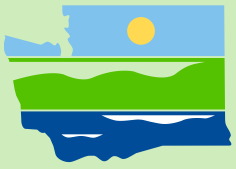
Appendix. Project Summaries

Puget Sound Toxics Control:

Toxics Projects in Puget Sound, 2011-2018, Funded by the NEP Toxics and Nutrients Prevention, Reduction, and Control Cooperative Agreement



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This appendix contains a one-page summary of each toxics project. The summaries are organized by project type.

The summaries provide funding totals, project contacts, access to deliverables such as reports or data, as well as a general overview and results for each toxics project funded by the Puget Sound *NEP Toxics and Nutrients Prevention, Reduction, and Control Cooperative Agreement.*

This appendix is linked to the report on the Department of Ecology's website at https://fortress.wa.gov/ecy/publications/SummaryPages/1703003.html

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Alternative Assessment Guide: C1200253, C2100170, C150007

Chemicals	All

Project Type	Prevention
Timeframe	2012-2013
Project Lead	Alex Stone
Funding	$262,024 (C1200253: $69,450; C2100170: $27,000; C150007: $165,574)
Data	Green Screen Hazard Assessments published at IC2 (www.theIC2.org)
Publication/s	2013. "Interstate Chemicals Clearinghouse, Alternatives Assessment Guide, Version 1.0." Interstate Chemicals Clearinghouse. http://theic2.org/article/download-pdf/file_name/IC2_AA_Guide_Version_1.0.pdf.
Description	Three separate grant projects supported the development of an Alternatives Assessment Guide. The Guide was created by the Interstate Chemicals Clearinghouse, a consortium of members from eight States, including Washington State. The focus is to exchange information to support toxics reduction. NEP grants funded several components of the work, including stakeholder outreach (conducted by Pure Strategies, Grant: C1200253), technical writing and consultation (conducted by Clean Production, Grant: C2100170), and an external review of the completed guide (performed by ToxServices, Grant: C150007). Ecology created a simplified version of the guide to support small to mid-sized businesses seeking to do alternative assessment screenings. Additional NEP funds were awarded to support the establishment of Northwest Green Chemistry which is currently using Washington's shortened version to conduct an alternative assessment for copper-containing boat paint.
Outcomes	A publicly available Alternatives Assessment Guide
Relevance	Effectively reducing toxics requires an established framework to evaluate alternatives. This project provided an alternative assessment process that incorporates hazards ranking for small- to medium-sized businesses.
Unknowns	The first alternative assessment using the guide in Washington State (copper boat paint) is just getting started.

Establishing Northwest Green Chemistry, a Center: C1300207

Chemicals	All

Project Type	Prevention
Timeframe	Start-up efforts in 2013 with funding to support to September 2016
Project Lead	Saskia van Bergen, Ecology
Funding	$497,631
Website	www.northwestgreenchemistry.org
Description	Ecology's Reducing Toxics Threats Unit created a five year plan for implementing green chemistry, called the Green Chemistry Roadmap. NEP funds were used as seed money to develop and launch the Northwest Green Chemistry Center. This non-profit Center, which now operates independently, promotes the growth of green chemistry and providing technical services and product reviews.
Outcomes	The Northwest Green Chemistry Center hosted a 2-day toxicology workshop and a green chemistry round table. The Center supported the testing of an EPDM513 a non-zinc containing marine fender that would replace old tires that are currently used. The Center, in partnership with the WSU Stormwater Center, conducted toxicology and performance testing. The EDPM fender proved less toxic and more effective at buffering boats than tires. More recent Center projects include a biofriendly product framework for additive manufacturing (also known as 3D printing), and a green entrepreneur series.
Relevance	One of the most important steps to reducing toxics in the environment is prevention. Redesigning products and processes to prevent harmful chemicals from being relied upon is the best way to keep them out of our environment. Transitioning to green chemistry is an important step in reducing toxics in the environment.
Unknowns	There is growth potential for green chemistry. While green chemistry is slowly gaining ground, but there remains a large infrastructure invested in traditional chemistry. Moving toward green chemistry will require sustained effort and investment.

Copper Boat Paint Alternatives Assessment

Chemicals	Copper
Target	Copper antifouling paint for recreational vessels under 65’ in length

Project Type	Prevention
Timeframe	2014-2017
Project Lead	Originally Alex Stone, now Brian Penttila, Washington State Department of Ecology, and the Northwest Green Chemistry Center
Funding	$170,000 (Grant still open, total as of April 2017)
Data	Contact the project lead or the NGC for details
Website	https://www.northwestgreenchemistry.org/boatpaint
Description	In 2011 Washington became the first state in the U.S. to limit copper in boat paint. Chapter 70.300 RCW requires the phase-out of copper containing paint for recreational vessels under 65’ in length and identification of safer alternatives. Northwest Green Chemistry (NGC) was contracted to develop the alternative assessment, using the Washington guide.
Outcomes	NGC formed an Industry Roundtable consisting of representatives from the boat paint industry, boat paint users, environmental groups, and other interested parties to evaluate alternatives to copper in antifouling boat paint. NGC is collecting additional data on potential alternatives, including chemical hazard, performance, cost and availability, and exposure as defined in the Washington Guide. The contract requires the completion of at least 15 chemical hazard assessments. The assessments will also consider things that are not 1:1 replacements, such as alternative technologies including biomimicry and ultrasonic antifouling. There will not be a full evaluation of all products on the market, but a representative of each category will be reviewed (Stone 2016). Stakeholder involvement has been high, including active participation via three webinars in 2016 and 2017. The assessment is ongoing, with a final result anticipated in Fall of 2017.
Relevance	This hazard-based assessment should lead to a determination of the least toxic anti-fouling paints available.
Unknowns	If no safer alternative is identified and funding is available, NGC will establish an Innovations Roundtable to explore the possibility of developing safer alternatives to copper antifouling paint using the 12 principles of Green Chemistry.

ecoPRO Landscaper Certification: C1300094, G1500029

Chemicals	Pesticides, herbicides, fertilizers, PAHs, particulates
Target	Landscaping professionals
Location	Statewide Certification Program, initial course offerings in the Puget Sound region

Project Type	Prevention and Education
Timeframe	2013 & 2014 (Cascadia, development); 2014 - Present (WSNLA/WALP, management)
Project Lead	Breanne Chavez (ecoPRO); Gwen Vernon (Cascadia)
Funding	$445,106 (C1300094: $280,000; G1500029: $165,106)
Data	Contact ecoPRO Executive Director Breanne Chavez
Website	ecoPROcertified.org
Report	ecoPRO. 2017. “ecoPRO Certified Sustainable Landscape Professional.” Tacoma, WA: Washington State Nursery & Landscape Association.
Description	During Phase I (C1300094), Cascadia guided the program’s formation. They identified stakeholders, formed a steering committee, conducted gap analysis of existing programs, performed market research and created a marketing plan, developed the curriculum and certification test, created a performance measurement plan, delivered a pilot training and exam, and drafted an implementation plan. In Phase II (G1500029), The Washington State Nursery and Landscaping Association (WSNLA) and the Washington Association of Landscape Professionals (WALP) implemented and administered the program following the Phase I plans. They also developed and piloted a tracking system to assess progress.
Outcomes	There are now 87 certified ecoPROs throughout the State, 10-15 of which were grandfathered in under the now defunct Oregon Tilth program. The three-year certification costs $150 and requires 24 continuing education credits. The first recertification (2016) had a 100% rate. A three-day training, along with a one-day exam, costs $350, and a $50 study guide is required. Partners co-host trainings, and ecoPRO delivers the materials. Partners include government agencies, whose permits have training requirements which ecoPRO satisfies. Partners supplement the training costs, to reduce barriers to participation. Local speakers are being incorporated into the trainings. The program aims to have 100 certified ecoPROs by the end of 2016, with continued increase thereafter.
Relevance	The market demand for sustainable landscaping is increasing, and Washington had no comprehensive program to support this demand. Oregon Tilth, which formerly offered a sustainable landscaping certification, ceased its program, making ecoPRO the only regional certification for sustainable landscaping.
Unknowns	As the program moves into independency, ongoing funding sources are needed.

Puget Sound Creosote Removal Project: G1200469

Chemicals	PAHs
Target	Creosote Pilings
Location	Northeastern Puget Sound

Project Type	Implementation (Associated Effectiveness Monitoring discussed on following page)
Timeframe	2012-2014
Project Lead	Washington State Department of Natural Resources
Funding	$972,490.47 total ($700,000 NEP, including $100,000 for effectiveness monitoring)
Website	http://www.dnr.wa.gov/programs-and-services/aquatics/restoration/creosote-removal
Publication/s	WDNR. 2014. "FY 2012 NEP Toxics and Nutrients Preventing PAH Pollution Grant Jefferson County Derelict Creosote-Treated Piling Removal Project Final Report Grant No. G1200469." Olympia, WA: Washington State Department of Natural Resources.
Description	DNR is removing creosote structures. With NEP funding DNR anticipated removing 418 pilings, 432 tons of creosote-treated materials would be removed. Estimated cost for piling removal is $350-500 per piling removal. Disposal of piling material is from $120 to $150 per ton. DNR provides public notice for such projects by posting signs and through a project website.
Outcomes	A total of 894 piling under State (DNR, DFW, DOT) and private ownership were removed from seven locations in Hood Canal. Some trestle pilings were cut off, with the remnants left in place. Massing resources and removing pilings on a regional approach allowed efficiencies and cost-savings, reduced PAH sources across the area, and will allow future removal efforts to focus on other segments of Puget Sound.
Relevance	The PAH CAP identified creosote pilings as a large source of PAHs to the marine environment. This project cleared many pilings from the Hood Canal region. Along with reducing PAHs, the removals improved habitat conditions for key species including eel grass, herring, and salmon, decreasing PAH sources and by removing structures that block light and impede sediment transport.
Unknowns	Ecosystem health and recovery post-removal remains to be seen. Associated effectiveness monitoring, showed about 17 times higher PAH exposure to herring embryos immediately and 1-year after removal, causing removal methods to be re-evaluated. With an estimated 100,000 pilings in Puget Sound, this removed under 0.9%, leaving much work to do.

Derelict Piling Removal, Chambers Regional Park, Chambers Bay: G1200438

Chemicals	PAHs
Target	Creosote Pilings
Location	Northeastern Puget Sound

Project Type	Implementation
Timeframe	2012-2013
Project Lead	Stefan Kamieniecki, Pierce County Planning and Public Works
Funding	$135,317
Publication/s	Pierce County. 2013. “Chambers Bay Piling Removal.” Pierce County, WA: Pierce County.
Description	Creosote-treated pilings have been identified as the second largest source of PAHs to Puget Sound. Up to 100,000 pilings remain in place in Puget Sound. Both WSDOT and WSDNR have undertaken initiatives to remove creosote pilings in areas they manage. While thousands have been removed, many more need to be removed and operating budgets allow for only so much removal work at a time. NEP funds were applied to assist Pierce County (as well as the WSDNR, see Puget Sound creosote removal) in removing pilings along the shoreline at Chambers Bay, a former gravel mine turned park and golf course.
Outcomes	225 pilings along the shoreline of Chambers Creek Regional Park were removed, half of which contained creosote. The pilings had been installed from 30 to 100 years ago. The average length of piling removed was 12 feet, with a 1.25-foot diameter, making 1,770 cubic feet. At an estimated 1.2 kg PAH per cubic foot, a total of 2,155 kg PAHs were removed.
Relevance	While this represented a small portion of the larger amount of creosote pilings in Puget Sound, the Chambers Regional Park is a popular recreation area with high public visibility. Formerly a gravel mine, removing the pilings further enhances the restoration of the area and increases the public benefit of the site.
Unknowns	Though toxic, pilings do allow a site for attachment of aquatic biota. The removal of pilings disposes of or displaces these creatures. Due to the decades of quarry activity, a dense layer of cobbles characterizes the surface in the former dock area. Observations have not yet shown the return of eelgrass communities, this is the hoped for habitat restoration.

Expansion of Wood Stove Removal Program: G1200455

Chemicals	PAHs
Target	Older, inefficient models of wood-burning stoves
Location	The Tacoma-Pierce County Nonattainment Area

Project Type	Implementation
Timeframe	2012 – 2017
Project Lead	Amy Warren, Puget Sound Clean Air Agency
Funding	$562,387 (Grant still open, total as of April 2017)
Website	http://www.pscleanair.org
Description	A portion of Pierce County has been designated as a nonattainment area for fine particulate matter since 2009. Seasonal peaks in air pollution, coincide with the winter wood burning season. Wood stoves were identified as the main source of particulate matter. The Puget Sound Clean Air Agency (PSCAA) began replacing wood stoves in 2007. Wood smoke also contains polycyclic aromatic hydrocarbons (PAHs); thus, wood stove removal also reduces PAHs. The program offers a $350 reward to scrap an old stove if taken to a designated recycler, or $200 if a PSCAA contractor does the removal. Greater incentives are given for scrapping a wood stove and replacing it with an alternate heat source. Recent air quality monitoring found particulate matter met federal health standards, and the area was designated as being in attainment in spring 2015. This must continue over three years to reach full attainment. A 10-year maintenance plan is also in place.
Outcomes	Over 800 wood stoves were removed under this program, for an estimated reduction of 600 pounds of PAHs, and 18 tons of particulate matter annually. The majority of NEP funds supported the stove buy-back rewards program in which wood stoves were scrapped and replaced with a non-wood burning heating method. This obtaining 100% PAH reduction for those homes. As of October 1, 2015, all uncertified wood-burning devices in the Tacoma-Pierce County smoke reduction zone must be removed, recycled, or rendered inoperable. In Phase 3 of this effort, there were about 225 wood stove buy-backs, of the over 800 in all three phases of the grant, were conducted in King, Kitsap, and Snohomish Counties.
Relevance	PAHs are a common pollutant in Puget Sound, especially in developed areas, with documented health effects to biota. Both PAHs and particulate matter can significantly impair health. The *Assessment* identified wood smoke as Puget Sound's largest source of PAHs.
Unknowns	The PSCAA covers King, Kitsap, Pierce, and Snohomish Counties. Future efforts, depending on funding, will expand the program throughout the PSCAA's jurisdiction.

Wood Stove Retrofit Device Challenge: G1200205

Chemicals	PAHs
Target	Older, inefficient models of wood-burning stoves
Location	All

Project Type	Implementation/Technological Innovation
Timeframe	2014 – 2016
Project Lead	Phil Swartzendruber, Puget Sound Clean Air Agency
Funding	$250,000
Website	http://www.pscleanair.org/priorities/woodheating/woodstoveprogram/Pages/WSChallenge.aspx
Publication	Swartzendruber, Phil. 2016. "Wood Stove Retrofit Open Challenge and Testing Final Report." NEP Grant G1400205. PSCAA. http://www.ecy.wa.gov/puget_sound/docs/WoodstoveRetrofitTechnologyTestingFinalReport.pdf.
Description	Heating with wood is the largest source of PAH emissions to the air in the Puget Sound region. About 300,000 tons of wood are burned in the region, with over a third in uncertified stoves. Replacement of older stoves with cleaner models is the common prescriptive action, and has been supported by PSCAA's wood stove removal program since 2007. However, the cost of a new stove is prohibitive for many. A retrofit device could provide the same or better reduction at a much lower cost. However, there was no such known device on the market. In order to promote the availability of such technologies, the PSCAA ran an open challenge seeking retrofit pollution reducing devices in Sept – Nov 2014. A total of 33 submissions were received, and four were selected for an initial round of testing at OMNI labs, an EPA-certified laboratory in Portland, Oregon. Reductions of carbon monoxide and particulate matter ranged from 40-90% and 57–90%, respectively, and PAHs were reduced from 71-88% by three of the four retrofit devices. Three devices qualified for a second round of testing and met the challenge criteria that included cost, pollution reduction, and expected maintenance and longevity.
Outcomes	The three finalist devices, using different technologies, proved successful at reducing particulates and PAHs. At least one of the devices is being produced and is available for about $600.
Relevance	Emission reductions improve air quality and reduce ambient PAH levels and PAH deposition.
Unknowns	Testing procedures were similar to EPA certification testing, and thus did not examine real-world use. The testing did not reach the lowest burn rates that EPA requires for certification. Market availability for the remaining two finalist devices remains unclear. PSCAA has yet to offer a retrofit device as an option in its wood stove program, and continues to fund partial replacement of stoves or alternative heat sources instead.

Preventing Automobile Leaks through Education and Outreach (Don't Drip and Drive): G1300029

Chemicals	Any present in automobiles
Target	Auto-owners needing to maintain their cars
Location	Initially Seattle, now multiple jurisdictions north and south

Project Type	Implementation
Timeframe	2012 to present
Project Lead	Originally Idris Beauregard, presently Bill Malatinsky (Seattle Public Utilities), Justine Asohmbom (Washington State Department of Ecology), and others
Funding	$209,735
Websites	Don't Drip and Drive: http://www.fixcarleaks.org Seattle Public Utilities: http://www.seattle.gov/util/EnvironmentConservation/OurWatersheds/ProtectOurWaters/PreventPollution/AutoLeaks/index.htm
Description	Recent NPDES Stormwater permits have required larger jurisdictions to conduct outreach and education programs that target behavioral change that will result in reducing common pollution sources. In response, Seattle Public Utilities (SPU) began the Automotive Maintenance Program (AMP) to reduce auto leaks. NEP funds were used to enhance and expand this program. The program provides workshops that include free inspections, training, and leak detection kits. This Program with additional support from GROSS grants have implemented a larger, regional campaign under the banner "Don't Drip and Drive. Fix that Leak!".
Outcomes	A number of promotional and educational materials have been created. Workshops have been given throughout the region, and more are being scheduled. During the initial phase of the program NEP helped fund 95 workshops that reached 1,120 attendees. Participant feedback indicated that rebates would improve the rate and timeliness of repairs, shorter, smaller workshops were more desirable, and choosing repair shops posed a barrier to fixing leaks. In response, future efforts included partnerships with local certified repair shops offering free inspections and discounts. Several phases of marketing and evaluation have occurred for the Don't Drip and Drive Program; a regional steering committee meets routinely to guide the program.
Relevance	Automotive leaks from poorly maintained vehicles are a cumulative source of pollution to Puget Sound. The *Assessment* estimated that 6,100 metric tons of motor oil leaks from cars annually in the Puget Sound basin. Educating residents to correct leaks will help to reduce this source.
Unknowns	The long-term effects of education on behavior change are unknown. Another unknown are the number of leaks detected without the program's aid, as some participating shops conduct leak inspections automatically, even without the program to encourage it.

Puget Sound Clean Cars Partnership

Chemicals	Those found in vehicle leaks
Target	Automotive design

Project Type	Management
Timeframe	2016-2018
Project Lead	Ken Zarker, Washington State Department of Ecology
Funding	$150,000 (Grant still open, total as of April 2017)
Data	Contact project lead for information on data obtained
Publication/s	Gradient and SAE. 2017. "Puget Sound Clean Cars Partnership Newsletter, Issue 1." Puget Sound Clean Cars Partnership.
Description	The primary objective of the Puget Sound Clean Cars Partnership is reducing stormwater impacts associated with automotive vehicle fluid leaks. A collaboration between Gradient Toxicological Services (a GreenScreen certified company), the Society of Automotive Engineers, Ecology, the Puget Sound Partnership aims to form a stakeholder group consisting of experts from the government, academia, non-governmental organizations, and industry. They will research and identify the following: • The environmental and human health impacts of automobile fluid leaks. • Vehicle leak data (sources, frequency, and volume of leaks, etc.) to identify potential management options. • Current automotive design and maintenance efforts. • Vehicle design efforts related to preventing vehicle leaks. • Innovative technologies and onboard diagnostics. • Policy options and incentives to accelerate efforts to reduce vehicle leaks using automotive technologies. • Drivers and barriers to preventing vehicle leaks using automotive technologies. • Safer chemical alternatives.
Outcomes	Though still in its initial phases, the stakeholder group is being formed and the first of newsletter has been published. A policy report has been produced with recommendations as well as information on products containing chemicals of concern, so that work can begin to replace/redesign these products, is expected in June of 2018.
Relevance	This type of partnership could model how to align a major manufacturing and design sector with environmental protection.
Unknowns	Final products and impacts are unknown.

Bothell, Kirkland, Snohomish County, Port Angeles, Puyallup: The Local Source Control Partnership

Chemicals	All
Target	Small Businesses

Project Type	Management
Timeframe	2012-June 2019
Project Lead	Peggy Morgan, Washington State Department of Ecology
Funding	$3,048,108 (Grants still open, total as of April 2017)
Data	Contact project lead for information
Publication/s	Ecology. 2016. "Local Source Control Partnership 2013-15 Biennium Report." Washington State Department of Ecology. https://fortress.wa.gov/ecy/publications/documents/1604006.pdf.
Description	In 2007 Ecology began funding interagency agreements (IAAs) with local jurisdictions to staff local source control specialists (LSCs) to reduce pollution and waste by supporting best management and waste reduction in small-businesses. Specialists conduct voluntary inspections, resolve issues cooperatively, and may refer for enforcement if needed. Initially in Puget Sound and Spokane and now, Clark County, NEP funds provided about 30% of the 2013-2015 budget and continued/expanded the Local Source Control Partnership (LSC) in/to five Puget Sound jurisdictions. IAAs stipulate that 70-75% of funded staff time support visits, 15-20% are allowed for unique elements, and 10% for required trainings. Visit records are used to track program metrics, which Ecology reports biennially.
Outcomes	Since inception, the program as a whole has made 19,235 site visits and found 27,763 problems, 90% of which were successfully resolved. Frequently encountered issues corrected include improper labelling and handling and no secondary containment.
Relevance	This program reaches businesses in a cooperative and supportive manner, and provides supporting to smaller businesses that may not have the resources to address issues. This program also provide a direct outreach network.
Unknowns	Effectiveness monitoring is being conducted, a current project attempting to assess effectiveness is underway in Clark County.

Sectors Go Green

Chemicals	All
Target	Small Businesses
Location	Jurisdictions within the Local Source Control Partnership

Project Type	Implementation
Timeframe	2014-2016
Project Lead	Ken Zarker, Washington State Department of Ecology
Funding	$75,397
Description	Sectors Go Green was created to support the the Local Source Control Partnership by providing informational resources, additional spill kits, and funds to promote best management practices.
Outcomes	Vouchers to support businesses that installed secondary containment were offered, though few were used. (Of $80,000 budgeted, only $6,400 was spent.) A total of 1,200 spill kits were purchased for distribution to businesses that create a spill response plan. Educational videos were made to assist businesses with proper procedures such as labelling, container management, and waste designation.
Relevance	The LSC offers voluntary inspections to support best management at local small quantity generators. Having additional tools, such as the spill kits, allows them to be of greater service to their communities.
Unknowns	Reasons for low response rate to the secondary containment vouchers are unknown. The amount of paperwork attached due to the federal funding source may have been a barrier.

South Lander Storm Drain Cleaning: C1300084

Chemicals	All
Target	Storm line Sediments
Location	Seattle

Project Type	Implementation
Timeframe	2014
Project Lead	Beth Schmoyer, P.E., Seattle Public Utilities (SPU)
Funding	$550,000 NEP (total cost $892,375)
Publication/s	Schmoyer, Beth. 2016. "G1300084 NEP Grant: S Lander St Storm Drain Cleaning Project, Final Report." Seattle, WA: Seattle Public Utilities (SPU).
Description	Traditionally SPU has performed line cleaning only as needed to maintain function, not as a systematic maintenance strategy. Stormline cleaning has been identified as a primary source control activity for PAHs and metals for the Lower Duwamish and East Waterway Superfund cleanup sites. The South Lander Street line drains the largest upland areas to these sites. Some portions of the line were constructed at the turn of the century and had never been cleaned. Using available resources, SPU would have perform the cleaning over a period of years. With the addition of NEP funds, SPU was able to pool enough money to perform the cleaning in one season, providing a significant overall cost-savings and greater environmental protection.
Outcomes	Because of the cost-savings and efficiencies of conducting all work within one season, the SPU's contractor was able to clean more line than planned. The contractor cleaned a total of 50,450 linear feet of stormline and 348 catch basins, disposing a total of 300 tons of debris in the landfill. Nine samples collected at three-week intervals during the cleaning, provided an average contaminant reduction of: 426 lbs of metals (240 lbs Zn, 96 lbs Cu, 85 lbs Pb, 5.3 As, 0.12 Hg), 3 lbs PAH, 2.7 lbs phthalates, and 0.1 lbs PCBs, or a total of 432 lbs.
Relevance	NEP funds supported a much quicker rate of implementation, reducing total costs, and furthering long-awaited cleanup action.
Unknowns	Recontamination rates. Actual reduction to waterways.

Review of Selected PCB Source Tracing Programs: G1500047

Chemicals	PCBs
Target	Source tracing
Location	Seattle, Tacoma, Spokane, San Francisco, and Delaware

Project Type	An overview of PCB source tracing programs
Timeframe	May 2015 - July 2016
Project Lead	Jenée Colton, King County Department of Natural Resources
Funding	$137,637
Publication	Colton, Jenée, Richard Jack, Carly Greyell, and Chris Magan. 2016. "A Review of Select PCB Source Tracing Programs." Seattle, WA: King County. http://www.ecy.wa.gov/puget_sound/docs/PCBSourceTracingProgramsReport.pdf.
Description	Several established regional PCB source tracing programs were reviewed, including the City of Tacoma, Seattle Public Utilities, and the Spokane River basin, as well as San Francisco and Delaware.
Outcomes	A final report detailing each source control program, as well as lessons learned and challenges related to tracing PCBs, was produced. The report accumulates decades of knowledge and experience in one place, providing a comprehensive reference guide for anyone conducting PCB monitoring.
Relevance	PCBs are known to be highly toxic, having been banned from production in 1979 over concerns of toxicity. Despite being banned for over three decades, their persistence, along with the large volume produced and their widespread use, has made them a ubiquitous presence in our environment including Puget Sound. Increasingly stringent stormwater standards may result in more local utilities conducting source tracing investigations in order to maintain compliance with their discharge permits. This document will aid others attempting to conduct PCB source tracing. While conducting source tracing is expensive and time consuming, it is possible.
Unknowns	Source tracing has successfully led to the identification of ongoing sources, such as specific construction materials, or contaminated sites. The amount and relative significance of inadvertently produced PCBs is unknown. This may be important, once easy to control sources have been addressed. Some sources identified in the source-tracing programs described have yet to be remediated.

Stormwater Information Repository Planning: C1200133

Chemicals	All
Target	Stormwater
Location	Western Washington

Project Type	Planning Support for Stormwater Management Tools
Timeframe	2012
Project Lead	Joel Baker, University of Washington, Tacoma, Center for Urban Waters
Funding	$27,000
Publication	Monsey, Valerie et al. 2012. "Source Identification and Diagnostic Monitoring Information Repository, Section S8E of the 2013-2018 Phase I and Western Washington Phase II Municipal Stormwater Permits: Preparing for the Creation of a Web-Based Municipal Stormwater Information Resource." Agreement C1200133/UW #GCX178857. Tacoma, WA: Washington Stormwater Center.
Description	With Phase 1 and 2 stormwater permits, Source Identification and Diagnostic Monitoring and Reporting (SIDIR) is now required. In September 2011 a subgroup of the Stormwater Work Group (SWG) formed to help guide the SIDIR. This document supported their efforts. Outputs included a literature review, interviews with stormwater managers, and a white paper sharing what was learned and next steps. Authors proposed a vision of the SIDIR as an exchange by which stormwater programs from around the region could share their experiences, promote uniformity, and improve the effectiveness of source control work.
Outcomes	Two repositories were suggested, one for methods and resources, and a second for results and findings of current programs with an analysis of what is most often detected. Each repository should support the other, in a feedback loop. Three entities that SIDIR would serve were identified: regulators, developed programs, and new programs. A literature search was conducted but scaled back to allow greater focus on direct interviews. Thirty-seven jurisdictions were contacted for interviews, with 18 staff from 12 jurisdictions being interviewed about current resources and how the repository might support their work. Additionally, the SIDIR subgroup requested information about common issues and program strengths. The interviews found a need to share information about existing resources. The report listed known resources. At the time Snohomish County had the only field staff training for Illicit Discharge Detection and Elimination (IDDE).
Relevance	As regional focus on stormwater management occurs, and due to stormwater permit requirements, formation of the SWG, and the Regional Stormwater Monitoring Program (RSMP), tools to help guide and foster communication are desired.
Unknowns	The present timeline, and plans for the SIDIR formation.

Western Washington NPDES Phase 1 Stormwater Permit: Final S8.D Data Characterization, 2009-2013

Chemicals	Conventionals, Metals, Nutrients, Organics, Pesticides
Target	Stormwater and stormwater sediments
Location	The Cities of Seattle and Tacoma; Clark, King, Pierce, and Snohomish Counties; and the Ports of Seattle and Tacoma

Project Type	Data Review
Timeframe	Sampling: 2007-2013; QAPP: 2012; Final Report published February 2015
Project Lead	Brandi Lubliner and Will Hobbs, Washington State Department of Ecology
Funding	$60,475 from NEP and $19,200 from Ecology for QAPP; Final report Ecology funded
Data	EIM Study IDs: WAR044001_S8D; WAR044002_S8D; WAR044003_S8D; WAR044200_S8D; WAR044501_S8D; WAR044502_S8D; WAR044503_S8D; WAR044701_S8D
Publications	Lubliner, B. 2012. "Quality Assurance Project Plan Phase I Municipal Stormwater Permit Data Review." Pub No. 12-03-125. Olympia, WA: Washington State Department of Ecology. https://fortress.wa.gov/ecy/publications/SummaryPages/1203125.html. Hobbs, W., B. Lubliner, N. Kale, and E. Newell, 2015. "Western Washington NPDES Phase I Stormwater Permit Final S8.D Data Characterization 2009-2013." Publication No. 15-03-001. Olympia, WA: Washington State Department of Ecology. https://fortress.wa.gov/ecy/publications/SummaryPages/1503001.html.
Description	This project (1) compiled and summarized the data collected by 2007-2013 NPDES Phase I Municipal Stormwater permittees and (2) provided a statistically robust baseline characterization of stormwater quality. The dataset contains 44,800 data records from 597 storm events, with up to 85 parameters analyzed per water sample and 67 in suspended stormwater sediments.
Outcomes	Concentrations and loadings were higher in dry seasons for metals and nutrients. Loads were higher for metals, diesel hydrocarbons, and nutrients during the dry season, and highest from commercial and industrial areas. PAHs, phthalates, and pesticides showed no seasonal variation. Commercial and industrial lands exported the highest loads, except dissolved nutrients, which were higher from residential areas. Copper, zinc, and lead exceeded water quality criteria more often than not. Mercury exceeded criterion in 17% of samples and polychlorinated biphenyls in 41%.
Relevance	This is the most complete analysis of regional stormwater condition to date, providing a baseline for comparing the effectiveness of future management, as well as the information to support prioritization efforts.
Unknowns	While the data provide a regional baseline, control options and their effects are uncertain. Ongoing monitoring under Stormwater Action Monitoring (SAM) will continue to provide data to inform future management efforts.

Flame Retardants in General Consumer and Children's Goods

Chemicals	Polybrominated Diphenyl Ethers
Target	Consumer products
Location	Purchased in retail stores in South Puget Sound and online

Project Type	Effectiveness Monitoring
Timeframe	2012-2013
Project Lead	Saskia van Bergen, Washington State Department of Ecology
Funding	$255,144
Data	Ecology's Product Testing Database, Under Study 14-04-021: https://fortress.wa.gov/ecy/ptdbpublicreporting/Reports/ReportViewer.aspx?ReportName=RawDataReport
Final Report	Bergen, Saskia van, and Alex Stone. 2014. "Flame Retardants in General Consumer and Children's Products." Pub No. 14-04-021. Olympia, WA: Washington State Department of Ecology. https://fortress.wa.gov/ecy/publications/SummaryPages/1404021.html.
Description	Washington restricted PBDEs in 2008, and manufacturers of Deca-BDE agreed to stop producing, importing, and selling Deca-BDE in the U.S. by the end of 2012. Washington passed the Children's Safe Product Act (CSPA) requiring that manufacturers report concentrations of chemicals in children's products. To confirm that the laws were being observed, Ecology tested 163 product components from 125 products for flame retardant chemicals, including cushions, mattresses, children's' furniture, electronics, clothing, and baby carriers. A subset of samples were tested for TBBPA and HBCD as well as a newer mixture called Antiblaze V6.
Outcomes	94% of the samples were non-detect at 100 ppm for PBDEs, and only 3 had detects >1,000 ppm. For alternative flame retardants TBBPA, HBCD, and Antiblaze V6, detections were observed above CSPA reporting limits, with TCEP, a V6 contaminant. HBCD was also above reporting levels in one product. A number of samples had chemicals of high concern to children (CHCC) under the CSPA, which Ecology compared to those reported by manufacturers to confirm compliance with the law.
Relevance	Testing confirmed compliance with the ban, demonstrating that regulation can control chemical hazards, but substitutions presenting greater toxicity may occur.
Unknowns	A number of plastics had XRF bromine detects, but no lab detections, indicating that unknown halogenated flame retardants may be in use. The XRF is only a screening tool.

Development of a Fish Consumption Rate: C120088

Chemicals	All
Target	Local Seafood Consumption Patterns and Health Impacts
Location	Statewide

Project Type	Management
Timeframe	2011 -2012
Project Lead	Frances Wilshusen, Northwest Indian Fisheries Commission
Funding	$100,000
Publication	NWIFC. 2012. "Fish Consumption Rates, Tribal Outreach, Stakeholder Exchange, and Coordination, Final Report to the Washington State Department of Ecology, Contract No. C1200088." Northwest Indian Fisheries Commission. Ecology. 2013. "Fish Consumption Rates, Technical Support Document: A Review of Data and Information about Fish Consumption in Washington, Version 2.0 FINAL." Publication No. 12-09-058. Olympia, WA: Washington State Department of Ecology. https://fortress.wa.gov/ecy/publications/summarypages/1209058.html.
Description	Washington's water quality criteria had long been set in accordance with the National Toxics Rule (NTR). The NTR applies a fish consumption rate of only 6.5 grams per day (gpd). Tribal communities, and others in the region, frequently consume much higher rates of seafood. Recent studies provided local data from several tribal communities and Asian Pacific Islanders verified higher consumption rates. As part of an effort to promulgate Human Health Criteria in Washington State's water quality standards, rather than relying on the NTR, Washington's consumption rate was reconsidered. Because of the tribal involvement, outreach with the tribal communities was desired. This grant funded a series of workshops and meetings between tribal leaders and Ecology. Ecology released a technical support document outlining proposed changes to the consumption rate, suggesting a range of 157 - 267 grams/day. Tribal leaders desired a level of 500 gpd, citing evidence that present consumption is suppressed by lack of suitable fisheries.
Outcomes	A number of meetings were held, with a final report describing the tribal position delivered to Ecology. A consumption rate of 175 gpd was selected.
Relevance	A higher consumption rate that more accurately reflects local consumption is important to protect public health. While consumption rate is only one factor in the formulation of water quality standards for the protection of human health, a higher rate would lead to more stringent standards.
Unknowns	Tribal communities feel that the 175 gpd is a compromise, and they continue to desire higher consumption levels with more stringent water quality standards and a higher degree of environmental protection overall.

Support of Human Health Criteria for Washington State Waters

Chemicals	Priority pollutants (pursuant to CWA 307(a)(1) toxic pollutants)
Target	Water quality criteria for human health and implementation tools (broadly applicable to all criteria, not just human health criteria)
Location	Statewide

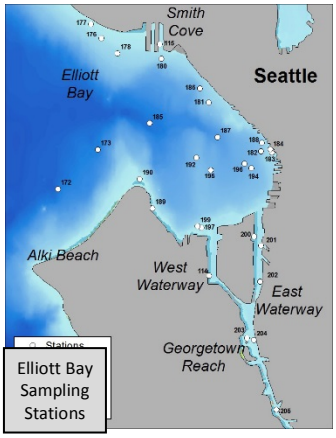
Project Type	Management
Timeframe	2011-2016
Project Lead	Cheryl Niemi, Washington State Department of Ecology
Funding	$58,197 NEP, plus additional state funds
Process	http://www.ecy.wa.gov/programs/wq/ruledev/wac173201A/1203inv.html
Final Rule	http://apps.leg.wa.gov/WAC/default.aspx?cite=173-201A
EPA Decision	https://www.epa.gov/wqs-tech/water-quality-standards-regulations-washington#fed
Publications	http://www.ecy.wa.gov/programs/wq/ruledev/wac173201A/1203docs.html
WAC	Wash. Admin. Code § 173-201A
Description	NEP funds helped support the development of new water quality standards for Washington that included human health criteria and revised and new implementation tools. After a lengthy public process, Ecology adopted rule revisions including new human health criteria for toxic pollutants and revised as well as new implementation tools.
Outcomes	The implementation elements adopted by Ecology were partially approved by the EPA, however, approval of the compliance schedule language for aquatic life criteria was not acted on because Endangered Species Act review and/or consultation must occur prior to EPA final action. EPA approved approximately one-fourth of the new human health criteria adopted by the state, and disapproved approximately three-fourths. In a simultaneous federal action, EPA promulgated criteria for the pollutant criteria that it disapproved. Implementation of the new standards began at the time of EPA approval of the state criteria and after publication of the final EPA regulation.
Relevance	Water quality criteria affect the management and permitting of discharges to state waters and serve to protect human health. Implementation tools assist with implementation of the broad suite of numeric and narrative water quality standards that comprise WAC 173-201A.
Unknowns	Ecology is in the process of developing/revising implementation guidance as needed to address the new rule, in particular the new implementation tools. Ecology's *Policy 1-11, Chapter 1: Assessment of Water Quality for the Clean Water Act Sections 303(d) and 305(b) Integrated Report* guides the use of the criteria in the Water Quality Assessment. The next water quality assessment will apply the revised policy 1-11 to the new criteria.

Toxics Overview Report

Chemicals	All
Target	Status review
Location	Sound-wide

Project Type	Review
Timeframe	2016 - 2017
Project Lead	Tanya Roberts, Washington State Department of Ecology
Funding	$140,000 (Total Budgeted)
Publication	Roberts, Tanya. Toxics Projects in Puget Sound, 2011-2018, Funded by the NEP Toxics and Nutrients Prevention, Reduction, and Control Cooperative Agreement. Washington State Department of Ecology, Olympia, WA. Publication No. 17-03-003**.** https://fortress.wa.gov/ecy/publications/SummaryPages/1703003.html
Description	Ecology conducted a series of studies aimed at understanding toxics loading in the Puget Sound. The results of these studies were presented in: *Control of Toxic Chemicals in Puget Sound: Assessment of Selected Toxic Chemicals in the Puget Sound Basin, 2007-2011* (*Assessment*). The EPA awarded the Department of Ecology Cooperative Agreement PC-00J20101 in February 2011, establishing Ecology as the Lead Organization (LO) for Toxics / Nutrients Prevention, Reduction, and Control. Ecology administered these funds to complete a series of projects. Because of the number, scope, and varying timelines of these projects a synthesis review documenting the efforts, for both nutrients and toxics, was needed.
Outcomes	One synthesis will be completed for toxics (this report) and one for nutrients (in 2018).
Relevance	Work under the next NEP funding cycle has already begun. This document represents the result of the toxics synthesis efforts.
Unknowns	Funding decisions for toxics-related work now falls under the Stormwater Strategic Implementation Action Team (SIAT). Under this new framework, the focus for toxics reduction efforts may change. While information from the synthesis report may prove useful, it is unknown how the SIAT will choose to prioritize future toxics projects.

Pharmaceuticals, Personal Care Products, and Perfluoroalkyl Substances in Elliott Bay Sediments



Chemicals	PPCPs and PFAS
Media	Sediments
Location	Elliott Bay

Project Type	Research into the presence of emerging contaminants
Timeframe	Sampling: June 2013; Report: December 2014
Project Lead	Maggie Dutch, Washington State Department of Ecology
Funding	$102,000
Data	EIM Study ID: UWI2013
Work Plan	Dutch, Margaret. 2013. "Project Work Plan Memo: Project Work Plan, Measurement of Personal Care Products and Pharmaceuticals and Perfluoroalkyl Substances in Elliott Bay Sediments." Washington State Department of Ecology.
Report	Dutch et al. 2014. Pharmaceuticals, Personal Care Products, and Perfluoroalkyl Substances in Elliott Bay Sediments: 2013 Data Summary. Publication No. 14-03-049. Olympia, WA: Washington State Department of Ecology. https://fortress.wa.gov/ecy/publications/publications/1403049.pdf.
Description	Ecology conducts a sediment monitoring program in Puget Sound since 1989. However, data on Contaminants of Emerging Concern (CECs) had not been collected. NEP funded additional analysis of samples collected from 30 stations in Elliott Bay in 2013 for the same 119 pharmaceuticals and personal care products (PPCPs) and 13 perfluoroalkyl substances (PFASs) analyzed for in Bellingham Bay in 2010, establishing a second set of baseline values for these CECs in urban bays in Puget Sound.
Outcomes	Thirteen of the 119 PPCPs were detected. Most frequently occurring were triclocarban, an antibacterial agent; diphenhydramine, an antihistamine; and triamterene, a diuretic. Ten additional PPCPs, including antibiotics, calcium-channel blockers, an antidepressant, a stimulant, a bronchodilator, and an opiate, were detected less frequently. Three of the 13 PFASs, perfluorooctane-sulfonate (PFOS), perfluorodecanoate (PFDA), and perfluoroundecanoate (PFUnA), were detected.
Relevance	PPCPs and PFAS compounds have been reported in detectable concentrations in a number of media, including surface waters, wastewater treatment plant influent and effluent, groundwater, and biota collected from Puget Sound and Washington State rivers and lakes; however, they have not been funded as part of the PSEMP programs.

Contaminants of Emerging Concern in Puget Sound English Sole (*Parophrys vetulus*): Exposure to Selected Estrogenic Chemicals and Pharmaceuticals: G1400206

Chemicals	Contaminants of Emerging Concern (CECs), Estrogenic and Pharmaceutical compounds
Target	English Sole (*Parophrys vetulus*)
Location	Sound-wide

Project Type	An extension of PSEMP Monitoring
Timeframe	2013-2015
Project Lead	Sandra O'Neill, Washington Department of Fish and Wildlife (WDFW)
Funding	$237,720
Data	Contact project lead
QAPP	O'Neill et al. 2014. Quality Assurance Project Plan: Chemicals of Emerging Concern in Puget Sound English Sole (Parophrys Vetulus): Exposure to and Effects of Selected Xenoestrogens and Pharmaceuticals. WDFW-Ecology Interagency Agreement #G1400206. Prepared for Washington State Department of Ecology.
Report	O'Neill et al. 2015. Contaminants of Emerging Concern in Puget Sound English Sole (Parophrys Vetulus): Exposure to and Effects of Selected Estrogenic Chemicals and Pharmaceuticals. Olympia, WA: Washington Department of Fish and Wildlife.
Description	NOAA and the PNNL developed tools to measure estrogenic compounds (ECs) in bile, serotonin reuptake inhibitors (SSRIs), and vitellogenin (VTG) induction, and applied them to English sole collected by WDFW.
Outcomes	Liver composites were analyzed for three SSRIs; bile for eight ECs. No SSRIs were detected, an indication of less direct exposure to WWTP effluent, where SSRIs are thought to be highest. Of the eight ECs: three natural estrogens (17β-estradiol (E2), estrone (E1), and estriol (E3)), the synthetic hormone 17α-ethinylestradiol (EE2), and four xenoestrogenic compounds (bisphenol A, nonylphenol, and octylphenol as tert-OP and n-OP), five were detected, with the three natural estrogens being the highest, followed by BPA, then t-OP. Urban stations showed the highest levels of ECs, particularly the Seattle waterfront and Sinclair Inlet. Vitellogenin induction in males was seen at all ten stations, and highest in developed areas. Urban areas had the highest levels of ECs, but the individual fish within a station were highly variable, with several mitigating factors proposed, including the potential presence for opposing hormones. Reproductive cycles in female fish from Elliot Bay were disrupted.
Relevance	This project provided data and new tools for analysis, lessening the data gap for CECs.
Unknowns	Fish with fuller stomachs had lower estrogen levels; sample handling may have impacted the EC levels found, as some were held live for up to 6 hours during sampling. Natural, baseline VTG expression in males is unknown. The concentration of ECs needed to induce a VTG response remains unknown.

Biomonitoring for Emerging Contaminants: G1300089

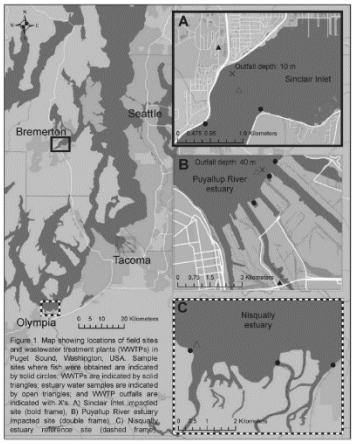


Figure 1. Map showing locations of field sites and wastewater treatment plants (WWTPs) in Puget Sound, Washington, USA. Sample sites where fish were obtained are indicated by solid circles, WWTPs are indicated by solid triangles, estuary water samples are indicated by open triangles, and WWTP outfalls are indicated with X's. A) Sinclair Inlet, impacted site (bold frame). B) Puyallup River estuary, impacted site (double frame). C) Nisqually estuary, reference site (dashed frame).

Chemicals	CECs
Target	Sculpin, Chinook, WWTP effluent, estuary waters
Location	Commencement Bay and Sinclair Inlet

Project Type	Monitoring
Timeframe	Sampling 2014, Final report 2016
Project Leads	Evan Gallagher, UW; and James P. Meador, NOAA
Funding	$499,998
Data	Supplement to the journal article
QAPP	Yeh, Andrew, Evan P. Gallagher, and James P. Meador. 2013. Quality Assurance Project Plan - Final Integrated Biomonitoring for Emerging Contaminants, Grant Number: G1300089." Olympia, WA: Prepared for the Washington State Department of Ecology.
Publication/s	Meador, James P., Andrew Yeh, Graham Young, and Evan P. Gallagher. 2016. "Contaminants of Emerging Concern in a Large Temperate Estuary." *Environmental Pollution* 213 (June): 254–67. doi:10.1016/j.envpol.2016.01.088.
Description	Effluent from both the Tacoma (Commencement Bay) and the Bremerton (Sinclair Inlet) wastewater treatment plants (WWTPs), water, and whole-body juvenile Chinook salmon (*Oncorhynchus tshawytscha*) and Pacific staghorn sculpin (*Leptocottus armatus*) were sampled for 150 contaminants of emerging concern (CECs). The CECs analyzed included pharmaceuticals, personal care products, and industrial compounds. 81 were detected in effluent, 25 in estuary water, and 42 in fish tissue. Migratory Chinook carried higher levels of contaminants than the resident sculpin. The authors found 29 CECs in effluent and tissue, but not in estuarine waters, indicating bioaccumulation and suggesting that water concentrations alone may not be adequate to assess CECs. The authors estimated several kg of CECs per day enter Puget Sound through each treatment plant.
Outcomes	This research shows that the present level of control for CECs may not be adequate to protect Puget Sound marine biota.
Relevance	This research provides data on CECs, a relatively unstudied compound group, in the estuarine environment and fish. This project also garnered a good deal of media attention (Altmetric score of 159), receiving coverage in the Seattle PI and inspiring a skit on TV's The Late Show featuring a stoned and deranged Puget Sound salmon.

Toxic Contaminants in Juvenile Chinook Salmon (*Oncorhynchus tshawytscha*) Migrating through Estuary, Nearshore, and Offshore Habitats of Puget Sound: C1300083 (WDFW) & C1300124 (NOAA)

Chemicals	POPs, PAHs, Copper, Lead, Nickel, Zinc, Cadmium
Target	Juvenile Chinook (*Oncorhynchus tshawytscha*)
Location	Estuarine and Marine

Project Type	Status and Trends Monitoring
Timeframe	Sample Collection: 2013; Final Report: 2015
Project Lead	James West, Washington Fish and Wildlife (WDFW)
Funding	$49,624 (WDFW sample collection); $87,376 (NOAA lab analysis)
Data	EIM Study ID: C1300083
QAPP	O'Neill et al. 2013. "Quality Assurance Project Plan Toxic Contaminants in Outmigrating Juvenile Chinook Salmon (*Oncorhynchus Tshawytscha*) from River Mouths and Nearshore Saltwater Habitats of Puget Sound." Pub No. 1609. Olympia, WA: Washington Department of Fish and Wildlife. http://wdfw.wa.gov/publications/01609/wdfw01609.pdf.
Report	O'Neill et al. 2015. "Toxic Contaminants in Juvenile Chinook Salmon (*Oncorhynchus Tshawytscha*) Migrating through Estuary, Nearshore and Offshore Habitats of Puget Sound." FPT 16-02. Olympia, WA: Washington Department of Fish and Wildlife. http://wdfw.wa.gov/publications/01796/.
Description	WDFW collected and reported contaminant uptake of juvenile Chinook from five river systems (one location in the lower estuaries and two in adjacent marine areas in each system, n= 480), along with four marine basins (Admiralty Inlet, Whidbey, Central, and South, n = 103). NOAA analyzed whole body composites for persistent organic pollutants (POPs) including PCBs (46 congeners), PBDEs, and organochlorine pesticides, stomach content for 42 PAHs. The Department of Ecology analyzed gills for metals (Cu, Zn, Pb, Ni, Cd).
Outcomes/ Findings	POP concentrations were higher in Chinook salmon migrating through more developed urban river systems. Fish showed continued accumulation of POPs at elevated levels uniformly throughout all marine basins, demonstrating that urban-sourced contamination affects fish Sound-wide. Overall POP concentrations were urban rivers > offshore basins > non-developed rivers. Lead and copper were elevated in gills of fish from urban rivers, with Cd, Ni, and Zn more uniformly dispersed. PCBs and PBDEs at Snohomish, Green/Duwamish, and Hylebos/Puyallup river systems, and PCBs from Whidbey and Central Puget Sound basins, were above thresholds known to cause adverse effects including reduced growth, weakened immune capacity, and altered hormone and protein levels. PAH levels in the Snohomish and Green/Duwamish systems were high enough to alter growth as well as plasma chemistry and lipid class profiles. Over a third of the fish samples exceeded known adverse effects levels for some parameter.
Relevance	Results support trends data back to 1988 and show that POP dispersal is ubiquitous.
Unknowns	The overall chemical burden to salmon remains unquantified, especially at population scale. Additional contaminants also harm Chinook (see Biomonitoring for emerging contaminants).

Toxic Contaminants in Puget Sound's Nearshore Biota: A large-scale synoptic survey using transplanted mussels (*Mytilus trossulus*)*: 11-1916 (WDFW)

Chemicals	Organics: PCBs, PBDEs, Chlorinated pesticides including DDTs and PAHs Metals: Mercury, Arsenic, Cadmium, Copper, Lead, Zinc
Target	Nearshore environments
Location	Sound-wide Shoreline

Project Type	Status Monitoring
Timeframe	Sampling: 2011-2012; Report: 2014
Project Lead	Jennifer Lanksbury, Washington Department of Fish and Wildlife
Funding	$180,000 (with an additional $128,000 in match from WDFW)
Data	EIM Study ID WDFW 11-1916
QAPP	Lanksbury, Jennifer et al. 2012. "Quality Assurance Project Plan: Mussel Watch Pilot Expansion Project." DFW 01596. Olympia, WA: Department of Fish and Wildlife. http://wdfw.wa.gov/publications/01596.
Report	Lanksbury, Jennifer, Laurie Niewolny, Andrea Carey, and James West. 2014. "Toxic Contaminants in Puget Sound's Nearshore Biota: A Large-Scale Synoptic Survey Using Transplanted Mussels (Mytilus Trossulus)." DFW 01643. Olympia, WA: Department of Fish and Wildlife. http://wdfw.wa.gov/publications/01643.
Description	WDFW conducted the first large-scale, Puget Sound-wide assessment of toxic contaminants (POPs and metals) in nearshore biota in the winter of 2012/13. They transplanted cages of mussels to 108 sample sites for 60 days prior to sampling. This was a cross-cutting study, drawing together three NEP grants: (1) Toxics and Nutrients, (2) Marine and Nearshore Protection and Restoration, and (3) Watershed Protection and Restoration. This study focused on toxic contaminants generated primarily from terrestrial sources and conveyed to Puget Sound nearshore habitats via stormwater and other hydraulic watershed processes.
Outcomes	PAHs, PCBs, PBDEs, and DDTs were the most abundant organics detected. Concentrations correlated with development in adjacent upland watersheds. PAHs and PCBs were detected in mussels from every site, and highest concentrations were observed in four of Puget Sound's most urbanized embayments: Elliott Bay, Salmon Bay, Commencement Bay, and Sinclair Inlet. Although lower in overall concentration, PBDEs and DDTs followed a similar pattern. In addition, although PCBs were elevated mainly along urbanized shorelines, PAHs were elevated in mussels from some non-urban shorelines including sites near marinas and ferry terminals. Other organic contaminants were detected at fewer than 22% of sites and at very low levels.
Relevance	PAH, PCB, PBDE, and DDT detections in nearshore mussels were positively correlated with development in adjacent upland watersheds. Urban areas appeared to be the source of most contaminants. PAH and PCB patterns may be used to help infer sources.
Unknowns	Variability in contaminant concentrations increased with development (i.e. impervious surface or road area); surroundings areas should be investigated for potential control options.

Toxic Contaminants in Dungeness Crab (*Metacarcinus magister*) and Spot Prawn (*Pandalus platyceros*) from Puget Sound, Washington USA: C1200126

Chemicals	Organics: PCBs, PBDEs, DDTs, HCHs, Chlordanes, Hexachlorobenzene, PAHs Metals: Mercury, Arsenic, Cadmium, Copper, Lead, Zinc
Species	Dungeness crab (*Metacarcinus magister*) and spot prawn (*Pandalus platyceros*)
Location	Sound-wide

Project Type	Status Monitoring
Timeframe	Sampling: 2011-2012; Report: 2014
Project Lead	James West, WDFW
Funding	$185,538
Data	Appendix C of the report; EIM Study ID C1200226
QAPP	West, James et al. 2012. "Quality Assurance Project Plan: Toxic Contaminants in Dungeness Crab (Cancer Magister) and Spot Prawn (Pandalus Platyceros) from Puget Sound, Washington, USA." 1436. Olympia, WA: Washington Department of Fish and Wildlife. http://wdfw.wa.gov/publications/01436/wdfw01436.pdf.
Report	Carey, Andrea et al. 2014. "Toxic Contaminants in Dungeness Crab (*Metacarcinus Magister*) and Spot Prawn (*Pandalus Platyceros*) from Puget Sound, Washington, USA." Washington Department of Fish and Wildlife. http://wdfw.wa.gov/publications/01608/.
Description	WDFW conducted the first Sound-wide assessment of both Dungeness crab and spot prawns, analyzing muscle composites of 240 Dungeness crabs and 777 spot prawns, as well as a smaller subset of hepatopancreas (crab), and head tissue (prawn), for POPs and metals from nine Marine Catch Areas (a fisheries management unit) and three urbanized bays (Elliott, Sinclair, and Commencement) for crab and one (Sinclair) for prawns. Prawn head and crab hepatopancreas concentrations were compared to those of muscle tissue to determine if concentration predictions for those organs could be made from those of muscle tissue alone.
Outcomes	PCBs were the most frequently detected POPs in both species, followed by PAHs and PBDEs in both species, and DDTs in crab. Hg, As, Cu, and Zn were detected in all samples of both species; all spot prawn samples also had detections of Cd. Most compounds were higher in the hepatopancreas and head tissues than muscle, and POPs and Hg were higher in urban areas. Metals were distributed more equally across areas and species, except for Hg in crab which was elevated in urban areas. DOH issued select health advisories based on this data.
Relevance	This is the first Sound-wide data set on contaminants in these species. Furthermore, as both species are consumed by humans in high numbers, these species represent a significant human exposure pathway which was previously unaddressed; this study provided the data needed to make a human health risk assessment for these species.
Unknowns	While the contaminant concentrations were higher in the hepatopancreas and head tissue than muscle, with the exception of a few metals, the range of variability leaves a degree of uncertainty around the predicted values.

Puget Sound Creosote Removal Project, Effectiveness Monitoring: G1200469 (Task 3)

Chemicals	PAHs
Target	Developing embryos of Pacific herring (*Clupea pallasii*)
Location	Quilcene Bay, Hood Canal

Project Type	Implementation Effectiveness Monitoring
Timeframe	2013-2015
Project Lead	James West, Washington Department of Fish and Wildlife
Funding	$132,803
Data	Contact project manager
QAPP	West, James et al. 2013. "Quality Assurance Project Plan, Effectiveness Monitoring for a Creosote-Piling Removal Project: Embryos of Pacific Herring (*Clupea Pallasi*) as Sentinels for The Presence of Polycyclic Aromatic Hydrocarbons (PAHs)." WDFW-DNR Interagency Agreement #13-120. Olympia, WA: Washington Department of Fish and Wildlife.
Report	West, James et al. 2016. "Effectiveness Monitoring for a Creosote-Piling Removal Project: Embryos of Pacific Herring (*Clupea Pallasii*) as Sentinels for the Presence of Polycyclic Aromatic Hydrocarbons (PAHs)." Cooperative Agreement G1200469. Olympia, WA: Washington State Department of Fish and Wildlife.
Description	To assess the effectiveness of a creosote removal project, herring embryos spawned for 10 days within 2 meters of the pilings were tested before, 2 weeks after, and 1 year after removal for 42 PAH compounds associated with creosote. The piling material, embryos at several reference areas, and source eggs were also tested for comparison. Concentrations were compared to known effects levels.
Outcomes	Mortality increased with increasing PAH levels, even though observed concentrations were lower than reported elsewhere. Pilings had been broken or cut, above or below the sediments, and creosote-treated debris littered the site. Total PAHs in samples taken 2 weeks and 1 year after removal were roughly 17 times (48 and 51 ng/g wet weight) those taken before (2.1 – 3.2 ng/g wet weight). The number of compounds detected went from 15 in 2013 to 40 in following years. C_3 and C_4-Chrysene were never detected. Mortality patterns suggest toxicity at concentrations as low as 3-5 ng/g wet weight, compared to the LOEC threshold for crude oil derived PAH mixtures reported by Carls (1999) of 26 ng/g. Local reference embryos from 2013 contained 0.4 to 1.2 ng/g ww, including those both naturally spawned and deployed.
Relevance	The results of this investigation led DNR to require independent post-removal underwater surveys, to review program BMPs, and to attempt new methods.
Unknowns	While it is proposed that the age of the pilings (~100 yrs) was the cause of higher PAHs after removal, other removal sites had not been investigated. While this project resulted in revised protocols for piling removal, the efficacy of the revised protocol still needs to be determined.

Monitoring Metals in Marinas

Chemicals	Copper, Zinc, and Lead
Target	Metals from recreational boat moorage areas
Location	Five Puget Sound Marinas

Project Type	Baseline monitoring to assess copper boat paint legislation
Timeframe	QAPP publication August 2016, Sampling September 2016 – June 2017, Final Report
Project Lead	Will Hobbs, Washington State Department of Ecology
Funding	$181,200 (Project still open, total as of April 2017)
Data	EIM Study ID: WHOB004
Publication/s	Hobbs, William. 2016. "Quality Assurance Project Plan: Copper, Zinc, and Lead in Five Marinas within Puget Sound." Publication No. 16-03-120. https://fortress.wa.gov/ecy/publications/SummaryPages/1603120.html.
Description	This is a one-year monitoring project to provide baseline data on metals water quality and its impacts to marine biota within marinas. This study will establish baseline data for copper (Cu), zinc (Zn), and lead (Pb) in five marinas within Puget Sound. Both Cu and Zn are common components in marine antifouling paint, and Pb is associated with upland boatyard activities. All three metals are monitored in stormwater and wastewater under the *Boatyard General Permit*. Sample media will consist of water (dissolved and total recoverable concentrations), sediments (suspended and bottom), and transplanted mussel tissue. Sufficient samples will be taken within each marina to allow for future comparisons to this dataset.
Outcomes	Initial samplings show higher Cu and Zn (dissolved) in waters and suspended sediments inside marinas than outside, though only one exceeded the acute water quality criteria for dissolved copper. Complete results are anticipated in August 2017.
Relevance	In 2011 the Washington State Legislature passed a bill phasing out copper in marine antifouling paints. This legislation states that new recreational vessels with copper-containing bottom paint may not be sold in the state after January 1, 2018. This baseline will provide a comparison against which future monitoring can be compared to determine effectiveness of the regulation.
Unknowns	An alternatives assessment is currently being performed by Ecology (see Copper boat paint alternatives) to find the least toxic alternatives to copper anti-fouling paints. The actual product selection and consumer practices and the long-term impact of the products is unknown.

Roofing Materials Assessment

Chemicals	PAHs, Phthalates, Arsenic, Cadmium, Copper, Lead, Zinc
Target	Roofing Materials

Project Type	Source Investigation
Timeframe	2012 - 2014
Project Lead	Nancy Winters, Washington State Department of Ecology
Funding	$566,379 (total for both rounds of sampling)
Data	[Electronic] Appendix B to the Report
QAPP	Winters, Nancy. 2013. "Quality Assurance Project Plan: Roofing Materials Assessment: Investigation of Toxic Chemicals in Roof Runoff." Publication No. 13-03-105. Olympia, WA: Washington State Department of Ecology. https://fortress.wa.gov/ecy/publications/SummaryPages/1303105.html.
Publication/s	Winters, Nancy et al. 2014. "Roofing Materials Assessment: Investigation of Toxic Chemicals in Roof Runoff from Constructed Panels in 2013 and 2014." Publication No. 14-03-033. Olympia, WA: Washington State Department of Ecology. https://fortress.wa.gov/ecy/publications/documents/1403033.pdf.
Description	In 2013 and 2014 storm runoff from 18 4' X 8' roofing panels that represented 16 unique roofing types considered to be the most commonly used in the Puget Sound region, along with 2 glass control panels, were sampled for metals, PAHs, and phthalates over 20 storms along with leaching tests.
Outcomes	Higher metal concentrations were observed in the first winter (new panels), than in the second (1+ year old panels), with the exception of zinc in painted galvanized steel. Concentrations were 30% to three orders of magnitude lower than those from literature used in a previous estimate (Roberts et al. 2011), with the latter reporting higher concentrations of contaminants from roofing systems.
Relevance	Leach tests indicated coatings could reduce metals; however, their long-term efficacy and environmental safety are unknown. The concentrations of contaminants seen in the runoff from these panels alone, in comparison to those reported for whole roofing systems from other studies, indicate that the magnitude of release from the roofing materials themselves may be lower than of other roofing components.
Unknowns	The contribution of components other than the roofing it is unknown, as are the effects of transport time over large roofing surfaces, climate variation, and changes in material over time.

Non-Agricultural Pesticide Use in Puget Sound Counties: C1200278

Chemicals	Pesticides (including copper- and zinc-based, herbicides, insecticides, and fungicides)
Target	Non-agricultural users
Location	Sound-wide

Project Type	Market Assessment and Use Survey
Timeframe	2012 - 2014
Project Lead	Kelly McLain, Washington State Department of Agriculture (WSDA)
Funding	$73,985
Data	Appendix B contains a list of retail products, as well as a copy of a completed survey.
Publication/s	McLain, Kelly. 2014. "Non-Agricultural Pesticide Use in Puget Sound Counties." Publication No. AGR PUB 103-409. Olympia, WA: Washington State Department of Agriculture. http://agr.wa.gov/FP/Pubs/docs/103-409PSReportfinal2014.pdf.
Description	The 2011 Assessment (Norton et al. 2011) considered non-agricultural pesticide use a potentially large source of copper to the Puget Sound basin. WSDA was selected to review usage. A retail survey revealed limited copper-based pesticides; thus, the study broadened to include all non-agricultural pesticides. WSDA used both an anonymous survey (to residential users) and direct inquiry methods (to public and commercial users) to ascertain pesticide use practices in the Puget Sound region.
Outcomes	The residential survey, developed in partnership with National Agricultural Statistics Service, was sent to 15,500 Puget Sound region homes; 19% were completed and returned. Reports of copper-containing products specifically was limited to fungicides, for which copper was 6.5% of the total reported. Pyrethroids and neonicotinoids represented about 75% of products on market shelves and 85% of reported insecticides used. 51.5% had used pesticides in the previous year, with weed and moss control the most prevalent reasons, and lawns and turf the most prevalently treated. Survey return rate was higher and reported pesticide use rates were lower from the Thornton Creek neighborhood, indicating previous outreach may have increased stewardship behavior. Public operators, ports, noxious weed boards, golf courses, and commercial operators were interviewed, very little copper based pesticides.
Relevance	This project provided new understanding of non-agricultural pesticide use, emphasized that licensed operators use responsible, best practices, and demonstrated the effectiveness of community education campaigns in reducing pesticide use and fostering watershed stewardship. It also provided a methodology for assessing non-agricultural pesticide use beyond the Puget Sound region.
Unknowns	Total volume of pesticide use was not assessed.

Copper and Zinc Sources in a Commercial-Industrial Watershed

Chemicals	Copper and Zinc
Target	Primary Sources of Copper and Zinc in Commercial/Industrial Land Use Types
Location	Woodland Creek Watershed, Lacey, Washington

Project Type	Source Investigation
Timeframe	2016-2018
Project Lead	Andy Bookter, Washington State Department of Ecology
Funding	$430,000 (Project still open, amount funded as of April 2017)
Data	Pending
Publication/s	*QAPP* expected July 2017; Final report expected June 2018
Description	Both the *Assessment* and Phase I stormwater data showed higher levels of metals coming from industrial/commercial land use areas. In order to identify the sources of these metals, further investigation was needed. Ecology is designing a study to identify primary sources of copper and zinc from commercial/industrial areas. The lower Woodland Creek watershed in the City of Lacey and Thurston County has been selected as the study area. The land use in the study area is 36% commercial/industrial, 13% residential, and 33% undeveloped. Of the area currently developed, 66% is commercial/industrial land use. Literature on sources, local data on the built environment (including building footprints, roof types, and construction materials), population, traffic counts, water usage, and tap water concentration of copper are being reviewed. The initial findings will be supplemented with stormwater data collected from within the project area. A QA Project Plan detailing the sampling methods and goals is expected in July 2017. Sampling will take place in the fall and winter of 2017. A final report is anticipated in June 2018.
Outcomes	Better source identification is expected.
Relevance	Identifying and prioritizing sources of these metals will inform a management strategy.
Unknowns	Results, and the potential for management controls are unknown.

Screening for PAHs and Metals in the Puget Sound Basin at Aquatic Habitats Adjacent to Mainline Railroad Tracks

Chemicals	PAHs, Metals
Target	Creosote-treated ties
Media	Fresh and marine waters, sediments, and soils

Project Type	Contaminant screening investigation
Timeframe	QAPP: September 2016; Final Report: August 2017
Project Lead	Randy Coots, Washington State Department of Ecology
Funding	$196,800 (Project still open, total as of April 2017)
Data	EIM Study ID: RCOO0016
QAPP	Coots, Randy. 2016. "Quality Assurance Project Plan: Screening for PAHs and Metals in the Puget Sound Basin at Aquatic Habitats Adjacent to Mainline Railroad Tracks." Publication No. 16-03-119. https://fortress.wa.gov/ecy/publications/SummaryPages/1603119.html.
Description	Ecology is conducting a baseline study to establish PAH and metals levels in soil, sediment, and water adjacent to 10 mainline railroad track sites (8 were sampled for soils only; 2 freshwater sites included sediment and water). Samples will be analyzed for 16 priority pollutant PAHs as well as related alkyls, total petroleum hydrocarbons, and 13 priority pollutant metals (dissolved), as well as total organic carbon and grain size for sediments and soils, and dissolved organic carbon and hardness for water. Because Ecology was unable to obtain access to railroad right of ways, study site locations were limited to areas where rail lines transect publically owned properties. Samples were collected beyond right-of-way boundaries of rail lines. Results will establish baseline PAH and metals concentrations at 10 sites for the area between mainline railroad tracks and surface waters. Initial results show elevated metals.
Relevance	PAHs are a concern for the health of the aquatic environment. PAHs may become alkylated, and alkyl PAHs are more toxic than their parent compounds. The Washington State Chemical Action Plan for PAHs (Davies et al. 2012) indicated that railroad ties may be the largest source of PAHs to Washington's land and air (releasing an estimated 170 tons a year), raising concern about PAH migration into nearby waterbodies. A mapping project showed half the state's rail lines are within 300 feet of sensitive aquatic habitat. Sampling was recommended to determine if indeed elevated PAHs are present in such areas, as data on the levels of PAHs or metals along rail lines was lacking (Sandvik 2013). Establishing baseline concentrations of PAHs and their alkyls, along with metals, is important to track future changes in these contaminants from rail activities. Study results may also provide insight into PAH or metals migration from railroad lines to surface waters.
Unknowns	There is no comprehensive work to establish background levels of PAHs in soil in Washington State (Davies et al., 2012). Most of the work has been for investigation and cleanup of hazardous waste sites. Migration of PAHs from sources such as creosote-treated wood is also not well understood (ATSDR 2002; Davies et al. 2012).

Puget Sound Regional Toxics Model Update

Chemicals	PCBs, PBDEs, PAHs, Copper, Lead, and Zinc
Target	Toxics Model
Location	Sound-wide

Project Type	Modelling
Timeframe	Data collection 2009 – 2011, Final report 2015
Project Lead	Greg Pelletier and David Osterberg, Washington State Department of Ecology
Funding	$117,000
Publication	Osterberg, David, and Greg Pelletier. 2015. "Puget Sound Regional Toxics Model: Evaluation of PCBs, PBDEs, PAHs, Copper, Lead, and Zinc." Publication No. 15-03-025. Olympia, WA: Washington State Department of Ecology. https://fortress.wa.gov/ecy/publications/SummaryPages/1503025.html.
Description	Ecology initially developed a combined model of contaminant fate, transport, and bioaccumulation for Puget Sound in 2009. The model was developed based on a box model of water circulation and transport (Babson et al. 2006), a mass balance model of contaminant fate (Davis, 2004), and a food web bioaccumulation model (Arnot and Gobas, 2004; Condon, 2007). Originally applied to PCBs, additional data collected on loadings were used to refine the model and expand the list of toxics addressed.
Outcomes	The model suggested that loadings were much higher than estimated from Puget Sound loading studies (up to about 5 -10 times higher). The model underestimated concentrations in water and sediments compared to environmental data when loading study estimates were used as inputs. Running the model in hindcast suggested that loading estimates were too low to support environmental concentrations; however, the model gave good comparisons of the relative importance of source pathways and loss processes and was used to back-calculate loading. Ocean exchange represented about half the loss of contaminants. Burial was significant for lead, accounting for 80% of removal, copper and zinc, about half, and PCBs, about a third. Degradation was important for PBDEs and PAHs, but not PCBs, with a half-life of 56 yrs compared to 1 year for PBDEs. The model did a good job of predicting PCB bioaccumulation in the food web based on environmental concentrations, with a bias of 0.97 (for comparison, a value of 1.0 means no bias). For PBDEs it was slightly less, with a bias of 0.59. The model predicted that sediment concentrations would generally need to be near analytical detection limits to meet the most restrictive biota thresholds tested, while contaminants in water would need to be at or below minimum measured concentrations.
Relevance	Understanding the long-term fate and transport of toxics in the Puget Sound region is an important piece of toxics control. Determining the concentrations of water and sediments needed to keep contaminants below harmful levels is also a useful management tool. In a management context, these sediment and water concentrations could inform the development of ecologically-relevant targets or benchmarks for effectiveness monitoring.
Unknowns	More data are needed to support refinements, particularly at the ocean exchange boundary.