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Health of the Salish Sea as measured using transboundary ecosystem indicators

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The Salish Sea ecosystem is a transboundary area of ecological, social, and economic significance shared by Canada and the United States. Accordingly, the United States Environmental Protection Agency and Environment Canada have committed to cross-border collaboration on Salish Sea issues. The transboundary ecosystem indicators project was established to support knowledge sharing and to identify common priorities for action. Mixed trends were observed among ecosystem indicators, reflecting the complexity of the system. Improvements were demonstrated among indicators of air quality, freshwater quality, and toxics in the food web. Declining trends were observed among indicators of marine water quality, marine species at risk, Chinook Salmon, and summer stream flow. Variable or neutral trends were observed among indicators of southern resident Killer Whale abundance, access to Shellfish beaches, and access to swimming beaches. While the indicators represent separate ecosystem components, including air, water, species condition, and human wellbeing, these indicators are interrelated through biophysical cycles. Methods and results of tracking transboundary ecosystem indicators are presented to facilitate the identification of primary drivers and pressures of observed trends, and responses that have had positive results on a site specific basis.

Keywords: ecosystem health, transboundary indicators, Georgia Basin Puget Sound, Strait of Georgia, Juan de Fuca Strait, Puget Sound

Introduction

The Salish Sea ecosystem extends from the north end of the Strait of Georgia in British Columbia, Canada, to the south end of Puget Sound in Washington state, U.S., west to the mouth of the Strait of Juan de Fuca where it meets the Pacific Ocean and east to the land and rivers that drain into these coastal waters. It spans 16,925 sq km of seawater and 7,470 km of coastline. Also known as the Georgia Basin Puget Sound, this area was officially named in 2010 by government leaders on both sides of the Canada-USA border (BC-Geographical Names, 2010; USGS, 2009) to refer to the transboundary ecosystem and language of First Nations and Tribes that originally occupied the area and continue to be an influential presence throughout the region.

In 1992, British Columbia and Washington State signed the first Environmental Cooperation Agreement, creating the Environmental Cooperation Council which identified the shared waters of Georgia Basin and Puget Sound as being of high priority and requiring joint action.

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Subsequently, a Marine Science Panel was formed which published a scientific assessment of status and trends in resource abundance and environmental quality in the Salish Sea (BC-WA Marine Science Panel, 1994). Along with this assessment were recommendations for an optimum scenario in 2014, and future reporting through ecosystem indicators.

In 2000, the United States Environmental Protection Agency (EPA) and Environment Canada (EC) signed a Joint Statement of Cooperation to facilitate cross-border understanding, dialogue, and collaboration on Salish Sea issues. From this partnership came the transboundary ecosystem indicators project to track progress in managing the Salish Sea ecosystem, and identify priorities for action. Earlier transboundary ecosystem indicator reports were published in 2002 and 2006. This current report updates the previous indicators and expands the suite of information to increase their relevance to ecosystem health, including human well-being.

A number of current publications report indicators on a national or regional scale (BCMOE, 2006; Department of Fisheries and Oceans, 2012; Environment Canada, 2013; Environmental Protection Agency, 2008; Puget Sound Partnership, 2012; Fraser Basin Council, 2011). Transboundary indicators uniquely report at the scale of the Salish Sea ecosystem to facilitate opportunities for cross-border collaboration. There is strong emphasis on transboundary interests such as the international air shed and shared coastline, regionally iconic species such as Southern Resident Killer Whales and Chinook Salmon, and common values such as having beaches from which to harvest shellfish and for recreation including swimming. Transboundary indicators rely on a smaller subset of all datasets to ensure cross-border representations of ecosystem conditions are minimally influenced by differences in sampling methods.

Methodology

Conceptual models and selection criteria

A biophysical framework, similar to ones used by EPA's Science Advisory Board (2002) and the Heinz Center (2008) was used to identify key ecological attributes of ecosystem condition. Indicators were identified along four themes, the state of air, state of water, species condition, and human wellbeing. Considerations for choosing this framework and potential reporting indicators within each of these themes are described by Van Cleve et al. (2010).

Among criteria presented in the literature for selecting indicators (Rapport, 1990; Niemeijer and deGroot, 2008; Gabrielsen and Bosch, 2003), transboundary indicators were chosen to ensure conceptual validity, practicality, reliability, and relevance to regional ecosystem goals. Preference was given to transboundary indicators that were previously reported. There was particular emphasis to facilitate compatibility with indicators reported through regional efforts (Puget Sound Partnership, 2012) to extend their geographic scope over the Salish Sea ecosystem (O'Neill, 2010).

