESA), PSAMP aerial surveys (1990–present) and shore-based and ferry surveys by WesternWashington University (WWU) of marine bird abundance (2003–present), and Christmas Bird Counts (CBCs, 1960s–present).	Significant declines occurred in species of four of the five feeding guilds, including piscivores, benthivores, omnivores and planktivores, and significant increases were seen in species of three feeding guilds, demonstrating that the factors affecting species abundance are complex and may be unique to each species. The WWU study largely corroborates declines documented by the PSAMP study, and analysis of 11 Salish Sea CBCs found the fewest species with significant declines.		Marine Ornithology 37:9-17
C0455	Marine - Species & Food Webs	n/a	All	Marine Bird and Mammal Component of the Puget Sound Ambient Monitoring Program web reports.	2010	Evenson, J.R, D.R. Nysewander, B.L. Murphie, and T.A. Cyra	Washington Department of Fish & Wildlife	The density atlas displays distributions and density indices of a selected subset of the major groups of marine birds and diving waterfowl species seen by aerial surveys conducted since 1992 by Washington Department of Fish and Wildlife on the inner marine waters of Washington State. The area of main focus extends from the western end of the Strait of Juan de Fuca eastwards, and from the Canadian borders near Point Roberts south to the southern end of Puget Sound.	n/a	http://wdfw.wa.gov/mapping/psamp/index.html	

Inventory of Recently Completed/Ongoing Scientific Studies

Ref #	Ecosystem Component	Primary Pressure	Action Area	Study Title	Date	Author(s) or Study Contact	Supporting Agency	General Study Design/Methods	Study Results	Weblink	Journal Citation (if applicable)
C0456	Nearshore - Species & Food Webs	Invasives - Marine	All	Washington State 2009/10 Mussel Watch Pilot Project: A Collaboration Between National, State and Local Partners	2010	Jennifer Lanksbury, James West, Kathleen Herrmann, Andrea Hennings, Kate Litle and Amy Johnson	Washington Department of Fish & Wildlife	PSAMP staff coordinated with Snohomish County and Washington Sea Grant staff to identify which of the 26 core Mussel Watch locations would be sampled by volunteer teams, and which would be sampled by PSAMP staff, to identify appropriate local volunteer groups for volunteer sampling, and to develop volunteer materials based on the NOAA Mussel Watch protocol. All Mussel Watch locations were successfully sampled using adapted NOAA protocols by either PSAMP staff or a citizen scientist team.	Chemical analysis of mussel samples has been delayed, but the sampling process was successful. The report includes five recommendations and next steps for adapting Mussel Watch to Puget Sound needs. Successful adaptation of the National Mussel Watch program to the Puget Sound level will require sufficient and consistent funding to conduct adequate pilot studies, establish more sampling locations than currently exist, add seasonal sampling where necessary, and establish a well-tended wide-ranging network of committed volunteers and volunteer organizations.	http://wdfw.wa.gov/publications/pub.php?id=01127	
C0457	Marine - Species & Food Webs	Unsustainable Fishing / Harvesting	All	Management Recommendations For Washington's Priority Species: Dungeness Crab (Cancer magister)	2008	Wendy Fisher and Donald Velasquez	Washington Department of Fish & Wildlife	The report summarizes habitat requirements and limiting factors for the Dungeness Crab and presents management recommendations.	Dungeness Crab is included as a priority species in WDFW's Priority Habitats and Species List (PHS List). They are an important resource for recreational, commercial and tribal harvests. Co-managed by the Washington Department of Fish and Wildlife and Washington's Treaty Tribes, Washington's commercial harvest ranked first among all Pacific states and provinces between 2000 and 2004 (Pacific States Marine Fisheries Commission data). Annual harvest from the Washington coast ranged from 8.6 to 25.0 million lbs from 1995 to 2005 (WDFW Commercial Fish Ticket Database). Over this same period, Puget Sound's annual harvest increased 24% to over 7.7 million lbs (WDFW Commercial Fish Ticket Database, WDFW Recreational Harvest Estimates). Puget Sound accommodates the vast majority of Washington's recreational crabbers (1.5 million lbs harvested annually between 2000-2004).	http://wdfw.wa.gov/publications/pub.php?id=00028	
C0458	Nearshore - Species & Food Webs	Unsustainable Fishing / Harvesting	All	Rebuilding Olympia oysters, Ostrea lurida Carpenter 1864, in Fidalgo Bay, Washington	2009	Dinnel, P. A., B. Peabody, and T. Peter-Contesse	UW - Fisheries, Puget Sound Restoration Fund	Skagit County Marine Resources Committee, working in cooperation with shellfish industry, tribal, and community partners initiated a project to establish self-sustaining Olympia oyster beds in Fidalgo Bay near Anacortes, WA. Thus, oysters on these beds must survive, grow, spawn, and produce larvae that recruit to the new beds and surrounding areas.	Olympia oyster seed on Pacific oyster cultch were planted in Fidalgo Bay during 2002, 2003, 2004, and 2006. Survival and growth of planted seed has been excellent at the first enhancement site. With the addition of seed on cultch during four years and augmentation of the enhancement site with five cubic yards of Pacific oyster shell in 2006, a structured oyster bed is gradually emerging. Deployment of temperature sensors in 2006 showed that water temperatures easily reached the minimum temperature for gameteogenesis and spawning. Examples of larval spawning (veligers in the mantle cavity) and natural postlarval recruitment to the enhancement site were documented in 2006. Several new sites within and around Fidalgo Bay are being evaluated for future rebuilding efforts.	http://www.bioone.org/doi/abs/10.2983/035.028.0114	Journal of Shellfish Research 28:79(77)
