

Synthesis of Habitat Strategic Initiative Lead 2016-2023 Investments for Puget Sound Recovery

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EXECUTIVE SUMMARY

Between 2016 and 2021, the Habitat Strategic Initiative (HSIL) disbursed \$21 million for 97 subawards to implement 100 near term actions identified in the 2016-2017 and 2018-2022 Action Agendas for Puget Sound. This report describes how the HSIL 1.0 investments have contributed to Puget Sound recovery within the Implementation Strategy (IS) framework. It is organized by four investment themes identified by HSIL's Strategic Initiative Advisory Team. Chapters 2 – 5 describe the individual subawards grouped by theme, then Chapter 6 describes the collective contributions of all the subawards to advancing the IS managed by HSIL. The report ends with further categorizations of the HSIL investments and a summary of key findings and recommendations. For this summary we provide some of the key conclusions from our analysis before providing an overview of each of the chapters.

Subaward contributions to the advancement of HSIL Implementation Strategies

We identified 10 strategies and 35 approaches associated with the three IS managed by HSIL. This delineation was used to assign relationships between individual subawards and approaches to determine how projects advanced IS. Our analysis showed about half of the subawards (\$12.3 million in funding) were associated with an HSIL-managed IS.

- The Land Development and Cover IS identifies three strategies and nine approaches. All subaward-driven progress was associated with three of the approaches: improve local jurisdiction implementation of GMA; identify and share data about ecologically important lands; and expand financial and technical assistance incentives for working lands. The reduce barriers to infill strategy needs attention.
- The Floodplains and Estuaries IS includes three strategies and 15 approaches. Some progress was made to support a Sound-wide Integrated Floodplain Management (IFM) framework and significant progress was made for the river basin scale integrated planning strategy. More work is needed to support the strategy focusing on risk tolerance and cost subsidies.
- The Shoreline Armoring IS has four strategies and 11 approaches. Significant progress was made implementing all of the strategies and all but one of the approaches. So much was accomplished for two strategies that future updates to this IS should reflect progress to date by refining the focus of those strategies.

The remaining subawards were associated with an Action Agenda priority or an Implementation Strategy managed by the Puget Sound Partnership or Stormwater Strategic Initiative Lead.

Key findings and recommendations

- Several of the projects in the HSIL 1.0 portfolio built upon earlier efforts funded by their 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.

- 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.
- Funding support from HSIL 1.0 ensured three programs could continue as they transitioned away from grant funding. The regional zooplankton monitoring program, Shore Friendly, and the Sea Grant Green Crab Team have since 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.
- Local Integrating Organization direct awards resulted in funding for Action Agenda priorities like K-12 curriculum development, volunteer engagement, and oil spill research. These types of projects are not well aligned with the SIL 2.0 funding model.
- Multiple IS—Land Development and Cover, Shoreline Armoring, and Chinook—emphasize the importance of understanding and improving implementation of existing regulations to ensure that remaining habitat is protected as intended by law. We recommend regional partners continue to encourage jurisdictions throughout the region to conduct effectiveness and compliance monitoring by providing funding and technical support. Since a recent solicitation for these types of projects did not generate proposals, we also recommend HSIL consider collaborating with regional recovery partners to investigate barriers jurisdictions face when initiating this type of work. Understanding specific roadblocks is necessary before designing technical assistance programs that could increase uptake of funding opportunities.
- It is crucial that the National Hydrography Dataset continue to receive updates to improve locational accuracy. This authoritative dataset is best available science for regulatory purposes and is a core data layer for many decision support tools. High Resolution Change Detection data products have proven to be extremely useful for regulatory effectiveness monitoring and should also continue to be updated. We recommend that HSIL collaborate with the PSEMP Spatial Data Work Group to identify additional opportunities to improve geospatial platforms managed by state agencies. In addition, there is work to be done to evaluate how tools developed with HSIL 1.0 funding are being used in the context of land use planning. There may be opportunities to expand to new geographies.
- Although regional partners have been successful in obtaining legislative appropriations for Floodplains by Design and Shore Friendly, there remains a need for funding to support important program elements not eligible for capital funding. Program elements like education and outreach, relationship building, grant application support, and reach scale

planning are prerequisites for development of the capital restoration projects funded by these programs.

- Regional partners should consider investigating barriers to more consistent implementation of social marketing principles during the development of new incentive programs or expansion of existing programs, then identify strategies to address those barriers. Since the Stewardship and Education Lead Organization did not have a clear successor in the Environmental Protection Agency's 2016 revised funding model, there may be a gap in social marketing expertise accessible to local organizations.
- Local jurisdictions are stretched thin and lack capacity to take on major climate planning and implementation efforts without outside support. Subawardees found that use of intermediary agents (e.g., regional organizations like the North Olympic Peninsula Resource Conservation and Development Council, University of Washington's Climate Impacts Group, or the Floodplains by Design network as well as consultants) helped to address capacity issues. The support intermediary agents provide can bridge the gap between smaller jurisdictions and state/federal government resources; build connections among neighboring entities; and expands regional capacity in grant writing and administration.
- We identify several opportunities for future cross-SIL collaboration on topics such as: brownfield redevelopment; incorporation of stormwater requirements into regulatory effectiveness work; sea level rise risk to on-site sewage systems; and design of floodplain, wetland, and estuary restoration projects to achieve nutrient reduction benefits. In addition, riparian decision support tools and models developed with HSIL 1.0 funding may be useful to the new Climate Resilient Riparian Systems Lead.

Monitoring and Information Gaps

Subawards supported development of new monitoring protocols and collaborative monitoring efforts. Results from HSIL 1.0 funded projects informed new Primary Productivity and Ocean Acidification Indicators for the Marine Water Vital Sign, as well as three new Zooplankton Vital Sign indicators.

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. The collaborative shoreline monitoring framework may be an approach to consider replicating for marine vegetation since there is already a network of volunteer-based organizations participating in monitoring activities. Analysis of data uploaded to the regional shoreline monitoring database indicates that ecological response variables measured at beach restoration sites were generally improved after armor removal.

Updating mapping platforms managed by state agencies and other spatial data products is crucial for improving local implementation of critical area protections. Funded projects corrected thousands of kilometers of stream reaches in the National Hydrography Dataset,

reclassified miles of streams in the WDNR Hydro Layer, and updated the High Resolution Change Detection data products.

HSIL 1.0 funding supported both long-term and short-term monitoring efforts. Two monitoring programs received support at a critical period as they transitioned from grant-supported pilot efforts to programs supported with operations funding from the Washington State Legislature. Funding pilot monitoring efforts provides valuable insights about how to expand an existing monitoring program or develop a new one. Short-term habitat surveys provided actionable information for regulators.

Behavior Change and Incentives

This group of projects collectively provided more than 800 technical assistance site visits to marine waterfront, streamside, or forested properties. Subawardees provided parcel-specific information about stewardship actions these property owners can take. More than 100 of these property owners received additional support to act on recommendations received.

Support for Shore Friendly helped to continue and expand homeowner site visit programs. Collaboration with regional recovery partners supported a transition to a new home for the program and capital funding from the Washington State Legislature. However, 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.

Four new pilot programs that provided education, technical assistance, and/or financial incentives to landowners to support stewardship behaviors were developed with HSIL 1.0 funding. These included a new Regional Forestry Stewardship Program, two new programs in Snohomish County which supported streamside landowners, and one Kitsap County program which encouraged residents to engage with regulators prior to making property development plans. The Regional Forestry Stewardship Program was unique in that it helped small forest landowners reduce their property taxes. This type of financial incentive is critical for reducing the costs associated with owning and maintaining forest lands and is expected to reduce the risk of conversion to non-forest land uses.

Geographic Scale Integration

This group of projects supported planning and design efforts to integrate regional priorities and local needs; development of tools and models to support prioritization activities; and implementation of broadly-supported recovery actions. Several projects had a focus on involving local stakeholders and volunteers in planning, monitoring, and recovery actions.

Several subawards supported Integrated Floodplain Management (IFM). The Nature Conservancy's five-year strategy for the Floodplains by Design program provided a regional vision for IFM and a path for transitioning away from grant funding. Several recommendations were institutionalized by the Department of Ecology in their 2019 report to the Legislature.

Regional partners were subsequently successful in increasing capital appropriations, but operations funding to support non-capital program components remains a gap. Local IFM groups in the Stillaguamish, Snohomish, Nooksack, Snoqualmie, and Skagit watersheds received support to provide education and outreach highlighting locally relevant benefits and challenges of multi-benefit floodplain management; complete technical studies to enhance understanding of floodplain and estuarine processes to inform reach-scale project prioritization and design; incorporate climate projections into local plans; and engage diverse communities in planning forums to develop and implement reach-scale priority project lists and designs.

HSIL 1.0 funded four fish passage barrier prioritization efforts and the development of a downstream barrier identification tool. These projects can help optimize funding allocations by sequencing correction actions so that they have the greatest impact. In addition, five barrier correction projects were designed and two were constructed.

Development of new K-12 education curricula and support for volunteer engagement helped to cultivate stewardship and motivate communities to support Puget Sound recovery. Volunteers conducted surveillance for European green crabs, monitored beach restoration sites, counted seabirds, uploaded water quality data from a nearshore sensor network, and helped implement restoration projects. The two programs that submitted detailed outputs reported 2,764 hours worked by over 600 volunteers. Successful volunteer programs require a dedicated volunteer coordinator and ongoing training. Absence of a stable, long-term funding source can make maintaining these program elements difficult.

Data-driven approaches for habitat protection and restoration were advanced via funding support for development of decision support tools, guidance documents, and refined indicators. This group of projects advanced recovery planning for Hood Canal summer chum, improved Floodplains Vital Sign reporting, and supported oil spill response planning. Several subawards supported development of decision support tools and models, or web-based data explorers for existing tools, that focus on identifying priority areas for restoration or conservation. Some of these products are focused on a limited geographic area but have the potential to be expanded for use elsewhere. However, more time is needed to see what types of tools are most useful for their intended purposes before recommending expansion to other geographies.

Eight habitat acquisition and restoration projects received funding from HSIL 1.0. Many of these projects received grants from one or more other sources as well, but there were gaps in funding packages that subawards were able to fill. Some elements of property acquisition and restoration efforts can be difficult 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.

Several projects supported planning for climate change resilience and adaptation. They include a parcel-scale sea level rise vulnerability assessment; efforts to integrate climate projections into reach-scale IFM plans; outreach to increase the capacity of San Juan County residents and planners to address the impacts of sea level rise; a market and cost analysis for sea level rise adaptation measures; a local planner survey; and development of a climate planning toolkit to support municipal climate actions.

Regulatory Effectiveness

HSIL 1.0 regulatory effectiveness investments 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.

Findings of a shoreline compliance monitoring project in one county covering the time period 2009-2019 corroborate those of previous monitoring efforts funded by the Marine and Nearshore Lead Organization. There is substantial evidence that shoreline construction often occurred without permits through 2019. However, a new Compliance Program was developed at Washington Department of Fish and Wildlife and civil penalties for Hydraulic Code violations were increased since the end of the study period. Repeating boat-based shoreline surveys where baseline data is available could provide an opportunity to observe potential effects of regulatory changes implemented after 2019.

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

HSIL 1.0 funding supported a Washington Department of Commerce webinar series for local planners about regulatory monitoring and adaptive management for critical areas and shorelines. Case studies and feedback about audience needs obtained from polls during the classes were used to comprehensively update a chapter of the Critical Areas Handbook. Kitsap County used HSIL 1.0 funding to implement permitting software process improvements and develop a regulatory monitoring plan consistent with this guidance. Regional partners should encourage jurisdictions throughout the region to emulate this type of project by providing funding and technical support.

A Multi-Agency Review Team developed with funding support from HSIL 1.0 reviewed federal and state permit processes to identify common causes of delay for armor removal and soft shore projects; identified potential process improvements; then piloted a collaborative permit review process to shorten review timelines. This group persisted after the contract period ended and their approach could potentially be emulated to address a recommendation from the Floodplains and Estuaries IS's Sound-wide support strategy to address permitting process barriers.

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CHAPTER 1: PUGET SOUND RECOVERY CONTEXT

Chapter At-A-Glance

- Between 2016 and 2021, the Habitat Strategic Initiative Lead (HSIL) funded 97 subawards to implement 100 near term actions identified in the 2016-2017 and 2018-2022 Action Agendas for Puget Sound.
- The purpose of this report is to describe how these investments have contributed to Puget Sound recovery within the Implementation Strategy (IS) framework.
- We identified 10 strategies and 35 approaches associated with the three IS managed by HSIL: Land Development and Cover, Floodplains and Estuaries, and Shoreline Armoring. This delineation was used to assign relationships between individual subawards and an IS.
- This report is organized by four investment themes HSIL’s advisory team used to guide their discussions about funding priorities. Chapters 2 – 5 describe the individual subawards grouped by theme, then Chapter 6 describes the collective contributions of all the subawards to advancing the IS managed by HSIL.

The U.S. Environmental Protection Agency (EPA) supports protection and restoration of water quality and biological integrity in the Puget Sound watershed with National Estuary Program (NEP) and Geographic Program funding. Distribution of this funding is guided by the [Action Agenda for Puget Sound](#) and [Implementation Strategies](#). The Action Agenda is a regularly updated plan that provides a shared vision and overarching strategies for Puget Sound recovery. Implementation Strategies (IS) provide a more detailed road map for achieving targets articulated in the Action Agenda for key species/habitats or threats to them.

1.1 STRATEGIC INITIATIVES

The 2012-2013 Action Agenda identified three “Strategic Initiatives” to emphasize priority topics and issues critical to Puget Sound recovery: (1) prevent pollution from **stormwater**; (2) protect and restore **habitat**; and (3) protect and recover **shellfish** beds. In 2016 EPA reorganized their [Puget Sound Program funding model](#) around these priorities, resulting in the creation of three Strategic Initiative Lead (SIL) teams. The SILs are cross-agency teams that receive awards from EPA via multi-year cooperative agreements. They are responsible for developing and managing IS; convening advisory groups, called Strategic Initiative Advisory Teams (SIATs), to provide technical and policy input; selecting projects to receive subaward funding consistent with recovery priorities identified in IS and the Action Agenda; and providing capacity to connect and coordinate efforts among federal, state, and local agencies. The SILs replaced five [Lead Organization \(LO\)](#) teams that had provided these functions since 2011.

The [Habitat Strategic Initiative Lead](#) (HSIL) is co-led by the Washington Department of Fish and Wildlife (WDFW) and the Washington Department of Natural Resources (WDNR). Between 2016 and 2021, HSIL advanced habitat protection and restoration in the Puget Sound region by funding 97 subawards to implement 100 “near-term actions” (NTAs) identified in the 2016-2017 and 2018-2022 Action Agendas.

As the end of HSIL’s first 7-year cooperative agreement was approaching, they engaged Puget Sound Institute at the University of Washington Tacoma to synthesize results of all subaward grants made with federal fiscal year 2016-2020 allocated funds. This project was intended to support close-out of the “HSIL 1.0” cooperative agreement and inform future activities associated with a second “HSIL 2.0” cooperative agreement executed in 2021. As an entity within the Puget Sound Program specifically charged with synthesizing knowledge across multiple programs in support of IS development and implementation, Puget Sound Institute is uniquely qualified to conduct this work. The co-authors were provided with access to HSIL 1.0 contract files and reviewed hundreds of reports associated with HSIL 1.0 subawards to conduct our analysis.

This report is a key project deliverable that describes how HSIL 1.0 investments have contributed to Puget Sound recovery within the IS framework. We identify successful approaches that could be expanded; compile lessons learned to support adaptive management of HSIL ISs; and provide recommendations for next steps.

1.2 IMPLEMENTATION STRATEGIES MANAGED BY HSIL

Implementation Strategies are a tool designed to accelerate progress towards 2020 ecosystem recovery targets, called indicators, for “Vital Signs” developed by the Puget Sound Partnership (PSP).¹ They identify priority approaches for achieving a specific indicator target and provide guidance about the types of actions needed to overcome barriers or reduce uncertainties.

Development of IS follows a process designed by PSP (2017). A volunteer Interdisciplinary Team recruited through a public process provides most of the technical input on what to include, focus on, and recommend as priorities within the IS. This occurs in facilitated workshops where *Open Standards for the Practice of Conservation* (Conservation Measures Partnership 2013) planning tools are used to structure group discussion and develop products.

¹ After PSP was formed in 2007, they developed a portfolio of Vital Signs to report on and guide assessment of progress toward Puget Sound recovery goals. Each Vital Sign had one or more specific and measurable metrics, called indicators, that provided quantitative targets for significantly improving conditions by 2020. In some cases, these Vital Signs were key components of the ecosystem (e.g., Chinook, estuaries) and in others they were threats to them (e.g., shoreline armoring, land development). **PSP completed revisions to the Vital Signs portfolio in 2022 and development of new targets was underway at the time of writing. As a result, some of the Vital Signs and target language used in this report are now outdated.** For example, “Shoreline Armoring” is no longer a Vital Sign but instead a progress indicator tracked for a new “Beaches and Marine Vegetation” Vital Sign.

HSIL 1.0 managed the three IS: Land Development and Cover; Floodplains and Estuaries; and Shoreline Armoring. HSIL 2.0 will continue to manage these IS and will also be developing a Marine Vegetation Implementation Strategy.

Each of these IS identify three or four “strategies” meant to accelerate progress towards the corresponding Vital Sign indicator target. Each of those strategies has its own results chain that show multiple “approaches” describing the specific types of activities needed to achieve desired results. We identified a **total of 10 strategies and 35 approaches** gleaned from review of IS narratives and associated schematics/result chains for the three HSIL-managed IS.

In sections 1.2.1 – 1.2.3, we briefly describe these three IS and identify strategies and approaches in bullet lists as shown in the example below.

- Strategy
 - Approach

This delineation of strategies and approaches provided the basis for all of our determinations as to whether a subaward/NTA advanced an HSIL IS or not and will reappear in abbreviated form in Chapter 6 where we synthesize subaward contributions to IS implementation.

1.2.1 LAND DEVELOPMENT AND COVER

Land Cover and Development Vital Sign indicators measured conversion of land from natural areas, working forests, and farms into homes, businesses, roads, and other development; population growth in Urban Growth Areas (UGAs); forest loss; and riparian restoration. The 2020 indicator target around which the IS was developed involved reducing the rate, compared to a 2011 baseline, of vegetated cover loss in ecologically important lands.²

The Land Development and Cover IS was initially developed by PSP in 2016 and updated by HSIL in 2021 (HSIL 2021a). This IS identifies three strategies to protect ecologically important lands from development:

- **Build Puget Sound-wide support to prevent conversion of ecologically important lands by:**
 - Improving local jurisdiction implementation of the Growth Management Act.
 - Identifying and sharing data about ecologically important lands.
 - Incorporating protections into regional infrastructure planning.
 - Incentivizing new market demand for growth in city centers.

² **Ecologically important lands** were defined as lands that, in their 2011 condition, provide high hydrological function with respect to water flows and provide high habitat or biodiversity value.

- **Reduce barriers to infill and redevelopment in preferred growth areas³** by:
 - Improving planning and regulatory predictability for developers and investors.
 - Improving the wellbeing of urban residents by increasing access to amenities and services.
- **Support long-term viability of agricultural lands and working forests** through:
 - Collaborative resilience planning.
 - Improved adoption and implementation of local plans, regulations, and policies that support healthy working lands.
 - Expansion of financial and technical assistance incentives.

1.2.2 FLOODPLAINS AND ESTUARIES

The Floodplains Vital Sign tells us about protection, loss, and restoration of functional floodplain area in the region's 17 major river basins.⁴ The indicator target was restoration of 42,386 acres of functionally impaired floodplains (15% of total estimated restoration need) by 2020. The Estuaries Vital Sign tells us about the area of estuarine wetlands restored to tidal flooding in the region's 16 major river deltas.⁵ The indicator target was restoration of 7,380 quality acres (20% of total estimated restoration need) by 2020.

PSP developed an Estuaries IS in 2015 and a Floodplains IS in 2016. Due to shared landscape and socio-economic contexts between these habitats in individual watersheds, HSIL decided to combine the IS for the 2021 update. This new IS (HSIL 2021b) includes three strategies to drive increases in functional acreage of floodplains and associated river delta estuaries:

- Develop and maintain a **Sound-wide integrated management support framework⁶** to promote and implement management approaches that achieve outcomes for fish populations, flood risk, and agricultural viability. This strategy entails:
 - Communicating benefits of integrated management to build public and political support.

³ Preferred growth areas include **Urban Growth Areas** (UGAs) and **Limited areas of more intense rural development** as defined in the Growth Management Act.

⁴ River basins included in Floodplains Vital Sign reporting: Elwha, Dungeness, Quilcene, Dosewallips, Duckabush, Hamma Hamma, Skokomish, Deschutes, Nisqually, Puyallup, Duwamish, Cedar/Sammamish, Snohomish/Snoqualmie/Skykomish, Stillaguamish, Skagit, Samish, Nooksack

⁵ Large river deltas included in Estuaries Vital Sign reporting: Elwha, Dungeness, Quilcene, Dosewallips, Duckabush, Hamma Hamma, Skokomish, Deschutes, Nisqually, Puyallup, Duwamish, Snohomish, Stillaguamish, Skagit, Samish, Nooksack

⁶ **Integrated Floodplain Management** (IFM) describes the use of "collaborative processes and practices that bring diverse interests together to come up with solutions that can achieve multiple benefits" (Washington Department of Ecology 2019).

- Developing a regional vision that mobilizes funding.
- Providing capacity for a network of regional and local practitioners to encourage coordination and shared learning.
- Developing shared goals and metrics to track regional progress and communicate collective accomplishments.
- Addressing regulatory and permitting process barriers.
- Support **river-basin scale integrated planning and project management** by:
 - Enhancing understanding of floodplain and estuarine processes, including future projections, to inform reach-scale project prioritization and design.
 - Addressing challenges for integrated planning across land uses.
 - Providing education and outreach that highlights locally relevant benefits and challenges of integrated management.
 - Engaging diverse communities in planning forums by building relationships, developing trust, and communicating a coordinated vision.
 - Considering diverse community needs and understanding social, ecological, and economic trade-offs when identifying restoration and protection priorities.
 - Expanding financial capacity to implement integrated reach-scale plans.
- Develop and integrate **risk tolerance and cost subsidies analyses** into land use planning. Risk tolerance analysis quantifies flood hazard probability and vulnerability. Cost subsidy analysis quantifies long-term economic costs of developing in flood-prone areas (e.g., public infrastructure, emergency services, utilities, repairing flood damage). This strategy recommends:
 - Developing a methodology and collecting data on hazard risk and associated costs of subsidies relative to the public benefit of developing in flood-prone areas.
 - Conduct outreach with the public and decision-makers to develop understanding about risk considerations, build support for land uses that are compatible with flooding, and encourage alignment of incentives for moving, instead of protecting, existing development in floodplains.
 - Incorporating risk and subsidy analysis results into regulations and permitting decisions.
 - Improving river-basin scale planning with risk and subsidy analysis results, best available science on ecosystem functions, and political climate feasibility considerations.

1.2.3 SHORELINE ARMORING

The Shoreline Armoring Vital Sign indicator tracked net change in length of WDFW-permitted bulkheads or seawalls along Puget Sound marine shorelines. The indicator target was for the total miles of armor removed to exceed total miles of new armor between 2011 and 2020. Other indicators for this Vital Sign involved use of soft shore techniques⁷ and prioritizing removal of existing armor and avoidance of new armor along feeder bluffs.⁸ A Shoreline Armoring IS was developed by HSIL in 2018 and updated in 2021 (HSIL 2021c). It included four strategies to reduce the amount and negative impacts of hard armor:

- **Improve and expand incentives and education for residential property owners** to encourage removal of hardened shoreline or protection of unmodified shorelines by:
 - Educating property owners about ecologically friendly shoreline management alternatives.
 - Delivering incentives (e.g., site visits, design assistance, permitting assistance, mini-grants) to residential property owners.
 - Coordinating among regional and local partners to ensure sustainable program funding and leverage knowledge gained from pilot efforts.
- **Increase and improve regulatory implementation, compliance, enforcement, and communication** to increase habitat protection and improve opportunities for the restoration of shoreline processes and habitat. This strategy entails:
 - Evaluating and improving implementation of existing regulations.
 - Conducting compliance monitoring and enforcement.
 - Increasing political support for regulatory staff to implement and enforce existing regulations.
- **Increase and improve coastal processes-based design and technical training** to expand technical solutions and capacity necessary to support regulatory requirements and voluntary actions that protect and restore the shoreline by:
 - Supporting use of the [Marine Shoreline Design Guidelines](#) (MSDG) and developing additional guidance.
 - Developing a comprehensive technical training program.
 - Developing and implementing a regional monitoring strategy.

⁷ The term **soft shore protection** describes shoreline stabilization techniques that utilize natural materials (e.g., sand, gravel, large wood, native plants) and have some capacity to adjust over time. Soft shore protection is considered a less damaging alternative to more rigid hard structures.

⁸ A **feeder bluff** is an “eroding coastal bluff that delivers a significant amount of sediment to the beach over an extended period of time and contributes to the local littoral sediment budget” (Shipman et al. 2014).

- **Improve long-term strategic planning** to support and connect regional and local partners to develop integrated restoration, protection, transportation, and infrastructure improvement plans. This strategy recommends:
 - Compiling and providing access to data about current and future shoreline conditions collected using regionally consistent protocols and spatially explicit sea level, storm surge, and wave height forecasts.
 - Improving communication among agencies at all levels of government, tribes, and industry partners to catalyze habitat improvements as part of capital and public works projects.

1.3 IMPLEMENTATION STRATEGIES MANAGED BY RECOVERY PARTNERS

Some HSIL-funded projects also advanced one of more strategies articulated in IS managed by other Puget Sound recovery partners:

- **Chinook** – The Chinook IS identifies seven strategies for accelerating Chinook salmon recovery, focusing on coordinated regional-scale approaches to support local watershed actions. It was developed and is managed by the Puget Sound Partnership (PSP 2018).
- **Freshwater Quality (B-IBI)** – The Freshwater Quality IS identifies four strategies to protect and restore the health of small streams as measured by the Benthic Index of Biotic Integrity (B-IBI). It was developed and is managed by the Stormwater SIL (Stormwater Strategic Initiative 2020).
- **Toxics in Fish** – The Toxics in Fish IS identifies five strategies to reduce the levels and impacts of contaminants on Puget Sound aquatic life and the people who consume them. It was developed and is managed by the Stormwater SIL (Stormwater Strategic Initiative 2021).
- **Marine Water Quality** – The Marine Water Quality IS identifies five strategies to reduce known anthropogenic nitrogen loads to Puget Sound and further our understanding of anthropogenic nutrient impacts to marine waters. It was developed by the Stormwater SIL and was undergoing review by the Puget Sound Science Panel at the time of publication.
- **Shellfish** – The Shellfish IS identifies five strategies to restore and protect harvestable shellfish beds by reducing and preventing pathogen pollution (Shellfish Strategic Initiative 2023). The recent IS update includes a new “second-tier strategy” to address ocean acidification impacts to shellfish.

“Cross cutting” activities which benefit more than one strategic initiative are of particular interest to the Puget Sound Program, so we note project connections to these other strategies where applicable.

1.4 ACTION AGENDA AND LOCAL PRIORITIES

HSIL 1.0 investments were also guided by regional recovery strategies identified in the Action Agenda, as well as ten [Ecosystem Recovery Plans](#) developed by [Local Integrating Organizations](#) (LIOs). To provide LIOs with predictable funding for implementation of their plans, EPA’s annual funding guidance to the three SILs included LIO set-asides for each of the federal fiscal years 2016-2020. Every LIO could select one NTA for “direct award” each year.

The HSIL 1.0 investment portfolio included subawards for the high priority issues and activities described below. Though these strategies also appeared in the 2016-2017 and 2018-2022 Action Agendas, here we reference the current (at the time of publication) numbering system from the 2022-2026 Action Agenda.⁹

- **Fish passage barriers** – Culverts, bridges, and dams lacking adequate fish passage prevent salmon and steelhead from accessing habitat and undermine other fishery recovery efforts. Strategy 6 identifies the need for additional resources to identify and prioritize the large number of barriers needing correction.
- **Freshwater availability** – The volume of water flowing in a river or stream channel (“streamflow”) is affected by changing climate conditions and water withdrawals. Strategy 7 seeks to support streamflow restoration planning. The Summer Low Flows Vital Sign Indicator (formerly Summer Stream Flow) is the queue for IS development.
- **Oil spills** – As vessel traffic in the Salish Sea increases, the risk of maritime oil spills also increases. Strategy 13 includes actions to strengthen spill prevention, preparedness, and response efforts.
- **Invasive species** – Strategy 14 covers prevention and response to introductions of terrestrial and aquatic invasive species.
- **Education partnerships** – Incorporating Puget Sound place-based content into K-12 curricula has long been an Action Agenda priority, and is now one part of the broader Institutional Strategy D.
- **Volunteer engagement** – Supporting participation in stewardship activities is an approach for fostering connection to Puget Sound and cultivating increased public support for recovery. Institutional Strategy E includes actions to build recovery partner capacity and infrastructure necessary to support volunteer activities.

Habitat acquisition and restoration is not a strategy in the 2022 Action Agenda but did appear as Strategy 2 in the 2016 Action Agenda. Action Agenda and IS strategies are often focused on upstream “intermediate outcomes” needed to accomplish direct recovery actions like property acquisition and habitat restoration. These types of investments may not be linked to identified strategies and approaches, but they do often accelerate progress to Vital Sign indicator targets.

⁹ All 2022-2026 Action Agenda strategies can be viewed at <https://actionagenda.pugetsoundinfo.wa.gov/2022-2026ActionAgenda>

Since many other funding programs support acquisition and restoration, recent EPA funding guidance encourages SILs to focus on project elements that are harder to fund with more traditional funding sources (e.g., integrated planning, project development, monitoring).¹⁰ **HSIL investments in direct recovery actions were generally associated with LIO direct awards and/or situations where combined funding from other sources fell short of total project cost.**

1.5 ORGANIZATION OF THIS REPORT

HSIL 1.0 subawards frequently advanced multiple IS, so we structured this report around four investment themes the Habitat SIAT developed to guide their discussions about federal fiscal year 18-22 funding priorities. These themes describe types of projects that are common across the HSIL-managed IS and are therefore a useful framework for assessing how investments have advanced regional priorities and for structuring recommendations about future work.

Chapters 2 - 5 describe how *individual subawards* have operationalized IS approaches, organized by SIAT themes. Several subawards are discussed in more than one chapter, so the number of individual subawards per chapter exceeds 97 (the total number of HSIL 1.0 subawards).

- **Monitoring and Information Gaps** – 22 subawards that gathered useful data to guide decisions, evaluate restoration effectiveness, and determine status and trends in habitat conditions.
- **Behavior Change and Incentives** – 13 subawards (17 NTAs)¹¹ that spurred habitat recovery actions through offsetting costs to make the actions and changes accessible, incentivizing participation in multi-benefit planning, and increasing trust building needed to advance habitat stewardship.
- **Geographic Scale Integration** – 63 subawards that filled funding gaps to support planning and design efforts at multiple spatial scales (regional and local) to integrate regional priorities and local needs, achieve broadly-supported recovery actions with beneficial outcomes for habitat conditions, and involve all stakeholder groups in planning process, when possible.
- **Regulatory Effectiveness** – 11 subawards that focused on gaps and barriers to effective regulatory programs designed to protect resources including compliance, effectiveness of existing regulations, capacity, and harmonization.

¹⁰ This represents a significant shift from earlier practice. For example, between 2011 and 2015 the Marine and Nearshore Lead Organization awarded more than \$7.2 million for habitat restoration and protection capital projects (Kinney et al. 2016) while HSIL 1.0 awarded only \$1.3 million for this category of projects.

¹¹ In most cases, there is a single NTA associated with each subaward made by HSIL. The one exception is covered in Chapter 3, where five Shore Friendly NTAs were supported via a single subaward to the Recreation and Conservation Office who then contracted with local programs. We use the terms project, subaward, and NTA interchangeably throughout this report.

Chapter 6 synthesizes the *collective contributions of all the subawards* to advancing the IS managed by HSIL and other regional recovery priorities.

Chapter 7 identifies projects that occurred within each LIO geographic area.

Chapter 8 provides some concluding observations about HSIL 1.0's investment portfolio and recommendations for HSIL 2.0 work to advance the IS they manage.

Tip: NTA numbers are helpful when you want to search for additional information about the projects discussed in the report.

You can visit <https://pugetsoundestuary.wa.gov/funded-projects/> and search by NTA number to see budget information, project fact sheets, and in some cases technical report deliverables. Information about projects funded by the other SILs and more recent HSIL 2.0 subawards is also available.

You can also visit <https://nepatlas.pugetsoundinfo.wa.gov/> to see schedule and financial information along with maps and PSP activity classifications.

CHAPTER 2: MONITORING AND INFORMATION GAPS

Chapter At-A-Glance

- 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. Initial results from an analysis of data uploaded to the regional database indicated that ecological response variables measured at beach restoration sites were generally improved after armor removal.
- Updates to mapping platforms managed by state agencies and other spatial data products are crucial for improving local implementation of critical area protections and advancement of the Land Development and Cover IS's prevent conversion of ecologically important lands strategy. Projects resulted in corrections to the location of >3,000 kilometers of stream reaches in the National Hydrography Dataset, and field assessments that documented salmonids in streams classified as non-fish in the DNR Hydro Layer. Updates to High Resolution Change Detection data products were used to evaluate the effectiveness of critical area ordinances.
- New monitoring protocols developed, and data obtained with HSIL funding are informing PSP's new Primary Productivity and Ocean Acidification Indicators for the Marine Water Vital Sign, as well as three new Zooplankton Vital Sign indicators.
- Stable funding is necessary for the success of a long-term monitoring program but is often lacking. HSIL supported zooplankton and European green crab monitoring programs during their transition from grant-support pilot efforts to programs supported with operations funding from the Washington State Legislature.
- Funding pilot monitoring efforts provides valuable insights about how to expand an existing monitoring program or develop a new one. HSIL-funded pilots for phytoplankton/nutrient and ocean acidification monitoring supported learning about sample collection logistics and staff capacity required to process samples.

The monitoring and information gaps investment theme includes 22 subawards involving data gathering and analysis to guide decisions, evaluate the effectiveness of restoration projects, or track status and trends in habitat conditions. Table 1 lists the subawards discussed in this chapter.

Table 1. Monitoring and information gaps investment theme subawards

NTA	Project	Owner
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 HRCO 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
2018-0822	Citizen Science and K-12 Education Program to Monitor Local Aquatic Habitat Effects from Climate Change	Department of Natural Resources
2018-0884	Washington Sea Grant Crab Team	Washington Sea Grant
2018-0893	Forage Fish Habitat Tidal Range	Department of Fish and Wildlife

We begin this chapter with two sections discussing subawards that advanced approaches identified in the Shoreline Armoring IS (develop and implement a regional monitoring strategy) and the Land Development and Cover IS (identify and share data about ecologically important lands to improve local implementation of the Growth Management Act). The Floodplains and Estuaries IS similarly recognizes the importance of data collection and sharing, but links these activities to the development of reach-scale Integrated Floodplain Management plans, so projects associated with that IS are discussed in Chapter 4.

The remaining sections of the chapter cover subawards that aimed to improve understanding of marine food web relationships and high priority threats such as ocean acidification and invasive species. These projects align with the Chinook IS and 2022-2026 Action Agenda Institutional Strategy C (coordinate and invest in research and monitoring). Some monitoring projects were prioritized by LIOs and selected for direct award funding.

[Puget Sound Ecosystem Monitoring Program](#) (PSEMP) work groups were engaged with several of these projects and new monitoring data obtained with HSIL funding were incorporated into new Vital Sign and/or indicator targets.

2.1 SHORELINE MONITORING

The Shoreline Armoring IS design and technical training strategy called for the development of a regional monitoring strategy to assess the success of individual projects and the cumulative effects of projects on ecosystem process and function. A near-term priority for this strategy was to compile and analyze existing monitoring information on implemented armor removal and soft shore projects to improve project designs and site selection.

In this section we describe four subawards that helped to accomplish these goals. These projects resulted in standardized regional monitoring protocols for data procurement and storage, as well as collection and analysis of monitoring data from beach restoration and armored/unarmored control sites throughout Puget Sound:

- NTAs 2016-0119 and 2018-0525: Supported Washington Sea Grant and University of Washington's School of Aquatic and Fishery Sciences work to implement Shoreline

Monitoring Toolbox protocols; develop a database to house and support analysis of data collected via toolbox protocols; analyze monitoring data collected to date to assess shoreline restoration effectiveness; and generate information that can be used in guidance to inform future armor removal projects.

- NTA 2018-0219: Supported Northwest Straits Foundation in coordinating application of Shoreline Monitoring Toolbox protocols by 13 volunteer organizations region-wide, and volunteer coordination for data collection at 28 shoreline restoration sites.
- NTA 2016-0328: Supported a study led by Puget Sound Institute and partners at the Northwest Fisheries Science Center to collect and analyze subtidal fish abundance data at 6 shoreline restoration sites.

2.1.1 SHORELINE MONITORING DATABASE

The Shoreline Monitoring Toolbox was launched in 2014 with support from PSP and the PSEMP Nearshore Work Group as a resource to standardize approaches for monitoring of Puget Sound shorelines and restoration project effectiveness. The toolbox is an online resource that consists of protocols for 15+ types of data (e.g., beach profile, wrack invertebrates, riparian vegetation, birds, insects) and a decision tree to help guide monitoring choices.

The first of two subawards to Washington Sea Grant and partner School of Aquatic and Fishery Sciences (via NTA 2016-0119) supported the creation of a [Shoreline Monitoring Database](#) that serves as a **regional repository for data collected by using Shoreline Monitoring Toolbox protocols**. Toft et al. (2023) developed the database and associated website with support from an advisory team of monitoring partners and restoration practitioners experienced in applying toolbox monitoring protocols. The advisory team provided guidance during database development, evaluated beta/final database products, and reviewed drafts of the database users guide. The project team also provided six training sessions for partners—citizen science, university, and agency restoration/monitoring practitioners—on toolbox protocols and how to use the database.

The second subaward (NTA 2018-0525) supported additional website and database development work, including an expansion of the number of [protocols](#) with metadata and instructions; addition of a [data visualization tab](#) with graphing capabilities to make outputs and queries interactive; and addition of a [map](#) showing locations of monitoring sites with an associated table with details about the sites.

At the end of the contract for the first subaward (January 2020), four protocols were included in the database and 12 organizations had uploaded/downloaded data. By the end of the contract period for the second subaward (March 2023), 11 protocols were included in the database and 35 organizations had uploaded/downloaded data. As of as of March 2023, 62 monitoring sites were included in the database with 22,693 feet of armor removed at 45 of these sites. As described in the next section, engagement with the Northwest Straits Foundation and WDFW facilitated the uptake of the protocols and regional database. Future

updates to the Shoreline Armoring IS's design and technical training strategy could potentially focus on supporting continued uptake.

Shoreline data collection

NTAs 2018-0525 and 2018-0219 also supported the collection and upload of old and new shoreline monitoring data. Toft et al. (2023) uploaded 11 historical datasets as well as data collected by partner organizations in 2021 and 2022. The Northwest Straits Foundation played a key role in coordinating data collection via partner organization, with funding from a separate HSIL subaward associated with NTA 2018-0219.

Northwest Straits Foundation (2022) worked with regional partners to identify restoration sites and roles for the management of monitoring efforts at each site. They coordinated multiple volunteer organizations (Friends of San Juans, Vashon Nature Center, Salish Sea Stewards, Sound Water Stewards, Friends of Saltwater State Park, and Marine Resources Committees for Whatcom, Skagit, Island, Snohomish, and Jefferson counties) and provided eight trainings for volunteers covering the purpose of monitoring, protocol details and the information they provide, and practical exercises for collecting field data. Northwest Straits Foundation (2022) led monitoring surveys, and subsequent data upload, for 28 restoration sites during the project period. Initial monitoring at several of these sites predated this subaward; Northwest Straits Foundation (2022) uploads to the Shoreline Monitoring Database include at least five years of post-construction monitoring data from 13 restoration sites. More information about volunteer involvement in this project is provided in Chapter 4.

Shoreline data analysis

The final element of NTA 2018-0525 was analysis of data uploaded into the Shoreline Monitoring Database with a focus on evaluating process, structure, and functional responses in the nearshore, as well as the effect of different types of restoration actions. This work was the culmination of almost a decade of coordination efforts and demonstrates that the Shoreline Monitoring Toolbox and Shoreline Monitoring Database have become a **framework for academic, agency, and community scientist collaboration that allows participating partners to achieve greater impact—both spatially and temporally—than they could working alone** (Toft et al. 2023).

The project team prepared six key deliverables documenting their analyses for a range of scientific, practitioner, and manager audiences:

- A [policy memo](#) that describes accomplishments to date and identifies current programmatic gaps and a [design memo](#) intended for project sponsors, design and engineering consultants, and funders.

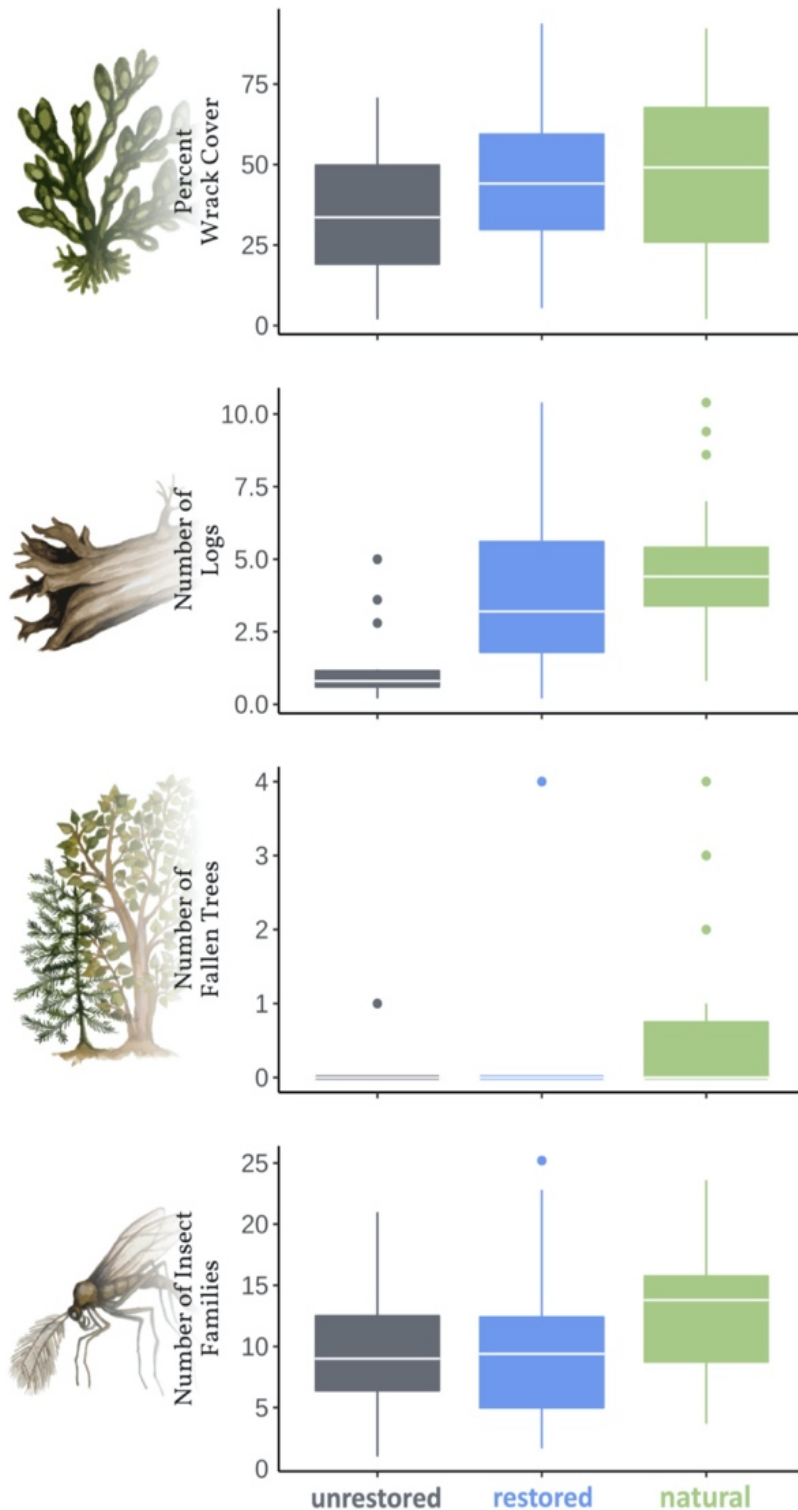
- A [case study report](#) (Des Roches et al. 2021) that assessed restoration outcomes at six sites¹² with at least five years of data. Data for four ecological response variables was analyzed and compared: percent wrack cover, number of logs, number of fallen trees, and number of insect families. Results demonstrated promising effects of restoration on all four response variables (Figure 1).
- Three manuscripts for publication in scientific journals. Two have been published to date: Des Roches et al. (2022) and Des Roches et al. (2024). Compared to the case study report, the manuscripts included analysis of data from more sites (n=18, 26, and 29) and additional ecological responses variables, including wrack depth, width or wrack line, wrack diversity (algae, eelgrass, terrestrial), width of log line, presence of one or both sizes of logs (small and large), richness of growth on logs, percent overhanging vegetation, insect density, number of insect orders. Additionally, two sediment protocol response variables (proportion of sand at surface and subsurface depths) were used for two of the papers.

The design memo and Toft et al. (2023) provided a few summary messages based on analyses conducted by the project team to help influence the design and implementation of future restoration projects:

- **Ecological response variables measured at restored sites were generally improved after armor removal.** Accumulation of wrack and driftwood were among the first observed responses to restoration. Response variables related to overhanging vegetation, fallen trees, and insects respond more slowly as growth and maturation of vegetation at restored sites takes time.
- **Shoretype influences restoration response.** Feeder bluffs had a higher proportion of surface sand and number of fallen trees compared to accretion shoreforms and pocket beaches. Natural pocket beaches had higher insect densities.
- **Fetch affects log and wrack input.** Sites with a large fetch had higher input from external marine sources. Sites with a small fetch had higher input from localized terrestrial sources.
- **Length of armor removed affected some of the response variables measured.** Total log count increased with length of armor removed. Invertebrate abundance was highest for the shortest lengths of armor removed. The proportion of wrack cover was similar for all lengths of armor removed. **Overall, results indicate that benefits can be achieved even with small-scale restoration.**
- **Addition of logs in combination with armor removal improved some response variables compared to removal alone.** Compared to before removal and removal only conditions, the proportion of surface gravel, total log count, proportion of wrack cover, and proportion of supratidal vegetation were all significantly higher when logs were added. Placement of logs post-armor removal may be an impactful supplemental strategy. **Placement of different log size classes can increase structural heterogeneity.**

¹² Shoreline monitoring sites generally include at least one “natural” (never armored) and at least one “restored” area. Many also include “unrestored” areas that still have armoring.

Figure 1. Effects of shoreline restoration on four response variables at six sites. Overall, the effects of restoration were positive for wrack cover, number of logs, number of fallen trees, and insect family diversity. Box plots summarize data across all transects at all sites across all years (Figure 2 from Des Roches et al. 2021)



2.1.2 SUBTIDAL MONITORING

The Shoreline Monitoring Toolbox includes fish protocols for beach-based snorkel and seine net surveys to measure species composition and abundance in intertidal waters. The adjacent (more waterward) shallow subtidal zone is also an important nursery habitat for Pacific salmonids and forage fish, but relatively little is known about the effectiveness of armor removal for subtidal habitats and the fish that use them.

Francis et al. (2020) aimed to address this gap with boat-based snorkel and lampara net surveys at six established intertidal monitoring sites. Monthly sampling events targeting Chinook and chum salmon, Pacific herring, and surf smelt occurred from April to September in 2018 and 2019. The occurrence and abundance of the four target species were patchy in space and time. Salmon were more commonly observed than the forage fish species. The lampara net surveys were more consistent in collecting quantifiable data in the subtidal zone.

Data were analyzed and results published in a scientific journal. Francis et al. (2022) estimated the effects of three variables on fish abundance: shoreline structure (restored, armor, natural); survey site location (geography); and subtidal habitat (eelgrass presence). The statistical models did not find consistently positive associations between salmon abundance and a lack of shoreline armor. Natural and restored shorelines were positively associated with chum abundance when eelgrass was present, but this benefit was limited when eelgrass was not present. If generalizable, this finding could potentially improve restoration planning by **prioritizing armor removal at sites where existing eelgrass beds are likely to support salmonids**. Herring and surf smelt abundance were positively associated with natural shorelines.

Francis et al. (2022) did not detect an impact of armor removal on fish use of subtidal habitats. This could be because benefits of armor removal are limited to beach and intertidal habitat, or due to other factors such as the scale of the study (temporal and spatial) or the impact of factors other than shoreline condition (e.g., prey availability, refuge from predators, water quality, and broader landscape features). The project team obtained funding from Washington Sea Grant in 2020 to continue and expand the spatial scale of sampling.

2.1.3 RECOMMENDATIONS

- Toft et al. (2023) provided several recommendations related to continued development and implementation of the Shoreline Monitoring Toolbox/Database:
 - Continue data collection at existing sites so 10+ year restoration trajectories can be developed. Continued funding support is instrumental for stewardship and analysis of resulting data.
 - Include more beach sites as they are restored to allow for analysis of additional spatial factors such as proximity to urban development, public versus private ownership, and climate. The addition of protected sites would help with assessment of natural functions.

- Add new protocols that could help improve project design. For example, sweep net sampling of insects and other arthropods in different types of vegetation could identify plantings that optimize production or diversity of salmon prey species.
- Include other shoretypes like embayments and river deltas.
- Successful volunteer and student involvement in monitoring at restoration sites requires ongoing training and staff time for organizational support. Future investments should attempt to make the level of monitoring effort more consistent across the region (i.e., central and south Puget Sound lack entities like Marine Resources Committees and the Northwest Straits Foundation).
- Given the amount of progress made towards the development of a regional monitoring strategy, future updates to the Shoreline Armoring IS should reflect progress to date and encourage continued use of the standardized protocols and regional Shoreline Monitoring Database. Additional focus on development of more physical protocols and/or new soft shore protection engineering performance metrics may also be warranted.
- The collaborative shoreline monitoring framework may be an approach to consider replicating for marine vegetation. Kelp distribution and trends monitoring was identified as a high priority in the 2020 kelp recovery plan and, like beach monitoring, there is already a network of volunteer-based organizations participating in monitoring activities. Standardized protocols and a centralized data repository may be beneficial in this context.

2.2 SPATIAL DATA PRODUCT UPDATES

The Land Development and Cover IS's prevent conversion of ecologically important lands strategy called for improving local implementation of the Growth Management Act. Regional partners can advance this goal by supplying data to support critical areas¹³ management via geospatial platforms managed by state agencies and resources to support effectiveness monitoring for local critical area regulations. Local partners also have a role in ensuring multi-directional flow of spatial data by submitting data collected within their geography to authoritative datasets (PSEMP 2019).

In this section we describe four subawards that corrected inaccuracies in stream data layers used by local governments to determine the size of and restrict development within riparian buffers; supplied information about the location of fish passage barriers that can support capital facilities planning to prioritize corrections; and updated a regional land cover change analysis that can be used to evaluate the effectiveness of critical area protections. The subawards described in this section are:

¹³ Types of critical areas and Growth Management Act requirements for their management are described in Chapter 5. Projects discussed in this chapter largely focus on riparian and stream habitats, which are protected as Fish and Wildlife Habitat Conservation Areas under the Act.

- NTA 2018-0436: Supported updates to the National Hydrography Dataset using WDFW stream survey data. The updated stream layer was then leveraged to develop a pilot downstream fish barrier prioritization tool.
- NTA 2018-0505: Supported Wild Fish Conservancy water typing and eDNA assessments in five Kitsap County watersheds. Results were used to update the location and classification (fish/non-fish) of streams in three state-managed data platforms.
- NTA 2016-0131: Supported North Olympic Lead Entity collection of fish passage barrier data for four Clallam County watersheds. Results were added to the statewide barrier map.
- NTA 2016-0141: Supported WDFW work to update High Resolution Change Detection (HRCd) data products and build two new landcover layers for tree canopy and visible surface water.

2.2.1 HYDROGRAPHY DATASET UPDATES

Washington state agencies manage two surface water geodatabases that provide a foundation for several resource management Geographic Information System (GIS) data tools and applications:

- The National Hydrography Dataset (NHD) is a comprehensive depiction of water drainage networks throughout the United States. The NHD is the hydrography standard for Washington and is maintained by the Washington Department of Ecology (Ecology), U.S. Geological Survey, and U.S. Forest Service (USFS).
- The Washington Department of Natural Resources Hydrography (DNR Hydro) layer contains both water feature location data and water typing classifications that provide information about fish usage of waterbodies and if streams experience perennial or seasonal flow. This information is used to determine the amount and pattern of riparian buffer protection required during forest practices activities on state-owned and private forestlands.

Most cities and counties use one of these layers to support local land use permitting on parcels where streams and freshwater riparian buffers are present. During an HSIL-funded Critical Area Ordinance (CAO) effectiveness evaluation discussed in detail in Chapter 5, Folkerts (2021) found that **water type is the most common criteria used in CAOs to determine riparian buffer widths**. Table 2 shows how buffers adjacent to fish streams tend to be larger than those adjacent to streams designated as non-fish, though the range of buffer size among the 22 jurisdictions in this sample was large. Folkerts (2021) also found that locational **errors in underlying hydrography data created inaccuracies in riparian maps and change analyses**. These “blue line” errors generally are not a problem given the scale and purpose for which these layers were designed but make analyzing sites at a finer scale difficult (Folkerts 2021).

Table 2. Variation in the width of riparian buffers required by CAOs of 22 local jurisdictions in the Puget Sound Region (data from Folkerts 2021)

Water Type	Minimum riparian buffer width	Maximum riparian buffer width
Type S (Shoreline)	100 feet	250 feet
Type F (Fish)	75 feet	250 feet
Type Np (Non-Fish)	25 feet	225 feet
Type Ns (Non-Fish Seasonal)	5 feet	225 feet

Since errors in water type and stream location data have the potential to reduce the effectiveness of local riparian protections, HSIL funded two subawards (via NTAs 2018-0436 and 2018-0505) that provided data used to update NHD and WDNR Hydro layers. After completion of these projects, such updates have been identified as a regional priority by the PSEMP Spatial Data Work Group (formed in 2021) and are now coordinated through their [Riparian Monitoring Focus Team](#).

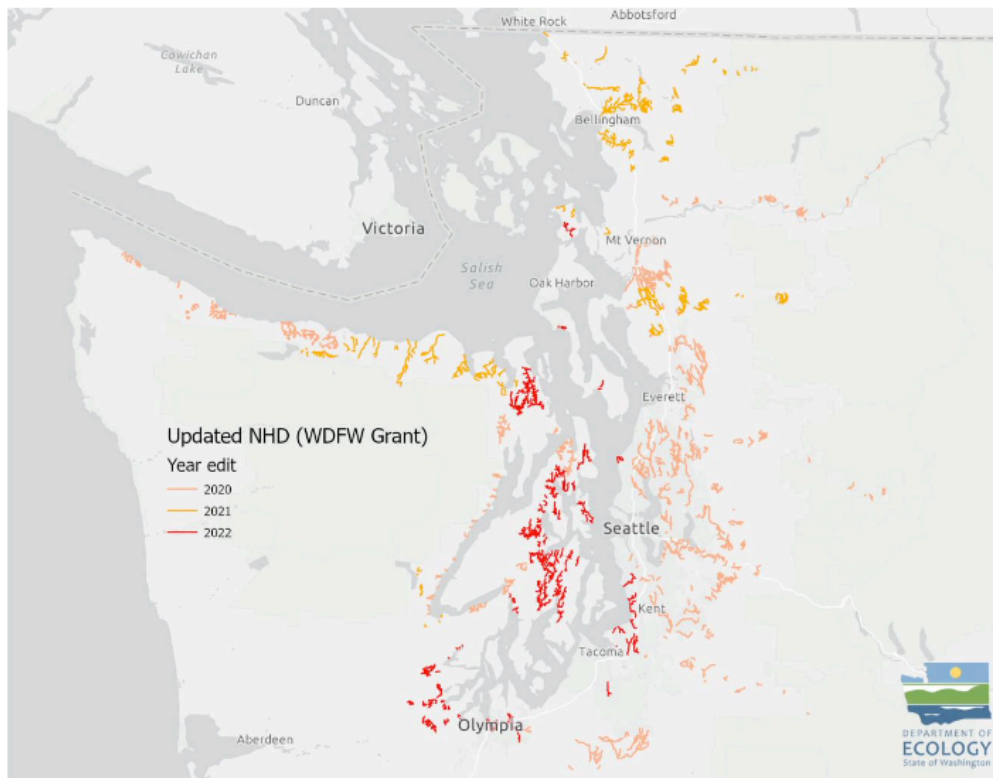
National Hydrography Dataset update

WDFW (2022) partnered with Ecology to incorporate data from 30 years of WDFW stream surveys into the NHD stream layer. The project team scanned fish passage habitat survey documents that included hand drawn maps and field notes of stream locations. Once digitized, these files were sent to Ecology to be compared to the existing NHD dataset. Ecology's NHD Data Steward reviewed and compared the maps to existing NHD data, aerial imagery, and LiDAR hillshade models to determine the best location for the watercourse and update where warranted. In cases when stream reaches crossed into USFS jurisdiction, Ecology would share suggested updates with the USFS NHD Data Steward for approval.

This process resulted in significant improvements to the accuracy of the NHD layer—**over 3,000 km of stream reaches** were updated (Figure 2). Many of the updated streams were in highly populated zones, where changes may have been due to human manipulation of streams over time.

However, Pierce et al. (2020) identified additional NHD stream location errors during development of a new Visible Surface Water Layer data product as part of a subaward described in Section 2.2.3. **There remain many streams that are still incorrectly located within the Puget Sound region and Ecology's NHD Data Steward is working on additional improvement actions** (WDFW 2022). The supplemental operating budget enacted during the 2024 session of the Washington State Legislature included \$3.3 million for Ecology to [modernize surface water mapping](#).

Figure 2. National Hydrography Dataset stream reaches updated via NTA 2018-0436



Kitsap County stream location and water type classification updates

The Wild Fish Conservatory performed water type assessments and eDNA sampling work throughout Kitsap County. The goal of this project was to gather fish distribution and stream location data to improve hydrography layers and other spatial data products. This project received a LIO direct award from the West Central LIO.

Water typing is a WDNR [classification system](#) that identifies whether streams and other water bodies are used by fish and whether they experience perennial or seasonal flow. Water type is used by some local governments to help designate the size of buffer zones adjacent to streams. WDNR generates a [water type map](#) using the hydro layer to predict the distribution of fish habitat in streams. However, WDNR has acknowledged that the map can be inaccurate (Glasgow and Jorgenson 2022). This project sought to improve the accuracy of the DNR Hydro Layer through traditional water type field surveys. The project additionally provided updates to the [Statewide Integrated Fish Distribution](#) data layer and the NHD. Wild Fish Conservatory has performed water typing field surveys since 1994; results of this award supported their Phase II water typing project which began in 2010 (WFC 2023).

Glasgow and Jorgenson (2022) coordinated with the West Central LIO to identify priority watersheds based on data gaps, anticipated development, development pressure, and local recovery priorities. Five were selected for assessment: Burley Creek, Curley Creek, Clear Creek,

Dogfish Creek, and Olalla Creek. To aid in stream site selection for the water type surveys, the subawardee developed a project-specific GIS model for the five prioritized watersheds. This model helped to predict the distribution of fish habitat in each watershed and helped to track the stream type updates for each spatial data product. Field sites could include city, county, or state road rights-of-way and private properties. For any potential site located on private lands, Wild Fish Conservancy mailed a letter to the landowners requesting permission to enter the property.

Permission request forms were mailed to 2,465 private property owners in the five watersheds; 706 owners replied and 424 granted access. Landowner participation is a well-known challenge for voluntary stewardship activities, but factors contributing to the particularly low response rate for this project are unknown. One possible explanation is that owners were concerned about the regulatory implications of critical areas being identified on their property.

At each site, Wild Fish Conservancy conducted field surveys following water type classification protocols.¹⁴ Through the field surveys, the subawardee collected 1,286 georeferenced photos; caught and identified 202 fish to assess fish distribution; and documented 391 instream barriers.

The subawardee **found miles of undocumented or incorrectly mapped streams and documented fish in numerous reaches previously identified as Type N (non-fish)**. Corrected stream reaches from the water type assessments were submitted for updates to DNR Hydro Layer and the NHD. Glasgow and Jorgenson (2022) submitted:

- 15 miles of Type F (fish) upgrades to the DNR Hydro Layer. 11.5 miles were previously undocumented, and 3.5 miles were found to be misclassified.
- 24 new stream segments (9.8 linear miles) submitted for the NHD layer. These upgrades were still pending at grant closing.

Fish occurrence updates were also provided to WDFW and the Northwest Indian Fisheries Commission for inclusion in the Statewide Integrated Fish Distribution dataset. Additionally, the project team identified 166 instream structures out of the 391 surveyed that acted as full or partial barriers to salmon migration. During the stream typing surveys it was noted that these structures impeded access to otherwise healthy fish habitat. Wild Fish Conservancy also added these barriers to their [interactive water typing survey results map](#).

Through this award, Wild Fish Conservancy found that the DNR Hydro Layer often under-represented the upper extent of fish habitat (Type F), and many streams were mis-mapped or not mapped at all. Similar inaccuracies were found in the Statewide Integrated Fish Distribution data and the NHD.

¹⁴ From [WAC 222-16-031](#) and [Section 13 of the Forest Practices Board Manual](#).

As part of this project the Wild Fish Conservancy also conducted eDNA analyses throughout West Central Puget Sound. eDNA analyses extract DNA out of an environmental sample (water, soil, snow, air) and classifies the genetic materials of known species. eDNA has the potential to be an important tool for classifying streams as it is less costly, less harmful to fish, and can more easily identify harder to find species (Glasgow and Jorgenson 2022). This work was aided by the USFS National Genomics Center who provided sampling materials as well as processing support. Sampling occurred between June 2020-April 2022 and resulted in 396 eDNA samples from 173 sites.

The eDNA analysis found 99 positive detections from 80 sites (Hernandez et al. 2022). Of particular interest, Chinook eDNA was detected in two streams where Chinook was previously undocumented; 16 *O. mykiss* detections occurred in streams previously undocumented; and 14 coho detections occurred in streams where they were previously undocumented. All results from the eDNA analysis were uploaded to the [interactive eDNA results map](#). Wild Fish Conservancy used the eDNA results to describe distribution of fish species of interest, but these results were not used to justify updates to official data products. Along with offering a more cost-efficient water typing method, eDNA analysis has the potential to act as a tool for examining the success of management actions like fish barrier corrections (Allan et al. 2023).

2.2.2 FISH PASSAGE DATABASE UPDATES AND 'FIND DOWNSTREAM BARRIERS' TOOL

Two HSIL subawards, funded through NTAs 2016-0131 and 2018-0436, resulted in updates to the [Washington State Fish Passage](#) geodatabase and web application managed by WDFW.

As part of a larger project to advance fish passage barrier removal in WRIA 19, the North Olympic Lead Entity for Salmon (2019) partnered with the Clallam County Roads Division and Streamkeepers of Clallam County to complete culvert assessments¹⁵ for county roads in the Pysht, Clallam, Sekiu, and Hoko watersheds. The process for identifying fish passage barriers included field work by the Lead Entity's restoration planner and a team of trained volunteer technicians from Streamkeepers. The team completed assessments for **437 county roads** within WRIA 19. Data was recorded on paper then entered onto a GPS collection device. Significant culverts were photographed. Transportation to the roads was paid for by Clallam County Public Works and the Road Department.

All data from the surveys was inputted to ArcGIS for an analysis. The GIS analysis included building a spatial database for fish species data, stock status, trend information for the region, and field photos. LiDAR and Digital Elevation Models were used to extract stream layers to determine stream gradients to help in determining upstream and downstream barriers. A Lead Entity culvert technical subcommittee reviewed the culvert survey data to provide

¹⁵ Following Level A protocols in WDFW's [Fish Passage, Inventory, Assessment, and Prioritization Manual](#). This involves collecting data on culvert size, shape, and depth; channel characteristics including bankfull width and tidal influence; and plunge pool length, depth, and width then completing a flowchart to determine status as a barrier.

recommendations on where to conduct general habitat assessments, which then informed selection of sites for formal habitat analysis.

The Lead Entity contracted with a former WDFW habitat biologist to help conduct the habitat assessment surveys. The habitat analyses provided descriptions of riparian conditions, substrate conditions, and instream features for each stream. The analyses included written and photo documentation of each site. Streams were also distinguished as either Fish Type or Non-Fish Type using the Interim Water Typing System in WAC 222-16-031. The habitat analyses were then used to prioritize culverts for correction. A spreadsheet with various categories of data was sorted based on culvert passability (those with <67% passability retained). Culverts in the Hoko watershed were removed from the list because they had been prioritized previously. This list was then reviewed by the technical team who compared it with the habitat analysis information to bin the culverts in four categories depending on stream gradient, habitat value, and downstream status. Results from these assessments were provided to WDFW for incorporation in the Fish Passage Barrier Statewide Map.

Development of a Downstream Barrier Identification Tool

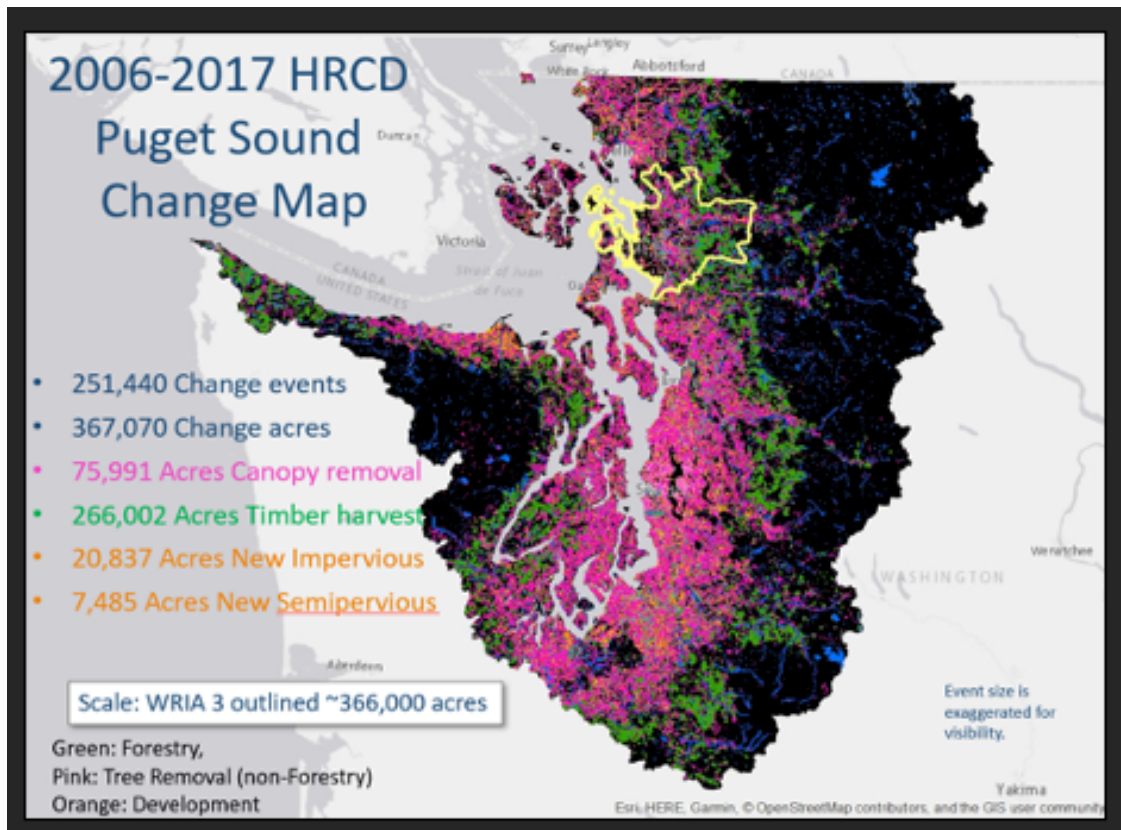
After new stream location data was incorporated as part of the NHD update project (NTA 2018-0436), WDFW (2022) uploaded the corrected layer to their fish passage geodatabase and developed a beta Find Downstream Barriers Tool that has been incorporated into the [fish passage web mapping application](#). This tool allows users to identify any barriers downstream of any mapped feature (Puget Sound watersheds only) by clicking on a new “Find Downstream Barriers” button at the bottom of the feature’s pop-up window. This tool fills a need identified by the [Brian Abbot Fish Barrier Removal Board](#); it provides planners and project sponsors with data that can improve barrier correction project sequencing and prioritization efforts.

2.2.3 HIGH RESOLUTION CHANGE DETECTION

In 2010, WDFW developed a [High Resolution Change Detection](#) (HRCD) project to utilize 1-meter resolution National Agriculture Imagery Program products to conduct detailed analyses of land cover change. This imagery is updated every 2 to 3 years and with each update the HRCD team conducts a change analysis. The analysis compares old and new images to detect four types of changes: tree canopy loss, new impervious surface, new semi-impervious surface, and total change area.

An HSIL subaward associated with NTA 2016-0141 supported Pierce et al. (2020) work to complete the 2013-2015 and 2015-2017 HRCD analyses. Results of this analysis are shown in Figure 3. The HRCD team catalogued 251,440 change events in the Puget Sound region between 2006-2017. Major causes of change between 2013-2017 were forestry, tree removal, and development. The observed annual increase in impervious surfaces was 0.05%; this is equivalent to a 1% increase in impervious area over 20 years (Pierce et al. 2020).

Figure 3. Puget Sound land cover change 2006-2017 (from Pierce et al. 2020)



This subaward also supported the development of three new data products. Pierce et al. (2020) used Washington Department of Natural Resources Photogrammetry Lab surface models to generate [Visible Surface Water](#) and [Tree Canopy](#) layers and then used these layers to support a beta [High Resolution Land Cover data product](#). This new product will include vegetation classes and height data to better display canopy coverage and land cover change over time.

The updated HRCD data products developed through this subaward were used by Folkerts (2021) in a pilot critical area ordinance effectiveness evaluation discussed in Chapter 5. Additionally, the HRCD is mentioned as a potential method to monitor PSP's Salmon Habitat Indicators and Forest and Wetlands Vital Sign Indicators.

2.2.4 RECOMMENDATIONS

- Regional partners should consider providing funding support for regular updates to spatial data products managed by state agencies. This is necessary to ensure these tools remain current and accurately identify ecologically important lands for regulatory and other purposes.
- Folkerts (2021) noted that many local jurisdictions use the DNR Hydro Layer or an outdated snapshot version thereof to support riparian buffer regulatory decisions. After the NHD update supported through NTA 2018-0436, the NHD is best available science on stream

location. Encouraging use of the NHD layer and providing training to local jurisdictions about how to use it could improve critical areas management.

- Glasgow and Jorgenson (2022) recommended an expanded effort to systematically field-verify the locations and classifications of streams through water type assessments.
- The benefits of using eDNA as a stream classification tool should be explored. If eDNA is a cheaper and simpler alternative to traditional water typing methods, it could support improved identification of fish bearing streams.

2.3 FOOD WEB AND CHINOOK INVESTIGATIONS

The Chinook IS and Southern Resident Orca Task Force both advocated for collecting data to improve understanding and management of Puget Sound’s marine food web. Zooplankton and forage fish monitoring were specifically called out in Southern Resident Orca Task Force [Recommendation 15](#) and [Recommendation 16](#).

In this section we describe 10 monitoring subawards reflecting a core principle that ecosystem health depends upon the vitality of trophic level interactions (Long Live the Kings 2019, Harrington 2021, Dionne et al. 2022). The following projects provided data about primary producers (eelgrass and phytoplankton), primary consumers (zooplankton), and secondary consumers (forage fish and juvenile salmon) as well as life history diversity in Chinook salmon:

- NTA 2018-0295 – Supported Jamestown S’Klallam Tribe in testing integration of phytoplankton sampling into the Puget Sound-wide Zooplankton Monitoring Program.
- NTA 2018-0409 – WDNR and the Suquamish Tribe conducted eelgrass nearshore monitoring surveys within various sites around Central Puget Sound.
- NTA 2016-0367 – Supported Long Live the Kings in transferring ownership of the Puget Sound-wide Zooplankton Monitoring Program to the Washington Department of Fish and Wildlife, while proceeding with monitoring efforts.
- NTA 2018-0575 – Supported the WDFW and the University of Washington in continuing the Puget Sound-wide Zooplankton monitoring effort.
- NTA 2018-0242 – WDFW conducted nearshore studies on sand lance to define where sand lance utilize beach habitat around Puget Sound to improve management effectiveness.
- NTA 2018-0893 – WDFW conducted nearshore surveys to better their understanding on surf smelt beach spawning ecology and improve management effectiveness.
- NTA 2018-0437 – WDFW and the Suquamish Tribe used acoustic trawl surveys to estimate Pacific herring biomass within Puget Sound.
- NTA 2018-0556 – Moss Landing Marine Labs sought to fill a gap in understanding the predator-prey relationship of salmon and Pacific Sand Lance in Puget Sound.

- NTA 2018-0624 – WRIA 19 Lead Entity tracked Chinook migration, residence time, and habitat use at multiple sites in the Lower Green River.
- NTA 2018-0809 – Supported WDFW in monitoring life history stages of salmon in Puget Sound.

2.3.1 NUTRIENT, PHYTOPLANKTON, AND EELGRASS MONITORING

The base of the Pacific salmon food chain begins with primary producers like phytoplankton and eelgrass. With funding from NTA 2018-0295, the Jamestown Tribe investigated incorporating phytoplankton and nutrient sampling into the Puget Sound Zooplankton Monitoring Program. This pilot project lasted between February and October 2021 and focused on two locations: Admiralty Inlet and Thorndike Bay. Researchers collected phytoplankton and nutrients samples simultaneously with zooplankton collections. The logistics associated with adding these extra samples did not cause an undue burden. However, the lab time for microscopy was very time consuming and additional capacity would be needed to support continuation and expansion of nutrient and phytoplankton monitoring. Harrington (2022) found:

- High concentrations of *Chaetoceros* spp. during early May, a time several species of out-migrating smolts are present. This algal species has been shown to cause mortality in farmed salmon in net pens.
- The dinoflagellate *Alexandrium catenella*, which produces paralytic shellfish toxins, was observed in high enough concentrations to produce toxic shellfish in July at Thorndike Bay and early September at Admiralty Inlet.
- Nutrient concentrations declined with phytoplankton growth in the spring and summer. Values near zero were observed in samples from Thorndike Bay in early May and July.
- Highest values of nitrate and nitrite found at the beginning (February 2021) and end (October 2021) of the sampling period.

This pilot sampling effort has informed PSEMP efforts to develop the new [Primary Production Indicator](#) associated with the new [Marine Water Vital Sign](#). PSEMP Marine Waters Workgroup workshops about indicator development identified a need for phytoplankton datasets that span the region. **This project is one of several HSIL-funded efforts that demonstrate the value of using pilots to expand or develop new monitoring programs.**

Eelgrass is an indicator of estuarine health and provides critical habitat for fish like out-migrating salmonids and Pacific herring. The HSIL subaward associated with NTA 2018-0409 supported 2019 and 2020 monitoring efforts for the West Sound Eelgrass Monitoring Program, a partnership between WDNR and the Suquamish Tribe that provides monitoring data for the larger WDNR Nearshore Habitat Program. Christiaen et al. (2021) completed baseline surveys at 25 new monitoring sites along the west shoreline of Colvos Passage; resampled 29 sites from Southworth north to Foulweather Bluff; and conducted a change analysis for 35 sites along the upper Kitsap Peninsula and eastern shore of Bainbridge Island. The trends analysis found that

eelgrass remained stable at 30 sites and declined at four sites; one site (Liberty Bay) never had eelgrass present. Results from this monitoring effort may support tracking of the [Eelgrass Area Indicator](#) for the new [Beaches and Marine Vegetation Vital Sign](#).

2.3.2 ZOOPLANKTON MONITORING

As a primary consumer in the food web, zooplankton play a key role as a prey item for juvenile salmonids, forage fish, and other species (Long Live the Kings 2019). Zooplankton are sensitive to environmental anthropogenic forcings. Monitoring of community composition over time may identify trends that can provide insights about ecosystem health.

The Salish Sea Marine Survival Project (SSMSP) was an international collaborative research effort led by Long Live the Kings (U.S.) and the Pacific Salmon Foundation (Canada). One of its first major pilot projects was the Puget Sound Zooplankton Monitoring Program which began in 2014. The creation of this monitoring program filled a high-priority need identified by the Puget Sound Science Panel, PSEMP, and others. HSIL provided two subawards for the zooplankton monitoring program (NTAs 2016-0367 and 2018-0575).

As of 2022, the Puget Sound Zooplankton Monitoring Program had sixteen stations and 12 partner organizations. Figure 4 shows the monitoring sites and associated partners. All data from the monitoring program is available on a [King County website](#). With the help of multiple funding sources, including HSIL, and partner cooperation, the zooplankton monitoring program ran continuously from 2014-2022, with a brief break in 2020 due to the COVID-19 pandemic.

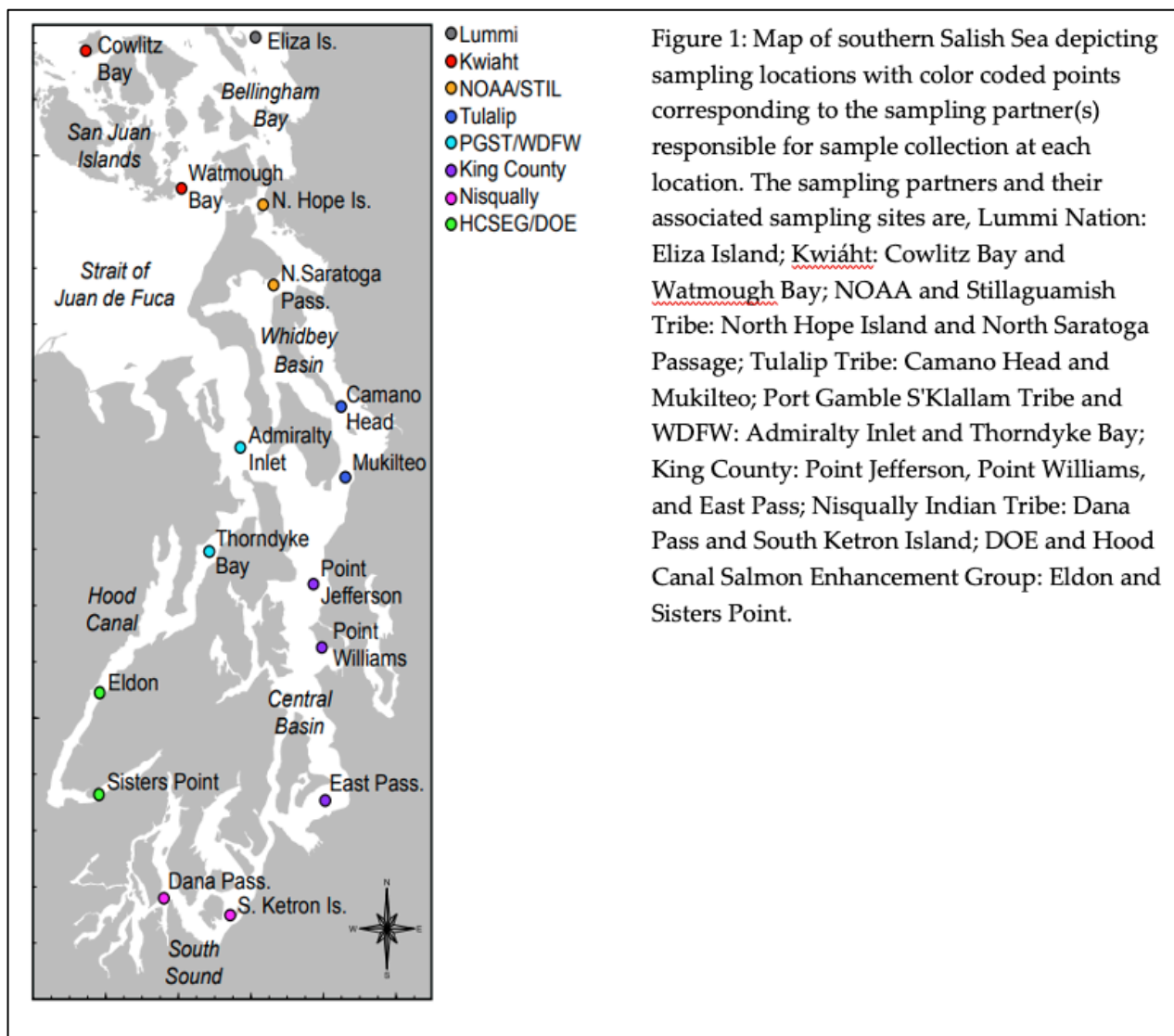
HSIL funding enabled Long Live the Kings (2019) to successfully transition the program to WDFW. The collaborative structure of the monitoring program was preserved through the transition.

WDFW, in collaboration with the University of Washington, continued the program with a second HSIL award to continue monitoring for the 2021-2022 season. Results from the overall monitoring effort indicate that the Puget Sound Zooplankton Monitoring Program has a high potential to reveal ecosystem trends, but a baseline condition has been difficult to determine. Dionne et al. (2022) suggest that it will be years before trends can be established.

The flexibility of HSIL funding allowed this program to continue during a critical period of transition. Secure funding is a necessary for the success of a long-term monitoring program. Since relocating to WDFW the Puget Sound Zooplankton Program has received additional financial support. During the 2023 session of the Washington State Legislature, WDFW received a \$645,000 appropriation for zooplankton monitoring.

The PSEMP Forage Fish and Food Webs Work Group has developed a new [Zooplankton Vital Sign](#) with three indicators. Data collected through the regional zooplankton monitoring program will be crucial for development of indicator targets and subsequent reporting.

Figure 4. Zooplankton monitoring stations (Figure 1 from Dionne et al. 2022)



2.3.3 FORAGE FISH MONITORING

Forage fishes—Pacific herring, surf smelt, and sand lance—are the critical link between marine zooplankton and larger fish in Puget Sound’s marine food web (Penttila 2007). HSIL funded four studies which helped to fill gaps in knowledge about forage fish abundance, geographic spread, and habitat preferences. Outcomes from these awards may enable more effective management of different forage fish species both inshore and offshore.

Intertidal forage fish habitat surveys

Two WDFW subawards specifically sought to improve management effectiveness by conducting nearshore surveys. The two projects had similar goals – to fill knowledge gaps about nearshore habitat use so that Hydraulic Project Approval conditions can be applied to better protect these areas. Olson et al. (2021) focused on increasing knowledge of burying habitat for sand lance,

while Faulkner (2022) studied surf smelt beach spawning ecology. Both studies resulted in increased knowledge of temporal and spatial habitat usage by sand lance and surf smelt. **These surveys are an example of highly actionable science because results have clear and immediate management applications.**

Olsen et al. (2021) determined that **sand lance can use the same nearshore burying habitat over multiple generations.** The surveys were comprised of shore-based digs and offshore boat-based Van Veen grabs at six sites around Puget Sound. Each site was chosen based on having previously documented sand lance spawning areas, existing nearshore habitat, and ease of access. Sampling occurred in November and December to coincide with the sand lance dormancy period. WDFW conducted a total of 19 surveys throughout the sites; only two sites received both onshore and offshore surveys. The survey results found sand lance at three of the six sites. Previous studies documented sand lance at two of the three sites found to have dormant sand lance, suggesting that these nearshore areas support multiple generations. Degradation or destruction of this nearshore habitat could then have a generational impact on local populations of sand lance. However, WDFW did also determine that the location of spawning habitat may not be a good indication of the presence of nearshore burying habitat based on not discovering sand lance at half of the surveyed sites. Results from this study were presented to the PSEMP Forage Fish and Food Webs Work Group during a Sand Lance Mini-Symposium.

Faulkner (2022) determined that **surf smelt can spawn in a range of beach conditions and in both summer and winter, making it necessary to conduct surveys before construction activities to reduce potential impacts.** Surf smelt spawning beds are a designated saltwater habitat of special concern per WAC 220-660-320(3)(b)(ii). As such, WDFW may add conditions on Hydraulic Project Approvals to limit or qualify construction activities if surf smelt spawning is documented. Surf smelt surveys have occurred in Puget Sound since the 1970s, but because of their short incubation period spawning sites have been difficult to study. WDFW sought to enable more effective management of surf smelt by increasing knowledge of the spatial and temporal variability of surf smelt spawning in the nearshore. For the survey, WDFW selected sites using the [WDFW beach spawning GIS database](#) of known surf smelt spawning areas. Selection was determined from frequency of spawning events and accessibility. Three sites were chosen: two in the Eld Inlet and one on the east shore of Port Susan Bay. Surveys were conducted every two weeks through summer (July – September 2020) and winter (January – March 2021) months. The surveys gathered data on substrate conditions and beach structure, while collecting surf smelt egg samples. Beach structure ranged between sites and between seasons. Results from the survey found surf smelt eggs at each site, but with varying counts. There was not a strong correlation between spawning activity and beach structure or between seasons which suggests that there is no known ideal site for smelt spawning in Puget Sound. A main conclusion from this study is that surveys are a requirement for knowing where and when surf smelt spawning occurs.

Subtidal sand lance habitat survey and salmon diet composition

Greene et al. (2023) examined the extent to which forage fish, particularly sand lance, made up the adult salmon diet in Puget Sound. This study, by Moss Landing Marine Labs, focused on the subtidal habitats within the San Juan archipelago. The goal was to understand the location of subtidal sand lance foraging habitat relative to salmon feeding areas. This study ran for two seasons, 2021 and 2022. The study methods included mapping the sea floor using high resolution bathymetry and collecting salmon stomach samples with help from chartered fishing vessels. Through the mapping process, the subaward identified previously unmapped banner banks, which are preferred habitat for sand lance, while the results of the stomach samples (n=109) determined that Chinook and coho were feeding primarily on herring, sand lance, or crustaceans.

Pacific herring acoustic trawl surveys

WDFW, in partnership with the Suquamish Tribe, piloted a study to improve understanding of Pacific herring abundance and age structure in Puget Sound. Since 1972, WDFW has conducted annual egg deposition surveys to estimate biomass of Pacific herring stocks. The results from these surveys are used to update the “Biomass of Spawning Pacific Herring” indicator for the [Forage Fish vital sign](#). Though successful in estimating biomass, the egg deposition surveys are unable to provide information on Pacific herring biometric indices and juvenile populations. To fill this gap, Sandell et al. (2022) tested the use of Acoustic-Trawl surveys as a potential preferred or additional survey method.

WDFW previously conducted Acoustic-Trawl surveys to gather Pacific herring biometric data. Acoustic-Trawl surveys use hydroacoustics and a mid-water trawl to find and catch fish at-sea for examination. This method was discontinued by WDFW in 2009 due to lack of funding and staff time (Sandell et al. 2022). Since then, egg deposition surveys have been the main source of biomass data for Pacific herring by WDFW. Egg deposition surveys typically consist of WDFW spending 10 days sampling forage fish eggs in nearshore waters throughout the southern Salish Sea and then sampling on a weekly basis once the eggs hatch. This method captures more spatial and temporal data about spawning activity, in contrast to the acoustic method which usually lasts a night or two per year and are more spatially limited.

The study used the acoustic surveys to test for Pacific herring biomass and determine trawl locations. The surveys focused on discrete locations that were linked with pre-spawning herring holding areas, apart from Elliott Bay which had an unknown pre-spawning area. The sites were selected based on previous WDFW Acoustic-Trawl work (Stick and Lindquist 2009). Between 2021 and 2022 the study surveyed sites in: Port Orchard-Port Madison, Quilcene Bay, Port Gamble, Elliott Bay, Holmes Harbor, and Port Susan. For the trawl survey, WDFW enlisted the F/V *Chasina* trawler to collect herring samples from the survey sites. Trawls were conducted at nautical twilight, and only when acoustic tags determined herring presence. The study noted the sex ratio, age-at-length, population structure, fish condition of Pacific herring and tracked bycatch numbers.

Biometric data was successfully pulled from at least 50 herring per trawl, through there was limited biomass result success from the acoustic surveys. The outcomes from the study found that the biometric data from acoustic and trawl surveys advanced understanding of the changes and differences in demographics among stocks. However, the egg deposition survey remained more accurate in estimating biomass. **Given the cost and effort involved, WDFW does not suggest replacing the egg deposition surveys with the Acoustic-Trawl method.** Sandell et al. (2022) suggest more extensive Acoustic-Trawl surveys are needed to understand the full picture of herring distribution and timing of aggregation areas.

2.3.4 CHINOOK MONITORING

HSIL funded two awards that provided insights into habitat use, migration, and residence times of Chinook salmon. These studies increased knowledge about juvenile Chinook rearing habitats in the Green River and life history diversity of returning adult Chinook. The results from these studies can be used to support restoration planning.

Lower Green River PIT tagging

King County (2022) led a study to fill a knowledge gap about the use of the lower Green River by juvenile Chinook. This work was completed in partnership with the WRIA 9 Lead Entity. Past monitoring efforts on the middle Green River found that Chinook parr (juveniles >45mm) made up half of the Chinook subyearling outmigration and produced nearly 95% of the adult returns (WDFW 2018a and 2018b). This study sought to better understand the importance of the lower Green as Chinook rearing habitat and to assess the effectiveness of past restoration projects. The focus of the study were juvenile Chinook that entered the lower Green as fry and left as parr.

King County (2022) measured the residence time, migration patterns, and survival of juvenile Chinook using 9mm passive integrated transponder (PIT) tags. This study was the first to use 9mm PIT tags on juvenile Chinook in Puget Sound. Seven sites were chosen as sample locations. These sites were chosen based on previous restoration history, Salmon Habitat Plan priority status, or association with WDFW or King County (King County 2021). The study also included hatchery Chinook which were retrieved from WDFW's Soos Creek Hatchery. Upon tagging, King County released the hatchery-born Chinook at the WDFW screw trap site. To detect the tagged specimens as they moved through the river, King County partnered with West Fork Environmental to construct two small antennas and a large PIT antenna barge. The primary point of detection was the PIT antenna barge near Tukwila.

Between May and July 2021, King County (2022) tagged 956 wild Chinook and 3,188 hatchery origin Chinook. 257 tagged fish were detected at the antenna barge between May 2 and July 7. Of the 257 detected 26 were from natural origin Chinook. Other results from this study found that:

- Residence time averaged 18.5 days for natural origin-Chinook. Residence time ranged from 3-59 days.

- The barge detected 2.5% of natural origin and 2.6% of hatchery origin Chinook released at the screw trap. The estimated survival rate from all Chinook released at the screw trap was ~27.7%. The highest survival occurred in June (32.3% and 39.3%).

The study determined that subyearling Chinook are spending up to 2 months in the mainstem lower Green River, suggesting that restoration of the **lower Green River benefits not only smaller Chinook fry but also offers rearing habitat for parr**. Results show that juvenile Chinook are rearing in the lower Green to a greater extent than previously known and suggest that **improving access to non-natal tributaries and off-channel areas should remain a priority** for the lower Green as should mainstem restoration activities. Due to data limitations this study could not assess the impact of restoration projects on residence time. A longer term-study may provide answers. An additional output from this subaward was [a video describing the project](#).

Life history strategy variability

Campbell et al. (2023) conducted a regional study on Chinook salmon life history stages within nine river basins of Puget Sound. The subawardee sought to understand the differences in life history patterns between the river basins. The study had three goals:

- Describe juvenile life history contributions to adult returns across western Washington;
- Examine interannual life history expression by brood year; and
- Describe environmental and biological factors that may shape juvenile life history expression.

To accomplish these goals, the project team used otolith microchemistry to reconstruct the juvenile life history pathways of individual salmon that returned to spawn in river basins from Puget Sound, Hood Canal, Strait of Juan de Fuca, and coastal Washington. The otolith is a calcium carbonate structure that grows in the head of a fish and can be used to indicate when salmon migrate from freshwater to seawater. Collection of otoliths allowed researchers to understand the size, growth, and the environmental chemistry an individual fish encountered in the life cycle. Campbell et al. (2023) assessed 1,559 otoliths from the river 9 basins. The return years examined ranged from 2015-2020.

The results for this study indicated that fry and late parr contributed to over a third of natural origin Chinook returns across Western Washington. The study also found a correlation between higher proportion of fry life history in locations with large functional estuaries (Campbell et al. 2023). **This result implies that estuary restoration has a positive effect on survival of out-migrating Chinook fry.**

2.3.5 RECOMMENDATIONS

- There remain outstanding questions on if and how to integrate nutrients and phytoplankton sampling with the zooplankton monitoring program long-term. Along with additional staff

capacity, standardized methods would need to be developed among regional partners. The PSEMP Marine Waters Workgroup could provide a venue to make these decisions.

- Sandell et al. (2022) recommended to continue testing the effectiveness of Acoustic-Trawl surveys in determining herring abundance, and to collaborate with researchers and managers to develop a survey method that is more financially sustainable. If surveys are continued, the biometric data obtained could be used to model juvenile herring stocks in Puget Sound. Surveys could also be expanded to include other forage fish like anchovies to give a more complete understanding of overall forage fish abundance and composition.
- King County (2022) recommended the creation of a Salish Sea PIT tag database similar to the Columbia River Basin PITAGIS database to enable use of PIT tag data beyond the scope of the individual study in the lower Green River.

2.4 HIGH PRIORITY THREATS

As noted in Section 1.4, past and current Action Agendas for Puget Sound include strategies to address high priority threats with potential to compromise on-going and future recovery efforts. In this section, we describe three subawards that supported monitoring for ocean acidification and one subaward that supported surveillance for the invasive green crab (Strategies 14 and 18 in the 2022-2026 Action Agenda):

- NTA 2016-0405 and NTA 2018-0822: Supported WDNr's ANeMoNe program in monitoring water quality and conducting ocean acidification resilience experiments.
- NTA 2016-0408: Support for the Department of Ecology to add two parameters to their marine monitoring program to measure ocean acidification trends in Puget Sound.
- NTA 2018-0884: Supported Washington Sea Grant Crab Team surveillance for the 2021 and 2022 seasons as well as a large removal effort in collaboration with the Lummi Nation.

2.4.1 OCEAN ACIDIFICATION

Ocean Acidification (OA) is increasing as a result of climate change. The ocean acts as a carbon sink, absorbing atmospheric carbon dioxide to the extent that the pH of marine and coastal waters is decreasing. Lower pH affects the ability of bivalves and crustaceans to form shells and can potentially impact fish behavior. HSIL funded two subawards which sought to monitor OA in Puget Sound. The subawards we discuss here are relevant for the Marine Water Quality IS's advance marine waters monitoring and research programs strategy. The November 2023 Shellfish Beds IS update included a new second-tier strategy to address ocean acidification impacts to shellfish.

Acidification Nearshore Monitoring Network (ANeMoNe)

HSIL supported the WDNr Aquatic Assessment and Monitoring Team's Acidification Nearshore Monitoring Network (ANeMoNe). The goal of the ANeMoNe program is to collect long-term monitoring data to measure the progress of OA in nearshore environments; assess the

potential of eelgrass as an OA refuge; and provide a dependable source of water quality data that can be leveraged in scientific experiments that inform and improve natural resource management. This monitoring program supports a recommendation from the Washington Ocean Acidification Blue Ribbon Panel to study the role vegetation may play in remediating the impacts of OA.

At the time of the first subaward (NTA 2016-0405), the ANeMoNe program consisted of eight intertidal sites (seven in Puget Sound). At each site, two autonomous water quality sensors measure pH, salinity, temperature, dissolved oxygen, and chlorophyll concentrations at 10-minute intervals year-round. One sensor is deployed within an eelgrass bed and the other in an adjacent unvegetated area. The program relies on a network of “Site Guardian” volunteers trained by WDNR to monitor and maintain water quality sensors and help to collect biological data (e.g., shellfish spat sampling, eelgrass density and morphology) to complement sensor observations

For the NTA 2016-0405 project, Horwith et al. (2020) had three goals:

- Ensure water quality sensors remained operational.
- Monitor water quality parameters at three eelgrass restoration sites.
- Ensure ANeMoNe data is available for scientific and public use.

This subaward provided support for replacement parts and new instruments; regular sensor calibration; maintenance of anchor, buoy, and pulley infrastructure; and a new 0.5 FTE volunteer coordinator position.

WDNR was also able to expand upon a previous Marine and Nearshore LO project that transplanted then monitored eelgrass effects on pH and salinity for over three years at three sites not within the ANeMoNe program. WDNR leveraged that previous investment by adding chlorophyll and dissolved sensors to the three Joemma Beach State Park restoration plots and extending sampling through 2019. Since transplanting plots occurred over multiple years, this additional sampling effort allowed WDNR to explore the effect of bed maturity on local pH. Horwith et al. (2020) concluded that the transplanted eelgrass appeared to seasonally elevate pH at 2 of the 3 restoration plots and this effect occurred during the time of year when sensitive bivalve larvae are most common in Puget Sound. But overall, pH varied more between the seasons and between day/night than between eelgrass and unvegetated areas.

During the project period, the ANeMoNe program supported experimental research projects by WDNR, WDFW, University of Washington Seattle, University of Washington Tacoma, and the Swinomish Tribe among others. Between 2016-2019, with assistance by the volunteer network and interns, WDNR conducted an experiment on shellfish growth within and outside of eelgrass. The shellfish included in the study were: Pacific and Olympia oysters, manila clams, and geoducks. The experiment was still on-going at the time of the project, but preliminary results indicated that higher pH was correlated with larger growth in Olympia oysters.

WDNR produced a [2019 State of ANeMoNe](#) report which details 2018 and 2019 monitoring results and results from experiments.

The second subaward (NTA 2018-0822) supported an update to the [ANeMoNe program website](#) which now publicized program water quality and biological data. This website became the main hub for data collection, volunteer support, and community engagement. This second subaward additionally allowed WDNR (2022) to expand the ANeMoNe program from eight to 13 sites (ten in Puget Sound). More information about NTA 2018-0822 and the Site Guardians volunteer program can be found in Chapter 4.

Ocean Acidification Monitoring at Ecology's Greater Puget Sound Stations (OMEGA Project)

HSIL funding allowed Ecology to add two new parameters relevant to OA to 20 sites within their pre-existing long-term marine water quality status and trends monitoring program. This effort was nicknamed the OMEGA project (**O**cean **A**cidification **M**onitoring at **E**cology's **G**reater Puget Sound **S**tations) and was supported through NTA 2016-0408.

The new parameters, total alkalinity and dissolved inorganic carbon, are used to calculate aragonite saturation or the omega value. The omega value has emerged through laboratory and field studies as a leading indicator of OA (Gonski et al. 2021). Omega values above 1 imply that waters are abundant in stable aragonite saturation which juvenile shellfish (mainly bivalves) can use to build shells (Horwith 2021). The OMEGA project obtained promising initial results that demonstrated the ability of the monitoring program to determine trends. To their knowledge, **Ecology is the first state agency to implement regular OA monitoring**. The project team published a paper in a peer reviewed journal (Gonski et al. 2021) about the project and early results to support the development of similar monitoring programs in other states.

The OMEGA project ran from October 2018-February 2020 and upon grant closing received funding from the Washington State Legislature to become a permanent fixture in Ecology's marine monitoring program. This subaward is another example that demonstrates the value of pilot efforts when planning for expansion of an existing monitoring program.

Ecology staff presented the results of this project to a variety of audiences, including academic conferences (e.g. Ocean Sciences Meeting 2020, the 2021 National Water Quality Monitoring Conference), resource managers (e.g. Ecology's Air Quality Program and the Environmental Assessment Program Seminar Series in 2020), and the public (e.g. [King 5 News](#) and [KBTC Northwest Now](#)).

The PSEMP Marine Waters Work Group is developing a new [Ocean Acidification Indicator](#) for the Marine Water Vital Sign. This indicator is expected to track water carbonate chemistry measured as Omega-saturation and ability for biological calcification. Data collected through the addition of these new parameters to Ecology's monitoring program will be crucial for this effort.

2.4.2 GREEN CRAB SURVEILLANCE

In 2015 Washington Sea Grant launched their volunteer-based early detection European green crab monitoring program. This launch was funded through two Marine and Nearshore LO awards, the first in 2014 and the second 2017. The 2018 HSIL award supported volunteer training, monitoring sites, purchasing equipment, and producing outreach and communication products for the 2021 and 2022 seasons (Adams et al. 2023). Additionally, the award helped to fund an intensive trapping effort in the Lummi Sea Pond on Lummi Nation (Adams et al. 2023). In this section we describe the monitoring results; volunteer support and outreach for the green crab monitoring program are discussed in Chapter 4.

The monitoring effort covered [58 Crab Team monitoring sites](#) that are visited once a month between April and September. Sites are spread between pocket estuaries, lagoons, and salt marshes. Monitoring at each site consisted of three components:

- Baiting traps: six baited traps, alternating between minnow and Fukui traps, were buried approximately 10m apart on a transect line, left overnight to soak, and retrieved the next day. Organisms were then identified, crabs were sexed and counted. The first 10 male and female crabs were measured.
- Conducting habitat surveys: 0.09m² quadrats were placed randomly along a 50m transect line parallel to the shoreline. Percent cover estimates were made for mobile wrack, rooted vegetables, and substrate. The dominant substrate was recorded.
- Conducting molt surveys: Consisted of volunteers conducting an area molt search for 20 total person minutes. All molts found were recorded.

The 2021 and 2022 season resulted in the removal of 11 green crabs. Three detections were at new sites with no history of green crabs. These three sites were found further south in the Hood Canal than seen before suggesting that green crabs are spreading. As a result of the Hood Canal detection, Washington Sea Grant began collaborating with WDNR to develop a molt search protocol and reporting system using the MyCoast app.

The second aspect of this award was the removal of a green crab invasion found at the Lummi Sea Pond. In late 2019, Lummi Nation Natural Resources staff identified the largest concentration of European green crabs in inland waters found to date (Adams et al. 2023). In the spring of 2021 Lummi Nation staff removed 3500 European green crabs, this award provided funding for a 2022 removal effort. The result of this effort was the removal of **111,872 European green crabs**. This effort helped to curve the growth in population as fewer and fewer green crabs found over time.

Like the Zooplankton Monitoring Program, discussed in Section 2.3, the Green Crab monitoring program is an example of how NEP funding can support the development and transition of a pilot program to long-term operational funding. In April 2023, the Washington State Legislature appropriated \$6 million annually for European green crab management in the 2023-2025

operating budget. \$1.34 million was directed at Washington Sea Grant and \$2.9 million to the Lummi Nation.

2.4.3 RECOMMENDATIONS

- Horwith et al. (2020) recommended further studies be conducted on “ocean acidification refugia” sites, focusing on how ocean acidification varies at local scales relative to Puget Sound. Recommended sites to focus on include:
 - Buffered: locations with stable carbonate chemistry and higher pH
 - Hot spot: locations with extremely variable carbonate chemistry and lower pH
 - Restoration sites: locations that historically hosted healthy eelgrass and shellfish populations and could be restored.
- Horwith (2021) recommended connecting Ecology OA data with biological data whenever possible. There is potential in exploring OA conditions as a driver of recruitment for shell-building species. Population data for these species are managed by state, federal, and tribal partners outside of Ecology, and data reporting varies greatly. Ecology believes that the provision of OA data to these partners and cooperative analysis of environmental and biological data to identify trends is a crucial next step for natural resource managers to respond to the threat posed by OA in greater Puget Sound.

CHAPTER 3: BEHAVIOR CHANGE AND INCENTIVES

Chapter At-A-Glance

- The group of projects covered in this chapter collectively provided more than 800 technical assistance site visits to marine waterfront, streamside, or forested properties. Subawardees provided parcel-specific information about stewardship actions these property owners can take. More than 100 of these property owners received additional support to act on recommendations received.
- Support for the Shore Friendly program significantly advanced the Shoreline Armoring IS's incentive strategy. Subawards to two local programs helped to continue and expand homeowner site visit programs. Collaboration with regional recovery partners supported a transition to a new home for the program and capital funding from the Washington State Legislature. However, 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.
- Funding for Marine Shoreline Design Guidelines training and development of a six-course Alternatives to Bulkheads training at the Coastal Training Program significantly advanced the Shoreline Armoring IS's design and technical training strategy.
- Four new pilot programs that provided education, technical assistance, and/or financial incentives to landowners to support stewardship behaviors were also developed. The Regional Forestry Stewardship Program was unique in that it helped small forest landowners reduce their property taxes. This type of financial incentive is critical for reducing the costs associated with owning and maintaining forest lands, and is expected to reduce the risk of conversion to non-forest land uses.

The behavior change and incentives investment theme includes 13 subawards that aimed to make stewardship actions more accessible to property owners. This work employed practices advocated by the [Stewardship and Education Lead Organization](#) (LO), which received and distributed EPA Puget Sound funding between 2010 and 2015. This program, operated by PSP under a cooperative agreement with EPA, worked to promote a paradigm shift in how partner organizations approach public engagement (PSP 2016). **Education and outreach programs that build awareness of a problem were deemphasized in favor of approaches that changed behavior.**

A key outcome of the Stewardship and Education LO was increased regional capacity for utilizing behavior change approaches, such as social marketing, to advance progress towards

recovery goals. Like their predecessor, the Marine and Nearshore LO,¹⁶ HSIL embraced this shift and integrated incentive-based strategies into their investment portfolio.

Social marketing applies traditional marketing principles to influence behavior in target audiences. It is a rigorous, evidence-based approach that has been used for decades to improve public health. Social marketing differs from traditional community outreach and education programs in that it focuses on **identifying and addressing specific barriers to action** (PSP 2015). Exchange-based approaches like incentives and social marketing are effective in changing behavior in ways information-based approaches cannot (PSP 2015).

In this section we discuss HSIL support for (1) Shore Friendly, one of the most comprehensive and largest social marketing strategies implemented in the region to date; (2) marine shoreline technical training and assistance; and (3) four pilot programs that offered education and incentives for protection of critical areas and forest lands.

Table 3 lists the subawards evaluated in this chapter.

¹⁶ The [Marine and Nearshore LO](#), also known as the [Marine and Nearshore Grant Program](#), received and distributed EPA Puget Sound funding from 2011 to 2017. Like HSIL, this LO was a partnership between WDFW and WWDNR and operated under a cooperative agreement with EPA.

Table 3. Behavior change and incentives subawards

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
2016-0380	Marine Shoreline Design Guidelines: Engineering Technical Assistance, Training, and Outreach	Department of Fish and Wildlife
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
2018-0886	Marine Shoreline Design Guidelines: Engineering Technical Assistance, Training, and Outreach 2020-2022	Department of Fish and Wildlife
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 County Northwest Straits Foundation Friends of the San Juans

3.1 SHORE FRIENDLY

Beginning in 2012, Marine and Nearshore LO grants funded the development and implementation of several incentive programs to encourage residential landowners along marine shorelines to consider alternatives to hard armor. Design of incentive tools was based on rigorous formative research that provided empirical evidence of specific barriers to changing target behaviors (e.g., Keller 2012, Johannessen 2012, Colehour + Cohen et al. 2014).

In 2014 and 2016, the Marine and Nearshore LO funded “Shore Friendly” branded campaigns in four counties (San Juan, Kitsap, Mason, and Island) as well as a continuation of the Northwest Straits Foundation’s (NWSF) Shoreline Armoring Reduction Project. These programs motivate waterfront homeowners to remove bulkheads and/or choose alternatives to hard armor on their property by utilizing an array of incentive tools, including workshops, site visits and property assessments, financial assistance, and design and permitting assistance. Kinney and Francis (2019) summarized outcomes from this era as well as program evolution that occurred in response to participant feedback and program evaluations.

The Shoreline Armoring IS incentive strategy aimed to sustain and improve coordination among this group of local programs. Near-term priorities identified in the IS were: continuing and expanding homeowner site visit programs; expanding financial incentives; and identifying sustained funding for existing programs.

3.1.1 SUPPORT FOR LOCAL SHORE FRIENDLY PROGRAMS VIA 2016 NTAS

This section describes outcomes of two subawards that supported local Shore Friendly programs during the time period after Marine and Nearshore LO funding ended but before development of a new regional funding model in 2019 (described in section 3.1.2):

- NTA 2016-0001 – Continuation of NWSF’s Shoreline Armoring Reduction Project (since re-branded as Shore Friendly) in Clallam, Jefferson, Island, San Juan, Whatcom, Skagit, and Snohomish Counties
- NTA 2016-0196 – Continuation of Shore Friendly Kitsap

During this time period, NWSF’s program focused on landowner workshops and events, site visits, project engineering and permitting assistance, and help securing construction funding via external grants. Kitsap County’s program focused on site visits, disbursement of mini-grants, and permitting assistance. Program outputs are summarized in Table 4 and described below. These subawards advanced the Shoreline Armoring IS’s incentive strategy.

Table 4. Shore Friendly program outputs (2017-2020)

Incentive Tool	Kitsap 2017-2020	Kitsap cumulative 2014-2020 ⁽¹⁾	NWSF 2017-2019	NWSF cumulative 2014-2019 ⁽¹⁾
Homeowner workshops	—	—	11	27
Number of participants	—	—	311	861
Preliminary site visits	13	88	6	13
Technical site visits	3	35	87	202
Design services	—	—	5	14
Permitting services	6	9	3	10
Permit fees waived/rebated	5	11	—	—
Mini-grants provided	8	22	see note (2)	—
Amount disbursed	\$50,000	\$130,500		—
Removal projects completed	7	17	—	3
Linear feet	527	1,445	—	1,190
Prospective removal projects	1	—	5	—
Linear feet	not provided	—	950+	—

Notes:

(1) 2014-2018 data from Kinney and Francis (2019)

(2) NWSF did not provide mini-grants using subaward funding, but they did prepare grant applications that resulted in \$426,965 of construction funding for multiple projects.

(3) An important part of Shore Friendly programs is providing technical assistance to landowners so that they decide to forgo installing armor. However, there is no metric to track this key program outcome.

Education and outreach

Strategic communications and outreach activities included development of Shore Friendly program marketing materials, fact sheets (e.g., [what is soft shore?](#)), and testimonials from program participants. Materials were distributed during community events (pre-pandemic) or via social media and electronic newsletters. Website metrics indicate that traffic to the Shore Friendly Kitsap website increased after an email newsletter blast (Kitsap County 2020a). Targeted community outreach for Homeowners Associations and neighborhood groups also occurred.

NWSF continued to offer three core workshops: Living with the Coast, Vegetation Management, and Benefits and Opportunities for Armor Removal. They also used smaller meetings and events like beach walks to reach groups of neighbors and community associations identified as high priority and high feasibility for armor removal.

- 11 workshops and outreach events reached 311 participants.
- Post-workshop surveys document changes in participant awareness and understanding of coastal processes and the value of natural shorelines (Kaufman 2019).

- Kaufman (2019) noted that soft shore protection is not feasible for every property, so care needs to be taken in how this alternative is presented in workshops.

Site visits

Both programs continued to provide participants with property assessments, including technical visits from professional coastal geologists or vegetation management specialists. After a technical site visit, landowner(s) receive a summary memo that details management alternatives for the property and best management practices that could prevent future problems.

- **Demand for site visits remains strong** (Kaufman 2019, Kitsap County 2020a).
- NWSF provided 87 technical site visits by geologists or urban foresters, and six site general visits by Conservation District or NGO partners.
 - Results of post-visit surveys indicate that for 86% of respondents the site visits increased awareness of the range of alternatives for managing erosion and 77% planned to implement at least some of the recommendations received (Kaufman 2019).
- Kitsap County provided 13 general and 3 technical site visits.

When small changes such as vegetation or drainage repairs are needed, site visits can be a primary motivator for action (Kaufman 2019). For larger projects like armor removal, these site visits are a key entry point for other program incentives.

NWSF also sent follow-up surveys to 207 recipients of site visits funded via earlier grants; the response rate was over 20%. Respondents identified common barriers to applying program recommendations: cost (19%), neighbor and/or family member dissent (30%), existing structures (30%), as well as the confusing process and regulations (Kaufman 2019). Survey results were used to inform 2019-2022 program development, including consideration of new types of advanced technical assistance, such as vegetation plans; drainage management support; assessment of the viability of relocating homes, structures, and/or septic systems to allow for armor removal that had been deemed infeasible due to the presence of such infrastructure.

Engineering design and permitting assistance

Kitsap County (2020a) interviews with previous Shore Friendly participants indicated that assistance with project development and coordination—particularly the permitting process—was highly valued by program participants. Kaufman (2019) noted that several completed armor removal projects took more than two years to gain landowner willingness and begin the design process plus several more years to get to construction. This required on-going communication and support throughout the entire process.

- NWSF's Shore Friendly program provided engineering design services for five projects and permitting assistance for three projects.

- Kitsap County's Shore Friendly program provided consultant and contractor referrals and six mini-grants used by landowners to pay for project designs. The program prepared local permit packages for six projects, and organized restoration site consultations with regulators for seven projects.

Kitsap County (2020a) also worked to streamline local permitting for Shore friendly projects and developed educational materials about local permitting pathways, requirements, and application steps. These regulatory elements of their subaward are discussed in Chapter 5.

Kaufman (2019) made two observations about permitting Shore Friendly projects that may be of interest to regional recovery partners that work on streamlining permitting for beneficial projects (an issue discussed further in Section 5.4):

- In the earlier years of the program, preliminary designs (30% design stage) were accepted by regulators and there was an understanding that following permit review design changes could be made to meet regulator requests. More recently, regulators are requiring drawings from the 60% design stage in application submittals. This has increased the cost and time required for the design service incentive.
- In most instances, removal of armor on private property will require compromises that prevent full restoration. For example, some amount of protection remains intact to protect existing infrastructure or neighboring properties, or to provide long-term beach access. New NOAA mitigation requirements for armor maintenance/replacement projects may complicate implementation of Shore Friendly projects because grant funding cannot be used to pay for mitigation actions.

Financial assistance

Kaufman (2019) and Kitsap County (2020a) both reiterated the importance of financial assistance for moving projects to construction. All armor removal projects implemented through NWSF's program cost >\$100,000 for construction and engineering, while Kitsap projects cost up to \$26,000 for construction alone. Even motivated landowners are not willing or able to fund these projects on their own (Kaufman 2019).

During this subaward, NWSF provided grant application assistance. Once a project was in permitting or had received permits, NWSF helped landowners apply for public and private grants to pay for construction. This type of assistance was provided for six projects during the grant period. 22 applications for 11 different funders were completed and eight were successful, resulting in a **total of \$426,965 in grant funding secured for five projects**. The cost to the program of providing this incentive was only \$7,500, but it proved critical to moving these projects forward (Kaufman 2019). Three of these projects had been scheduled for construction at the end of the grant period.

Shore Friendly Kitsap disbursed six mini-grants (\$5000) and two construction grants (\$10,000). **Five of the projects that received grants had been constructed by the end of the contract period, for a total of 357 feet of armor removed.**

3.1.2 REGIONAL COORDINATION AND SUPPORT FOR SHORE FRIENDLY

HSIL also advanced the Shoreline Armoring IS's incentive strategy by coordinating among regional and local partners to ensure sustainable program funding and leverage knowledge gained from pilot efforts.

In 2019, HSIL worked with regional recovery partners and the [Ecosystem Coordination Board](#) to secure a new home for Shore Friendly at WDFW's Estuary and Salmon Restoration Program (ESRP), who then obtained an appropriation from the state capital budget. This transition was important for the long-term sustainability of the program. Shore Friendly is an example of National Estuary Program grants being used as "seed money" for an innovative pilot effort. Since this funding is not intended to provide long-term support for such programs it was necessary to identify an agency sponsor and other source of funding to ensure it can continue indefinitely. This transition also resulted in the geographic expansion recommended by the Shoreline Armoring IS. The number of local Shore Friendly programs increased during the 2019-2020 transition, and all Puget Sound counties now have coverage.

Two HSIL subawards provided support for Shore Friendly program improvement and expansion at the regional scale:

- NTA 2018-0085 – As part of a larger project discussed further in Chapter 5, Washington Sea Grant developed and facilitated a Shore Friendly Advisory Board to support ESRP with strategic planning for program development.¹⁷
- NTA 2018-0266 – Supported the feasibility phase for a Shore Friendly loan program to provide an additional financial incentive to program participants. This project is also discussed in Chapter 4 because the loan program could provide support for sea level rise adaptation actions.

Shore Friendly Advisory Committee

Washington Sea Grant worked with ESRP to form and facilitate a Shore Friendly Advisory Committee charged with providing strategic planning support to guide development of the regional program during its transition. Sea Grant served as an intermediary between regional partners to provide programmatic and facilitation support, identify program needs, develop a coalition to provide feedback and advice, and connect ESRP to advisory committee member resources (Faghin et al. 2023). Committee members include high-level managers at other state agencies, representatives from non-governmental organizations, other regional experts, and a shoreline homeowner. A funding sub-committee is focused on maintaining and expanding

¹⁷ NTA 2018-0085 was originally intended to support the integration of [Green Shores for Homes](#) and Shore Friendly. Both programs were developed around the same time and provide incentives intended to encourage more environmentally friendly shoreline practices. The NTA proposal focused on enhancing the scope of Shore Friendly by integrating Green Shores for Homes' LEED-style [credit rating system](#) for waterfront properties. However, after the project was initiated, it became clear that Shore Friendly partners were not as interested in this integration as expected (N. Faghin, pers. comm.). As a result, the project manager shifted focus to supporting the Shore Friendly program as it expanded and transitioned to ESRP.

funding for local programs, and a research sub-committee identified research priorities to support growth and evolution of the Shore Friendly incentive toolbox. As of late 2023, the committees remain active.

Shoreline loan program feasibility study

To advance a Shoreline Armoring IS incentive strategy near-term priority to develop new financial incentives, Puget Sound Institute led a feasibility study for development of a shoreline loan program. A loan program was recommended as part of the original Shore Friendly social marketing strategy (Colehour + Cohen et al. 2014), but early program implementation focused on technical assistance components of the strategy. Over time, it became clear that additional financial incentives would be necessary to complete more of the armor removal projects identified and developed by local Shore Friendly programs.

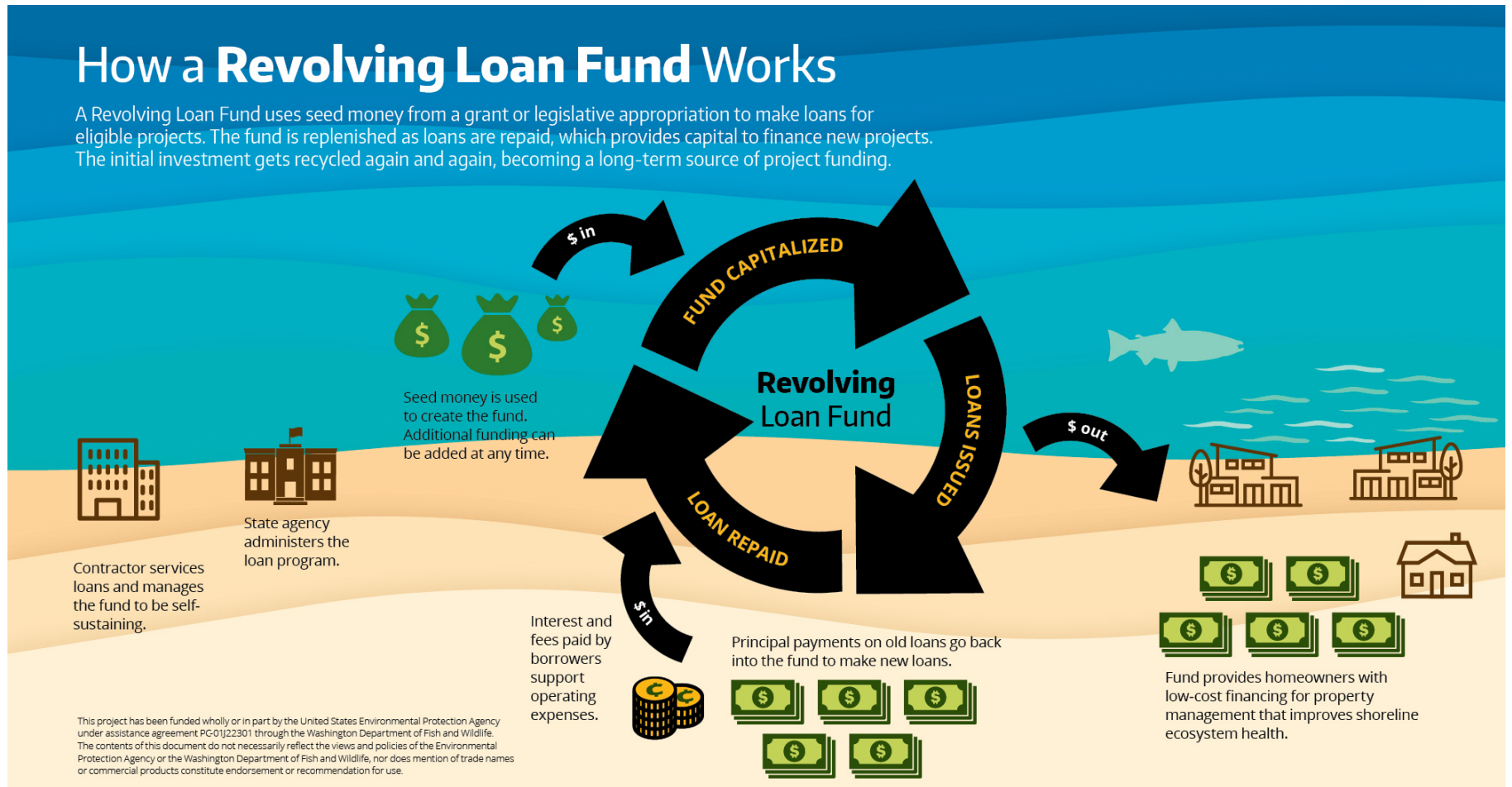
Creation of a **revolving loan fund** (Figure 5) had been suggested as a mechanism to develop a sustainable loan program by multiple experts in the region since 2014, so this was the type of program assessed in the feasibility study. Since local Shore Friendly programs reported that waterfront homeowners are increasingly concerned about flooding and bluff instability associated with sea level rise, house elevation and relocation were added as target shoreline management activities included in the feasibility study.¹⁸

The feasibility study entailed a series of technical analyses that estimated market size (Coastal Geologic Services 2020), potential demand (Puget Sound Institute and Coastal Geologic Services 2020), expected project costs (Coastal Geologic Services 2020), and the amount of funding needed to establish a self-sustaining revolving loan fund (Northern Economics 2020). The final feasibility report (Kinney et al. 2021) also included review of six model programs in four states to inform design of a loan program; an evaluation of potential sources of seed money for a loan fund; and a compilation of partner input and key considerations regarding program administration, including potential state/local partners and project eligibility criteria.

Results of the market analysis indicated that there is demand for six to eight loans per year, but demand is expected to increase in the future as extreme high-water events become more frequent. Projected construction costs varied widely—from a low of \$33,000 for a simple armor removal project to a high of \$324,000 for home relocation plus armor removal and soft shore protection. Financial model simulations predicted annual loan disbursements ranging from \$396,000 to \$791,000. An estimated \$4.5 million in capitalization funding would meet this demand and result in a self-sustaining (i.e., able to continue funding projects without addition of more capital) revolving fund over nine years, assuming a \$500,000/year capitalization schedule for those nine years.

¹⁸ When the original Shore Friendly social marketing strategy was developed, a decision was made to avoid education and incentives related to climate change and sea level rise. Shore Friendly partners are now working to incorporate resources about climate change hazards and adaptation measures into the program. NWSF and Island County programs have begun to include recommendations about relocating homes in site visit discussions and follow-up reports (Kaufman 2019).

Figure 5. How a revolving loan fund works (Figure 1 from Kinney et al. 2021)



Since revolving loan funds are replenished as loans are repaid, a relatively low initial investment can have a large impact. The financial model indicated that \$4.5 million in seed money could fund \$9.7 million in projects over the first 15 years of a loan program.

The feasibility report ended with an outline of the next steps needed to develop a Shore Friendly loan program. The first step was to identify a state agency champion willing to either dedicate existing staff time or hire new staff to engage potential partners, develop program guidelines, and secure capitalization funding. In early 2022, WDFW created a new Shoreline Revolving Loan Fund Program Coordinator position and hired a new staff member to carry the remaining work described in the feasibility report. HSIL provided the funding to support the new loan coordinator position. As of late 2023, the program coordinator was working with agency management, the Office of the Attorney General, and a Technical Advisory Group to make the program described in the feasibility study a reality. WDFW plans to seek capitalization funding during the 2025 legislative session (K. McCaffrey, WDFW, pers. comm.).

3.1.3 SUPPORT FOR LOCAL SHORE FRIENDLY PROGRAMS VIA 2018 NTAS

As described in the previous section, ESRP funded [six local Shore Friendly programs](#) with state capital dollars in 2019. To support this transition, HSIL provided additional support for new and continuing programs that had submitted a 2018 NTA proposal. **Much of this 2019-2022 funding supported workshops and other general education activities since these program elements are not eligible for capital funding.**¹⁹ HSIL funding was disbursed to four local programs through an interagency agreement with the Recreation and Conservation Office (RCO):

- NTA 2018-0172 – Supported an expansion of Shore Friendly to two new south Sound counties (Pierce and Thurston) and a continuation of Shore Friendly Mason
- NTA 2018-0322 – Continuation of Shore Friendly Kitsap
- NTA 2018-0432 – Supported an expansion of Shore Friendly to King County
- NTA 2018-0707 – Continuation of Shore Friendly in the seven Northwest Straits counties, including support for a new partnership between NWSF and Friends of the San Juans for implementation of Shore Friendly in San Juan County (NTA 2018-0826).

Outreach mechanisms employed by local programs to support landowner recruitment and build awareness about the importance of natural shorelines included promotion during community events, direct mail targeting specific parcels, social media, and electronic newsletters. These efforts resulted in a cumulative total of over 15,000 contacts (Table 5). Educational events like workshops and community/neighborhood scale forums, meetings, and/or beach walks have been a part of Shore Friendly programs since the beginning. Although they continued throughout this grant period, pandemic restrictions reduced the overall number of in-person events and programs pivoted to virtual outreach tools like online webinars and recorded content.

¹⁹ Capital funding provided through ESRP can only be used to support project identification, development, and construction.

Table 5. Shore Friendly education and outreach outputs for 2020-2022

PRISM Project #	Local Program	Current Sponsor	Number of contacts	Number of events
19-1703	Shore Friendly South Sound Initiative	Pierce Conservation District	4,213	13
19-1704	King County Shore Friendly	Mid-Sound Fisheries Enhancement Group	1,012	7
19-1706	Northwest Straits Shore Friendly Program	Northwest Straits Foundation	4,408	5
19-1707	Shore Friendly Kitsap	Kitsap County	6,244	3

Notes:

(1) Data source: September 2022 Quarterly Reports and final project facts sheets.

(2) Contacts = mailings, emails, calls, requests for information outside of workshops

(3) This table does not capture local program outputs funded by the ESRP Shore Friendly Program with capital funding (e.g., site visits, permitting assistance, mini-grants, and implemented projects).

(4) ESRP also continued funding for Island County Shore Friendly (PRISM Project [19-1702](#)) and funded a new program led by the Swinomish Indian Tribal Community (PRISM Project [19-1705](#)). These programs did not receive HSIL funding, so they are not included in the table.

Communication products of note produced during the grant period include:

- A “Shore Friendly Living” video series led by NWSF. At the end of the grant period, three episodes had been completed and posted and three others had scripts drafted and some footage recorded. As of early 2024, six videos were available online:
 - [Coastal Beaches and Bluffs](#) (2,350 views since 9/21/20)
 - [Restoring the Connection between Land and Water](#) (1,325 views since 5/12/21)
 - [Managing Shoreline Erosion: Bulkheads or Natural Solutions](#) (1,900 views since 10/28/21)
 - [Native Plants: Holding the Shoreline Together](#) (1,043 views since 10/11/22)
 - [Stewards of our Shorelines](#) (312 views since 7/11/23).
 - [Trees and Views](#) (403 views since 1/2/24)
- The August 2022 and September 2022 episodes of the Thurston Conservation District’s [Conservation Starters Podcast](#) featured Shore Friendly staff, an engineering geologist, an arborist, and a shoreline landowner helped by the program.

3.1.4 RECOMMENDATIONS

- Work remains to develop a stable, longer-term funding source for Shore Friendly education and outreach program elements (Kaufman 2019, Kitsap County 2020a, RCO 2022).

- Influencers²⁰ were not a focus of local program strategic communications during the most recent grant cycles. Real estate agents should be reincorporated as a secondary target audience as funding allows. The Recreation and Conservation Office (2022) noted that NWSF had secured external grant funding to support outreach efforts and intended to use some of this funding for influencer training.
- Another program element not eligible for capital funding was grant application assistance, which Kaufman (2019) identified as critical to program success. NWSF was able to leverage NEP program support for a substantial increase in overall investment—\$7,500 in staff time resulted in \$427,000 of grant dollars for project implementation.
 - Expanding this type of assistance could potentially support projects involving relocation of existing infrastructure (e.g., septic systems) before armor can be removed. Funding sources that can cover all necessary steps need to be identified in order to overcome limiting factors for restoration projects (Kaufman 2019).
- Several research needs were identified by the Shore Friendly Advisory Committee research sub-committee (Faghin et al. 2023) and in the shoreline loan program feasibility report (Kinney et al. 2021). Key among them was a recommendation to conduct a follow-up survey of waterfront property owners since it has been about a decade since the Colehour + Cohen et al. (2014) social marketing formative research upon which Shore Friendly was based. As of late 2023, the Shore Friendly Advisory Committee research sub-committee was advising WDFW on survey design.
 - Repeating questions from the original surveys and focus groups would allow for a quantification of overall Shore Friendly program impacts related to perceptions of hard armor and soft armor.
 - Climate change and sea level rise were not incorporated into the original Shore Friendly social marketing strategy. Adding questions about property owner perceptions and experiences could inform messaging about coastal flooding and sea level rise; improve the loan program feasibility study demand analysis; and identify barriers/motivators for Shore Friendly adaptation measures like home elevation and relocation.
 - A list of other research needs specific to advancing climate change adaptation efforts is provided in Section 4.5 (Projecting and Planning for Climate Change Impacts).

²⁰ **Influencers** are people who provide information to property owners when they are making shoreline modification decisions. They include real estate agents, contractors/consultants, county permitting staff, and neighbors. Between 2014 and 2018, local programs held 18 realtor trainings that reached almost 376 agents (Kinney and Francis 2019). Section 3.2 describes complementary regional training efforts targeting the contractor/consultant and regulator audiences.

3.2 MARINE SHORELINE TECHNICAL TRAINING AND ASSISTANCE

Shifting armoring behaviors and trends also requires training professionals like project designers, consultants, contractors, and regulators about alternative shoreline management techniques. The [Marine Shoreline Design Guidelines](#) (Johannessen et al. 2014) provides a framework for site assessment and alternatives analysis to identify technique(s) that best suit the conditions at any given Puget Sound shoreline site.

The Marine Shoreline Design Guidelines (MSDG) were developed, with financial support from the Marine and Nearshore LO, to help project proponents and regulators determine where alternatives to traditional armoring are a feasible option for erosion control.²¹ The Shoreline Armoring IS noted that progress towards regional goals for bulkhead removal is limited by insufficient technical capacity to apply MSDG principles and a lack of confidence in less traditional techniques. The IS's design and technical training strategy was developed to address this barrier.

In this section, we describe three subawards that advanced IS recommendations to (1) expand regional technical capacity by supporting the use of the MSDG; (2) develop a comprehensive technical training program; and (3) increase training and technical support for local jurisdiction regulatory staff:

- NTAs 2016-0380 and 2018-0886 – Funded an environmental engineer position at WDFW to provide MSDG training and technical assistance
- NTA 2018-0142 – Supported Washington Sea Grant's development a six-course "Alternatives to Bulkheads" training series for planners, consultants, and contractors

3.2.1 MSDG TECHNICAL TRAINING AND OUTREACH

In 2016, a Marine and Nearshore LO grant established engineering technical assistance capacity at WDFW with support for a new environmental engineer position in the Habitat Engineering and Technical Assistance Group. HSIL's 2018 and 2020 subawards were used to continue work promoting MSDG among audiences both within and outside of WDFW. The subawardee:

- Provided project-level technical assistance site visits and engineering support for WDFW Habitat Biologists reviewing Hydraulic Project Approval applications.
- Delivered in-person classroom/field trainings for WDFW Habitat Biologists and others involved in permitting shoreline stabilization projects, including local planners via a "Using the Marine Shoreline Design Guidelines for Marine Shoreline Stabilization" course offered

²¹ WDFW is the lead agency for the MSDG. It is part of an Aquatic Habitat Guidelines collection created by a consortium of public agencies to provide "how to" guidelines to facilitate consistent application of best available science for the protection and restoration of marine, freshwater, and riparian fish and wildlife habitat. Others in the collection include [Integrated Streambank Protection](#) (2002), [Stream Habitat Restoration](#) (2012), and [Water Crossing Design Guidelines](#) (2013).

by the [Coastal Training Program](#)²² in 2019 and a workshop for the Multi-Agency Review Team (MART) described in Chapter 5.

- By spring 2020, pandemic restrictions caused delays or cancellation of additional in-person workshops and WDFW shifted focus to online trainings in partnership with Washington Sea Grant. A [four-part webinar series](#) was developed and delivered to the Shoreline and Coastal Planning Group in 2020, and ten online training modules that walk users through individual MSDG chapters were developed and recorded.
- Developed a [MSDG website](#) that provides interactive information about case studies; recordings of the 10 training modules; example engineering site plans; and four downloadable checklists/worksheets that include hyperlinked definitions and rollover pop-up imagery to assist users in step-by-step application of MSDG principles.

3.2.2 ALTERNATIVES TO BULKHEADS TRAININGS FOR PLANNERS AND CONTRACTORS

In 2020, Washington Sea Grant began development of a comprehensive training program for shoreline professionals. Target audiences are public/private biologists, engineers, planners, landscape architects, marine contractors, restoration specialists, and local/regional government staff (Faghin et al. 2023). Sea Grant created an advisory team to guide program development; assessed training needs with survey data, interviews, and a market analysis (Faghin and Angell 2021); then developed curriculum and supporting materials for five courses. Research on adult learning principles was used to optimize delivery mechanisms and ensure course work was suitable for different learning styles and engaging for seasoned professionals.

Faghin and Angell (2021) identified the Coastal Training Program as the best course provider option because of their experience offering courses and large reach from their mailing list of over 4,000 coastal and shoreline professionals. Courses 1 and 2 were offered as a pilot to test the delivery format in 2022, then curriculum development for courses 3-5 proceeded and those courses were offered in 2023 (Table 6). The curriculum for course 6 was under development at the end of the grant period; this course was first offered in early 2024.

²² The **Coastal Training Program** at the Padilla Bay National Estuarine Research Reserve is funded through NOAA's National Estuarine Reserves Division and implemented by Ecology's Shorelands and Environmental Assistance Program. Classes are accredited by American Institute of Certified Planners (ACIP), so planners can meet continuing education requirements.

Table 6. “Alternatives to Bulkheads” training courses offered at the Coastal Training Program

Name	Offered	Format
Course 1: General Concepts Related to Shorelines and Stabilization	April 1-May 11, 2022 and February 20-March 10, 2023	virtual, self-paced
Course 2: An overview of Local, State and Federal Permit Requirements	May 11-12, 2022	virtual, two half-days
Course 3: How to Address Site Assessments for Design and Construction	March 23-24 2023	hybrid, two days with field component
Course 4: Demonstration of Need, Risk Assessment, and Alternatives Analysis	April 5, 2023	virtual, one day
Course 5: Techniques for Erosion Control, including Construction Materials and Maintenance	May 17-18, 2023	virtual, two half-days
Course 6: Sea Level Rise	January 8-February 2, 2024	virtual, self-paced

Thirteen instructors participated in course development and delivery, including the WDFW environmental engineer that led the MSDG training discussed in the previous section. Course attendees reflected the diversity of professionals in the target audiences, although relatively few contractors attended and Faghin et al. (2023) recommended finding new ways to reach this audience. Between 92% and 100% of evaluation respondents for courses 1-3 reported that the course was a good use of their time. With course development nearly complete, costs to continue offering the courses at the Coastal Training Program are minimal since their funding model typically includes a course fee that may cover costs for private sector instructors.

3.2.3 RECOMMENDATIONS

- WDFW (2023) noted that since the MSDG was published almost 10 years ago, new design techniques are becoming more common (e.g., intermittent breakwater, dynamic revetment, living dike, and hybrid designs), state regulations have changed, and there is demand for more information about managing coastal flooding and upland drainage. They suggest launching a comprehensive update to the MSDG.
- WDFW (2023) also made two recommendations specific to trainings for WDFW staff:
 - Given staff turnover at WDFW, continued training is necessary to maintain an adequate level of service. Recorded trainings and modules are well-suited to onboarding new staff, but the field component will be an ongoing need.
 - A 2021 Hydraulic Code update (RCW 77.55.231(1)(b)) requires that applications for replacement marine shoreline armoring projects include a site assessment to consider the “least impactful alternatives.” New requirements related to this site assessment report are now included in WAC 220-660-370(3)(d-f). Future MSDG trainings for WDFW Habitat Biologists should be updated to address these new requirements.

- Faghin et al. (2023) suggested investigating ways to offer a certification upon completion of the six “Alternatives to Bulkheads” courses. For example, creation of a list of individuals or firms that could be posted on a WDFW website, or a graphic logo that could be added to a business website or business card.

3.3 PILOT INCENTIVE PROGRAMS

In addition to supporting the continuation and expansion of Shore Friendly, HSIL also funded the development of four new pilot programs that provided education, technical assistance, and/or financial incentives to landowners to support stewardship behaviors:

- NTA 2016-0071 – Supported development of a Living with Beavers Program at Snohomish Conservation District.
- NTA 2018-0701 – Supported Puget Sound Conservation Districts in developing a Regional Forestry Stewardship Program that provides technical assistance to small-forest landowners.
- NTA 2018-0641 – Supported development and of Kitsap County’s Start Here! program to improve landowner development decisions.
- NTA 2018-0810 – Supported development of a Snohomish County program to educate about and incentivize stewardship of streamside properties.

A fifth program is discussed in Section 4.5.1 (Sea Level Rise) due to the topic and level of public sector engagement:

- NTA 2016-0140 – As part of a larger project focusing on sea level rise adaptation, Friends of the San Juans developed educational resources, held workshops, and provided technical assistance site visits to residential landowners.

3.3.1 LIVING WITH BEAVERS

Snohomish Conservation District worked with non-profit Beavers Northwest to develop a program to support streamside landowners who struggle with beavers on their property. Alternative methods to beaver management (i.e., not dam destruction and lethal removal) options were offered to landowners to encourage leaving beavers on-site with the aid of a water management device if necessary (Pittman 2018).

The program developed education and outreach materials about the value of beavers and alternative management methods. Materials were shared on the [Living with Beavers website](#) and presented at in-person workshops and farm tours. The program also provided technical and financial assistance for installation of management structures like beaver deceivers and pond-lever devices. **Assistance was provided to 29 landowners, 11 of which installed beaver management devices with cost-share assistance and permitting support** (Pittman 2018). Others expressed interest in taking a no-action beaver management approach.

3.3.2 REGIONAL FORESTRY STEWARDSHIP PROGRAM

Puget Sound Conservation Districts developed a Regional Forestry Stewardship Program to engage and provide technical assistance to Non-Industrial Private Forests landowners. The project funded new foresters/forest technician staff who worked alongside existing Conservation District staff to provide forest stewardship services to support retention of forest cover, fish and wildlife habitat improvements, water quality protections, and reductions in stormwater runoff (Snohomish Conservation District 2023). The regional forestry team helped landowners develop forest stewardship plans, identify stewardship project opportunities (e.g., invasive species control, forest structure/canopy restoration, tree/shrub establishment, road abatement, fish passage barrier removal), and connect with other programs that provide financial incentives.

This project was notable among HSIL’s investment portfolio because it is one of only two projects to advance the Land Development and Cover IS’s support the viability of working lands strategy. The Regional Forestry Stewardship Program provided technical assistance to help landowners enroll in local Open Space Taxation²³ programs to reduce property taxes and obtain cost share funding to implement stewardship projects. These types of financial incentives are critical for reducing the costs associated with owning and maintaining forest lands, which is expected to reduce the risk of conversion to non-forest land uses (Snohomish Conservation District 2023).

Puget Sound Conservation Districts (2021a) incorporated social marketing techniques when developing the program engagement strategy. Target audiences were segmented based on the type (commercial/noncommercial) and size (more/less than 5 acres) of land holdings. Influencer audiences involved in real estate, local taxation/land use, federal/state agencies, WSU Extension Forestry, and others were also identified. Similar to Shore Friendly, key messages and a content/branding toolkit were developed for the regional program but could be tailored by an individual Conservation District to meet the needs and preferences of local audiences.

Puget Sound Conservation Districts (2021b) engaged with partners including WSU Extension Forestry, local tribes, and WDNR to prioritize target areas for service delivery. Top resource concerns were identified then ArcGIS was used to identify parcels with the highest potential impact. Top concerns identified by partners included: development/conversion of forest land; noxious or invasive weeds; forests with only one major species; young forests with too many trees; and fish passage. Attributes analyzed in ArcGIS were parcel size and tax status; forest

²³ Washington’s State Open Space Taxation Act ([RCW 84.34](#)) allows counties to reduce property taxes when owners preserve or restore their land. Tax relief is provided when open space, agricultural, or timber lands are valued at “current use” rates rather than the “highest and best use” typically assessed. This reduces the assessed value for the portion of the property enrolled. Faghin and Mateo (2014) provide an excellent summary of programs in Puget Sound counties and recommendations for regional partners to consider for potential improvements to advance regional recovery priorities. Since the enrollment process is complex, providing technical assistance to landowners was one such recommendation.

cover; and proximity to local resource concerns identified in Table 7. The prioritization process identified 19,609 parcels across nine counties (Figure 6).

Between 2021 and March 2023, the Regional Forestry Team provided technical assistance to 619 Non-Industrial Private Forest landowners (10,531 acres); supported development of 81 Forest Management Plans; helped 63 landowners (1,564 acres) enroll in Open Space Taxation programs; and helped 64 landowners (2,051 acres) secure cost-share funding to implement stewardship projects (Snohomish Conservation District 2023). In addition, communication products had reached materials had reached more than 10,000 individuals.

A continuation and geographic expansion (to 11 counties) of the Regional Forestry Stewardship Program was [selected for additional HSIL funding in February 2023](#).

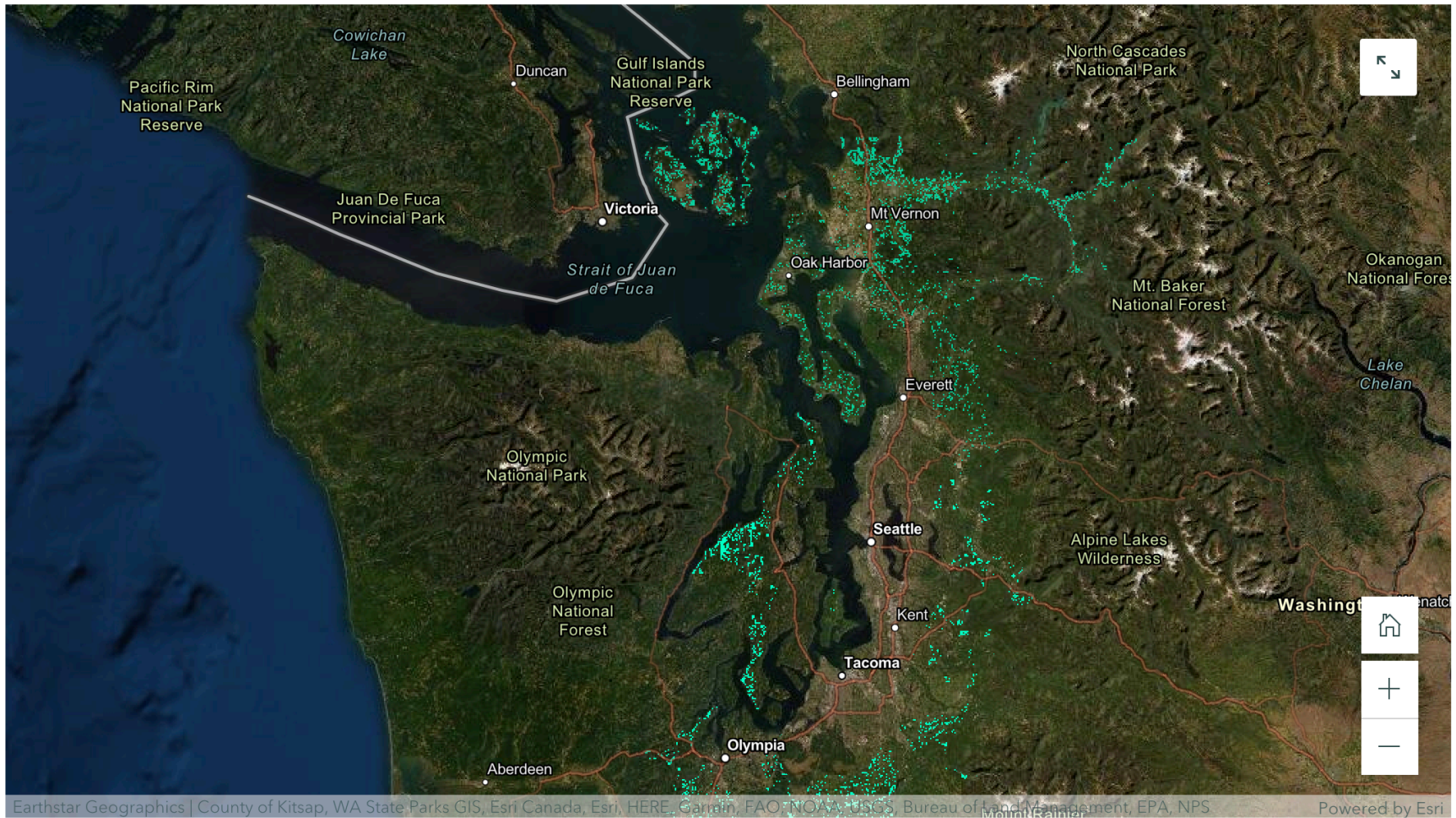
The rapid scale-up and expansion of the Regional Forestry Stewardship Program supports a PSP (2016) conclusion that Conservation Districts are one of the few recovery partners in a position to provide coordinated local service delivery region wide. For this program, they employed a “cluster model” that allowed foresters and forest technicians who worked at one Conservation District to provide services to other Conservation Districts that lacked forestry staff. This enabled the pilot program to reach landowners in seven Puget Sound counties during the pilot phase. This organizational framework allowed Conservation District foresters in the region to work together more effectively, strengthen the quality of services, improve the quality of expertise across the region, and create new partnerships with other forestry programs (Snohomish Conservation District 2023).

Table 7. Regional Forestry Stewardship Program geographic prioritization analysis attributes and results by county

County	Parcel Size	Parcel Status	Land Cover	Resource Concerns	Results (# of parcels)
<i>Island</i>	5-200 acres	<ul style="list-style-type: none"> Privately owned Open Space tax program excluded 	All forested areas using National Land Cover Database	<ul style="list-style-type: none"> All parcels were considered close to resource concerns due to proximity to shorelines 	1,016
<i>King</i>	1-5 acres	<ul style="list-style-type: none"> Parcels with adjacent platted communities 	All forested areas	<ul style="list-style-type: none"> Basin steward priority zones Conservation initiative overlap Areas with degraded forest Within mid-Puyallup watershed Firewise communities/wildfire risk areas 	2,767
<i>Kitsap, Pierce, & Thurston</i>	5-120 acres	<ul style="list-style-type: none"> Designated Timberland excluded 	Forested areas with >70% canopy cover across 4 forest types (deciduous, evergreen, mixed, shrub) using National Land Cover Database	<ul style="list-style-type: none"> Priority zones in WDNR 2020 Forest Action Plan 	Kitsap: 1,175 Pierce: 2,396 Thurston: 1,561
<i>Mason</i>	5-120 acres	<ul style="list-style-type: none"> Privately owned, except timber company ownership excluded Designated Timberland excluded 	Forested areas with >70% canopy cover and >30' in height using LiDAR-derived data	<ul style="list-style-type: none"> Priority zones in WDNR 2020 Forest Action Plan 	1,550
<i>San Juan</i>	5-200 acres	<ul style="list-style-type: none"> Privately owned Open Space tax program excluded 	All forested areas using high-resolution WDFW land cover data	<ul style="list-style-type: none"> Parcels within 200' of shorelines Parcels within 200' of streams 	1,513
<i>Skagit</i>	< 40 acres	<ul style="list-style-type: none"> Open Space tax program excluded 	Forested areas with >10% canopy cover and areas with tree cover gain using Global Forest Change data	<ul style="list-style-type: none"> Parcels within 200' of streams 	5,539
<i>Snohomish</i>	5-200 acres	<ul style="list-style-type: none"> Privately owned Open Space tax program excluded 	All forested areas using National Land Cover Database	<ul style="list-style-type: none"> Priority zones in WDNR 2020 Forest Action Plan Within 200' of potential fish-bearing stream in Statewide WA Integrated Fish Distribution layer 	2,092

(Table from Puget Sound Conservation Districts 2021)

Figure 6. Map showing Regional Forestry Stewardship Program prioritized parcels



(Figure from Puget Sound Conservation Districts 2021)

3.3.3 START HERE!

Kitsap County (2022) developed the Start Here! social marketing campaign to influence landowner development decisions made early in the site design process (i.e., before permitting). Like many Puget Sound jurisdictions, Kitsap County is experiencing rapid growth. The County found that prospective buyers and landowners were often not aware of land cover, stormwater, and critical area protections that will impact their development projects. Projects designed without this knowledge can result in unexpected permitting difficulties, higher project costs, and degradation of critical areas. These observations were consistent with previous regulatory effectiveness work funded by the Marine and Nearshore LO that resulted in recommendations to expand pre-application assistance for Shoreline Master Permit applications (Kinney et al. 2015). **This subaward put this earlier recommendation into practice and expanded the scope to cover stormwater and critical area regulations as well.**

Start Here! was developed to increase community knowledge about critical areas and how development affects them; let landowners and potential landowners know to check in with the County's Department of Community Development to get information about developing their property; and build a professional community that refers landowners to Department of Community Development resources about critical areas.

Kitsap County (2020b) conducted audience research and found that 83% of respondents turned to other sources of development information (e.g., septic designers, building contractors, excavation companies, architects, Kitsap Health District, and civil engineers) before contacting the Department of Community Development. They also identified a disconnect between what residents believe they understand and their actual abilities to properly manage critical areas. Department of Community Development clients are interested in onsite pre-application visits and thought that such visits should be free.

Kitsap County developed general outreach materials and educational products for six key topic areas: (1) the permit process; (2) site plans; (3) timber harvest and tree removal; (4) stormwater management for residential projects; (5) critical areas; and (6) the Growth Management Act. Brochures were produced and webinars were held for each topic. Materials were distributed via print and digital methods to provide introductory information, build awareness of the campaign, and advertise the webinars. Target audiences were residential property owners, future property owners, and "visited-first" businesses. Secondary audiences were professional organizations, community groups, and professional networks.

The [Start Here! website](#) provides access to all of the brochures and webinar recordings organized by topic, as well as a link to a [Start Here! Professionals website](#) that provides contact information for participating contractors, consultants, and realtors. Kitsap County (2022) recognized that not everyone had the time to view an hour-long webinar recording, so they engaged a local television station to convert recorded webinar content into three professionally produced 10–15-minute videos. Questions asked by participants during the live webinars

informed development of the short video scripts. These short videos are also available on the Start Here! website and [YouTube channel](#). As of late 2023, these videos had more than 3,100 views.

Department of Community Development website metrics indicated 5 times the normal amount of traffic after a whole-county mailer was sent out. To evaluate the effectiveness of the campaign, the project team added a question to their online permit application system: Did you review any of the “Start Here! Land Use and Building Development Basics” resources including videos, webinars, or brochures before beginning your permit application? Data indicated that between summer 2021 (when webinars began) and March 2022, 49.55% of respondents (n=55) utilized Start Here! resources. Of those yes respondents, 10.68% (n=11) said that they changed elements of their project based on the information they gathered.

3.3.4 STREAM LANDOWNER EDUCATION AND ASSISTANCE PROGRAM

Snohomish County developed a [Streamside Landowner Program](#) that promotes actions urban, suburban, and rural landowners can take to protect and enhance riparian areas. Residential streamside landowners were the primary audience. Snohomish Conservation District was a partner in delivering education and technical assistance incentives.

Pittman and Hughes (2022) identified sub-basins with the least amount of forested riparian area then prioritizing these sub-basins for outreach and engagement. The project team then sent postcard mailers to 14,347 residential streamside parcel landowners in the targeted sub-basins. These postcards advertised the program and invited recipients to a workshop held about a month after the mailing.

The project team hosted three webinars intended to increase the adoption of riparian best management practices along streams and develop a list of landowners interested in technical assistance site visits. Presentations covered topics including stream morphology, stream ecology, beavers, working in streams, and assistance available to landowners. The second and third webinars were paired with in-person field tours to allow attendees to observe real-world examples of concepts explored in the online workshops a few days prior.

The project team had completed 73 site visits as of the end of June 2023 (six months prior to the end of the project period). During these site visits, the team provided landowners with best management practices for streamside properties, suggestions for enhancement project specific to the landowner’s riparian corridor, and information about resources and funding that may be available for projects. After the site visits, project staff followed up with phone calls, emails, and technical assistance letters.

The project team assisted seven landowners with planning and/or implementation of riparian enhancement projects on residential streamside parcels. Enhancement projects involved invasive species removal (knotweed, reed canary grass, blackberry, ivy), site preparation, and planting of native trees and shrubs. As of the end of June 2023, 4.61 acres had been prepared

and planted with 3,620 native plants along 1,457 of streambank and an additional 4.48 acres of enhancements were planned.

3.3.5 RECOMMENDATIONS

- Social marketing formative research (e.g., audience segmentation and research, deliberate testing of branding concepts and key messages) did not occur for two of the pilot incentive programs discussed in this section. In one case, this was specifically recognized as a deficiency holding the program back. Pittman and Hughes (2022) suggested that a rigorous application of social marketing techniques was needed to develop the Streamside Landowner Program more fully. The subawardee indicated that this could support development of clear, consistent information for landowners and incentive tools that more effectively encourage desired behaviors. **Regional partners should consider investigating barriers to more consistent implementation of social marketing principles during the development of new incentive programs or expansion of existing programs, then identify strategies to address those barriers.**
 - Since the Stewardship and Education LO did not have a clear successor under EPA's 2016 revised funding model, is there now a gap in social marketing expertise accessible to local organizations? Would social marketing training sessions or project development support be useful for practitioners?
 - Recent SIL request for proposals have included information collection requirements associated with the federal Paperwork Reduction Act that may significantly increase the complexity and timeline for audience research supported with EPA funding. Approval from the Office of Management and Budget is required for any survey, questionnaire, or information-gathering activity for more than 10 people. It is not yet clear if this requirement will discourage the inclusion of audience research in proposals, potentially hindering the development of new social marketing campaigns. We recommend regional partners proactively work to minimize any hesitation prospective respondents experience about including audience research in proposals. The SILs and/or PSP could consider offering potential subawardees additional information and guidance about the federal requirements, as well as dedicated support throughout the survey instrument development and review process.
 - There may be opportunities to build capacity for social marketing and make subaward investments more scalable by working with the Washington State Conservation Commission and Puget Sound Conservation District Caucus. The geographic expansion of Shore Friendly and rapid scale-up of the Regional Forestry Stewardship Program demonstrated the role of Conservation Districts as a key partner in coordinated delivery of incentive programs. PSP (2016) also identified [Regional Fishery Enhancement Groups](#) as organization with potential to bridge regional-local program delivery challenges.
- Kitsap County (2020b) audience research indicated that cost could be a barrier to requesting pre-application services. Focus group participants thought a pre-application site visit should be free, but Kitsap County charges \$2,320 for a pre-application meeting (Kitsap

County 2023). The Start Here! program ultimately focused disseminating information about development regulations, but there may be value in investigating if reducing or eliminating applicant costs for pre-permit consultation activities would increase demand for services and be a more effective way to improve development decisions.

- If there is interest in expansion of beaver management incentives, regional recovery partners should consider funding research into the impact of pond levelers on salmon migration. Pittman (2018) indicated that this has been a concern raised by WDFW Habitat Biologists during permitting and may be a barrier to more widespread implementation.

CHAPTER 4: GEOGRAPHIC SCALE INTEGRATION

Chapter At-A-Glance

- The Nature Conservancy's five-year strategy for the Floodplains by Design program 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's Sound-wide support strategy. Several recommendations were institutionalized by Ecology in their 2019 report to the Legislature. Regional partners were subsequently successful in increasing capital appropriations, but operations funding to support non-capital program components remains a gap.
- The Floodplains and Estuaries IS's reach-scale planning strategy was advanced with HSIL support for local Integrated Floodplain Management groups. Fourteen subawards allowed local partners to provide education and outreach highlighting locally relevant benefits and challenges of multi-benefit floodplain management; complete technical studies to enhance understanding of floodplain and estuarine processes to inform reach-scale project prioritization and design; incorporate climate projections into local plans; and engage diverse communities in planning forums to develop and implement reach-scale priority project lists and designs.
- The development of four K-12 education 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, counted seabirds, and helped implement restoration projects. The two programs that submitted detailed outputs reported 2,764 hours worked by over 600 volunteers.
- HSIL funded four fish passage barrier prioritization efforts and development of a downstream barrier identification tool. These projects can help sequence correction 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.
- Data-driven approaches for habitat protection and restoration were advanced via funding support for development of decision support tools, guidance documents, indicators, and monitoring protocols. Several spatially explicit prioritization tools focused on a limited geographic area but have the potential to be expanded for use elsewhere. However, more time is needed to see what types of tools are most useful for their intended purposes before recommending expansion to other geographies.

- Eight habitat acquisition and restoration projects received funding from HSIL. Many of these projects received grants from one or more other sources as well, but there were gaps in funding packages that HSIL subawards were able to fill. Some elements of property acquisition and restoration efforts can be difficult 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.
- A cross-cutting goal for the Implementation Strategy program is to promote climate change adaptation and resilience. HSIL subawards supported several projects that advanced the Shoreline Armoring IS long-term planning strategy, including a parcel-scale sea level rise vulnerability assessment. Support for integration of climate projections into reach-scale Integrated Floodplain Management plans occurred via three subawards. Municipal climate action was addressed through a local planner survey and climate planning toolkit.

The geographic scale integration theme is the largest of the four SIAT funding themes with a total of 63 subawards funded by HSIL. Originally called the multi-benefit planning theme, the purpose of this group of projects is to support geographically specific planning and design efforts to achieve locally-supported prioritization of actions, which will ultimately result in beneficial outcomes for habitat conditions. In this chapter we also include seven projects more closely associated with other themes but with elements warranting discussion here (e.g., use of volunteers for monitoring).

We have organized our analysis of projects within this theme by grouping the subawards into five subjects: (1) integrated floodplain management; (2) planning and stakeholder engagement; (3) tools for data integration; (4) direct recovery actions; and (5) projecting/planning for climate change impacts. Note that some subawards are described in more than one of these section.

4.1 INTEGRATED FLOODPLAIN MANAGEMENT

In 2013, The Nature Conservancy (TNC), Department of Ecology (Ecology), and the Puget Sound Partnership (PSP) created a Floodplains by Design (FbD) partnership to encourage Integrated Floodplain Management (IFM) in Washington State. IFM seeks to develop and implement multi-benefit floodplain projects to reduce community flood risks, restore natural floodplain functions, and recover aquatic habitat. Achieving multiple benefits requires participation of diverse interests (e.g., flood, fish, farm) and highly collaborative processes and practices. Ecology launched a FbD capital grant program in 2013 to implement multi-benefit floodplain projects and/or single-focus projects identified in an integrated river basin plan or project package developed by a diverse group of local stakeholders.

MacIlroy et al. (2014) describes the complexity of successful reach-scale integration planning and project development. Technical studies and modeling to understand past/present/future floodplain function and stakeholder engagement should be pursued concurrently and iteratively. Technical studies to inform alternatives analysis must be scoped, and results communicated in relation to the diverse interests and goals of river corridor partners. MacIlroy et al. (2014) says “it is essential to integrate information to the greatest extent possible to enable effective comparison of the relative benefits likely to result from implementation of alternative potential projects.”

However, some of these critical elements of integrated planning may not be eligible for capital grant funding. FbD funding is limited to the eligible project types described below because FbD is “normally funded through the State Building Construction Account, which means any project activities must relate to capital project implementation” (Ecology 2023). Eligible project types and activities include:

- Community engagement and/or integrated planning committee support.
- Studies and/or modeling, conceptual, preliminary, and/or final designs (including post-project data acquisition or measuring project effectiveness).
- Permitting, construction, and/or plantings.

Additional projects eligible for FbD funding include land acquisitions and/or easements; and home demolition, home elevations, and/or home relocation projects. FbD will also cover costs for related administrative items, such as grant management, obtaining required permits and approvals, and completing Letters of Map Revisions or Conditional Letters of Map Revision.

Building strong working relationships is foundational for the success of IFM (MacIlroy et al. 2014, TNC 2018a, TNC 2018b), but can be hard to justify as an activity relating to capital project implementation. Likewise, the integrated planning process is time-intensive, and it can take several years to produce an integrated plan and set of projects (MacIlroy et al. 2014). This timeframe exceeds typical two-year grant durations. FbD does not fund general operating and administrative costs needed to support continued operations of organizations and coalitions, yet this type of support is crucial for sustaining progress made by regional and local programs. The 2016 Floodplains IS included strategies to build the regional capacity necessary to address this gap, and HSIL provided financial support for elements of IFM that are harder to fund via traditional state capital and federal single-focus grant programs.

HSIL’s 15 IFM subawards (Table 8) supported a variety of activities at both the Sound-wide and River-basin scales.

Table 8. Integrated Floodplain Management Subawards

NTA	Project	Owner	Watershed(s)	Local Group
2016-0019	Accelerate Integrated Floodplain Management	The Nature Conservancy	Sound-wide	n/a
2018-0741	Integrating Climate Change in Multi-Objective Floodplain Management	Climate Impacts Group	multiple	n/a
2016-0113	Develop Data and Support for Floodplain Management Strategies	Whatcom County	Nooksack	Floodplain Integrated Planning (FLIP)
2016-0124	Numerical Groundwater Model to Support Stream Flow Management	Whatcom PUD #1		
2018-0401	Regional (WRIA 1-Wide) Water Supply and Management Plan	Whatcom PUD #1		
2018-0564	Drainage-Based Management Planning	Whatcom County		
2018-0620	WRIA 1 Integrated Program Outreach and Engagement	Whatcom PUD #1		
2018-0587	Skagit HDM Priority Projects	WDFW	Skagit	Farm, Fish and Flood Initiative (3FI)
2016-0074	Climate Resiliency in Snohomish River Floodplain	Snohomish Conservation District	Snohomish	Sustainable Land Strategy (SLS)
2018-0623	Geomorphic Flood Hazard Risk on the Lower Skykomish River	Snohomish County		
2018-0249	North Fork Stillaguamish Integrated Floodplain Management	Snohomish County	Stillaguamish	
2016-0310	Integrated Floodplain Management	Snohomish County	Snohomish and Stillaguamish	
2018-0097	Sustainable Lands Strategy Communication and Outreach	WDFW		
2018-0873	Monitoring Effectiveness of Multi-benefit Floodplain Project Implementation in the Snohomish and Stillaguamish Rivers	Snohomish Conservation District		
2018-0715	Integrating climate resilience into farm-fish-flood project packages in the Snohomish and Stillaguamish River floodplains	Snohomish Conservation District		
2016-0045	Balancing Fish, Farms and Floods in King County's Snoqualmie Watershed	King County	Snoqualmie	Fish, Farm and Flood

Local groups funded through these subawards are multi-disciplinary partnerships and coalitions formed to advance IFM in Puget Sound. These groups work to address the challenges associated with managing floodplains and estuaries in a way that balances flooding, agriculture, habitat interests.

- [Sustainable Land Strategy](#) (SLS) operates primarily in Snohomish County and focuses on the Snohomish and Stillaguamish Rivers. SLS is a multi-jurisdictional program within Snohomish County striving to protect and restore salmon habitat and viable farmland. It was convened in 2010 by Snohomish County, Tulalip and Stillaguamish Tribes, state and federal agencies, agricultural stakeholders, and environmental organizations to improve coordination and generate progress for fish, farm, and flood management interests. SLS is supported administratively by the Snohomish County Surface Water Management Division and Department of Conservation and Natural Resources.
- [King County's Fish, Farm and Flood](#) operates in the Snoqualmie Watershed, focusing on the Snoqualmie Agriculture Production District. It is led by the County's Department of Natural Resources and Parks. The Snoqualmie Watershed occupies the lower 30 miles of the Snoqualmie valley from Snoqualmie Falls north to the Snohomish County line. This area includes the 14,600-acre Snoqualmie Agriculture Production District and some of the most important habitat for Chinook salmon in the region. The Snoqualmie Valley has a "mile-wide floodplain" with a large portion of that floodplain in agricultural use. The Snoqualmie River basin and the Snohomish River basins produce between 25 to 50 percent of coho in Puget Sound.
- [Skagit Farm, Fish and Flood Initiative \(3FI\)](#) focuses on the Skagit River and Samish River watersheds. It was formed in 2011 to create and advance mutually beneficial strategies that support the long-term viability of agriculture and salmon while reducing the risks of destructive floods. Over time 3FI morphed as representatives joined or stepped away; it is currently led by staff at WDFW.
- [Floodplain Integrated Planning](#) (FLIP) process focuses on updating and broadening the scope of the Lower Nooksack River Comprehensive Flood Hazard Management Plan (CFHMP) to address the needs of fish, farms, and other floodplain uses. It is led by the Whatcom County Flood Control Zone District and staff from the Public Works Department. Additional work in Whatcom County includes the Whatcom Management Board, which acts as the WRIA 1 Local Integrating Organization (LIO). Whatcom Management Board includes Whatcom County and Whatcom Public Utility District No. 1 as members, among others.

Wright (2021) provides extensive information about each local coalition, including their history, mission, key stakeholders, funding sources, and projects/accomplishments. One other Puget Sound IFM partnership, [Floodplain for the Future](#) (operating in the Puyallup, White, and Carbon Rivers) is also included in Wright's comparative analysis of integrated floodplain planning in Washington.

We have organized our discussion of the 15 IFM projects around the Floodplains and Estuaries IS strategies and approaches they advance, so individual subawards may be discussed in more than one of the five sub-sections below.

4.1.1 REGIONAL SUPPORT FOR IFM

The Floodplains and Estuaries IS seeks to promote IFM through development and maintenance of a regional support framework for practitioners. The Floodplains and Estuaries IS Sound-wide integrated floodplain and estuary management support strategy advocates for further developing a regional vision to mobilize funding for IFM; boosting capacity for a network of regional and local practitioners to encourage coordination and shared learning; developing shared goals and metrics to track regional progress; and addressing regulatory and permitting process barriers. In this section we describe two subawards that supported significant progress towards several of these goals:

- NTA 2016-0019 – Supported The Nature Conservancy’s efforts to advance IFM in Puget Sound. They supported organizations in the IFM network and developed a five-year strategy for the FbD program.
- NTA 2016-0401 – Supported the Puget Sound Partnership in refining and producing data for Floodplains Vital Sign recovery targets. They delineated baseline floodplain extent for each river and established metrics for function and degradation that could be applied to assess current condition in those areas with a regional floodplain condition assessment. This subaward is covered in Section 4.3.2 on common indicators but is noted here because it resulted in recommendations for project-related performance metrics and tracking guidelines.

The Nature Conservancy provided technical support to four watersheds to advance reach-scale planning; connected local practitioners to grant funders; convened workshops on storytelling and property acquisition; developed a multi-agency project support team; facilitated a large project implementation group; prepared a report that provided a summary of progress implementing IFM in Puget Sound watersheds (TNC 2018a); and worked with local and regional partners to develop a five-year strategy aimed at transitioning FbD from a grant-funded initiative to an ongoing state program (TNC 2018b).

TNC’s five-year strategy work provides a vision for the FbD program through 2023. It outlined a path for building capacity at the regional and local levels; harmonizing policies and regulatory programs; and positioning the network for expanded funding. The five strategic focus areas of the work include:

- Culture and Network – Broaden and deepen reach by strengthening local community engagement as well as regional, state, and federal engagement.
- Capacity – Increase capacity by disseminating information about IFM principles and practices, developing human capital, engaging planning departments, and developing performance metrics.

- Policy – Improve the policy/regulatory framework by determining key limitations and advancing policies that harmonize with IFM.
- Funding – Increase and diversify resources for IFM. Increase state capital budget sources of project funding; secure operating budget resources for non-capital program components; develop new funding sources.
- Markets – Build market demand and better understand how markets can incentivize IFM and influence the behavior of farmers, landowners, businesses, and others.

The future of Floodplains by Design

TNC's effort under this subaward increased political support for IFM as evidenced by a 2018 Legislative proviso and subsequent Ecology (2019) report. Ecology's report to the Legislature built on the extensive outreach TNC conducted during development of the five-year strategy and recommended statutory and policy changes for the FbD program. These included increased capital funding for FbD projects and adequate funding to support local and regional integrated planning. Ecology's recommendations reflect progress towards institutionalizing the TNC (2018b) strategy.

In 2021, the Bonneville Environmental Foundation stepped into a leadership role to support the FbD program and assumed some of the critical functions that TNC had performed (e.g., convening, facilitation, coalition building, and fostering regional-local collaboration). As of late 2023, Bonneville Environmental Foundation continued to implement the organizational plan and final years of the five-year strategy work.

4.1.2 COMMUNICATING BENEFITS OF INTEGRATED MANAGEMENT

The subawards discussed in this and the following three subsections were implemented by local IFM partners to advance the Floodplains and Estuaries IS river-basin scale planning and project management strategy. Providing education and outreach that highlights locally relevant benefits and challenges of integrated management is one component of this strategy. Two IFM subawards focused on this strategy element:

- NTA 2018-0097 – Supported outreach and education events to expand the reach of the Sustainable Lands Strategy.
- NTA 2018-0620 – Supported Whatcom County PUD No. 1 and the Whatcom County LIO to develop a WRIA 1 Coordinated and Integrated Outreach and Education Program that creates a communication strategy to address Whatcom ecosystem recovery plan elements.

As part of NTA 2018-0097, HSIL supported the Sustainable Lands Strategy in developing broader communication products and tools. Communications products and tool outputs include:

- Building a new website for SLS.
- Publication of eight online newsletters and sharing out of data collected at farmer's markets at an SLS Special Topic session in February 2022.

- Conducting two farm tours: one looking at an anaerobic digester at a Snohomish County dairy farm and another at a local ranch (a third planned tour did not occur due to lack of timing at a planned location).
- Presenting at the Salish Sea Ecosystem Conference in April 2022 in partnership with King County's Farm Fish Flood and collaborative partners in British Columbia (Watershed Watch Salmon Society, Lower Fraser Fisheries Alliance, and Resilient Waters)
- Engaging with the public and farmers at events like farmer's markets, county fairs, and annual Focus on Farming workshops; conducted farm tours; and built relationships with other IFM practitioners during a session at the 2022 Salish Sea Ecosystem Conference.
- A video storytelling workshop and presentation. The virtual workshop was conducted January 2022 with twelve participants, which consisted of five, two-hour training sessions over two weeks. The resulting products were 12 short films sharing the stories of people living and working in the Snohomish and Stillaguamish River floodplains and a film festival, "[Tales of Two Rivers](#)" which occurred in the summer of 2022.

As part of NTA 2018-0620, HSIL supported the Whatcom County PUD No. 1 on behalf of the WRIA 1 Watershed Management Board, which serves as the Whatcom LIO, to develop and implement a communication strategy that addresses Whatcom ecosystem recovery plan elements including water supply, water quality, floodplains, Chinook, and streamflow. Outputs of the project include:

- Support for outreach and training events hosted by the Whatcom Watersheds Information Network, a group of organizations, individuals, businesses, tribes, academic institutions, and local and state governments interested in coordinating on outreach and engagement to support the Whatcom LIO. Events included two equity and Anti-Racism trainings in 2022; [a 2021 and 2022 speaker series](#) led by the Whatcom County Marine Resources Committee; and the [Whatcom Watersheds Information Network Water Week](#). The Water Week was a series of events that occurred in September 2021 and 2022 and included work parties, an education booth at SeaFeast, a photo contest, stormwater center tours, and community water-wise/pollution and water safety events.
- A public [story map](#) providing an overview of water availability and uses in 11 subbasins. The foundation of the story map is Regional Water Supply Plan Phase 2 Report (funded by NTA 2018-0401 and discussed in the following section).

The subaward also enabled the Whatcom LIO to support grantees through a Whatcom Assistance Program. Local organizations apply for grants available through this subaward to conduct on-the-ground actions and outreach and engagement. Grantees were awarded funding to pursue the following projects:

- Evergreen Land Trust Association's outreach/education project entitled "South Fork Nooksack River Watershed Community Engagement on Streamflow and Forests". The project informed community members about water resource management and promoted greater awareness about the role forests can play in increasing summer streamflow.

- Lummi Indian Business Council’s outreach/education project entitled “South Fork Edfro Phase 3 Community Outreach and Engagement”. The project engaged stakeholders in a design project for salmon habitat restoration.
- Nooksack Salmon Enhancement Association’s outreach/education project entitled “Salmon Discovery Program” which funded a collection of community-based salmon education programs including salmon viewing events and education opportunities throughout WRIA 1.
- Nooksack Tribe’s outreach/education project entitled “South Fork Nooksack Fish Camp Integrated Flood and Fish Project (formerly Integrated Design Project) – Community Outreach and Engagement” to develop broadly supported, multi-benefit solutions to address habitat degradation and reduce flood risk to the Acme community.
- Washington State University Whatcom County Extension’s sustainable landscaping short courses outreach and engagement events

Lastly, the subaward funded a Whatcom County community survey to better understand public perspectives and level of knowledge on a variety of ecosystem topics including Chinook, stream flows, habitat, and water quality and quantity, and types of solutions for managing resources. The survey was sent out to over 16,000 households and additionally emailed to numerous groups and listservs. Whatcom PUD received 269 completed surveys and released a summary report in July 2022. **Overall top issues for respondents included concerns over future water supply and quality in Whatcom County, pressures on salmon including low stream flows, human population growth, and riparian area loss.**

4.1.3 INCREASING UNDERSTANDING TO INFORM REACH-SCALE PLANNING

Another approach associated with the River-basin scale strategy is enhancing understanding of floodplain and estuarine processes to inform reach-scale project prioritization and design. Seven HSIL subawards supported technical studies necessary to advance IFM planning and project implementation. These studies related to streamflow/groundwater management, riparian buffers, and flooding hazard risk assessment.

Streamflow analyses and assessments

To ensure the health of habitats dependent on surface and groundwater, Washington State promulgated rules and regulations that would help to control removal of water from these sources. Ecology’s Instream Flow Rule sets instream flows for rivers and streams throughout Washington State and helps to guide water rights permitting (Sawabini 2020). As a result of this rule, restrictions were placed on any new man-made output or diversion from rivers, lakes, and groundwaters sources. These regulations presented significant challenges to WRIA 1 in Whatcom County because while flows were established to protect instream uses, out of stream water rights were also impacted, potentially affecting tribal water rights. The location of WRIA 1 is shown in Figure 7.

Figure 7. Map of the WRIA 1 Zone Within Whatcom County



(Figure from Dunn 2023)

In 2007, Whatcom County – WRIA 1 published the first iteration of their Watershed Management Project Implementation Plan. This Plan was built to meet Ecology’s regulatory requirements and included creating strategies that addressed current and future water rights; the water needs of agriculture; land-use and infrastructure water requirements; and instream flows (WRIA 1 2007). As instream flows are considered a significant challenge for WRIA 1, management decisions are intended to be made using best available science. In 2016, an update occurred to the Instream Flow Rule when the Washington State Supreme Court passed the Hirst Decision, which placed the onus on counties to manage their water resources.

In facing this challenge, a strategy was developed that would consist of designing a technical tool to reevaluate instream and out-of-stream water needs. This model would also support the 2005 WRIA 1 Instream Flow Action Plan which was written to address water use and water need challenges at the drainage level.

Several NTAs support water use and water supply management strategies in Whatcom County and in particular WRIA 1:

- NTA 2016-0124 – Supported the WRIA 1 Watershed Management Board in completing a Numerical Groundwater Model tool used to protect instream resources, quantify tribal water rights, and address the out of stream needs for existing and future uses.
- NTA 2016-0113 – Supported the Whatcom County Flood Control Zone District in advancing the FLIP effort within the lower Nooksack River area and developed a database and an expansive library of technical documents that includes information on past, present, and the potential future of the floodplain.
- NTA 2018-0401 – Supported WRIA 1 in establishing a framework to address water supply needs for instream and out-of-stream uses with the Regional (WRIA 1-Wide) Water Supply and Management Plan.

- NTA 2018-0564 – Supported WRIA 1 Drainage-Based Management Planning workgroup meetings which identified drainage specific targets for water supply needs.

Development of a numerical groundwater tool

NTA 2016-0124 supported the Whatcom County PUD No. 1 and WRIA 1 Watershed Management Board with Phase 4 of a longer-term project to characterize the groundwater flow system for Whatcom County. The end goal was for the tool to support planning decisions regarding protecting instream resources, quantifying tribal water rights, and addressing the out of stream needs for existing and future uses (Associated Earth Sciences, Inc. 2019).

The numerical groundwater model developed during this project covered 445 square miles of the Fraser-Whatcom Lowland, a geographic area that stems from the Strait of Georgia coastline between Burrard Inlet in the north to Bellingham Bay in the south. The model simulated groundwater flow including flow from irrigated agricultural lands throughout the area. The results were two simulations: a Steady-State and a Seasonal-Average-Transient model (S.S. Papadopoulos & Associates 2019). The Steady-State model provided an initial opportunity to examine the current hydrologic state of the watershed, while the Seasonal-Average-Transient model simulated the typical system-response range seen between irrigation and non-irrigation seasons.

Funding from this award also supported the refinement of a surface hydrologic model (Bandaragoda and Greenberg 2016). The surface model, when coupled with a groundwater model, produced water use and recharge estimates for specific drainages throughout WRIA 1 and Bertrand Creek.

The awardee submitted the models to USGS and Ecology for peer review. In June 2021, Whatcom County received the peer review results relayed in a technical memo (Porcello et al. 2021). The model was found to be well-calibrated and capable of producing consistent results that simulate long-term impacts. However, the numerical groundwater model faltered when evaluating daily or monthly changes in use. The conclusion of the peer review offered a series of improvements for the model. In February 2022, the subawardee issued a Request for Proposals to further develop the groundwater model based on results from the peer review (Whatcom County PUD 2022).

Advancing the FLIP effort within the Lower Nooksack River

While the numerical groundwater model simulates specific stream flows, the Whatcom County FLIP process provides a comprehensive look at the Nooksack River floodplain. During Phase 2 of NTA 2016-0113, FLIP team members hired outside consultants with the US Geological Survey to develop [technical work products](#) focused on the four river reaches as well as the larger watershed scale. These products provided a thorough analysis of past, present, and potential future geomorphic, hydrologic, hydraulic, and habitat conditions in the Nooksack River and floodplain. These analyses included input from County staff, University of Washington Climate Impacts Group, and consultants. The development of a hydrodynamic model of the river and its floodplain in Reach 1, accounts for future sea level rise, storm surge, and changing

sedimentation patterns. As part of this work, the consultants also built a geodatabase assessing flooding risk to occupied structures. This project element is discussed in the “Risk assessment” subsection.

Together the Whatcom County numerical groundwater model and FLIP process provide insights on small stream and large-scale water processes within the Nooksack watershed. These tools aid salmon recovery efforts and can support local and county watershed plans and salmon recovery plans. Both these subawards were accomplished with input from local, state, and tribal authorities and resulted in collaboratively developed tools. Hydrologic models serve a significant purpose in examining water rights and ecosystem health. Application of these tools should be monitored and, if warranted, regional partners could support development of similar tools in other watersheds.

[Supporting the creation of a WRIA 1-wide water supply and management plan](#)

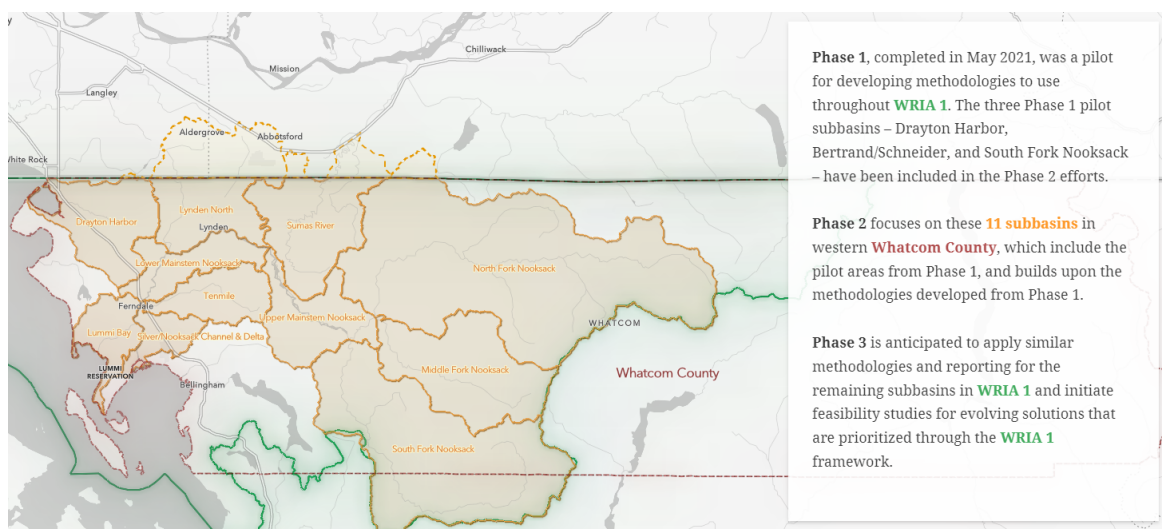
NTA 2018-0401 supported Whatcom PUD No. 1 in developing a Regional (WRIA 1-Wide) Water Supply and Management Plan to establish a framework to address water supply needs for instream and out-of-stream uses. Using a pilot-based approach, this subaward addressed water use and availability in selected drainage basins in WRIA 1 to inform the future development of the WRIA 1 Water Supply and Management Plan. The Regional Water Supply and Management Plan is a critical component of the [WRIA 1 Watershed Management Board 2018-2023 Implementation Strategy](#) which is the current five-year work plan to implement actions in WRIA 1 regarding water supply, water quality, salmon, instream flow, and habitat restoration.

The coordination process for the project was established by the WRIA 1 Watershed Management Board and the information gathered from this project will be integrated into a future regional WRIA 1-wide plan and connected to other efforts in WRIA 1 (Dunn 2022).

The Regional Water Supply and Management Plan was developed in two phases: Phase 1 of the project consisted of analyzing current and future projected water usage as well as changes in instream flows in the overall WRIA 1 watershed. Phase 2 of the project conducted in-depth analyses of the South Fork Nooksack River and related western WRIA 1 subbasins specifically (11 in total).

Research was conducted for Phase 1 by Aspect Consulting, LLC (2021) and for Phase 2 by RH2 Engineering (Dunn 2023) on behalf of the subawardee. Phase 1 of the RWSP focused on characterizing three subbasins as pilot areas to quantify current and future out-of-stream water supplies and identifying management solutions for instream flow needs and out-of-stream water uses. The pilot area subbasins consisted of Bertrand Creek and Schneider Creek, Drayton Harbor, and the South Fork Nooksack River watersheds. The Phase 2 report focused on 11 western WRIA 1 subbasins.

Figure 8. Map of the subbasins analyzed in Phase 1 and Phase 2 of the WRIA 1 Regional Water Supply and Management Plan



(Figure from Dunn, WRIA 1 Whatcom Management Board 2022)

The goal of the phased projects was to identify potential water supply source alternatives to meet future water needs and evaluate them for technical, economic, regulatory, administrative, and political feasibility. The reports include a summary, background information, alternatives evaluation and policy recommendations.

The methodologies of the projects included analyzing current and future total and consumptive water use for residential, municipal, industrial and irrigation/agriculture use. Current use was measured using available stream gage data. Future use was based on a 50-year planning horizon. For each subbasin, the analysis considered the current water use (as of 2020) and projected water use (2070). It measured projected streamflow impacts due to climate change, summarized existing water rights, and identified potential solutions. Current and future water use was broken down into five categories: (1) self-supplied domestic (permit-exempt wells), (2) municipal and group domestic, (3) commercial and industrial, (4) crop irrigation, and (5) dairy.

Preliminary water needs assessments were made at streamflow gages for minimum instream flows. Calculated historical streamflow and current streamflow conditions were compared to minimum instream flow. Future streamflow was estimated by looking at “percent change in surface water runoff for a point location as the center of the delineated surface water drainage contributing to the gage” (Dunn 2023). Percentage change was estimated based on climate change modeling. Climate change models were applied to the estimated current streamflow at the gage locations studied.

As a result of the data synthesized, information in the analyses include:

- The status of existing water right permits by source of water to identify surplus water and/or additional water supply needs.
- Projections of future water supply needs in the pilot areas over next 80 years.
- Projections of water use for the next 50 years.
- A summary of:
 - stream flow information
 - current and historic fish presence
 - current and historic habitat conditions
 - land use effects on water availability
 - Instream flow needs for fish.

Current and future consumptive uses were estimated (based on 50-year planning horizon) for the following subbasins:

- For the Bertrand Creek subbasin water use is projected to increase by 23 percent; and Schneider Creek subbasin by 44 percent.
- For the Drayton Harbor subbasin, projected annual total water use is estimated to increase on average 65 percent (with the highest increase in water usage originating from an increase of 72 percent in self-supplied single domestic and an increase of 61 percent in municipal and group domestic and an increase of 66 percent in crop irrigation consumption).
- For the South Fork Nooksack River, projected annual total water use is estimated to increase 93 percent with the highest increase originating from an increase of 98 percent for domestic consumptive water use. **Based on the worst-case climate change models, due to projected warming temperatures and less water stored as snow in the winter, average winter flows are projected to increase (up to 112 percent) and summer low flows are expected to decrease (up to 76 percent) in the South Fork Nooksack River subbasin by the year 2070.**

The consultants, Aspect Consulting, LLC. (2021), and Whatcom PUD No. 1 noted that climate change impacts will have a **significantly greater impact on retiming of the availability of instream flows than current and future consumptive uses**. Projected streamflow for the South Fork Nooksack and related forks showed that nearly all subbasins predict higher total runoff November through February and lower total runoff and flow June through August but with approximately the same volume of water. The impact of low summer stream flows was the highest impact on projected water availability.

The Regional Water Supply Plan highlighted significant management opportunities for the WRIA 1 Management Board and confirmed that **nearly all subbasins will experience a significant decrease in summer streamflow and an increase in winter streamflow. The intensity and frequency of peak-flow events may increase with climate change. Increased peak flows can result in scour, channel downcutting, and channel widening.** These geomorphic effects will impact habitat as well as storm event emergency floodplain management – necessitating incorporating climate adaptation and resilience measures into Whatcom PUD No.1’s management efforts.

WRIA 1 drainage-based management planning

Further management activities for water usage and water availability in WRIA 1 were supported by NTA 2018-0564 which provided funds to Whatcom County Public Works to conduct WRIA 1 drainage-based management planning. Elder (2022) identified subbasin specific targets for water supply needs with the resulting plan addressing potential strategies for two drainages: South Fork Nooksack River and the Bertrand-Schneider subbasin. For each subbasin, technical targets were created to establish benchmarks for the purpose of understanding the existing baseline conditions of the areas.

The primary goal of this project was to coordinate meetings among workgroup members to identify drainage specific targets. Between September 2021 and July 2022, the work group engaged in monthly meetings, including two longer-format workshops, to identify key elements of drainage plans. Facilitation was provided by Kramer Consulting and Anchor QEA

The facilitation team researched existing data, best available technical information, and other existing plans and programs to suggest measures and conceptual numeric ranges for drainage-based management targets and to estimate the magnitude of benefit provided by potential actions. Within work group discussions, strategies emerged to address the identified needs by proposing new conceptual approaches, or in many cases, by suggesting ways to accelerate the work of the many ongoing programs in these drainages.

A technical memo of recent storage projects and estimated costs was completed by the consultant for the subawardee (Kramer and Rohrbach 2022). The memo addressed the costs and instream flow benefits of projects to be considered in the Nooksack Basin. The projects under consideration included:

- An off-channel storage project in the Dungeness Reservoir (located near the City of Sequim) to store water to provide additional flow to the river during critical low-flow periods. Estimated project costs range around \$36 to 37 million.
- Creating new water storage at 20 potential water storage sites in the Snoqualmie River Watershed. Estimates of the individual sites range from \$1.8 million to \$125 million with 76 to 3,311 acre-feet in storage volume, respectively.

Understanding the cost and instream flow benefits of potential storage projects informed the work group about the magnitude of storage needed to maintain instream flow benefits in the

Nooksack Basin. Additional on-going planning efforts discussed during the work group meetings, which this subaward funded, included riparian restoration efforts in the South Fork Nooksack, wetland restoration and floodplain reconnection projects in the Black Slough (as well as communications and outreach about these projects), the ongoing acquisition efforts and management of the Steward Community Forest, and an ongoing process to identify future agricultural land that will require land protection through acquisition and access to irrigation water. The overall goal of these planning efforts was to understand how to operate with a future of decreased late summer instream flows and its impact on water availability in WRIA 1.

King County Riparian Buffer Task Force

Adequately sized riparian buffers can lower stream temperature, filter agricultural and forestry runoff, and support flood-prone freshwater shoreline infrastructure. In this section we discuss:

- NTA 2016-0045 – Funded King County’s Buffer Task Force to provide guidance for riparian buffer projects.

King County’s Riparian Buffer Task Force was formed to provide the foundation and guidance for a scientifically credible, context-sensitive, locally derived riparian buffer strategy developed. Parties representing the Fish, Farm, Flood organization and additional representatives participated. The task force developed a set of voluntary, variable-width riparian planting recommendations based upon land use, watercourse type, and/or needed riparian habitat function for salmon. Additionally, the task force developed an Agriculture Riparian Decision Tool for the Snoqualmie River area.

King County (2020) provided a comprehensive synthesis of riparian buffer literature and a white paper that discusses the positives and concerns of riparian buffers from an agricultural perspective. The task force agreed to a variable width strategy for watercourses for implementation in the King County Snoqualmie Agriculture Production Districts. The riparian buffer task force report produced an agreed-on set of recommendations that “set forward ecologically meaningful riparian buffers based on best available science” and are specific to the agriculture landscape of King County.

Non-tangible outcomes of the buffer tasks force included the importance of having conversations across, fish, farm and flood interests, according to the final report. Conversations in the last few meetings revolved around how the recommendations could result in the increased uptake of riparian buffers. King County (2020) determined that **incentives play an important role in adopting voluntary riparian plantings**. It was also determined that **farmable land would be lost when trees were planted within 165 feet of the watercourse and became at least four inches in diameter** because these conditions result in a critical area designation in King County.

Risk assessment

Two IFM subawards (NTAs 2018-0623 and 2016-0113) are related to the Floodplains and Estuaries IS’s risk tolerance and cost subsidy analyses strategy. This strategy highlights

opportunities to incorporate flood risk and long-term costs of development within floodplains and estuaries into land use planning. Generating data about flooding and geomorphic (channel avulsion, erosion, aggradation) exposure is necessary if this strategy is to be advanced.

The subaward associated with NTA 2016-0113, discussed previously in section 4.1.3, produced a geodatabase assessing flooding risk of occupied structures for the FLIP effort in Whatcom County. The database included digitized structure footprints, assessed values (in dollars), and the approximate elevation of the first finished floor above surrounding ground (Harris and Ewbank 2021). This represents a dataset that Whatcom County has not historically had available in making flood risk reduction investments, and that will be directly useful in developing recommendations in each of the five reaches in the FLIP study area. This dataset also has the potential to be useful for a future cost subsidy analysis.

NTA 2018-0623 supported an assessment of geomorphic flood hazard risk on the lower Skykomish River undertaken by the Snohomish County Public Works Surface Water Management (2021) and partners. The project team delineated a reach-scale channel migration zone and completed a geomorphic assessment that quantified rates of channel migration/erosion along the river corridor based on historical information. Results will be used to establish a comprehensive technical basis for evaluating and prioritizing multi-benefit projects. Additional analysis would be required to quantify risk exposure to buildings and critical facilities.

The project team also conducted an infrastructure assessment that identified two areas of high concern on the Lower Skykomish River. The infrastructure assessment led to repairs at the Haskel Slough levee prior and assisted project partners in identifying priorities/needs for long-term infrastructure maintenance activities along the assessed river reaches.

Results of these efforts were communicated via in-person and online community outreach. The [virtual open house format](#) was a new approach for Snohomish County but it resulted in increased participation and comments on IFM plans moving forward.

4.1.4 FUTURE PROJECTIONS

Incorporating future flood projections into IFM planning efforts advances the river-basin scale strategy. Climate change projections suggest that more frequent and severe winter flooding and reduced summer streamflows are likely (as suggested by NTA 2018-0401 referenced above). Puget Sound communities are currently at a pivotal moment for deciding how to prepare for climate change. This is especially true among communities who are most at risk, which includes people within coastal and floodplain zones. To help local communities, IFM groups are collaborating with climate specialists to incorporate climate resilience into regional and local plans.

HSIL provided funding for three subawards focused on incorporating climate resilience into reach scale plans. These subawards are:

- NTA 2016-0074 - Supported the Snohomish Conservation District in integrating climate resilience into the Agriculture Resilience Plan for Snohomish County.
- NTA 2018-0741 – Supported the Climate Impact Group in collaborating with Whatcom and Snohomish County floodplain management groups on filling gaps in climate-resilience planning through designing technical reports that highlight shared vulnerabilities particularly around the Stillaguamish and Snohomish rivers and leveraging funds among climate-related interests.
- NTA 2018-0715 – Incorporated climate projection tools into climate modeling and assessment efforts to be used by the Snohomish County Sustainable Lands Strategy

Agriculture resilience planning in Snohomish County

NTA 2016-0074 supported work by the Snohomish Conservation District and partners, including TNC, the Tulalip Tribes, and Snohomish County, to integrate climate resilience information into an [Agriculture Resilience Plan for Snohomish County](#). The award funded Snohomish Conservation district to:

- Analyze ground water and salinity in the Snohomish and Stillaguamish watersheds
- Update TNC’s Coastal Resilience/Floodplains by Design decision support tool
- Review Snohomish County’s farmland viability prioritization mapping effort
- Conduct landowner and stakeholder outreach

Climate change is expected to impact groundwater conditions and timing in the Snohomish and Stillaguamish River watersheds by raising groundwater levels which can a) extend the period of saturation in the spring, thereby delaying agricultural field access and b) may also shorten the agricultural season in the fall as groundwater levels return to pre-spring conditions earlier. Snohomish County’s consultant, Cardno (2019), analyzed regional groundwater and determined that current effects of sea level rise on the timing of groundwater conditions in the autumn are not likely to be significant because anticipated changes in levels would be within the range already experienced under natural tidal cycles. Updated flood prediction models determined that a delay of start times for agriculture will increase and become more pronounced over time because of climate change in the region.

For low-lying farmland, delays could occur up to approximately three weeks by the 2050s and four to five weeks by the 2080s. Areas closer to the Puget Sound coast (within a few miles) will feel the greatest effects of this change because of their proximity to rising marine waters. In the Snohomish and Stillaguamish Rivers, relative sea level rise is projected to increase by around 0.8 feet by 2050, 1.5 feet by 2080 and 2.2 feet by 2100. Groundwater levels are a major variable affecting agricultural operations in the lower Snohomish and Stillaguamish River floodplains. The study found that two- and five-year flood events were likely to impact nearly triple the amount of agricultural acreage by the 2050s, from approximately 9,000 acres to over 41,000 acres for two-year events and from approximately 37,000 acres to 56,000 acres for five-

year events. This demonstrates that future flooding will inundate more agricultural land than current flooding.

Besides the impact of groundwater and impact of future flooding on agriculture fields, modeling from this subaward depicted where increased salinity may have impacts in the two river basins. The increase in salinity will impact agriculture operations and farms near the Snohomish estuary and coast in particular.

The work conducted during this subaward resulted in the inclusion of climate-related information (such as details about sea level rise and groundwater salinity intrusion for Snohomish County) into the Agriculture Resilience Plan (Snohomish Conservation District 2019). The outcome of the research was an updated plan which addressed flooding risk and identified reach-scale priorities to increase resilience.

The Snohomish Farmland Conservation Working Group completed a prioritization mapping effort for Snohomish County that included information on farmland viability and a study of the potential risk of conversion factors affecting farmland. This project funded a follow-up effort in which the group reviewed the groundwater and flooding predictions to determine focus areas for protection. The information will be adapted based on landowner willingness and funding priorities for future restoration activities by Snohomish Conservation District and SLS.

Additional outputs from this subaward included establishing of a regional Learning Network that has shared and promoted similar climate resilience efforts around the region, upgrading TNC's Coastal Resilience/Floodplains by Design decision support tool with more comprehensive flood prediction data and conducting stakeholder outreach.

Outreach efforts conducted under this award were extensive and included workshops with over 75 attendees including farmers in the Stillaguamish/Snohomish watersheds, members of the Stillaguamish/Snohomish LIO Executive Committee, members of the Snohomish County Agriculture Advisory Board, the Stillaguamish Watershed Council, and Snohomish Estuary Working Group, and various drainage/flood control districts staffers.

Integrating climate change into multi-objective floodplain management

NTA 2018-0741 supported the University of Washington Climate Impacts Group (CIG) to **develop analyses and communications products, and conduct interviews and workshops to increase capacity for both SLS and FLIP to implement climate-resilient planning efforts**. This was done by producing research that (1) highlighted shared vulnerabilities, (2) increased capacity, awareness and understanding of climate adaptation, and (3) identified opportunities to leverage funds among management interests.

This project built upon previous HSIL and IFM investments to support integration of climate-resilient information into the future work project packages, including [previous work](#) accomplished in Pierce County by the subawardee.

CIG produced several climate adaptation and resilience reports for the subawardees. [Climate Adaptation for Floodplain Management: An Introductory Guide](#) directs stakeholders and managers to initiate a seven-step adaptation planning process to identify the best ways to manage flooding so that farm, fish, and floodplain outcomes can be improved. [Technical Guidance: Quantifying Climate Change Impacts](#) is a technical companion to the adaptation planning guidance. It answers questions about how to quantify sensitivity and exposure, manage uncertainty, locate the latest climate data, and identifies things to consider when seeking new data.

The technical guidance document provides detailed suggestions for the best approaches to answer questions related to sensitivity, exposure, and uncertainty. These approaches include:

- Quantifying sensitivity by using field observations (easily recognizable flooding) and/or modeling to estimate projected impacts.
- Quantifying exposure by using existing or “downscaled” global climate model data and/or using impacts model data. The document includes a decision flowchart to guide readers to better identify which approach may be more useful and relevant for their situation.
- Managing uncertainty in model projects by breaking them down into three categories 1) uncertainty regarding projected level of greenhouse gas emissions, 2) uncertainty regarding timing and magnitude of natural variations and 3) uncertainty regarding modeling of key processes. The document suggests using six to ten global climate models per climate projection to decrease uncertainty in projections, including focusing on the Coupled Model Intercomparison Project Phase 6 model (its newest iteration). The document also suggests that if despite best efforts modeling results are still unclear, developing plans with a high degree of uncertainty is to be considered.
- Directing readers to where the latest climate data can be found and best practices when seeking to understand sensitivity and exposure data.

For SLS, CIG also developed a database with a selection of key resources related to climate change; an adaptation needs assessment for integrating climate change into floodplain management; and a climate adaptation needs assessment specific to Snohomish County floodplains.

In Whatcom County, CIG worked with the FLIP to develop deliverables specifically for that group. **Because of the impact of the flooding events that occurred in November 2021, CIG and the FLIP determined that the most helpful deliverables would be those centered around communications and perception of the floodplain management process in Whatcom County** (Mauger et al. 2022).

To that end, CIG conducted a literature review and [media analysis](#) of 33 news articles to “better understand public perception on flood impacts and the role of climate change” (Asinas et al. 2022). The media analysis was done in close collaboration with the FLIP Steering Committee

and its goal was to explore the community values, experiences and perceptions of floodplain issues. Highlights of the media analysis included that:

- Flood impacts were generally talked about in terms of the amount of damage and displacement caused by the floods — in particular damage to homes, buildings, infrastructure, loss of livestock/farms, and impacts to salmon habitat.
- A lack of attention was paid to the “emotional and social impacts” of the floods in addition to a lack of attention to the community support that emerged in response to the flooding (e.g., community members offering support to each other on social media).
- Respondents stated that **climate was not perceived to be a driver of the flooding**. The discourse around climate change in relation to the flooding **was not discussed by local government and residents’ groups as it was viewed as politically contentious**. Instead, the flooding was more often described in terms of “aggradation and the Nooksack River’s geography, the history of colonialism and subsequent development and loss of natural floodplain functions, the lack of a comprehensive flood control system and government inaction.” Local officials and experts on the ground were often quoted speaking about those terms in particular on sediment build-up affecting the floodplain, development changing the natural dynamics of the Nooksack, a lack of a flood control system and government inaction.

In response to the media analysis, FLIP asked CIG to develop a [StoryMap](#) describing basic flood concepts of the Nooksack River for a lay audience. The StoryMap provides a history and orientation of the geography of the river followed by the physical processes, human influences, and other factors that shape the Nooksack.

The final output from CIG (in collaboration with UW EarthLab) for the FLIP was a series of [case studies](#) from around the Salish Sea synthesizing best practices in gravel/sedimentation removal. The case studies range from looking at the Fraser River in British Columbia, Puyallup River in Pierce County, and the Chilliwack River/Vedder River in British Columbia.

Findings from the case studies include that **gravel removal is limited in its effectiveness to the immediate vicinity of the removal site, is short-lived in the duration of its benefits** because rivers replenish removed gravel over time, and if done multiple times at the same site, **can have significant impact to fish habitat** and is a complex and costly process that must be done repeatedly for observable benefits.

Additionally, CIG conducted public and professional outreach including hosting **five stakeholder workshops**, gave **five presentations** on the work and spoke with over **50 stakeholders**.

The project results were significant because they incorporated previously disparate efforts by both the FLIP and SLS — allowing the organizations to integrate climate change analysis and climate-resilient planning into their future restoration work plans, proposed projects and communications efforts.

Integrating climate resilience into Snohomish and Stillaguamish farm-fish-flood project packages

This subaward to the Snohomish Conservation District funded three tasks to support the Sustainable Lands Strategy. The first task was to integrate climate modeling and assessment efforts previously completed by the SLS into project packages for SLS and partners. The second tasks provided support to SLS staff in scoping and facilitation of two Integration Teams (one for the Stillaguamish watershed and one for the Snohomish watershed). The third task supported the prioritization, identifying, scoping and initial design of agricultural resilience projects and work with the Integration Teams to create multi-benefit project packages.

The subawardee assisted project partners in developing a working strategy document that details the formation and next steps of the Integration Teams. The working strategy document was informed by the subawardee participating in **64 meetings** with the teams to catalog their needs. The working strategy documents, one for each of the Integration Teams operating in the Snohomish and Stillaguamish watersheds, describe the goals, decision making processes, stakeholder engagement plans, and identify information gaps relevant for each team.

Additionally, the subawardee supported the Integration Teams with scoping and designing priority projects that will improve agriculture resilience at the landscape-scale. These projects were identified and added to the priority project list through engagements with over **75 members** of the agricultural community and the Integration Teams. These activities helped to narrow down the projects for inclusion in a priority project list.

Alongside findings from the community outreach process, the Integration Teams incorporated climate prediction data for flooding, sea level rise, groundwater levels, saltwater intrusion, land subsidence, and channel aggradation into the discussions of existing project priorities for salmon recovery and agricultural resilience. These findings were informed through previous work done by SLS (such as the groundwater analysis of the Snohomish River basin that was conducted during NTA 2016-0074).

Following the creation of a prioritized project list, Snohomish Conservation District staff assessed projects and determined feasibility for project concepts. Through the screening criteria, the Snohomish Conservation District, alongside SLS, selected four near-term projects to advance to conceptual design. Several of these projects include feasibility studies for infrastructure-related activities in drainage districts. Preliminary design (30% design) for two of the projects were funded through an amendment to the grant in 2020. The four near-term projects with their initial start dates are:

- Swans Trail Slough in Diking District 13 (April 2021). This project will explore different ways to split habitat and agriculture drainage systems. Potential alternatives could include levee improvements, ditch plugging, culvert upgrades, pump relocation, and changes to outlets to Snohomish River. This project is in the development phase. A portion of this project is funded by a Floodplains by Design 2021 – 2023 grant. The project report was prepared by Environmental Service Associates.

- Douglas Creek Catchment in Diking District 13 30% design plans (September 2022). The goal of this project is to create a complex channel system to slow flow, capture sediment, and attenuate peak flows. This project is in the development phase and some or a portion of this project is funded by Floodplains by Design 2021 – 2023 grant. The project report was prepared in partnership with Ducks Unlimited.
- Jorgensen Tide Gate conceptual drawings (2022). This project has completed landowner outreach and stakeholder, regulatory, and funder agency/funding procurement. It is funded by the Stillaguamish Flood Control District at this time.
- Schwegler Stream/Wetland Enhancement preliminary designs (2022). The conceptual design of this project, in part, is funded by a Floodplains by Design 2021 – 2023 grant.

The project priorities identified will help the subawardee and SLS with future work in the Stillaguamish and Snohomish River watersheds. A key finding of the project prioritization process was the **importance of incorporating voices from the agricultural community and accurately scoping projects to determine feasibility and cost**, particularly in regard to expensive infrastructure projects and those projects' benefits to the entire watershed.

4.1.5 REACH-SCALE PLANNING

HSIL funding supported four subawards that engaged diverse communities in planning forums to develop reach-scale project prioritization and designs and/or implement reach-scale plans. Those subawards are:

- NTA 2016-0310 – Supported SLS in developing four reach level plans in the Stillaguamish and Snohomish Watersheds.
- NTA 2018-0249 – Supported SLS in developing and prioritizing multi-benefit projects in the North Fork Stillaguamish River.
- NTA 2016-0113 – Supported the Whatcom County Flood Control Zone District in advancing the FLIP effort within the lower Nooksack River area.
- NTA 2018-0587 – Supported continued facilitation of 3FI meetings throughout the Skagit Delta to advance priority projects.

SLS reach scale planning and multi-benefit project prioritization

NTA 2016-0310 supported SLS efforts to develop four reach scale plans. The creation of the reach scale plans involved striking a balance between fish, farm and flood interests in the area. Each reach scale plan consisted of a background of the area, conditions in the reach, considerations of projects to address fish, farm and flood interests, developing success measures, and articulating next steps (Anchor QEA, LLC. 2018).

The reach scale plans were for the Lower Skykomish, mainstem Stillaguamish, the Snohomish River, and the Snohomish River Estuary (the latter two were one combined document). The

plans were created through input from stakeholder groups during community meetings. Consultants used existing GIS data layers to map out the river reaches.

The development of the reach scale plans allowed SLS to implement projects, such as the Smith Island Restoration Project in the Snohomish estuary and a Snohomish-Skykomish Agricultural Alliance and Tulalip Tribes-led dairy farm digester project in the Lower Skykomish near Monroe, WA. The [Smith Island Restoration Project](#) involved the construction a new dike and the removal of the old dike to restore 378 acres of Snohomish County and City of Everett-owned land.

The subsequent subaward, NTA 2018-0249, allowed SLS to develop a plan specific to the North Fork Stillaguamish River (Snohomish County 2020). This plan focuses on the development and prioritization of projects that benefit salmon habitat, agriculture and flood risk reduction in the North Fork Stillaguamish River. Planning for this reach included two workshops – one of which was for the Stillaguamish River and the other was for the Skykomish. Both helped to support the Floodplains by Design project packages.

Additional components of the subaward included a [story map](#) that discusses climate change impacts specific to the North Fork Stillaguamish River. An agricultural survey was updated along with additional geomorphic assessment and hydraulic/hydrologic modeling of the river channel using GIS.

A related subaward, associated with NTA 2018-0218, provided funding to the Stillaguamish Tribe to purchase floodplain lands along the North Fork. The selection of these lands was informed by the reach-scale plans developed by Snohomish County and the Tribe. This NTA is discussed in Section 4.4, which covers projects that implemented direct recovery actions that resulted in habitat benefits.

FLIP reach scale planning

NTA 2016-0113 supported the FLIP to develop reach-scale plans for the four reaches of the lower Nooksack River. A steering committee and reach experts were convened, alongside staff from Whatcom County's River and Flood Natural Resources Divisions, the Nooksack Indian Tribe, Lummi Nation, and the agricultural community via Whatcom Family Farmers to provide input on the reach scale plans. Before a reach plan could commence, the team conducted a technical analysis of each reach. The purpose of technical analysis was to get each team member on equal footing with knowledge on floodings, farms, and fish. Using this knowledge as a base, the FLIP team sought to develop reach-scale plans for each of the four reaches. Through HSIL funding, the FLIP team completed one reach-scale plan and began on a second (Harris and Ewbank 2021).

Supporting 3FI

HSIL funding through NTA 2018-0587 supported the continuation of this work by funding 3FI meetings from January 2020 to March 2022 (Baker and Wiltse 2022). The meetings advanced

the decision by 3FI to develop a suite of restoration projects and to allow all parties to develop agreed-upon criteria for ranking of projects.

Following a NEP Watershed LO grant (see Wright 2020 for more information) that examined potential project dimensions in the Skagit River Basin, the 3FI Oversight Team conducted outreach to landowners and dike/drainage districts to “assess where opportunities may exist for projects to move forward” (TNC 2014). One key milestone for the 3FI coalition was scoping a project that would identify multi-benefit projects to achieve the long-term viability of Chinook salmon and reduce community flood risk in a manner that would protect and enhance agriculture and drainage. Technical representatives of participating 3FI organizations and other local and regional experts guided the Skagit Hydrodynamic Modeling Project. This project assessed the benefits and impacts of project concepts across interests using best available science and resulted in a suite of well-supported priority projects. Results were presented to many local organizations and area tribes when it was completed in 2017.

As of 2021, the 3FI effort has faced a legal challenge to the Tidegate Flood Initiative and a lack of agreement around “basic facts about progress toward estuary restoration goals”. These two challenges have halted further progress of the 3FI effort.

4.1.6 RECOMMENDATIONS

TNC (2018b) and Ecology (2019) identified several priority actions relevant for the Floodplains and Estuaries IS Sound-wide support strategy that may be suitable for consideration by Puget Sound Program partners. They include:

- Provide funding for planning and grants management.
- Provide strategic and technical support to integrated floodplain management efforts.
- Improve coordination with other water and salmon grant programs.
- Develop curriculum and implement training program for integrated floodplain management.
- Convene a policy/technical work group to guide a study of development trends in floodplains and potential actions to address.
- Create more sustainable funding and capacity for the backbone organization role.

Technical efforts

Elaborating on the above suggestions, several subawards recommended additional technical support for IFM efforts. These include:

- **Funding a study to project future conversion of agricultural lands** and its relation to floodplain management was recommended by several subawards, including Whatcom PUD No. 1 (2022) and Snohomish Conservation District (2019).

- Understanding future growth in agricultural lands is important because 1) climate change will have significant impacts on future water availability for irrigation 2) growth in domestic and municipal water usage and supply will affect adjacent agricultural use 3) water rights and recent Nooksack Basin adjudication could have far-reaching impacts on water right ownership and use. In addition to data synthesis from existing sources (such as the Farmland Information Center’s [Protected Agricultural Lands Database](#)), Aspect Consulting (2022) recommended ground truthing and aerial photography studies to determine agricultural land in Whatcom County and beyond.
- **Extensive research into climate change impacts on floodplains and water supply was recommended by several subawards**, including NTA 2018-0741, NTA 2018-0715, and 2018-0401. In particular, Climate Impact Group’s analyses to support Whatcom and Snohomish County in incorporating climate change into IFM should be elaborated upon. Additional research into the following is recommended:
 - Understanding the impact of forestry on summer stream flows in the South Fork Nooksack River subbasin
 - Additional mapping and characterization of habitat quality, quantity, and connectivity in Bertrand Creek and Drayton Harbor to support salmonid habitat improvement projects
 - The interplay of sea level rise, groundwater, and surface water management for the lower Stillaguamish and Snohomish River floodplains is complex, and many uncertainties remain that have not yet been resolved. As a next step from NTA 2016-0074, Snohomish Conservation District’s NTA recommends a focused data collection effort to evaluate the degree to which salinity already affects crop yields in the region.

Funding for outreach, communications, and training

In addition to technical support, further communications and outreach efforts are recommended. Wright (2021) recommended additional exploration into effective strategies for engaging agricultural communities successfully (e.g., consistent engagement, compensation for participation, project ranking methods). CIG’s media analysis for the Whatcom LIO found that extreme flood events were not linked to climate change by the public or in the media. Hosting workshops, question and answer sessions, or trainings, could help in working to better explain the impact of climate change on flooding and in particular its impact on those who live in flood-prone areas.

Funding for planning, relationship-building and operations/administration

As noted by MacIlroy et al. (2014), successful integrated reach-scale planning is a complex and resource-intensive process. Grants that go beyond short-term horizons and those that are not relegated to pre-construction activities (such as those funded by FbD) are needed to sustain IFM organizations. The importance of long-term, sustained funding for organizations building relationships, applying for grants for infrastructure projects, developing databases for acquisitions, and more has been noted in the beginning of section 4.1 and throughout this

synthesis. Funding for these types of operating activities is critical for the continued success of regional IFM organizations and coalitions.

4.2 VOLUNTEER ENGAGEMENT, COMMUNITY SCIENCE, AND LOCAL RECOVERY

In this section we describe 17 subawards that supported activities related at the local level. Each project empowered, educated, or supported community learning. These subawards involved a wide range of topics and activities including fish passage improvements, education and volunteer programs, and restoration project support. The projects advanced Puget Sound Action Agenda Strategies and salmon recovery goals. The subawards detailed in this section are listed in Table 9.

Table 9. Subawards involving volunteer engagement, community science, and local recovery actions

NTA	Project	Owner
2016-0107	Engaging the Community in Strait Ecosystem Recovery	Jefferson County
2016-0119	Shoreline Monitoring Toolbox Phase I – Protocol Implementation and Data Management	Washington Sea Grant
2016-0131	Advancing Western Strait Fish Passage Barrier Removal	North Olympic Lead Entity for Salmon
2016-0136	Recovery of select freshwater salmonid habitat in the San Juan Islands	San Juan County Lead Entity
2016-0198	Stream Crossings Prioritization along Puget Sound Shores with a Railroad	Confluence Environmental Company
2016-0305	Hood Canal Bridge Assessment	Hood Canal Coordinating Council
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
2016-0405	Ocean Acidification Resilience Across Habitat Types	Washington Department of Natural Resources
2016-1216	Kristoferson Creek Fish Passage Improvements	Snohomish Conservation District
2018-0219	Shoreline Restoration Effectiveness Monitoring	Northwest Straits Foundation
2018-0525	Shoreline Monitoring Toolbox Phase II – Data Analysis and Interpretation	Washington Sea Grant

2018-0603	Local Coordination to Advance PSNERP-identified projects: Livingston Bay Restoration Feasibility Study	Whidbey Camano Land Trust
2018-0822	WDNR citizen science and K-12 education program to monitor local aquatic habitat effects from climate change.	Washington Department of Natural Resources
2018-0884	Washington Sea Grant Crab Team	Washington Sea Grant
2018-0901	Curley Creek Prioritized Restoration	Mid Sound Fisheries Enhancement Group
2018-0965	Phase 2: Implementation of Recommendations from the Coastal Streams and Embayments Prioritization along Railroad	Tulalip Tribes

4.2.1 EDUCATION PARTNERSHIPS

Cooperation and consistency are key to building successful learning programs, especially among communities that may be overburdened (WDNR 2022, Simmons et al. 2020). The 2022-2026 Puget Sound Action Agenda Strategy D - Education Partnerships seeks to ensure learners of all ages can prepare for careers in the green economy and supports K-12 education collaborations with recovery partners. HSIL funded two subawards that developed student curricula to advance science literacy and connect students with real world scenarios and actors:

- NTA 2018-0822 – Supported Washington Department of Natural Resources (WDNR) in developing a K-12 climate resilience curricula.
- NTA 2016-0107 – Supported the North Olympic Salmon Coalition in initiating a Real Learning Real Work curriculum for middle-school age students in Clallam and Jefferson Counties.

K-12 climate curricula

Established in 2015, WDNR’s Aquatic Assessment and Monitoring Team works to understand the effects of climate change on coastal and nearshore habitats while bringing awareness to climate change through community engagement and education. For this project, WDNR (2022) developed three curricula—elementary school (grades 3-5), middle school, and high school—to educate on ocean acidification and climate change within nearshore waters. These curricula took advantage of findings and sites from WDNR’s ocean acidification monitoring program – ANeMoNe (see the section below for information on volunteers and Chapter 2 for program description and findings).

WDNR hired master’s students from University of Washington’s Program on Climate Change to develop the middle school curriculum, while Aquatic Assessment and Monitoring Team staff developed the high school and elementary school curricula. The curricula used learning standards and climate-specific [ClimeTime resources](#) from the Washington State Office of Superintendent of Public Instruction. Each curriculum was catered to the grade level, but all

included ocean acidification aspects. **The intent of the curriculum was to empower Washington youth to engage with developing and implementing climate change adaptation in their own backyard.** By grant closing, WDNR (2022) completed [the three curricula](#). Unfortunately, the COVID 19 pandemic prevented introduction of the curricula at schools. The subaward additionally resulted in a trial Climate Resilience Youth Internship program, also funded by the Governor's Office on Salmon Recovery.

Real Learning Real Work curriculum

The North Olympic Salmon Coalition used the [Real Learning, Real Work](#) framework to develop a curriculum that challenged middle-school students to use science skills to develop and initiate revegetation plans to restore local salmon habitat. The goal was to foster environmental stewardship among the students and to build interest in the sciences. HSIL funded the curriculum for 2018-2019 and the beginning of the 2019-2020 school years. This project also received funding from the Recreation and Conservation Office.

Three schools participated for the 2018-2019 school year: Blue Heron Middle School, Chimacum Middle School, and Clallam Bay School. In total, **the curriculum reached 180 students, seven teachers, and 20 volunteers** (Simmons et al. 2020). Throughout the year, the students designed and implemented restoration projects at Salmon Creek, Chimacum Creek, and the Hoko River. In all, **students planted 400 native trees and shrubs**. These restoration projects benefitted chum and steelhead salmon in the area.

North Olympic Salmon Coalition continued the Real Learning, Real Work program for two of the three schools into the next school year switching Clallam Middle School for Sequim Middle School. Through this project, Simmons et al. (2020) learned that curriculum flexibility is key for working with schools. By working with the teachers directly, the project team was able to tailor the curriculum and ensure it met the needs of the students, the local watershed, and the school district's priorities. Through forming a relationship with the schools and teachers it showed accountability by North Olympic Salmon Coalition and deepened the partnership.

4.2.2 VOLUNTEER ENGAGEMENT AND COMMUNITY SCIENCE

The 2022-26 Action Agenda supports the spread of stewardship and motivating action throughout Puget Sound with Strategy E - Cultivating Stewardship. This strategy focuses on stewardship, engagement, and public interest in recovery actions and has appeared in each Action Agenda since 2009. Encouraging engagement with volunteer, stakeholders, and the community is a theme seen throughout HSIL investments. Citizen scientists and volunteers are valuable for supporting monitoring efforts and restoration activities. HSIL funded multiple awards that engaged with volunteers and provided supportive websites to encourage citizen engagement. Three of these awards related to Shoreline Armoring supported development and implementation of a regional monitoring strategy, thereby advancing the Shoreline Armoring IS's increase and improve coastal processes-based design and technical training strategy.

In this section we cover nine subawards that advanced volunteer engagement and community science:

- NTA 2016-0107 – Supported Washington State University (WSU) Jefferson Extension in developing a volunteer training and engagement strategy.
- NTA 2018-0884 – Supported invasive species surveillance with Washington Sea Grant’s Crab Team.
- NTA 2016-0119 and NTA 2018-0525 – Supported Washington Sea Grant in advancing the Shoreline Monitoring Database through data management and interpretation.
- NTA 2018-0219 – Supported the Northwest Strait Foundation in training a volunteer network to monitor shoreline restoration. This work supported the Shoreline Monitoring Database.
- NTA 2016-0405 and NTA 2018-0822 – Supported WDNR’s Aquatic Assessment and Monitoring Team in maintaining and expanding the Acidification Nearshore Monitoring Network.
- NTA 2016-0322 – Supported Seattle Audubon in establishing a local volunteer network trained to respond to an oil spill event within the Puget Sound.
- NTA 2016-0315 – Supported Washington State Snohomish County Extension in the development of a model volunteer-led Oil Spill Awareness and Response Support (OSARS) program.

North Olympic Salmon Coalition Stream Stewards program

HSIL funding supported two major engagement efforts by WSU Jefferson County Extension that filled gaps left when funding for previous outreach efforts—Citizen Action Training, Beach Watchers and EcoNet—expired. This work was funded alongside the North Olympic Salmon Coalition Real Learning, Real Work curriculum discussed in the section previous. The two major engagement efforts performed by WSU for this subaward included: 1) developing a volunteer training curriculum and 2) developing a volunteer engagement strategy.

The volunteer training curriculum was accomplished through re-initiating the [Stream Stewards program](#). Funding for this program covered training for two years: 2018 and 2019. The Stream Stewards program, set in Jefferson and Clallam County, trained volunteers over a six-day course on restoration practices with the goal of raising community awareness of the challenges facing the Strait ecosystem (Simmons et al. 2020). The **focus was to build a volunteer base to help implement restoration projects**. Upon completing the course, participants were asked to volunteer at least 40 hours in total with either WSU or a partner organization.

Simmons and McNamara (2018 and 2020) completed the second goal to develop a volunteer engagement strategy through two strategy reports. The first, a 2018 strategy report, used a literature review and interviews with volunteer and volunteer coordinators to understand current needs. The report covered volunteer motivation; recruitment and retention; strategies

to engage volunteers in restoration efforts; and collaboration among organizations that utilize volunteers. Some key findings included:

- Volunteer coordinators are seen as integral for increasing community engagement.
- Key motivators for volunteers are they want to make a difference, they want to give back, they love nature and where they live, and they want to deepen their connections to their community.
- Two limiting factors for increasing community engagement appear to be lack of appropriate projects available and coordinator capacity.
- Organizations recruit and retain most of the volunteers they need, but coordinators agreed that a locally based online volunteer portal would be of benefit.
- Most organizations interviewed said they had reservations about taking on more volunteers because they lack capacity to coordinate them.

Despite these key findings, WSU created a [volunteer webpage](#) that advertised current volunteer opportunities and allowed for Stream Stewards volunteers to easily submit hours. Through this portal, tracking results indicated that Stream Steward graduates from the 2018/2019 volunteer training courses completed **1,262 in total volunteer hours post-course** which benefited **over 30 partner organizations**.

Simmons and McNamara (2020) in their second report assessed potential sustainable funding options to reduce dependence on grants. The strategy report found there was little literature specifically focused on sustainable funding for volunteer programs. The report, informed by the work of Rosenthal (2015) and Scheirer (2005), identified several ideas to increase funding:

- Integrate volunteer and donor programs to increase fundraising. In non-profit organizations, fundraising typically receives more organizational resources than volunteer engagement. Yet, donors give 7-10 times more money if they also volunteer.
- Increase emphasis on corporate social responsibility and explore partnerships with local businesses (e.g., workplace giving, corporate volunteering).
- Improve measurement and tracking of volunteer hours to show the impact they are making to potential funders.
- Increasing registration costs for training programs. Stream Stewards participants paid a registration fee of \$25 for 40 hours of training in 2018 and 2019.
- Integrate funding from local (ports, cities, counties, Tribes) entities with stable revenue sources (e.g., stormwater funds, Conservation District tax assessments). Three “models to explore” were provided: Mountains to Sound Greenway Trust, Project Green (Thurston County), Native Plant Steward Program (Washington Native Plant Society).

Washington Sea Grant Green Crab Team

In 2015 Washington Sea Grant launched their volunteer-based early detection European green crab monitoring program. This program was originally funded through two Marine and Nearshore LO grants in 2014 and 2017. The 2018 HSIL subaward funded a Volunteer Coordinator position, supported monitoring for the 2021 and 2022 seasons, and supported a large-scale removal effort in collaboration with the Lummi Nation. The monitoring results, including the large-scale removal effort, are discussed in Chapter 2. Here we describe the stakeholder engagement and volunteer aspects of the Crab Team.

The Crab Team recruited volunteers through various volunteer networks: Sound Water Stewards, Beach Naturalists, Beach Watchers, Marine Resource Committee, and others. Returning volunteers received a “refresher course” of new techniques while new volunteers received a full training course that covered background and status of green crabs, monitoring efforts, protocols and practice, and species identification. The Crab Team also engaged directly with resource managers and stakeholders on green crab issues through two types of meetings:

- “Stakeholder” – information sharing opportunities with updates on monitoring or research findings, status updates or techniques.
- “Advising” – sharing experience and knowledge in a meeting or in the field on strategies and best practices and approaches to conducting safe and effective management for European green crab.

Between 2020 and 2022, Adams et al. (2023) tracked that the Green Crab team trained **272 volunteers and held 90 stakeholder/advising meetings**. The Crab Team **also produced over 100 outreach and communication products** including press, presentations, newsletters, blogs, radio, seminar engagement, and website updates. These outcomes were possible due to the new volunteer coordinator position freeing time for the program manager to increase engagement with stakeholders.

Trainings for the Shoreline Monitoring Toolbox and Database

The Shoreline Monitoring Toolbox was launched in 2014 with support from PSP and the PSEMP Nearshore Work Group. It provides standardized protocols for monitoring Puget Sound shoreline restoration sites. As discussed in Chapter 2, Washington Sea Grant received two subawards that supported the development of a regional [Shoreline Monitoring Database](#) and advanced partner and volunteer engagement

To encourage use of the toolbox’s monitoring protocols and the new database, Toft et al. (2023) led several trainings among partners (citizen science organizations as well as university, and agency restoration/monitoring practitioners). The trainings focused on protocol use on data upload.

- Over 70 participants attended six trainings in 2018 and 2019. Twelve organizations from these trainings uploaded and/or downloaded data to the Shoreline Monitoring Database as of January 2020.

- Partner organizations included: Vashon Nature Center, Northwest Straits Foundation, Snohomish County Beach Watchers, Sound Water Stewards, Harbor WildWatch, Port Townsend Marine Science Center, DNR Aquatic Reserves, WDFW, and Washington Sea Grant. Students from a field marine biology class at UW’s Friday Harbor Marine Labs also participated.

Shoreline Restoration Effectiveness Monitoring

Northwest Straits Foundation (2022) recruited, coordinated, and trained volunteers to collect shoreline monitoring data from 29 shoreline restoration sites. Volunteers used established Shoreline Monitoring Toolbox protocols to ensure consistency in data collection at sites. Trainings included classroom, virtual, and field components. The subaward associated with NTA 2018-0219 was a close partnership with Washington Sea Grant. The results of this project were:

- Eight trainings attended by 102 volunteers. Participating organizations included the Salish Sea Stewards, Sound Water Stewards, Jefferson County Marine Resource Committee, and Island County Marine Resources Committee.
- Data was collected at 28 sites (22 existing and 6 new) during the grant period.
- 85 volunteers participated in monitoring efforts between 2020 and 2021.
- **Volunteers provided 2,719 hours of service** assisting with field data collection tasks.

ANeMoNe Site Guardians

In 2015, WDNR’s Aquatic Assessment and Monitoring Team established the Acidification Nearshore Monitoring Network (ANeMoNe) to study the effects of climate change and ocean acidification on nearshore zones. As of 2023, the monitoring network had 13 sites (11 in Puget Sound) each with sensors measure pH, salinity, temperature, dissolved oxygen, and chlorophyll concentrations with autonomous water quality sensors. Each site is monitored by WDNR and a group of citizen scientists called “Site Guardians.” The monitoring program is discussed in Chapter 2. In this section we focus on the citizen science volunteers.

Horwith et al (2020) described Site Guardians as volunteers who are trained by WDNR to monitor and maintain water quality sensors and collect biological data (e.g., shellfish spat sampling, eelgrass density and morphology). Site Guardians include staff from non-profit organizations and Marine Resource Committees; tribal members and biologists; and interested community members. To provide support and information for Site Guardians, the Aquatic Assessment and Monitoring Team built [an inclusive website](#). NTA 2016-0405 funded website construction and NTA 2018-0822 funded an update to site. The original purpose of the webpage was to help with recruitment and provide easy access to protocols and supporting materials. The newer site improved upon this while also providing downloadable monitoring data for interested parties. In 2018, WDNR began hosting an annual “community science” summit for ANeMoNe volunteers (these continued to occur through at least 2023, the time of writing).

Horwith et al. (2020) saw that the Site Guardians became a strong resource for ANeMoNe. Since including Site Guardians, the program saw:

- Valuable feedback and ideas. Site Guardians brought a valuable understanding of local conditions to ANeMoNe.
- That by sharing what they learned with their community, Site Guardians played a large part in increasing awareness about the impact of acidification.
- Better support for experimental research projects. Trained Site Guardians helped to take measurements and monitor conditions for experiments throughout ANeMoNe sites independent of WDNR staff.
- An expansion of ANeMoNe sites from eight initial sites to 13. This was partially due to the interest and assistance volunteers brought to support necessary upkeep and data gathering for each site. This expansion occurred during the later subaward (WDNR 2022).

WSU Oil Spill Awareness and Response Support Network

Marine and Nearshore LO grants funded training for volunteers to assist with three elements of spill response: early on-scene reconnaissance to capture information about the extent of oiling and fish/wildlife presence; baseline and post-spill data collection to assist with Natural Resources Damage Assessment; and oiled wildlife care (as summarized in Kinney et al 2016). Each activity required different levels of training. However, grantees recognized that building and maintaining a community's capacity for meaningful action in the event of a spill requires regular investment in recurring training sessions (NWSF 2015). Maintaining volunteer response capabilities was challenging for organizations. Consideration of alternative training strategies that would reduce costs and volunteer attrition associated with annual recertification requirements was recommended.

In 2020, WSU Snohomish County Extension brought together a coordinated network of volunteer organizations to workshop how to engage multiple volunteer organizations in oil spill response and assessment quickly and efficiently (Robinson and Townsend 2020). This work was informed by WSU Snohomish County Extension's Beach Watchers Oil Spill Assessor program, which ran from 2005-2007 and was also co-led with Ecology. The resulting Oil Spill Awareness and Response Support network provided a two-day training (11 hours in total) to interested volunteer groups. Topics in training covered oil spill science, response, oil spill assessments, recovery, and finally volunteer efforts (WSU Snohomish County Extension 2020). There was a range of speakers for the training, this included representatives from federal and state governments, universities, and experts in oil spill response.

An outcome of this training was **improved understanding by organizations of the appropriate use of volunteers after a spill**. Volunteers can play a supporting role in oil spill response, but it is important to recognize formal chain of command and requirements necessary to ensure volunteers do not end up impeding a response. In the event of a spill, exposing volunteers without permission could cause more harm than benefits. The Northwest Area Contingency

Plan (2020) provides a coordinated framework for federal, state, local, tribal, and international entity response to a significant oil spill or hazardous substance leak in the Salish Sea and includes how and when to incorporate volunteers. Within the Contingency Plan the use of volunteers is strictly decided upon by the Unified Commander. The role of the Unified Commander is to decide if volunteers will be exposed to unnecessary harm and be of use.

Programs like the Oil Spill Awareness and Response Support network that train volunteer program managers could reduce confusion about volunteer needs while providing a forum for discussion with oil spill response professionals. However, it is not clear from the project record whether this training could be delivered as a “just-in-time” program for use in the event that volunteers must be trained in a short amount of time after a major spill. Kinney et al. (2016) noted that four hours of training is generally considered to be sufficient for beach surveillance, consistent with the “First Responder Awareness Level” designated from federal regulations.

Seattle Audubon Puget Sound Seabird Survey and oil spill volunteer program

In 2006, the Seattle Audubon Science Committee conducted a review of gaps and priorities within the Audubon chapter and found that a comprehensive land-based seabird survey was needed to understand the status and trends of seabirds in Puget Sound. In 2007 the Puget Sound Seabird Survey (PSSS) was formed to fill that gap. First focused on sites throughout central-south Puget Sound, the PSSS was a **citizen science research program** that collected data between October and April each year on wintering bird density and distribution.

In 2013, the PSSS expanded to the Strait of Juan de Fuca and Admiralty Inlet. This first expansion, partially funded by the Marnie and Nearshore LO, placed the PSSS in eight of the 12 Washington counties with marine shorelines and totaled 122 site locations throughout. The overarching objective of the PSSS was to eventually develop a baseline for all the different bird species that pass through the US portion of the Salish Sea. HSIL funding supported a second PSSS expansion to include north Puget Sound counties (San Juan, Whatcom, and Skagit). Out of a list of 55 potential sites **37 sites were ultimately identified as being suitable for seabird surveys**. 17 new sites were located in San Juan County, 10 in Skagit, and 10 in Whatcom.

Prior to the North Puget Sound expansion, the PSSS needed approximately 200 volunteers each year to cover the 122 sites. Additional volunteers were needed to fill the new sites. A call for volunteers occurred through an email to PSSS mailing list; a notice in 12 Audubon local chapter newsletters; and on social media. A total of **417 people responded**. After follow-up, **258 were chosen for 63 survey teams**. 42 of these volunteers were recruited for the North Puget Sound area. 32 of the 37 new sites had survey teams assigned to them for the 2018-19 season. Before entering the field, all volunteers were trained in data collecting and data reporting. In all, **nine trainings** took place for the 2018-19 season.

The PSSS volunteers conducted 1,042 surveys over 154 sites. **The surveys recorded 10,997 individual birds comprising 56 species**. All data was uploaded via the online data-entry portal

and summaries were made using Tableau Public data visualization tool. A full database of the seabird survey is available on [Asgard Data Marketplace](#).

Ross and Joyce (2019) noted setbacks in the PSSS program from funding and staffing issues. And of 2022, Seattle Audubon announced that they had transitioned PSSS over to the [Puget Sound Bird Observatory](#). The Puget Sound Bird Observatory will now run the PSSS program, including volunteer coordination and data collection activities.

Seattle Audubon was a recipient of one of the Marine and Nearshore LO oil spill response grants noted in the previous section. They used this grant to develop a volunteer-led on-scene reconnaissance that captures information about the extent of oiling and fish/wildlife presence (Ross and Joyce 2014).

As part of the HSIL subaward for the PSSS, Ross and Joyce (2019) build off that previous work with additional documentation including a PSSS 2018 Oil Spill Action Plan (Joyce and Ross 2018) and the volunteer [Oil-Spill Response Manual](#) (Seattle Audubon 2018) both which documented organizational and volunteer procedures during an oil spill. During this time Seattle Audubon led trainings among interested PSSS volunteers on oil spill response and conducted an oil spill response drill. **183 PSSS volunteers (71%)** were trained and enrolled in the oil-spill program.

PSSS conducted an oil spill response drill during the grant period. This drill was to test the process of alerting volunteers, recording data, and the availability of volunteers to make observations. The oil-spill drill was conducted on March 28, 2019. Volunteers were notified through text and email. Overall, **96 of the 183 volunteers responded**. A post-drill survey found that 41 out of 44 respondents would have acted in an actual spill.

4.2.3 FISH PASSAGE IMPROVEMENTS

Correction of fish passage barriers supports salmon recovery by providing access to upstream habitat. Fish passage improvements are a regional priority identified by Strategy 6 – Fish Passage Barriers in the 2022-2026 Action Agenda. The subawards we discuss in the section used coordinated efforts to prioritize fish passage barriers for correction, conduct restoration activities, and apply studies to improve on fish passage designs. The five subawards in this section are:

- NTA 2016-0198 – Supported the Confluence Environmental Company in producing a screening tool to prioritize fish passage sites along the Burlington Northern Santa Fe (BNSF) railway for habitat improvements that lead to the most benefit of Chinook salmon.
- NTA 2018-0965 –Phase 2 of NTA 2016-0198 supported Tulalip Tribes efforts to design and implement barrier correction for prioritized culverts.
- NTA 2016-0305: The Hood Canal Coordinating Council conducted an acoustic telemetry study as a part of Phase 1 for the Hood Canal Bridge Ecosystem Impact Assessment.

- NTA 2016-1216 – Supported the Snohomish County District replacement of two fish passage barriers along Kristoferson Creek.
- NTA 2016-0131: Supported North Olympic Lead Entity to collect fish passage barrier data for four Clallam County watersheds and contribute results to the statewide barrier map.

A Snoqualmie watershed pilot fish passage prioritization tool (NTA 2018-0964) developed using the U.S. Forest Service’s Ecosystem Management Decision Support Model is discussed in Section 4.3.4.

BNSF Railway

Confluence Environmental Company (Confluence) developed a fish passage barrier prioritization method to prioritize fish passage barriers found along BNSF Railway. This was Phase 1 of a two-part project funded by HSIL. Confluence et al. (2019) partnered with Environmental Science Associates, Coastal Geologic Services, and the Tulalip Tribes to develop a screening tool that prioritized sites on habitat improvement which have the most benefit of Chinook salmon. To draw upon local knowledge and expertise an Advisory Group was assembled to provide input for the project approaches and review interim deliverables. Participants included representatives from WDFW, Ecology, BNSF, Snohomish County, and South Puget Sound Salmon Enhancement Group. The knowledge from each of these representatives helped to provide a regional approach for this project. There were three elements to this award:

- GIS and field data collection,
- Prioritization framework development and scoring, and
- Evaluation of prioritization scores to inform future decisions.

The team used GIS to determine stream locations and collected field data from each selected site. The GIS and field survey protocols were both provided by WDFW. In total, the team **surveyed 196 streams and 13 embayments**. Results from the survey along with additional data were used to rate the ecological value for each site, which was determined by two factors: likelihood of stream use by juvenile Chinook salmon (Beamer et al. 2003, 2006, 2013) and upstream habitat access and quality (Zackey et al. 2015). Results from both factors were binned in order to create a combined ranking score.

Seventeen streams were placed in the “highest” priority bin. The top sites for both streams and embayments contained the highest potential to benefit fish stocks if restored. Phase 1 resulted in a robust geodatabase that filled critical data gaps and a prioritized list of sites recommended for restoration investment. In addition, **engagement with BNSF advanced dialogue and helped build a relationship with this regionally important partner.**

The relationships built during Phase 1 continued to strengthen during Phase 2 which advanced the planning stage for restoration of high priority coastal stream mouths and embayments sites. For Phase 2, the Tulalip Tribes partnered with multiple environmental consulting firms –

Environmental Science Associates, Confluence Environmental Company, Hanson Professional Services, and Shannon & Wilson. Together the team re-engaged with restoration partners and the advisory group members from Phase 1.

There were two goals for this phase: 1) develop programmatic recommendations for restoring coastal estuaries along the railroad and 2) develop conceptual restoration plans for three high-priority sites. Environmental Science Associates (2022a) completed the programmatic restoration recommendations report which was used to guide restoration actions. This report included details on:

- Crossing structure and sizing standards,
- Railroad site characteristics affecting constructability,
- A case review from Meadowdale Beach Park Restoration, and
- Potential grant funding opportunities.

Using these guiding materials, Environmental Science Associates (2022b) produced restoration designs to improve fish passage for three high-priority sites: 1) Squalicum Creek Estuary, 2) Japanese Gulch Creek Estuary, and 3) an unnamed creek estuary at Joint Base Lewis-McChord. These sites were selected for four reasons: geographic distribution; the apparent differences in the engineering complexities associated with each site; the differences in anticipated crossing structures; and the willingness of the landowner to partner on the restoration work.

The **successful implementation of the restoration designs will require continued dialogue with BNSF, tribes, agencies, and restoration partners to determine acceptable restoration approaches** that meet the needs of railroad safety and operations, as well as Chinook salmon recovery. The results from these two phases are further detailed in a project [StoryMap](#).

Hood Canal Bridge

The Hood Canal Coordinating Council (HCCC) worked alongside eight partner organizations to complete a discrete study within Phase 1 of the Hood Canal Bridge Ecosystem Impact Assessment led by Long Live the Kings. The Hood Canal Bridge Ecosystem Impact Assessment is a collaborative effort by a consortium of federal, state, tribal, and non-profit partners to better understand and ultimately address steelhead mortality at the bridge. Two years (2017-2018) of intense data collection and analysis, culminated in a Phase 1 assessment report (Hood Canal Bridge Assessment Team 2020). This subaward supported one component of the Phase 1 assessment: an acoustic telemetry study to isolate the specific patterns of behavior and locations of steelhead mortality as they encounter the bridge.

HSIL helped to fund the acoustic telemetry study that would isolate the specific patterns of behavior and locations of steelhead mortality as they encountered the bridge. Long Live the Kings (2021) used HSIL funding to purchase 180 of the 250 acoustic tags needed for the study, which isolated the specific patterns of behavior and locations of steelhead mortality as they encountered the bridge. The results of the study, which was completed after grant closing,

found that **half of the steelhead that encountered the bridge perished**, mainly by getting trapped behind corners of the bridge and becoming easy prey to birds and seals (Moore and Berejikian 2022). The outcomes from this award informed the design of mitigation techniques to improve fish passage.

Kristoferson Creek

The Kristoferson Creek Fish Passage Improvement Project began in 2013 with the goal to make Kristoferson Creek in Snohomish County 100% fish passable. The creek held three culverts; this project focused on correcting two. HSIL provided support for this project during a gap in funding during 2017.

The Snohomish Conservation District (2018) led this project with input from interested residents, the Island County Technical Advisory Group, and regulatory agencies. Over the course of the project period, the subawardee led multiple public outreach and stakeholder engagement activities, including four presentations, site tours with elected officials and project funders, and multiple publications. These publications included a [project website](#) with an email list to communicate information with interested parties. The results of this work included two corrected fish passage barriers along with enhanced habitat surrounding the creek.

There were two major challenges faced throughout the Snohomish Conservation District project which stemmed from lack of experience: 1) this was the first project sponsored by the Conservation District that occurred on a public right-of-way and 2) it was also the first fish passage barrier project that involved Island County. From these challenges, Snohomish County District learned that cooperation between all interested parties was key to overcoming barriers.

Advancing Western Strait Fish Passage Barrier Removal

The North Olympic Lead Entity for Salmon (2019) identified and prioritized fish passage barriers on 437 county roads within WRIA 19 (Western Clallam County). The results of this project included uploaded fish passage barriers to WDFW's Fish Passage Barrier map and prioritized barriers for correction within WRIA 19. Rivers included in this project were the Pysht, Clallam, Sekiu, and Hoko.

This project was a cooperative endeavor and included partnerships with trained volunteers from Streamkeepers of Clallam County, transportation workers from Clallam County Road Department, Elwha Klallam Tribe and the Makah Tribe, Lead Entity partners, and the Clallam County Department of Community Development. These partnerships supported barrier identification, habitat assessments and surveys, GIS analyses, and culvert prioritization. More details on this process are included in Chapter 2.

The North Olympic Lead Entity for Salmon (2019) additionally held landowner and stakeholder engagement meetings during the prioritization process. Feedback from landowners, Clallam County Board of Commissioners, the Clallam County roads department, and the Lead Entity Citizens Policy Group was incorporated into the prioritization. This collaboration ultimately

resulted in partnerships to obtain funding for barrier correction work. The Lead Entity worked closely with the Clallam County Roads Department to apply funding to replace culverts in the Hoko Watershed, and similar assistance was provided to the North Olympic Salmon Coalition for replacement of a culvert located on private land.

4.2.4 SALMON RESTORATION AND RECOVERY PLANNING

This section describes three LIO direct awards involving salmon restoration and recovery planning. These projects all advanced restoration actions identified by either region-wide programs or by more localized, county and watershed level, recovery plans. The subawards we discuss include:

- NTA 2018-0603 – Supported a feasibility study to advance a project involving restoration of tidal hydrology on lands adjacent to Livingston Bay.
- NTA 2018-0901 – Supported project prioritization and implementation planning for the Curley Creek Watershed Assessment and Restoration Plan.
- NTA 2016-0136 – Supported San Juan County in their assessment of freshwater habitat to be included in their Salmon Recovery Chapter.

Livingston Bay

The Puget Sound Nearshore Ecosystem Restoration Project (PSNERP) identified Livingston Bay on Whidbey Island as a priority restoration zone as the bay habitat supports all eight salmon species. PSNERP was a multi-year, multi-agency effort led by WDFW and the U.S. Army Corps of Engineers to identify problems and opportunities associated with Puget Sound's nearshore zone.

Island LIO provided Whidbey Camano Land Trust with funding to determine the best course of action for restoring the Livingston Bay site. Three scenarios were evaluated: partial restoration, partial restoration with land swap, and full restoration with a west outlet.

Environmental Science Associates et al. (2022) completed a feasibility study and cost-benefit analysis to compare the restoration scenarios. The study focused on five agricultural parcels and one residential parcel. The results from this study found that Scenario 3 - Full restoration with a west outlet would provide the greatest cost per benefit ratio. This scenario will take time to achieve as not all parcels have been acquired.

Curley Creek

In 2017, the Suquamish Tribe completed the [Curley Creek Watershed Assessment and Restoration Plan](#) which identified 31 Action Areas in the Curley Creek basin in need of restoration or protection. This subaward built upon that work by prioritizing the top 15 Action Areas and initiating restoration designs for feasible sites. Mid Sound Fisheries Enhancement Group (2023) partnered Wild Fish Conservancy, the Suquamish Tribe, and WDFW for this

project. The project team also worked closely with the LIO Technical Advisory group for the subaward duration.

The Action Areas were scored on two criteria: 1) benefit to salmon criteria and 2) project implementation criteria. Implementation considerations were reviewed to identify Action Areas that should be clustered, or Action Areas where sequencing considerations meant Actions should be moved higher or lower on the ranked list. Action Areas with the strongest benefit to salmon criteria were placed highest in ranking. A feasibility analysis was then conducted on four of the top ranked areas. The feasibility analysis used results from landowner outreach and eDNA samples collected by Wild Fish Conservancy through another HSIL subaward discussed in Chapter 2.

The results from the feasibility analysis found that none of the four Action Areas were capable of advancement at that time. The Long Lake Shoreline Action Area was listed as highest priority but was too complex an issue to complete in this award period. However, **the prioritization process to rank each area did highlight the largest potential threats to salmon in the watershed and will be useful in future restoration and protection applications.** Mid-Sound Fisheries Enhancement Group began initial discussions with Wild Fish Conservancy, WDFW, the Suquamish Tribe, and the Hood Canal Salmon Enhancement Group on a Long Lake Predation Study. The study would look at the effects of bass predation on juvenile salmonids in Long Lake.

WFC completed a **Restoration Project Draft Conceptual Design** for a site at the Long Lake Action Area which includes the lower 800 feet of Salmonberry creek. This site is not any of the three Action Areas assessed in the feasibility analysis. This project site was originally ignored because of its small scale and low implementation score (difficulty to complete), but it is an important transition zone for coho, chum, and steelhead salmon and cutthroat trout. The project team had previously met with landowners and they were receptive to restoration work.

San Juan Islands freshwater habitat assessment

In 2004 San Juan County published their Salmon Recovery Chapter and in 2022 the Chapter received an update. This direct award from San Juan LIO to San Juan County Public Works aimed to provide information for updating the freshwater section of the salmon recovery plan (Rot et al. 2019). This subaward built off of previous work conducted by Wild Fish Conservancy who conducted stream surveys throughout the San Juan Islands. The goal of this subaward was to evaluate the potential for restoration within freshwater areas.

Rot et al. (2019) produced a report listing limiting factors for salmonids in freshwater and recommended restoration and protection actions. This report provided the San Juan Island Lead Entity with new freshwater content for the 2022 salmon recovery plan update. The subaward originally aimed to write a freshwater recovery strategy, however during the data gathering stage it became obvious that the study area mostly supported cutthroat trout and in one case coho salmon. This shifted the subaward from a salmon recovery project to a cutthroat

trout recovery project. Because of this they did not take the next step of writing a freshwater recovery strategy.

4.2.5 RECOMMENDATIONS

- Toft et al. (2023) noted that successful volunteer and student involvement in monitoring at restoration sites requires ongoing training and staff time for organizational support. Funding support is also instrumental for stewardship and analysis of resulting data. A priority noted in the policy memo was to make the level of monitoring effort more consistent across the region.
- Simmons et al. (2020) provided recommendations for future work under their different tasks. The following list combines tasks and includes top priority recommendations:
 - Support integration of volunteer efforts and school programs in restoration projects and curriculum delivery.
 - Seek funding and partnerships to continue annual Stream Steward courses and the Real Learning, Real Work program to benefit all organizations working on recovery.
 - Focus on non-point source pollution, stormwater mitigation and management, in addition to education about restoration. Engage volunteers in relevant projects to help implement stormwater mitigation related projects and outreach programs.
 - Encourage all organizations to have a community engagement component in their projects and ensure adequate funding for volunteer coordination.
- Robinson Townsend (2020) noted there is still work that needs to be done to strengthen ties between Puget Sound volunteer organizations interested in informing oil spill response. The subawardee recommended that affiliate volunteer organizations have yearly presentations from the Ecology's Oil Spill team or other relevant experts.
- We recommend grant-making organizations coordinate with Ecology before funding oil spill projects. Oil spill response is strictly coordinated through a Unified Command that may not want to encourage participation of volunteers. Lessons learned through Marine and Nearshore LO oil spill investments should be considered during future project development.

4.3 TOOLS FOR DATA INTEGRATION

The 18 subawards discussed in this section (Table 10) relate to all three HSIL-managed IS, the Chinook IS and multiple Action Agenda Strategies. The three HSIL managed IS include strategies that encourage data-driven approaches for habitat protection and restoration:

- The Shoreline Armoring IS long-term planning strategy calls for spatial data improvements;
- The Land Development and Cover IS seeks to improve planning decisions at the local level through development of maps and tools which incorporate cumulative impacts of the watershed region; and

- The Floodplains and Estuaries IS River-Basin strategy recommends prioritizing and designing landscape-scale plans using decision-making tools that consider current and future ecological, social, and economic outcomes.

Table 10. Data integration subawards

NTA	Project	Owner
2016-0149	Vessel Traffic Oil Spill Risk Consequences in the Salish Sea	San Juan County
2016-0297	Integrated Watershed Plan Monitoring and Adaptive Management Phase 1	Hood Canal Coordinating Council
2016-0376	Puget Sound Chinook Recovery Nearshore Chapter Update	WDFW
2016-0397	Hood Canal Landscape Assessment & Prioritization Tool (Phase 1)	Hood Canal Coordinating Council
2016-0401	Floodplain Condition Assessment and Vital Sign Refinement	Ecology
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
2018-0167	North Sound Riparian Modeling and Monitoring	Skagit River System Cooperative
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
2018-0582	Developing Strategies and Accompanying Web Tool for Science-Based Beach Restoration and Protection	Washington Department of Fish and Wildlife
2018-0600	Incorporation of Salish Sea Marine Survival Project findings into local Recovery Plans	Long Live the Kings
2018-0613	A Salmon Life Cycle Model to Support Multi-Benefit Actions and Adaptive Planning in the Stillaguamish Watershed	Tulalip Tribes
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
2018-0692	Map Viewer of ecologically important areas in the Puget Sound basin	Department of Natural Resources
2018-0863	Vessel Traffic Oil Spill Risk Consequences in the Salish Sea – Expanded Assessment	San Juan County
2018-0964	EMDS Open Platform for Spatial Decision Support for Salmon Recovery	Tulalip Tribes

Some of the subawards in this section are standalone projects focused on a particular LIO geography or county but have potential to be used elsewhere. These subawards provide guidance for salmon recovery, project identification tools, and scenario modeling. This section identifies opportunities to strengthen regional management and offers tools to support planning decisions.

The analysis in this section is organized by the four broad approaches these subawards have taken to support integration of data into management decisions: (1) salmon recovery guidance; (2) development of indicators and monitoring protocols; (3) oil spill scenario analysis, and (4) spatially explicit models and tools for decision support.

4.3.1 GUIDING SALMON RECOVERY

The Puget Sound Chinook Salmon Recovery plan was developed in 2005 and adopted by NOAA in 2007, meeting the requirements under the Endangered Species Act (Shared Strategy for Puget Sound 2007). Within the Puget Sound Salmon Recovery plan is a consolidation of the strategies from 16 individual watershed salmon recovery plans (chapters), a nearshore habitat recovery plan, and an overall regional recovery plan. Since its creation in 2005, updates have occurred in half of the salmon recovery plans, while the nearshore chapter has not received any updates. To support salmon recovery work, HSIL funded four projects that provided technical support for updates to salmon recovery plans and recovery efforts:

- NTA 2018-0600 – Supported Long Live the Kings (LLTK) in producing guidance documents to incorporate results of the Salish Sea Marine Survival Project into watershed recovery plans.
- NTA 2016-0376 – Supported the Puget Sound Partnership (PSP) in providing materials to help update the Chinook Recovery Nearshore Chapter through summarizing recent data and projects.
- NTA 2018-0382 – Supported the Hood Canal Coordinating Council (HCCC) in evaluating what is necessary to remove Hood Canal summer Chum from the endangered species list.
- NTA 2018-0697 – Supported the Skagit River System Cooperative in creating a habitat status and trends model to evaluate effectiveness of past recovery actions.

Communication products for the Salish Sea Marine Survival Project

The [Salish Sea Marine Survival Project](#) (SSMSP) was an international research effort dedicated to identifying the most likely factors influencing survival of juvenile Chinook and other endangered salmon in the Salish Sea. It was led in the U.S. by Long Live the Kings. At the close of this five-year effort, HSIL funding supported Long Live the Kings (2021) in creating a communication product that relayed key findings for Lead Entities, Local Integrating Organizations, Marine Resource Committees, and local stakeholders. For this award, Long Live the Kings engaged with relevant stakeholders through workshops and presentations to review key findings and recommendations. During the workshops, several watershed planners notified Long Live the Kings that they had already begun incorporating recommendations from the SSMSP into their salmon recovery strategies and plans.

The result of these efforts was a [Guidance Document](#) (Long Live the Kings and Environmental Science Associates 2021) for salmon recovery planning at the local and regional level. The purpose of this document was to provide a framework for planners to incorporate SSMSP findings into recovery plans and the adaptive management process. The Guidance Document covers four sections: 1) a breakdown of impacts to early marine survival of salmonids, 2) recommendations for fixing those impacts, 3) resources, examples, and useful links, and 4) simplified results chains for key strategies.

There were two lessons learned from this subaward. The first was found during synthesizing the project findings. Synthesizing and translating materials for non-scientific audiences is a challenging and difficult skill that not all scientists have or are willing to put in the effort to do, sometimes seeing it as an afterthought to tack on to the end of a study. The difficulty for synthesizing this project was high due to its size with over 60 partner organizations and 200 scientists involved. Therefore, **it was important to fund a separate effort such as this one to carry out post-project synthesis and translation geared towards users of the information.** The second lesson was that it is important to include audience feedback during the workshop planning process to help ensure that the future workshops and the resulting guidance document will meet their needs.

Chinook Recovery Nearshore Chapter

The initial purpose of this subaward was to update the nearshore chapter of the Chinook Salmon Recovery Plan, based on new research findings and other planning that has occurred since 2005. The original project owner, WDFW's Estuary and Salmon Restoration Program (ESRP), proposed doing this by updating the nearshore chapter of the Puget Sound Salmon Recovery Plan to support integration of those recommendations into individual watershed chapters rather than continuing a stand-alone chapter. However, after the project proposal was submitted, PSP developed the Chinook Implementation Strategy. The Chinook IS is intended to provide the basis for all future updates to the recovery plan, but it contained little nearshore-specific content. The owners and purpose of the project shifted away from updating Chinook nearshore chapters to focus on filling gaps to support local salmon recovery plan.

ESRP and the PSEMP Nearshore Workgroup identified the highest critical needs for advancing nearshore salmon recovery planning and implementation, then PSP (the new project owner) and HSIL identified alternative outputs to address those needs (PSP 2019). The resulting three products—Trujillo 2018, WDFW and PSP 2018, and Coastal Geologic Services 2018—were intended to provide explicit recommendations to incorporate nearshore priorities adequately and consistently into local salmon recovery plans.

The three priority needs identified by regional nearshore experts and their corresponding products/deliverables are summarized in Table 11. The Shoreline Armor Common Indicator is discussed further in Section 4.3.2.

Table 11. Chinook nearshore needs and products from NTA 2016-0367

Identified Need	Corresponding Product
Align regional and watershed nearshore recovery strategies to ensure that collectively they advance Puget Sound salmon recovery.	A Puget Sound Nearshore Chinook Salmon Strategies report that identifies the highest priority nearshore restoration actions.
Advance critical components of nearshore monitoring via database and protocol development.	A Shoreline Armor Common Indicator Protocol that details methodology for collecting armor monitoring data for parameters such as length, location, material, condition, and toe elevation.
Support technical analyses that could inform an improved system for ranking and evaluating projects in the nearshore.	A Salmon Benefit Index tool that provides a method to identify priority restoration actions. This tool will be used by the Puget Sound Acquisition and Restoration Program to rank and select projects for funding.

These products provide a diverse set of local restoration project sponsors with tools that can help protect and restore nearshore environments for salmon recovery benefits. These tools should support alignment and consistency as local plans are revised and local monitoring results are rolled up to the regional level. The outcomes of this award should allow for improved identification and implementation of high priority restoration projects and advance critical components of nearshore monitoring.

Hood Canal Summer Chum Recovery Plan

The Hood Canal Coordinating Council (HCCC) is working on several assessments to evaluate the extent to which factors that contributed to Hood Canal summer chum being listed under the Endangered Species Act continue to represent a threat the future survival (Brewer 2022). This work will inform an update to the Hood Canal Summer Chum recovery plan and articulate a clear path to delisting.

For this subaward, Brewer (2022) completed three actions:

- Designed an analytical and technical approach that provided a framework for the tasks necessary towards completing a formal Issues Assessment. This approach focused on the highest priority watersheds as described in the Hood Canal and Strait of Juan de Fuca Summer Chum Recovery Plan.
- Compiled an HCCC Recovery Actions document to provide insight into outstanding threats and limiting factors for summer chum and support identification of summer chum recovery actions. This document was an executive summary to two products funded by alternative sources: ICF and Biostream Environmental (2022) and Lestelle (2022). Results from these products specified where there were threats to summer chum salmon and the areas in greatest need of protection/restoration.
- Discussed policy recommendations for recovery actions and next steps with the HCCC's Board of Directors and in watershed forums.

Status and Trends of Chinook Salmon in response to recovery plan actions

This project advanced an ongoing effort by Skagit River System Cooperative to support monitoring and adaptive management for the 2005 Skagit Chinook Recovery Plan. Beamer et al. (2023) constructed a conceptual **habitat status and trends model to evaluate the progress made in salmon recovery**. The goals of this project were: 1) to provide an overview of restoration actions in the Skagit Basin through a past restorative analysis, 2) to use the restoration analysis results within the habitat status and trends model to track habitat changes associated with Chapters 9-11 of the 2005 Skagit Chinook Recovery Plan; and 3) to create an Integrated Population Model with application to the Skagit River Watershed.

Beamer et al. (2023) **ran an analysis of past restoration projects conducted between 1986-2021 in the Skagit Basin to understand their influence on freshwater and estuarine habitats**. Candidate restoration projects were found through PRISM, Skagit Watershed Council's Riparian Restoration database, and effectiveness monitoring reports from the Skagit Intensively Monitored Watershed. Projects were selected based on geography, habitat type, restoration type, and influence on the long-term monitoring period.

The projects were categorized by habitat type and project type (fish passage, instream large wood structures, floodplain and channel process, and riparian planting) then quantified using the reported effect units. The effectiveness of the model in detecting restoration projects was determined by testing how well the model could find specific restoration projects against the ability of an orthophoto analysis that used remote sensing datasets.

The past restoration analysis included a total of 95 restoration projects completed between 1992-2021 that covered **108 total restoration activities**. Beamer et al. (2023) found these restoration activities resulted in:

- **~88.6 ha** plus of total floodplain fish passage restoration since 1986 with an additional **5.1 km** in channel length. The total tributary fish passage restoration was **~6.5 km** starting in 2001.
- Restoration on floodplains has accumulated over **400 large wood structures** starting in 2001, and from 2007 on tributary instream wood structure restoration is estimated at **55 structures plus 7.24 km of channel length**.
- Since 2001, **24 floodplain structures** have been removed, 59ha of floodplain channel area improved through restoration, and **2.7 km in length of floodplain road/dike/riprap** has been removed.
- **919 ha of riparian planting** area has occurred since 1999, with a steady average of 46ha of new planting per year since 2007.

To assess the accuracy of the Habitat Status and Trends model in determining these results, Beamer et al. (2023) compared the restoration actions to the Habitat Status and Trends model and orthophoto datasets. When compared to the orthophoto analysis, the Habitat Status and Trends model detected fewer projects (36% to 63%). The results suggest there may be an under-detection occurring. Under detection may be a result of project size (too small) or because of the lag between restoration project completion and habitat response.

For approximately 30 years (1992-2021) Skagit County has kept habitat status and trends monitoring data for freshwater and estuarine habitat. This was used in combination with the past restoration analysis to examine the current status of salmon habitat in the context of the 2005 Skagit Chinook Recovery Plan, specifically chapters 9-11. These chapters cover forest road treatments and landslides, freshwater rearing habitat, and estuarine rearing habitat.

The results of the model found that, generally **Chinook salmon rearing habitat has improved over the past 30 years**, and there were observed improvements after the implementation of the 2005 Skagit Chinook Recovery Plan. The Habitat Status and Trends model observed that restoration actions for forest road treatments and landslides have been fully implemented. Forest practices have reduced landslides; however, fish response is slow. Recovery plan actions for increasing freshwater rearing habitat and increasing estuarine habitat are partially implemented. Many freshwater rearing habitat projects have “delayed” benefits and are difficult to track on the model. Whereas estuarine rearing habitats are well detected and have mostly immediate effects.

The results for the Habitat Status and Trends model will be added to a dataset of existing long-term multiple life stages of Skagit Chinook. This dataset will be used to inform on an Integrated Population Model. The Integrated Population Model determines what abiotic and biotic factors most influence population dynamics. Schooler and LeMoine (2023) completed an initial run of the model. This model is discussed further in section 4.3.4.

4.3.2 INDICATOR DEVELOPMENT AND REFINEMENT

The three subawards in this section advanced two HSIL IS strategies as well as the Chinook IS. The Floodplains and Estuaries IS Sound-wide strategy calls for the development of shared goals and metrics to track regional progress and communicate collective accomplishments. The Shoreline Armoring IS long-term planning strategy prioritized compilation of shoreline data using regionally consistent protocols. The subawards in this section furthered the development of indicators and monitoring methodologies:

- NTA 2016-0401 – Supported Department of Ecology in providing a foundation for Floodplain Vital Sign reporting.
- NTA 2016-0376 – As part of a larger project, supported PSP in developing armor mapping methods for the Puget Sound region.
- NTA 2016-0297 – Supported HCCC in updating the 2020 Summer Chum and Human Well Being indicators and the publication of the 2020 Hood Canal Ecosystem Report Card.

Floodplains Vital Sign Reporting

The Floodplains Vital Sign tracked protection, loss, and restoration of functional floodplain area in the region's 17 major river basins. The 2011 indicator target sought restoration of 42,386 acres of functionally impaired floodplains by 2020. However, that target proved difficult to implement due to a lack of clear, consistent criteria for baseline (2011) floodplain extent and assessment of functional condition. Without quantifiable metrics, regional partners found it difficult to systematically measure progress for individual watersheds or the region as a whole. The intent of this project was to provide a foundation for Floodplains Vital Sign monitoring by **delineating baseline floodplain extent** for each river and establishing metrics for function and degradation that could be applied to **assess current condition** in those areas.

Ecology partnered with PSP, Environmental Science Associates, and Carol MacIlroy Consulting to convene a regional advisory committee over 10 months in 2018 to develop consensus criteria and methods for mapping floodplain extent and assessing floodplain condition. In coordination with three watershed technical committees in the Dungeness, Green-Duwamish, and Stillaguamish watersheds, the project team then **conducted pilot condition assessments** using the refined criteria/methods and incorporating local data. The project team also developed **project performance metrics/tracking guidelines that could be used by grant programs** to support consistent reporting of recovery progress.

Using the consensus mapping methods, Environmental Science Associates et al. (2019a) produced a set of GIS layers that delineate baseline floodplain extent and provide assessments of their current condition. The geospatial data is available via a [web map](#) operated by PSP. However, the project team notes that their projects are **not** intended for use in site scale decisions about funding or project selection.

The project Advisory Committee's consensus condition assessment criteria were incorporated into Vital Sign revision work conducted in 2020. [Vital Sign reporting from February 2022](#) utilized

condition categories developed during the project. The project Advisory Committee also developed **recommendations for criteria** that could be applied to determine if a floodplain-related project should “count” towards the 2011 indicator target (restoration of 42,386 acres of functionally impaired floodplains by 2020). They produced a flow chart and questionnaire to guide such evaluations. Additionally, two deliverables from this project - a geospatial methodology deliverable and a Vital Sign condition assessment refinement deliverable, have been incorporated as monitoring protocols for the Salmon Habitat Indicators (formerly Common Indicators).

Shoreline Armor Mapping Methods

As part of PSP’s Chinook Monitoring and Adaptive Management project, 14 common indicators and associated monitoring protocols are being developed to track and report on local and regional progress towards Chinook recovery goals. Regular reporting on the status of these [Salmon Habitat Indicators](#) is intended to inform [Salmon Recovery Council](#) decision making. The results of this work also support Lead Entities, Local Integrating Organizations, and other local partners in salmon recovery. For the common indicators to remain comparable between watersheds, a common documentation method is needed. Therefore, a first step in the common indicator development process was to establish protocols to guide the collection of data for each indicator.

PSP (2019) partnered with Coastal Geologic Services to **develop a monitoring protocol for the shoreline armor indicator**. Since the 1990s, several projects have mapped bank stabilization structures along Puget Sound shorelines. However, mapping methodologies have not been consistent, and in some cases, methods were not well-documented. The intent of this subaward was to establish protocols and standards for future armor data collection and processing that results in replicable high-resolution datasets able to identify current armor status, track trends over time, and inform planning and restoration priorities (Coastal Geologic Services 2018). The standardized methodologies (preparation, collection, mapping, and post-processing procedures) focused on two indicator attributes: extent of armor in the nearshore, and percent of feeder bluffs without armor by drift cell.

Mapping methods were based on feeder bluff mapping work funded by the Marine and Nearshore LO (Coastal Geologic Services 2013). Method improvements were informed and supported by recommendations discussed in a May 2017 workshop (PSP 2018). The results were a standardized methodology for shoreline armor mapping that can be used to update data obtained through aged, poor, or inconsistent methods.

HCCC nature-based recreation and 2020 Report Card

The Hood Canal Coordinating Council (HCCC) is a council of governments that work together to advance a shared regional recovery and protection vision for Hood Canal environments and inhabitants. To guide this vision, the HCCC (2020) designed their Integrated Watershed Plan in coordination with government and tribal agencies, local organizations, and community

partners. The Integrated Watershed Plan includes a framework for ecosystem and salmon recovery which is based on PSP Action Agenda Vital Signs. For this award, the HCCC:

- Aligned HCCC's Integrated Watershed Plan Human Wellbeing Nature-Based Recreation indicator with the Puget Sound Action Agenda Vital Signs.
- Updated indicators on the OurHoodCanal.org website.
- Produced the [2020 Hood Canal Ecosystem Report Card](#).

The Human Wellbeing Nature-Based Recreation Indicator used surveys to determine the frequency of Hood Canal residents participating in outdoor activities. The purpose of this indicator is to ensure residents and visitors have access to the outdoor activities which enrich their lives. The Landscape Assessment and Prioritization tool, discussed in section 4.3.4, may be used to assess the Human Well-Being Indicator among other ecosystem functions.

Along with the Human Wellbeing Indicator, the HCCC introduced a Summer Chum Salmon Spatial Diversity Indicator to the Integrated Watershed Plan. This indicator is based on the health, proximity, and location of unique summer chum spawning aggregations within the Hood Canal. The idea behind this indicator is that the greater the spread of summer chum spawning aggregations the less likelihood of extinction. This indicator uses data from the Summer Chum Recovery plan which HSIL funded an update to with NTA 2016-0376 as seen in Section 4.3.1.

4.3.3 OIL SPILL PREVENTION AND RESPONSE

The outcomes of the subawards we discuss in this section were associated with the Puget Sound Action Agenda Oil Spills strategy which seeks to effectively prevent, plan for, and respond to oil spills. This is a consistent strategy found throughout current and past iterations of the Action Agenda. These subawards are:

- NTA 2016-0149 – Supported San Juan County in conducting a study that would provide support for the cost-benefit business case of investing in a rescue tug for Boundary Pass/Haro Strait.
- NTA 2018-0863 – Supported San Juan County in determining drift time of broken vessels before they come aground, and the time needed to rescue a vessel adrift using a rescue tug.
- NTA 2016-0151 – Supported UW Friday Harbors Lab in providing information to San Juan County Council on the pros and cons of oil spill dispersant use.

Vessel traffic risk consequences in the Salish Sea

Previous studies funded by the Marine and Nearshore LO identified Haro Strait and Boundary Pass in San Juan County as the waterway zone with the highest potential vessel accident frequency and the highest potential oil loss (Van Dork and Merrick 2014). During a 2016 Salish Sea Vessel Oil Spill Risk Assessment and Management Workshop led by Ecology, attendees prioritized multiple risk mitigation measures for implementation. Pre-positioning of multi-mission rescue tugs for Haro Strait/Boundary Pass was identified as a high-priority action. The

implementation plan for this measure recommended developing a cost/benefit analysis to build a strong case statement for a rescue tug in this geography, using the Neah Bay rescue tug success as a model (Ecology 2016). HSIL funded two subawards to assess the costs and benefits of placing a rescue tug within Haro Strait/Boundary Pass. Both of these subawards were selected for direct subaward funding by the San Juan LIO.

The cost-benefit study used a scenario analysis for two spill scenarios and a literature review on potential impacts of an oil spill to determine the costs a spill would accrue against the cost of placing a rescue tug in San Juan County. Green et al. (2019) found that the cost of positioning a rescue tug in San Juan County ranged between \$4-6 million per year, while potential damages from a 4-million-gallon spill of diluted bitumen could cost between \$142-500 million. Meanwhile, the potential costs from a 1-million-gallon spill from heavy fuel oil ranged between \$84-243 million. The subawardee provided members of industry with these results, and in return industry had two major questions:

- How much time may be available for a rescue tug to arrive at a disabled ship before the ship grounds, considering winds and currents?
- What is the probability that a rescue tug could arrive before a ship drifting from the typical shipping route grounds?

San Juan County received their second subaward to conduct analyses needed to answer both questions. That study assessed drift times to shore based on location of a broken vessel. In their drift analysis, Robertson et al. (2021) determined that in the 50% percentile of cases a vessel will have 10 hours of drift time before grounding in the Strait of Juan de Fuca, three hours around Turn Point, and five hours in Boundary Pass and the Strait of Georgia. The study also suggested that the probability for a rescue tug arriving before a ship ran aground is significantly improved with a rescue tug in the San Juan area.

The results of these awards were referenced in the Chapter 173-182 WAC Oil Spill Contingency Plan draft rule amendment for San Juan County. The results were also considered by Ecology during a 2021 update to their Strait of Juan de Fuca and Puget Sound Vessel Traffic Safety Report originally published in 2019 (Ecology 2019, Ecology 2022). It is likely that to be included in the Safety Report a more detailed analysis considering a wider range of potential sites, optimal rescue tug coverage, and funding alternatives would be needed.

Oil spill dispersant use in San Juan County

San Juan LIO additionally sought to assess the pros and cons of using oil spill dispersants during a large spill. The San Juan LIO provided this direct award to UW Friday Harbor labs to better understand dispersant use before drafting a policy statement to the Northwest Area Contingency Plan planning process. The Northwest Area Contingency Plan documents the region's plan for a unified and coordinated response to spill events. For this project, King and Dethier (2017) summarized existing scientific knowledge on chemical dispersant effectiveness and their potential impacts to marine organisms when used on surface spills. The results of the study determined that there was considerable scientific uncertainty about the "best" response

to oil spills, but recommended San Juan County marine waters remain under its previous authorization which was to use dispersants on a case-by-case basis (Dethier 2017). Prior to this award some San Juan County stakeholders were advocating for a ban on dispersants based on outdated literature, this award helped to change minds on this position through a concise summary of modern literature and could potentially increase trust in the Northwest Area Contingency Plan decision process.

4.3.4 SPATIALLY EXPLICIT DECISION SUPPORT TOOLS AND MODELS

In this section we describe 11 subawards that supported development of spatially explicit models and tools developed to support planning, restoration, and protection efforts. These tools contribute to the Shoreline Armoring IS long-term planning strategy, the Land Development and Cover IS's prevent conversion of ecologically important land strategy, the Floodplains and Estuaries IS river-basin scale strategy, and the Chinook IS improve regional technical support for research strategy. Spatial data products described in Chapter 2, particularly the NHD, were key layers in the subset of tools that is GIS-based. Inaccuracies in the NHD were mentioned as a limitation for some of these projects.

The subawards we discuss in this section include:

- NTA 2018-0582 – Supported WDFW in improving upon their Beach Strategies assessment through developing a web tool that incorporates data and improves user accessibility.
- NTAs 2016-0397 and 2018-0388 – Supported HCCC in initiating the next phase of the Hood Canal Landscape Assessment and Prioritization Tool
- NTAs 2018-0652 and 2018-0692 – Supported WDNR's Washington Natural Heritage Program in identifying "ecologically important lands" in forested wetlands and upland sites.
- NTA 2018-0636 – Supported the Pierce County Lead Entity in developing a Riparian Decision Support System to assist land managers.
- NTA 2018-0167 – Supported the Skagit River System Cooperative in building models to predict shade and large wood recruitment in the Skagit Basin.
- NTA 2018-0964 – Supported the Tulalip Tribes to constructing an Ecosystem Management Decision Support (EMDS) tool that evaluates potential management actions to guide planning decisions.
- NTA 2018-0667 – Supported Snohomish County to run the NOAA Life Cycle Model to improve understanding of current habitat conditions limiting survival of Chinook salmon, coho salmon, and steelhead in the Stillaguamish Watershed
- NTA 2018-0613 – Supported the Tulalip Tribes to run the NOAA Life Cycle Model to improve understanding of current habitat conditions limiting survival of Chinook salmon, coho salmon, and steelhead in the Snohomish basin.
- NTA 2018-0697 – Supported the Skagit River System Cooperative in testing an integrated population model that will support recovery actions for the Skagit Chinook Recovery Plan.

Table 12 provides an overview of subset of GIS-based tools to provide a comparison of geographic coverage and outputs. One project included in this table, the sea level rise vulnerability assessment, is discussed in Section 4.5.

Table 12. Spatial data analysis and decision support tools

Tool	Geography	Methodology	Outputs	Web application available?
Beach Strategies Data Exploration Dashboard	Region-wide	Pre-existing geodatabase and prioritization framework	Labeled beach segments as Protect (high, medium, low) and Restore (high, medium, low) based on sediment supply, pocket beaches, and forage fish	yes
Landscape Assessment and Prioritization Tool	Hood Canal	Newly constructed GIS data layers using a variety of data sources	Specific outputs unknown as the tool is still under development. Outputs will focus on current ecosystem conditions, land use management, and future pressures within the Hood Canal	under development
Washington Natural Heritage Program Data Explorer	Region-wide	Updated a pre-existing portal with results from ecological integrity assessments conducted to classify ecologically important areas	Areas classified as Excellent (A) to Poor (D). A-B ranks are good for candidates for conservation while C-D are good candidates for restoration	yes
Riparian Decision Support system	Puyallup watershed	Created a new model using a Bayesian network to estimate the likelihood a contributing factor will impact an outcome of interest on the catchment scale	Catchments categorized on a 1-5 scale for restoration vs protection based on relative Catchment Conditions outcomes	no
Shade and wood recruitment model	Skagit	Used recent lidar data within a newly constructed model to depict riparian canopy in the Skagit River watershed.	Delineated where restoration and protection may support riparian canopy growth and wood recruitment potential.	no
Ecosystem Management Decision Support	(1) Snoqualmie Basin (2) Lower Skykomish Floodplain	(1) Used the pre-existing EMDS platform to input project specific cost and prioritization scenarios (2) Used the pre-existing EMDS platform to combine prioritization strategies to support parcel level acquisition for salmon recovery	(1) Generated portfolios for prioritization scenarios for fish passage projects and acquisition. (2) Provided tiered priority scores for floodplain and salmon recovery	no
Parcel-scale sea level rise vulnerability assessment	Region-wide	A new tool that combines topobathymetric data, updated sea level rise projections, and existing datasets	Calculated parcel-level index scores for exposure, sensitivity, and vulnerability to sea level rise.	under development

Beach Strategies Web Tool

WDFW's [Estuary and Salmon Restoration Program](#) (ESRP) Beach Strategies for Nearshore Restoration and Protection project is built on more than 15 years of data compilation and analysis efforts. HSIL funding supported a third phase of this work to develop an interactive web-based tool. For this subaward ESRP:

- Developed an [ArcGis Hub](#) to display spatial data, derived metrics, and management recommendations.
- Developed a long-term [data stewardship plan](#) to manage the associated geodatabase and web tool.
- Developed [a user guide](#) and outreach material for restoration practitioners, planners, scientists, and others.
- Developed an [Armor Data Collection Template](#) to support integration of newly-collected shore armor mapping data from field and remote surveys into the Beach Strategies geodatabase.

Previous phases involved improvements to geospatial data and development of an integrated Beach Strategies Geodatabase (Coastal Geologic Services 2017), this was Phase 1. In Phase 2, evaluation metrics and strategies for beach restoration/protection were refined and new metrics of degradation and potential benefit of protection/restoration were calculated using the updated geodatabase (Coastal Geologic Services 2020). During both phases, the project team held multiple workshops with potential end users.

When developing the Beach Strategies website, Conway-Cranos et al. (2023) formed a steering committee to provide input to inform web tool design and development. The steering committee was comprised of staff from key partner institutions including the Department of Ecology, Puget Sound Partnership, WDFW, and University of Washington. Together, this steering committee developed use cases that identified desired functionality for achieving specific goals. Use cases were developed for five types of potential users: 1) restoration planner/practitioner, 2) restoration project application, 3) technical reviewer, 4) researcher, and 5) educator/communicator.

The result of this work was the Beach Strategies for Nearshore Restoration and Protection site. The site includes a variety of sources for potential users. These include a “guided data exploration” widget that allows the user to download data; educational pages on the role of nearshore ecosystems; a page breaking down the Beach Strategies framework that includes an explanation of the metrics involved; as well as resources on project history, reports, and other materials.

Hood Canal Landscape Assessment and Prioritization Tool

White and Harguth (2020) and HCCC (2023) advanced work on the Hood Canal Landscape Assessment and Prioritization (LAP) tool. The LAP tool will be a web-app that layers land use,

spatial, and ecological datasets in order to **identify locations for protection or restoration within the Hood Canal and the Strait of Juan de Fuca**. The tool will support HCCC in prioritizing and advancing strategies and actions within the Hood Canal integrated watershed plan and summer chum salmon recovery work. HSIL funded the first two phases of this project which included:

- Phase 1: built a framework to identify priority ecological areas with support from an Advisory Committee, tested the utility of the LAP Tool at a reduced scale with a pilot study, and compiled initial LAP tool data layers.
- Phase 2: refined existing data layers based on Advisory Committee feedback and compiled new layers that are especially relevant to watershed health and summer chum salmon.

White and Harguth (2020) led the first phase. They sought advice for the LAP tool and pilot study – what should be prioritized, criteria, and the location for the study. The Advisory Committee was comprised of land use and environmental planners from Jefferson, Kitsap, and Mason counties, as well as the Port Gamble S’Klallam Tribe and the Skokomish Indian Tribe. Based on partner feedback, White and Harguth (2020) derived initial LAP tool data layers from a variety of land use plans, policies, and regulations. The aim was to have these layers show where external pressures were impacting prioritized areas for summer chum and forage fish spawning areas.

The pilot study was conducted in Jefferson, Kitsap, and Mason County and tested how well the LAP Tool identified parcels in ecologically prioritized areas that are most susceptible to future development. The focus was on parcels that are currently undeveloped and are projected to be more developed in the future based on zoning codes. Data was derived from tax assessor data and land use zoning. The **results from this process displayed areas of highest projected change** in the three counties and informed on three LAP Tool data layers: Highest Priority Parcel, Highest Priority Parcel Selection, and Other Important Parcels.

White and Harguth (2020) completed Phase 1 with a list of ~14 data layers for the LAP Tool. The layers are split between three data types: 1) current ecosystem conditions, 2) land use and management, and 3) future pressures. During Phase I, the team found that current land use codes and critical area ordinances were inconsistent across jurisdictions which made it difficult to compare between counties.

In Phase 2, HCCC (2023) added to the data layer list and expanded the geographic scope of the LAP tool to encompass the entire Hood Canal Basin. New layers focused on current ecosystem conditions and climate change. Much of the data was derived from a 2022 *“EDT Modeling Assessment of Summer Chum Performance in Hood Canal and the Strait of Juan de Fuca”* by ICF and Biostream Environmental and a 2015 *“Guidance for Prioritizing Salmonid Stocks, Issues, and Actions for the Hood Canal Coordinating Council”* by Larry Lestelle. At the end of Phase II, the LAP Tool was still a work in-progress and was not yet available for wider use. The Tool could visualize and help with initial land use investigations, but a deeper analysis would require

additional aid by HCCC GIS specialists. More testing and calibration were needed before the LAP Tool could be released more broadly. HCCC does plan to continue adding new data layers.

HCCC received two other HSIL subawards which will be supported by the LAP tool, these include: Integrated Watershed Plan Monitoring and Adaptive Management (NTA 2016-0297) and Summer Chum Salmon Recovery Status of Threats (NTA 2018-0382).

Washington Natural Heritage Program Data Explorer

WDNR's Washington Natural Heritage Program received two subawards from HSL to assist local planners and land managers in identifying ecologically important areas :

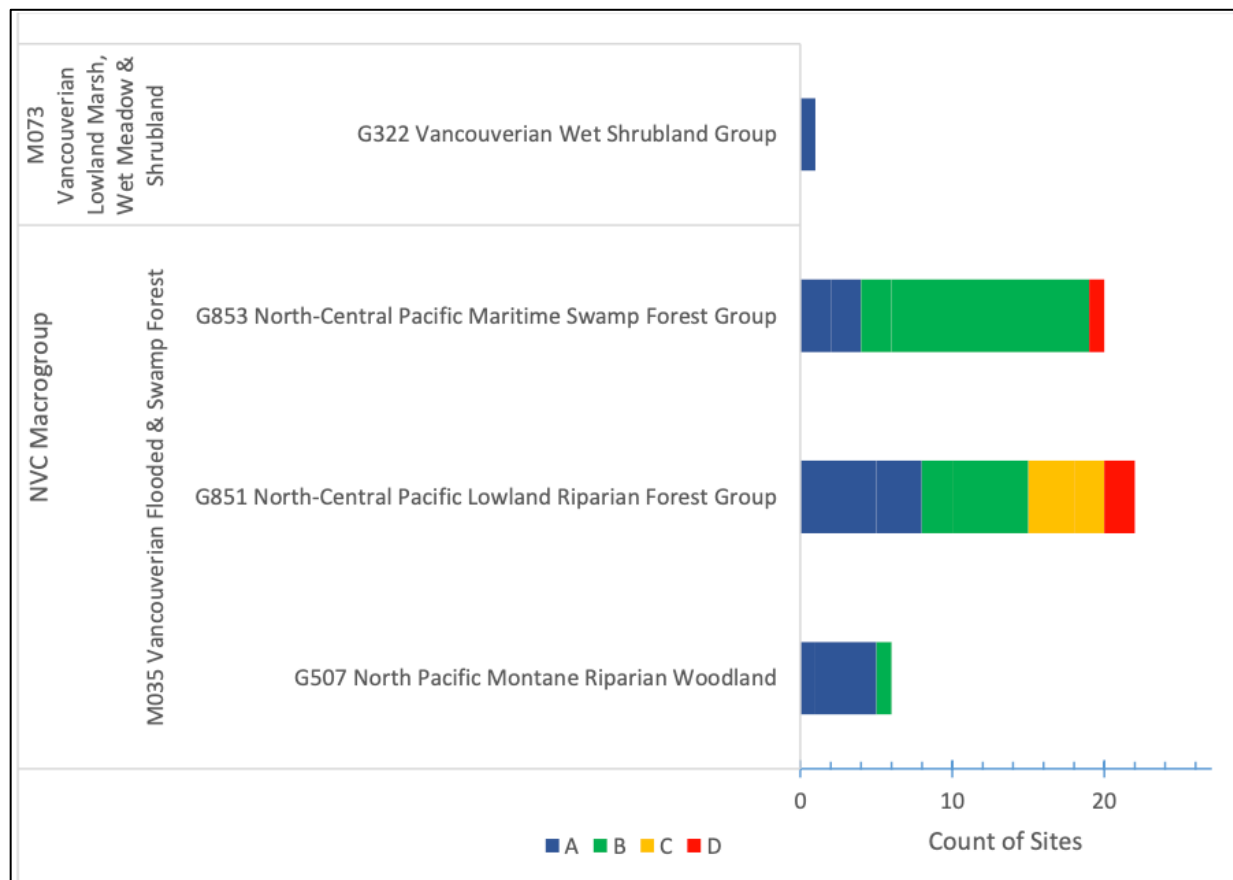
- NTA 2018-0652 – Supported ecological integrity assessments to identify areas for protection or restoration.
- NTA 2018-0692 – Supported the transition from a Washington Wetlands of High Conservation Value map viewer to a new [Washington Natural Heritage Program Data Explorer](#) site.

For the purposes of this project, Weber et al. (2022) defined **ecologically important lands as “occurrences of rare or high-quality ecosystems.”** This differs from the Vital Sign definition: lands that provide high hydrological function with respect to water flows and provide high habitat or biodiversity value. WDNR conducted Ecological Integrity Assessments to measure the conditions of upland and wetland ecosystems and classify areas for restoration or protection. Two levels of assessments were conducted for different geographies:

- Level 1 involves remote classifications using high-level GIS models. Areas are classified on an Excellent (A) through Poor (D) ranking. A-B ranks are good for candidates for conservation while C-D are good candidates for restoration. A Level 1 assessment is useful for landscape-level assessments and as an initial site screening tool. Results are used to select locations for Level 2 EIAs.
- Level 2 involves field assessments. The field assessment refines priority area rankings in the Level 1 model and identifies Element Occurrences. An Element Occurrence is an ecosystem stand or rare species location with practical biodiversity conservation value. Element Occurrences areas are zoned for priority protection.

Level 1 assessments were conducted for underdeveloped areas in the Puget Sound Basin, while the Level 2 assessments focused on lowland to montane forests and forested wetlands specifically within WRIA 10 (Puyallup/Chambers Creek). Weber et al. (2022) conducted Level 2 assessments on 39 upland sites and 41 lowland wetland sites. Results are shown in Figure 9 and generally swayed towards A-B rankings. This data likely overstated the integrity of the habitats as many C-D ranked sites were unreachable. However, through the Level 2 assessment six new Element Occurrences were identified as likely good candidates for conservation.

Figure 9. Results of Level 2 EIAs on 80 lowland and wetland sites in WRIA 10. Rankings range from Excellent (A) to Poor (D).



(Figure 2 from Weber et al. 2022)

These results helped to revise the Level 1 assessment and update results displayed in the new [Washington Natural Heritage Program Data Explorer](#). The Data Explorer is a re-imagining of the former Washington Wetlands and Conservation Value map viewer. The new data hub includes a user guide and two map pages that show:

- Rare Plant and Ecosystem Locations - displays all publicly available rare plant and ecosystem locations (Element Occurrences), including wetlands.
- Ecological Integrity Assessment Data - displays EIA results.

This project was inspired by HSIL efforts to facilitate discussions with LIOs about the values that underpin “ecologically important lands” as defined by PSP for the purposes of indicator tracking and the Land Development and Cover IS. These discussions occurred during an earlier HSIL-funded project, Effectiveness of CAO Riparian Protections (NTA 2016-0368). A small element of that subaward had WDFW Priority Habitats and Species Program staff providing technical support to LIOs seeking to better define and map “ecologically important lands” in their watersheds. Discussions with LIOs identified three important considerations for such efforts: (1) wetlands need to be more accurately mapped, (2) maps should be as fine-scale (parcel-based)

as possible, and (3) distinguish between restoration and conservation priorities. These requirements were filled by WNHP with the Data Explorer.

Puyallup Riparian Decision Support System

This project supported development of a Riparian Decision Support System and land cover change analysis tool for the Puyallup Watershed. This tool assesses the quality of riparian habitat and provides spatially explicit outputs to assist land managers in **identifying, prioritizing, protecting, and restoring riparian habitat** in the Puyallup Watershed. The project was led by the Pierce County, serving as the Puyallup and Chambers Lead Entity. It is intended to support the Lead Entity's efforts to achieve their 50-year habitat goals and 10-year implementation goals, as well as Floodplains for the Future's integrated floodplain management efforts. The tool was developed input from stakeholders, including the Lead Entity's Citizens Advisory Committee and Technical Advisory Group, and regional experts at PSP and WDFW.

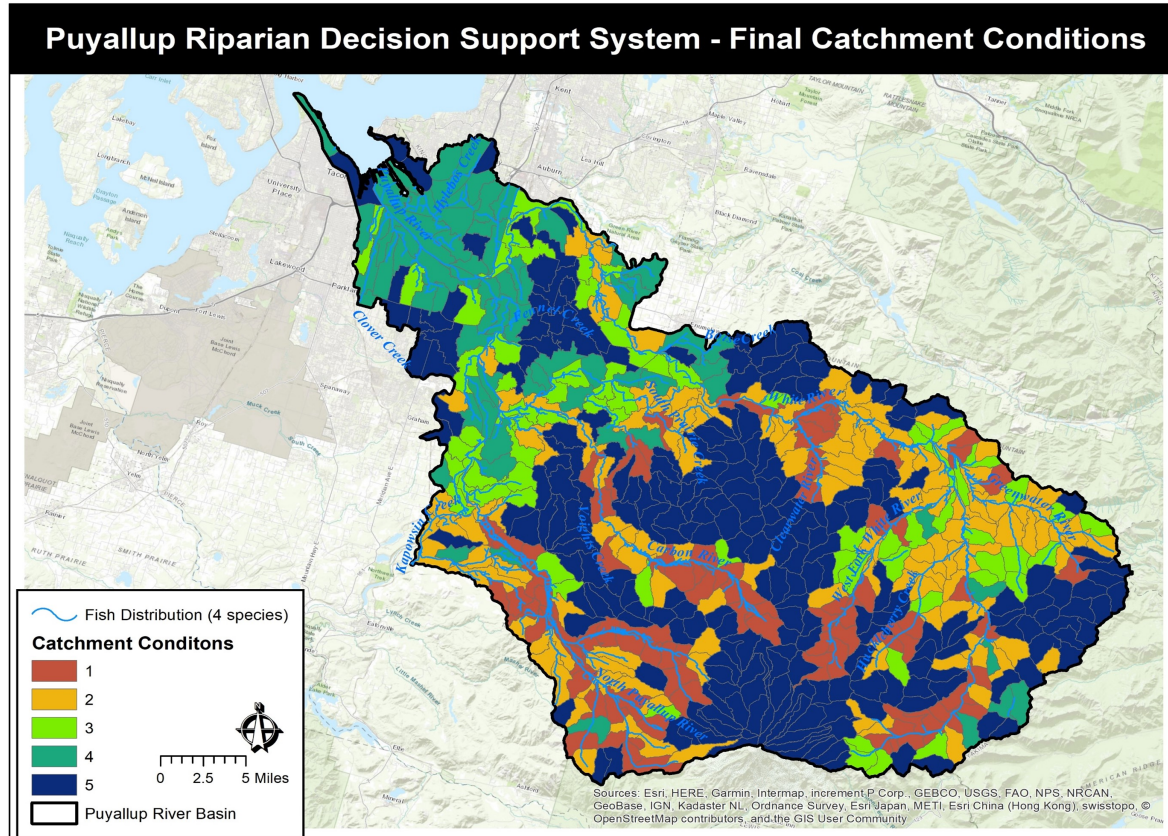
Duncan et al. (2021) assessed habitat conditions for four salmon species found in the watershed: Chinook, coho, steelhead, and bull trout. The decision support system was developed using a Bayesian network model, which is a tool that uses influence diagrams to estimate the likelihood that a factor will impact an outcome of interest. For this project, the outcome of interest is relative (e.g., high, high-moderate, moderate, low-moderate, low) condition of riparian habitat at the catchment level. A score of "low" can indicate a degraded habitat in that catchment which may warrant restoration actions, while a score of "high" can indicate a less degraded habitat which may warrant a suite of actions more geared towards protection.

The Bayesian network model was developed using empirical data and expert knowledge to inform the selection and valuation of model variables known to influence habitat conditions and functions in the Puyallup Watershed. For each catchment, three indicator summaries (habitat function, habitat conditions, and stressors) were used to determine catchment index scores:

- Catchment condition scores of 1 and 2 are considered to have high and moderate-high habitat potential for salmonids,
- Catchment condition scores of 3 and 4 are considered moderate-low, and
- Catchments with a condition score of 5 vary from low to high. These areas have no habitat or potential habitat for the selected species.

Figure 10 displays results from the first model run.

Figure 10. Catchment condition rankings and fish distribution for the Puyallup River Basin



(Figure 63 from Duncan et al. 2021)

The specific outcomes of the model, alongside the sensitivity analyses offered by the model, provided decision-makers with the data to see the trade-offs between certain actions. The model demonstrated that certain catchments ranked “high” may be more suited to protection actions versus those catchments ranked “low” by the model that may be suited to restoration actions. Results of the first model run provide a baseline against which future riparian corridor, floodplain, and marine nearshore habitat conditions can be compared to track changes over time. The decision support system was designed to be repeatable, transparent and adaptable as new data becomes available.

North Sound Riparian Monitoring and Modeling

The Skagit River System Cooperative developed a hydrography layer and two lidar-based models to compare current and potential future conditions of potential shade and wood recruitment along the Skagit River. The purpose of these models was **to help direct where protection and restoration actions could occur** within riparian areas. This project aimed to support salmon recovery in the Skagit River basin and implementation of local Critical Area Ordinances.

Errors in National Hydrography Dataset stream location data (discussed in section 2.2.1) hindered model development. Hyatt (2022) developed a **lidar-derived hydrography layer** to overcome this barrier. The new hydrography layer combined the best available data from either the National Hydrography Dataset or a 2016 lidar dataset. This new layer was used as a base layer for the two models.

Hyatt (2022) then created two scenarios within the shade model: a layer containing current shade conditions and a layer of potential future shade conditions. The current shade model used riparian buffers as recorded in 2016 lidar and delineated at 45 m and 90 m buffer widths. The potential shade conditions used the same buffers, with the addition of 100-year site-potential tree height (SPTH). SPTH depicts the shade that could happen if trees were allowed to grow freely for 100 years. Hyatt (2022) then added potential shade to both the current-conditions (2016) and SPTH maps (100 years in the future) **to assess where the most gains and losses in riparian shade would occur over time**. Potential protection and restoration areas were determined by subtracting potential future conditions with current conditions. Restoration actions can occur in places that show reduced or less shade, while protection can occur in areas that provide substantial shade.

The second model depicts wood recruitment by determining which trees within 90 m buffer zones had the potential to provide large wood to streams if the tree were to fall directly into the water. This model used the same input data as the current-conditions shade model but included a height to distance ratio for each cell above 0.9 m. Pixels with a ratio greater than 1 were considered capable of providing large wood. Additionally, Hyatt (2022) categorized the large wood recruitment results by five land use categories: agriculture, rural, city urban growth area, commercial forest, and federal forest.

Results between the two models found that the shade model was more effective in assisting in restoration planning than the wood recruitment model. The shade model demonstrated the benefits of restoration and protecting shade among southern mainstem channel edges and tributaries. Restoration in these areas would have the greatest benefit to salmon by providing the most shade. The wood recruitment model displayed bare areas in need of vegetation, but it did not show where planting efforts would have the most benefit.

Hyatt (2022b) provided [supplementary materials](#) available as public download. This work was intended to be easily available and repeatable to support local restoration practitioners throughout Puget Sound. The [Salmon Habitat Indicator](#) monitoring protocols/methods for the freshwater riparian habitat indicator – vegetation shade hours over stream are still in development. This subaward could potentially help inform that work.

Ecosystem Management Decision Support Model

The Ecosystem Management Decision Support Model (EMDS) was first developed in 1994 by the U.S. Forest Service's Pacific Northwest Research Station and is now in version 8 (USDA 2022). The EMDS is a decision support system that employs advanced modeling tools to

synthesize spatial and temporal information to provide decision support for a wide variety of landscape decision processes.

Hinton and Murphy (2022) used the EMDS open platform to compare single classes of actions at two pilot locations under future scenarios of population growth and climate impacts. This project supports the Tulalip Tribes' long-term project, the Harmonization Initiative, which intends to create **a standardized approach to habitat assessments for salmon recovery** within the Snohomish Basin (Tulalip Tribes Office of Treaty Rights 2017). The two pilot model scenarios for this assessment included:

- Snoqualmie Basin pilot: developed prioritization portfolios for fish passage by evaluating culvert projects under specific budgets and trend scenarios. The goal of this pilot was to sequence annually which high-priority fish passage barriers (as identified during the data-gathering phase by King County) should be removed using different prioritization algorithms to best support salmon recovery over time.
- Lower Skykomish Basin pilot: tested how different prioritization efforts, working at different scales in the same landscape, could be leveraged and combined to develop an acquisition strategy at the parcel level to focus on salmon recovery and floodplain risk reduction.

Hinton and Murphy (2022) partnered with King County's Fish Passage Barrier Removal Team to **identify fish passage barriers within five watersheds of the Snoqualmie Basin**. The initial stream barrier assessment found the watersheds contain **221 fish passage barriers**, 133 of which had no additional downstream barriers.

A full analysis was conducted on the 221 fish passage barriers. The analysis included three steps: 1) determine how close each barrier was to a stream, 2) conduct a cost benefit analysis for each fish passage barrier; and 3) place a modified prioritization approach through the EMDS tool to generate portfolios for each fish passage barrier. Portfolios were used to help the project move from an abstract analysis of the benefits of individual projects to creating a fundable program of projects. The results of the analysis would identify a subset of projects that maximize some quantified benefits against a theoretical limit in financial resources.

The results of the first steps found that there were extensive errors in the stream layer – 80% of the fish passage barriers fell within 20 m of the stream networks and 5% do not fall within 200 m. King County provided their stream layer which is based off the NHD. The second step, the cost-benefit analysis, determined that the estimated cost for removing all barriers was **\$542.3 million**.

For the third step, the resulting model was run through three prioritization scenarios. Two scenarios used simple geometric prioritization which penalized fish passage barriers that have downstream barriers. Specific project costs were not included for these two scenarios. The third was a Simple Weight Sum Prioritization / costs which benefits barriers with no downstream barriers and includes project costs within the prioritization.

When run through the EMDS the scenarios demonstrated the potential number of projects funded and the cumulative benefit (intrinsic potential values) under the project constraints of a \$100m budget with 5 years to complete. The intrinsic potential value is a reflection of the habitat potential for fish use, the higher intrinsic potential the better the habitat potential within the stream.

Hinton and Murphy (2022) found that the prioritization method which included individual project costs resulted in a larger number of projects funded than when costs were excluded. The placement of the projects, in this third scenario, were also more evenly distributed over the five watersheds. However, there was a lower cumulative benefit. These results can be seen in Table 13.

Table 13. Snoqualmie EDMS results for number of fish passage barrier projects funded under different prioritization scenarios

Portfolio Strategy	# of Projects funded	Cumulative Benefit (ATIIP)	\$ spent (%)
Simple Geometric Prioritization, Descending	34	221 IPUs	\$99.6m(99.6%)
Simple Weighted Sum Prioritization, Descending	34	211 IPUs	\$98.9m (98.9%)
Simple Geometric Prioritization / Cost, Descending	85	113 IPUs	\$98.8m(98.8%)

(Table 8 from Hinton and Murphy 2022)

For the lower Skykomish Pilot, Hinton and Murphy (2022) tested the EMDS platform as a tool to **combine existing prioritization strategies that support parcel-level acquisition** and salmon recovery in the Lower Skykomish floodplain. The pilot tool had two focuses: Salmon Recovery and Floodplain Risk Reduction.

Hinton and Murphy gathered datasets for this pilot through discussions during a Lower Skokomish Basin Pilot Workshop and subsequent virtual workshops and through stakeholder meetings between 2017-2021. The analysis leaned heavily on datasets from the Sustainable Lands Strategy – Lower Skykomish Floodplain Lands Strategy and the Tulalip Snohomish Floodplain Acquisition Strategy. The EMDS platform additionally was combined with a 2019 multi-criteria decision analysis model that previously prioritized floodplains for conservation and restoration in the Snohomish Basin (Shattuck and Totman 2021).

The methods used in this pilot study included using the EMDS platform to 1) run the Tulalip Strategy at the parcel scale, 2) create a new multi-criteria decision analysis to compare

prioritized parcels, 3) develop a NetWeaver to create needed data, 4) run the multi-criteria decision analysis twice one for salmon recovery and one for floodplain risks, and 5) compare results.

The results of this work were two maps one with priority scores for floodplain parcels with restoration potential and a second with priority scores for parcels with salmon recovery restoration potential. These maps could be compared to determine which parcels could support both floodplain and salmon recovery. The model does not fully provide answers to which parcels are key to hydrology and depredation in the whole floodplain. A similar study to the fish passage barriers analysis may provide this insight as additional analysis is required to understand the adjacent possibility of risk that might occur as restoration projects are implemented.

Salmon Life Cycle Model to support multi-benefit actions and adaptive planning

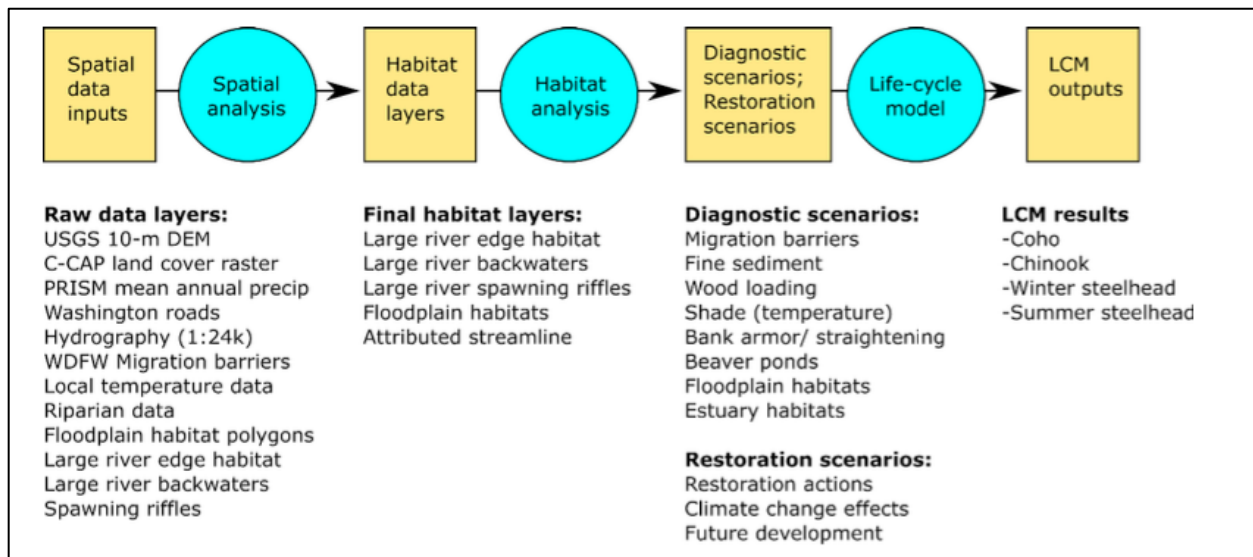
Beechie (2022a and 2022b) conducted a study on the Snohomish and Stillaguamish Basins to identify habitat restoration actions that were most **likely to increase spawner abundance** for salmon species. HSIL provided two separate subawards one to Snohomish County the other to the Tulalip Tribes, who partnered with Dr. Timothy Beechie of NOAA to complete the analyses.

The studies applied the NOAA Habitat Assessment and Restoration Planning (HARP) model. The HARP model **quantifies historical, current, and future habitat conditions then predicts the potential benefit of alternative restoration actions to salmon populations**. The purpose of the model is to help identify key restoration actions that will benefit culturally and ecologically important salmon. The HARP Working Group provided advice throughout the modeling effort. The working group was comprised of members from the Tulalip Tribes, Snohomish County, Washington Department of Fish and Wildlife, and King County.

The HARP model consists of three modules, as shown in Figure 11:

- The spatial analysis, which uses raw geospatial layers to create a habitat data layer.
- The habitat analysis that takes the data layers and other information to produce estimates of historical (circa 1880-1890) and current habitat conditions (~ 2020). These conditions are used to produce diagnostic habitat scenarios. And,
- The life-cycle models which run different scenarios to identify habitat restoration actions that could increase spawner abundance for each modeled species.

Figure 11. Habitat Assessment and Restoration Planning modules



(Figure 2-2 from Beechie et al. 2022)

The HARP model focused on three salmon species in the Stillaguamish and Snohomish River Basins: coho, Chinook, and steelhead. Results for restoration actions that would best benefit salmon were similar in both basins and included:

- For coho salmon the diagnostic scenarios suggest focusing on four restoration actions: beaver ponds, floodplain habitat, restoring wood, and migration barriers.
- For summer- and fall-Chinook salmon the diagnostic scenarios suggest wood augmentation, bank armor removal, and floodplain reconnection. In addition, Snohomish County saw strong results for delta reconnection.
- For steelhead the diagnostic scenarios suggest wood augmentation, shade restoration, and floodplain reconnection. Steelhead abundance is likely linked to summer rearing temperatures which benefit through increased shade and hyporheic exchange.

These results suggest that restoration actions vary between salmon species within single watersheds, but **actions have similar benefits across watersheds**. Certain restoration activities such as floodplain reconnection and riparian restoration may inadvertently include other actions (bank armor removal, wood recruitment). Beechie (2022a) states that these multi-benefit restoration activities may then provide support between salmon species or provide greater benefit to one.

Beechie (2022a and 2022b) found that the model needs improvement, especially within the hydrography layers. The hydrography layers used the NHD for Snohomish and DNR Hydro for Stillaguamish. They found the hydrology depicted in both had large room for improvement. Additionally, insufficient data of salmon life histories could also produce model uncertainty. As the model continues to improve it offers one source of suggestions on restoration actions.

Integrated Population Model for Skagit River Chinook

Schooler and LeMoine (2023) developed, applied, and evaluated a Bayesian state-space life cycle integrated population model for Skagit River Chinook salmon. The goal for the integrated population model once complete is to support Skagit River Chinook Recovery Plan efforts by evaluating recovery actions. Schooler and LeMoine (2023) aimed to build an integrated population model capable of including multiple life stages, so that the model may determine what factors most influence demographic processes. For this project, the model team outlined and evaluated the current state of the model and highlighted next steps for the development.

The data sources used within the integrated population model included:

- WDFW time series data (1994-2016) for outmigrating fry and parr in the Skagit River.
- Skagit River system regional comanagers' escapement and age structure estimates.
- A dataset compiled by Schooler and LeMoine (2023) of environmental covariates for temperature, flow, weather, and ocean productivity.
- recruitment brood year estimated through an age-structure population model.

Schooler and LeMoine (2023) tested the model fit and model evaluation. The integrated population model is split between two salmon life stages: the freshwater stage and the marine stage. For this project, the model fit was found by determining the non-least squares model best suited to both stages. A multi-stage space-model was used to apply the fits. The model evaluation then assessed how well the model connected the freshwater stage to the marine stage. The model evaluation used Bayesian p-values to check model fit and compared the results to a separate identical model to validate outputs.

Though the model was successful in producing outputs, the lack of data for some parameters caused model errors. In this initial run of the model, Schooler and LeMoine (2023) found that the model estimated smolt and recruitment abundance well but had difficulty differentiating between productivity and density dependence. This is likely due to unknown observational errors in the datasets. Schooler and LeMoine (2023) plan to continue work on the model, strengthening the model framework through more precise parameters and more precise external drivers.

This project connects to the Habitat Status and Trends model discussed in section 4.2. Both of these projects supported the Skagit Chinook Recovery Plan. Results from the Habitat Status and Trends will eventually be used within the integrated population model to examine impacts of restoration on specific life stages.

4.3.5 RECOMMENDATIONS

Guiding salmon recovery

- The PSP Strategies Report provides a high-level overview of nearshore threats; the complex mix of programs and partners involved in nearshore recovery; key Chinook Implementation

Strategy elements; lessons learned about past NEP investments in Puget Sound recovery; example nearshore restoration actions; and a few post-2005 publications. We recommend some opportunities to further advance use of nearshore science in recovery planning that was not included in this draft:

- Add specificity about how to identify priority geographic areas for protection/restoration and develop actions that would have the most benefit to Chinook.
- Provide a comprehensive summary of nearshore science using the most recent literature available.
- Provide specific examples that would maximize benefits for Chinook. For instance, “acquire high value nearshore habitat” could include guidelines on what high value constitutes.

Indicators

- Ecology recommends refining the remaining 14 major floodplain maps by integrating data from local partners. Additional mapping would improve the suitability of the dataset for tracking regional progress and also increase its use for local recovery planning. The subawardee further recommends developing quantitative recovery target(s) for the new Streams and Floodplains Vital Sign’s [floodplain function in large and small river systems indicator](#).
- Environmental Science Associates (2019a) recommend engaging with regional grant programs to support the use of project tracking methods. We recommend first ascertaining whether typical project sponsors have the GIS skills (or easy access to GIS support) necessary to develop existing and projected functional category acreage estimates easily. Project sponsors indicate that grant reporting requirements are already a challenge, so the potential for over-burdening grantees must be considered carefully.

Oil Spills

- San Juan County and their consultant identified several opportunities for future oil spill research. However, we recommend that future studies which focus on oil spills should be scoped in collaboration with Ecology’s Spill, Prevention, Preparedness, and Response Program.

Decision support tools and models

- The Tulalip Tribes provided recommendations for advancing the EMDS tool. The next steps provided by the subawardee are to continue testing and refining the tool. The recommendations include:
 - Repeat the fish passage barrier analysis using the NOAA Life Cycle Model with the updated NHD layer.
 - Repeat the floodplain acquisition analysis using similar methods as the fish barrier analysis.

- Introduce the EMDS tool to floodplain managers within the Snohomish Basin. There continue to be basin level planning efforts that should allow the Tulalip Tribes to continue integrating different modeling methodologies through the tool.
- We recommend that future tool development projects emulate the Beach Strategies approach of developing specific use cases and repeatedly engagement with potential users throughout the development process. Ensuring that underlying data layers are accurate is also crucial. Work done by Hyatt (2022) to improve locational accuracy of the models' hydrography layer increases confidence in the results.

4.4 DIRECT RECOVERY ACTIONS

The Geographic Scale Integration theme includes direct recovery actions that resulted in habitat benefits. The eight subawards included in this section (Table 14) involve projects which sought to improve habitat conditions through restoration or acquisition as well as removal of toxic materials from the marine environment.

Table 14. Direct recovery actions

NTA	Project	Owner
2016-0088	Maylor Point Feeder Bluff Armoring Removal	Northwest Straits Foundation
2016-0161	Puget Sound Creosote Removal Program	Department of Natural Resources
2016-0169	Snohomish Estuary Derelict Vessel Removal	Snohomish Marine Resources Committee
2016-1158	South Prairie Creek (RM 4.0-4.6) Floodplain Project Phase 1	South Puget Sound Salmon Enhancement Group
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
2018-0959	Revegetating the Elwha	Lower Elwha Klallam Tribe

4.4.1 PROPERTY ACQUISITION AND HABITAT RESTORATION

In this section we describe projects that support habitat recovery through direct actions. HSIL provision of gap funding for acquisition and restoration projects allows for a small amount of funding, when combined with other sources, to have a big impact. Some elements of a property acquisition and restoration efforts can be difficult to fund with capital dollars and/or other types of grants. The flexibility of HSIL funding helped projects to move forward.

HSIL funded five acquisition and restoration projects. Three of these were LIO direct awards. These projects partially supported two strategies in the 2022-2026 Action Agenda: Strategy 5 –

Floodplains and Estuaries and Strategy 15 - Salmon Recovery. These strategies have been in past iterations of the Action Agenda. The most recent strategies feature the acquisition of floodplains and estuaries as a main goal and supports salmon recovery through expanding available habitat. The subawards also supported the Chinook Salmon Recovery Plan which seeks to protect and restore areas where benefits to salmon are expected (Shared Strategy for Puget Sound 2007). The subawards included in this section are:

- NTA 2018-0218 – Supported the purchase of 158 acres of floodplain lands along the North Fork Stillaguamish River
- NTA 2018-0189 – Supported the Capital Land Trust in acquiring 55 acres of Puget Sound shoreline.
- NTA 2018-0179 – Supported Jefferson County to partner with agricultural landowners along Chimacum Creek to assist in protection and restoration efforts.
- NTA 2016-1158 – Supported restoring habitat for fish and wildlife within the South Prairie Creek valley.
- NTA 2018-0959 – Supported the Lower Elwha Klallam Tribe in restoration efforts throughout the Elwha watershed.

Stillaguamish Floodplain Acquisition and Restoration

With the financial assistance from HSIL and six other funders the Stillaguamish Tribe purchased **158 acres of floodplain** lands along the North Fork Stillaguamish River in November 2019 (Griffith 2020). The total cost of purchase that included two water rights was \$2 million. In June of 2020, tribal staff led members of the Stillaguamish Watershed Council to discuss restoration actions for the site. Restoration included activities that would benefit both juvenile and adult Chinook and other salmonids. These actions discussed were to: 1) improve instream and off channel habitats with the restoration of riparian/instream areas and 2) remove bank armoring to reducing flood energy and improve egg-to-migrant survival for salmonids.

Mud Bay Habitat Protection

The Capitol Land Trust (2022) acquired **45 acres of land** at Mud Bay with HSIL and four other funders. Located along the Eld Inlet, Mud Bay contains freshwater and marine shoreline habitat that supports Chinook, other salmonids, and wildlife. This sub-award to Capitol Land Trust was a direct LIO award from the Alliance for Healthy South Sound. This phase of acquisition included hiring contractors to permit, plan, and design restoration work; demolition of former structures; and removal of debris and invasive vegetation.

Chimacum Creek Acquisition

HSIL funding supported the acquisition of **0.67 acres of critical floodplain habitat** at Chimacum Creek. Chimacum Creek, located on the Olympic Peninsula, provides habitat for the Hood Canal summer chum and has been a monitoring site for the North Olympic Salmon Coalition for

almost 30 years (Bush 2021). This history led to a multi-year, multi-party effort to restore and protect the creek.

In 2016, the North Olympic Salmon Coalition was awarded a [Watershed LO](#) grant to fund the first phase of the Chimacum Creek project. This phase concluded with a Chimacum Creek Protection and Restoration Plan, an outreach plan for engaging with agricultural landowners, and a riparian and beaver management plan (PSP 2023). This direct LIO award supported the second phase of restoration efforts at the site.

For the duration of the award the North Olympic Salmon Coalition partnered with Jefferson County Conservation District, Jefferson Land Trust, Kodama Farmers, and Natural Systems Design (Doyle 2022). There were four main focuses of this award: 1) install native plants in riparian zones, 2) mitigate beaver dams, 3) acquire floodplain habitat, and 4) communicate with partners. This sub-award met these goals by:

- North Olympic Salmon Coalition working with willing landowners to install native plants. This resulted in installation of **seven acres of native plants** on four properties.
- Jefferson County Conservation District leading the efforts to mitigate beaver dams on farmland properties. At project conclusion, they had **installed nine beaver dam devices on four farms**. The reduction in dams aimed to mitigate flood risks.
- Jefferson County **acquiring the 0.67 acres of critical floodplain habitat**. The HSIL award additionally funded Phase 1 and 2 environmental assessments at the site.
- North Olympic Salmon Coalition partnering with Jefferson Land Trust to [produce a video](#) about this work.

South Prairie Creek Preserve

HSIL's subaward was one of 12 grants that provided support for the South Prairie Creek Preserve Floodplain Restoration project. Established in 2005 and expanded in 2021, the South Prairie Creek Preserve consists of 167 acres of former agricultural lands along South Prairie Creek. Three of the preserve's parcels are owned by Pierce County, one is owned by the Pierce Conservation District, and one by Forterra. The acquisition occurred in 2005.

The goal by the South Puget Sound Salmon Enhancement Group (2020) was to provide habitat for fish and wildlife through full restoration of the floodplain and surrounding forest habitat. The project began in 2013 and HSIL funded activities from 2017-2020. The project team consisted of representatives from Pierce Conservation District, the Pierce County Surface Water Management, the Puyallup Tribe and the South Puget Sound Salmon Enhancement Group who designed and implemented the large-scale floodplain restoration project. There were two phases to this project.

The first stage consisted of an alternative analysis, a feasibility study, an iterative design process to balance floodplain connectivity and flooding concerns, and a cultural resources investigation and consultation. This stage brought in consultants from the Natural Systems Design group,

Aqua Terra Cultural Resource Consultants, and a Snohomish Conservation District cluster engineer. HSIL partially funded activities in this first phase. The second stage was to perform the restoration activities. This commenced March 2020 and lasted seven months requiring cooperation from multiple stakeholders.

The results from the restoration activities included:

- Installing 5 engineered log jams and 113 log structures.
- Installing 3,500 cubic yards of gravel to raise creek bed and improve spawning habitat.
- Removing 19,400 cubic yards of non-native grass, poison hemlock, and sediment to restore channel connections.
- Demolishing 9 remnant barn and dairy structures, plus a bridge made from creosote-treated wood.
- Installing a 36-foot-span steel bridge.
- Installing 10,783 plants. Plant installation began in 2016 and lasted throughout the project period.

The South Prairie Creek preserve project was made possible because of the strong partnerships and dedicated staff from over 35 different sectors. After construction the team observed Chinook spawning in the newly constructed log jams and juvenile steelhead feeding in the pools and increased flow events through the side-channels.

Revegetating the Elwha

The Lower Elwha Klallam Tribe leads restoration of the Elwha watershed. In 1992, Congress passed the [Elwha River Ecosystem and Fisheries Restoration Act](#) which authorized dam removal and promoted restoration for the Elwha watershed. The first dam was removed in 2011 and the second dam in 2014 (NPS 2023). Miller (2022) notes that the destruction of the dams caused a large growth of invasive weeds which will take years to control. The restoration actions commence during this project resulted in:

- Planting 16,675 native plants/trees,
- Treating 1,483 acres of floodplain for noxious weeds,
- Assisting 30 Elwha riparian landowners in improving fish habitat,
- Leading 7 outreach/educational field trips, and
- Hosting 19 volunteer work events to enhance Elwha riparian habitat.

The Lower Elwha Klallam Tribe received funding through the Salmon Recovery Funding Board to continue restoration efforts into 2025. However, noxious weed control will need to be continued indefinitely at this site.

4.4.2 TOXICS REMOVAL

Removing toxins is critical to healthy ecosystems. The Stormwater SIL's Toxic in Fish IS specifically highlights creosote-treated wood as a source of Polycyclic Aromatic Hydrocarbons to be addressed by the incentivize product replacement strategy. That strategy focuses on removal of primary legacy sources of contaminants, focusing where efforts are likely to have the greatest reduction of toxic impacts to marine species. The monitoring and removal of toxic substances is also addressed in recommendation 33 from [Governor Inslee's Southern Resident Orca Task Force](#).

HSIL funding supported three subawards with toxics removal elements:

- NTA 2016-0161 – Supported WDNR's Creosote Removal Program in their continuing efforts around Puget Sound shorelines.
- NTA 2016-0169 – Supported the Snohomish Marine Resources Committee (MRC) in the prioritization and removal of derelict vessels within the Snohomish estuary.
- NTA 2016-0088 – Supported Northwest Straits Foundation in removing remaining armoring, including a bulkhead made of tiers, at the Maylor Point feeder bluffs.

WDNR Creosote Removal Program

Bulkheads, docks, and other types of marine structures were sometimes constructed with creosote-treated wood. WDNR's [Creosote Piling Removal Program](#) works to remove and properly dispose of creosote debris throughout the Puget Sound. HSIL filled a funding gap for the program via NTA 2016-0161.

Robertson (2019) set a goal to remove 225+ tons of diffuse creosote and other marine debris from the shorelines of Puget Sound. With support by the Washington Conservation Corps, this project resulted in the removal of **303 tons (18,341 gallons) of creosote/marine debris**.

The Creosote Piling Removal Program now receive additional funding through PSP's [Nearshore Conservation Credit Program](#)²⁴ developed in 2022.

Snohomish River Estuary Derelict Vessel Removal

Snohomish County Marine Resources Committee (MRC) aimed to improve habitat for forage fish larvae and Chinook salmon by prioritizing and removing derelict vessels in the Snohomish estuary. To achieve this goal, the Snohomish MRC worked in partnership with Snohomish

²⁴ New regulatory requirements for maintenance of existing structures that require Section 404 permits, including bulkheads, add compensatory mitigation conditions. NOAA Fisheries' [Puget Sound Nearshore Habitat Conservation Calculator](#) was developed to support implementation of this change can be used to determine the mitigation credit value of creosote piling removal, which can be sold to permittees through the new PSP mitigation credit marketplace or other approved conservation credit providers.

County Surface Water, WDNR's [Derelict Vessel Removal Program](#), the Sheriff's office, and Ecology (Pozarycki 2019).

Snohomish MRC along with WDNR surveyed and prioritized derelict vessels. The prioritized vessels were then uploaded to WDNR's prioritization database to estimate removal costs. Removal costs helped to determine how many vessels could be removed within the scope of work. With additional support from the project team, the subawardee **removed five derelict vessels**, a total of 22 tons of total waste, from the Snohomish estuary (Pozarycki 2019).

Because this type of vessel removal had not previously occurred in Snohomish County, Snohomish MRC identified and piloted all the steps necessary for this type of work. After completion of the subaward in 2018, the Snohomish MRC and WDNR have [continued to](#) remove derelict vessels from the Snohomish River estuary.

Funding for WDNR's Derelict Vessel Removal Program received a significant increase through [House Bill 1700](#), passed in 2022. The bill provided a dedicated source of revenue for the program via the vessel watercraft excise tax. Along with continuing to remove derelict vessels, WDNR now plans to work with Washington Sea Grant to pilot a better recycling program for boat metals and plans to provide more funding to local law enforcement to reduce abandoned vessels (Williams 2022).

Maylor Feeder Bluff Armor Removal

In 1978, the U.S. Army Corps of Engineers installed several different types of shoreline armor as a 'Low Cost Shore Protection' experiment along a high feeder bluff at Maylor Point on Naval Air Station Whidbey Island. A year after installation much of the hard armor broke apart spreading debris across the feeder bluff (Kaufman 2019). Since that time, the Northwest Straits Foundation (NWSF) identified Maylor Point as a priority restoration project, after which a Marine and Nearshore LO grant helped with initial coordination, feasibility, preliminary design, and permitting to begin restoration.

The NWSF received funding from three source (HSIL, the U.S. Fish and Wildlife Service Puget Sound Coastal Program, and the Puget Sound Acquisition and Restoration Program) to continue restoration at the site. The intent of this subaward was to remove the remaining hard armoring from the shoreline to increase availability of spawning habitat for surf smelt and sand lance, restore sediment transport processes, and reduce toxic leachate contamination from creosote-treated wood (Kaufman 2019). This project resulted in the removal of:

- 1,500 linear feet of armor,
- 21.34 tons of creosote-treated wood,
- 36.53 tons of tires,
- 1,511 tons of angular rock and armor stone, and
- 304.96 tons of concrete bags.

This project helped to restore the natural sediment process to **3.5 miles of shoreline and unbury 1.32 acres of intertidal habitat**. NWSF completed a year-one post-construction assessment in 2019. Results indicated that the feeder bluff was rebuilding (Kaufman 2019). In addition, HSIL funding supported preliminary monitoring efforts that would assess the effects of shoreline restoration at Maylor Point. NWSF in partnership with WDFW used monitoring methods consistent with Shoreline Monitoring Toolbox protocols (NTA 2016-0119). Analysis of the monitoring data from Maylor Point and other sites was completed by NWSF under NTA 2018-0219 (as discussed in section 2.1.1).

4.4.3 SUMMARY OF RECOVERY ACTION OUTPUTS

Tables 15-18 compile results of the direct recovery actions supported by HSIL funding:

- Table 15 describes acquisitions that were made possible with the addition of HSIL funding.
- Table 16 connects HSIL recovery actions with 2022-2026 Action Agenda strategy goals. This is to provide example projects for these strategies.
- Table 17 is a compilation of revegetation and weed removal efforts. Revegetation is not a strategy goal but was an action produced in many of the HSIL awards.
- Table 18 shows HSIL contributions to overall project funding for those projects that received financial support from multiple sources. Total grant costs were retrieved from PRISM.

Table 15. Acquisition projects supported through HSIL

Subaward	Acquisition size	Habitat type
NTA 2018-0218	158 acres	Floodplain
NTA 2018-0189	45 acres	Shoreline/nearshore habitat
NTA 2018-0179	0.67 acres	Floodplain
Total	203.67 acres	

Table 16. HSIL-funded recovery action results

Results	Project Name	Associated 2022-2026 Action Agenda Strategies
324.34 tons of creosote	WDNR Creosote Removal Program (NTA 2016-0161)	Toxic Chemical Pollution - 8
	NW Straits Foundation Maylor Feeder Bluff Armor Removal (NTA 2016-0088)	
2,027 linear feet of armor removed	NW Straits Foundation Maylor Feeder Bluff Armor Removal (NTA 2016-0088)	Healthy Shorelines – 3
	Kitsap County West Central Nearshore Restoration and Shore Friendly Kitsap Bridge Funding (NTA 2016-0198 / NTA 2018-0322)	
167 acres of salmon habitat partially restored	SPSSEG South Prairie Creek Floodplain Restoration (NTA 2016-1158)	Floodplains and Estuaries – 5
203.67 acres of salmon habitat acquired for restoration	Stillaguamish Tribe of Indians Floodplain Acquisition and Restoration (NTA 2018-0218)	
	Capitol Land Trust Mud Bay Habitat Protection (NTA 2018-0189)	
	North Olympic Salmon Coalition Chimacum Creek Restoration and Protection (NTA 2018-0179)	
2 known culverts restored – 0.8 miles of stream restored	Snohomish CD Kristoferson Creek Fish Passage Improvement Project (NTA 2016-1216)	Fish Passage Barriers – 6
5 derelict vessels removed	MRC Snohomish Derelict Vessel Removal (NTA 2016-0169)	Responsible Boating – 17
47,858 native plants planted	Lower Elwha Klallam Tribe Revegetating the Elwha (NTA 2018-0959)	n/a
	SPSSEG South Prairie Creek Floodplain Restoration (NTA 2016-1158)	

	WSU Jefferson County Extension Engaging the Community in Strait Ecosystem Recovery (NTA 2016-0107)	
	Capitol Land Trust Mud Bay Habitat Protection (NTA 2018-0189)	

Table 17. HSIL contributions to larger acquisition and restoration efforts

NTA	Name	PRISM #	Project Size	HSIL Contribution	Total Funding
2016-1158	South Prairie Creek Acquisition Phase 1	15-1224	Miles 4.0-4.6	\$248,000	\$1,611,438
2018-0218	Stillaguamish Floodplain Acquisition and Restoration	18-1443	85 acres of floodplain	\$100,000	\$800,000
2018-0959	Elwha River Revegetation Support Phase 2	13-1078		\$100,000	\$1,430,999
2016-1216	Kristoferson Creek Fish Passage Improvements	15-1050	First 500ft of Kristoferson Creek	\$37,025	\$355,274
2018-0189	Mud Bay Habitat Protection	19-1398	55 acres for acquisition	\$100,000	\$177,811

Total funding amounts were obtained from PRISM and may not always include HSIL subawards.

4.5 PROJECTING AND PLANNING FOR CLIMATE CHANGE IMPACTS

A cross-cutting goal for the Implementation Strategy program is to promote climate change adaptation and resilience. The Shoreline Armoring IS and Floodplains and Estuary IS both include content about projecting and planning for climate impacts.

The 12 subawards in this section (Table 19) supported development of tools and resources to: understand climate resilience in farm, fish and flood efforts; support municipal climate action planning; conduct community outreach and stakeholder engagement around regional climate change impacts; and undertake research on sea level rise, groundwater and salinity, flood hazards and their impact on infrastructure and agriculture, and future water availability/usage.

Table 19. Subawards with climate change elements

NTA	Project	Owner
2016-0074	Climate Resiliency in Snohomish River Floodplain	Snohomish Conservation District
2016-0089	Community-scale Sea Level Rise and Coastal Hazard Assessment in Puget Sound	Climate Impacts Group
2016-0140	Advancing Sea Level Rise Adaptation in San Juan County	Friends of the San Juans
2016-0405	Ocean Acidification Resilience across Habitat Types	Department of Natural Resources
2016-0408	Add Acidification Parameters to Ecology Monitoring Network	Department of Ecology
2018-0266	Residential shoreline loan program feasibility study	Puget Sound Institute
2018-0327	Puget Sound Critical Areas Monitoring and Adaptive Management Program	Department of Commerce
2018-0685	Prioritizing Sea Level Rise Exposure and Habitat Sensitivity Across Puget Sound	Washington Sea Grant
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
2018-0952	Phase 2 Municipal Level Climate Action Planning for the North Olympic Peninsula	North Olympic Peninsula Resource Conservation and Development Council

Three of these subawards are discussed elsewhere in this report because they do not focus on planning related to climate. The projects involving water quality monitoring (NTAs 2016-0405 and 2016-0408) were described in Chapter 2. Development of a climate focused K-12 curriculum was discussed earlier in this chapter.

4.5.1 SEA LEVEL RISE

The Shoreline Armoring IS's long-term planning strategy recognizes that addressing future climate challenges along the region's shorelines requires development of tools and resources in the near term. Identifying and communicating how vulnerable areas may change over time is

crucial for both land-use and infrastructure planning, as well as community engagement in planning processes.

In this section we describe three HSIL subawards that advance the long-term planning strategy and a fourth subaward that investigated new financial incentives for Shore Friendly sea level rise adaptation measures on residential parcels:

- NTA 2016-0089 – Supported Climate Impacts Group work to address gaps identified during the Washington Coastal Resilience Project related to quantification of the combined impact of sea level rise, storm surge, and wave runup.
- NTA 2018-0685 – Supported Washington Sea Grant work to integrate new high-resolution topobathymetric data, updated sea level rise projections, and existing datasets to develop a regional analysis of relative sea level rise vulnerability at the parcel scale.
- NTA 2016-0140 – Supported Friends of the San Juans work to communicate results of a sea level rise vulnerability assessment to increase resident and County planner awareness and advance coastal adaptation projects.
- NTA 2018-0266 – As part of the feasibility study for a shoreline loan program discussed in Chapter 3, Coastal Geologic Services estimated the cost of residential home elevation and relocation projects along marine shorelines.

Addressing needs identified during the Coastal Resilience Project

The University of Washington Climate Impacts Group (CIG) and Washington Sea Grant collaborated with partner groups to update information and fill gaps identified during the [Washington Coastal Resilience Project](#). Funded in 2016 by NOAA, this three-year effort sought to improve coastal risk projections, provide better guidance for land use planners and strengthen capital investment programs for coastal restoration and infrastructure (Washington Sea Grant 2020).

Coastal managers reported that the information on sea level rise (SLR) generated by the Washington Coastal Resilience Project was not adequate for developing resilience strategies. The managers also stated that the existing research did not quantify the combined impacts of sea level, surge, and waves (Raymond et al. 2018). The project team collaborated with outside partners to fill these gaps with three projects that expanded upon and leveraged results of the Washington Coastal Resilience Project. These partners:

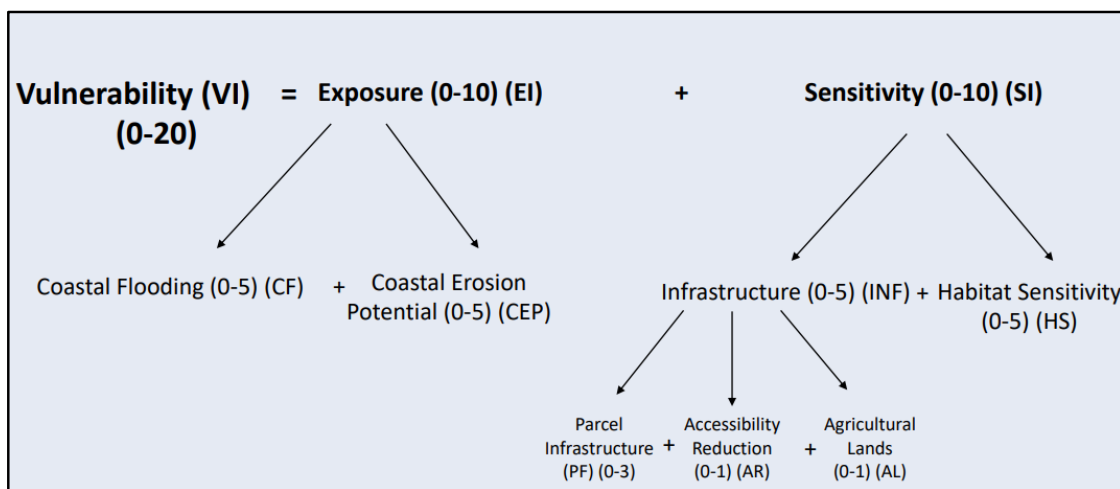
- Developed guidelines for incorporating coastal hazards projections in the siting, design, and maintenance of nearshore habitat restoration projects (Raymond et al. 2018);
- Developed maps and guidelines for mapping SLR projections in Puget Sound (Norheim et al. 2018); and,
- Developed a computational wave model simulation evaluating the relative exposure to waves across the Puget Sound coastline (Yang et al. 2018).

Products from this subaward were a key data source for Sea Grant’s parcel-scale vulnerability assessment (NTA 2018-0685, described below). Other users are restoration practitioners, instructors at the Coastal Training Program, and local jurisdictions.

Parcel scale sea level rise vulnerability assessment

Miller et al. (2022) and Miller et al. (2023) constructed, calculated, and mapped a vulnerability index designed to inform SLR planning and risk mitigation efforts. The quantitative framework developed by the project team, with the assistance of a 14-member advisory group, involved calculating an **exposure index** for two sea level rise hazards (coastal flooding and erosion) and a **sensitivity index** reflecting the extent to which coastal assets (buildings, critical public facilities, roads, agricultural lands) and habitats (brackish/transitional wetland, estuarine wetland, palustrine emergent wetland, unconsolidated shore) would be affected by those hazards. Figure 12 illustrates how **physical vulnerability scores** were calculated.

Figure 12. Component indices and sub-component measures of the Physical Vulnerability Index



(Figure 5 from Coastal Geologic Services et al. 2022)

More than 14 existing datasets were incorporated into this assessment, including the Beach Strategies marine parcel layer used for NTA 2018-0582 and significant wave height predictions from a Salish Sea wave model developed by Yang et al. (2019) with funding support from HSIL via NTA 2016-0089. The **study area for this project excluded the Strait of Juan de Fuca west of Dungeness Spit** due to limitations in the boundaries of the USGS 1-meter resolution topobathymetric model of Puget Sound when the project began.

The physical vulnerability of a parcel or asset may be reduced through adaptive measures such as relocating or elevating a building above expected flood level. Adaptive capacity (i.e., the ability to reduce exposure or sensitivity by implementing adaptive measures) is therefore an important component of vulnerability but was outside the scope of this project to measure. Instead, the project team coupled physical vulnerability results with a complementary **social**

vulnerability index developed by Fleming and Regan (2022) via application of a part of NOAA's National Centers for Coastal Ocean Science vulnerability assessment framework. This index was calculated by Zip Code Tabulation Areas and included 36 variables combined into 7 components (diversity and urbanity; income and education; age and housing occupancy; isolation, access to social services, and dependence on extractive industries; housing and infrastructure; institutional inequities; life satisfaction and belonging). Components were adjusted for directionality and placed in an equal-weighted additive model to achieve a community-level index score that provides insights about people and places that may be predisposed to adverse impacts from SLR-related risks.

For each of the **111,249 parcels in the study area**, Coastal Geologic Services et al. (2022) calculated **12 scores**:

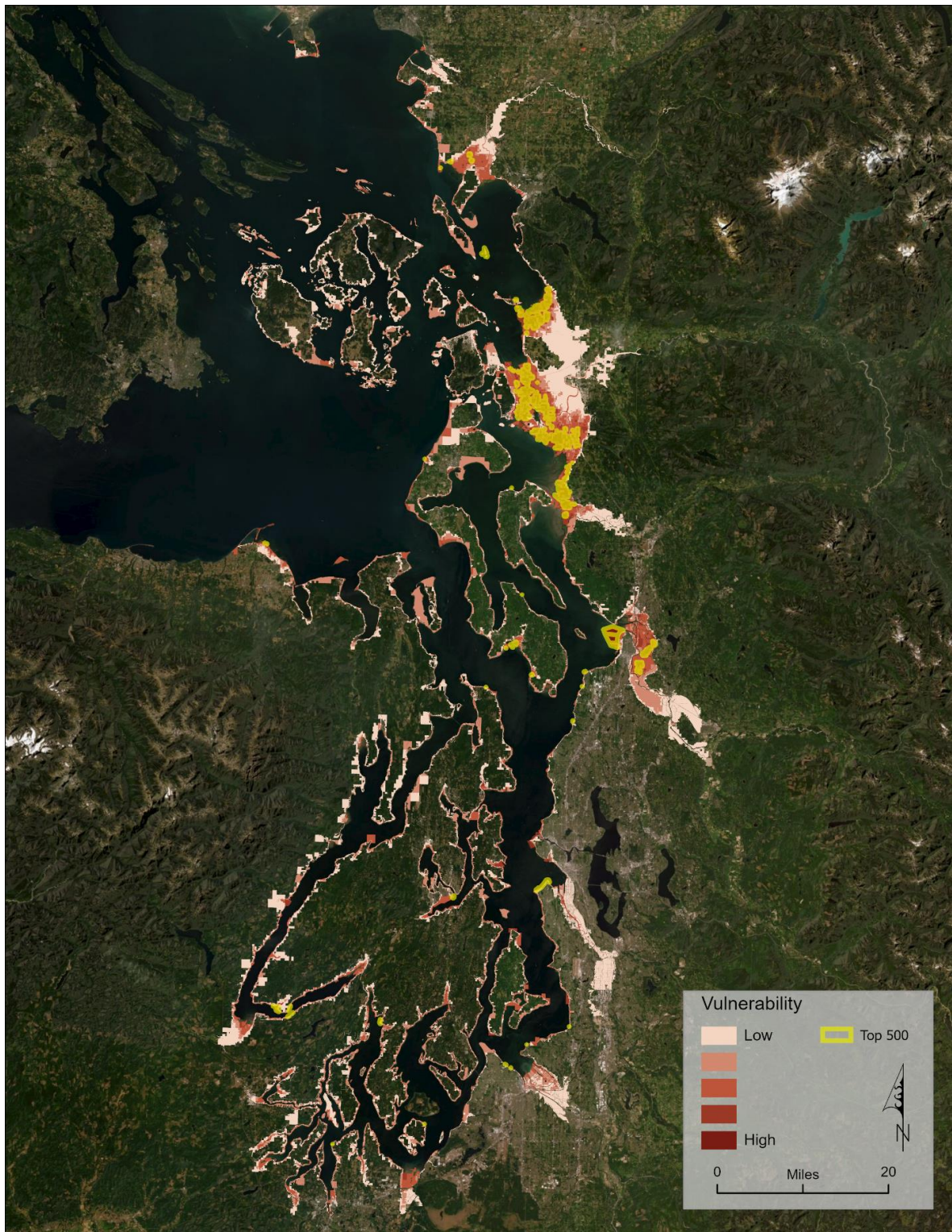
- 2 vulnerability indices — physical vulnerability and socially modified vulnerability
- 3 component indices — exposure, sensitivity, and social vulnerability
- 7 sub-component measures — coastal flooding, coastal erosion potential, infrastructure sensitivity, parcel infrastructure, accessibility reduction, agricultural lands, and habitat sensitivity

Physical vulnerability assessment results are provided in Figure 13. A total of 37,380 parcels (33.6%) had a physical vulnerability score of 0-1 and 2,900 parcels (2.6%) had scores within the 14-20 range. This suggests that the **overall vulnerability of communities in Puget Sound can be reduced by directing our efforts to a relatively small number of parcels region wide**. The top 500 scoring parcels are distributed throughout the study area, though clusters of high-scoring parcels are found in low-lying river deltas.

Socially modified vulnerability assessment results are provided in Figure 14. Adding social vulnerability scores to physical vulnerability scores resulted in higher scores for approximately 107,000 parcels and lower scores for about 4,000 parcels. Many of the most dramatic increases occurred in the southern portion of the study area where the population is larger (e.g., the lower Duwamish River valley).

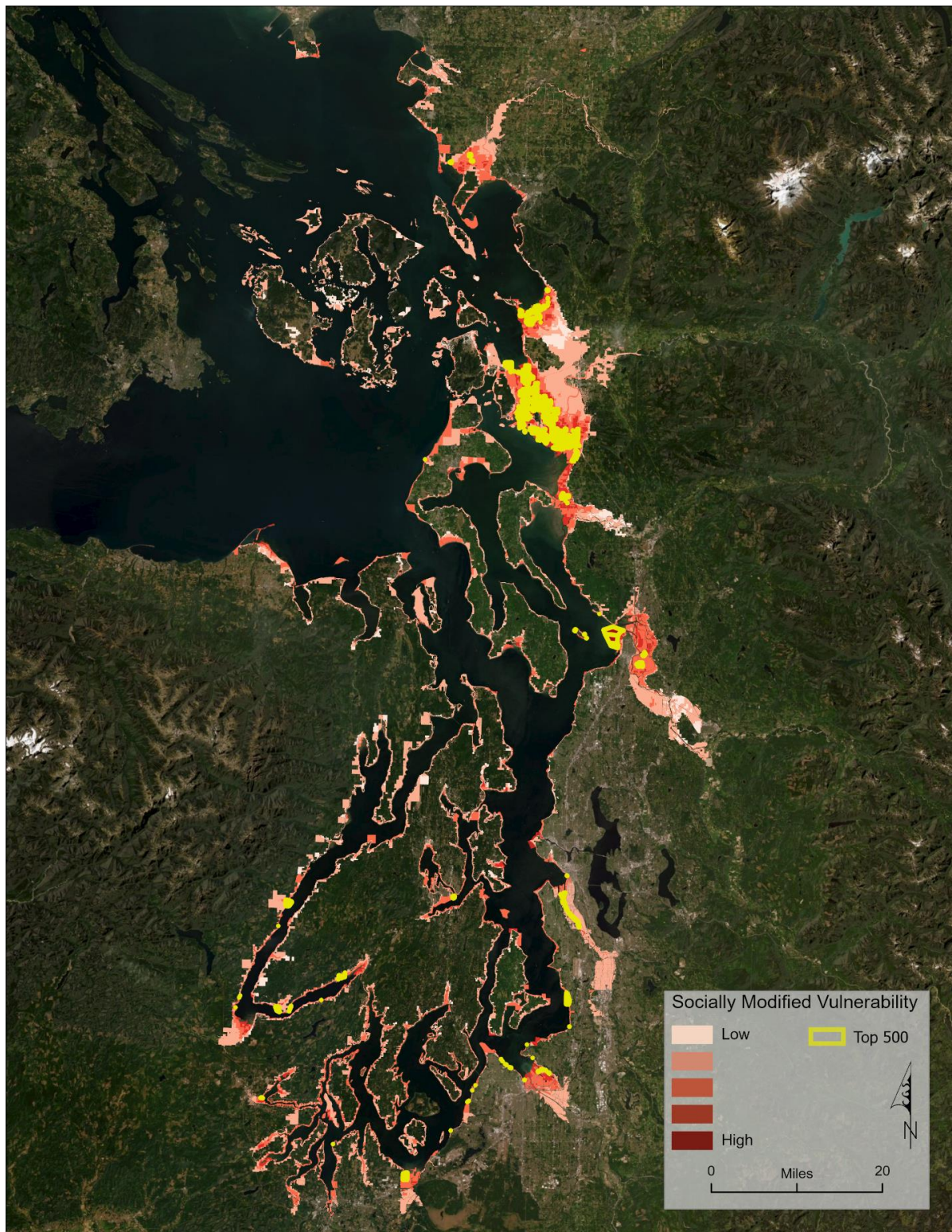
Assessment results were packaged in a format that makes them easy to visualize in GIS. The project geodatabase package, which is available for download on the [project's landing page](#) on the Washington Coastal Resilience Network website, includes input data, inundation layers developed for the project, intermediate analysis layers, and a **parcel layer with all 12 scores associated with vulnerability**.

Figure 13. Sea level rise physical vulnerability results with the top 500 highest scoring parcels in yellow



(Figure 15 from Coastal Geologic Services et al. 2022)

Figure 14. Sea level rise socially modified vulnerability results with the top 500 highest scoring parcels in yellow



(Figure 19 from Coastal Geologic Services et al. 2022)

Maps and data on the percentage of agricultural parcels flooded under the baseline and four inundation scenarios (calculated for the agricultural lands component of the infrastructure scores) may be relevant for other IS. Habitat sensitivity scores, maps, and data for the major river deltas may also be useful for IFM reach-scale planning.

This vulnerability assessment resulted in an improved understanding of the distribution of risk on the landscape. The identification of coastal assets most vulnerable to SLR impacts can be used to inform risk reduction efforts. However, the project team notes that this analysis should not be used as a stand-alone decision-making tool. Results should be interpreted carefully and viewed as one input for a planning context, as they are limited by the type and quality of input data as well as the weightings applied.

Given the demand for information about sea level rise vulnerability for Puget Sound and level of interest in the project, Miller et al. (2022) recommended additional work to support use of the geodatabase (e.g., an interactive web map and additional training materials). A Sea Grant proposal to continue development of this tool and communicate results was [selected for additional HSIL funding in February 2023](#).

San Juan County local government and community engagement

Friends of San Juans (2018) aimed to increase the capacity of San Juan County residents and planners to address the impacts of SLR. Project goals were to help landowners and County government overcome the perception that rising sea levels are a future concern and to foster an action response. This project leveraged results of a San Juan Islands SLR assessment funded by the Marine and Nearshore LO (Friends of the San Juans 2014) to increase awareness in vulnerable communities and advance coastal adaptation projects.

The project team included Washington Sea Grant and Coastal Geologic Services. Together the project partners:

- Developed new island-specific educational materials and a new [website](#) to house them.
 - One novel product was a king tide and storm response media toolkit. It included images, a press release, supporting materials, and social media post templates. The project team used this kit to engage local citizens in monitoring king tides.
- Held three community workshops during the summer of 2017. There were a total of 185 attendees, including shoreline planners.
- Conducted live-results survey at the workshops and sent SLR surveys via mail to waterfront property owners. Survey questions focused on gaining respondents' insight on SLR concerns, why/how they want to protect shorelines, their beliefs on the potential impacts on the community, and their preferred approach to protecting both public and private property. 293 responses were received.
 - Over 90% of the respondents believed sea level rise would affect their community.

- 68% felt the most important reason to protect shorelines was for fish and wildlife habitat.
- When asked about managing public infrastructure, respondents preferred the most permanent solution. 57% thought relocation was a solution; 40% supported shoreline protection involving gravel, berms, vegetation, or beach nourishment; and 1.5% supported fortifications using bulkheads or seawalls.
- When asked about protecting private property, 41% of respondents thought that new development should be restricted in vulnerable areas; 24% thought information should be provided to property owners; and 3% supported bulkheads or seawalls.
- Provided technical support to advance adaptation projects.
 - The project team visited 45 residential waterfront properties to provide parcel-specific information about flood and erosion risk, and adaptation options that would reduce risk and protect nearshore habitat.
 - The project team conducted site assessments at multiple public and private sites that may be candidates for multi-benefit adaptation projects. Feasibility assessments and early design work were completed for five projects: 2 private road relocations; projects at a private home and high-use county park; and tide gate upgrades.
- Participated in a County comprehensive plan update work group for the Eastsound Subarea, which involved potential road relocations.

This subaward was the only example in HSIL 1.0's investment portfolio that *directly* advanced the Shoreline Armoring IS strategy advocating for improved communication among agency and other partners to catalyze habitat improvements as part of capital/public works projects. During development of the long-term planning strategy, Shoreline Armoring IS Interdisciplinary Team members highlighted the importance of building a relationship with the BNSF Railway Company before any planning for major capital upgrades needed to address expected future climate impacts to their operations occurs. Although the subawards associated with NTAs 2016-0198 and 2018-0965 focused on correcting fish passage barriers, we consider them to have *indirectly* advanced this strategy due to the collaboration that occurred with the BNSF Railway Company.

Cost of Shore Friendly adaption measures

The proposed Shore Friendly loan program discussed in Chapter 3 would improve the adaptive capacity of owners of waterfront parcels vulnerable to SLR. **Linking implementation of SLR adaptation measures and beach restoration via armor removal is important because the adverse impacts of conventional shore stabilization structures will be amplified as sea level rises** (Kinney et al. 2015).

The cost analysis appendix to the loan program feasibility report (Coastal Geologic Services 2020) provided some data about the cost of residential-scale adaptation actions. They gathered cost data about projects constructed between 2009 and 2019 in Puget Sound counties. For

home relocation (i.e., away from an eroding bluff but on the same parcel) and elevation projects, pricing reflected the size of the structure, distance to be moved/elevated, safety factors, access (narrow roads, lot slope, utilities overhead), foundation construction method (slabs or basement), and the number of needed permits. In 2019 dollars, the cost of home elevation projects ranged from \$60,000 to \$140,000 and the cost of home relocation projects ranged from \$44,000 to \$243,000 (Coastal Geologic Services 2020). When the cost of armor removal and soft shore protection was added, project costs went as high as \$324,000.

Based on data from Table 5 of Kinney et al. (2021), **implementing SLR adaptation measures and Shore Friendly shoreline stabilization techniques (including armor removal) at 70 residential parcels would be expected to cost \$10.4 – 17.1 million** (in 2019 dollars).

4.5.2 INCORPORATING CLIMATE PROJECTIONS INTO FLOODPLAIN PLANNING

Floodplain planning requires incorporation of climate projections to understand how flood hazards may increase risk to existing infrastructure and impact farm, fish and flood projects. HSIL funded two subawards that incorporated climate planning into floodplain projects, focusing on how flood hazard and sea level rise will have future impacts on agriculture and how communications around climate impacts can affect community support for multi-benefit projects.

NTA 2018-0741 supported work by the Climate Impacts Group (CIG) to develop analyses, communications products and conduct interviews and workshops to increase capacity for both Sustainable Lands Strategy (SLS) in Snohomish County and the Floodplain Integrated Planning Process (FLIP) in Whatcom County to implement climate-resilient planning efforts. Additional details on these awards in Section 4.1. Subaward activities included producing research that (1) highlighted shared vulnerabilities in both Snohomish and Whatcom Counties, 2) increased capacity, awareness and understanding on climate adaptation and resilience, and (3) identified opportunities to leverage funds among management interests.

The funding of this subaward builds on previous HSIL and integrated floodplain management investments to support integration of climate-resilient information into the future work project packages. The deliverables also built off previous work accomplished in Pierce County by the subawardee, CIG, that analyzed how to best prioritize Floodplains for the Future's [proposed capital projects](#) considering the impacts of climate change.

CIG produced several climate adaptation and resilience reports for both SLS and the FLIP. These included Climate Adaptation for Floodplain Management: An Introductory Guide, a guide that assists managers in answering the question of how to best manage and improve outcomes for farms, fish and the floodplains, keeping in mind our changing climate.

Additional project results included the creation of a database that provides a selection of key resources related to climate change; an adaptation needs assessment for integrating climate change in general floodplain management efforts; and a climate adaptation needs assessment

specific to Snohomish County floodplains. Additionally, a series of case studies from around the Salish Sea were analyzed for best practices in sedimentation and gravel removal to inform potential aggradation projects.

The project results were significant because they incorporated previously disparate climate-related efforts by both the FLIP and SLS—allowing the organizations to integrate climate change analysis and climate-resilient planning into their future restoration work plans, proposed infrastructure projects and outreach and community education efforts.

Climate resilience in the Snohomish and Stillaguamish River floodplains

The second subaward, as described previously in Section 4.1, funded two specific sub-tasks undertaken by the Snohomish Conservation District to support climate integration efforts for SLS. The first task was to integrate climate modeling and assessment efforts completed by consultants into the Snohomish *Agriculture Resilience Plan*. The second task was to support the identifying, scoping, prioritization and initial design of agricultural resilience projects and work with the Integration Team to create multi-benefit project packages that incorporated climate resilience information.

Consultants hired for this subaward conducted an impact assessment (Mauger 2022) for the Stillaguamish and Snohomish River basins including climate prediction data for sea level rise, groundwater levels, saltwater intrusion, land subsidence, and channel aggradation.

Results indicate that a rise in relative sea level is expected to raise groundwater levels and extend the period of saturation in the spring, thereby delaying field access. The impact of sea level rise on groundwater levels may also shorten the agricultural season in the fall as groundwater levels return to pre-spring conditions earlier. Predicted increases in the relative sea level rise in Snohomish and Stillaguamish River as described in the climate resilience part of the *Agriculture Resilience Plan* are:

	Year 2050	Year 2080	Year 2100
Snohomish River	0.8 feet	1.5 feet	2.2 feet
Stillaguamish River	0.7 feet	1.5 feet	2.2 feet

Separate research (Mauger 2022) in flooding and flood hazards in Snohomish County was conducted by CIG and Fathom, a consultant, and is also incorporated into the *Agriculture Resilience Plan*. This research was funded by Floodplains by Design and not NEP funding. [Results of that research](#) describe future climate change projections for the 2050s and 2080s as depicted on flood hazard maps. According to CIG’s research, climate change is expected to lead to more frequent and severe flooding as sea levels rise and as precipitation patterns change through loss of snowpack despite more intense winter storm events.

The climate integration-related subtask of NTA 2018-0715 was to incorporate this research into the discussions of existing and future project priorities for salmon recovery and agricultural

resilience in the region. These findings were informed through previous work done by SLS (such as the groundwater analysis of the Snohomish River basin that was conducted during NTA 2016-0074).

A prioritized near-term project list of restoration projects was created as a result of this award. Following the creation of a prioritized project list, Snohomish Conservation District staff assessed projects and determined feasibility for project concepts. Using the agreed-upon project screening criteria, as described in detail in Section 4.1, the Snohomish Conservation District, alongside SLS, selected four near-term projects to advance to conceptual design.

Several of these projects included feasibility studies for infrastructure-related activities in drainage districts. The climate integration work funded by this subaward including the groundwater analysis, sea level and salinity data is informing current and future project implementation decisions for Snohomish Conservation District and SLS.

4.5.3 SUPPORT FOR MUNICIPAL CLIMATE PLANNING

HSIL funded two subawards related to climate action planning by local jurisdictions:

- NTA 2018-0952 – Supported North Olympic Peninsula Resource Conservation and Development Council efforts to collaboratively develop climate change priorities and actions that require cross-jurisdiction coordination; build a climate planning toolkit for local and Tribal governments; and provide 4 local governments with consultant support for climate change planning.
- NTA 2018-0327 – As part of a larger project discussed in Chapter 5, Commerce surveyed local planners to assess their needs and priorities for climate change planning.

North Olympic Peninsula climate action planning

In 2014, the North Olympic Peninsula Resource Conservation and Development Council (NODC) received a Watershed LO grant to produce an assessment of climate related vulnerabilities and develop a climate adaptation plan for the North Olympic Peninsula region. As NODC began implementing key strategies from the resulting [2015 Climate Change Preparedness Plan](#), it became apparent that there was a need for multi-jurisdictional coordination and support for local governments to overcome implementation barriers. With assistance from a project steering committee and Tribal advisory committee, NODC (2022):

- Worked with a consultant to convene a **3-day long meeting series** with regional partners to identify, define, and agree on climate change priorities and a set of actions that require regional coordination and collaboration.
 - The 43 participants agreed on seven regional climate change priorities, then developed goals and specific objectives for each.
 - Participant feedback led to a fourth meeting attended by 60 people. This meeting helped to **identify challenges, strategy considerations, and case studies for each goal**

and objective; connect local government and Tribal representatives with state and federal agencies; and **identify funding opportunities**.

- Built a [climate action toolkit](#) geared towards local and Tribal governments.
 - Based on feedback from participants in the meeting series, the focus of the climate action toolkit became more implementation and action than planning.
 - The toolkit is intended to make climate action and resilience achievable for rural governments of differing sizes, resources, and capacity. The website went live in November 2022 and addresses three topic areas: transportation and land use; energy and housing; water supply and infrastructure.
- Provided consultant support to 1 county, 2 cities, and 1 Tribal government to provide **technical assistance** with their climate change planning. Cascadia Consulting assisted each jurisdiction develop a plan or analysis of their choosing.

NODC (2022) articulated several lessons learned about regional climate planning as a result of this subaward:

- Capacity building for local and tribal governments and organizations in rural and disadvantaged communities is key to long-term success.
- Having a trusted intermediary agent, like NODC, helps bridge jurisdictional and sectoral boundaries for a successful regional approach. Intermediary agents provide extra capacity needed in smaller local jurisdictions to incorporate climate adaptation and resilience into local plans and activities and can play an important role in providing the technical and financial support needed to achieve regional planning goals.
- Relatively small investments in technical assistance can spur buy-in and local investment.
- Making the effort to develop regional relationships through this type of planning pays off.

Regional planning needs assessment survey

Andrade and Newman (2021) surveyed local planners across the state about the current status of climate change planning at the local level as well as their needs and priorities to advance climate change planning. This survey was intended to inform development of a Commerce workplan with near term priority actions to support local climate change planning efforts. The online survey received 97 responses (49 from staff representing at least 29 Puget Sound jurisdictions). HSIL funding was subsequently used to further analyze Puget Sound region responses and guide informal follow-up conversations with 15 planners from 10 Puget Sound jurisdictions.

Survey results indicated that local concerns about climate change impacts varied regionally and by type of jurisdiction (city versus county). Increased flood risk and wildfire were of high concern statewide in both cities and counties. Sea level rise is of high concern in most shoreline jurisdictions. Drought is of high concern statewide, especially at the county level. Increased

stormwater runoff is of high concern in many Puget Sound cities and is of moderate concern in Puget Sound counties.

Survey results indicated that about half of jurisdictions were already doing some planning for climate change while the remaining had not yet begun to plan. **Jurisdictions that planned to add climate change to their Comprehensive Plans were grappling with how to do so.** Most have concluded that **to facilitate implementation, climate change needs to be integrated throughout plan elements instead of restricting climate policies to a separate chapter.**

Some ways jurisdictions are already addressing climate change adaptation through their plans and development codes include directing growth away from shorelines and hazards that will be exacerbated by climate change; restricting development in areas that will be affected by storm surge; limiting development in wildland urban interfaces and forestry zones that are prone to wildfire; and sewer hookups for communities in flood zones. However, some jurisdictions are struggling to translate policies into action.

Respondents were asked to rate the usefulness of various climate change planning resources. **Funding was the top need, followed by guidance about the most impactful policies/actions, and information about developing and implementing programs.** Local planners indicated they wanted funding to hire consultants with technical expertise and experience writing climate change policy; conduct vulnerability assessments; develop targets; and conduct cost benefit analyses to identify the most impactful actions. Multi-jurisdictional and cooperative process, like the King County Cities Climate Collaborative (K4C), have begun to emerge and should be encouraged.

During the 2023 Legislative session, [House Bill 1181](#) regarding climate change planning was passed and signed into law. Climate change and resiliency are now a required element that must be included in local Comprehensive Plans. **The new law also requires Commerce to consult with other agencies to adopt guidance that creates a model climate change and resiliency element and publish guidelines that specify a set of actions available to counties and cities to reduce greenhouse gas emission and vehicle miles travelled.** Based on the survey and follow-up conversations, Andrade and Newman (2021) developed eight recommendations for Commerce to consider when developing assistance resources for local governments. These are good places to focus early efforts to implement the new law.

4.5.4 RECOMMENDATIONS

- Climate change adaptation and resilience planning takes significant effort, as well as support from key stakeholders. In addition to technical studies and reports, increased outreach and communications to public stakeholders, in particular those from the agricultural community, will be necessary to support a holistic approach for climate-related projects in IFM. As noted by several subawards, the dialogue around climate change, in particular in the media, and its causal relationship to flooding events is constrained and fraught with discord. To better support the emergency management aspect of IFM and

planning for the conservation and preservation of agricultural lands, continued dialogue on the reality of climate change and its impact regionally is critical (Mauger et al. 2022).

- Andrade and Newman (2021) and NODC (2022) found that local governments are stretched to their limits and lack capacity to take on major climate planning and implementation efforts without outside support. NODC (2022) recommended use of intermediary agents to provide outside support that bridges the gap between smaller jurisdictions and state/federal government resources; build connections among neighboring entities; and expands regional capacity in grant writing and administration.

CHAPTER 5: REGULATORY EFFECTIVENESS

Chapter At-A-Glance

- HSIL’s regulatory effectiveness investments 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. This group of projects advanced the Shoreline Armoring IS’s regulatory strategy and the Land Development and Cover IS’s prevent conversion of ecologically important lands strategy.
- A regional assessment of change in riparian areas indicated that, generally, Critical Area Ordinances seem to be shifting development away from riparian areas. However, riparian buffer widths in local codes vary widely and are usually smaller than best available science guidelines.
- A San Juan County shoreline compliance monitoring subaward found that between 2009 and 2019, installation of new shoreline armor largely occurred outside of permit processes. Since 2019, a new Compliance Program was developed at Washington Department of Fish and Wildlife and civil penalties for Hydraulic Code violations were increased. Repeating boat-based shoreline surveys where baseline data is available could provide an opportunity to observe potential effects of regulatory changes implemented after 2019.
- The Department of Commerce hosted a webinar series for local planners focusing on regulatory monitoring and adaptive management for critical areas and shorelines. Case studies and feedback about audience needs obtained from polls during the classes was used to comprehensively update a chapter of the Critical Areas Handbook.
- Kitsap County implemented permitting software process improvement and developed a regulatory monitoring. We recommend regional partners encourage jurisdictions throughout the region to emulate this type of project by providing funding and technical support.
- A Multi-Agency Review Team reviewed permit processes to identify common causes of delay for armor removal and soft shore projects; identified potential process improvements; then piloted a collaborative permit review process to shorten review timelines. This group persisted after the contract period ended and their approach could potentially be emulated to address a recommendation from the Floodplains and Estuaries IS’s Sound-wide support strategy to address permitting process barriers.

The three HSIL-managed IS and the Chinook IS all include content about opportunities and barriers related to regulatory programs. However, Shoreline Armoring is the only one that has an entire strategy focusing exclusively on improving regulatory outcomes. This may be partially attributable to several projects funded by HSIL's predecessor, the Marine and Nearshore LO, between 2011 and 2017. These projects explored the effectiveness of programs that regulate shoreline armoring and had been synthesized prior to IS development (Kinney et al. 2015, Kinney et al. 2016). This body of work identified opportunities to improve implementation of regulatory programs with changes to project review and tracking procedures; highlighted the need for compliance monitoring and enforcement; provided recommendations for regulator and applicant education; and recognized the importance of collaboration among permitting agencies.

In addition to providing evidence to support the development of the Shoreline Armoring regulatory strategy, this work was a foundation upon which HSIL subawards could build. The 11 projects discussed in this section (Table 20) continued to affect shoreline armoring outcomes while also expanding application of similar monitoring methods and improvement strategies to regulations relevant for other IS.

Understanding the regulatory effectiveness work funded by HSIL requires some knowledge of local, state, and federal authorities applicable to the IS they manage. We therefore begin with a very brief overview of key regulations organized by the level of government where implementation occurs.

The analysis in this chapter is organized by the four broad approaches these subawards have taken to improve regulatory outcomes: (1) change and compliance monitoring; (2) implementation and effectiveness monitoring; (3) reducing regulatory barriers to implementing beneficial projects; and (4) training and support for planners and regulatory staff.

Table 20. Subawards with regulatory effectiveness elements

NTA	Project	Awardee
2016-0196	West Central Nearshore Restoration Prioritization and Armor Removal	Kitsap County
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
2018-0085	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
2018-0265	Improve soft shore permitting processes	Department of Fish and Wildlife
2018-0327	Puget Sound Critical Areas Monitoring and Adaptive Management Program	Department of Commerce
2018-0641	Improved Landowner Development Decisions to Protect Critical Areas and Manage Stormwater	Kitsap County
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

5.1 KEY REGULATIONS

Several regulations are referenced in more than one of the sub-sections below. This is because some federal and state environmental laws require protections administered at the local level. In the state of Washington, cities and counties have authority to regulate land use and development but local permitting actions are required to conform with applicable state and federal requirements.

More detailed information about these regulations and their relevance to individual IS can be found in the “Base Program Analysis” appendices to the Shoreline Armoring IS (Kinney 2018), the Land Development and Cover IS (Wright 2020), and the Benthic Index of Biotic Integrity IS (Kinney and Roberts 2020). Program analyses have not been prepared for the Floodplains and Estuaries IS nor the Chinook IS.

5.1.1 LOCAL AUTHORITIES

- **Critical Area Protections** – The state Growth Management Act (GMA) requires all cities and counties to designate environmentally critical areas²⁵ and adopt development regulations to protect them. Local governments must include the “best available science” in developing policies and development regulations to protect critical area functions and values. These regulations often take the form of Critical Area Ordinances (CAOs).
- **Comprehensive Planning** – GMA also prescribes comprehensive land use planning requirements for local governments and requires adoption of development regulations consistent with those plans. Comprehensive Plans identify Urban Growth Areas²⁶ (UGA) sufficient to accommodate population growth projected for the next 20 years; ensure sufficient infrastructure is available to accommodate growth; and limit conversion of Natural Resource Lands²⁷ to more intensive uses. As of 2022, Comprehensive Plans are updated every 10 years.
- **Shoreline Master Programs (SMPs)** – The state Shoreline Management Act (SMA) requires cities and counties to develop, adopt, and implement SMPs to manage modifications along marine, river, large stream, and lake shorelines. SMPs consist of land use designations (e.g., urban, natural, aquatic), development standards, and regulations intended to protect natural resources. Local jurisdictions regulate shoreline modifications through four types of approvals: Substantial Development Permit, Variance, Conditional Use Permit, or Exemption.
- **Floodplain Management** – In order to maintain good standing in the National Flood Insurance Program, local governments must adopt land use controls in flood hazard areas. Communities become eligible for federal loans, grants, guarantees, insurance, and assistance like flood disaster relief when their floodplain management regulations meet or exceed Federal Emergency Management Agency (FEMA) minimum floodplain management criteria. These criteria largely focus on structural safety for flood damage reduction and are implemented via local Floodplain Development Permits.

²⁵ **Critical areas** include wetlands, aquifer recharge areas, fish and wildlife habitat conservation areas, frequently flooded areas, and geologically hazardous areas. GMA requires development regulations to preserve the functions and values of the natural environment and safeguard the public from hazards to health and safety. Riparian and stream habitats must be considered for classification and designation as fish and wildlife habitat conservation critical areas.

²⁶ **Urban Growth Areas** represent a boundary outside of which growth is constrained. Adjacent and overlapping jurisdictions must coordinate to identify where growth should occur and set housing unit targets for specific areas. Within urban areas, most growth must be allocated with minimum densities of four housing units per acre. Rural areas are typically zoned for not more than one unit per five acres. Outside the UGA, cities are limited in their ability to extend utilities and other governmental services.

²⁷ **Natural Resource Lands** are agricultural lands, forestlands, and mining resource lands that have long-term commercial significance and were not already characterized by urban growth at the time of original designation in 1991. Development regulations must prevent conversion to a use that removes land from resource production.

- **Stormwater Management** – Cities and counties with populations above certain thresholds are regulated under Municipal Stormwater General Permits issued by the Washington Department of Ecology (Ecology) on 5-year cycles. These permits require incorporation of stormwater discharge controls into local development and construction permits. Recent state permits added new requirements for integration of Low Impact Development²⁸ provisions into local development regulations and new planning requirements that aim to expand the focus of stormwater management from the site scale to the watershed scale. This approach emphasizes identification of lands to protect/conserv from impervious surface conversions or native vegetation removal.
- **State Environmental Policy Act (SEPA)** – This state law delineates procedural requirements for environmental review of state and local actions (including permitting of private projects) that are not categorically exempt. The intent of this review is to identify and evaluate probable environmental impacts of an action and develop mitigation measures to reduce adverse impacts. The review process starts with preparation of an Environmental Checklist which is reviewed by a lead agency, typically a city or county, along with any permit applications or other submittals. The lead agency makes a threshold determination regarding the significance of project impacts and the need for conditions to be added to an approval. If a proposal is unlikely to have a significant adverse environmental impact, the lead agency will issue a determination of non-significance or a mitigated determination of non-significance. If impacts are expected to be significant, an Environmental Impact Statement must be prepared.

5.1.2 STATE AUTHORITIES

- **Hydraulic Code** – This state law administered by WDFW was established for the protection of fish life. It requires permits, called Hydraulic Project Approvals (HPAs), for activities that will use, divert, obstruct, or change the natural flow or bed of any of the salt or fresh waters of the state.
- **Growth Management Act (GMA)** – The Washington Department of Commerce (Commerce) provides guidance, training, technical assistance, and financial support to help local governments comply with GMA requirements. Commerce reviews local comprehensive plans for consistency with GMA but does not formally approve them.
- **Shoreline Management Act (SMA)** – Ecology provides guidance, training, technical assistance, and financial support to help local governments comply with SMA requirements. Ecology formally approves local SMPs and reviews some types of permits issued by local governments.

²⁸ **Low Impact Development** applies methods that minimize impervious surfaces and manage stormwater runoff at its source to reduce the volume and pollutant load of runoff leaving a site. It is characterized by smaller-scale distributed controls and conservation of natural site features sometimes called “green” infrastructure. Traditional stormwater management practices focused on reducing flooding risk by quickly conveying runoff to receiving waterbodies with centralized “gray” infrastructure.

- **Clean Water Act Section 401** – This federal law gives Ecology authority to approve, condition, or deny a federal Section 404 permit for a discharge of fill material to state waters. Ecology can certify that a discharge will not violate state water quality standards with an individual Water Quality Certification or via regional conditions included in general permit authorizations.
- **Clean Water Act Section 402** – Ecology, under delegated authority from EPA, regulates discharge of stormwater to and from municipal separate storm sewer systems via National Pollution Discharge Elimination System Municipal General Stormwater Permits. Ecology and the Washington Stormwater Center provide guidance, training, technical assistance, and financial support to help local government implement stormwater permit requirements.

5.1.3 FEDERAL AUTHORITIES

- **Clean Water Act Section 404** – This federal law established a program that regulates the discharge of fill into waters of the United States to protect aquatic habitats and water quality. Section 404 permits are issued by the U.S. Army Corps of Engineers (Corps). Discharge authorizations occur via Individual Permits, General Permits, Nationwide Permits, or Regional General Permits. Prior to authorizing an activity, the Corps must ensure compliance with other federal laws including (but not limited to):
 - **Endangered Species Act Section 7** – This law requires federal agencies to consult with the National Oceanic and Atmospheric Administration (NOAA) Fisheries and/or U.S. Fish and Wildlife Service (USFWS) when any action they carry out, fund, or authorize may affect a species listed as endangered or threatened.
 - **National Historic Preservation Act Section 106** – This law requires federal agencies to consult with the State Historic Preservation Officer and Tribes when any project they carry out, assist, fund, permit, license, or approve has potential to affect historic and/or prehistoric properties.

5.2 SHORELINE CHANGE AND COMPLIANCE MONITORING

Since 2008, at least nine Puget Sound shoreline change analysis and compliance monitoring efforts have demonstrated that a potentially significant amount of shoreline construction has occurred without permits.²⁹ The Shoreline Armoring IS's regulatory strategy recognized that these types of monitoring efforts can support improvements in the enforcement of existing regulations and recommended that additional monitoring occur. Since previous armor mapping projects had not always used consistent and well-documented methodologies, HSIL funded the development of a protocol for armor mapping as part of PSP's [Salmon Habitat Indicators](#)

²⁹ Kinney et al. (2015) and Kinney et al. (2019) describe individual projects that sought to quantify the extent of unpermitted shoreline changes in Puget Sound marine waters. A table in each report summarizes the outcome(s) measured, methods, time period, geographic coverage, and results for each study.

project.³⁰ The resulting common protocol, Coastal Geological Services (2018), provides a standardized methodology that will improve the consistency of shoreline armor compliance monitoring efforts. In this section we describe a subaward that applied the new protocol:

- NTA 2018-0828 – Supported a shoreline armor mapping update, change analysis, and permit review/compliance assessment for San Juan County conducted by the Friends of the San Juans. This project also included a permit review/effectiveness assessment (described in Section 5.3).

In 2009, Friends of the San Juans conducted boat-based surveys to inventory shoreline modifications along 400+ miles of marine shoreline in San Juan County. In 2019, they conducted follow-up surveys and a regulatory review to: (1) quantify the change in linear extent of armor over the 10-year interval between surveys, and (2) determine if observed changes had been permitted at the state (HPA) and/or local level (shoreline permit or exemption).

Friends of the San Juans (2022) documented the addition of 1.85 miles of armor and the removal of 0.3 miles of armor, for a net increase of 1.6 miles of armor over 10 years. Compliance evaluation results indicate that **installation of new shoreline armor largely occurred outside of the permit process** and **enforcement intensity was low** during the study period:

- Only 20% of projects had at least one permit prior to initiation of construction and less than 10% had both state and local permits.
- At the end of the project period, only 7% of unpermitted projects had been identified as violations and subjected to an after-the-fact permit process or formal enforcement action. Three projects received after-the-fact permits; two of these were authorized with some mitigation or required changes to the structure (e.g., partial removal). Three projects were slated for removal by regulatory agencies, but removal had not occurred as of mid-2022.

These findings further corroborate those of previous compliance monitoring efforts. There is substantial evidence that shoreline construction often occurs without permits. Through 2019, enforcement programs did not appear to be detecting violations nor implementing penalties at a scale sufficient to deter non-compliance. Compliance monitoring and enforcement activities should continue to be a priority for the Shoreline Armoring IS.

³⁰ This work was one part of a subaward associated with NTA 2016-0376, which is discussed further Chapter 4.

5.2.1 RECOMMENDATIONS

- Since 2019, there have been some changes specifically meant to improve the compliance outcomes measured here.³¹ Given the availability of Friends of the San Juans' extensive dataset, funding a repeat of this project could provide an opportunity to observe potential effects of state/local changes implemented after the study period as well as recent changes at the federal level (e.g., Corps Section 404 jurisdictional change and new NOAA mitigation requirements for repair/replacement of existing structures). Other geographies with sufficient baseline data on shoreline condition could be identified so that similar follow-up assessments can be scoped.
- Friends of the San Juans identified a few enforcement cases being pursued by regulators. Working with regulators to observe that process could inform future activities associated with implementation of several IS. Can specific barriers/concerns about levying significant fines or requiring removal be identified? Can agencies track the level of effort involved to estimate how much staff time is required, departments engaged (e.g., State Attorney General's Office), and total costs to complete significant enforcement actions? This information could potentially inform new ways to increase enforcement consistent with the Shoreline Armoring IS.
- Friends of the San Juans included a rock size attribute in both the 2009 and 2019 surveys despite it not being a common protocol attribute. This was done because large rock (rip rap) indicates the likely engagement of professional contractors and thus can inform management options for noncompliance. Since only 32% (by length) of the new armor observed constructed with rock used large rip rap, Whitman (2022) postulated that there may be a trend towards homeowners installing "do it yourself" armor or hiring landscapers instead of marine contractors. This could be a cost-saving measure, and/or it could indicate that efforts to educate marine contractors about the need for permits have been somewhat successful. There may be value in encouraging PSEMP Nearshore Work Group discussions to: (1) determine if this is a real trend and, if so, what is driving it; and (2) discuss whether rock size has been or should be considered as a mapping attribute in the common protocol.

5.3 IMPLEMENTATION AND EFFECTIVENESS MONITORING

Another recurring theme of Marine and Nearshore LO-funded projects related to shoreline armoring was that regulatory protections as written were generally strong, but poor on-the-ground implementation hampers their effectiveness in reducing harmful impacts of development to the maximum extent possible. Permit conditions may not be sufficient to reduce harm; structures may not be built to plans; and/or permit conditions may not be implemented.

³¹ The Legislature provided funding to WDFW for dedicated Civil Compliance inspector positions and additional Fish & Wildlife Officer capacity. The Legislature also increased the civil penalty for Hydraulic Code violations (up to \$10,000 per violation from \$100 per day) and provided WDFW with stop-work authority for Hydraulic Code violations.

Multiple IS (Shoreline Armoring, Land Development and Cover, Chinook) emphasize the importance of understanding and improving implementation of existing regulations to ensure that remaining habitat is protected as intended by law. In this section we describe three subawards that evaluate the implementation and effectiveness of local environmental regulations:

- NTA 2016-0368 – Supported WDFW Priority Habitats and Species Program in developing methodologies to evaluate the effectiveness of local critical area ordinances (CAOs) in protecting key habitats while conducting a pilot regional effectiveness evaluation specific to riparian areas.
- NTA 2018-0713 – Supported Kitsap County work to develop methodologies, metrics, and tracking systems that will enable implementation and effectiveness monitoring of their shoreline, critical area, and stormwater protections.
- NTA 2018-0828 – Supported a Friends of the San Juans shoreline armor permit review/effectiveness assessment (as part of a larger project also discussed in Section 5.2).

5.3.1 CRITICAL AREA ORDINANCE EFFECTIVENESS

The WDFW [Priority Habitats and Species](#) Program provides “best available science” to local governments in the form of data, maps, and guidance designed to support the development and implementation of local CAOs, land use plans, and development regulations. Riparian areas are important for fish and wildlife habitat conservation per GMA rules and are considered “ecologically important lands” for the purposes of the Land Development and Cover IS. For this project, the Priority Habitats and Species Program developed and tested a methodology and indicators to evaluate the effectiveness of local CAOs in conserving riparian areas. This work leveraged existing geospatial analysis tools and datasets from WDFW’s [High Resolution Change Detection](#) (HRCD) project.³²

The project team developed a set of five quantitative indicators that can be used to assess the performance of CAOs in protecting riparian areas. One of the indicators reports on current conditions; three indicators look at recent trends; and one indicator predicts future conditions based on recent trends (Folkerts 2021). These indicators provide data about current tree canopy coverage in riparian areas; observed changes (loss of tree canopy and addition of impervious/semi-impervious surface); rates of change; and compare changes observed within riparian areas to changes observed outside of riparian areas (i.e., non-critical areas).

³² The **High Resolution Change Detection** project tracks land cover change over time using National Agriculture Imagery Program 1-meter resolution aerial imagery. Multiple National Estuary Program [grants awarded since 2013](#) have supported detailed analyses of land cover change in the Puget Sound region. HSIL-funded NTA 2016-0141 supported the analysis of 2013-2015 and 2015-2017 imagery, which was an underlying dataset used for the CAO effectiveness project. NTA 2016-0141 is discussed in Chapter 2.

The effectiveness analysis began with preparation of three map layers delineating riparian areas of different widths. The **CAO min scenario** represented the smallest possible riparian area protected by local CAOs (i.e., higher confidence that local regulations apply in this zone), and the **CAO max scenario** represented the largest possible riparian area protected by local CAOs.³³ The **SPTH scenario** represented a riparian area equivalent to the site-potential tree height (SPTH) of a 200-year-old tree. This scenario is based on Priority Habitat and Species Program recommendations for defining riparian buffer width (Quinn et al. 2020, Rentz et al. 2020). **SPTH buffers are wider than those currently specified in most CAOs, so riparian area in the SPTH scenario are larger than riparian area in the CAO max scenario.**

After the three riparian area scenario maps were complete, the next step was to overlay them with HRCD and WDFW tree polygon datasets to calculate the CAO performance indicators for 2006-2017. Folkerts (2021) initially intended to report individual results for all 122 local jurisdictions in the Puget Sound region. However, the accuracy of stream locations in the hydrography datasets used to develop the riparian map scenarios varied. This generally isn't an issue given the scale and purpose for which these layers were designed, but when working at a finer scale locational error becomes more of a problem. In this case, it was not possible to quantify the error in modeled riparian buffer location and this reduced confidence in the results. Therefore, more general results were reported by WRIA or land use category.³⁴

A tabular summary of results for each indicator is provided in Table 21 and select visualizations by WRIA are provided in Figures 15 and 16. **Regionally, CAOs do seem to be shifting development away from riparian areas,** as evidenced by:

- **Very low rates of change within riparian areas relative to rates outside of riparian areas.** For example, Indicator 4 results show there was 0.15 acre of change within the CAO min riparian area for every 10 acres of change outside of riparian area over the study period. This result is circled in orange on Table 2.
- **The sharp increase in change rate observed immediately outside of the CAO min buffer.** For example, Indicator 3 results show a relatively low riparian change rate of 0.58% within UGAs.³⁵ By contrast, the rate in the larger SPTH buffer increases to 2.28% (22.8 per 1000 acres), approaching the overall change rate in UGAs of 3.6%. These results are circled in green on Table 2. This pattern is consistent with an assumption that development generally disallowed in a buffer is likely to be located in the zone adjacent to that buffer.

³³ As described in Folkerts (2021), minimum and maximum values were assigned based on WDNR water type and associated CAO buffer requirements from 20 cities and the 12 Puget Sound counties. The range of buffer width values in this sample was: 100 to 200 feet for Type S (Shoreline), 75 to 250 feet for Type F (Fish), 25 to 225 feet for Type Np (Non-Fish), and 5 to 225 feet for Type Ns (Non-Fish Seasonal).

³⁴ Local performance results may be reported once more reliable data is available. HSIL funded updates to the National Hydrography Dataset through NTA 2018-0436, which is discussed in Chapter 2.

³⁵ The modeled result was 5.8 acres of riparian change per 1000 acres of riparian area. This corresponds to a rate of 5.8/1000 or 0.58%.

Table 21. Riparian CAO effectiveness indicator calculations by buffer width scenario and land use (from Folkerts 2021)

Geography	Puget Sound			Rural			UGAs (n=10)		
Buffer Scenario	CAO min	CAO max	SPTH	CAO min	CAO max	SPTH	CAO min	CAO max	SPTH
Portion of study area mapped as riparian buffer	9.1%	10.7%	18.3%	9.9%	11.6%	20.5%	4.4%	5.5%	9.8%
Indicator 1: Portion of riparian buffer with tree canopy in 2017	73%	73%	77%	74%	74%	79%	Cities		
							67%	64%	64%
							Unincorporated UGAs		
							58%	56%	57%
Indicator 2: Portion of riparian tree canopy predicted to be lost in next decade based on 2007-2017 rate of change	0.25%	0.59%	0.96%	0.23%	0.54%	0.63%	Cities		
							0.50%	1.17%	1.94%
							Unincorporated UGAs		
							0.65%	1.70%	2.41%
Indicator 3: Acres of riparian change per 1000 acres of riparian area (2007-2017)	2.5 acres	Not reported	Not reported	2.2 acres	5.0 acres	6.2 acres	5.8 acres	14.9 acres	22.8 acres
Indicator 4: Acres of riparian change for every 10 acres of upland change (2007-2017)	0.15	0.41 acres	0.84 acres	0.19 acres	0.49 acres	1.12 acres	0.07 acres	0.23 acres	0.55 acres
Indicator 5 “Power Score” Ratio of change outside riparian area to change inside riparian area (bigger is better)	65	25	12	52	20	9	135	43	18

Legend

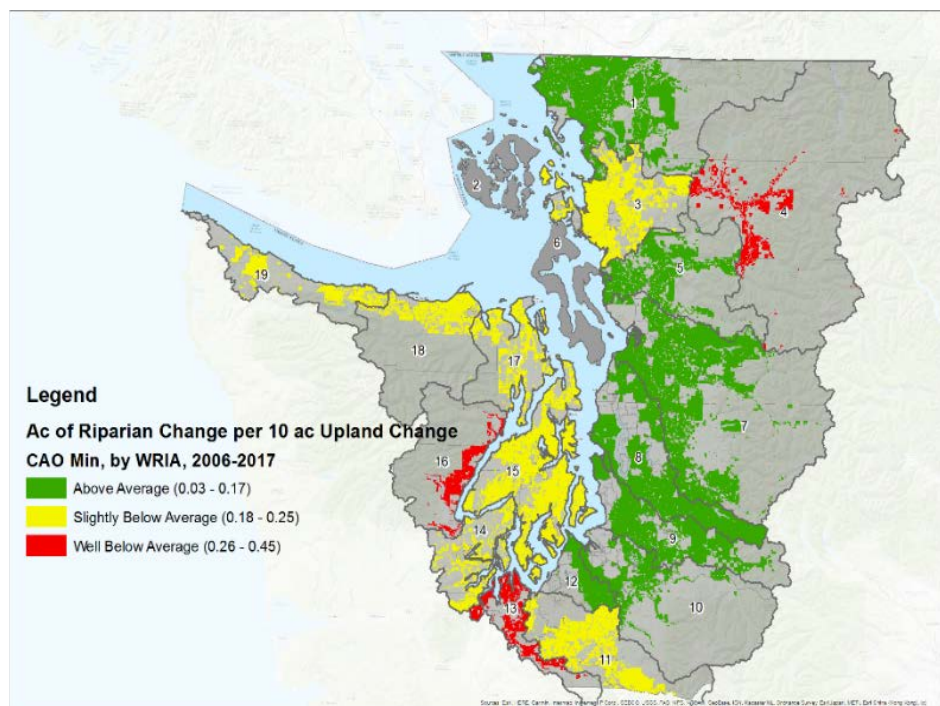
Riparian Canopy Cover, CAO Min (2017)

WRIA's % of Riparian Area with Tree Canopy

- 44%
- 45% - 55%
- 56% - 63%
- 64% - 69%
- 70% - 73%
- 74% - 77%
- 78% - 79%
- 80% - 84%
- 85% - 93%

Sources: DWR, HNTB, Corbin, Hennessy, and others; FDOT, GISDC, USGS, NAD 83, NAD 2011, GeoBase, On Vectors, L, Onshore Survey, Derivative, HNTB, Derivative, Long, Long, L

Figure 16. Relative acres of riparian change for every 10 acres of upland change by WRIA (Indicator 4)



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Other notable findings from Folkerts (2021) include:

- As of summer of 2017, the region-wide portion of riparian area with tree canopy was 77% in SPTH buffers and 73% in both CAO buffers. Tree canopy coverage varied by land use and WRIA. 79% of rural SPTH area had tree canopy and 58% of unincorporated UGA SPTH area had tree canopy. These results are circled in yellow on Table 2. A breakdown by WRIA found that tree coverage ranged from 44% to 93% for the CAO min scenario (Figure 15). Geographic trends were similar for the other scenarios. **Geographic patterns could be used to target future regulatory effectiveness investments.**
- For the CAO min scenario, riparian areas experienced 564 acres of tree loss and 689 acres of total change Sound-wide between 2006 and 2017.
- The type of changes observed in riparian buffers varied by land use. New impervious/semi-pervious surfaces comprised a larger percentage of the total change within UGAs, while in rural areas loss of tree canopy was more common. **Regional partners should consider developing an indicator relating to impervious surface in the riparian buffer.** Recent B-IBI research funded by the Stormwater SIL (NTA 2016-0382) indicates that stream macroinvertebrate communities change significantly when percent impervious surface in the riparian buffer exceeds 2.2% (King County 2019).
- The *overall* rate of change in riparian areas was roughly three times higher in urban/urbanizing areas (Indicator 3), but the *relative* riparian vs. upland rate of change in urban/urbanizing areas was half that of rural areas (Indicator 4). This may be because stream buffers comprise a much larger portion of the landscape in rural areas.

The project team developed an Excel file which jurisdictions can use to prepare their own report on CAO performance indicators. It includes a list of recommended data sources and detailed instruction. Locals only need to enter a prescribed set of inputs and the file auto-generates a four-page report with graphs and tables displaying indicator calculations.

The Kitsap County project discussed in the next section applies some of the CAO effectiveness indicators and HRCD methodology developed by Folkerts (2021). A companion subaward to Commerce (NTA 2018-0327) supported development of training and guidance for local jurisdictions related to CAO effectiveness monitoring and adaptive management. That project, discussed in Section 5.5, provides resources that may enable future application of the indicators and HRCD methodology at the local scale.

5.3.2 KITSAP EVALUATION OF SHORELINE, CRITICAL AREA, AND STORMWATER PROTECTIONS

Barnhart et al. (2015) identified several procedural deficiencies in Kitsap County’s shoreline permitting program.³⁶ Among these were concerns about insufficient and/or incomplete data in searchable permit databases hindering program effectiveness monitoring and a lack of enforcement of long-term mitigation requirements partially attributable to the absence of a tracking system. HSIL funding through NTA 2018-0713 allowed the County to address some of these previously identified limitations in environmental-related data housed in their SmartGov electronic permitting tracking system (Kitsap County 2022a). While the earlier LO-funded project focused exclusively on implementation of the County’s SMP, this project was expanded to also addresses CAO and stormwater regulations. The subawardee:

- Developed electronic checklists documenting conditions of permit approval
- Developed a tracking and notification system for permits requiring multi-year mitigation monitoring plans
- Developed a CAO and SMP effectiveness monitoring plan

This project was significant among HSIL subawards in the regulatory effectiveness investment theme in that it is the only instance of a jurisdiction using HSIL funding to evaluate and improve local implementation of Growth Management Act and Shoreline Management Act requirements.

Electronic checklists

Prior to this project, the SmartGov system did not have a way to query information about permits with critical areas or stormwater requirements. The project team developed checklist tools within the system and staff procedures to identify and track permits with critical area features within the project area and permits where stormwater best management practices were applied.³⁷ The checklists are simple questionnaire completed by permit review staff using information from critical area delineations,³⁸ critical area assessments, and stormwater engineer/technician reviews (Kitsap County 2022b).

³⁶ Kitsap County, San Juan County, and WDFW received a Marine and Nearshore LO grant in 2013 to monitor and improve shoreline permitting effectiveness through “Troubleshooting, Action Planning, Course Correction, Tracking and Monitoring” or TACT. The three partner agencies reviewed and assessed the effectiveness of existing permitting programs to identify deficiencies and develop recommendations for improvement. Their analysis focused on marine shoreline bulkhead HPAs issued by state and local shoreline permits from 2 counties. The project team’s intent was to develop new approaches to improve both process (speed and accuracy) and function (level of resource protection) of these programs.

³⁷ After the TACT project (Barnhart et al. 2015), a shoreline “parcel tag” had been added to the system to identify where permits intersect with SMP jurisdiction so a separate shoreline checklist was not necessary.

³⁸ Inaccuracies in critical area mapping—primarily for wetlands and streams—prevent County staff from reliably using GIS to intersect critical area polygons with parcels.

The checklists prompt planners capture information typically embedded in permit documents stored as PDFs, making it easier to extract and analyze for effectiveness monitoring. The new system, implemented in late 2020, improves data accessibility and will streamline the data acquisition process for effectiveness monitoring.

Mitigation monitoring permit

When permits require mitigation to reduce impacts to critical areas or shorelines (e.g., vegetation plantings), Kitsap County requires permittees to submit monitoring plans and annual reports for a minimum of five years to assess the success of the mitigation strategies and whether corrective actions are necessary to avoid damage to protected features. Barnhart et al. (2015) identified two issues related to implementation and enforcement of shoreline mitigation requirements in Kitsap County:

- Though mitigation conditions require annual monitoring and photo documentation, there is no trigger mechanism to remind permittees and permit reviewers when a submittal is due.
- Permitting staff are unable to follow-up on mitigation conditions because permit fees have been expended.

To address these deficiencies, the project team created a new permit type in SmartGov that provides a mechanism to remind landowners when annual monitoring reports are due, and funding for staff time³⁹ needed to intake/review reports and recommend corrective actions if needed (Kitsap County 2022c). New staff procedures developed for this permit outline a consistent method for reviewing monitoring reports and determining corrective actions. The new permit was implemented in January 2023.

County officials had concerns about additional costs to landowners associated with the new permit. The project team recommended exploring options to reduce the financial burden of ongoing monitoring on permittees to reduce the impact of new monitoring permit fees (e.g., reduce frequency of monitoring or requirements for certified professionals to conduct monitoring).

Effectiveness monitoring plan

The project team also developed a monitoring plan that describes how the County will measure implementation and effectiveness of their CAO and SMP. The plan identified key questions to determine if regulations are effective in meeting no net loss goals; six metrics to assess code effectiveness; and data collection and analysis methods (Kitsap County 2022d).

³⁹ Fees collected for permits provide a local funding stream for many cities or counties to run their regulatory programs. In many jurisdictions, including Kitsap County, the fees collected dictate how many hours staff can spend to review an application and conduct site visits/inspections (i.e., staff bill their working hours to a specific project under review). During development of the new monitoring permit, the project team estimated staff implementation time for three permittee compliance scenarios: 5-7.75 hours for a compliance scenario, 6.75-12.5 hours for moderate compliance, and 7.75-14.25 for minimal compliance. Permittees are charged \$780 for “Effectiveness Monitoring” permits per the [2023 Department of Community Development fee schedule](#).

Plan development was informed by the 2017 version⁴⁰ of Chapter 7 in Commerce’s Critical Areas Handbook. The project team’s focus was on developing a methodology with low technical barriers for application, utilized pre-configured data products, and minimized the need for field observations to reflect organizational constraints (e.g., limited staff capacity).

Two metrics derived from Folkerts (2021) were selected to monitor landscape scale outcomes. HRCD data generated by WDFW will be used to quantify vegetation changes inside and outside of critical areas and shoreline buffer zones. Four metrics derived from an Ecology (2017) manual for outlining procedures to characterize compliance with wetland buffers will be tracked to assess site scale outcomes. Methods involve comparing a subsample of HRCD change polygons (a geographic area that has undergone tree canopy loss, impervious or semi-impervious increases between two time periods) with County permit records to determine if observed changes were subject to permit review and, if so, were consistent with permit conditions.

Kitsap County plans to conduct SMP monitoring in 2024-2025 to inform the 2026-2028 SMP update process, and CAO monitoring in 2030 to inform the 2030-2032 Comprehensive Plan update.

5.3.3 SAN JUAN SHORELINE ARMOR PERMIT IMPLEMENTATION MONITORING

During the change analysis and compliance assessment discussed in Section 5.2, the project team obtained shoreline permits/exemption letters and HPAs for the subset of armor installations that had received them. Friends of the San Juans (2022) conducted a detailed review of the individual permit files to assess their effectiveness in reducing the impact of the new armor.

Permit records included materials submitted by applicants such as project design drawings and assessment reports; conditions included in permits; and documentation of site inspections or interagency coordination. This review largely focused on record-keeping because the Hydraulic Code and San Juan County SMP were amended during study period (2009-2019), so evaluating permit consistency with relevant regulations (i.e., were conditions included in a permit appropriate?) would have been challenging.

Results for the 17 San Juan County shoreline approvals showed:

- The type and quality of application materials varied widely. Nine files contained habitat reports. Five of these included a no net loss evaluation and none concluded new armor would result in a net loss. No files included forage fish surveys. Eleven files contained geotechnical reports and only two concluded a primary structure would be threatened by erosion within 10 years. Two files contained to-scale design drawings/site plans. The

⁴⁰ Kitsap County work supported via NTA 2018-0713 was included as an example in the revised Critical Areas Handbook Chapter 7 appendix produced via NTA 2018-0327 and described in Section 5.5.

awardee noted inaccurate location of the Ordinary High Water Mark (occasionally seaward of Mean Higher High Water) and “wildly inaccurate” scales for cross sections on some drawings in habitat reports and other application materials.

- Mitigation was required for four permits, and all were associated with unauthorized installation of armor. No mitigation was required for projects authorized prior to construction.
- Four files contained evidence of interagency coordination, and all were associated with unauthorized installation of armor.
- There was little post-construction verification (i.e., evidence mitigation required in permits being implemented, post-construction inspections).

Results for the 20 HPAs indicated:

- Files contained limited biological, geological, and mitigation information.
- WDFW restricted the time of work to limit fish impacts for all 20 projects and required pre-construction forage fish surveys for three projects. Two files contained records of surveys occurring.
- WDFW required mitigation for 10 projects. As of spring 2021, no files contained evidence that the required actions had been completed.
- Three files contained evidence of interagency coordination, and all were associated with unauthorized installation of armor.
- One new armor segment had an HPA application that was rejected, but the survey indicated it was built anyway.

These results of the were consistent with previous LO-funded investigations (as summarized by Kinney et al. 2015 and Kinney et al. 2019) that highlighted procedural gaps related to difficulty implementing Shoreline Management Act “no net loss” and “demonstration of need” provisions; inconsistent addition of mitigation requirements to permits; lack of pre- and post-construction inspections which can result in structures being installed lower on the beach profile than permitted; and poor inter-agency coordination.

Overall, there was little evidence in permit records to suggest that effects on priority shoreforms and habitats were minimized to the greatest extent possible, though Whitman (2022) indicated that more information was available in records from the later years of the study period. The majority of the study period for this project preceded or had some overlap with implementation of changes specifically meant to improve some of the regulatory outcomes quantified, including 2016 WDFW Habitat Program changes to address specific procedural deficiencies identified in Barnhart et al. (2015). **Repeating this analysis in a few more years may allow for detection of improvements in outcomes associated with these procedural changes.**

5.3.4 RECOMMENDATIONS

- Subawardees identified opportunities for regional recovery partners to provide local governments with technical support that could help improve regulatory program implementation and compliance monitoring. For example:
 - As noted in Chapter 2, funding and/or technical assistance to incorporate the latest online technologies and a migration from WDNR Hydro to the more accurate National Hydrography Dataset (Folkerts 2021).
 - Kitsap County (2022d) acknowledged that inaccuracies in stream and wetland geospatial data will impact effectiveness monitoring results. Continued improvements to these datasets, such as those described in Chapter 2, are needed to advance IS regulatory effectiveness goals.
 - Implementing the Kitsap County (2022d) monitoring plan is dependent on continued HRCD updates as new imagery is released.
 - Kitsap County (2022a) noted that the SmartGov permitting system software is somewhat limited in functionality and they have limited control over modifications to meet different needs. Relying on the software’s “recurring inspection” function would not have achieved mitigation process improvement goals, so the project team instead developed the new monitoring permit as a work around. **If other jurisdictions use this same software, sharing this and other software hints may be beneficial to those wanting to make similar implementation improvements.**
- Future SIL Request for Proposals that include a solicitation for regulatory effectiveness projects should reference subawards discussed in this section, as well as the new guidance discussed in Section 5.5, to help potential respondents envision what this type of project entails and identify resources available to support their efforts.
- Geographic trends in riparian tree canopy loss observed by Folkerts (2021) could inform could be used to help target future regulatory effectiveness investments.
- Regional partners should consider adding an indicator relating to impervious surface in the riparian buffer. Recent B-IBI research funded by the Stormwater SIL (NTA 2016-0382) indicates that stream macroinvertebrate communities change significantly when percent impervious surface in the riparian buffer exceeds 2.2% (King County 2019).

5.4 REDUCING REGULATORY BARRIERS TO BENEFICIAL PROJECTS

Multiple IS (Shoreline Armoring, Floodplains and Estuaries, and Chinook) identify the permitting process as a potential barrier for restoration projects. Participants in IS development noted that long and unpredictable permit timelines can be a problem when restoration funding comes with a relatively short timeframe for expenditure. They also expressed frustration at the lack of efficiency and transparency associated with permit application/review processes. The Shoreline Armoring IS noted one additional regulatory obstacle for the soft shore protection projects the strategy seeks to encourage: due to exemptions or general permits for repair/replacement of

existing structures, it may be quicker and easier to get a permit to replace an existing bulkhead than it is to remove that bulkhead and restore natural beach processes.

The two projects discussed in this section aimed to address some of these concerns:

- NTA 2018-0265 – Supported a collaborative effort led by WDFW, Ecology, and EPA to develop a Multi-Agency Review Team focused on improving permitting processes for armor removal and soft shore projects.
- NTAs 2016-0196 – As part of the continuation of Shore friendly Kitsap (also discussed in Chapter 3), Kitsap County continued development a streamlined county permitting process for shoreline restoration projects within the parameters of existing Kitsap County code, and developed a permit process procedure document that identifies four common local permitting pathways, requirements, and step-by-step application instructions for beneficial shoreline projects

5.4.1 THE MULTI-AGENCY REVIEW TEAM

The Multi-Agency Review Team (MART) consisted of regulatory program staff from WDFW, Ecology, EPA, Corps, NOAA Fisheries, USFWS, and FEMA. Their goal was to improve the permitting processes for beneficial marine shoreline projects (e.g., armor removal, beach restoration, and/or installation of soft shore protection) by enhancing communication and coordination among their agencies (Ecology, WDFW, and EPA 2022). Representatives of local governments, local Shore Friendly programs, consultants/contractors, and the Northwest Indian Fisheries Commission provided input during four virtual workshops as well as during partnering meetings.

The MART reviewed records for previously permitted projects to document baseline processes and timelines. Findings were used to identify choke points that frequently resulted in delays. Ecology, WDFW, and EPA (2022) observed that permitting delays can occur on both the applicant side and the agency side. Common causes of delay were:

- Incomplete application materials – Applicants find the permit process confusing and hard to navigate, so it can be difficult for them to produce the right documents at the right time.
 - Different agencies make redundant requests for submittal of similar information in different forms.
 - Different compliance pathways may require different forms and/or reports. For example, submittals for Endangered Species Act compliance vary based on the type of consultation (programmatic, informal, formal).
 - Determination of permitting pathway – There is no clear and universal definition of “soft” shore protection. Different staff have varying expertise and experience permitting beneficial shoreline projects, so it may be difficult to determine if a project qualifies for streamlined or expedited permitting (e.g., SMP exemption, Fish Habitat Enhancement Project, general vs. individual 404 permit, programmatic endangered species consultation).

- Corps High Tide Line jurisdictional determinations must occur before federal reviews can begin. Issues with permit delays have become more prominent since the Shoreline Armoring IS was first developed because of a change in Corps 404 jurisdiction means that more projects must now obtain federal permits.
- Sequential review requirements – Instead of concurrent review and approval by each agency, some reviews are completed in a stepwise fashion (i.e., decision from one agency is needed before permit can be obtained from another agency).
- Local SEPA review had to occur before WDFW can consider an HPA application complete. This issue has since been addressed.⁴¹
- The Section 404 permit process is most dependent on other agencies due to the need for Endangered Species Act and National Historic Preservation Act consultations prior to issuance of permits.

The MART then brainstormed 26 possible solutions to identified barriers and selected six solutions to implement for the remainder of the grant period. These solutions focused on increasing inter-agency agency coordination via mechanisms like meet and greets with local, state, and federal agencies to discuss each other's permitting processes; joint pre-application meetings and site visits with applicants; coordinated messaging for applicants; and regular inter-agency meetings to support information sharing about projects being reviewed. These solutions aimed to improve efficiently, shorten timelines, and reduce challenges for applicants.

A pilot collaborative permit review process was applied to three beneficial projects during the grant period as a test to see if metrics tracked during the baseline process mapping exercise improved. The projects were sponsored by the Hood Canal Coordinating Council, San Juan County Public Works, and Northwest Straits Foundation. The pilot process involved joint pre-application meetings with MART members, respective local government staff, and project sponsors. Following these meetings, the MART used regular monthly team meetings to communicate progress and develop coordinated responses to applicant questions.

Relative to 10 comparable previously permitted projects, two of the **MART pilot projects had a 30% shorter review timeline**. The timeline for the third pilot project was extended due to the presence of cultural resources in the project area. Ecology, WDFW, and EPA (2022) highlighted the following elements of the pilot review process as contributing to this result:

⁴¹ HSIL regulatory effectiveness investments influenced two April 2021 changes to state law that streamline permitting for qualifying fish recovery and habitat restoration projects: (1) The Hydraulic Code was amended with the addition of [RCW 77.55.480](#), creating the **Habitat Recovery Pilot Program** and a **state multiagency permitting team**. New dedicated staff positions at PSP (Salmon Permitting Projects Coordinator) and WDFW (Habitat Recovery Pilot Program Coordinator) were created as a result. (2) SEPA was amended in April 2021, with the addition of [RCW 43.21C.515](#), which exempts projects processed via **Habitat Recovery Pilot Program** from SEPA review. Restoration projects funded through the Puget Sound National Estuary Program, Puget Sound Restoration and Acquisition Program, Floodplains by Design, Salmon and Estuary Restoration Program, and Salmon Recovery Funding Board are eligible. These amendments are currently set to expire on June 30, 2025.

- Early engagement with permitting agencies via pre-application meetings can reduce delays.
- Cross-agency communication and collaboration helped to resolve many of the roadblocks that arose during the pilot review process.
- The MART coordinator/facilitator position and a dedicated MART member at the Corps were particularly helpful.
 - After the pre-application meeting, the MART coordinator sent follow-up emails to applicants outlining required permits by agency, streamlined or expedited permits that would apply to the project, and links to permit application forms.
 - A few months after application materials were submitted to the Corps, their MART representative took over as project manager for the pilot projects. The result was quicker and more efficient federal permitting.
 - Once applicants indicated that local permitting was taking a long time, Habitat Biologists contacted the local jurisdictions to see if they had questions about benefits of the projects and let them know that HPAs could not be completed until a SEPA determination had been made.
- Pilot projects that qualified for ESA programmatic consultations had relatively short (~35 days) NOAA Fisheries and USFWS processing times compared to individual consultations that can take six months to two years.
- Technical assistance on project design and permitting support from organizations like Shore Friendly appears to make the permit process more efficient.

In contrast, **local permits took much longer than the MART had anticipated.** Applicants lacked a clear understanding of local permit requirements and noted frequent staff turnover of the local level. They observed that new staff seemed unfamiliar with permitting and were confused by exemptions for projects designed to improve fish or wildlife habitat. FEMA noticed that local jurisdictions were not requiring applicants to obtain floodplain permits as required by the National Flood Insurance Program. These findings corroborate results of Marine and Nearshore LO funded projects and reiterate the importance of improving implementation of local regulatory programs as part of the Shoreline Armoring IS Regulatory Strategy.

Ecology, WDFW, and EPA (2022) concluded that the permitting process for restoration projects would be more effective if agencies had staff dedicated to permitting restoration projects and able to participate in the MART or similar collaborative groups.

5.4.2 STREAMLINED PERMITTING FOR SHORELINE RESTORATION IN KITSAP COUNTY

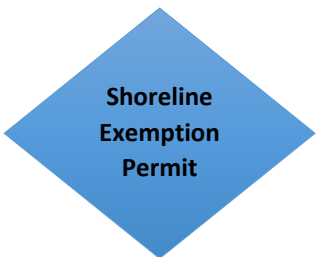
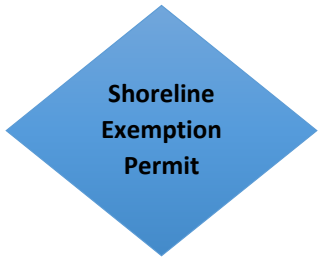

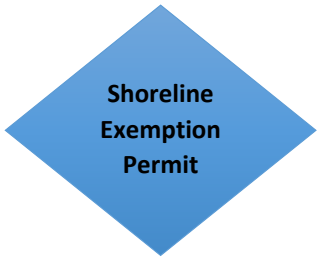

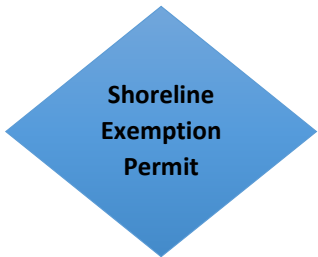


As discussed further in Chapter 3, HSIL provided two subawards to Shore Friendly Kitsap to continue the work they piloted with support from the Marine and Nearshore LO. As one of only two Shore Friendly grantees housed within a county government, Shore Friendly Kitsap is in the unique position to support development of a streamlined local permit process for restoration projects.

During a previous LO subaward, Kitsap County Department of Community Development and Shore Friendly Kitsap developed a grading permit exemption for armor removal projects. When this exemption is used, the state HPA becomes the governing permit and WDFW agrees to inspect the project for water quality/stormwater impacts. During the 2017-2020 HSIL subaward, this exemption was institutionalized by integrating a new stormwater review checklist into the County's permitting database.

Kitsap County (2020) developed a [permitting process document](#) for applicants that is available on the Shore Friendly Kitsap website resources page. This document identifies four common local permitting pathways, requirements, and application steps for Shore Friendly projects. The pathways relate to different types of armor removal projects. The overview graphic (Figure 17) allows applicants to identify the category into which their project falls. The individual detail graphics (example in Figure 18) provide step-by-step details instructions to help the applicant provide all the documents needed by the county.

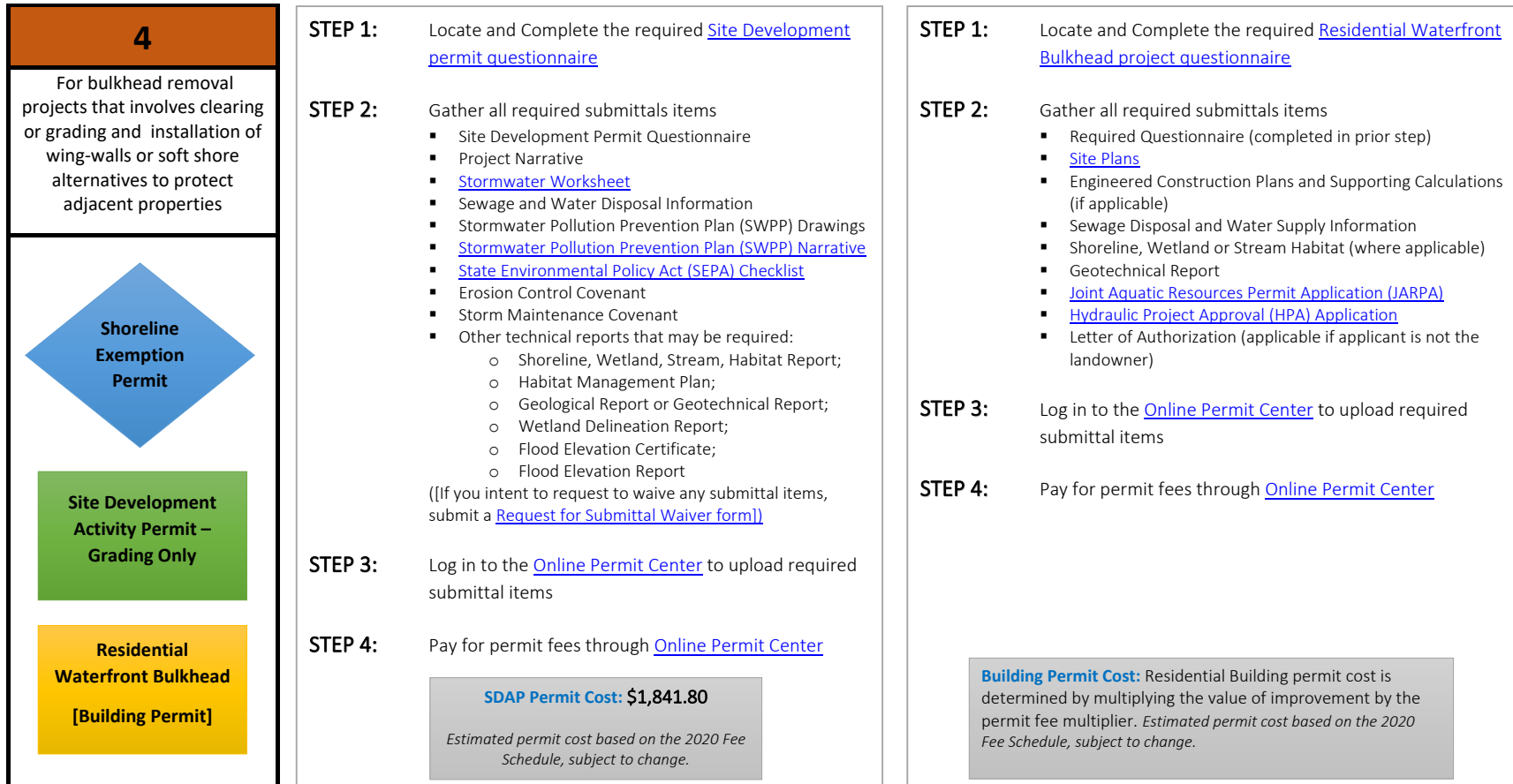
Though intended for applicant education, these figures illustrate the complexity of local permitting and could help MART members better understand relevant processes and procedures (though specific requirements will vary for each of the 47 local jurisdictions with Puget Sound marine shorelines).

Figure 17. Kitsap County local permitting pathways for Shore Friendly projects

Four Common Permit Pathways for Shore Friendly Restoration Projects			
1	2	3	4
For simple bulkhead removal projects that do not require clearing, grading, or installation of wing-walls	For bulkhead removal projects that involve land clearing or grading (grading may include installation of soft shore armoring)	For bulkhead removal projects that do not involve land clearing or grading, includes installation of <i>wing-walls</i>	For bulkhead removal projects that involves clearing or grading and installation of wing-walls or soft shore alternatives to protect adjacent properties
 <p>Shoreline Exemption Permit</p>	 <p>Shoreline Exemption Permit</p>  <p>Site Development Activity Permit – Grading Only</p>	 <p>Shoreline Exemption Permit</p>  <p>Residential Waterfront Bulkhead [Building Permit]</p>	 <p>Shoreline Exemption Permit</p>  <p>Site Development Activity Permit – Grading Only</p>  <p>Residential Waterfront Bulkhead [Building Permit]</p>

Source: Kitsap County 2020, Appendix B

Figure 18. Kitsap County Shore Friendly project local permitting pathway 4



Source: Kitsap County 2020, Appendix B

5.4.3 RECOMMENDATIONS

- Ecology, WDFW, and EPA (2022) indicated that several regulatory and non-regulatory organizations could play a role in exploring and implementing other solutions identified by the MART. Solutions that regional recovery partners may be well-positioned to support include:
 - One common cause of delay was applicant confusion about the permit process generally as well as the various permitting pathways available for restoration projects. The MART recommended increased investment in resources and tools to improve applicant awareness. The Kitsap Shore Friendly four common permit pathways document described in Section 5.4.2 is one example of a product that could be emulated by other regulatory authorities.
 - Development of a clean and universal definition for “soft” armoring.
 - Development of coordinated mitigation recommendations or an interagency mitigation manual for armor removal and soft shore projects to avoid the sometimes-conflicting requirements from different agencies observed the MART.
 - Ecology, WDFW, and EPA (2022) observed that a dedicated project manager position at the Corps was key to ensuring that federal compliance activities proceeded efficiently. The state could consider funding a staff position at the Seattle District to expedite the review of applications for restoration projects, as allowed under [Section 214 of the Water Resources Development Act](#).
- Given the importance of inter-agency coordination in resolving violations in San Juan County noted by Whitman (2022), consider expanding the scope of any future MART-like efforts to include support for unified enforcement action.
- Prior to their expiration in June 2025, regional partners should track and report on the effectiveness of the Habitat Recovery Pilot Program and the state multiagency permitting team (Footnote 41) in reducing permitting delays for beneficial projects.
- Procedures and lessons from California’s [Cutting Green Tape](#) Initiative may be applicable if adjustments are necessary.

5.5 TRAINING AND SUPPORT FOR REGULATORY STAFF AND PLANNERS

A near-term priority of the Shoreline Armoring IS’s regulatory strategy was to increase training and technical support for local jurisdiction regulatory staff. Three subawards described in Chapter 3 advanced this priority. NTAs 2016-0380 and 2018-0886 supported Marine Shoreline Design Guidelines engineering technical assistance, training, and outreach. NTA 2018-0142 supported development of a Marine Alternative Shoreline Training Program. Local planners and other regulators are a target audience for these programs. In addition to changing perceptions around shoreline armoring, these training programs should help improve permit review and application of appropriate mitigation sequencing. Both programs include instruction on topics

flagged by the IS as needing additional implementation guidance, such as demonstration of need and alternatives analysis.

Here we describe a fourth subaward that provides a forum for peer-to-peer sharing of information and best practices:

- NTA 2018-0085 – As part of a larger project (also discussed in Chapter 3), Washington Sea Grant developed and facilitated a pilot Local Government Working Group to provide resources and support to local shoreline planners.

In this section we also describe new training and guidance for local government planners about monitoring and improving the performance of critical area and shoreline regulations:

- NTA 2018-0327 – Supported Commerce and other state agencies to provide training, technical assistance, and guidance for local governments about how to monitor and improve critical area permit implementation and effectiveness.

The Commerce subaward provided tools that local governments can use to advance three strategies from three different IS: improve local jurisdiction implementation of GMA (Land Development and Cover), evaluate and improve implementation of existing regulations (Shoreline Armoring), and evaluate the effectiveness of existing land use regulations (Chinook).

5.5.1 LOCAL GOVERNMENT WORKING GROUP

Washington Sea Grant piloted a Local Government Working Group to provide resources and support for planners who review shoreline armoring, soft shore, and beach restoration permit applications. The group met 10 times between December 2020 and May 2022 to discuss a range of topics identified by the target audience, such as reviewing geotechnical reports; training programs; sea level rise and Shoreline Master Programs; regulatory and incentives tools to encourage soft shore protection; Shore Friendly; bluff toe erosion; geology of shorelines; and how to conduct an alternatives analysis (Faghin et al. 2023).

Agency partners, topic experts, and local Shore Friendly program staff participated in the meetings as guest presenters, but local planners also played a key role in sharing their own work. Findings from regulatory effectiveness projects funded by the Marine and Nearshore LO highlighted the benefits of peer-to-peer communication and facilitated networking for local shoreline planners (Johannessen 2013, Barnhart et al. 2015). The workgroup provided a venue for such communications, while also increasing awareness of resources and programs developed with Puget Sound Program funding.

5.5.2 CRITICAL AREAS MONITORING AND ADAPTIVE MANAGEMENT

Section 5.3 underscored the complexity of regulatory implementation and effectiveness monitoring. To help local governments tackle the challenges associated with this type of work, Commerce partnered with Ecology and WDFW to provide training and support in the form of a webinar series and updated written guidance in their [Critical Areas Handbook](#).

Webinar series

This subaward supported development of an online [Critical Areas and Shorelines Monitoring and Adaptive Management webinar series](#) that ran for 11 weeks in early 2021. The goal of this training was to provide local jurisdictions with resources to develop or enhance their regulatory monitoring and adaptive management (M&AM) programs, focusing on critical area permit implementation and effectiveness (Dial et al. 2021). An average of 164 participants attended each webinar live. Most attendees were local planners, who were able to earn American Institute of Certified Planners continuing education credits by attending. Other audience members included tribal staff, consultants, and students. Webinar recordings and supporting materials are available on the project's [EZ View web page](#).

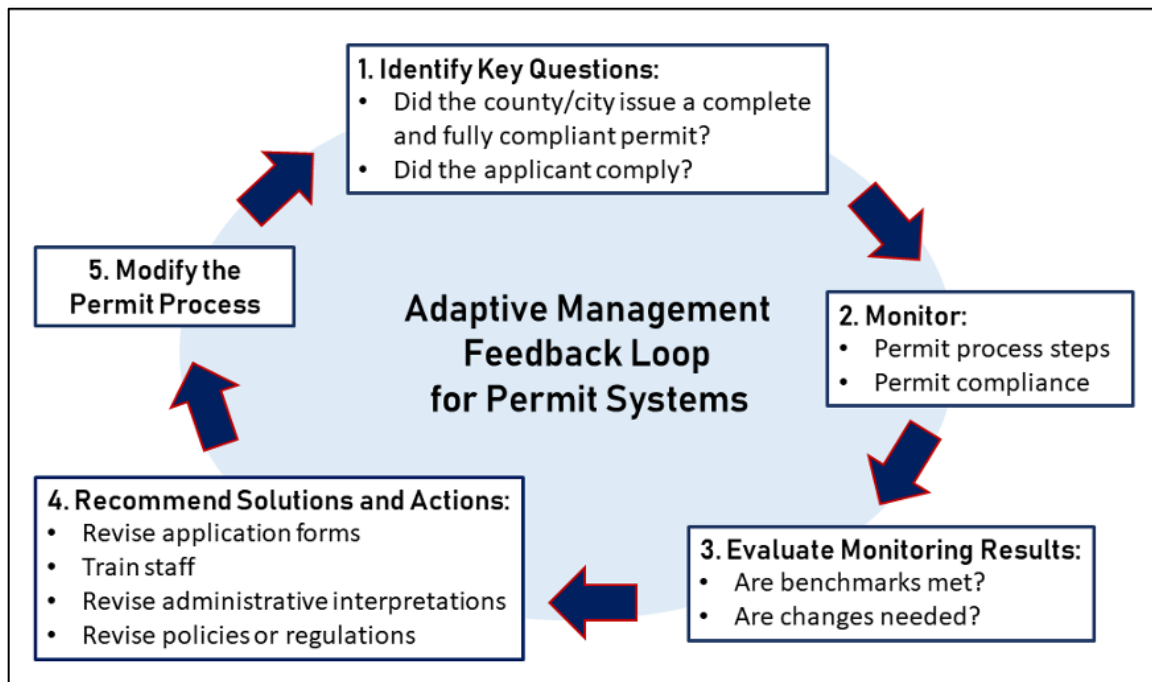
During each webinar, voluntary polls were used to identify barriers and audience needs. Poll results were used by the project team during the second phase of the project to ensure Critical Area Handbook updates would meet user needs. Participant feedback was also obtained through pre- and post-webinar questionnaires (Dial et al. 2021). When asked about barriers to regulatory monitoring efforts, the top responses were staff capacity (n=181), lack of training or expertise (n=66), and funding (n=49). The local planner audience appreciated the use of examples from other jurisdictions. Peer learning and exchange of interjurisdictional knowledge is important to local planners (Dial et al. 2021). When local government staff participated in webinars as presenters, attendance and audience participation were highest.

Critical Areas Handbook revisions

This subaward also supported revisions to Commerce's Critical Areas Handbook. The project team used information gathered before, during, and after the webinars to update the handbook in a way that addressed local planner needs (Newman et al. 2023). The revised handbook and [Critical Areas Checklist](#) were published in February 2023. Chapter 7 (Monitoring and Adaptive Management) received most of the updates. New appendices to Chapter 7 include case studies from local programs, model ordinance language, and tools developed by local governments (e.g., templates, checklists).

Chapter 7 defines M&AM as “a systematic process to continually evaluate and improve the effectiveness of critical areas policies, regulations and practices by learning from feedback loops and the outcomes of implementation” (Commerce 2023). The five elements of this feedback loop are described in Figure 19.

Figure 19. Feedback loop for permit implementation and effectiveness monitoring



(Figure 7.1 from Commerce 2023)

Chapter 7 explains why effectiveness monitoring is important and how to initiate a program to adaptively manage local GMA and SMA regulations.

- Notably, critical areas M&AM is not required under the GMA. During the project period, a Growth Management Act Hearings Board decision (Munce and Evergreen Islands v. City of Anacortes, GMHB case no. 21-2-0002c) determined that critical areas policies and regulations are assumed to be protective if they are based on best available science. Commerce has interpreted this ruling to mean that program M&AM is an optional activity.
- In contrast, SMA rules do require M&AM of local SMPs to improve shoreline management over time (WAC 173-26-201(2)(b)). Local governments are required to document all project review actions in shoreline areas and identify a process for periodically evaluating the cumulative effects of authorized development (WAC 173-26-191(2)(a)(iii)(D)).

The focus of Chapter 7 is on permits and permit programs. Limited information about ecological monitoring is provided because outcomes are more difficult to monitor/assess and adaptive management is more complex and harder to implement.

The new chapter includes sections addressing how to develop a M&AM program; data resources and tools; funding sources; details about things to consider when monitoring the different types of critical areas (e.g., wetlands, fish and wildlife habitat conservation areas,

frequently flooded areas, geologic hazard areas, shoreline areas, aquifer recharge areas); and manuals and guidance documents. In the revised Chapter 7:

- Use of WDFW High Resolution Change Detection tools for effectiveness monitoring is promoted. The HSIL-supported work by Folkerts (2021) described in Section 5.3.1 is highlighted.
- Section 7.4 addresses program development and emphasizes designing a program to ensure the results are unbiased and actionable. The importance of permit tracking systems and specific information should be considered for tracking is discussed, as is the development of benchmarks for adaptive management actions (i.e., when should monitoring results trigger regulatory program changes).
- Several adaptive management strategies to improve regulatory program performance are provided: creating a better training program for staff; educating applicants and property owners about the permit process; improving the application process and forms; improving permit software; and refining development regulations so they are easier to apply consistently and correctly. These themes are consistent with results of earlier Marine and Nearshore LO regulatory effectiveness projects.
- The Section 7.5 subsection on frequently flooded areas subsection is particularly strong.

New Appendix 7.A provides several local case studies that provide both ideas for what a local government might choose to monitor, and the types of process improvement recommendations that may result from monitoring. Several of the case studies described projects funded with Puget Sound NEP/geographic funding:

- Kitsap County projects funded through the Marine and Nearshore LO (Barnhart et al. 2015) and HSIL (NTAs 2018-0713 and 2018-0641) are mentioned.
- The Thurston County and WDFW project that used HRCD to evaluate SMP effectiveness and compliance was funded by the Marine and Nearshore LO.
- Island County and Bainbridge Island also received Marine and Nearshore LO regulatory effectiveness grants, so some elements of the work described in their case studies were supported with NEP/geographic funding (e.g., Bainbridge LiDAR data).

New Appendix 7.B provides model monitoring and adaptive management language that local governments can add to their Critical Area Ordinances and Shoreline Master Programs.

Climate change planning needs assessment

A third element of this subaward to Commerce was a survey of local planners to assess their needs and priorities for climate change planning. Results of Andrade and Newman (2021) are described in Section 4.5 (Projecting and Planning for Climate Change Impacts).

5.5.3 RECOMMENDATIONS

- The availability of the updated Critical Areas Handbook Chapter 7 and webinar recordings/materials should be promoted regularly to local government planners, elected officials, LIOs, and other practitioners. Future Puget Sound Program request for proposals that include a solicitation for regulatory effectiveness projects should reference this resource to help potential respondents envision what a successful project proposal would entail and identify resources available to support their efforts.
- Newman et al. (2023) recommended development of a new grant and technical assistance program to provide ongoing capacity for implementing the updated M&AM guidance. This program would:
 - Support additional outreach and interjurisdictional coordination.
 - Provide grants to local governments to help them develop and implement M&AM programs, including funding for development or purchase of software or other permit tracking tools.
 - Provide technical assistance to design and implement M&AM programs, including reviewing local codes and figuring out what to track, how to track it, and how to use results.
- Prior to funding this proposed assistance program, we recommend regional partners first assess local jurisdiction needs for other topics/issues that may require support and identify program delivery methods preferred by this audience.
 - Conducting a needs assessment could allow for development of a comprehensive program that provides technical expertise for more than one type of topic/issue. Regional or “circuit rider” type support for local jurisdictions has also been raised as a potential solution to several local challenges: applying for and managing grants (B-IBI IS, NODC 2022), permitting restoration projects (Floodplains and Estuaries IS, Chinook IS), climate change planning (Andrade and Newman 2021, NODC 2022), and geotechnical support for review of shoreline demonstration of need determinations (Shoreline Armoring IS). There may be other pressing local needs that regional partners won’t know about until they ask.
 - Results of the planner survey conducted by Andrade and Newman (2021) indicated that there may be more interest in technical assistance from consultants compared to state agencies. There are several model programs that help communities access funding and technical assistance through not-for-profit organizations, university extension, or consulting firms. Examples that could be explored include the [Safe and Affordable Funding for Equity and Resilience Program](#) (California), [Municipal Research and Services Center](#) (Washington), [Coastal Hazards Organizational Resilience Team](#) (Washington), [Center for Planning Excellence](#) (Louisiana), and [Municipal Vulnerability Preparedness Program](#) (Massachusetts).

CHAPTER 6: SYNTHESIS OF SUBAWARD CONTRIBUTIONS TO STRATEGY IMPLEMENTATION

Chapter At-A-Glance

- About half of HSIL 1.0's subawards advanced an approach identified in one or more of the three Implementation Strategies they managed. The remaining subawards were associated with an Action Agenda priority or an Implementation Strategy managed by the Puget Sound Partnership or Stormwater Strategic Initiative Lead.
- The Land Development and Cover IS identifies three strategies and nine approaches. All subaward-driven progress was associated with three of the approaches: improve local jurisdiction implementation of GMA; identify and share data about ecologically important lands; and expand financial and technical assistance incentives for working lands. The reduce barriers to infill strategy needs attention.
- The Floodplains and Estuaries IS includes three strategies and 15 approaches. Some progress was made to support a Sound-wide IFM framework and significant progress was made through HSIL awards for the river basin scale integrated planning strategy. More work is needed to support the strategy focusing on risk tolerance and cost subsidies.
- The Shoreline Armoring IS has four strategies and 11 approaches. Significant progress was made implementing all of the strategies and all but one of the approaches. So much was accomplished for two strategies that future updates to this IS should reflect progress to date by refining the focus of those strategies.

In previous chapters, we described how individual subawards advanced specific IS strategies and approaches. The purpose of this chapter is to synthesize the collective contributions of all 97 subawards to implementing IS managed by HSIL as well as other regional recovery priorities. As noted in Section 1.2, we identified 10 strategies and 35 approaches in HSIL-managed IS and used this list as the basis for all of our determinations as to whether a subaward/NTA advanced an HSIL IS or not. **We linked a subaward with an IS only when it truly operationalized a specific approach. A project being generally related to a Vital Sign was not enough for us to assign a project to an IS.** Section 6.4 provides a few examples describing how we made decisions to exclude some subawards that had been linked to a Vital Sign by NTA owners.

We focus this chapter's analysis on subawards that made notable contributions to advancing specific priorities identified in HSIL-managed IS. About half of the 97 subawards meet this standard; these projects received \$12.3 million (57%) of HSIL 1.0 subaward funding. The remaining subawards were all aligned with IS managed by others and/or Action Agenda priorities, as shown in the summary tables that appear in sections 6.5 and 6.6.

6.1 LAND DEVELOPMENT AND COVER

The Land Development and Cover IS identifies three strategies and nine approaches. Table 22 shows that implementation progress associated with subawards occurred for three approaches: improve local jurisdiction implementation of GMA; identify and share data about ecologically important lands; and expand financial and technical assistance incentives for working lands. One strategy and several approaches had no associated subawards.

Prevent conversion of ecologically important lands

Some progress was made to advance two of the four approaches associated with the prevent conversion strategy. Efforts to improve local implementation of GMA-required critical area protections were discussed in Chapter 5. Commerce provided training and developed guidance for local planners in support of regulatory implementation and effectiveness monitoring. This new guidance incorporated results of a WDFW subaward that resulted in a set of quantitative indicators that can be used to assess the performance of CAOs in protecting riparian areas.

The Kitsap County effectiveness monitoring project was the only instance of a jurisdiction using HSIL funding to evaluate and improve local implementation of GMA and SMA requirements. There are 12 counties and 112 cities in the Puget Sound region implementing CAO regulations but only a few of them have used Puget Sound Program funding to support regulatory monitoring and adaptive management activities.⁴² We recommended that similar projects be implemented throughout the region with priority given to counties and then cities based on their extent ecologically important lands under development pressure. Geographic trends in riparian tree canopy loss observed by Folkerts (2021) could inform this prioritization.

HSIL 2.0's federal fiscal year 2021-2022 investment priority D recognized the opportunity to replicate regulatory effectiveness monitoring activities in other jurisdictions. However, [only two proposals were received](#) and neither were developed by a local jurisdiction aiming to monitor effectiveness. HSIL should consider collaborating with regional recovery partners to investigate barriers jurisdictions face initiating this type of work. This could take the form of workshops or Commerce conducting follow-up surveys with webinar participants. As noted in Section 5.5.3, understanding specific roadblocks is necessary before designing technical assistance programs that could increase uptake of funding opportunities.

⁴² Most of these were Marine and Nearshore LO funded projects focused on Shoreline Master Program monitoring. San Juan County, Island County, and the City of Bainbridge Island also received funding for projects with effectiveness monitoring elements (Kinney et al. 2015, Kinney et al. 2019). Work by other organizations, like Friends of the San Juans and WRIA 9, to track compliance has also occurred.

Table 22. Subawards contributing to Land Development and Cover Strategy Implementation

Build regional support to prevent conversion of ecologically important lands	
Improve implementation of GMA by local jurisdictions	<ul style="list-style-type: none"> • Effectiveness monitoring of regulations regarding shoreline, critical areas, and stormwater requirements (Kitsap County) • Enhancing Critical Area Ordinance Effectiveness via Adaptive Management (WDFW) • Improved Landowner Development Decisions to Protect Critical Areas and Manage Stormwater (Kitsap County) • Puget Sound Critical Areas Monitoring and Adaptive Management Program (Commerce)
Identify and share data about ecologically important lands	<ul style="list-style-type: none"> • Completing HRCO 2015 w/ land cover through 2017 (WDFW) • Ecological Integrity Assessment as an approach to prioritize protection and restoration (WDNR) • Map viewer of ecologically important areas in the Puget Sound basin (WDNR) • National Hydrography Dataset Update (WDFW) • North Sound Riparian Modeling and Monitoring (Skagit River System Cooperative) • Riparian/Land Cover Change Analysis and Decision Support System (Pierce County LE)
Incorporate protections into regional infrastructure planning	No HSIL subawards
Incentivize new market demands for growth in city centers	No HSIL subawards
Reduce barriers to infill and redevelopment in Urban Growth Areas	
Improve planning and regulatory predictability for developers and investors	No HSIL subawards
Improve wellbeing of urban residents by increasing access to amenities and services	No HSIL subawards
Support long-term viability of agricultural lands and working forests	
Collaborative resilience planning	No HSIL subawards

Expand financial and technical assistance incentives	<ul style="list-style-type: none"> • Forest Health Management for Reduced Stormwater Runoff and Land Conversion (Puget Sound Conservation District Caucus) • Chimacum Creek Restoration and Protection Project (North Olympic Salmon Coalition)
Improve adoption and implementation of local plans, regulations, and policies that support healthy working lands	No HSIL subawards

Several projects identified and shared data about ecologically important lands, primarily riparian areas. Chapter 2 described updates to important spatial data products like the NHD, which is used both by regulators and developers of tools discussed in Chapter 4 (e.g., Pierce County LE's riparian decision support system and Skagit River System Cooperative's riparian models). We recommend that HSIL collaborate with the PSEMP Spatial Data Work Group to identify additional opportunities to increase the accuracy of geospatial platforms managed by state agencies. Could the Skagit River System Cooperative's approach to developing a hydrography layer using LiDAR data be used to improve location data in areas where the NHD is less accurate? There is also work to be done to evaluate how tools developed with HSIL funding are being used in the context of land use planning. Are spatial tools that prioritize locations to protect and locations to restore accessible by land use planners? Are outputs actionable?

There were no subawards relating to incorporation of habitat protections into regional infrastructure (transportation and utilities) planning or incentivizing new market demand for growth in city centers. However, market mechanisms for habitat protection and infill may be advanced by a project [recently funded](#) by HSIL 2.0; Commerce and Puget Sound Regional Council will support feasibility studies for Transfer of Development Rights/Local Infrastructure Programs in three jurisdictions.

Reduce barriers to infill and redevelopment

No progress to advance this strategy was made through HSIL 1.0 subawards. This may be because the long-term, broad nature of the strategy is not conducive to advancement via short-term Puget Sound Program grants. Or it could be that there is potential for the strategy to be made more actionable during adaptive management of the IS. In the near term, understanding current research needs surrounding this approach may assist in specifying future funding opportunities.

Specific aspects of the infill and redevelopment strategy involve understanding the market incentives that impact redevelopment from both the developers' and the residents' perspectives. This includes a need to understand the mechanism around market incentives that may encourage developers to build in urban areas versus rural areas. Existing resources such as the Base Program Analyses for Land Development and Cover (Wright 2020) and B-IBI (Kinney and Roberts 2020) include information on incentive programs, but more research may be needed.

Understanding the decision-making mechanisms behind why residents may prefer to move to rural or ex-urban areas instead of redeveloped, high-density city centers is also a critical component to advancing the infill and redevelopment approach. These decision mechanisms include demographics, income, crime and security, transit and transportation, employment opportunities, sense of place, quality of life, and cost of housing (including utilities such as [sewer service](#) and [stormwater utility fees](#) that many rural residents do not pay). Some of these questions appear in the [Grand Uncertainties Matrix](#) (curated and managed by PSI) and may be suitable for critical analysis.

There may also be opportunities for HSIL 2.0 to support cross-cutting work in collaboration with the Stormwater SIL. Incentivizing redevelopment of brownfield properties is a Toxics in Fish IS strategy to reduce toxics loading that could have co-benefits for the Land Development and Cover infill strategy. The Toxic in Fish Base Program Analysis (Dvorak et al. 2021) summarized tools municipalities can use to accelerate redevelopment of brownfields, such as Redevelopment Opportunity Zones and Brownfield Redevelopment Trust Fund Accounts. There may be value in the SILs working together with PSP boards to address identified barriers to municipal use of these tools. There is also a nexus with the Marine Water Quality IS develop a funding pathway to implement wastewater treatment plant nitrogen removal strategy. Over-reliance of utility fees to finance clean water infrastructure may exacerbate the rural cost subsidy discussed in the Land Development and Cover narrative.

A significant advancement in supporting infill and redevelopment that occurred recently was the 2023 passage of two housing bills by the Washington State Legislature and signed into law by the Governor. The two “missing middle” bills, [House Bill 1110](#) and [House Bill 1337](#), require many local governments to revise their regulations to allow for a greater number and increased types of housing in areas traditionally dedicated to single-family detached housing. Both bills took effect on July 23, 2023, but local governments are not required to update their local regulations until six months after their periodic comprehensive plan update (Butler 2023).

The bills support “missing middle” housing which includes duplexes up to sixplexes, townhouses, stacked flats, courtyard apartments, and cottage housing for areas within cities but does not apply to counties or unincorporated areas. The bills also reduce restrictions around the building of accessory dwelling units.

According to the [Department of Commerce’s Fact Sheet](#), HB 1337 requires that, within urban growth areas, cities and counties allow two accessory dwelling units on all lots in zoning districts that allow single-family homes and E2SHB 1110 requires that cities allow at least six of the nine types of middle housing (as listed above) to achieve the required unit count stipulated in the bill. By reducing barriers to “missing middle” housing, these two bills may support future efforts to encourage infill and redevelopment. Both are critical approaches for operationalizing the Land Development and Cover and Toxics in Fish IS.

Support long-term viability of agricultural lands and working forests

One approach was advanced through two awards that helped to expand financial and technical assistance incentives. As discussed in Chapter 3, the Puget Sound Conservation Districts’ Regional Forestry Stewardship Program provided support to help landowners enroll in local Open Space Taxation programs to reduce their property taxes, and technical assistance to obtain cost share funding to implement stewardship projects. These types of financial incentives are critical for reducing the costs associated with owning and maintaining forest lands, which is expected to reduce the risk of conversion to non-forest land uses. The second project to advance this approach occurred on a much smaller scale. The Chimacum Creek

project provided agricultural landowners with technical assistance and incentives for stewardship activities on their property.

No progress was made on collaborative resilience planning, nor improving adoption and implementation of local plans, regulations, and policies that support healthy working lands. The Snohomish County Agriculture Resilience Plan discussed in Chapter 4 has elements that could support collaborative resilience planning. With more attention to strategies that could ensure long-term viability of agricultural operations, that work could be a model for a type of project described in the IS.

6.2 FLOODPLAINS AND ESTUARIES

The Floodplains and Estuaries IS includes three strategies and 15 approaches. Some progress was made to support a Sound-wide IFM framework and significant progress was made for the river-basin scale support for IFM strategy. More work is needed to support the strategy focusing on risk tolerance and cost subsidies. Table 23 summarizes implementation progress achieved via HSIL subawards.

Sound-wide integrated management support framework

Several projects advanced this strategy, the most notable being TNC's work on accelerating IFM. This award established TNC's 5-year strategic plan, which has laid the framework for regional IFM and has informed the Floodplains and Estuaries IS 2021 update. TNC's 5-year strategy for IFM recommended advancing several necessary IFM components in the region including broadening IFM culture and networks; increasing capacity for IFM; improving regulatory frameworks and policy around floodplain management; increasing and diversifying funding; and building market demand. Although FbD received its highest appropriation to date during the 2023 Legislative session, the funding is for capital projects and a need for operations funding remains.

No awards addressed improving regulatory/policy and permitting process barriers, a significant gap in advancing regional IFM efforts. Permitting process barriers are a well-known challenge with floodplain management and the on-the-ground situation may be worse than when this IS was developed because [FEMA Region 10 rescinded their Fish Enhancement Structures Regional Policy in August 2020](#). Before this change, restoration projects like engineered log jams were not required to undergo a hydrologic and hydraulic analysis to determine the project's effect on the Base Flood Elevation. For projects in mapped floodways, restoration practitioners are now required to obtain a local floodplain permit; complete a hydraulic analysis to determine if the project will result in an increase to the Base Flood Elevation; and, if the project will cause the Base Flood Elevation to increase in the floodway, then a Conditional Letter of Map Revision is required.

Table 23. Subawards contributing to Floodplains and Estuaries Strategy Implementation

Sound-wide Integrated Management Support Framework	
Communicate benefits of integrated management to build public and political support	<ul style="list-style-type: none"> Accelerate Integrated Floodplain Management (The Nature Conservancy)
Address regulatory and permitting process barriers	No HSIL subawards
Develop shared goals and metrics To track regional progress and communicate collective accomplishments	<ul style="list-style-type: none"> Floodplain Recovery Target Refinement (Department of Ecology) Monitoring effectiveness of multi-benefit floodplain project implementation in Snohomish and Stillaguamish Rivers (Snohomish Conservation District)
Develop a regional vision that mobilizes funding	<ul style="list-style-type: none"> Accelerate Integrated Floodplain Management (The Nature Conservancy)
Provide capacity for a network of regional and local practitioners to encourage coordination and learning	<ul style="list-style-type: none"> Accelerate Integrated Floodplain Management (The Nature Conservancy)
River-basin scale integrated planning and project management	
Engage diverse communities in planning forums by building relationships, developing trust, and communicating a coordinated vision	<ul style="list-style-type: none"> Climate Resiliency in Snohomish River Floodplain (Snohomish Conservation District) Develop Data and Support for Floodplain Management Strategies (Whatcom County) Integrated Floodplain Management (Snohomish County) North Fork Stillaguamish IFM (Snohomish County Public Works)
Provide education and outreach that highlights locally relevant benefits and challenges of integrated management	<ul style="list-style-type: none"> Accelerate Integrated Floodplain Management (The Nature Conservancy) Integrating Climate Change in Multi-Objective Floodplain (Climate Impacts Group) Skagit HDM Priority Projects (WDFW) Sustainable Lands Strategy Communication and Outreach (WDFW) WRIA 1 Integrated Program Outreach and Engagement (Whatcom PUD)

Enhance understanding of floodplain and estuarine processes, including future projections, to inform reach-scale project prioritization and design	<ul style="list-style-type: none"> • Balancing Fish, Farms and Floods in King County's Snoqualmie Watershed (King County) • Climate Resiliency in Snohomish River Floodplain (Snohomish Conservation District) • Develop Data and Support for Floodplain Management Strategies (Whatcom County) • Drainage-Based Management Planning (Whatcom County) • Flood Hazard Risk on the Lower Skykomish River (Snohomish County) • Integrated Floodplain Management (Snohomish County) • Integrating Climate Change in Multi-Objective Floodplain Management (Climate Impacts Group) • Integrating climate resilience into farm-fish-flood project packages in the Snohomish and Stillaguamish River floodplains (Snohomish Conservation District) • North Fork Stillaguamish IFM (Snohomish County Public Works) • Numerical Groundwater Model to Support Stream Flow Management (Whatcom PUD No. 1) • Regional (WRIA 1-Wide) Water Supply and Management Plan (Whatcom PUD No. 1) • Skagit HDM Priority Projects (WDFW)
Consider diverse community needs and understanding social, ecological, and economic trade-offs when identifying restoration and protection priorities	<ul style="list-style-type: none"> • Balancing Fish, Farms and Floods in King County's Snoqualmie Watershed (King County) • Climate Resiliency in Snohomish River Floodplain (Snohomish Conservation District) • Develop Data and Support for Floodplain Management Strategies (Whatcom County) • Drainage-Based Management Planning (Whatcom County)
Expand financial capacity to implement integrated reach-scale plans	No HSIL subawards
Address challenges for integrated planning across land uses	No HSIL subawards
Develop and integrate risk tolerance and cost subsidies analyses into land use planning	
Develop a methodology and collect data on hazard risk and subsidies relative to the public benefit of developing in flood-prone areas	<ul style="list-style-type: none"> • Geomorphic Flood Hazard Risk on the Lower Skykomish River (Snohomish County) • Develop Data and Support for Floodplain Management Strategies (FLIP/Whatcom County)

Conduct outreach with the public and decision-makers about risk and land uses that are compatible with flooding	No HSIL subawards
Incorporate risk and subsidy analysis results into regulations and permitting decisions	No HSIL subawards
Improve river-basin scale planning risk and subsidy analysis results, best available science on ecosystem functions, and political climate feasibility considerations	No HSIL subawards

Based on input from restoration practitioners and discussions during FbD Funding and Action Group meetings, this change has significantly extended permitting timelines and project planning costs.⁴³ Conditional Letter of Map Revision reviews take up to 90 days to process, are subject to an appeal period, and usually become effective within six months after they are issued. The review process requires a submittal to FEMA with a letter signed by a community official and an application fee. Fees range widely, but bridge, culvert, channel, or combination review is \$5,300 while review of levees, berms or other structural measures is \$7,150. There may be an opportunity for HSIL to engage the Puget Sound Federal Leadership Task Force with an ask for increased FEMA staff capacity/funding to expedite review of map revisions.⁴⁴

Of the subawards administered in this Sound-wide strategy, only two focused on developing shared goals and metrics for IFM. A current IFM goals and metrics framework, Floodplain for the Future's [Index of Floodplain Health](#), was under consideration as a model for a similar framework by the Snohomish Conservation District and SLS but was ultimately considered too problematic for their use (see additional details in Section 4.1). Therefore, funding future subawards to allow grantees to develop shared goals and metrics is a recommended next step.

Additional funding for visioning and developing a network of floodplain practitioners is also recommended, as only one subaward addressed this approach.

River basin scale support for Integrated Floodplain Management

These subawards assisted grantees in specific aspects of river basin scale integrated planning, in particular the development of reach-scale plans, scoping and design of critical infrastructure projects, engaging with diverse communities, providing education and outreach about integrated floodplain management, and research into climate change impacts to groundwater and flood hazards, as described in Section 4.1.

The river basin scale strategy approach to expand financial capacity to implement reach-scale plans had no specific subawards. Although several subawards briefly mentioned cost considerations for reach-scale planning, none focused in-depth on the economic elements of implementing said reach-scale plans.

We recommend funding support for IFM organizations to pursue additional financial capacity for implementation of reach-scale plans, operations and administrative costs, and enabling grantees to pursue multi-year awards for the required infrastructure maintenance and upgrades that are mentioned in all of the reach-scale plans.

⁴³ PSP recently developed a [resilient floodplains story map](#) that provides results from their survey of salmon recovery Lead Entities and identifies specific project impacts associated with the change to FEMA policy.

⁴⁴ In November 2023, the Ecosystem Coordination Board sent a [letter](#) to the chairs of the Federal Leadership Task Force to request that they prioritize support for streamlining the review process until a long-term solution to this issue is implemented.

Develop and integrate risk tolerance and cost subsidies analyses into land use planning

Two subawards had elements that could support future development of risk tolerance analyses, but no subawards considered cost subsidies analyses. The two subawards to consider hazard risk were assessing geomorphic flood hazard risk on the lower Skykomish River and producing a database of flooding risk for occupied structures in part of Whatcom County. The geomorphic flood hazard risk subaward did result in improvements to infrastructure at risk and included some outreach to the public about flood risk through a community-focused educational website. The database of flooding risk for occupied structures is a resource that the FLIP is using.

Other approaches regarding risk tolerance, including building support for land uses that are compatible with flooding through incentives, incorporating risk and subsidy analysis results into regulations and permitting decisions, considering political climate feasibility for river basin scale planning were not a component of any HSIL-funded awards.

This gap is notable, in particular, because no activities focused on assessing the economics, incentives, and political feasibility activities of floodplain management. Awards in this category would connect to the TNC's 5-year strategy plan which highlights the importance of building market demand. Understanding market demand, the economic aspects of floodplain management, and therefore the ability and role that incentives can play in risk tolerance (and their relation to regulatory policy) is an integral part of IFM efforts.

Greater understanding of these aspects of IFM could assist organizations in making the case for why incentives tied to restoration, climate adaptation and resilience projects need to be implemented—helping them to convince legislators, state, local and federal funders, and even community members why their projects are not just the right projects for fish, farm and flood but also to sustain and improve upon the economic livelihood of their communities.

6.3 SHORELINE ARMORING

The Shoreline Armoring IS has four strategies and 11 approaches. Table 24 shows how HSIL supported implementation progress across all but one strategy.

Improve and expand incentives and education for residential property owners

Significant progress was made towards all three near-term priority outcomes associated with the incentives strategy. As described in Section 3.1, property owner site visit programs were continued and expanded to all 12 Puget Sound counties; sustained funding for incentive programs was obtained via a Legislative appropriation to ESRP; and financial incentives were expanded through project mini-grants and grant application assistance. A new type of financial incentive may be introduced in coming years after completion of a loan program feasibility study.

Table 24. Subawards contributing to Shoreline Armoring Strategy Implementation

Improve and expand incentives and education for residential property owners	
Educate property owners about ecologically friendly shoreline management alternatives	<ul style="list-style-type: none"> • Advancing Sea Level Rise Adaptation in San Juan County (Friends of the San Juans) • Second year of funding for ESRP Shore Friendly recipients with a 2018 NTA (RCO) <ul style="list-style-type: none"> ○ Expand South Sound Shore Friendly Programs (Pierce Conservation District) ○ Marine Shoreline Technical Assistance (King County) ○ Shore Friendly Kitsap - Reduction in Marine Shoreline Armoring (Kitsap County) ○ Shoreline Armoring Reduction Project (Northwest Straits Foundation) • Shoreline Armoring Reduction Project (Northwest Straits Foundation) • West Central Nearshore Restoration Prioritization and Armor Removal (Kitsap County)
Deliver incentives to residential property owners	<ul style="list-style-type: none"> • Development of a residential shoreline loan program (Puget Sound Institute) • Shoreline Armoring Reduction Project (Northwest Straits Foundation) • West Central Nearshore Restoration Prioritization and Armor Removal (Kitsap County)
Coordinate among regional and local partners to ensure sustainable program funding and leverage knowledge from pilots	<ul style="list-style-type: none"> • Improve soft shore permitting processes (WDFW) • Integration of Green Shores for Homes and Shore Friendly (Washington Sea Grant)
Improve regulatory implementation, compliance, enforcement, and communication	
Evaluate and improve implementation of existing regulations	<ul style="list-style-type: none"> • Improve soft shore permitting processes (WDFW) • Improved Landowner Development Decisions to Protect Critical Areas and Manage Stormwater (Kitsap County) • Integration of Green Shores for Homes and Shore Friendly (Washington Sea Grant) • Effectiveness monitoring of regulations (Kitsap County) • Marine Alternative Shoreline Trainings for Planners and Contractors (WA Sea Grant) • MSDG Engineering Technical Assistance, Training & Outreach (WDFW) • MSDG Engineering Technical Assistance (WDFW) • San Juan County Shoreline Armor Change Analysis (Friends of the San Juans) • West Central Nearshore Restoration Prioritization and Armor Removal (Kitsap County)

Conduct compliance monitoring and enforcement	<ul style="list-style-type: none"> San Juan County Shoreline Armor Change Analysis (Friends of the San Juans)
Increase political support for regulatory staff to implement and enforce existing regulations	No HSIL subawards, but WDFW's Habitat Program has increased staff for compliance monitoring.
Increase and improve coastal processes-based design and technical training	
Develop a comprehensive technical training program	<ul style="list-style-type: none"> Marine Alternative Shoreline Trainings for Planners and Contractors (WA Sea Grant)
Support use of MSDG and develop additional guidance	<ul style="list-style-type: none"> Marine Alternative Shoreline Trainings for Planners and Contractors (WA Sea Grant) MSDG Engineering Technical Assistance, Training & Outreach (WDFW) MSDG Engineering Technical Assistance (WDFW)
Develop and implement a regional monitoring strategy	<ul style="list-style-type: none"> Shoreline Monitoring Toolbox: Protocol Implementation & Data Management (WA Sea Grant) Shoreline Monitoring Toolbox: Data Analysis & Interpretation (WA Sea Grant) Shoreline Restoration Effectiveness Monitoring (Northwest Straits Foundation) Subtidal Monitoring of Shoreline Restoration Effectiveness (Puget Sound Institute)
Improve long-term strategic planning	
Compile and provide access to data about current and future shoreline conditions collected using regionally consistent protocols and spatially explicit sea level, storm surge, and wave height forecasts	<ul style="list-style-type: none"> Community-Scale Sea Level Rise and Coastal Hazard Assessment (Climate Impacts Group) Developing Strategies and an Accompanying Web Tool for Science-Based Beach Restoration and Protection (WDFW) Prioritizing Sea Level Rise Exposure and Habitat Sensitivity (WA Sea Grant) Puget Sound Chinook Recovery Nearshore Chapter Update (WDFW)
Improve communication among agencies at all levels of government, tribes, and industry partners to catalyze habitat improvements as part of capital/public works projects	<ul style="list-style-type: none"> Advancing Sea Level Rise Adaptation in San Juan County (Friends of the San Juans) Stream Crossing Prioritization Along Puget Sound Shores with a Railroad (Confluence Environmental Company) Stream Crossing Prioritization Along Puget Sound Shores with a Railroad Phase 2: Implementation (Tulalip Tribes)

One remaining gap for this strategy involves identifying sustained funding for education and outreach activities. These activities are not eligible for capital funding disbursed by ESRP, so ongoing grants have been necessary.

Looking ahead, we recommend continuing to focus on integrating sea level rise education and assistance into Shore Friendly programs. Some local programs have begun to address climate vulnerability with participants, and work by Friends of the San Juans to educate and provide technical assistance to residential landowners about potential adaptation measures could provide ideas to help expand these offerings.

Improve regulatory implementation, compliance, enforcement, and communication

Some progress was made towards two of the three near-term priority outcomes associated with the regulatory strategy. As described in Section 5.5, several subawards provided training for local jurisdiction regulatory staff. Opportunities to provide technical support remain. Regulatory implementation and effectiveness monitoring was advanced through subawards discussed in Section 5.3. Although regulatory monitoring and adaptive management guidance and training is now available as a result of HSIL subawards, application by jurisdictions has been limited to date. Moving forward, we recommend funding support for counties and cities to develop and implement programs for their SMP and CAO programs. As noted in Section 6.1, we also recommend HSIL collaborate with regional partners to identify barriers local jurisdictions may face when attempting to develop project proposals for this type of work.

Only one HSIL-funded subaward supported active compliance monitoring via boat-based surveys. Additional grant funding for shoreline surveys may not be necessary. During the 2023 Legislative session, Ecology received funding for Puget Sound marine shoreline habitat surveys ([SB 5104](#)). A baseline survey is due by December 2024 and will be updated on a two-year cycle. However, this appropriation does not include funding for change analysis so there may be need for supplemental funding to identify unpermitted shoreline construction activities.

Design and technical training strategy

Significant progress was made towards both near-term priority outcomes associated with the technical training strategy. As described in Section 2.1, the Shoreline Monitoring Database now houses standardized monitoring protocols for 15 parameters and serves as a regional data repository. Ecological monitoring data spanning 25+ restoration sites and multiple years was analyzed and provided some insights for improving project designs. Gaps relating to protocols for assessing project outcomes from an engineering perspective and property owner satisfaction remain. Given the amount of progress made towards the development of a regional monitoring strategy, future updates to the Shoreline Armoring IS should reflect progress to date and encourage continued use of the standardized protocols and regional Shoreline Monitoring Database.

Progress towards advancing application of the MSDG was discussed in Section 3.2. Although new checklists and other tools to support step-by-step site assessments using MSDG principles

are now available, the need for additional work was reiterated by a subawardee that recommended a comprehensive update to the MSDG.

Looking ahead, we recommend considering investments in workforce development. It is not clear that the new Coastal Training Program class series is reaching enough established engineers/geologists and contractors to overcome their lack of confidence in newer shoreline management techniques. There may be opportunities to instill MSDG principles in trainees by working with students and early career professionals via university programs and the Puget Sound Corps. Centering these efforts on broadening participation from underrepresented populations could also advance Diversity, Equity, and Inclusion goals. The Swinomish Tribe's Shore Friendly program emphasized the use of tribal construction crews for project implementation.

Improve long-term strategic planning

Some progress was made towards near-term priority outcomes associated with the long-term planning strategy. As discussed in sections 4.3.2 and 4.3.4, standardized protocols for mapping Puget Sound shoreline attributes have been developed along with a tool share Beach Strategies data compiled over the past decade. Sea Grant's parcel-scale vulnerability assessment was a big leap forward with respect to providing data about current and future conditions. Other projects discussed in Section 4.5 highlighted application of vulnerability assessments to plan for road relocations in San Juan County, and relationship-building that occurred with the BSNF Railway Company. Similar projects in other jurisdictions and with other partners, such as the Washington State Department of Transportation, should be encouraged.

6.4 DISCREPANCIES WITH NTA OWNER VITAL SIGN SELECTIONS

In several cases, our methods for assigning relationships between subawards and IS resulted in discrepancies with selections made by NTA owners that were captured in funding narratives and Puget Sound data systems like [PS Info](#). In some cases, projects were clearly related to Vital Sign targets but not necessarily to any specific strategies identified in the associated IS. In other cases, we determined projects were more closely aligned with a different IS.

Two specific examples of instances where we made determinations that differed with NTA owner Vital Sign assignments are provided below to describe the type of logic we used to include or exclude projects:

- The Maylor Point feeder bluff armor removal project (NTA 2016-0088) has obvious ties to the (now retired) Shoreline Armoring Vital Sign but did not advance any of the strategies identified in the Shoreline Armoring IS. This is not entirely surprising given that the NTA solicitation occurred prior to development of the IS in 2017.
 - We highlight this example to explain why this project is not discussed in Section 6.3 and also point out a general misalignment between direct recovery actions and IS strategies that typically focus on “upstream” activities and enabling conditions.

- The NTA owner for the Snohomish stream landowner education and assistance program (NTA 2018-0810) linked their project to Shoreline Armoring, Floodplains and Estuaries, and Land Cover and Development.
 - Shoreline Armoring was excluded because the target geography was not marine shorelines.
 - Floodplains and Estuaries was excluded because the project focused on (1) riparian areas adjacent to small rivers and streams rather than floodplains adjacent to the Snohomish River and (2) parcel-scale habitat improvements rather than reach-scale integrated planning.
 - Land Cover and Development was excluded because the financial and technical assistance incentives approach is associated with the working lands strategy. Project assistance was provided for residential parcels not working lands.
 - We ultimately determined that the best fit was the B-IBI IS's develop and deploy incentives to encourage property owners to voluntarily address stream degradation strategy. This IS is managed by the Stormwater SIL. The public review draft of the B-IBI IS was not released until early 2020 so there was a timing mismatch associated with this example as there was with the first example.
 - The Chinook IS's deliver outreach to ensure communities understand the need for and benefits of restoration strategy is also relevant for this project. Some landowners that participated in the program live adjacent to Chinook-bearing rivers.

We've belabored this point not to be pedantic but because the distinction between a funded project being somewhat related to a Vital Sign versus truly operationalizing a specific strategy is important to recognize as the larger Implementation Strategy program matures and individual IS are being adaptively managed. Reliance on NTA owner-reported data may overstate project funding for implementation of older IS and understate the number of projects associated with newer IS. With the 2022-2026 Action Agenda, the Puget Sound Program funding model moved from a single biennial solicitation for NTA proposals to multiple strategic solicitations that can better articulate IS strategies and approaches. It is expected that, compared to the NTA model, this SIL 2.0 funding model will result in more proposed projects that more closely align with IS strategies.

6.5 SUBAWARDS RELATED TO OTHER IMPLEMENTATION STRATEGIES

Table 25 identifies linkages between HSIL subawards and IS managed by others.

We had difficulty assigning connections with Chinook IS strategies because some are fairly broad. This was particularly true for the research strategy, where several other monitoring and information gap subawards (e.g., food web subawards) could be considered an emerging issue. Following our method of strictly construing relationships, we ultimately included only those research projects with a Chinook focus. We identified 29 projects that advanced seven strategies and ten approaches.

We assigned projects focusing on smaller rivers and streams with B-IBI rather than Floodplains and Estuaries since that Vital Sign references 17 major rivers. Nine projects advanced three strategies and four approaches.

We linked a two projects with the Toxics in Fish IS remove legacy sources of contaminants approach and two with the Marine Water Quality IS advance marine waters monitoring and research programs strategy. In Table 25 we also identify an opportunity for cross-cutting work with the Stormwater SIL. The Marine Water Quality IS's restore natural nutrient attenuation strategy identifies a need to expand knowledge about design of floodplain, wetland, and estuary restoration projects to achieve nutrient reduction benefits.

Table 25. Subawards related to IS not managed by HSIL

Chinook: Improve regional technical support for research	
Research that helps address emerging issues	<ul style="list-style-type: none"> • Growth and life history strategies Salish Sea Chinook salmon (WDFW) • Status and Trends of Chinook salmon abundance, life history diversity, and productivity in response to recovery plan actions and environmental variability (Skagit Co-Op)
Research that identifies where specific efforts need more attention in the biogeographic regions	<ul style="list-style-type: none"> • EMDS Open Platform for Spatial Decision Support (Tulalip Tribes) • Developing tools for multi-benefit project selection and sequencing in the Snohomish River Basin (Tulalip Tribes) • Hood Canal Landscape Assessment and Prioritization Tool (HCCC) • North Sound Riparian Modeling and Monitoring (Skagit River System Cooperative) • A Salmon Life Cycle Model to Support Multi-Benefit Actions and Adaptive Planning in the Stillaguamish Watershed (Snohomish County) • Utilizing PIT technology to assess juvenile Chinook use of and survival within habitat improvement project (King County) • Water Type and eDNA Assessment (Wild Fish Conservancy)
Chinook: Improve regional support for protection and acquisition	
Increase funding for acquisition and landowner incentives to protect remaining habitat	<ul style="list-style-type: none"> • Forest Health Management for Reduced Stormwater Runoff and Land Conversion (Puget Sound Conservation District Caucus) • Improved Landowner Development Decisions to Protect Critical Areas and Manage Stormwater (Kitsap County) • Living with Beavers Program (Snohomish Conservation District)
Evaluate the effectiveness of existing land use regulations	<ul style="list-style-type: none"> • Effectiveness monitoring of regulations regarding shoreline, critical areas, and stormwater requirements (Kitsap County) • Enhancing Critical Area Ordinance Effectiveness via Adaptive Management (WDFW) • Puget Sound Critical Areas M&AM Program (Commerce) • San Juan County Shoreline Armor Change Analysis (Friends of the San Juans)

Chinook: Improve regional support for restoration	
Improve permitting processes to reduce administrative delays	<ul style="list-style-type: none"> • Improve soft shore permitting processes (WDFW)
Deliver outreach to ensure communities understand the need for and benefits of restoration	<ul style="list-style-type: none"> • Engaging the Community in Strait Ecosystem Recovery (Jefferson County) • Stream Landowner Education and Assistance Program (Snohomish County)
Chinook: Improve regional disaster preparedness	
Oil spills	<ul style="list-style-type: none"> • Evaluate the status of marine birds at greatest risk from oil spills (Seattle Audubon) • Model Volunteer Program for Oil Spill Response/Assessment (WSU Extension) • Policy use on dispersant use in San Juan County Waters (University of Washington) • Vessel Traffic Risk Consequences in the Salish Sea (San Juan County) • Vessel Traffic Oil Spill Risk Consequences - Expanded Assessment (San Juan County)
Chinook: Increase collaboration with resource industries	
Align industry plans and practices with salmon recovery	<ul style="list-style-type: none"> • Implementation of Recommendations from the Coastal Streams and Embayments Prioritization Along Puget Sound Shores with a Railroad (Tulalip Tribes) • Stream Crossings Prioritization Along Puget Sound Shores with a Railroad (Confluence Environmental Company)
Chinook: Establish and enforce water quantity and quality standards	
Ensure regulations protect, conserve, and restore water resources for salmon	<ul style="list-style-type: none"> • Effectiveness monitoring of regulations regarding shoreline, critical areas, and stormwater requirements (Kitsap County)
Chinook: Develop funding and communication strategies	
Mobilize public action and support for recovery	<ul style="list-style-type: none"> • Engaging the Community in Strait Ecosystem Recovery (Jefferson County) • Restoring Nearshore Habitat for Chinook (WDFW)

Freshwater Quality (B-IBI): Develop and deploy incentives to encourage property owners to voluntarily undertake actions to remedy conditions associated with stream degradation	
Riparian, in-stream, and wetland habitat restoration	<ul style="list-style-type: none"> • Living with Beavers Program (Snohomish Conservation District) • Forest Health Management for Reduced Stormwater Runoff and Land Conversion (Puget Sound Conservation District Caucus) • Stream Landowner Education and Assistance Program (Snohomish County)
Freshwater Quality (B-IBI): Improve funding, increase staff, and expand the availability of decision support tools for local stormwater management programs	
Improve implementation of stormwater permit requirements	<ul style="list-style-type: none"> • Effectiveness monitoring of regulations regarding shoreline, critical areas, and stormwater requirements (Kitsap County) • Puget Sound Critical Areas Monitoring and Adaptive Management Program (Commerce)
Freshwater Quality (B-IBI): Promote multi-program and cross-jurisdictional planning to protect high quality streams and coordinate restoration actions	
Synthesis, evaluation, and effectiveness monitoring	<ul style="list-style-type: none"> • Effectiveness monitoring of regulations regarding shoreline, critical areas, and stormwater requirements (Kitsap County) • Enhancing Critical Area Ordinance Effectiveness via Adaptive Management (WDFW)
Coordinate restoration actions at the basin scale to maximize benefits	<ul style="list-style-type: none"> • EMDS Open Platform for Spatial Decision Support for Salmon Recovery (Tulalip Tribes) • National Hydrography Dataset Update and Pilot Downstream Fish Passage Barrier Tool (WDFW) • Recovery of select salmonid habitat in the San Juan Islands (San Juan County LE)
Toxics in Fish: Incentivize Product Replacement Programs	
Remove legacy sources of contaminants	<ul style="list-style-type: none"> • Puget Sound Creosote Removal Program (WDNR) • Snohomish Estuary Cleanup (Snohomish Marine Resources Committee)

Marine Water Quality: Restore Natural Nitrogen Attenuation	
Expand knowledge about design of floodplain, wetland, and estuary restoration projects to achieve nutrient reduction benefits	No HSIL subawards, but this strategy provides a cross-cutting opportunity for HSIL and the Stormwater SIL
Marine Water Quality: Advance Marine Waters Monitoring and Research Programs	
Improve understanding of biological responses to nutrient stressors	<ul style="list-style-type: none"> Investigation of nutrients, phytoplankton and food web interactions in the Eastern Strait of Juan de Fuca and Admiralty Inlet (Jamestown Tribe)
Expand ambient monitoring programs	<ul style="list-style-type: none"> Add Acidification Parameters to Ecology Monitoring Network (Ecology)

6.6 SUBAWARDS RELATED TO ACTION AGENDA PRIORITIES

Table 26 provides information about HSIL subawards that addressed high priority issues identified in the 2016-2017 and 2018-2022 Action Agendas. Strategy identifiers reflect the [numbering system](#) used in the 2022-2026 Action Agenda.

Table 26. Subawards related to Action Agenda priorities

Fish Passage Barriers (Strategy 6)
<ul style="list-style-type: none"> • Advancing Western Strait Fish Passage Barrier Removal (North Olympic Peninsula LE) • Implementation of Recommendations from the Coastal Streams and Embayments Prioritization Along Puget Sound Shores with a Railroad (Tulalip Tribes) • Kristoferson Creek Fish Passage Improvements (Snohomish Conservation District) • National Hydrography Dataset Update (WDFW) • Stream Crossings Prioritization Along Puget Sound Shores with a Railroad (Confluence Environmental Company)
Streamflow Restoration Planning (Strategy 7)
<ul style="list-style-type: none"> • Numerical Groundwater Model to Support Stream Flow Management Needs (Whatcom PUD #1) • Regional (WRIA 1-Wide) Water Supply and Management Plan (Whatcom PUD #1)
Oil Spills (Strategy 13)
<ul style="list-style-type: none"> • Evaluate the status of marine birds at greatest risk from oil spills (Seattle Audubon) • Model Volunteer Program for Oil Spill Response/Assessment (Washington State University Extension) • Policy on Dispersant Use in San Juan County Waters (University of Washington) • Vessel Traffic Risk Consequences in the Salish Sea (San Juan County) • Vessel Traffic Oil Spill Risk Consequences - Expanded Assessment (San Juan County)
Invasive Species (Strategy 14)
<ul style="list-style-type: none"> • Washington Sea Grant Crab Team (Washington Sea Grant)
Research and Monitoring (Institutional Strategy C)
<ul style="list-style-type: none"> • