

Habitat protection and restoration in Puget Sound

An overview of Strategic Initiative Lead investments 2016-2023



PUGET SOUND INSTITUTE

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Billy Frank Jr. Nisqually National Wildlife Refuge. Photo: Zack Fank / Adobe Stock

About the Puget Sound Institute

The Puget Sound Institute (PSI) was established at the University of Washington to identify and catalyze the science driving Puget Sound and Salish Sea ecosystem recovery. Since its founding in 2010, PSI has advanced our understanding of the region through synthesis, original research and communication in support of state and federal agencies, tribes and other organizations working in the region. PSI receives major funding from the Environmental Protection Agency.

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Background: Hood Canal near Seabeck, Washington. Photo: Danita Delimont / AdobeStock

Left inset: Snohomish Conservation District and Sustainable Lands Strategy partners discuss floodplain planning at Swans Trail Farms in Snohomish, Wash. Photo: Summer Daugherty / Snohomish Conservation District

Middle inset: Volunteers conduct quadrat surveys at Washington Park. Photo: Jason Morgan / Northwest Straits Foundation

Right inset: Volunteers and agency staff count crabs on Lopez Island (NTA 2018-0884). Photo: Mike Higgins / courtesy Washington Sea Grant Crab Team 2018

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HSIL 1.0 Synthesis Report

Download the full report (pdf): Synthesis of Habitat Strategic Initiative Lead 1.0 2016-2023 Investments for Puget Sound Recovery at: https://www.pugetsoundinstitute.org/wp-content/uploads/2024/03/Final_HSIL1.0_Synthesis_Report_03.25.24.pdf.

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Introduction

A treasure trove of big ideas

Between 2016 and 2021, \$21 million provided by the Environmental Protection Agency (EPA) funded 100 different projects to protect, restore, and study critical habitats in Puget Sound (Figure 1). The Puget Sound Institute synthesized the results of these investments in the report, “[Synthesis of Habitat Strategic Initiative Lead 1.0 2016-2023 Investments for Puget Sound Recovery](#)” (HSIL 1.0 Synthesis Report). This publication presents an overview of many of the key accomplishments and lessons learned from these efforts. It is a catalogue of some of the ‘big ideas’ presented by the scientists and conservationists involved, and it is meant to inform and guide future Puget Sound recovery efforts.

To this end, this overview is divided into two parts. The first outlines how the funded projects advanced three Implementation Strategies (IS): Floodplains and Estuaries, Land Development and Cover, and Shoreline Armoring. The second presents key findings from those projects.

Strategic Initiative Leads

In 2016, the EPA authorized three groups headquartered at Washington state agencies to distribute federal funding from the Puget Sound Geographic Program to support implementation of the Puget Sound Action Agenda under the National Estuary Program. These groups, known as the Strategic Initiative Leads, represent three areas of focus: Habitat, Shellfish, and Stormwater. These three Strategic Initiatives each address a series of federally established recovery plans. This overview focuses solely on grants issued by the [Habitat Strategic Initiative Lead](#) (HSIL), a cross-agency team co-led by the WA Department of Fish and Wildlife and the Department of Natural Resources between 2016 and 2021. Each project is a Near Term Action (NTA) from the 2016 or 2018 Action Agendas for Puget Sound.

How to use this overview

This overview serves as a companion to the full HSIL 1.0 Synthesis Report. It follows that report’s structure but also offers easy to read graphics and narratives that capture some of the stories behind the facts and

statistics. Most will not read this document straight through, but as with any overview, it provides a reference for those who need a quick sense of what was accomplished and why it is important.

While every project that was funded during the grant period is included in an appendix at the end, it would be impractical and unwieldy to include details of all the work that was done in this overview. Instead, the authors have provided key findings determined through review and analysis of project files and in consultation with the HSIL. The goal is not just to provide a list of grant results but also to make connections between sometimes seemingly disparate projects and to understand the most effective uses of scarce funding resources.

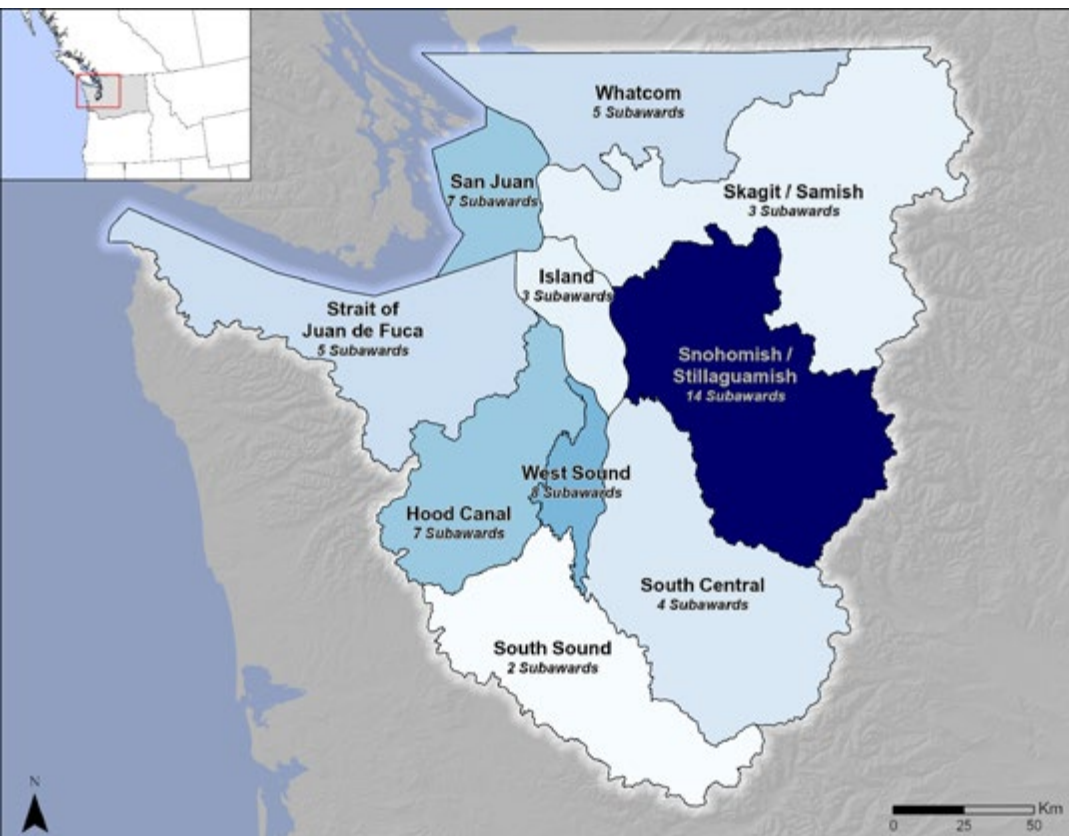


Figure 1. Between 2016 and 2021, the EPA funding supported a mix of 59 local projects (mapped) and 41 regional efforts to protect, restore, and study critical habitats in Puget Sound. Map: Kevin Bogue/Puget Sound Institute

Accomplishments

Funding from the Habitat Strategic Initiative Lead was aimed at improving the health of the rivers, forests, shorelines, and estuaries that make up Puget Sound. Investments described in this overview addressed a wide range of issues, including floodplain management, climate change, stewardship on private property, oil spills, shoreline restoration, and regulatory effectiveness. Project impacts were supported in a variety of ways including on-the-ground restoration actions, data collection and analysis, training for professionals, and development of decision support tools.

The collective accomplishments of HSIL 1.0 awardees reflect the breadth of investments. Some project outcomes are easily quantified, while others including programmatic or catalytic outcomes cannot be easily tallied. A few reflections about notable achievements are presented here.

Building on past efforts

Several HSIL 1.0 projects built upon earlier efforts funded by HSIL's predecessor, the Marine and Nearshore Lead Organization, or other Puget Sound Program partners. This allowed for significant progress beyond what can be accomplished in the two-year timeframe of individual subawards. Examples include Shore Friendly, Marine Shoreline Design Guidelines implementation support, the Shoreline Monitoring Database, Kitsap County regulatory monitoring and adaptive management, European green crab surveillance, and the model volunteer program for oil spill response and assessment.

Replicating success

HSIL 1.0 also invested in projects that replicated earlier successes and innovations. Social marketing techniques were applied to new issues like forest conservation and permit pre-application assistance.

Regulatory effectiveness studies expanded to address Critical Area Ordinance and stormwater rules. The focus on training and development of riparian protection evaluation metrics is expected to ensure ongoing impact.

Transitioning from grant funding

Funding from HSIL 1.0 allowed three programs to continue as they transitioned away from grant funding. The Puget Sound Zooplankton Monitoring Program, Shore Friendly, and the Sea Grant Green Crab Team have received legislative appropriations. HSIL 1.0 also provided seed money to support the development of new programs: the alternative to bulkheads training program, the Multi-Agency Review Team, the regional forestry stewardship program, and the shoreline loan program feasibility study.

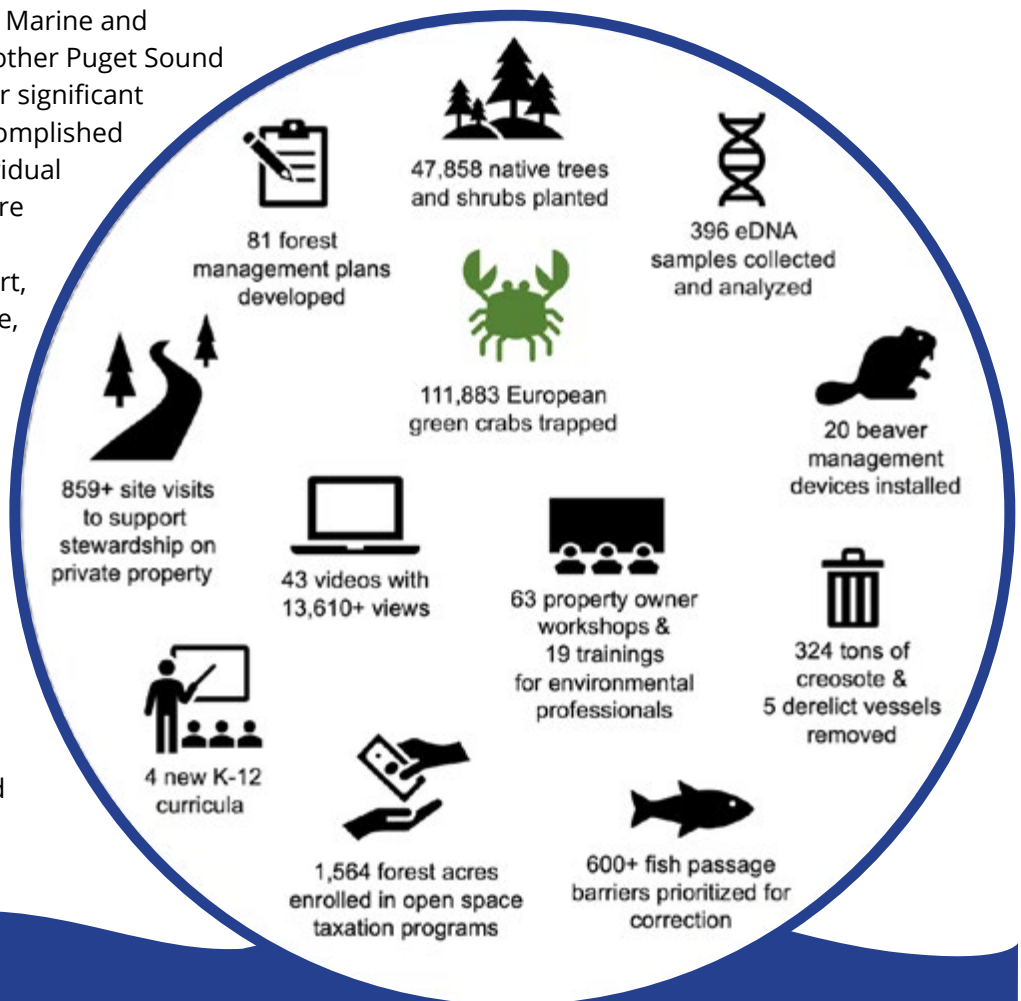


Figure 2. Some of the outputs from 100 projects funded by HSIL from 2016 to 2023.

Part I. Advancing Habitat Implementation Strategies

“Implementation Strategies are plans for achieving specific ecosystem targets for the Puget Sound Vital Sign indicators. The Vital Sign indicators are like a human’s blood pressure reading, helping reflect the health of the patient. Implementation Strategies are like the treatment plan to achieve better health - they describe the sequence of steps, activities, and results needed to move closer to a recovery goal.”

– Puget Sound Strategic Initiatives

Each of the three HSIL Implementation Strategies (IS) identify specific strategies comprised of actionable approaches intended to advance the IS. Together, 10 strategies and 35 approaches were identified. Half of the subawards (or projects) funded by HSIL were associated with the three HSIL Implementation Strategies; these

projects received \$12.3 million in funding. The rest addressed high priority issues identified in the 2016-2017 and 2018-2022 Action Agendas or were related to Implementation Strategies not managed by HSIL. Progress to advance the three HSIL Implementation Strategies was uneven as summarized in Tables 1-3.

Floodplains and Estuaries

Restore Puget Sound habitat that provides critical connections between terrestrial and aquatic systems through Integrated Floodplain Management.



Land Development and Cover

Protect ecologically important lands in Puget Sound by encouraging sustainable development patterns and supporting working lands and local communities.



Shoreline Armoring

Reduce the impacts of shoreline armor so that shoreline processes, such as the supply and movement of sediment, are not impeded.



Floodplains and Estuaries

IMPLEMENTATION STRATEGY | Progress dashboard 2016-2023



Aim: Restore Puget Sound habitat that provides critical connections between terrestrial and aquatic systems through Integrated Floodplain Management.

The Floodplains and Estuaries Implementation Strategy included **three strategies**. **Seventeen projects** (\$4.14 million) advanced **nine of 15 approaches** (Table 1).

Table 1. A summary of progress made by 17 HSIL funded projects to advance the Floodplains and Estuaries IS.

Sound-wide integrated management support	River-basin scale integrated planning and project management	Risk tolerance and cost subsidy analyses
Develop shared goals and metrics to track progress	Inform reach-scale project prioritization and design	Collect hazard risk and subsidy data related to developing in flood-prone areas
Communicate benefits of Integrated Floodplain Management	Engage diverse communities in planning	Conduct outreach about risk and land uses compatible with flooding
Develop regional vision that mobilizes funding	Share locally relevant benefits and challenges through outreach	Incorporate risk and subsidy analyses into regulations and permitting decisions
Develop network for coordination and learning	Consider diverse community needs when identifying priorities	Improve river-basin scale planning using risk and cost subsidy analysis results
Address regulatory and permitting barriers	Expand financial capacity for reach-scale integrated plans	
3 projects advanced 4 approaches	Address challenges for integrated planning across land uses	2 projects advanced 1 approach
	15 projects advanced 4 approaches	Approach advanced by projects No funded projects related to approach

Land Development & Cover












IMPLEMENTATION STRATEGY | Progress dashboard 2016-2023



Aim: Improve implementation of the Growth Management Act in local jurisdictions and to identify and share data about ecologically important lands and expand financial and technical assistance incentives for working lands.

The Land Development and Cover Implementation Strategy was supported by **11 projects** (\$3.19 million) associated with **two of three strategies** which advanced **three of nine approaches** (Table 2). No projects were associated with the strategy to reduce barriers to infill and redevelopment in Urban Growth Areas.

Table 2. A summary of progress made by 11 HSIL funded projects to advance the Land Development and Cover IS.

Build regional support to prevent conversion of ecologically important lands	Support long-term viability of agricultural lands and working forests	Reduce barriers to infill and redevelopment in Urban Growth Areas
Improve GMA implementation by local jurisdictions 	Collaborative resilience planning 	Improve planning and regulatory predictability for developers and investors 
Share data about ecologically important lands 	Expand financial and technical assistance incentives 	Improve wellbeing of urban residents by increasing access to amenities and services 
Include protections in regional infrastructure planning 	Implement local plans, policies, and regulations that support healthy working lands 	0 projects advanced 0 approaches
Incentivize growth in city centers 	2 projects advanced 1 approach	 Approach advanced by projects  No funded projects related to approach
10 projects advanced 2 approaches		

Shoreline Armoring

IMPLEMENTATION STRATEGY | Progress dashboard 2016-2023



Aim: Reduce the impacts of shoreline armor so that shoreline processes, such as the supply and movement of sediment, are not impeded.

The Shoreline Armoring Implementation Strategy included **four strategies**. **Twenty-two projects** (\$5.29 million) advanced **10 of 11 approaches** (Table 3).

Table 3. Progress to advance the Shoreline Armoring IS was made by 22 HSIL funded projects across all but one approach.