A causal chain approach known as Drivers-Pressures-State-Impact-Response (DPSIR) was the overall organizing framework for the transboundary indicators. The DPSIR is used in a number of other ecosystem management frameworks (Altman et al., 2011; Niemeijer and deGroot, 2008; Gabrielsen and Bosch, 2003), including indicator reporting initiatives (Kristensen, 2004; New Zealand Ministry of Environment, 2013). State and impact indicators were the focus of current reporting on the health of the Salish Sea.

Ecosystem health indicators and data sources

Ten ecosystem indicators were reported among the four themes. The state of air was indicated by fine particulate levels. The state of water was indicated by dissolved oxygen levels in marine waters, freshwater quality index scores, and long term trends in summer stream flows. Species condition was indicated by the number of marine species at risk, the abundance of Chinook Salmon, the abundance of Southern Resident Killer Whales, and levels of persistent pollutants in the marine food web. Human wellbeing was indicated by areas of beaches closed to swimming access and shellfish harvesting.

Air quality

The Air Quality indicator examined trends related to concentrations of airborne particulates that are 2.5 μm or smaller in size. Data from 7

Canadian monitoring stations were provided by the Air Quality Unit of the Meteorological Service of Canada and were extracted from the Canadian Trade database. Data from 7 U.S. monitoring stations were provided by the Office of Environmental Assessment of the EPA and were extracted from EPA's Air Quality System database or from Puget Sound Clean Air Agency's web-based data server. Sites north and south of the border were chosen based on data completeness, spatial coverage, and to have an equal number of sites from each jurisdiction.

Data were aggregated as the 3-year 98% maximum average for each station, as this metric is directly comparable to the Canada wide standards (Canadian Council of Ministers of the Environment (CCME), 2000; Canada Gazette, 2013) and EPA national daily standard (EPA, 2006). The 3-year 98% maximum average for 2011 was then compared to the current Canada wide standard of 30 μm $PM_{2.5}$ per cubic meter (CCME, 2000), the Canada wide standard that is due to come into effect in 2015 (Canada Gazette, 2013) and EPA national daily standard of 35 μm $PM_{2.5}$ per cubic meter (EPA, 2006). In addition, the 3-year 98% maximum average for 2011 was compared to 2005. The year 2011 represented the most current year of data available for calculating the metric and the year 2005 represented the latest year represented in the previous transboundary indicators report.

Freshwater quality

The Freshwater Quality Index (WQI) provided an overall measure of the suitability of streams to support aquatic life at selected monitoring stations in the Salish Sea. Data were provided by the Freshwater Quality Monitoring Unit of EC's Science and Technology Branch and the Freshwater Monitoring Unit of Washington Department of Ecology's Environmental Assessment Program for 17 water quality monitoring stations. Rivers in the Georgia Basin were evaluated by EC using the Canadian Council of Ministers of the Environment's Water Quality Index (CCME, 2001) and rivers in Puget Sound were evaluated by the Washington Department of Ecology's Water Quality Index (Washington Department of Ecology, 2002). Both indices compared water quality monitoring data to water quality benchmarks and consolidated the scope of parameters exceeding benchmarks with the frequency of exceedances and the magnitude of exceedances into a single score for each river and year.

Scores were placed into categories to define water quality condition. Categories for the two indices were the same with higher scores reflecting cleaner water:

- WQI scores from 80–100 indicated high water quality, where guidelines were rarely exceeded, and if so, only by a narrow margin.
- WQI scores from 70–79 indicated fair or marginal water quality that sometimes exceeded guidelines, possibly by a wide margin.
- WQI scores below 69 indicated poor water quality that often exceeded guidelines by a wide margin.

Stream flow

The Stream Flow indicator reflected the degree to which annual summer stream flows have changed between 1975 and 2009. Data were provided by the Water Survey of Canada and the Modelling and Information Support Unit of the Washington Department of Ecology (WA DOE) for 17 stream flow stations. All data were analysed using the same metric which was developed by the WA DOE (Pickett, 2010) for reporting through the Washington Salmon Recovery Office's State of Salmon in Watersheds reports (Salmon Recovery Office, 2012) and the Puget Sound Partnership's Dashboard of Indicators (PSP, 2012). Trends were evaluated for whether and how flow conditions are changing rather than their status at a fixed point in time. Average annual changes were sorted to visualize relative changes among streams.