C0459	Marine - Species & Food Webs	Unsustainable Fishing / Harvesting	All	Precipitous declines in pinto abalone (Haliotis kamtschatkana kamtschatkana) abundance in the San Juan Archipelago, Washington, USA, despite statewide fishery closure	2008	Rothaus, D. P., B. Vadopalas, and C. S. Friedman	Washington Sea Grant, National Oceanic Atmospheric Administration	Pinto abalone (Haliotis kamtschatkana kamtschatkana) index stations in the San Juan Archipelago were systematically monitored by the Washington Department of Fish and Wildlife from 1992 through 2006.	From 1992 through 2006, abalone abundance declined by 77% and the mean shell length (SL) increased 10.4 mm. Abalone densities at all index stations are currently well below the threshold of 0.15 abalone•m–2 required for successful fertilization. From 1992 to 1996, 16% of individuals encountered measured <90 mm SL, while only 6% of the individuals from 2003 to 2006 were in this small size class. Similarly, the number of those >114 mm SL was greater in the 2000s than in the 1990s. The mean SL of all live abalone observed in the 1990s (107.62 ± 0.87 mm) was significantly different from the mean SL of empty shells (114.21 ± 2.1 mm), but no difference was detected between the mean SLs of empty shells and live abalone in the 2000s (114.97 ± 1.42 mm). Taken together, these data suggest recruitment failure from an Allee response to low population densities.	http://www.nrcresearchpress.com/doi/abs/10.1139/F08-168	Canadian Journal of Fisheries and Aquatic Sciences 65:2703(2709)
C0460	Nearshore - Species & Food Webs	Aquaculture	All	Effects of geoduck aquaculture on the environment: A synthesis of current knowledge	2008	Straus, K. M., L. M. Crosson, and B. V. Vadopalas	Washington Sea Grant	Literature review.	Review covers biological and environmental status of geoduck in Puget Sound and the ecological effects of geoduck aquaculture, including: abiotic and biotic effects, disease, and genetic effects on wild conspecific.,	http://www.wsg.washington.edu/research/geoduck/geoduck_literaturereview.pdf	
C0461	Nearshore - Species & Food Webs	Aquaculture	All	2008 Annual Report: Commercial and Recreational Shellfish Areas in Washington State	2009	Washington Department of Health	Washington Department of Health	The report describes several of the main programs and services of the Washington State Department of Health's Office of Shellfish and Water Protection, including the office's work monitoring and classifying the state's prized shellfish harvest areas and related efforts to safeguard these areas for continued use by current and future generations. A poster-size map of the state's shellfish growing areas accompanies this publication. The map includes information on commercial growing area classifications, major water bodies and cities, sewage treatment plants, and recreational shellfish beach classifications.	n/a	http://www.doh.wa.gov/ehp/sf/pubs/annual-inventory.pdf	
C0462	Nearshore - Species & Food Webs	Unsustainable Fishing / Harvesting	All	Evaluation of Olympia oyster (Ostrea lurida carpenter 1864) status and restoration techniques in Puget sound, Washington, United States	2009	White, J. M., E. R. Buhle, J. L. Ruesink, and A. C. Trimble	UW Fisheries	This paper documents the distribution and abundance of O. lurida in one of the last remaining locations where it forms extensive beds: the North Bay Oyster Reserve in south Puget Sound. We monitored recruitment every 2 wk between May and September 2004 and found a small recruitment peak in late July, which was much later than reported for these oysters when they were abundant throughout Puget Sound. We also experimentally tested two factors that could influence recovery: tidal elevation and substrate type.	Recruitment improved at low tidal elevations and differed across substrates. Ostrea lurida shell consistently provided a better recruitment substrate than gravel or bare plots, but shell treatments could not be distinguished statistically. Postrecruitment mortality occurred in all treatments; however the rates of mortality were not significantly different by elevation or substrate treatment. Habitat restoration (low intertidal and subtidal shell areas) should promote the recovery of O. lurida where natural recruitment still occurs.	http://www.bioone.org/doi/abs/10.2983/035.028.0101	Journal of Shellfish Research 28:107(106)
C0463	Nearshore - Habitats	n/a	All	Area of Eelgrass Depth Bands in Greater Puget Sound	2011	Dowty, P.	Washington Department of Natural Resources	DNR has found that there is a need for more information on both the historical and potential distribution of eelgrass in greater Puget Sound to support target setting. The purpose of this report is to contribute in this area by presenting new estimates of the area within the eelgrass depth range in greater Puget Sound. The approach utilized available gridded bathymetry datasets and existing information on the distribution of eelgrass by depth.	The estimated area of the eelgrass depth band in greater Puget Sound was 53,785 ± 12,580 ha (95% confidence interval). This is a wider confidence interval than expected. Based on this estimate, the current regional percent cover of eelgrass is 40%. Note that depth is only one of many environmental factors that constrain the distribution of eelgrass.	http://www.dnr.wa.gov/ResearchScience/Topics/AquaticHabitats/Pages/aqr_nrsh_publications.aspx	
C0464	Nearshore - Habitats	n/a	San Juan/Whatcom	Eelgrass (Zostera marina L.) Abundance and Depth Distribution Along Selected San Juan Archipelago Shallow Embayments	2010	Berry, H.D. and L. Ferrier	Washington Department of Natural Resources	Work specific to San Juan Archipelago follows protocols of DNRs Submerged Vegetation Monitoring Program	Report summarizes the findings of collaborative work to document current abundance and depth distribution of Z. marina in the Westcott Bay Complex (inclusive of Westcott Bay proper and five other sites) as well as several other shallow embayments in the San Juan Archipelago. No recovery of previous losses as well as new declines were recorded.	http://www.dnr.wa.gov/ResearchScience/Topics/AquaticHabitats/Pages/aqr_nrsh_publications.aspx	
C0465	Nearshore - Habitats	n/a	All	Puget Sound Submerged Vegetation Monitoring Project-2009 Report	2011	Gaeckel, J., P. Dowty, H. Berry, L.Ferrier	Washington Department of Natural Resources	In 2000, DNR established the Submerged Vegetation Monitoring Project (SVMP) to track this valuable resource. The SVMP uses a statistically robust sampling design and underwater videography to monitor Z. marina on an annual basis. This report presents the soundwide and San Juan County-Cypress Island focus area monitoring results from the 2009 field season	The results in 2009 continue to indicate a pattern of Z. marina decline throughout Puget Sound. Although there is a marginally significant increasing trend in Z. marina area, the pattern of site level decline throughout Puget Sound suggests losses are prevalent at individual sites. There is consistently greater prevalence of year-to-year and long-term declines in Z. marina area and depth distribution throughout the study area. There is also strong evidence of Z. marina decline in the Hood Canal region. The occurrence and soundwide distribution of sites with significant declines is of concern for habitat connectivity and ecological functions.	http://www.dnr.wa.gov/ResearchScience/Topics/AquaticHabitats/Pages/aqr_nrsh_publications.aspx	
C0466	Nearshore - Habitats	n/a	San Juan/Whatcom	Eelgrass Stressor-Response Report 2007-2008: Zostera marina L. (eelgrass) transplant growth and survival along a spatial and tidal gradient in Westcott Bay	2011	Schanz, A., H. Julich, L. Ferrier, H. Berry	Washington Department of Natural Resources	The study combined Z. marina transplant experiments and continuous environmental monitoring to assess habitat suitability. Hypothesizing that unfavorable physical conditions prevent Z. marina growth at sites in the inner and head of Westcott Bay, we transplanted Z. marina in currently and formerly vegetated areas along a spatial gradient of decreasing eelgrass abundance from the mouth to the bay head at three different tidal elevations, and related transplant performance to environmental parameters	The study demonstrates that current environmental conditions do not support Z. marina survival at three tested tidal elevations at the head of Westcott Bay and in the intertidal at the site of the inner bay. This suggests that the current observed Z. marina distribution in Westcott Bay most likely represents the extent of suitable habitat.	http://www.dnr.wa.gov/ResearchScience/Topics/AquaticHabitats/Pages/aqr_nrsh_publications.aspx	
C0467	Nearshore - Habitats	n/a	All	Puget Sound Submerged Vegetation Monitoring Project: 2008 Monitoring Report, Nearshore Habitat Program	2009	Gaeckle, J. L., P.Dowty, H. Berry, and L. Ferrier	Washington State Department of Natural Resources	Zostera marina, a marine flowering plant, is recognized globally as an indicator of ecosystem health and provides valuable nearshore habitat to ecologically and economically important species. In 2000, DNR recognized the important functions and values Z. marina provides to nearshore systems and established the Submerged Vegetation Monitoring Project (SVMP) to track this valuable resource. The SVMP uses a statistically robust sampling design and underwater videography to monitor Z. marina on an annual basis. This report presents the monitoring results from the 2008 field season.	Multiple indications suggest a pattern of slight Z. marina decline throughout Puget Sound, however, the magnitude of the observed changes were not sufficient to cause a significant year-to-year or long-term decrease in the total sound-wide Z. marina area estimate. The current Z. marina area estimate in Puget Sound is 22,800 ± 4,500 hectares. The Focus Area effort in the North Puget Sound Region completed the project's initial sampling of all 5 regions in the study area. There are 9,859 ± 2,603 ha of Z. marina in the North Puget Sound Region and nearly 91% of this resource is located in large, shallow embayments.	http://www.dnr.wa.gov/Publications/aqr_nrsh_2008_svmp_report_final.pdf	
C0468	Humans - Health	Climate Change	All	Impacts of climate variability and future climate change on harmful algal blooms and human health	2008	Moore, S., V. Trainer, N. Mantua, M. Parker, E. Laws, L. Backer, and L. Fleming	NSF/NIEHS Centers for Oceans and Human Health, West Coast Center for Oceans and Human Health (WCCOHH)	This study reviews the interactions between selected patterns of large-scale climate variability and climate change, oceanic conditions, and harmful algae.	Evidence that climate change has influenced the frequency, duration, and geographical range of HABs is emerging as monitoring data temporally and spatially accumulates. Given the potential impact it is recommended that the influence of climate be considered and incorporated into future HAB research and monitoring efforts.	http://www.ehjournal.net/content/7/S2/S4	Environmental Health 7:S4
C0469	All	n/a	Whidbey, South Central Puget Sound	King County Biodiversity Report	2008	King County	King County	n/a	The report describes the ecology of biodiversity in King County, describes threats to biodiversity, exames biodiversity management in county governance, and recommends public participation programs.	http://www.kingcounty.gov/environment/animalsAndPlants/biodiversity/king-county-biodiversity-report.aspx	
