

PugetSoundPartnership

our sound, our community, our chance

INITIAL DISCUSSION DRAFT HUMAN HEALTH TOPIC FORUM

APRIL 14, 2008

Puget Sound Partnership

Introduction to the Topic Forum Discussion Draft

The attached topic forum discussion draft is one of five papers designed to provoke and inspire a long-term, community conversation and critical thinking about the specific problems facing Puget Sound, and the strategies and actions needed to address the threats we face. These papers and your comments will be used to help create the 2020 Action Agenda. Background on the topic forum process and how this information will be used can be found on our website at www.psp.wa.gov in the Action Agenda Center.

These initial draft papers are the first effort in our region to synthesize and document what we know about the problems, solutions that work, our current approach to solving problems, and what approaches we need to continue, add, or change. This is hard work that has not been done before. It means 1) looking at Puget Sound ecosystem from the crest of the Cascades to the Strait of Juan de Fuca, 2) providing sources to back up our statements and conclusions, and 3) establishing links between science and policy.

The discussion papers are DRAFT. They do not yet represent an opinion or position of the Partnership. We very much appreciate your interest and expertise in reviewing this initial work. The Partnership asked a small group of science and policy experts to prepare this draft discussion paper as starting place for the discussion. As you read this paper and prepare to participate in one of the five upcoming workshops, participate in an online discussion, or submit specific comments, the Partnership requests that reviewers keep this context in mind.

- **The Partnership will be identifying priority actions that are based on science.** There is currently a wide range of opinion about the problems and literally hundreds ideas for solutions. Our hope is that if we can agree on the documented threats to Puget Sound in terms of magnitude and impact, we will have a better chance of creating priority and durable solutions.
- **The papers mainly focus on the Sound as a whole.** We know that there are variations in problems and solutions in different parts of our region. The action area profiles that we are also preparing will highlight local issues.
- **The papers are organized to logically step through three initial questions (two are science and one is policy) that build to a rational conclusion (the fourth question)** about the strategies and actions that we will need continue, add, or change as a region. The design is intentional so that 1) our policies are based on science and 2) scientists and policy experts talk to one another.
- **These initial papers will contribute to a synthesis paper that will describe links between each of the topic areas.** Reviewers may want to read more than one paper to begin to see the links across our individual interests and concerns. The papers reach different types of conclusions for where to focus efforts, and in some cases the suggested solutions are far-reaching. Before we get to a synthesis paper (and workshop), we want the initial papers to be as accurate as we can in the time that we have available.
- **The intent of papers is to focus on WHAT the problem is and WHAT solutions are needed, rather than HOW to implement specific solutions.** For example, we know that we will need to do more to protect habitat and concentrate growth into urban areas. There are many ways to accomplish this task and different methods will be needed around Puget Sound. We will create the “how” with those who have to implement the solutions.

- **The papers intentionally do not focus on the need for more education/outreach, new funding strategies including creative incentives, and a coordinated monitoring and adaptive management program.** The Partnership knows that these three aspects are critical to long-term success and is using other processes to address them. That work is linked to the development of the action agenda. By addressing the system-wide needs, we will be able to more effectively focus the education/outreach and funding.
- **The Quality of Life “topic”, or Partnership goal, is not yet represented in these papers, but will be part of our subsequent work to synthesize across the topics.**

You may comment on the draft papers by attending in the topic forum workshop, participating in the online discussion at www.psp.wa.gov, or submitting a comment via email or in writing. When reviewing the papers, please consider the following questions:

- **Current knowledge:** Have we accurately described what we know and don't know about the status of and threats to this topic in the Puget Sound region and the certainty of our knowledge? Have we missed any major documented findings?
- **Effectiveness of tools:** Have we accurately characterized what is certain and uncertain about the effectiveness of the tools available to address threats to this topic? Have we missed any major documented findings?
- **Current strategies:** From a topic perspective, have we accurately characterized what we are now doing to address threats? Have we missed any major programs or projects?
- **Strategies to continue, add, or change:** Given the status of and threats to the topic, effectiveness of the tools available, and current strategies to address threats, have we accurately captured the strategies we should continue, add or change? Have we missed any strategies and actions we should continue, add or change to address the threats (not just good ideas)? What sources have informed your thinking?
- **Establishing criteria:** Are the proposed criteria for prioritizing topic-specific actions appropriate and sufficient? Are there other criteria to consider?
- **Measuring progress:** Have we identified appropriate measures to assess progress toward goals for this topic? Have we missed any key measures of progress?

INITIAL DISCUSSION DRAFT PAPER

HUMAN HEALTH

APRIL 14, 2008

Science Question 1 (S1): Status of Threats to Human Health in Puget Sound

Key Findings from Previous Efforts

A. What is the current documented knowledge about threats to human health in the water, sediment, and biota of Puget Sound?

The type of threats addressed in this paper are pathogens, biotoxins, and toxic contaminants including metals, PCBs, PBDEs, petroleum compounds, endocrine-disrupting compounds, and others described in more detail below. This paper addresses the nature of human exposure to these threats resulting from:

- Consumption of fish, shellfish, and other marine biota;
- Direct contact with water and sediment (including beaches); and
- Decline in the availability of food sources.

The sources of threats to human health include:

- Point- and non-point-source discharges to Puget Sound;
- Direct spills to aquatic systems;
- Contaminants from historical land uses that remain in sediment or the water column;
- Threats introduced from contributory surface waters, groundwater, or air deposition; and
- Naturally occurring biotoxins.

The focus of this discussion draft is threats to human health in the water, sediment, and biota of Puget Sound. Human health threats not being considered in this paper include natural disasters such as earthquake and tsunami, direct exposure to air toxics through inhalation, and use of groundwater in the Puget Sound basin for drinking water. Air toxics and contaminated drinking water are threats in the region as a whole and need to be incorporated into future discussions and evaluations.

B. What is the nature of threats to human health in the water column, sediments, and biota?

There are a variety of threats to human health in Puget Sound. In some cases the threats are well documented and understood. In other cases the threats may have undergone less study or documentation, or they may be emerging threats that have not yet been studied.

Consumption of fish, shellfish, and other marine biota

The consumption of fish, shellfish, sea plants, and other marine biota represents the most significant human health exposure risk to toxic contaminants, pathogens, and biotoxins.¹ Toxic contaminants include metals, polychlorinated biphenyls (PCBs), polybrominated diphenyl ethers (PDBEs, a class of flame retardants), petroleum compounds, endocrine-disrupting compounds, and others.^{2,3}

While a detailed discussion of all toxic, pathogen, and biotoxin sources and their effects on human health is beyond the scope of this paper, the following is a summary of major findings:

- **Organisms exposed to toxics in sediments, the water column, or their natural food sources may bioaccumulate or concentrate contaminants in their tissues and subsequently be consumed by people.** Consumption of fish, due to the persistent and lipophilic (the tendency to be fat-soluble) nature of many of these toxics, has been the focus of toxics risk analysis.³ Consumption of marine biota and the toxics they carry, including mercury and PCBs, can lead to chronic health problems.^{4,5, 6, 7, 8, 9, 10, 11} Children are at greatest risk for developmental effects from this exposure. Frequent consumers, including Tribes and some immigrant populations, are at particular risk because they fish in urban areas, tend to consume more of what they catch, and consume a greater dietary proportion of bottomfish.^{12,13,14} Bottomfish from urban areas of Puget Sound and long-lived species such as rockfish are of particular concern with respect to toxics.¹⁵ Concentrations of contaminants in resident Chinook salmon are also of concern.¹⁶

¹ Swinomish Water Resources Program. Final Report: Swinomish Tribal Community's Bioaccumulative Toxics in Native American Shellfish Project: 2002-2006. http://www.swinomish.org/departments/planning/water/toxics/btnas/toxics.btnas_main.html

² Puget Sound Action Team. "2007 Puget Sound Update: Ninth Report of the Puget Sound Assessment and Monitoring Program". February 2007.

³ Washington State Department of Health. "Human Health Evaluation of Contaminants in Puget Sound Fish". 2006.

⁴ ATSDR. 1999. Toxicological Profile for Mercury. U.S. Department of Health and Human Services. Public Health Service. Agency for Toxic Substances and Disease Registry. March 1999.

⁵ ATSDR. 2000. Toxicological Profile for Polychlorinated Biphenyls (PCBs). U.S. Department of Health and Human Services, Public Health Service. Agency for Toxic Substances and Disease Registry. November 2000.

⁶ Clarkson TW. 1993. Mercury: major issues in environmental health. *Environmental Health Perspect.* 100:31-38.

⁷ Clarkson TW. 1997. The Toxicology of Mercury. *Crit. Rev. Clin Lab Sci.* 34(4):369-403

⁸ Goldman LR and Shannon MW. 2001. Technical Report: Mercury in the Environment: Implications for Pediatricians. *Pediatrics.* 108:197-205.

⁹ Schwartz P, Jacobson W, Fein G, Jacobson J, and Price H. 1983. Lake Michigan fish consumption as a source of polychlorinated biphenyls in human cord serum, maternal serum, and milk. *Am J. Public Health.* 73(3):293-6.

¹⁰ NRC. 2000. Toxicological Effects of Methylmercury. Committee on the Toxicological Effects of Methylmercury, Board on Environmental Studies and Toxicology, Commission on Life Sciences. National Academy of Science National Research Council. National Academy Press. 2000.

¹¹ Kostyniak P, Stinson C, Greizerstein H, Vena J, Buck G, and Mendola P. 1999. Relation of Lake Ontario fish consumption, lifetime lactation, and parity to breast milk polychlorobiphenyl and pesticide concentrations. *Environ. Res.* 80(2):5166-5174.

¹² Washington State Department of Health. Final Public Health Assessment: Lower Duwamish Waterway. September 30, 2003.

¹³ US EPA. Environmental Justice Quarterly. "Safe and sustainable shellfish harvesting program." (Summer 2007), p. 8-9. www.epa.gov/compliance/resources/newsletters/ej/ej-newsletter-summer2007.pdf

¹⁴ Washington State Board of Health. Final Report of the State Board of Health on Environmental Justice. June 2001

¹⁵ Washington State Department of Health. "Human Health Evaluation of Contaminants in Puget Sound Fish". 2006. p. 13.

¹⁶ Ibid.

Limited data on toxics in shellfish from Puget Sound have been collected and evaluated by the Washington State Department of Health (DOH).¹⁷ However, a detailed parallel study to the DOH study of contaminants in finfish has not been conducted for Puget Sound shellfish¹⁸. Guidance on toxics in shellfish is detailed in the National Shellfish Sanitation Program Model Ordinance.¹⁹

Sources of toxic contamination to biota (that are subsequently consumed) include:

- Spills and direct discharge of chemicals to Puget Sound or its freshwater basins;
 - Leaching or biotic activation of historical contaminants that are still present in the environment;
 - Toxics in the food web that are sequestered in plant and animal tissue;
 - Transport of toxics from contaminated soil or groundwater via seeps;
 - Stormwater runoff;
 - The flow of marine waters from the Pacific Ocean; and
 - Air deposition both from local and global sources (with specific concern in this latter category about mercury, PCBs, and PBDEs).^{1,20}
- **Exposure to pathogens (both natural and human-related) and biotoxins is most likely to occur through the consumption of shellfish.** ^{21,22,23} This is because clams, oysters, and other bivalve molluscan shellfish are filter feeders that can efficiently accumulate disease-causing organisms that may be present in the surrounding water and sediments. Most seafood illnesses are associated with the consumption of molluscan shellfish harvested from waters contaminated with raw or poorly treated sewage.²⁴

Pathogens include a variety of viruses, bacteria, protozoa, and parasites, some of which occur naturally in the marine ecosystem, but the majority of which are associated with humans and are spread mainly via the fecal-oral route.²⁵ Human-related pathogens from many sources have the potential to contaminate shellfish habitat. These sources include combined sewer overflows, failing on-site sewage systems, stormwater runoff, boat/ship discharges (sewage, ballast water)²⁶, marina sewage, pet and livestock wastes, wildlife waste, and other diffuse fecal sources (e.g., recreationalists).²⁷ Fecal pollution levels are used as an indicator of pathogens in shellfish growing areas; in some areas of Puget Sound these levels have shown improvement, while other areas continue to show moderate to high levels of pollution.²⁸

- **Biotoxins found in Puget Sound shellfish can cause Paralytic Shellfish Poisoning (PSP) (also known as “red tide”) as well as Amnesic Shellfish Poisoning (ASP) (also known as Domoic Acid**

¹⁷ Washington State Department of Health. 1996. Puget Sound Ambient Monitoring Program: 1992 and 1993 Shellfish Chemical Contaminant Data Report.

¹⁸ Washington State Department of Health. “Human Health Evaluation of Contaminants in Puget Sound Fish”. 2006

¹⁹ United States Food and Drug Administration, National Shellfish Sanitation Program. “Guide for the Control of Molluscan Shellfish.” (2005).

²⁰ Hart Crowser, Inc.; Washington Department of Ecology; U.S. Environmental Protection Agency; and Puget Sound Partnership. “Phase 1: Initial Estimate of Toxic Chemical Loadings to Puget Sound”. Ecology Publication Number 07-10-079. October 2007.

²¹ David Lees. 2000. Viruses and Bivalve Shellfish. *International Journal on Food Microbiology*. 59(2000):81-116.

²² National Research Council. 1991. *Seafood Safety*. Committee on the Evaluation of the safety of Fishery Products. Food and Nutrition Board, Institute of Medicine. National Academy Press. Washington, D.C. 452 pp.

²³ Sair, A.I., D.H. Souza, L.A. Jaykus. 2002. Human Enteric Viruses as Causes of Foodborne Disease. *Comprehensive Reviews in Food Science and Food Safety*. 1(2002):73-89.

²⁴ National Research Council. 1991. *Seafood Safety*. Committee on the Evaluation of the safety of Fishery Products. Food and Nutrition Board, Institute of Medicine. National Academy Press. Washington, D.C. 452 pp.

²⁵ Puget Sound Partnership Nutrients and Pathogens Work Group. “Nutrients and Pathogens in Puget Sound: Recommendations for Scientific Advances”. No date. p.5.

²⁶ Washington State Department of Health. “Assessment of Potential Health Impacts of Virus Discharge from Cruise Ships to Shellfish Growing Areas in Puget Sound”, report to Washington State Legislature. November 2007.

²⁷ Puget Sound Partnership Nutrients and Pathogens Work Group. “Nutrients and Pathogens in Puget Sound: Recommendations for Scientific Advances”. No date. p.5.

²⁸ Office of Shellfish and Water Protection - Washington State Department of Health. “2006 Annual Inventory of Commercial and Recreational Shellfish Areas in Washington State”. 2007..

Poisoning).²⁹ Exposure to these biotoxins can result in serious health effects and death. These toxins are produced by microscopic algae that concentrate in filter-feeding shellfish, filter-feeding bait fish, or crabs.³⁰ Biotoxic algae blooms, also called Harmful Algal Blooms (HABs), usually occur when temperature, light, and nutrient conditions are favorable to these phytoplankton communities. Most PSP shellfish closures occur between July and November. However, closures can occur at any time of the year.³¹

- **“Emerging” chemicals and pathogens include several contaminants and organisms that scientists suspect may pose serious risks to human health via exposure through fish and shellfish consumption.** However, more information needs to be collected to confirm their concentrations in fish and shellfish and/or specific threats to human health. **Emerging toxic contaminants** include a variety of chemicals found in stormwater and wastewater discharges (such as synthetic hormones, antibiotics, and other pharmaceuticals), as well as perfluorinated compounds (PFCs).^{32,33,34,35,36} **Pathogens** such as the bacteria *Vibrio vulnificus* have been detected at low levels in Washington State shellfish tissue.³⁷ Although there have been no reported illnesses, further information is needed concerning environmental studies and potential risks to consumers. Several **biotoxins** are also emerging as potential human health threats, including the occurrence and spread of domoic acid in the Puget Sound region (Trainer et al., 2007) and the possible emergence of Diarrhetic Shellfish Poison (DSP) and Neurotoxic Shellfish Poison (NSP) that are present in coastal waters in other parts of the country.³⁸

Direct contact with sediment and water, including contact on beaches

Direct contact with sediment, water, or biota contaminated with chemical toxics³⁹ and pathogens within Puget Sound and on its beaches poses a human health threat⁴⁰, although not as great as that posed by consumption of contaminated fish and shellfish, because the magnitude of exposure is less significant. Pathways for contact may include dermal (through the skin), ingestion, and inhalation of contaminants and pathogens in sediment and water that could expose individuals to a variety of toxic contaminants (including “emerging” toxics), pathogens, or biotoxins^{41,42}. Areas of particular concern for direct contact with toxics, pathogens, or biotoxins include:

- Sites of known toxic contamination of sediments⁴³;
- Industrial outfalls;
- Stormwater outfalls (for both toxics and pathogens);

²⁹ Washington State Department of Health - Division of Environmental Health, Office of Shellfish and Water Protection. *Biotoxin Program*. Accessed via <http://www.doh.wa.gov/ehp/sf/BiotoxinProgram.htm> on March 27, 2008.

³⁰ Washington State Department of Health. “Establishing Tolerable Dungeness Crab (*Cancer magister*) and Razor Clam (*Siliqua patula*) Domoic Acid Contaminant Levels.” (1996)

³¹ Trainer, Vera L., et al. “Paralytic Shellfish Toxins in Puget Sound, Washington State”. *Journal of Shellfish Research*, Vol. 22, No. 1, p. 218.

³² Chapter 173-333 WAC – Persistent Bioaccumulative Toxins

³³ Washington State Department of Health. “Human Health Evaluation of Contaminants in Puget Sound Fish”. 2006.

³⁴ Washington State Department of Ecology. Results of a Screening Analysis for Pharmaceuticals in Wastewater Treatment Plant Effluents, Wells, and Creeks in the Sequim-Dungeness Area. November 2004.

³⁵ King County, 2007. Survey of Endocrine Disruptors in King Surface Waters. Prepared Richard Jack and Deborah Lester. Water and Land Resources Division. Seattle, Washington.

³⁶ Washington State Department of Ecology. PCPP Draft Literature Review 2008. (Note: this document is not yet available.)

³⁷ Food and Drug Administration 2007 retail foods study; preliminary findings provided verbally to DOH.

³⁸ Van Dolah, F.M. 2000. Marine Algal Toxins: Origins, Health Effects, and Their Increased Occurrence. *Environmental Health Perspectives*. 108(1):133-141.

³⁹ Serdar, David. Washington State Department of Ecology. Control of Toxic Chemicals in Puget Sound: Identification and Evaluation of Water Column Data for Puget Sound and Its Ocean Boundary. March 2008.

⁴⁰ US EPA. Bacteriological Ambient Water Quality Criteria for Marine and Fresh Recreational Waters. 1986.

⁴¹ Dziuban, Eric J., et al. Surveillance for Waterborne Disease and Outbreaks Associated with Recreational Water --- United States, 2003—2004. <http://www.cdc.gov/mmwr/preview/mmwrhtml/ss5512a1.htm>

⁴² PBS&J. 2006. Ecological and Toxicological Assessment of Lyngbya in Florida Springs. Final Report. Jacksonville, FL http://www.doh.state.fl.us/environment/community/aquatic/pdfs/Eco_Tox_Eval_Lyngbya_FL_Spring.pdf

⁴³ United States Environmental Protection Agency. March 2000. First Five Year Review Report for Ruston/North Tacoma Superfund Site Ruston and Tacoma, Washington.

- Combined sewer outfalls;
- Beaches or coastal waters as seaweed and other organic material decompose, producing hydrogen sulfide⁴⁴;
- Spill areas; and
- Freshwater drainages.

In 2005, levels of enterococci bacteria exceeded state water quality standards at 24 of the 65 recreational swimming beaches monitored under the state beach program.

Decline of food source availability

The dwindling supply of Puget Sound's once abundant food resources is a threat to human health. The health benefits of eating fish are well documented.⁴⁵ The traditional methods of measuring and assessing human health risk do not always support what Tribes define as "health" or what is prescribed by treaty rights.⁴⁶ For Tribes and other populations that traditionally rely on seafood as a primary component of a healthy diet, the unavailability of marine food sources may have serious health, social, and economic consequences.⁴⁷

C. What is the certainty about our understanding of these threats and their status?

The certainty of understanding relating to characterizing human health risks varies. Human health risk is dependent on chemical toxicity, pathogen virulence, and level of exposure. However, many years of monitoring data help to shape the understanding of these risks, and in some cases provide a reasonable certainty. More information is known about the short-term health effects of ingesting pathogen-contaminated shellfish than the long-term health effects (including cancer) of ingesting seafood contaminated with low levels of chemical toxics.

The 2007 Puget Sound Action Team Report documented sampling conducted by the Puget Sound Assessment and Monitoring Program (PSAMP) for various chemicals, pathogens, and biotoxins. This sampling has identified risks to human health that are occurring across Puget Sound and are discussed below.

Human-related pathogens

Ecology and DOH monitor marine water quality at long-term stations located throughout Puget Sound. In addition, the King County Department of Natural Resources and Parks conducts similar monitoring at a series of stations located in the central Puget Sound basin.⁴⁸ This long-term monitoring information has been used to determine the status and trends of water quality in shellfish-growing areas in Puget Sound.

Overall, the water quality and classification trends associated with the region's commercial shellfish-growing areas have been improving over the past 15 years.⁴⁹ Substantially more acreage has been upgraded to a higher classification during this period than downgraded due to improved water quality conditions. Also during this period, DOH has increased its shellfish water quality monitoring program to cover more area.⁵⁰ The state also monitors many recreational beaches for fecal coliform bacteria in shellfish harvest areas. DOH works cooperatively with WDFW, local health jurisdictions, Tribes, and other stakeholders to classify beaches and educate the public regarding personal responsibility for safe shellfish harvests and consumption.⁵¹

⁴⁴ Washington State Department of Health. 1991. Fauntleroy Cove Odor Investigation. 1990 Report. Environmental Health Programs. Olympia, WA. 17 pp.

⁴⁵ Science Advisory Committee on Nutrition. "Advice on Fish Consumption, Benefits, and Risks." TSO. United Kingdom. (2004).

⁴⁶ EPA - Tribal Science Council. "National Tribal Science Priorities". April 2006. p.8.

⁴⁷ Washington State Department of Health. "Human Health Evaluation of Contaminants in Puget Sound Fish". 2006, p. 64.

⁴⁸ Ibid. p. 203.

⁴⁹ Puget Sound Partnership. 2007 State of the Sound Report. January 2007.

⁵⁰ Puget Sound Partnership. 2007 State of the Sound Report. January 2007.

⁵¹ Ibid. p. 216.

Ecology and DOH jointly administer the Beach Environmental Assessment, Communication and Health (BEACH) Program, an EPA-funded effort that monitors for fecal bacteria (enterococcus) at saltwater beaches used for swimming, surfing, scuba diving, wind surfing, and other water contact activities.⁵² There is evidence that restoration work is creating a positive trend in beach classification.

Natural pathogens

From May through September, DOH obtains oyster samples for laboratory analysis at least every other week from selected harvest sites in Puget Sound. These sites represent areas that were sources of two or more confirmed *Vibrio parahaemolyticus* illnesses annually within the past three years.^{53,54} There is certainty about the effects of *Vibrio parahaemolyticus* and the extent of illness caused by this pathogen. However, there is less certainty about the causes for its occurrence and spread across Puget Sound.

Biotoxins

DOH conducts comprehensive monitoring for biotoxins as part of its commercial and recreational shellfish programs.⁵⁵ In Puget Sound, DOH samples mussels biweekly for paralytic shellfish poison and domoic acid at sites that are part of its Sentinel Monitoring Program. When shellfish show harmful levels of either biotoxin, DOH closes commercial, recreational, and tribal growing areas.^{56,57}

Metals

Most of the data characterizing metals are from sediment sampling programs. There is less information characterizing metals in the water column. King County has monitored sediment quality at one station along the Seattle waterfront as part of its ambient sediment monitoring program. Samples were collected annually from 1988 through 1993, in 1995, and biennially from 1996 through 2004. In addition, as part of PSAMP, Ecology sampled sediments at 10 fixed stations each spring, from 1989 through 2000. Stations were chosen from a variety of habitats and geographic locations in Puget Sound.⁵⁸ Since 1986, NOAA's National Status and Trends (NS&T) Program has been monitoring contaminants in mussel tissue from Puget Sound and the Strait of Juan de Fuca. Samples were collected annually to 1994 and every other year since then.⁵⁹

Limited site-specific data for metals indicate a potential human health risk from consumption of shellfish in urbanized bays and at hazardous waste sites. Levels of metals in shellfish outside of these sites indicate little risk, but comprehensive data are lacking.^{60,61}

Persistent bioaccumulative toxics (PBTs)

Sediment and fish in Puget Sound, particularly in urban bays, are contaminated with PBTs at higher levels than are found in coastal estuaries on the West Coast.^{62,63,64,65} PBTs permeate the Puget Sound food web, not only in its

⁵² Ibid. p. 214.

⁵³ Ibid. p. 223.

⁵⁴ Washington State Department of Health – Office of Shellfish and Water Protection. “2006 Annual Inventory of Commercial and Recreational Shellfish Areas in Washington State”. June 2007. P. 23

⁵⁵ Puget Sound Action Team. “2007 Puget Sound Update: Ninth Report of the Puget Sound Assessment and Monitoring Program”. February 2007. 209, 216.

⁵⁶ Ibid. 209, 220.

⁵⁷ Washington State Department of Health – Office of Shellfish and Water Protection. “2006 Annual Inventory of Commercial and Recreational Shellfish Areas in Washington State”. June 2007. P. 23

⁵⁸ Ibid. p. 180.

⁵⁹ Ibid. p. 182.

⁶⁰ ATSDR. 2007. Geoduck Tract #6100 Tribal Request. King County, Washington.

⁶¹ ATSDR. 2007. Geoduck Tracts # 9900, 9950, and 10400. King County, Washington

⁶² West, J. and S. O'Neill, G. Lippert, and S. Quinnell. “Toxic contaminants in marine and anadromous fishes from Puget Sound, Washington: Results of the Puget Sound Assessment Monitoring Program Fish Component, 1989-1999.” Technical Report [FTP01-14](#). Washington Department of Fish and Wildlife, Olympia, WA. (2001).

⁶³ Washington State Department of Health. “Human Health Evaluation of Contaminants in Puget Sound Fish”. 2006.

⁶⁴ Missildine B., Peters RJ, Chin-leo G., and Houck D. 2005. Polychlorinated biphenyl concentrations in adult Chinook salmon returning to coastal and Puget Sound hatcheries of Washington State. Environmental Science and Technology. 39: 6944-6951.

bottom-dwelling species but also in the pelagic component of the food web, including herring and salmon. PCBs and mercury are at levels of human health concern in Puget Sound fish, while increasing levels of PBDEs are also of concern. Ecology has identified PBTs as a priority for their toxics reduction strategy as evidenced by their recently adopted rule calling for chemical action plans to reduce or eliminate the threat of PBTs in Washington State (WAC Chapter 333).

While PBTs have been a focus of PSAMP monitoring, additional information is needed on PCB congeners (individual congeners can act by multiple mechanisms which are not well defined; traditionally, analytical results have been reported as PCB aroclors), and on dioxin and furans.^{66,67} The significance of emerging contaminants such as perfluorinated compounds and pharmaceuticals is also unknown.

Polycyclic aromatic hydrocarbons (PAHs)

PAH concentrations have been studied in mussels, crab, fish, and herring using limited sampling sites. Except for site-specific contamination at some hazardous waste sites (e.g., Wyckoff/Eagle Harbor), PAH exposure to fish and shellfish appears to be of limited health concern based on levels that have been detected.

Oil spills

Since 1998, Puget Sound and its tributaries experienced one major spill (in 1999) and 165 serious spills, totaling at least 350,000 gallons.⁶⁸ This is of limited concern for the consumption of fish and shellfish because harvest for consumption does not typically occur when spilled oil is present. It is more of a concern relative to availability of the resource. While spills themselves are infrequent, they have the potential to significantly impact human health by removing fish and shellfish from the potential harvest (e.g., Dalco Passage oil spill in October 2004).⁶⁹

Sediments

As noted previously, direct contact with sediment is secondary to fish/shellfish consumption in terms of overall potential health risk. However, there are specific sites, such as hazardous waste sites, where there is a potential threat to human health from sediments. Risks at these sites would still be secondary to fish/shellfish consumption.⁷⁰

D. What are the main gaps in our understanding?

While many of the human health risks in Puget Sound are understood to a great degree, there are a number of gaps in our assessment of these threats that, if filled, would provide a more comprehensive understanding. These gaps include:

Fish consumption rates

More data about the historical use of resources across different populations would allow for a more accurate assessment of human health exposure for different communities and their cultural uses. Currently EPA uses the results of studies from the Suquamish Tribe and Tulalip Tribes as guidance in estimating fish consumption rates. While these surveys are scientifically valid, they represent a "snapshot" of consumption patterns that may underestimate current and traditional consumption rates.

⁶⁵ O'Neill, S, Ylitalo, G, West, J, Bolton, J, Sloan, C, Krahn, M. 2006. Regional patterns of persistent organic pollutants in five Pacific salmon species (*Oncorhynchus* spp) and their contributions to contaminant levels in northern and southern resident killer whales (*Orcinus orca*). 2006 Southern Resident Killer Whale Symposium. April 3-5, 2006. Extended Abstract.

⁶⁶ Puget Sound Action Team. February 2007. p. 140.

⁶⁷ Puget Sound Action Team. "2007 Puget Sound Update: Ninth Report of the Puget Sound Assessment and Monitoring Program". February 2007. p. 66.

⁶⁸ Ibid. p. 174.

⁶⁹ Puget Sound Action Team. "2007 Puget Sound Update: Ninth Report of the Puget Sound Assessment and Monitoring Program". February 2007. pp. 174-177.

⁷⁰ United States Environmental Protection Agency. March 2000. First Five Year Review Report for Ruston/North Tacoma Superfund Site Ruston and Tacoma, Washington.

"Emerging" contaminants, pathogens, and biotoxins

A host of chemicals are present in discharges to Puget Sound that have not yet been assessed for their risk to human health. These include pharmaceuticals and PFCs, amongst others. In addition, there are a number of pathogens that will require additional analysis to determine the risk they pose to human health. One example is *Vibrio parahaemolyticus*, for which there are data available regarding presence in water, shellfish, and plankton, but the synthesis of that information has not yet occurred. Several biotoxins have also recently come to light that may present a threat to human health through consumption or direct contact.⁷¹

Broad risk assessment for toxics in shellfish

While a Puget Sound-wide risk assessment has been done for human health threats associated with the consumption of toxics in finfish⁷², a similar risk assessment has not been conducted for shellfish. Additional chemical analysis of shellfish samples will be necessary to determine the Sound-wide sources of human health risk associated with consuming shellfish, whether current reference conditions are accurate, and how to determine health-protective consumption advice.⁷³ More data are available for metals in shellfish than other contaminants.

Toxics and pathogens in crab

Data are limited for toxics and pathogens in Puget Sound crab. Some sampling in Puget Sound and elsewhere in the U.S. indicates that organic contaminants (e.g., PCBs) and domoic acid accumulate in the hepatopancreas of crabs. DOH has advised that consumers not eat this part of crabs harvested from the Duwamish River. More sampling will be necessary to determine exposure and risk to toxics and pathogens in crabs across Puget Sound. Currently, DOH routinely monitors domoic acid levels in Puget Sound crab when shellfish sampling indicates the presence of elevated levels.

Toxics in additional species

Information about toxics in other salmon species such as pink, chum, and sockeye is currently limited. This information is needed to confirm predicted low contaminant levels in these Puget Sound species. DOH work has characterized these as species likely to be consumed, but for which data are unavailable (DOH professional judgment). Lingcod, cabezon, and shrimp are additional species that are consumed, but with little characterization of contaminants.⁷⁴

Cumulative impacts

Little is known about the cumulative, additive, and synergistic impacts of exposure to multiple contaminants through multiple consumption pathways or direct contact over time. Traditional risk assessment should assume that exposure to multiple contaminants is additive with respect to overall risk when considering the same toxic endpoint (e.g., neurodevelopment). More specific information about interaction of toxics in the body would be helpful in validating this assumption.

Toxics in the water column

There is a lack of understanding about the presence and concentration of toxics in the water column. Information from PSAMP and NPDES monitoring is available, but it is either site-specific or does not address the specific toxics of concern. More complete information about toxics in the water column may lead to a better understanding of the human health risk from direct exposure, as well as the sources of contamination in fish and shellfish.

⁷¹ Human Health Ad Hoc Group. "Recommendations from the Human Health Ad Hoc Group". November 11, 2006. p.8-9

⁷² Washington State Department of Health. "Human Health Evaluation of Contaminants in Puget Sound Fish". 2006.

⁷³ Ibid, p. 8

⁷⁴ Puget Sound Action Team. "2007 Puget Sound Update: Ninth Report of the Puget Sound Assessment and Monitoring Program". February 2007. p. 65.

Freshwater toxics entering Puget Sound

Sources of toxic contamination in Puget Sound contributed from freshwater tributaries are not well understood. This information may be useful in controlling toxic contamination before it reaches the Sound.

Reference conditions

While some site-specific data are available, the extent to which current conditions in Puget Sound meet or exceed reference conditions is not fully known.

Effectiveness monitoring

Monitoring the effectiveness of actions undertaken to address human health risk would help direct future studies and actions.

Effects of climate change on pathogens and biotoxins

Little is known about the potential for climate change to influence the extent and frequency of pathogen and biotoxin contamination within Puget Sound, or the effects these changes may have on biota such as algae, which serve as a primary food source for many other aquatic species. For biotoxins, more information about the environmental factors that initiate and drive their production, cause algae to be toxic, and end algae blooms is also needed.⁷⁵

Current Status of Puget Sound Compared to 'Healthy' Condition

A. What is the definition of a healthy or reference condition?

Reference conditions for human health are developed from data aggregated from a number of individual sites to account for their "natural" variability. Reference conditions provide a consistent means of determining whether other site conditions meet or exceed an environmental norm and/or require further study or action. However, the definition of "reference condition" depends on what is being assessed and how it is being measured. Several definitions of a healthy condition can be found in the literature supporting this effort. These include the following:

- Fish and shellfish are plentiful and safe to eat⁷⁶ and individuals may exercise choice in their consumption.
- Waters and beaches are safe for drinking and swimming, and toxics should not harm humans.⁷⁷
- Well-being means that people are able to use and enjoy the lands and waters of the Puget Sound region.⁷⁸
- Tribal cultures are sustained through subsistence, ceremonial, and tribal harvest; treaty rights are supported/restored.⁷⁹

B. Where does the current condition meet, exceed, or not meet these reference conditions?

Fish and shellfish are plentiful and safe to eat⁸⁰ and individuals may exercise choice in their consumption

Currently, existing conditions meet applicable standards and/or regulations in some but not all areas of Puget Sound. While recommendations of no more than one meal per week for resident Chinook (blackmouth) are applicable Sound-wide, some areas of Puget Sound, such as the waters around the San Juan Islands, have no consumption

⁷⁵Trainer, Vera L., "Harmful Algal blooms on the U.S. west coast." National Marine Fisheries Service. (No date). p. 14.

⁷⁶ Puget Sound Partnership. "Sound Health, Sound Future: Protecting and Restoring Puget Sound, Puget Sound Partnership Recommendations, Executive Summary". December 2006. p.8.

⁷⁷ Human Health Ad Hoc Group. "Recommendations from the Human Health Ad Hoc Group". November 11, 2006. p.8-9

⁷⁸ Ibid.

⁷⁹ Ibid.

⁸⁰ Puget Sound Partnership. "Sound Health, Sound Future: Protecting and Restoring Puget Sound, Puget Sound Partnership Recommendations, Executive Summary". December 2006. p.8.

restrictions for other fish species.⁸¹ Other areas, typically urban embayments like Elliott Bay, and those in close proximity to hazardous waste sites or wastewater outfalls, have advisories for no or limited consumption based on toxic contamination levels.

In 2005, nearly one-third of Puget Sound's commercial shellfish growing areas had restrictions on harvest due to bacterial pollution. While this represents a large proportion of the available shellfish harvest areas in the Sound, the trend is showing improved water quality conditions when compared with the previous decade. Between 1995 and 2005, harvest restrictions were lifted on 12,617 acres, while 5,218 acres were downgraded due to pollution.⁸² These overall improvements are tempered by the consideration that many of the beaches where restrictions were lifted remain in a "threatened" classification. In 2007, 11 of the shellfish growing areas in Puget Sound were classified as "threatened" due to contamination concerns.⁸³ While the majority of these areas are located in the south Sound, this classification is applied to some beaches as far north as Samish Bay in Skagit County.

In spite of a substantial increase in recent years of the areas monitored for contamination, the classification program is only applied to approximately one-third of Puget Sound harvest areas. The best shellfish conditions and classifications are in rural areas, where there are few sewage treatment and stormwater outfalls. Wastewater treatment plants have mandatory zones closed to shellfish harvest around outfalls. Recreational classifications are maintained for approximately 250 of Puget Sound's more than 1,000 beaches. Of those beaches most highly used for recreational harvest of shellfish, about 25 percent are not classified (data are unavailable).⁸⁴

[Waters and beaches are safe for drinking and swimming, and toxics should not harm humans](#)

Most of Puget Sound is safe for direct contact. Hazardous waste sites represent only very specific risks for small segments of the population for direct contact. Area-wide contamination by arsenic and lead from smelter operations affects large areas, with the greater risks closer to the contamination source.⁸⁵

DOH currently monitors 53 beaches for swimming safety. The monitoring is conducted mostly on high-use, high-risk areas and covers only 20 of the roughly 2,500 miles of beach in Puget Sound. In March 2008, caution advisories for swimming were placed on seven recreational beaches in Puget Sound. Some areas have good water quality; other beaches located in proximity to urban areas, marinas, and/or wastewater outfalls often have poor water quality conditions that have potential to pose a threat to human health through direct contact.

[Tribal cultures are sustained through subsistence, ceremonial, and tribal harvest; treaty rights are supported/restored](#)

Contamination has made some fish, shellfish, and other marine biota unavailable for consumption across Puget Sound. Sites of intense cultural harvest, including Usual and Accustomed tribal fishing grounds, have been affected or abandoned due to contamination. As an example, the Suquamish Tribe's 2008 Suquamish Marine Bottom Fish Regulations list three areas (Sinclair Inlet, Eagle Harbor, Elliott Bay) within the Tribe's Usual and Accustomed fishing areas that are closed due to human health concerns associated with the consumption of resident fish.⁸⁶

⁸¹ DOH. Puget Sound Fish Consumption Advisory Areas Accessible at:<http://www.doh.wa.gov/ehp/oehas/fish/ps.htm>; Accessed April 10, 2008

⁸² PSAT. "State of the Sound". January 2007; p.9.

⁸³ DOH "Shellfish Growing Area Annual Reports" Accessible at <http://www.doh.wa.gov/ehp/sf/growreports.htm>; Accessed April 10, 2008

⁸⁴ DOH. Puget Sound Fish Consumption Advisory Areas Accessible at:<http://www.doh.wa.gov/ehp/oehas/fish/ps.htm>; Accessed April 10, 2008

⁸⁵ Washington State Department of Ecology, et. al. Area Wide Soil Contamination Task Force Report. June 23, 2003.

⁸⁶ Suquamish Tribe Marine Bottom Fish Regulations. Tribal Regulation 07-75F/08-01F.

Science Question 2 (S2): Management Approaches Addressing Threats to Human Health

What are the main scientific findings relating to management approaches and their documented effectiveness to address threats to human health?

A. What are the general categories and specific examples of management approaches used today to address threats?

A variety of management approaches are currently used to address threats to human health. These efforts originate from federal, tribal, and state governments, and in some cases from nonprofit organizations and NGOs. These approaches generally fall into one of three general types:

- **Source Reduction:** Prevents or reduces the existence of threats;
- **Management of Threat Exposure:** Controls the entry of threats into the environment and human exposure to threats; and
- **Cleanup:** Removes threats from the environment.

Examples of these management approaches are provided in Table S2-1.

Table S2-1. Examples of Management Approaches

Management Approach Examples	Source Reduction	Management of Threat Exposure	Cleanup
Regulation of municipal sewage treatment plants and industrial and stormwater discharges through the Clean Water Act		X	
Wastewater system industrial pretreatment		X	
Regulation of on-site sewage systems through local implementation of State Board of Health and Department of Health rules		X	
State of Washington Sediment Quality Standards			X
State of Washington Model Toxics Control Act Cleanup Standards			X
State of Washington and federal chemical spill response, cleanup, and prevention regulations	X		X
Federal and State of Washington regulations for boating waste, oil, and trash disposal in Washington and federal waters		X	
State of Washington Persistent, Bioaccumulative Toxics Initiative	X	X	
State and federal regulations on fish and shellfish harvest and sale for human consumption		X	
Local development standards, including requirements for erosion control and on-site stormwater management, and use of marinas	X	X	
State Environmental Policy Act (SEPA) review requirements	X		
State of Washington water reclamation and reuse standards and programs		X	
State, local, and tribal fish and shellfish consumption advisories		X	
Beach closures for swimming and shellfish harvesting		X	
Biotoxin advisories and closures		X	

Management Approach Examples	Source Reduction	Management of Threat Exposure	Cleanup
Product and chemical content bans and use of non-toxic product alternatives	X		
Education and social marketing to change behaviors	X	X	

B. How is effectiveness measured and documented?

The effectiveness of these programs in addressing human health threats can be measured and documented in the following ways:

- Shellfish closures;
- Swimming beach closures;
- Reported illnesses connected to pathogens and biotoxins;
- Trends in water quality data, relative to water quality and pollution prevention standards; and
- Trends in concentrations of chemical toxics in fish tissue.

If fewer shellfish and swimming beach closures are recorded and fewer illnesses are reported, these programs are presumed to be effective. Less is known about the use of water quality and fish tissue monitoring as measures of effectiveness of programs in reducing threats to human health.

C. From a scientific standpoint, which management approaches have been documented to have the most effective response?

Several programs have been documented as effective in reducing threats to human health, within the limitations of effectiveness measurement. These are generally management-related programs which have a longer history with more effectiveness measurement. These programs are presented in Table S2-2.

Table S2-2. Effectiveness of Management Approaches

	Documented Effective Programs	Source Reduction	Management of Threat Exposure	Cleanup
1	Washington State Mercury Chemical Action Plan ⁸⁷ , based on reductions in mercury concentrations in the 2005-2006 biosolids data. ⁸⁸	X	X	
2	Fish consumption advisories, based on awareness of advisories and on success of outreach efforts (including Washington Department of Fish and Wildlife pamphlet, website hits, and grocery store pilot project and evaluation). There are limited data that show these advisories are reducing human health risk. However, there is some indirect evidence of the programs' effectiveness in that species with lower contamination levels are increasingly preferred by consumers		X	
3	Biotoxin advisories and closures, based on contamination levels or illnesses reported to public health officials. These programs are deemed effective based on low incidence of reported illness.		X	

⁸⁷ Washington State Department of Health and Department of Ecology. "Washington State Mercury Chemical Action Plan." (January 2003).

⁸⁸ Bennett, Jon. "2006 Update- Biosolids as an Indicator of the Effectiveness of Mercury Reduction Programs." (June 1, 2007).

	Documented Effective Programs	Source Reduction	Management of Threat Exposure	Cleanup
4	Designation of shellfish harvest areas as open, advisory, or closed, based on results of sanitary surveys and fewer reported illnesses.		X	
5	Targeted efforts in shellfish areas that have been downgraded due to pollution and declining water quality, based on fewer reported illnesses.		X	
6	Improvements to wastewater management systems that have been effective in reducing output of toxic contaminants, based on monitoring conducted by NPDES permit-holders.		X	
7	Improvements to industrial pre-treatment programs, based on monitoring conducted by NPDES permit-holders.		X	

DRAFT

Policy Question 1 (P1): Policy Approaches to Address Threats to Human Health

What policy approaches are being used to address threats to human health associated with water, sediments, and biota in the Puget Sound region?

A. Which threats are addressed by existing regulations or management programs?

An array of federal, tribal, state, and local regulations and management programs address threats to human health associated with water, sediments, and biota in Puget Sound. Table P1-1 provides examples of these programs and indicates the types of threats they address.

Table P1-1. Threats Addressed by Regulations and Programs

Regulation/Management Program	Chemical Toxic Threat	Biotoxin Threat	Pathogen Threat
Regulations to protect water and air quality from ongoing discharges (Clean Water Act and Clean Air Act requirements), as well as additional state, tribal, and local requirements.	X		X
Regulations to require cleanup of known contamination such as CERCLA, MTCA, and the sediment management standards.	X		
Federal and state regulations requiring spill response and cleanup, and controlling discharge of waste from certain types of aquatic vessels.	X		X
Ecology's Persistent Bioaccumulative Toxics Regulation, which was put in place to establish a list of PBTs and to outline procedures for developing chemical action plans for each identified PBT. A chemical action plan identifies, characterizes, and evaluates uses and releases of a specific PBT, a group of PBTs, or metals of concern, and recommends actions to protect human health and the environment.	X		
State, tribal, and local laws requiring implementation of specific land development and land use (including agricultural) practices, resource management programs (e.g., shellfish protection districts and programs), on-site sewage systems, and water reclamation and reuse requirements.	X		X
The National Shellfish Sanitation Program ⁸⁹ , administered by the U.S. Food and Drug Administration and implemented by the DOH, is a policy that protects threats to human health through regulation of shellfish-growing areas, license of harvesters, and sale for consumption.	X	X	X
State Department of Health programs monitor water quality for biotoxins (paralytic shellfish poison or "red tide" and amnesic shellfish poison or domoic acid) and pathogens (fecal coliform bacteria). DOH initiates fish and shellfish advisories and beach closures as needed to protect public health from existing health threats associated with contaminated seafood. These programs provide information to the public on where and how to safely harvest shellfish that are free from contamination by classifying beaches to identify safe areas for harvesting.		X	X

⁸⁹ United States Federal Drug Administration, National Shellfish Sanitation Program. "Guide for the Control of Molluscan Shellfish." (2005).

Regulation/Management Program	Chemical Toxic Threat	Biotoxin Threat	Pathogen Threat
The BEACH (Beach Environmental Assessment Communication and Health) Program, which is jointly administered by the Departments of Health and Ecology, tests water at swimming beaches for pathogens, notifies the public when results are high, and educates people about what they can do to avoid getting sick from playing in saltwater. ⁹⁰			X
The State Department of Health shellfish growing area classification program evaluates all commercially harvested shellfish growing areas in Washington State to determine their suitability for harvest. Growing areas classification is determined through completion of a sanitary survey, which involves a shoreline survey to identify pollution sources, water sampling to determine pathogen levels, and analysis of weather conditions, tides and currents to evaluate potential distribution of contaminants.			X
State Department of Health programs promote the safe treatment and disposal of domestic and non-industrial wastewater in areas of Washington not served by municipal sewage treatment works.	X		X
State Parks boater education programs reduce discharge of untreated sewage and trash into Puget Sound.			X
Washington State Department of Transportation stormwater program provides guidance and technical support for planning, design, construction and maintenance of roads to its regional offices.	X		X
The Stormwater Management Manual for the Puget Sound Basin outlines recommendations established by Ecology for temporary stormwater controls for use on construction sites, and permanent stormwater controls for long-term protection of water quality. The manual also defines stormwater Best Management Practices (BMPs) which are designed to prevent pollutants from entering stormwater by eliminating the source of pollution or by preventing the contact of pollutants with rainfall and runoff.	X		X
Local health jurisdiction regulatory, public education, and management plan activities address on-site sewage systems.	X		X
State Department of Health provides assistance to local health jurisdictions regarding on-site wastewater issues and the design and implementation of on-site sewage management plans.			X
State Department of Health and local health programs guide the siting, design, installation, operation, maintenance, and permitting of on-site sewage systems at all scales, and help design and implement education and training courses on these and other sewage-related subjects.			X
Combined Sewer Overflow Public Notification Programs, established by many municipalities around Puget Sound, notify the public not to swim or fish near outfalls after heavy rains have resulted in discharge from CSO locations.	X		X
Conservation commission and local conservation districts provide outreach and technical assistance to landowners, conservation planning, and implementation of BMPs.	X		X
An existing memorandum of understanding (MOU) between the State and the cruise ship industry bans discharge into Puget Sound except for vessels with advanced wastewater treatment systems (AWTS).	X		
State, local, and tribal water cleanup plans (including TMDLs) and implementation programs, watershed management plans, shellfish closure response strategies, and other plans or planning processes address restoration of water quality.	X		X

⁹⁰ BEACH (Beach Environmental Assessment, Communication and Health) <http://www.doh.wa.gov/chp/ts/WaterRec/beach/default.htm>

B. Which threats are not being addressed and why?

The existing regulations and management programs are targeted at specific projects/actions, chemicals, practices and/or geographic areas, and do not encompass all potential sources of similar threat or all potential threats. Most of these regulations and programs address the threat once it is present, or at the discharge point into Puget Sound, rather than in a preemptive, preventive manner. Table P1-2 summarizes the limitations of existing programs.

Table P1-2. Limitations of Existing Programs

Threats Not Fully Addressed	Chemical Toxic Threat	Biotoxin Threat	Pathogen Threat
Stormwater permit holders are not required to meet water quality standards for pathogens and toxics.	X		X
Not all chemicals present in wastewater are either monitored or addressed by NPDES permits.	X		
Not all contaminated sites have been cleaned by CERCLA or MTCA.	X		
Some "emerging" chemical contaminants and pathogens, which are known to be present in the environment and for which little information is known about exposure and toxicity, are not being addressed by existing programs.	X		X
PBTs that are not currently included in the list of chemicals identified in Ecology's PBT regulations are not being addressed by existing programs.	X		
Although all commercial shellfish areas and most major recreational beaches are regularly tested for biotoxins and pathogens, some beaches are not included in existing programs. In addition, monitoring covers only a portion of Puget Sound shoreline areas.			X
The state's current use of a default assumed fish consumption rate of 17.5 grams per day to establish water quality criteria is not protective for frequent fish consumers.	X		
Risk management assumptions that are inherent in the regulations and management programs, such as the prescribed cleanup levels for an MTCA site, may not coincide with actual exposure that currently exists, Native American treaty-reserved rights to harvest, or the desired uses. ⁹¹	X		
Programs designed to educate and protect the public against these threats are not adequate to reach and inform all members of the public.	X	X	X
Discharge of untreated and limited-treatment sewage waste from smaller aquatic vessels is not being addressed by an existing program.			X
Discharges of sewage to Puget Sound directly and from failing and older on-site sewage systems are not being corrected comprehensively.			X
Discharges from most municipal sewage systems do not remove all contaminants, including nutrients. ^{92 93 94}	X		

⁹¹ National Environmental Justice Advisory Council – Cumulative Risks/Impacts Work Group. "Ensuring Risk Reduction in communities with Multiple Stressors: Environmental Justice and Cumulative Risks/Impacts". December 2004.

⁹²EPA Report: EPA/600/R-04/171 APM 201 - National Screening Survey of EDCs, including some Pharmaceuticals in Municipal Wastewater Treatment Effluents. Jim Lazorchak <http://epa.gov/ppcp/projects/survey.html>

⁹³ Municipal Nutrient Removal Technologies. November 2007 Draft, Volume 1 – Technical Report. Prepared for the U.S. Environmental Protection Agency Office of Wastewater Management, Municipal Support Division Municipal Technology Branch. Prepared by Tetra Tech, Inc., Under Contract EP-C-05-046; WA 1-46

⁹⁴ Advanced Wastewater Treatment to Achieve Low Concentration of Phosphorus United States. April 2007. Environmental Protection Agency, Office of Water and Watersheds. EPA 910-R-07-002

C. What types of plans or programs are being used in other locations to address threats to human health from water, sediments, and biota, and what is their documented effectiveness?

Pathogens

Several programs are in place on the U.S. coasts to prevent and reduce contamination from boat sewage. These programs include, for example, bans on discharging untreated sewage from boats, requirements to use shore pumping stations or sewage boats, no-discharge zones, requirements for marinas to have sewage pumpout facilities, and boater education. Avalon Harbor on Santa Catalina Island, off the Coast of California, has instituted a mandatory policy of placing dye tablets in holding tanks of all vessels entering the harbor. If dye is detected in the water around any vessel, a stiff penalty is imposed for the first offense, and the boat is barred from mooring in the harbor for any subsequent offense. The effectiveness of these programs has not been documented.

Toxics

A new European Community Regulation, referred to as the Registration, Evaluation, Authorization and Restriction of Chemical Substances (REACH), was established in 2007. This regulation requires that manufacturers and importers of chemical substances gather information about the properties of these substances to ensure their safe handling and register the information in a central database maintained by the European Chemical Agency. The agency will coordinate in-depth evaluation of chemicals that present a potential threat and maintain a public database for consumers and professionals to provide information on these chemicals. The regulation also calls for the progressive substitution of the most dangerous chemicals when suitable alternatives have been identified. The effectiveness of these regulations is also unknown.

Policy Question 2 (P2): Needs Assessment and Actions: What Are the Gaps?

The preliminary findings and recommendations in response to this set of questions will be refined as additional input is received through the Topic Forum and feedback is obtained from the wide variety of participants in the Action Agenda process.

What needs to be done to address the documented threats to human health from water, sediments, and biota in the Puget Sound region?

A. What plans and programs appear to be on track to address the identified threats? Why?

A number of programs appear to be addressing identified threats, although it is unknown if the effectiveness of these programs has been documented. They include:

Source Reduction Programs

- Ecology's Technical Resources for Engineering Efficiency (TREE) program is a free technical assistance service for businesses. TREE works with up to five businesses a year to help reduce waste generation, reduce resource consumption, and increase savings through pollution prevention actions.⁹⁵
- The control of specific chemicals such as mercury through implementation of Chemical Action Plans as a result of Ecology's Persistent Bioaccumulation Toxics (PBT) regulations and strategy.⁹⁶ Some controls of specific chemicals, not related to programmatic efforts (such as banning use of lead in gasoline and landscape timbers treated with arsenic), have also been effective.⁹⁷

Management Programs

- Shellfish and fish monitoring and advisory programs provide decisions about shellfish beach closures and fish advisories. (Interactive fish consumption advisory maps can be accessed at <http://www.doh.wa.gov/ehp/oeahas/fish/ps.htm>.)
- Programs sponsored by the State Department of Health assist in identifying sources of pollutants, conduct water quality monitoring, assess the safety of beaches for recreational shellfish harvesting, and certify the safety of commercial shellfish operations.^{98,99,100,101,102,103,104}

⁹⁵ Technical Resources for Engineering Efficiency (TREE) <http://www.ecy.wa.gov/biblio/0004021.html>

⁹⁶ Washington State Department of Health and Department of Ecology. "Washington State Mercury Chemical Action Plan." (January 2003).

⁹⁷ Bennett, Jon. "2006 Update- Biosolids as an Indicator of the Effectiveness of Mercury Reduction Programs." (June 1, 2007).

⁹⁸ Washington State Department of Ecology and Department of Health. "Online data listed by county for water quality data at selected swimming beaches." Accessed via <http://www.doh.wa.gov/ehp/ts/WaterRec/beach/default.htm> on March 26, 2008.

⁹⁹ Natural Resources Defense Council. "Testing the Waters 2007: A Guide to Water Quality at Washington State's Vacation Beaches." (2007) <http://www.nrdc.org/water/oceans/tw/sumwas.pdf>.

¹⁰⁰ United States Centers for Disease Control. "Surveillance for Waterborne Disease and Outbreaks Associated with Recreational Water --- United States, 2003—2004." (December 22, 2006). <http://www.cdc.gov/mmwr/preview/mmwrhtml/ss5512a1.htm>

¹⁰¹ United States Environmental Protection Agency. "The EMPACT Beaches Project: Results from a Study on Microbiological Monitoring in Recreational Waters." (August 2005). <http://www.epa.gov/microbes/empact.pdf>

¹⁰² United States Environmental Protection Agency. "Implementing the BEACH Act of 2000 Report to Congress." (September 2006). <http://www.epa.gov/waterscience/beaches/report/report-fs.pdf>

¹⁰³ United States Environmental Protection Agency. "National Beach Guidance and Required Performance Criteria for Grants." (June 2002). <http://www.epa.gov/waterscience/beaches/grants/guidance/all.pdf>

¹⁰⁴ Puget Sound Fish Consumption Advisory Areas <http://www.doh.wa.gov/ehp/oeahas/fish/ps.htm>

- The BEACH program jointly administered by the Departments of Health and Ecology monitors water quality at high-risk marine swimming beaches.¹⁰⁵ (Interactive maps can be accessed at <http://www.doh.wa.gov/ehp/ts/waterrec/beach/default.htm>.)
- An Ecology Memorandum of Understanding (MOU) for larger cruise ships requires these vessels to treat sewage onboard with advanced wastewater treatment systems (AWTS).¹⁰⁶
- Shellfish restoration efforts have been successful in some areas, as evidenced by changes in classifications for beaches.¹⁰⁷

Cleanup Programs

- Ecology's Toxics Cleanup Program has been effective in moving sites toward cleanup.

B. What are the gaps between existing programs or plans and the identified needs?

There are both "general" gaps (such as geographic gaps in data collection) and "specific" gaps (such as lack of information on specific biotoxins) that limit the effectiveness of existing programs and plans. Collectively, these gaps are considered "knowledge gaps" that, if resolved, enable health protecting actions. Addressing gaps in programs related to source control is likely where the greatest gains can be achieved because controlling biotoxins and widespread chemical toxics will be more difficult and costly. These knowledge gaps include:

- Although limited information is available for some Tribes¹⁰⁸, there is a lack of information about use of the resource, specifically consumption of fish and shellfish, by all users. Assumptions that are inherent in how site cleanups are conducted assume certain levels of consumption and how much of the diet is obtained from Puget Sound. These assumptions are not necessarily consistent with either how the resource is actually used by all individuals, or how the resource is allowed to be used through Native American treaty-reserved rights to harvest.¹⁰⁹
- The swimming beach program is entirely federally funded and covers only a fraction of the Sound's popular swimming areas and total shoreline area. Some threats may exist that are not being addressed.
- The contribution of pathogen loading to Puget Sound due to waste discharge from large and small vessels not covered by Ecology's MOU for larger cruise ships is uncharacterized and unknown.^{110,111}
- The contribution of pathogen loading to Puget Sound from aging and/or underfunctioning on-site sewage systems is unknown. Although laws and regulations prohibit direct and deliberate discharge, the contribution of nutrients and pathogens from failing systems is unknown in many areas because water quality sampling is not conducted in all areas. Similarly, direct residential discharge of waste (nutrients, toxics, pathogens) to Puget Sound has been documented, but the extent of this problem has not been determined.^{112,113}

¹⁰⁵ Beach Environment Assessment, Communication, and Health Program <http://www.doh.wa.gov/ehp/ts/waterrec/beach/default.htm>

¹⁰⁶ Washington State Department of Health, November 2007. "Report to the Legislature – Assessment of Potential Health Impacts of Virus Discharge from Cruise Ships to Shellfish Growing Areas in Puget Sound." (November 2007)

¹⁰⁷ Puget Sound Partnership. 2007 State of the Sound Report. January 2007.

¹⁰⁸ Washington State Department of Health. "Report to the Legislature – Assessment of Potential Health Impacts of Virus Discharge from Cruise Ships to Shellfish Growing Areas in Puget Sound." (November 2007).

¹⁰⁹ National Environmental Justice Advisory Council – Cumulative Risks/Impacts Work Group. "Enduring Risk Reduction in Communities with Multiple Stressors: Environmental Justice and Cumulative Risks/Impacts". (December 2004).

¹¹⁰ Washington State Department of Health. "Report to the Legislature – Assessment of Potential Health Impacts of Virus Discharge from Cruise Ships to Shellfish Growing Areas in Puget Sound." (November 2007).

¹¹¹ United States Environmental Protection Agency. "Draft Cruise Ship Discharge Assessment Report" (December 2007).

http://www.epa.gov/owow/oceans/cruise_ships/pdf_disch_assess/cruiseship_discharge_assessment_report.pdf

¹¹² Puget Sound Partnership Nutrients and Pathogens Work Group. Nutrients and Pathogens in Puget Sound: Recommendations for Scientific Advances." (July 27, 2007).

¹¹³ Newton, Jan, Corinne Bassin, Al Devol, Mitsuhiro Kawase, Wendi Ruef, Mark Warner, Dan Hannafious, and Renee Rose. "Hypoxia in Hood Canal. An overview of status and contributing factors. (January 2008)

- The “emerging” pathogens and biotoxins (those present but largely uncharacterized with respect to extent or toxic effects) represent a potential threat in Puget Sound, but we lack sufficient understanding of the extent and level of threat. Additionally, these emerging pathogens and biotoxins are typically not included in existing monitoring efforts.
- Although a study has been completed for Puget Sound on chemical contamination of fish¹¹⁴, a parallel study for shellfish (including crab) has not been completed. This knowledge gap represents a potential human health threat from this source. A scoping document for such a study has been completed, but funding is not guaranteed at this point.
- A comprehensive inventory of data being collected would enhance the coordination of data collection and information between state and local agencies and Tribes.¹¹⁵
- Numerous public education and outreach programs address various aspects of these threats; however, we don’t have much understanding of their effectiveness.

What areas or issues need the greatest attention or action and why?

Areas or issues that were identified as in greatest need of attention or action, based on their ability to have the highest potential impact on human health, include:

- **Address limitations on harvesting and consuming fish and shellfish from Puget Sound and recommendations to decrease consumption of this resource because of fish/shellfish advisories, beach closures, and levels of chemical contamination in biota.** These limitations curtail dietary choice for all, and inhibit the ability of some to enjoy the extent of their cultural heritage. The impact of this issue is not evenly distributed across the population of Puget Sound, and disproportionately affects some subgroups, raising issues of risk equity and environmental justice.^{116,117,118}
- **Address the impact of PBTs on the environment and ultimately on our ability to harvest and consume local seafood.** The chemicals are toxic to the environment and their presence in seafood results in diet restrictions.¹¹⁹ More effort needs to be dedicated to addressing these chemicals at their source, rather than addressing the issues once they have been released to the environment. The effect of individuals’ actions needs to be addressed in addition to the industrial and stormwater contribution of contaminants.
- **Address the presence of known and emerging pathogens and biotoxins in Puget Sound and their presence in fish and shellfish, which potentially limits our ability to use the available resource.** At present, these threats are addressed primarily after they have been detected to be present. More effort is needed in prevention of the problem, and a greater geographic area of Puget Sound needs to be covered by existing programs. For example, many beach areas are currently not confirmed as acceptable for harvesting simply because sampling to assure safety has not been conducted.¹²⁰

¹¹⁴ Washington State Department of Health. “Human Health Evaluation of Contaminants in Puget Sound Fish”. (2006).

¹¹⁵ Collier, Tracy, et al (prepared by). “Technical and Policy Analyses to Support a Toxics Action Agenda for Puget Sound”. March 6, 2008. p.10

¹¹⁶ National EPA-Tribal Science Council. “National Tribal Science Priorities” (April 2006).

¹¹⁷ Wood, Mary Christina. EPA’s Protection of Tribal Harvests: Braiding the Agency’s Mission. Presentation to the US EPA Region 10 Tribal Leader’s Summit, August 22, 2006.

¹¹⁸ National Environmental Justice Advisory Council – Cumulative Risks/Impacts Work Group. “Enduring Risk Reduction in Communities with Multiple Stressors: Environmental Justice and Cumulative Risks/Impacts”. (December 2004).

¹¹⁹ National EPA-Tribal Science Council. “National Tribal Science Priorities” (April 2006).

¹²⁰ Ibid.

C. Specific strategies addressing areas for action

Several specific strategies were identified that need to be changed or modified to address these issues:

- **Improve management of older and underfunctioning on-site sewage systems around Puget Sound.** At present, programs that identify and address specific problems are not sufficient. There is a general lack of access by the community to technical experts who can help them address the problem in a systemic way, and a lack of guidance/models that can be used by citizens to help them take appropriate and sustainable measures. There is an overall lack of dedicated and predictable funding for government in resolving these problems and for individuals in taking action to correct problems including a simple mechanism to fund repair and replacement of their on-site sewage systems. Although direct discharge of untreated sewage to Puget Sound is prohibited by existing law and regulations, many continue to exist and water quality monitoring does not identify these problems outside of potential shellfish growing. Many individuals may believe that older on-site sewage treatment systems are exempt from current regulations.
- **Improve land use regulations and guidance to manage stormwater on-site and limit the amount of impervious area within a development to reduce stormwater volume that needs to be managed.** Improved permitting processes are needed to address these issues and provide certainty to developers in their planning. Additional ways to improve and encourage on-site stormwater infiltration are needed. Additional education of developers and improved availability of technical experts to the public are needed, along with incentives to encourage site development in a responsible, low-impact manner.¹²¹
- **Improve and update wastewater and stormwater infrastructure.** Overburdened and inadequate infrastructure can lead to sewage releases into Puget Sound. The cost of expanding, upgrading, and repairing this infrastructure will be significant, and more sustainable alternatives to the traditional “hard” infrastructure need to be evaluated for potential use. Much of the infrastructure that was designed in the 1970s is at the end of its life and must be replaced, yet funding for this work is lacking.
- **Reduce pollutant discharges that threaten shellfish resources.** Shellfish protection districts should be established around the Sound, and funding should be provided for local governments and Tribes to assist in this effort. Additional funding is needed for both local governments and Tribes to identify where the threats exist. More stringent standards should be established for wastewater, with All Known and Reasonable Available Treatment (AKART) established as the end goal. Additional funding and resources need to be dedicated to educating the public on actions they can take as individuals to reduce this threat.
- **Expand and accelerate work related to PBTs.** The list of chemicals currently included in Ecology’s PBT regulations is limited, and needs to be reviewed and potentially updated. Additionally, the work to develop Chemical Action Plans for the identified chemicals should be accelerated to allow more rapid identification and control of sources.

What criteria should be considered for prioritizing actions to address threats to human health?

Several criteria were identified that are considered key in distinguishing high-priority strategies:

- The action addresses the greatest exposure threat, which is the consumption of fish and shellfish contaminated with toxics and/or pathogens.
- The action directly addresses reduction of the origin of threat (actions that address source control rather than addressing the results of the threat once released to the environment).

¹²¹ D. B. Booth and C.R. Jackson. “Urbanization of aquatic systems – degradation thresholds, stormwater detention, and limits of mitigation.” *Journal of American Water Resources Association*, v. 33, No. 5, p. 1077-1090. (1997).

- The action eliminates the threat.
- The action benefits populations that are disproportionately affected by exposure, including populations that are frequent consumers of fish and shellfish due to cultural or economic reliance on the resource.
- The action is cost effective in terms of reducing threats (i.e., where will we achieve greatest impact in threat reduction for dollars spent?).
- The action addresses threats with the highest potential severity of endpoint.

How will we know we are making progress on human health?

We will know we are making progress on reducing threats to human health when:

- We have established a current baseline of conditions relative to all potential threats.
- We have identified viable indicators to measure progress toward reducing human health threats.
- We have increased resource harvest options.
- We have reduced the number and severity of data gaps.
- We increase our effective communication with the public about human health threats, and have a means of measuring this improvement.
- We increase coordination within and between federal, tribal, state, and local governments and other entities working to address these threats.