Marine water quality

The Marine Water Quality indicator reflected levels of dissolved oxygen for the Strait of Georgia and Puget Sound. Depth profiles of dissolved oxygen in the Strait of Georgia were provided by the Department of Fisheries and Oceans (DFO), and depth profiles of dissolved oxygen in Puget Sound were provided by the Marine Monitoring Unit of WA DOE. Dissolved oxygen concentrations within three depth layers (surface to 35 m, 35–105 m, and 105 m to the bottom) in Georgia Basin and two depth layers in Puget Sound (surface to 35 m, 35–105 m) were compared over the period from 2000 to 2009.

Marine Water Condition Index (MWCI; WA DOE, 2012) scores were also provided by WA

DOE for 12 stations throughout Puget Sound from 1999 to 2010. The MWCI assessed water conditions relative to historical baseline conditions to account for seasonal, tidal and spatial variability found in Puget Sound. MWCI scores greater than zero indicated improving water quality while scores less than zero indicate decreasing water quality. Annual MWCI scores were compared for each site over time, to determine whether conditions are becoming increasingly eutrophic and whether physical conditions are affecting the availability of oxygen.

Shellfish beaches

The Shellfish Beaches indicator described status and trends in the opening and closing of Shellfish harvesting areas in the Salish Sea. As part of the Canadian Shellfish Sanitation Program and the U.S. National Shellfish Sanitation Program, commercial Shellfish beaches in the Salish Sea are assigned a classification to communicate whether Shellfish in that area are safe to eat. The Shellfish Beaches indicator considered all beaches which are classified prohibited, restricted, conditionally restricted or conditionally approved (EC, 2009; Washington Department of Health, 2013).

Data on the total area of closed beaches were provided by the Marine Water Quality Unit of EC's Science and Technology Branch and the Office of Shellfish and Water Protection of the Washington Department of Health (WA DOH). These data were used to convey geographic differences in the status of Shellfish beach closures north and south of the border, and temporal trends between 1989 and 2010. Data on the cumulative change in areas upgraded since 2007 were also provided by WA DOH. These data were used for comparison against the Puget Sound Partnership's restoration target of 10,800 total net acres upgraded between 2007 and 2020.

Swimming beaches

The Swimming Beaches indicator reported the percentage of core marine swimming beaches that met water quality standards through the swimming season. Data were provided for swimming beaches in the Georgia Basin by the Vancouver Coastal Health Authority and the Vancouver Island Health Authority for the period from 2004 to 2010. Data were similarly provided for swimming beaches in Puget Sound by the WA DOH from 2004 to 2011. Different parameters and benchmarks were used to interpret water quality data north (Health Canada, 1992, 2012) and south of the border (EPA, 1986, 2012) to reflect jurisdictional authorities, nevertheless, the percentage of beaches passing standards was determined in the same way as a proportion of the beaches in Georgia Basin and in Puget Sound.

Chinook Salmon

Salmon are a keystone species of iconic significance to the Salish Sea ecosystem. Because of their transboundary nature, salmon are the subject of bilateral collaboration through the Pacific Salmon Commission (PSC) to conserve Pacific Salmon and divide harvests such that Canada and the United States benefit from their investments in salmon management (PSC, 2012). The Chinook Salmon indicator estimated abundance using data provided by the PSC on the number of harvested and spawning Chinook in the Salish Sea (PSC, 2012). Stocks in the catch estimates included Strait of Georgia, Fraser River, Strait of Juan de Fuca, Strait of San Juan and other Puget Sound Chinook. Stocks in the escapement estimates included Lower Georgia Strait, Upper Georgia Strait, Fraser spring, Fraser summer, Harrison, Skagit spring, Skagit summer, Skagit fall, Stillaguamish, Snohomish, Green, Nooksack and Lake Washington Chinook.