C0470	Terrestrial - Species & Food Webs	Residential, Commercial, Port & Shipyard Development	All	Landscape Planning for Washington's Wildlife: Managing for Biodiversity in Developing Areas (A Priority Habitats and Species Guidance Document)	2009	Jeff Azerrad, John Carleton, Jennifer Davis, Timothy Quinn, Chris Sato, Michelle Tirhi, George Wilhere, and Suzanne Tomassi	Washington Department of Fish & Wildlife	The goal of this document is to provide information for planners and others to use in minimizing the impacts of development to terrestrial wildlife, and to conserve biodiversity that supports healthy, native wildlife populations.	The focus of this document is on lessening adverse impacts to biodiversity as land uses change, thereby enabling more wildlife habitat and species, and the ecological services they do provide, to be retained in developing areas.	http://wdfw.wa.gov/publications/pub.php?id=00023	
C0471	Marine - Species & Food Webs	Unsustainable Fishing / Harvesting	Hood Canal, Strate of Juan de Fuca	Early marine survival and behavior of steelhead trout (Oncorhynchus mykiss) smolts through Hood Canal and the Strait of Juan de Fuca	2010	M. E. Moore, B. A. Berejikian, E. P. Tezak	NOAA Fisheries	Acoustic telemetry transmitters and stationary receivers were used to investigate the survival, migration timing, and migratory behavior of 159 steelhead smolts in 2006 and 187 smolts in 2007 from four Hood Canal (part of Puget Sound) streams and one stream flowing into the Strait of Juan de Fuca.	The estimated population-specific survival rates for wild and hatchery smolts from the river mouths to the northern end of Hood Canal (28.1–75.4 km) ranged from 55% to 86% in 2006 and from 62% to 84% in 2007. Survival was much lower from the northern end of Hood Canal to the Strait of Juan de Fuca (135 km) in 2006 (23–49%) and could not be reliably measured in 2007. Travel rates through Hood Canal (8–10 km/d) were significantly lower than those estimated as the fish migrated through northern Puget Sound and the Strait of Juan de Fuca (26–28 km/d), while the mortality rates per unit of distance traveled were very similar in the two segments. The high daily mortality rates estimated during the early marine phase of the steelhead life cycle (2.7%/d) suggest that mortality rates decrease substantially after steelhead enter the Pacific Ocean.	http://www.nwfsc.noaa.gov/publications/displayallinfo.cfm?docmetadataid=7015	Canadian Journal of Fisheries and Aquatic Sciences, Volume 139 Issue 1, Pages 49-61

Inventory of Recently Completed/Ongoing Scientific Studies

Ref #	Ecosystem Component	Primary Pressure	Action Area	Study Title	Date	Author(s) or Study Contact	Supporting Agency	General Study Design/Methods	Study Results	Weblink	Journal Citation (if applicable)
C0472	Marine - Habitats	Derelict Gear & Vessels	All	Derelict Fishing Nets In Puget Sound And The Northwest Straits: Patterns And Threats To Marine Fauna	2010	T. P. Good, J. A. June, M. A. Etnier, G. Broadhurst	NOAA, Northwest Fisheries Science Center	Summary of analysis of 870 derelict fishing gillnets recovered since 2002 in Washington's inland waters.	most were recovered from northern Puget Sound and high-relief rocky habitats and were relatively small, of recent construction, in good condition, stretched open, and in relatively shallow water. Marine organisms documented in recovered gillnets included 31,278 invertebrates (76 species), 1036 fishes (22 species), 514 birds (16 species), and 23 mammals (4 species); 56% of invertebrates, 93% of fish, and 100% of birds and mammals were dead when recovered. For all taxa, mortality was generally associated with gillnet effectiveness (total area, age and condition, and suspension in the water). Mortality from derelict fishing gear is underestimated at recovery and may be important for species of economic and conservation concern.	http://www.nwfsc.noaa.gov/publications/displayallinfo.cfm?docmetadataid=7032	Marine Pollution Bulletin Volume: 60, Issue: 1, Pages: 39-50
C0473	Marine - Habitats	n/a	All	Marine Protected Areas in Washington: Recommendations of the Marine Protected Areas Work Group to the Washington State Legislature	2009	F. Brie Van Cleve, Greg Bargmann, Michele Culver	Washington Department of Fish & Wildlife	The MPA Work Group was established by the Washington State Legislature in 2008 and tasked to inventory MPAs in Washington's state waters, assess current MPA management, and provide a series of recommendations to the Legislature on how to improve the use and effectiveness of MPAs in the future. The MPA Work Group was chaired by WDFW and populated with governmental representatives, including tribal representatives, and agencies that manage MPAs in Washington's state waters.	The group agreed that the current terminology used to describe various types of MPAs complicates and even frustrates efforts to improve coordination and consistency among MPAs and MPA managers. The group identified the need for a Puget Sound and coast-wide coordinating entity to oversee the implementation of the recommendations in this report, review new MPA proposals, convene MPA managers, and lead coordination efforts. The MPA Work Group developed 17 recommendations for improving the use of MPAs as a management tool		
C0474	Terrestrial - Water	Agriculture & Livestock Grazing	King County	Manual of Best Management Practices for Maintenance of Agricultural Waterways in King County	2010	King County	King County	This manual is meant as a starting point to assist farmers as professional and cost-conscious land stewards. It provides an agglomeration of thinking to date on how to (1) classify waterways according to channel structure and existence of fish and (2) link best management practices (BMPs) to those waterway classes.	The goal for the BMPs is to improve water flow and drainage from fields, minimize negative impacts on fish during and after dredging, and help improve or maintain water quality. For many activities, BMPs are described in the manual; for a few activities, a range of BMPs is provided to be field-tested by pilot projects conducted in 2010 and discussed further; for a few others, discussions are under way as part of the larger effort.	http://www.kingcounty.gov/environment/waterandland/agriculture/documents/bmp-ag-waterway-maintenance-manual.aspx	
C0475	Terrestrial - Water	n/a	All	An Assessment of Washington Lakes: National Lake Assessment Results	2010	Bell-McKinnon, M.	Washington Department of Ecology	In 2007, the Washington Department of Ecology collected biological, chemical, and physical data at 30 randomly selected lakes in Washington State. This study was part of EPA's National Lake Assessment which encompassed monitoring at 1,028 lakes in the lower 48 U.S. States. Measurements of environmental stress were evaluated using the reference site approach. This approach involves setting a reasonable expectation, or reference condition, for each measured parameter.	This study showed over 80% of the lake sample population in Washington is in fair or good condition with regard to physical habitat. The results also showed nutrients and chlorophyll-a were the parameters of highest concern.	http://www.ecy.wa.gov/biblio/1003029.html	
C0476	Nearshore - Habitats	n/a	North Central	Seasonal patterns of coarse sediment transport on a mixed sand and gravel beach due to vessel wakes, wind waves, and tidal currents:	2009	Curtiss, G.M., Osborne, P.D., and Horner-Devine, A.R.	Federal Transportation Adminstration	Used direct measurements of coarse sediment (gravel) transport from a mixed sand and gravel beach on Bainbridge Island, Puget Sound, WA that is exposed to wind waves, vessel wakes, and tidal currents in order to quantify the relative role of different forcing mechanisms and the corresponding time scales of morphological response. Also used Radio Frequency Identification (RFID) Passive Integrated Transponder (PIT) technology for tracking studies of sediment particles.	These results, which are unique in their duration, suggest that mixed sand and gravel beaches experience different modes of behavior over the range of forcing conditions observed during a typical year. They point to the need for including grain composition in modeling mixed sand and gravel beach response and the need for long term observations of both forcing and response.		Marine Geology, v. 259, p. 73–85
C0477	Nearshore - Habitats	n/a	All	Principles for Strategic Conservation and Restoration	2010	Courtney M. Grenier	Puget Sound Nearshore Partnership (U.S. Army Corps of Engineers & Washington Department of Fish and Wildlife)	The purpose of this document is to summarize principles of landscape ecology and conservation biology that are applicable to the conservation and restoration of nearshore ecosystems in the Puget Sound. The principles in this report were drawn from a scientific literature review of landscape ecology and conservation biology. The review focused on literature related to the selection of sites for the conservation and restoration of ecosystems.	Eleven principles were derived from the literature and have been organized into three hierarchical scales to provide context. They are listed by relative importance in landscape ecology and conservation biology but their application is flexible. The principles are tailored towards PSNERP's goals and objectives, and are therefore restoration focused; however they are also applicable to conservation actions. While a few of the principles can be applied explicitly, most are conceptual and require further evaluation to ensure appropriate application.	http://www.pugetsoundnearshore.org/technical_papers/conservation_and_restoration_principles.pdf	
C0478	Nearshore - Habitats	n/a	All	A geomorphic classification of Puget Sound nearshore landforms	2008	Shipman, H.	Puget Sound Nearshore Partnership (U.S. Army Corps of Engineers & Washington Department of Fish and Wildlife)	This report proposes a conceptual classification of nearshore landforms that is hierarchical, reflects the primary role of geomorphic processes in shaping the landscape and is relevant to the unique setting of Puget Sound. This framework is based on the concept that ecosystems are shaped by physical processes and are uniquely associated with particular coastal landforms. The report identifies the factors that influence the primary shoreline types observed on Puget Sound and discusses the close relationship between geomorphic processes and landforms.		http://www.pugetsoundnearshore.org/technical_reports.htm	
C0479	Nearshore - Habitats	Dams, Levees & Tidegates	Strait of Juan de Fuca	Beach morphology and change along the mixed grain-size delta of the dammed Elwha River, Washington	2009	Warrick, J.A., George, D.A., Gelfenbaum, G., Kaminsky, G., and Beirine, M.,	US Geological Survey	Examination of the effects of almost a century of sediment supply reduction from the damming of the Elwha River in Washington on shoreline position and beach morphology of its wave-dominated delta using erosion rate data 1939-2007	An armored layer of cobble clasts are not generally competent in the physical setting of the delta. Thus, the cobble low-tide terrace is very likely a geomorphological feature caused by coastal erosion of a coastal plain and delta, which in turn is related to the impacts of the dams on the Elwha River to sediment fluxes to the coast.	http://dx.doi.org/10.1016/j.geomorph.2009.04.012	Geomorphology, v. 111, p. 136–148
C0480	Nearshore - Habitats	Point Source Pollution	San Juan/Whatcom	Thatcher Bay, Washington, Nearshore Restoration Assessment	2009	Breems, Joel, Wylie-Echeverria, Sandy, Grossman, Eric, and Elliot, Joel	US Geological Survey	The distribution and thickness of residual wood-waste at Thatcher Bay was determined using sediment coring and GIS-based interpolation techniques. Additionally, pilot studies were conducted to characterize in place sediment redox, organic composition, and sulfide impacts to nearshore flora and fauna. Three restoration alternatives were considered, and a ranking matrix was developed to score each alternative against site-specific and regional criteria.	The process identified the removal of wood-waste from a water-based platform as the preferred alternative. The investigation identified the location, thickness, and potential impacts of wood-waste that has persisted in the nearshore environment of Thatcher Bay since at least 1942. It also provided a process to efficiently evaluate alternatives to remediate the impact of this historical disturbance and to potentially contribute to an increase of nearshore diversity and productivity at this site.	http://pubs.usgs.gov/of/2008/1369/	
C0481	Nearshore - Habitats	Shoreline Armoring	All	Impacts of shoreline armoring on sediment dynamics, *in* Shipman et al 2010	2010	Ruggerio, P.	Oregon State University	A (non-exhaustive) review that highlights a variety of recent efforts aimed at understanding the impacts of seawalls on sediment dynamics. Finishes with a suggestion as to why such confusion remains and suggest some areas where studies specific to the Puget Sound can shed light on this difficult problem.	The effect of seawalls on beaches seems to be most sensitive to the position of the seawall within the surf zone, the beach slope, and the reflection coefficient, and future work should investigate these parameters in detail. Rigorous field measurements at a variety of sites with differing morphologic and hydrodynamic characteristics as well as physical and numerical modeling efforts are still necessary to provide much needed insight into the seawall problem.	http://pubs.usgs.gov/sir/2010/5254/	
C0482	Nearshore - Habitats	Dams, Levees & Tidegates	All	Management Measures for Protection and Restoring the Puget Sound Nearshore	2009	Clancy, M., I. Logan, J. Lowe, J. Johannessen, A. MacLennan, F.B. Van Cleve, J. Dillon, B. Lyons, R. Carman, P. Cereghino, B. Barnard, C. Tanner, D. Myers, R. Clark, J. White, C. A. Simenstad, M. Gilmer, and N. Chin	Washington Department of Fish & Wildlife	The protection and restoration of nearshore habitats in Puget Sound requires the application of recovery actions or "management measures" that address nearshore ecosystem processes, functions, and structures. Management measures (MMs) are specific actions that can be implemented alone or in combination to restore the nearshore ecosystem. PSNERP has identified 21 management measures for implementing nearshore ecosystem restoration recognizing that (1) the measures can be capital projects, regulation, incentives, or education and outreach, and (2) the measures contribute to ecosystem recovery via protection, restoration, rehabilitation and substitution/creation. This technical report helps determine how to most effectively use the 21 management measures to accomplish process-based restoration in Puget Sound.	n/a	http://www.pugetsoundnearshore.org/technical_reports.htm	
C0483	Nearshore - Habitats	Residential, Commercial, Port & Shipyard Development	All	White Paper - Protection of Marine Riparian Functions in Puget Sound, Washington	2009	Washington Sea Grant	Washington Department of Fish & Wildlife	This document was developed to provide shoreline planners and managers with a summary of current science and management recommendations to inform protection of ecological functions of marine riparian areas	This information contained in this report will help inform local decisions regarding what is needed to protect ecological functions of marine riparian areas. Specifically, we summarize the range of marine riparian buffer widths needed to meet particular levels of ecosystem function based on a literature review and input from an expert panel workshop.	http://wdfw.wa.gov/publications/pub.php?id=00693	
C0484	Humans - Social Conditions	n/a	All	Social and Economic Considerations for Coastal and Watershed Restoration in the Puget Sound, Washington: A Literature Review	2009	Stinchfield, H.M., Koontz, L., and Sexton, N.R.,	US Geological Survey	Summarize and synthesize information regarding the impacts of socioeconomic factors on coastal and watershed restoration in Puget Sound.	Socioeconomic factors play an important role in determining the designation, process, and success of restoration projects. Specific findings are reported for various topic areas.	http://pubs.usgs.gov/of/2009/1079/	
C0485	Terrestrial - Habitats	n/a	All	Description of Existing Data for Integrated Landscape Monitoring in the Puget Sound Basin, Washington	2008	Danielle P. Aiello, Alicia Torregrosa, Allyson L. Jason, Tracy L. Fuentes and Edward G. Josberger	US Geological Survey	The report summarizes existing geospatial data and monitoring programs for the Puget Sound as part of the USGS Puget Sound Integrated Landscape Monitoring pilot project.	The data and monitoring efforts cataloged here are intended to be used to discover what knowledge and data are available between ecosystems and at different spatial scales across the Puget Sound Basin. The data sources included can be used to answer questions on conditions, impacts, and changes to the marine and terrestrial systems of the Puget Sound Basin. The data can also be evaluated collectively to gain an understanding for the time and location of monitoring efforts within the Puget Sound Basin and PSILM study area.	http://pubs.usgs.gov/of/2008/1308/	
C0486	Terrestrial - Species & Food Webs	Unsustainable Fishing / Harvesting	Hood Canal	Intensively Monitored Watersheds: 2008 Fish Population Studies in the Hood Canal and Lower Columbia Stream Complexes	2009	Clayton Kinsel, Pat Hanratty, Mara Zimmerman, and Bryce Glaser, Steven Gray, Todd Hillson, Dan Rawding, Steven VanderPloeg	Washington Department of Fish & Wildlife	Salmonid population studies in the Hood Canal and lower Columbia stream complexes are conducted annually by the Washington Department of Fish and Wildlife. This report presents methodology and results from the 2008 field season. In each watershed, coho abundance was estimated at three life stages – parr, smolt, and spawner.	The report summarizes results from the 2008 field season, including parr, smolt, and spawner results from the Hood Canal stream complex.	http://wdfw.wa.gov/publications/pub.php?id=00783	
C0487	Humans - Health	Onsite Sewage Systems	All	Status and Trends in Fecal Coliform Pollution in Shellfish Growing Areas of Puget Sound: Year 2009	2010	Determan, T.	Washington Department of Health	Detailed methods of sampling in report	Over 92% of stations (1317 stations) showed negligible impact. Just over 2% of stations had very high impact.	http://www.doh.wa.gov/ehp/sf/Pubs/fecalreport.pdf	
C0488	Marine - Species & Food Webs	n/a	All	Incorporating catastrophic risk assessments into setting conservation goals for Pacific salmon	2008	T. P. Good, J. R. Davies, B. J. Burke, M. H. Ruckelshaus	NOAA, Northwest Fisheries Science Center	Explored the likelihood of Puget Sound chinook salmon ESU persistence by examining spatial patterns of catastrophic risk and testing ESU viability recommendations for 22 populations of the threatened Puget Sound chinook salmon ESU.	Recovery strategies that called for two viable populations in each of five geographic regions had lower risk than random strategies; strategies that included life-history diversity had even lower risks. Geographically distributed populations have varying catastrophic-risks profiles, thus identifying and reinforcing the spatial and life-history diversity critical for populations to respond to environmental change or needed to rescue severely depleted or extirpated populations. Recovery planning can promote viability of Pacific salmon ESUs across the landscape by incorporating catastrophic risk assessments	http://www.nwfsc.noaa.gov/publications/displayallinfo.cfm?docmetadataid=6609	Ecological Applications Volume 18, Issue 1, Pages 246-257
C0489	n/a	n/a	All	Using Existing Scientific Capacity to Set Targets for Ecosystem-based Management: A Puget Sound Case Study	2011	J. F. Samhouri, P. S. Levin, C. Andrew James, Jessi Kershner, Greg Williams	NOAA, Northwest Fisheries Science Center	Paper reviews five approaches, borrowed from a variety of disciplines, to establish target reference levels for EBM.	The approaches include the use of existing reference levels, reference directions, and reference levels based on nonlinear functional relationships, baselines, or social norms. Each approach is particularly suitable for EBM because it can be used alone or in combination with others to contextualize status for a diverse suite of ecosystem goals influenced by a wide variety of human activities.	http://www.nwfsc.noaa.gov/publications/displayallinfo.cfm?docmetadataid=7684	Marine Policy Volume: 35 Pages: 508-518

Inventory of Recently Completed/Ongoing Scientific Studies

Ref #	Ecosystem Component	Primary Pressure	Action Area	Study Title	Date	Author(s) or Study Contact	Supporting Agency	General Study Design/Methods	Study Results	Weblink	Journal Citation (if applicable)
C0490	Terrestrial - Water	Water Withdrawals & Diversions	Whidbey	Instream Flow Rule Implementation: Skagit Basin Water Reservation Tracking (part of the Western WA Watershed Planning Act Workshop)	2009	Jacque Klug, Watershed Lead	Washington Department of Ecology	Assesses the Skagit Instream Flow Rule and Issues with Implementation	Successes: Enhanced understanding of local and state land use, water use and public water law, and Greater integration of land use and water management; Limitations: Implementation resources-expensive and time consuming, and Limitations of state and local regulatory authority complicate implementation	http://www.ecy.wa.gov/watershed/pdf/102209_skagit_isfr.pdf	
C0491	Terrestrial - Water	Water Withdrawals & Diversions	All	2009 Report to the Legislature: Watershed Plan Implementation Statutory Changes, Progress Report on Setting Instream Flows, and Reclaimed Water in Adopted Plans	2010	Bill Zachmann, et al.	Washington Department of Ecology	n/a	RCW 90.82.043 (5) (a), 90.82.040 (5) (b) and 90.82.080 (6) require the Department of Ecology (Ecology) to provide the Legislature with an annual report related to the Watershed Planning Act (Chapter 90.82 RCW). This report fulfills these requirements.	http://www.ecy.wa.gov/biblio/0911033.html	
C0492	Terrestrial - Water	Water Withdrawals & Diversions	All	2008 Report to the Legislature - Progress on Watershed Planning and Setting Instream Flows	2008	Bill Zachmann, Barb Anderson	Washington Department of Ecology		This report includes information on legislative funding, watershed planning and implementation expenditures, water banking initiatives, and integration of watershed planning and implementation with other environmental protection efforts.	http://www.ecy.wa.gov/biblio/0806027.html	
C0493	All	All	All	Ecosystem Status and Trends	2009	Puget Sound Partnership	Puget Sound Partnership	The Puget Sound Partnership's report on the status of Puget Sound ecosystem provides a system level evaluation of human health and well-being, species and food webs and habitats, and water quantity and quality.	Within a human-biological-water framework, the Partnership's 2009 ecosytem status and trends reporting uses a number of ecosystem indicators to describe conditions related to the scope and span of interests described above. Ecosystem status and trends interpretations presented here reflect the Partnership's current understandings and judgments about system features most directly relevant to recovery of the Puget Sound ecosystem	http://www.psp.wa.gov/downloads/2009_tech_memos/Ecosystem_status_and_trends_tech_memo_2009_06_11_FINAL.pdf	
C0494	Marine - Species & Food Webs	Unsustainable Fishing / Harvesting	All	Impacts of Hunting on Scoter Numbers in Puget Sound	2011	Kraege, D.	Washington Department of Fish and Wildlife		Hunting season changed 2010-2011		
C0495	Marine - Species & Food Webs	Unsustainable Fishing / Harvesting	All	Data Input Requirements for the Designation of Rockfish Conservation Areas in Howe Sound: Improving Tools for Decision-Making to Enable Rockfish Recovery Strategies in British Columbia	2011	Marliave, J.	SeaDoc Society (funding), Vancouver Aquarium				Marliave, J. and W. Challenger. 2009. Monitoring and evaluating rockfish conservation areas in British Columbia. Canadian Journal of Fisheries and Aquatic Sciences 66(6): 995-1006.
C0496	Marine - Species & Food Webs	n/a	San Juan/Whatcom	One Species of Two? Gentic Analysis of the Taxonomic Status of Pinto Abalone *Haliotis kamtschatkana* in Northern Puget Sound-Georgia Basin	2011	Naish, K.	SeaDoc Society (funding), University of Washington				
C0497	Marine - Species & Food Webs	n/a	All	Linking Marine Birds to Forage Fish - Is Diet a Limiting Factor in Puget Sound?	2011	Parish, J.	SeaDoc Society (funding), University of Washington				
C0498	Terrestrial - Species & Food Webs	n/a		The Role of Bald Eagles in Declines of Waterbirds in Puget Sound/Strait of Georgia	2011	Butler, R.	Pacific Wildlife Foundation				
C0499	All	n/a		What is Natural in the Puget Sound Ecosystem? Establishing Baseline Conditions and Identifying Ecological Indicators	2011	Essington, T.	SeaDoc Society (funding), University of Washington				
C0500	Marine - Species & Food Webs	n/a	San Juan/Whatcom	Investigation of Outplant Strategies in the Recovery of Pinto Abalone Populations in Washington State	2011	Friedman, C.	SeaDoc Society (funding), University of Washington				
C0501	Marine - Species & Food Webs	n/a	All	Development of Genetic Markers for Evaluating Fine-Scale Population Structure of Western Grebes (*Aechmophorus occidentalis*)	2011	Girman, D.	SeaDoc Society (funding), Sonoma State University				
C0502	Marine - Species & Food Webs	Dams, Levees & Tidegates	Whidbey	Can Intertidal Resources Alone Support Wintering Shorebirds? Stable Isotope Analyses of Dunlin Diet in the Skagit River Delta	2011	Lank, D.	SeaDoc Society (funding), Simon Fraser University				
C0503	Marine - Species & Food Webs	Climate Change	All	Testing the Limits of Diet - Short-Term Climate Effects of Seabird-Forage Fish Linkages in Puget Sound	2011	Parrish, J.	SeaDoc Society (funding), University of Washington				
C0504	Marine - Species & Food Webs	Unsustainable Fishing / Harvesting	All	Asssessing Apropriate Limits to By-Catch of Small Cetaceans in Commercial Fisheries in Coastal British Columbia Waters: A Proposal to the SeaDoc Society	2011	Williams, R.	SeaDoc Society (funding), Raincoast Conservation Society				Williams, R., Hall, A., Winship, A., 2008. Potential limits to anthropogenic mortality of small cetaceans in coastal waters of British Columbia. Canadian Journal of Fisheries and Aquatic Science. 65:1867-1878
C0505	Marine - Species & Food Webs	n/a	San Juan/Whatcom	The efficacy of aggregation as an in-situ restoration technique for the recovery of pinto abalone (*Haliotis kamtschatkana*) in the San Juan Archipelago	2011	Friedman, C.	SeaDoc Society (funding), University of Washington				
C0506	Marine - Species & Food Webs	n/a	San Juan/Whatcom	Evaluating adult aggregations of Northern abalone (*Haliotis kamtschatkana*) for restoration in the Puget Sound, Washington	2011	Bennett, W.	SeaDoc Society (funding), University of California, Davis				
C0507	Marine - Species & Food Webs	n/a	All	Assembling and Assessing Seabird Diet Information in the Salish Sea	2011	Pearson, S.	SeaDoc Society (funding), Washington Department of Fish and Wildlife				
C0508	Marine - Species & Food Webs	Climate Change	All	Ocean Acidification: Developing Probes of Marine Ecosystem Health	2011	Pfister, C	SeaDoc Society (funding), University of Chicago				Aquatic Conservation: Marine and Freshwater Ecosystems
C0509	Marine - Species & Food Webs	Unsustainable Fishing / Harvesting	All	Mini-Sabbatical for Minke Whale Project Data Analysis and Publication: Decadal Scale Changes in Minke Whale Numbers and Distribution; Optimal Movement Patterns of Minke Whales	2011	Stern, J	SeaDoc Society (funding), San Francisco State University				
C0510	Marine - Species & Food Webs	Roads, Transportation & Utility Infrastructure	All	A Synthetic Review of the Adverse Effects and Potential Risks of Marine Hydrokinetic Alternative Energy Projects to the Marine-Associated Biota of Washington State	2011	Hayes, M	SeaDoc Society (funding), Washington Department of Fish and Wildlife				

Inventory of Recently Completed/Ongoing Scientific Studies

Ref #	Ecosystem Component	Primary Pressure	Action Area	Study Title	Date	Author(s) or Study Contact	Supporting Agency	General Study Design/Methods	Study Results	Weblink	Journal Citation (if applicable)
C0511	Marine - Species & Food Webs	Invasives - Marine	All	Evaluating Effects of Invasive Tunicates on Benthic and Epifaunal Communities in Puget Sound, Washington	2011	Herwig, R.	SeaDoc Society (funding), University of Washington				
C0512	Marine - Species & Food Webs	Unsustainable Fishing / Harvesting	All	Assessing the effects of predator recovery, habitat complexity, and no-take compliance on the population structure and recovery rates of rockfishes in shallow-water Rockfish Conservation Areas of British Columbia	2011	Marliave, J.	SeaDoc Society (funding), Vancouver Aquarium				
C0513	Marine - Species & Food Webs	n/a	All	Pacific white-sided dolphin Photo ID study	2011	Ashe, E.	SeaDoc Society (funding), Tides Canada				