<p>Expand incentives and education for residential property owners</p> <ul style="list-style-type: none"> Educate property owners Deliver incentives to residential property owners Coordinate regional/local partners; insure sustainable funding; leverage knowledge from pilot projects <p>8 projects advanced 3 approaches</p>	<p>Improve regulatory effectiveness</p> <ul style="list-style-type: none"> Evaluate and improve implementation of existing regulations Conduct compliance monitoring and enforcement Increase political support to implement and enforce existing regulations <p>9 projects advanced 2 approaches</p>
<p>Improve design and technical training based on coastal processes</p> <ul style="list-style-type: none"> Develop a technical training program Support use of MSDG and develop additional guidance Develop and implement a regional monitoring strategy <p>7 projects advanced 3 approaches</p>	<p>Improve long-term strategic planning</p> <ul style="list-style-type: none"> Develop regionally consistent protocols; provide access to data for current/future shoreline conditions Catalyze habitat improvements as part of capital/public works projects <p>7 projects advanced 2 approaches</p>

Approach advanced by projects No funded projects related to approach

PART II.

Investing in Puget Sound Recovery

This section presents highlights from the HSIL 1.0 Synthesis Report that illustrate how individual subawards have advanced Puget Sound recovery priorities identified by Implementation Strategies and/or Action Agendas for Puget Sound. Key findings from the authors of the HSIL 1.0 Synthesis Report are organized by four Investment Priorities established by the Habitat Strategic Initiative Advisory Team (Habitat SIAT) including: monitoring and information gaps, behavior change and incentives, geographic scale integration, and regulatory effectiveness (Figure 2). This section also includes in-depth profiles of projects related to monitoring, stewardship, and integrated floodplain management.

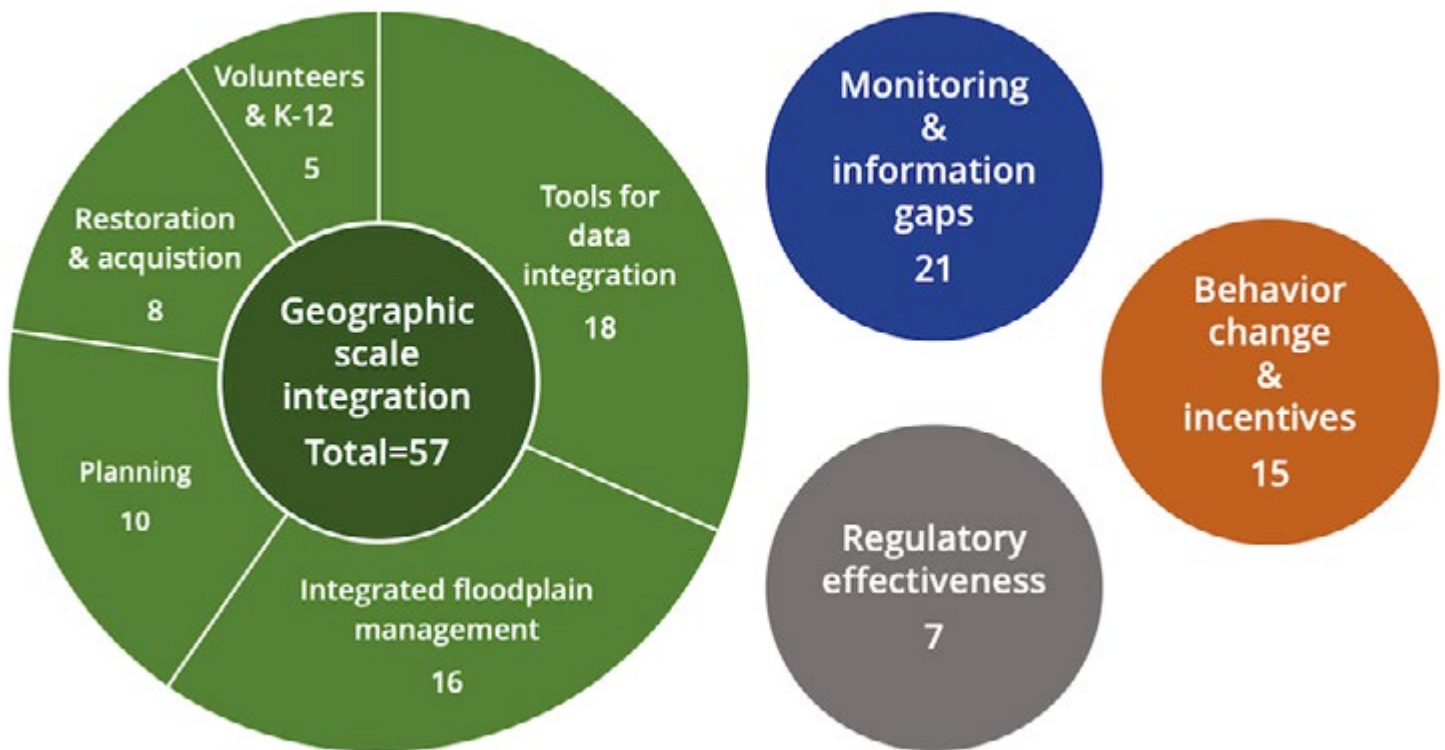


Figure 3. Number and distribution of Puget Sound habitat recovery projects across four investment themes established by the Habitat Strategic Initiative Advisory Team.

Investing in Puget Sound | **Monitoring and Information Gaps**

The monitoring and information gaps investment theme includes 21 subawards involving data gathering and analysis to guide decisions, evaluate the effectiveness of restoration projects, or track status and trends in habitat conditions. Projects related to this investment theme are listed in [Appendix A page 26](#).

Corrections were made to the location of >3,000 kilometers of stream reaches in the National Hydrography Dataset significantly improving the accuracy of this data layer. Field assessments documented salmonids in streams classified as non-fish in the DNR Hydro Layer.

Updates to data products from the WDFW High Resolution Change Detection project, which tracks land cover change over time, were used to evaluate the effectiveness of critical area ordinances.

Informing Puget Sound Partnership Vital Signs

Newly developed monitoring protocols and data obtained with HSIL funding are informing Puget Sound Partnership Vital Signs including two indicators for the new Marine Water Vital Sign: Ocean Acidification and Primary Production, as well as three new indicators for the Zooplankton Vital Sign (see [Feature on page 12](#)).

Funding for long-term monitoring

Long-term monitoring programs require but often lack secure funding. HSIL supported zooplankton and European green crab monitoring programs during their transition from grant-support pilot efforts to programs supported with operating funds from the Washington State Legislature. HSIL funding also supported maintenance of autonomous water quality sensors used by the WDNR ANeMoNe program to monitor ocean acidification.

Pilot projects for monitoring

Pilot project monitoring efforts provide valuable insights about how to expand existing or develop new monitoring programs. HSIL funded two pilot projects, one to monitor phytoplankton/nutrients and the other ocean acidification, to learn about sample collection logistics and staff capacity required to process samples.

Short-term habitat surveys

Short-term surveys to better characterize priority habitats like forage fish spawning areas can provide actionable information that enables regulators to add protective conditions to permits.



Volunteers and agency staff count crabs on Lopez Island (NTA 2018-0884). Photo: Mike Higgins/courtesy Washington Sea Grant Crab Team 2018

Key findings

Shoreline monitoring framework for collaboration

Development of a regional shoreline monitoring strategy with standardized protocols and a data repository created a framework for academic, agency, and community scientist collaboration that allows participating partners to achieve greater impact than they could working alone.

Analysis of data uploaded to the regional database indicates that ecological response variables measured at beach restoration sites were generally improved after armor removal.

Spatial data product updates

Updating mapping platforms managed by state agencies and other spatial data products is crucial for improving local implementation of critical area protections and advancement of the Land Development and Cover strategy to improve local implementation of the Growth Management Act.

Featured Project: Monitoring



The ups and downs of zooplankton in Puget Sound

By Eric Wagner

Zooplankton are critical to the marine food web, but until recently there have been few surveys of the zooplankton community in Puget Sound. Ongoing monitoring is now revealing a system full of complexity and surprises.

In 2014, Long Live the Kings, a non-profit organization devoted to Pacific salmon restoration and recovery, received a grant to begin what biologists hoped would be a long-term zooplankton monitoring project in Puget Sound. The project would involve tribal governments, universities, state agencies, federal agencies, and other non-profits. “It was quite the undertaking, given that there are so many partners and stakeholders,” says Julie Keister, a biologist at NOAA who now helps oversee the program. “It was a reflection not just of how important zooplankton are to Puget Sound, but also how not a lot was known about them.”

Plankton form the sprawling base of every conventional marine food web. They are divided into two general types.

*Above: Routine sampling helps scientists understand how changes in the environment affect zooplankton populations and what prey are available for juvenile salmon to feed on.
Photo: Amanda Winans/UW*

In 2015, the first year of The Blob, rather than becoming a zooplankton desert, Puget Sound was full of copepods and other organisms.

Phytoplankton are, in essence, plants; they are at the very bottom of the food web, or the lowest trophic level. Zooplankton, as organisms that eat phytoplankton, sit just above them. Zooplankton can be small animals, like copepods; or younger life stages of what will eventually grow to become larger, more visible animals like crab or shellfish larvae. As such, most zooplankton are microscopic, but some, like jellyfish, are so large that they can be seen quite easily.

The word *plankton* comes from *planktos*, which is Greek for “wanderer”; and plankton in general are marked by a certain tendency to drift, or wander, going as they do largely where the tides or currents take them. But rather than being mere passive drifters, zooplankton are particular organisms in their own right. Many can swim up and down in the water to help control the direction they drift. Some do well in warmer water, and others thrive in cold. Some are large and fatty (relatively speaking), while others are smaller and comparatively



Most zooplankton are tiny, microscopic animals like copepods (left) but some, including jellyfish (middle), are large enough to be easily seen. Others may be early life stages of animals that grow larger like Dungeness crab zoea (larvae) seen on the right. Photos: (Left) NOAA; (middle) M.Evans (public domain); (right) Don Rothaus/WDFW

less nutritious.

Where zooplankton become vital is that they themselves are then eaten by a host of species, including some that humans care a lot about, like young salmon. The purpose of the monitoring project, then, was to see how the zooplankton's ups and downs played out in the more or less confined spaces of Puget Sound. The approach would be straightforward conceptually if not logistically. Every year, teams of biologists would do biweekly zooplankton surveys from the spring through the fall, at points from the San Juans down to South Sound. By lowering a net to within a few meters of the bottom and drawing it to the surface, they would be able to characterize Puget Sound's zooplankton community, seeing how it varied in space and time.

The monitoring project is ongoing, but that was not always assured. After the initial grant to Long Live the Kings ended in 2016, it was not at all clear the program would survive. That it does is thanks to funding from the Environmental Protection Agency distributed through a consortium of state agencies known as the [Habitat Strategic Initiative Lead](#). Funds from that program allowed the project to transition to the Washington Department of Fish and Wildlife (WDFW), which will steward it going

forward. And in April, some results of the survey work were published in the journal [Progress in Oceanography](#). There, the authors took advantage of their dataset to see how Puget Sound's zooplankton community responded to The Blob, as the large marine heatwave that affected the northeastern Pacific from 2014 through 2016 has come to be called.

The Blob was a massive event. At its peak, more than one million square miles of the north Pacific were affected, and to a depth of up to three hundred feet. Its ecological effects were profound and are still being investigated. But with such a wide area to consider, scientists sometimes have to rely on a kind of geographic shorthand. "Most efforts to study and characterize The Blob's effects in the California Current system have been on the outer coast," Keister says. "What happens out there obviously influences what happens in the inland waters, but these data gave us a chance to focus more on Puget Sound and the Salish Sea."

For their paper, the authors focused on 2015 and 2016, when The Blob most greatly affected the inland waters, and considered the regional zooplankton community at the intersection of time, space, and climate. What they found was a marine space full of complexity and

surprises. Levels of chlorophyll, for instance—an indicator of phytoplankton levels, or how much food was available to zooplankton—did not show a consistent relationship with temperature, being fairly high in 2015 before becoming patchier in 2016.

Where zooplankton were concerned, there were anomalously high increases in their biomass across the entire Puget Sound. In 2015, the first year of The Blob, "It was across the board," says Amanda Winans, a research scientist in the University of Washington School of Oceanography who was lead author on the paper. Rather than becoming a zooplankton desert, Puget Sound was full of copepods and other organisms. These increases persisted through 2017 in southern Puget Sound sites, but not in northern sites in the Strait of Juan de Fuca. Copepod species in Puget Sound that favor warm water did well throughout, while species that prefer cooler water, and thus tend to be larger, did not. ("That, at least, was not a big surprise," Winans says.)

"This increase in zooplankton contrasted with reports of many coastal populations, especially in the [California Current System] where total biomass generally decreased during the [marine heatwave]," the authors wrote. Why the patterns in



Young salmon including Chinook feed on microscopic zooplankton like krill and copepods seen on the right. Photos: (Left) Roger Tabor/USFWS ([CC BY-NC 2.0](#)); (right) Jeff Napp/NOAA ([CC BY 2.0](#))

Puget Sound differed from those on the outer coast is not entirely clear, although there are some clues. The [Salish Sea Model](#), for instance, suggested that freshwater inputs into Puget Sound were much higher in 2015, which in turn increased the [exchange flow](#) and brought more nutrients into the inland waters from the outer coast, leading to greater amounts of phytoplankton. Additionally, the warmer temperatures experienced in Puget Sound during The Blob may have spurred growth for resident zooplankton, which were able to gorge on those phytoplankton.

“It appears that a lot of what is happening in Puget Sound is affected by local processes, rather than necessarily mirroring what’s happening on the coast,” Winans says. “That was our really big takeaway.” The work for the recent paper ties in with [a study](#) Keister published last fall, looking for links between climate, zooplankton dynamics, and survival patterns of Chinook and coho salmon in the Strait of Juan de Fuca, which is at the northern terminus of Puget Sound. In that study, she and her co-authors showed that zooplankton communities had strong seasonal patterns, alternating between species

that were present in Puget Sound (which tended to be smaller) and others brought in from the outer coast (which tended to be larger). Juvenile salmon tended to do better when zooplankton communities were dominated by outer coast species—precisely the kind that did not fare so well during The Blob.

“People had been making assumptions about how Puget Sound food webs would operate based on coastal observations,” she says. “This study shows that Puget Sound is actually quite different.” Continuing the zooplankton survey for years to come will be crucial in this regard; that it is now housed in WDFW could help it stretch on indefinitely. “That’s one of the key takeaways from this work,” Keister says. “To understand Puget Sound, you have to study Puget Sound.” ■

This article was originally published in *Salish Sea Currents Magazine*:

<https://www.eopugetsound.org/magazine/ups-and-downs-of-zooplankton-Puget-Sound/HSIL>

Puget Sound Zooplankton Monitoring Program

The Puget Sound-Wide Zooplankton Monitoring Program was established as part of the Salish Sea Marine Survival Project in 2014 to monitor changes in zooplankton communities of Puget Sound. The program involves 12 partners from tribal, county, state, federal, academic, and non-profit entities that collaborate to sample the zooplankton community regularly at 16 sites throughout Puget Sound. The program’s long-term data collection and monitoring allows scientists and managers to track ecosystem health and understand the primary food source for juvenile salmon, herring, and other fish in Puget Sound. With the help of multiple funding sources and partner cooperation, the zooplankton monitoring program has run continuously from 2014-2022, with a brief break in 2020 due to the COVID-19 pandemic.

Additional information for the zooplankton monitoring projects funded in [2016](#) and [2020](#) is available on the Puget Sound National Estuary Program [website](#).

Investing in Puget Sound | Behavior Change and Incentives

This investment theme includes 13 subawards that aimed to make stewardship actions more accessible to property owners. Behavior change strategies emphasize exchange-based approaches like incentives and social marketing over information-based approaches. Social marketing differs from traditional community outreach and education programs in that it focuses on identifying and addressing specific barriers to action. Projects related to this investment theme are listed in [Appendix B on page 27](#).

Key findings

Technical assistance for property owners

Technical assistance site visits were provided to more than 800 marine waterfront, streamside, or forested property owners. They were provided with parcel-specific information about stewardship actions to take, and more than 100 received additional support to act on recommendations they received.

Training for planners and engineers

Marine Shoreline Design Guidelines training and outreach, and a new six-course Alternatives to Bulkheads training developed by Washington Sea Grant and offered at the Coastal Training Program significantly advanced the Shoreline Armoring strategy to improve design and technical training based on coastal processes.

Stewardship programs

Four new pilot programs provided education, technical assistance, and/or financial incentives to landowners to support stewardship behaviors. Puget Sound Conservation Districts developed a Regional Forestry Stewardship Program offered in seven counties that helped to advance the Land Cover and Development strategy to support the long-term viability of agricultural lands and working forests. Two new programs in Snohomish County, Living with Beavers ([see Feature on page 16](#)) and the Snohomish Streamside Landowner Program, supported streamside landowners. Start Here!, a new program in Kitsap County encouraged residents to engage with regulators prior to making property development plans.

Shore Friendly Program

Support for the [Shore Friendly](#) program significantly advanced the Shoreline Armoring Implementation Strategy. Homeowner site programs were expanded, and collaboration with regional recovery partners supported a transition to a new home for the program and capital funding from the Washington State Legislature. Operations funding to support education and outreach remains an ongoing need. Other subawards supported development of an advisory board charged with strategic planning for program development and a feasibility study for a new financial incentive.



Property in Dyes Inlet before (top) and after (bottom) bulkhead removal (NTA 2018-0322).

Photos courtesy Shore Friendly Kitsap

Featured Project: Stewardship



Seeking alternatives to beaver dam removals

By Sarah DeWeerd

Beavers provide critical benefits for wetland ecosystems but can also alter the landscape in ways that are unpredictable for property owners and conservationists alike. New techniques are helping humans and beavers share the landscape with the goal of benefiting both parties.

“It’s not a huge dam, but it’s holding back a couple feet of water,” says Ariana Winkler, eyeing a modest pile of mud and sticks just above a wooden footbridge on a tributary of Hulbert Creek, which feeds into Ebey Slough in Snohomish County. The dam is likely the handiwork of a family of beavers who live in a lodge in an adjacent, larger pond that was built when the surrounding neighborhood of modest two-story suburban houses was developed.

The industrious rodents probably constructed this auxiliary dam to create deeper water that provides easier access to food and other resources as well as protection from predators, says Winkler, a program manager with the Snohomish Conservation District (SCD) who coordinates the Living with Beavers program.

Above: Beaver activity can benefit hydrology, biodiversity, climate change resilience, and salmon recovery in western Washington’s watersheds. Seen here is a beaver dam on a tributary to Hulbert Creek in Snohomish County, Wash. Photo: Sarah DeWeerd. Inset photo: yrjö jyske (CC BY 2.0)

The program, which began in 2017, aims to educate property owners about the benefits of having beavers around and promote alternatives to beaver dam removal – which in the past has been the default response to beaver activity in many rural and semi-rural areas of Washington State.

Sharing wetlands

Beavers are increasingly recognized – even celebrated – for their contributions to wetland and watershed health. “Beaver habitat just provides incredible benefits to the ecosystem,” says Winkler’s boss, Kristin Marshall, habitat restoration and floodplain resilience program director for SCD.

Beavers benefit hydrology, biodiversity, climate change resilience, and salmon recovery in western Washington’s watersheds. Their dams help slow the flow of water through stream systems, diminishing flooding during

the wet months of winter and spring and increasing streamflow during the region's increasingly warm and dry summers. Water backed up behind a beaver dam seeps into the soil and replenishes groundwater stores, reducing water temperature downstream. And by creating complex wetlands and adding woody debris to streams, they provide crucial rearing habitat for salmon, especially coho.

But beavers can also play havoc with human endeavors. They sometimes build dams across culverts – they favor narrow points of streams for their construction work – causing roads to flood. Other dams flood yards, driveways, or agricultural fields. The standing water in a new beaver pond may kill trees and other plants. Or the animals choose vegetation that people really want to preserve – fruit trees, or native plants installed as streamside buffers in salmon restoration projects – for their building materials.

“They want to be in the same places that we want to be, really,” says Jennifer Vanderhoof, a wildlife biologist with King County and president of Beavers Northwest, a nonprofit that provides beaver management services in western Washington and SCD's collaborator on the Living with Beavers program.

Prior to European settlement, many of the riversheds that drain into Puget Sound would have had thousands of beaver-created wetlands and the beavers to go with them. But widespread trapping nearly extirpated the animals from the area that is now Washington State by the mid-1800s.

More recently, though, over the last 20 years, what Vanderhoof calls “the beaver trifecta” — a near-cessation of trapping due to both a state ban on body-gripping traps, a broader collapse in the price of beaver pelts, and the Endangered Species Act listings of multiple Puget Sound

populations of salmon that triggered stream restoration efforts — has enabled beaver populations to bounce back in many areas.

Meanwhile, expanding development has brought more people living in closer proximity to beaver habitat, as well as an expansion of pavement that sends more stormwater runoff through local streams. Sometimes, beavers get blamed for flooding related to urban development, or dams that previously didn't interfere with human infrastructure begin to do so with more runoff entering the system, Winkler says.

The small beaver dam on the Hulbert Creek tributary is a perfect illustration of these forces. It sits in a larger landscape of newly laid asphalt and half-finished traffic circles and is surrounded by an amalgam of native and invasive vegetation that reflects the area's position at the fringes of urban growth: salmonberry and Himalayan blackberry, salal and creeping buttercup. The homeowner's association reached out to SCD last year because of flooding on the greenbelt's walking trails.

Funding the work

The grant that gave the Living with Beavers program its start is one of roughly 90 distributed by the Habitat Strategic Initiative Lead (HSIL).

HSIL grants often support difficult-to-fund activities such as relationship building, planning, and preliminary work: vital to the eventual success of restoration efforts but disfavored by most other funding channels.

In this realm, the original Living with Beavers program grant, which ran from March 2017 through November 2018, was a wild success. It resulted in the development of social media posts and outreach materials, six workshops in various cities to help landowners learn more about the benefits of beavers and the alternatives to dam removal, and a tour of a property where beavers are present so that interested landowners could see coexistence strategies in action.

“There is a real demand for these services, and it seems that the limiting factor for completing this



Exclusion devices, like the one seen here on Stitch Creek in Lake Stevens, being installed in front of a road culvert, can prevent problems caused by beavers. Photo: Courtesy Snohomish Conservation District



Caption: A beaver dam before and after notch exclusion fencing was installed to promote water flow and manage water levels on a tributary to Stevens Creek in Lake Stevens. Photo: Courtesy Snohomish Conservation District

work is simply making people aware that the services exist, and may provide benefit to them and the environment,” Marshall and Alex Pittman, who at the time worked for SCD and is now a watershed steward with Snohomish County, wrote in a 2019 report about the program.

The program is now part of SCD’s Making Space for Water Initiative; a grant from the state Streamflow Restoration Program will continue to provide funding through 2024.

Finding solutions

When beavers are causing problems for landowners, there are several ways to intervene. Trees and shrubs can be enclosed in cages to prevent the animals from cutting down the vegetation. Beaver dam management strategies are designed to get more water to flow through the dam – ideally without the beaver noticing or at least without being able to easily do anything about it. This lowers the level of the pond and reduces flooding behind the dam, making it easier for people to tolerate the beavers’ presence.

At the greenbelt site near Hulbert Creek, Winkler is planning to install a device known as a notch

exclusion fence on the dam. Her team will remove some material from the center of the dam – creating a “notch” in it – and then build a big cage around the notch so that the beavers can’t easily access it to repair it. Today, she aims to get a better sense of where the dam’s crest is, how much space there is to install the device, and how much material – and therefore grant money – will be necessary to build it.

Beavers can be unpredictable. They might respond to a notch exclusion device by doing nothing, by jamming sticks into the mesh to restore the higher water level, by abandoning the dam, or even by building a new dam just downstream – on which a new device must often also be installed.

But the dynamic and often iterative nature of beaver dam management also has its upside. As SCD staff build relationships with landowners through beaver work, this can become a gateway to other habitat restoration efforts such as adding streamside buffers or a rain garden, Marshall says.

Sometimes, after learning more about the benefits of beaver wetlands and being reassured that the beavers on their property aren’t threatening the ecology or the infrastructure,

landowners opt not to intervene at all. “We’ve seen a number of property owners who really shifted their thinking and then those dams create really nice, long-standing water storage,” Marshall says.

And despite the challenges, beaver management work can be a welcome respite from the uncertain slog of conventional habitat restoration. “A lot of my time and energy is spent on coming into degraded situations and figuring out how to turn them around,” Pittman says. But with beaver dams, “we’ve got this awesome ecosystem feature that’s providing all sorts of benefit to the site and everything downstream of it. And all we need to do is figure out if there’s a way that we can modify things slightly so that the landowner or infrastructure can coexist with it.” ■

A version of this article was first published in *Salish Sea Currents Magazine*:

<https://www.eopugetsound.org/magazine/alternatives-to-beaver-dam-removals/HSIL>

Investing in Puget Sound | **Geographic Scale Integration**

The geographic scale integration theme is the largest of the four SIAT funding themes with a total of 47 beneficial outcomes for habitat conditions. Geographic scale integration includes planning and stakeholder engagement, data integration tools, and recovery actions. Projects related to this investment theme are listed in [Appendix C on page 28](#).