Southern resident Killer Whales

The Killer Whale (*Orcinus orca*) indicator described Southern Resident Killer Whales (SRKW) population status and trends. Three distinct populations of Killer Whales occupy waters along the Washington – British Columbia coast: residents, transients and offshores (Ford et al., 2000). These populations differ in ecology, behaviour, and genetics (Ford et al., 2000; NOAA, 2011). The range of SRKW overlaps with the geography of the Salish Sea, with reliable sightings occurring in the Southern Strait of Georgia, Strait of Juan de Fuca and Puget Sound over spring, summer, and fall months (Ford et al., 2000). Three related pods (J-pod, K-pod and L-pod) make up the Southern Resident Killer Whale population. The US National Oceanic and Atmospheric Agency provided data on the total abundance of SRKW and abundance within each pod in the population from 1973 to 2012. Data from 1960 to 1973 were calculated using a model matrix (Olesiuk, 1990). Demographic information was interpreted from publications by Ford (2000) and Bigg (1990 and 1987).

Toxics in the food web

The toxics in the food web indicator reflected spatial and temporal trends in levels of polychlorinated biphenyl congeners (PCBs) and polybrominated diphenyl ethers (PBDEs) in Harbour Seals (*Phoca vitulina*) and Pacific Herring (*Clupea pallasi*). Lipid concentrations of PCBs and PBDEs in Harbour Seals were provided by the Canadian Department of Fisheries and Oceans. Spatial trends in Harbour Seals were assessed among four stations in the Salish Sea. These included Hornby Island and the Fraser River estuary in Georgia Basin, and Smith Island and Gertrude Island in Puget Sound (Ross, 2013). Temporal trends in Harbour Seals were assessed at the southernmost side, Gertrude Island from 1984 to 2009 (Ross, 2013). Whole body composite concentrations of PCBs and PBDEs in Herring were provided by the Washington Department of Fish and Wildlife. Spatial trends in adult Herring were assessed from four locations in the Salish Sea, namely, Denman/Hornby Island and Semiahmoo in Georgia Basin, and Port Orchard and Squaxin Pass in Puget Sound. Temporal trends in fish tissue were assessed at Semiahmoo from 1994 to 2007 and Port Orchard and Squaxin Pass from 1999 to 2010.

Marine species at risk

The Marine Species at Risk indicator reflected status and trends in the number of marine species formally listed under Canadian or American protection legislation. Four jurisdictions within the Salish Sea have processes for assessing and listing species that require special initiatives to ensure protection and survival of the population. These are the Province of British Columbia, the State of Washington, the Canadian Federal Government, and the United States Federal Government. The SeaDoc Society of the University of California in Davis compiled a list of invertebrates, fish, reptiles, birds, and mammals that use the Salish Sea marine ecosystem and are listed as species of concern by one or more jurisdictions in 2011 (Gaydos and Brown, 2011). These data were compared to lists compiled in 2002 (Gaydos and Gilardi, 2003), 2004 (Brown and Gaydos, 2005), 2006 (Brown and Gaydos, 2007), and 2008 (Gaydos and Brown, 2009).

Results

Air quality

Levels of fine particulates at 13 of the 14 monitoring stations met both the Canada Wide Standard (30 μg m^{-3}) and the U.S. Daily Standard (35 μg m^{-3}). Levels at the southernmost station in Tacoma, Washington exceed the more stringent Canada Wide Standard but meet the U.S. Daily Standard. It should be noted that more stringent Canadian Ambient Air Quality Standards (CAAQS) will soon supersede the existing Canada Wide Standards (Canada Gazette, 2013). As of 2015, the fine particulate levels must not exceed 28 μg m^{-3}; by 2020, levels must not exceed 27 μg m^{-3} (Canada Gazette, 2013). If current fine particulate levels were subject to the stricter 2015 standards, 13 of the 14 monitoring stations would continue to be in compliance. Nevertheless, if they were subject to the 2020 standards, only 12 of the 14 stations would be in compliance.

Comparison of current fine particulate levels to levels in 2005 when the previous transboundary indicators report was published reveal decreases in 12 out of 14 stations. A slight 1% increase was observed at the Bellingham, Washington station which is close to the international border in Puget Sound, and a more significant 30% increase was observed at the Victoria, British Columbia station which recently benefitted from equipment upgrades to improve their sensitivity. A number of other monitoring stations in British Columbia are due for similar equipment upgrades in the coming year. Closer review of the monitoring network is required to determine whether the observed increases in fine particulates are due to equipment sensitivity or actual changes in air quality.

Freshwater quality

The average Freshwater Quality Index scores for 17 monitoring stations from 2000 to 2010 indicated that 5 had good to excellent water quality that consistently met water quality guidelines or only rarely fell below standards, 7 had marginal to fair water quality, and 5 had poor water quality that often exceeded guidelines by a wide margin.

Rivers with stations that demonstrated good to excellent water quality are the Quinsam and Fraser Rivers in Georgia Basin, and Duckabush, Skokomish and Snohomish Rivers in Puget Sound. Rivers with stations that have marginal to fair scores include Sumas River in Georgia Basin, and Elwha, Cedar, Lower Skagit, Upper Skagit, Deschutes, and Nisqually Rivers in Puget Sound. Rivers with poor water quality are Green, Stillaguamish, Samish, Nooksack and Puyallup Rivers in Puget Sound. Over the 10 year period, no stations showed significantly declining trends, while three showed significantly improving trends. These were observed at stations on the Samish, Nisqually and Deschutes Rivers.

Stream flow

Statistically significant increasing trends were identified at 2 water survey stations in Puget Sound: Puyallup River which originates from Mount Rainier Glaciers and Dungeness River which is fed by snow and rain. Statistically significant decreasing trends were identified at 10 stations including 5 in Georgia Basin and 5 in Puget Sound. Three of the 5 Georgia Basin stations showing decreasing trends are located on rivers that are primarily rain-fed or pluvial. These are the Koksilah, Chemainus and San Juan Rivers. Oyster River is primarily snow-fed or nival, originating from the Comox Glacier, and Chilliwack River is strongly influenced by both rain and snow. Three of the 5 Puget Sound stations showing decreasing trends are mainly influenced by rain and snow: Snohomish, Deschutes, and Issaquah Rivers. The Nooksack and North Fork Stillaguamish Rivers are primarily snow-fed.

Marine water quality

When seasonal cycles were removed from dissolved oxygen data collected between 2000 and 2009 and the average of the data were fit to a straight trend line, a slightly increasing trend was observed in the surface layer (0–35 m) in the Strait of Georgia while a decreasing trend was observed in the surface layer in Puget Sound. This surface layer reflects variations due to exchange with the atmosphere and biological productivity. A decreasing trend was observed in the subsurface layer (35–105 m) in both the Strait of Georgia and Puget Sound. Subsurface layers, particularly where water column stratification is persistent, typically reflect naturally lower oxygen concentrations because of limited atmospheric exchange; nevertheless, the data indicate that dissolved oxygen levels were generally higher in the mid-20th century than they are today.

In the Puget Sound, where Marine Water Condition Index scores were calculated using data from 1999 to 2010, overall conditions have been shifting in the direction of lower water quality, although recent, more stable conditions have slowed the apparent decline. In parts of Puget Sound where water circulation is restricted, marine water quality is found to be poor or only moderate. These areas include Hood Canal, South Puget Sound, Sinclair Inlet and Port Susan. Monitoring stations in South Puget Sound, the central basin from Tacoma to Port Townsend and in Bellingham Bay all show significant declining trends in water quality.

Shellfish beaches

Nearly 739 square km of Shellfish beaches are currently closed to commercial harvesting in the Georgia Basin and about 147 square km are closed in Puget Sound. These numbers include all areas that are prohibited, restricted, or have only conditional approval for commercial harvest. Since 1989, the area of tidal lands closed to Shellfish harvesting in Georgia Basin has steadily increased by 17%. This is mostly due to increased monitoring efforts. Since 1989, the area of tidal lands closed to commercial Shellfish harvesting in Puget Sound increased by 6%. Recovery efforts which began in earnest in 2007 are beginning to reverse this trend.

Swimming beaches

Between 2004 and 2010, over 85% of swimming beaches in Georgia Basin and almost 82% of beaches in Puget Sound consistently met water quality guidelines and standards. All beaches in the Georgia Basin met Canadian water quality guidelines for recreation in 2011. In Puget Sound, 8 swimming beaches out of the 60 that were monitored exceeded water quality standards more than once through the 2012 swimming season.

Chinook Salmon

Just over 485,000 Chinook Salmon were reported to be in the Salish Sea in 2010 by the Pacific Salmon Commission. This estimate reflects Chinook Salmon that were harvested through recreational, commercial, and subsistence fisheries (157,325) in Georgia Basin and Puget Sound, as well as fish that escaped harvest and returned to spawn in their native streams (328,432). This is a 60% reduction in Chinook abundance since the Pacific Salmon Commission began tracking Salmon data in 1984. Since 1999, when Puget Sound Chinook were listed as a threatened species under the U.S. Endangered Species Act, there has been a 29% reduction in the number of harvested Salmon and a 30% increase in the number of spawning Salmon.

Southern resident Killer Whales

From 1974 to 2012, the southern resident Killer Whale population showed periods of both growth and decline. When the first population census began in 1974, 66 whales were sighted. Their population increased by 48% to a high of 98 in 1995, then dropped almost 20% from 1996-2001, prompting governments to list them as a threatened species. Today the population is down 13% from its 1995 peak. The three pods within the southern resident orca population have shown different patterns of change. Between 1974 and 2012, J-pod and K–pod grew slightly (25% and 15%, respectively), while L-pod decreased slightly (3%). From their recent peak in 1995 until 2001, L-pod's declining numbers drove the overall decrease in southern resident orca population, prompting the species to be listed as endangered. L-pod has the highest proportion of older females that are no longer reproducing.

Toxics in the food web

PCBs and PBDEs were found in all Harbour Seals sampled from the Salish Sea, but levels were declining (Ross, 2013). Similarly, levels of PCBs and PBDEs in Pacific Herring were generally declining or remaining stable (West et al., 2008, 2011). PCB and PBDE levels were 6 to 7 times higher in Herring sampled in the more urbanized and industrialized areas of central and southern Puget Sound than in Herring sampled in the Strait of Georgia. Although levels of PCBs in Herring from southern Puget Sound were above levels that may cause negative effects, they were not increasing. PCBs in Herring in the southern Strait of Georgia are also not increasing. PBDEs levels in Herring were mostly below levels that may cause negative effects, and trends appear to be either declining or remaining stable (West et al., 2011).

PCBs and PBDEs levels were higher in Harbour Seals living in the more urbanized and industrialized areas of southern Puget Sound than in seals living in the Straits of Juan de Fuca and Georgia. The levels of PCBs were about four times higher than PBDEs (Ross, 2013), highlighting the tremendous persistence of PCBs in the environment. Nevertheless, PBDE levels are still moderately high and are seen as a significant contaminant in Harbour Seals (Ross, 2013). Concentrations of PCBs have been declining in Harbour Seals, and levels of PBDEs appeared to have peaked in 2003, following a previous rapid increase since 1984 (Ross, 2013).

Marine species at risk

As of January 2011, 113 marine species and sub-species were formally listed as being at risk or vulnerable to extinction, including 56 birds, 37 fish, 15 mammals, 3 invertebrates and 2 reptiles (Gaydos and Brown, 2011). Between 2008 and 2011, 23 species were added to the list, including five fish species and 18 birds (Gaydos and Brown, 2011). This represents the largest increase in species of concern since the list was first established in 2002.

Discussion and conclusions

In the process of selecting indicators for reporting, efforts were made to represent a cross-section of ecosystem components using a biophysical framework and to assess state and impact indicators of Salish Sea ecosystem health. Mixed trends observed among indicators reflect the complexity of the ecosystem. Improvements were demonstrated among indicators of air quality, freshwater quality, and toxics in the food web. Declining trends were observed among indicators of marine water quality, marine species at risk, Chinook Salmon, and summer stream flow. Variable or neutral trends were observed among indicators of southern resident Killer Whale abundance, access to Shellfish beaches and access to swimming beaches.

The suite of Salish Sea indicators represents an integrated system with indicators acting as receptors to multiple drivers and pressures. Threats to Salish Sea ecosystem health were not studied. Nevertheless, two primary drivers to consider for further investigation include climate change and human population growth. Climate change has been implicated in studies on changes in marine dissolved oxygen and summer stream flow. Impacts of climate change on habitat and species composition have also been reported. Population growth yields challenges for landscape and water systems as development takes place to accommodate increased numbers of people. Studies of how changes in land cover and land use may impact Salish Sea ecosystem health are currently unavailable.

Responses to ecosystem changes have also not been studied thoroughly although restoration efforts are being taken on a site specific basis in a number of areas, particularly the Puget Sound. Studies on interactions between condition indicators and responses should be considered and best practices shared within the transboundary ecosystem. A comparison of current conditions, practices, and recommendations made by the 1994 BC-WA Marine Science Panel on ecosystem management of specific transboundary issues, may help to identify responses that have had particularly favourable results. Partnerships that were developed in the course of the Salish Sea Transboundary Ecosystem Indicators project should prove beneficial to understanding threats and identifying responses to indicator trends.

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