The Whidbey Camano Land Trust, in partnership with the Washington Department of Fish and Wildlife, conducted a restoration feasibility study for a large area along the north end of Livingston Bay (NTA 2018-0603). Photo courtesy of Dawn Spilsbury Pucci

Key findings

Regional Integrated Floodplain Management

The Nature Conservancy developed a five-year strategy for the Floodplains by Design program which provided a regional vision for Integrated Floodplain Management and a path for transitioning away from grant funding. This work advanced the Floodplains and Estuaries IS strategy to support development of a Sound-wide integrated management framework. The Department of Ecology instituted several of their recommendations in a 2019 report to the Legislature. Regional partners were subsequently successful in increasing legislative capital appropriations, but operating funds to support non-capital program components are lacking.

Local Integrated Floodplain Management

Support for local Integrated Floodplain Management groups advanced the Floodplains and Estuaries IS strategy to improve river-basin scale integrated planning and project management. Fourteen subawards supported local partners:

- To provide education and outreach highlighting locally relevant benefits and challenges of multi-benefit floodplain management.
- To complete technical studies to enhance understanding of floodplain and estuarine processes to inform reach-scale project prioritization and design.
 - To incorporate climate projections into local plans.
 - To engage diverse communities in planning forums to develop and implement reach-scale priority project lists and designs.

Fish passage

Four fish passage barrier prioritization efforts and development of a downstream barrier identification tool that can help sequence corrective actions so that they have the greatest impact. In addition, five barrier correction projects were designed and two were constructed with funding support from HSIL.

Education and volunteer engagement

Development of K-12 curricula and support for volunteer engagement were the focus of ten subawards intended to cultivate stewardship and motivate communities to support Puget Sound recovery. Volunteers conducted surveillance for European green crabs, monitored beach restoration sites, uploaded water quality data from a nearshore sensor network, and helped implement restoration projects.

Tools for data integration

Data-driven approaches for habitat protection and restoration advanced the development of spatially explicit decision support tools, guidance documents, and indicators. Several products focused on a limited geographic area but have the potential to be expanded for use elsewhere.

Three subawards supported salmon recovery planning. User-friendly summaries of recent scientific findings and guidance for incorporating them into local plans were developed. Information about the status of threats to Hood Canal summer chum was synthesized to support recovery priorities necessary for delisting.

Geographic Scale Integration (continued)

Three subawards supported the development of refinements to indicators. Baseline floodplain extent for 17 major river basins was delineated and metrics of function and degradation were cooperatively developed to support Floodplains Vital Sign reporting. A standardized monitoring protocol was developed for the shoreline armor Salmon Habitat Indicator, and the Hood Canal Coordinating Council developed a 2020 Ecosystem Report Card that included a new Nature-Based Recreation indicator.

Two subawards provided cost/benefit and scenario analysis related to potential rescue tug operations in the San Juan Islands for prevention of oil spills. A third evaluated the pros and cons of chemical dispersants after a large oil spill.

Ten subawards supported development of decision support tools and models, or web-based data explorers for existing tools. Most focused on identifying priority areas for restoration or conservation.

Eight habitat acquisition and restoration projects received funding from HSIL. Many of these projects received grants from one or more additional sources, but HSIL subawards filled funding gaps. Some elements of property acquisition and restoration are challenging to fund with capital dollars or other types of grants. The flexibility of HSIL funding allowed these projects to move forward, resulting in:

- the purchase of over 203 acres of habitat
- installation of five engineered log jams and 113 log structures
- removal of 2,027 feet of shoreline armor; planting of almost 50,000 native plants
- and removal of 324 tons of creosote and five derelict vessels from Puget Sound.

Climate change adaptation and resilience

Several HSIL subawards supported the cross-cutting Implementation Strategy program goal to promote climate change adaptation and resilience (see [Feature on page 21](#)). Some projects, including a parcel-scale sea level rise vulnerability assessment, advanced the Shoreline Armoring IS strategy to improve long-term strategic planning. Three subawards supported integration of climate projections into reach-scale Integrated Floodplain Management plans. A local



A regional meeting to discuss climate and disaster resilience held at Red Cedar Hall of the Jamestown S'Klallam Tribe on Sequim Bay in September 2022 as part of the Climate Action Planning North Olympic Peninsula project (NTA 2018-0952). Photo: Courtesy Karen Affeld / North Olympic Development Council

planner survey gathered data about climate priorities and needs, and a climate planning toolkit was developed to support climate action at the municipal level. Intermediary agents can help bridge the gap between smaller jurisdictions and state/federal government resources; build connections among neighboring entities; and expand regional capacity in grant writing and administration.

Featured project: Integrated Floodplain Management



Studies target increasing flood risks

By Eric Wagner

All across the region, communities are finding that rising seas and rising rivers are two sides of the same coin. New research funded by the Environmental Protection Agency may help managers target their responses to climate-fueled flood risks in Puget Sound.

On the morning of December 27, 2022, a mix of torrential rains, exceptionally high tides, and heavy snow melt caused the Duwamish River to flood in south Seattle. Water overtopped the river's banks and flowed down the streets of South Park. One resident told KOMO News that three feet of water had poured into his home in "a matter of minutes." By the time the floodwaters had receded, dozens of homes and businesses had been affected, resulting in millions of dollars in damage.

In the aftermath, the Seattle city government noted that, while the metropolitan area as a whole was likely to see significant effects of sea level rise, the low-lying Duwamish Valley "is among the most vulnerable areas in Seattle to these impacts." Several months later, Senator Patty Murray toured South Park as part of her effort to get several million dollars of federal funding for flood

mitigation work. "Everyone, in South Park and across Seattle, knows that rising sea levels and extreme storms are becoming the new normal and so is flooding," she said in a statement.

The floods of last December were neither restricted to the Seattle area nor, necessarily, to December. All throughout Puget Sound people are dealing with the consequences of rising waters, whether due to high river flows or high marine water levels. Both vulnerabilities were the focus of several climate change-related grants from the Habitat Strategic Initiative Lead (HSIL). The awards, distributed on behalf of the Environmental Protection Agency, focused on quantifying vulnerability, increasing manager capacities, providing technical guidance to municipalities and other stakeholder groups, and raising public awareness both for and about climate-related issues throughout the Puget Sound region.

For some HSIL award recipients, simply explaining how rivers in the Pacific Northwest function was a critical component. A river can wind without being allowed to roam as it used to. Removing plants and building dikes and other structures creates, in effect, a

*Above: In areas like Snohomish County where the Nooksack River has been known to flood its banks, sea level rise can exacerbate the problem. Shown here is flooding of the Nooksack River in 2009 along Interstate 5 near Ferndale, Wash.
Photo: WSDOT (CC BY-NC-ND 2.0)*

kind of riparian raceway. Planting vegetation and placing large woody debris—anchoring downed trees in the riverbanks, in essence—can slow a river down, make it wend a little more. This in turn lessens the flooding risk to surrounding communities, in addition to providing habitat for fish and other organisms.

“The basic motivation is that there’s a lot of dimension to floodplain management and preparedness,” says Guillaume Mauger, a research scientist with the Climate Impacts

1,000 homes and businesses. “When you see a flood, you don’t always see the climate change behind it,” he says. “But once you start delving into the details of what happened, it becomes clear how there are a lot of different dimensions on which you can act.” These might be policy issues, or capacity-building to understand how the effects of climate change will affect particular locales or regions.

Different polities can have different needs; although climate change

polished, or public-facing in that sense.”

Other projects tackled the scope and threat of sea level rise in the Puget Sound Basin as a whole. One of those was led by Ian Miller, a Coastal Hazards Specialist with Washington Sea Grant. That project mapped vulnerability to sea level rise across the entire Puget Sound coastline, land parcel by land parcel.

“We had a couple of approaches,” Miller says. One approach, used during previous assessments, was to look at various community-driven, discussion-oriented processes. “The other that we wanted to experiment with,” he says, “was more data-driven.” That approach involved recent HSIL funding and took advantage “of GIS systems and publicly-available data on coastal elevation and location and presence of buildings and roads, whatever we can pull in on potentially impacted in areas that are flooded under different sea-level-rise scenarios.” That the data be public was key; Miller wanted people to be able to access anything he was able to access.

The project led to some nice innovation in the way Miller thought about flooding risk. For example, sea-level-rise vulnerability is commonly assessed only for flooding, which is easy to map. (“We call these the Big Blue Blobs,” Miller says, for the inundated areas of a map.) But there are other impacts of sea level rise besides flooding that can negatively affect people. One other thing it can do is exacerbate erosion. Homes that sit on bluffs, or other infrastructure, or habitats—all of these, sitting as they do one hundred feet above Puget Sound, are well outside of the range of possible flooding. “There’s no way they would come out as vulnerable in traditional analysis,” Miller says. So he wanted to expand the number of potential impacts he considered, incorporating erosion, for instance.



Engineered log jams like this one installed in the South Fork Nooksack River can reduce the risk of flooding by slowing down the flow of the river. Photo: Lance Cheung/USDA NRCS

Group at the University of Washington. “What we want to do is try to help these [integrated floodplain management](#) groups start using climate change in their planning. They’re thinking about it already, we can help advance it.”

Mauger led a project that worked in Snohomish County and Whatcom County. Both counties have experienced significant floods in recent years; in Whatcom County, floodwaters from the [Nooksack River](#) rose to unprecedented levels in November 2021, damaging more than

affects everyone, there is also the fact that one size doesn’t fit all. Also, some counties are stretched thin in their ability to take on major new projects without outside support. This was where Mauger and others came in. “In Snohomish County, what we did was geared a lot more towards a manager audience,” Mauger says. “What we did in Whatcom County was a mix. They’d had these big floods, and so they needed to focus more on how they were communicating things. Our products for them ended up being little more



In addition to flooding, sea level rise can contribute to coast erosion as seen at the base of the bluffs north of Libbey Beach Park on the west side of Whidbey Island. Photo: Ecology (CC BY-NC-ND 2.0)

“What we’re doing is acknowledging these concerns that people have about impacts to their communities,” Miller says. “We can incorporate not only the traditional approach of assessing impacts to infrastructure, but also these less obvious impacts.”

In the end, what Miller had was a map of the entire Puget Sound shoreline with different scores for different parcels. One surprising find was that, of the roughly 110,000 parcels Miller and his team evaluated, only about 2,000 were scored as being highly vulnerable to flooding. “We were kind of like, *Oh wow, this is kind of hopeful*, in the sense that, if it’s true, you can make a targeted sort of investment on a relatively small scale and achieve some significant gains,” Miller says.

Miller’s hope is that the work will direct attention to those parcels that are most vulnerable, and find means to pick away at what drives their vulnerability, or vulnerabilities.

After all, the components of a parcel’s vulnerability can vary. Some are physical—flooding or erosion, for example—while others are geographic, and still others social. The ultimate goal, then, is to provide as nuanced a perspective as possible on all those vulnerabilities in Puget Sound. “We want to generate a new starting point for people, municipalities, communities, tribes, neighborhoods,” Miller says. “Basically, anyone who is interested in thinking about what a flood’s traditional impacts may be, and then beyond, to options for reducing those impacts.” ■

This article was originally published in *Salish Sea Currents Magazine*:

<https://www.eopugetsound.org/magazine/studies-target-increasing-flood-risks/HSIL>

Investing in Puget Sound | Regulatory Effectiveness

This investment theme included eleven subawards that tracked changes in the condition of marine shorelines and riparian areas; monitored the implementation and effectiveness of regulatory programs; evaluated and reduced regulatory barriers to implementing beneficial projects; and provided training and support for planners and regulatory staff. These projects advanced the Shoreline Armoring IS regulatory strategy and the Land Development and Cover IS strategy to prevent conversion of ecologically important lands. Projects related to this investment theme are listed in [Appendix D on page 30](#).

Key findings

Riparian protections

A regional assessment of change in riparian areas indicates that Critical Area Ordinances are shifting development away from riparian areas. However, riparian buffer widths in local codes vary widely and tend to be smaller than what best available science guidelines indicate.

Shoreline compliance

A shoreline compliance monitoring project in San Juan County found that between 2009 and 2019, installation of new shoreline armor largely occurred outside of permit processes. Since 2019, the Washington Department of Fish and Wildlife developed a new compliance program and civil penalties for hydraulic project code violations were increased. Where baseline data is available, regular boat-based shoreline surveys could provide an opportunity to observe potential effects of regulatory changes implemented after 2019.

Critical areas

The Washington Department of Commerce developed a webinar series for local planners about regulatory monitoring and adaptive management for critical areas and shorelines. Case studies and feedback from planners during the series were used to comprehensively update a chapter of the Critical Areas Handbook. With HSIL funding, Kitsap County implemented process improvement for permitting software and developed a regulatory monitoring plan based on the updated chapter.



Stream buffers (dark and light green) as defined by Critical Area Ordinances and riparian ecosystems as defined by site-potential tree heights (olive green). Photo: WDFW

Reducing permitting process barriers for restoration projects

A multi-agency team reviewed federal, state, and local level permit processes to identify common causes of delay for armor removal and soft shore projects and potential process improvements. The team then piloted a collaborative permit review process designed to shorten timelines. This group persisted after the contract period ended. Their approach could be emulated to also address permitting process barriers for floodplain projects, a recommendation of the Floodplains and Estuaries IS strategy to improve support for Sound-wide integrated management.

Appendices



Removing concrete blocks that armor a beach on McNeil Island in south Puget Sound. Photo: Doris Small / WDFW

Appendix A. Monitoring and information gaps investment theme projects

NTA	Project	Awardee
2016-0119	Shoreline Monitoring Toolbox: Implementation and Data Management	Washington Sea Grant
2016-0131	Advancing Western Strait Fish Passage Barrier Removal	North Olympic Lead Entity for Salmon
2016-0141	Completing HRCD 2015 with Land Cover through 2017	Department of Fish and Wildlife
2016-0328	Subtidal Monitoring of Shoreline Restoration Effectiveness	Puget Sound Institute
2016-0367	Puget Sound-wide Zooplankton Monitoring Program	Long Live the Kings
2016-0405	Ocean Acidification Resilience across Habitat Types	Department of Natural Resources
2016-0408	Add Acidification Parameters to Ecology Monitoring Network	Department of Ecology
2018-0219	Shoreline Restoration Effectiveness Monitoring	Northwest Straits Foundation
2018-0242	Puget Sound Sand Lance Habitat Characterization and Mapping	Department of Fish and Wildlife
2018-0295	Investigation of Nutrients, Phytoplankton and Food Web Interactions in the Eastern Strait of Juan de Fuca and Admiralty Inlet	Jamestown Tribe
2018-0409	West Sound Eelgrass Monitoring Program	Suquamish Tribe
2018-0436	National Hydrography Dataset Update and Pilot Downstream Fish Passage Barrier Tool	Department of Fish and Wildlife
2018-0437	East Kitsap Forage Fish Monitoring	Suquamish Tribe
2018-0505	Strategic West Central Water Type and eDNA Assessment	Wild Fish Conservancy
2018-0525	Shoreline Monitoring Toolbox: Data Analysis and Interpretation	Washington Sea Grant
2018-0556	Assessing Pacific Sand Lance Subtidal Habitats and Biomass in the San Juans	Moss Landing Marine Labs
2018-0575	Puget Sound-Wide Zooplankton Monitoring Program	Department of Fish and Wildlife
2018-0624	Utilizing Passive Integrated Transponder (PIT) Technology to Assess Juvenile Chinook Use of and Survival within Habitat Improvement Project	WRIA 9 Lead Entity
2018-0809	Growth and Life History Strategies of Salish Sea Chinook Salmon as It Relates to Marine Survival, Habitat Condition, and Population Recovery	Department of Fish and Wildlife
2018-0884	Washington Sea Grant Crab Team	Washington Sea Grant
2018-0893	Forage Fish Habitat Tidal Range	Department of Fish and Wildlife

Appendix B. Behavior change and incentives investment theme projects

NTA	Project	Awardee
2016-0001	Shoreline Armoring Reduction Project	Northwest Straits Foundation
2016-0071	Living with Beavers Program	Snohomish Conservation District
2016-0140	Advancing Sea Level Rise Adaptation in San Juan County	Friends of the San Juans
2016-0196	West Central Nearshore Restoration Prioritization and Armor Removal/Shore Friendly Kitsap	Kitsap County
2018-0085	Integration of Green Shores for Homes and Shore Friendly	Washington Sea Grant
2018-0142	Marine Alternative Shoreline Trainings for Planners and Contractors	Washington Sea Grant
2018-0266	Development of a Residential Shoreline Loan Program	Puget Sound Institute
2018-0641	Improved Landowner Development Decisions to Protect Critical Areas and Manage Stormwater	Kitsap County
2018-0701	Forest Health Management for Reduced Stormwater Runoff and Land Conversion	Puget Sound Conservation District Caucus
2018-0810	Stream Landowner Education and Assistance Program	Snohomish County
2018-0172 2018-0322 2018-0432 2018-0707 2018-0826	Education and Outreach Funding for ESRP Shore Friendly Recipients with a 2018 NTA (via Contract with the Recreation and Conservation Office)	Pierce Conservation District Kitsap County King Conservation District Northwest Straits Foundation Friends of the San Juans

Appendix C. Geographic scale integration investment theme projects

NTA	Project	Awardee
2016-0019	Accelerate Integrated Floodplain Management	The Nature Conservancy
2016-0045	Balancing Fish, Farms and Floods in King County's Snoqualmie Watershed	King County
2016-0074	Climate Resiliency in Snohomish River Floodplain	Snohomish Conservation District
2016-0088	Maylor Point Feeder Bluff Armoring Removal	Northwest Straits Foundation
2016-0089	Community-scale SLR and Coastal Hazard Assessment in Puget Sound	Climate Impacts Group
2016-0107	Engaging the Community in Strait Ecosystem Recovery	Jefferson County
2016-0113	Develop Data and Support for Floodplain Management Strategies	Whatcom County
2016-0124	Numerical Groundwater Model to Support Stream Flow Management	Whatcom Public Utility District #1
2016-0136	Recovery of select freshwater salmonid habitat in the San Juan Islands	San Juan County Lead Entity
2016-0149	Vessel Traffic Oil Spill Risk Consequences in the Salish Sea	San Juan County
2016-0151	Policy on Dispersant Use in San Juan County	UW Friday Harbor Labs
2016-0161	Puget Sound Creosote Removal Program	Department of Natural Resources
2016-0169	Snohomish Estuary Derelict Vessel Removal	Snohomish MRC
2016-0198	Stream Crossings Prioritization along Puget Sound Shores with a Railroad	Confluence Environmental Company
2016-0297	Integrated Watershed Plan Monitoring and Adaptive Management Phase 1	Hood Canal Coordinating Council
2016-0305	Hood Canal Bridge Assessment	Hood Canal Coordinating Council
2016-0310	Integrated Floodplain Management	Snohomish County
2016-0315	Model Volunteer Program for Oil Spill Response/ Assessment	Washington State University Extension
2016-0322	Evaluate the Status of Marine Birds at Greatest Risk from Oil Spills	Seattle Audubon
2016-0376	Puget Sound Chinook Recovery Nearshore Chapter Update	Department of Fish and Wildlife
2016-0397	Hood Canal Landscape Assessment & Prioritization Tool (Phase 1)	Hood Canal Coordinating Council
2016-0401	Floodplain Condition Assessment and Vital Sign Refinement	Department of Ecology

Appendix C. (continued)

NTA	Project	Awardee
2016-1158	South Prairie Creek (RM 4.0-4.6) Floodplain Project Phase 1	South Puget Sound Salmon Enhancement Group
2016-1216	Kristoferson Creek Fish Passage Improvements	Snohomish Conservation District
2018-0097	Sustainable Lands Strategy Communication and Outreach	Department of Fish and Wildlife
2018-0167	North Sound Riparian Modeling and Monitoring	Skagit River System Cooperative
2018-0179	Chimacum Creek Restoration and Protection Project: Phase 2	North Olympic Salmon Coalition
2018-0189	Mud Bay Habitat Protection	Capitol Land Trust
2018-0218	Stillaguamish Floodplain Acquisitions and Restoration	Stillaguamish Tribe of Indians
2018-0249	North Fork Stillaguamish Integrated Floodplain Management	Snohomish County
2018-0382	Hood Canal and Eastern Strait of Juan de Fuca Summer Chum Salmon Recovery Status of Threats	Hood Canal Coordinating Council
2018-0388	Hood Canal Landscape Assessment & Prioritization Tool (Phase 2)	Hood Canal Coordinating Council
2018-0401	Regional (WRIA 1-Wide) Water Supply and Management Plan	Whatcom Public Utility District #1
2018-0564	Drainage-Based Management Planning	Whatcom County
2018-0582	Developing Strategies and Accompanying Web Tool for Science-Based Beach Restoration and Protection	Department of Fish and Wildlife
2018-0587	Skagit HDM Priority Projects	Department of Fish and Wildlife
2018-0600	Incorporation of Salish Sea Marine Survival Project Findings into Local Recovery Plans	Long Live the Kings
2018-0603	Local Coordination to Advance PSNERP-identified Projects: Livingston Bay Restoration Feasibility Study	Whidbey Camano Land Trust
2018-0613	A Salmon Life Cycle Model to Support Multi-Benefit Actions and Adaptive Planning in the Stillaguamish Watershed	Tulalip Tribes
2018-0620	WRIA 1 Integrated Program Outreach and Engagement	Whatcom Public Utility District #1
2018-0623	Geomorphic Flood Hazard Risk on the Lower Skykomish River	Snohomish County
2018-0636	Riparian/Land Cover Change Analysis and Decision Support System	Pierce County Lead Entity
2018-0652	Ecological Integrity Assessments as an Approach to Prioritize Protection and Restoration Actions and monitor Progress	Department of Natural Resources
2018-0667	A Salmon Life Cycle Model to Support Multi-Benefit Actions and Adaptive Planning in the Stillaguamish Watershed	Snohomish County

Appendix C. (continued)

NTA	Project	Awardee
2018-0685	Prioritizing SLR Exposure and Habitat Sensitivity Across Puget Sound	Washington Sea Grant
2018-0692	Map Viewer of Ecologically Important Areas in the Puget Sound Basin	Department of Natural Resources
2018-0697	Status and Trends of Skagit Chinook Salmon Abundance, Life History Diversity, and Productivity in Response to Recovery Plan Actions and Environmental Variability	Skagit River System Cooperative
2018-0715	Integrating Climate Resilience into Farm-Fish-Flood Project Packages in the Snohomish and Stillaguamish River Floodplains	Snohomish Conservation District
2018-0741	Integrating Climate Change in Multi-Objective Floodplain Management	Climate Impacts Group
2018-0822	Citizen Science and K-12 Education Program to Monitor Local Aquatic Habitat Effects from Climate Change	Department of Natural Resources
2018-0863	Vessel Traffic Oil Spill Risk Consequences in the Salish Sea – Expanded Assessment	San Juan County
2018-0873	Monitoring Effectiveness of Multibenefit Floodplain Project Implementation in the Snohomish and Stillaguamish Rivers	Snohomish Conservation District
2018-0901	Curley Creek Prioritized Restoration	Mid Sound Fisheries Enhancement Group
2018-0952	Phase 2 Municipal Level Climate Action Planning for the North Olympic Peninsula	North Olympic Peninsula Resource Conservation and Development Council
2018-0959	Revegetating the Elwha	Lower Elwha Klallam Tribe
2018-0964	EMDS Open Platform for Spatial Decision Support for Salmon Recovery	Tulalip Tribes
2018-0965	Phase 2: Implementation of Recommendations from the Coastal Streams and Embayments Prioritization along Railroad	Tulalip Tribes

Appendix D. Regulatory effectiveness investment theme projects

NTA	Project	Awardee
2016-0368	Enhancing Critical Area Ordinance Effectiveness via Adaptive Management	Department of Fish and Wildlife
2016-0380	Marine Shoreline Design Guidelines: Engineering Technical Assistance, Training, and Outreach	Department of Fish and Wildlife
2018-0265	Improve Soft Shore Permitting Processes	Department of Fish and Wildlife
2018-0327	Puget Sound Critical Areas Monitoring and Adaptive Management Program	Department of Commerce
2018-0713	Effectiveness Monitoring of Regulations Regarding Shoreline, Critical Areas, and Stormwater Requirements	Kitsap County
2018-0828	San Juan County Shoreline Armor Change Analysis 2009 to 2019	Friends of the San Juans
2018-0886	Marine Shoreline Design Guidelines: Engineering Technical Assistance, Training, and Outreach 2020-2022	Department of Fish and Wildlife



View of the Nooksack River looking south toward Bellingham Bay after flooding in 2021. Photo courtesy (November 16, 2021). Photo: Courtesy of Larry McCarter.



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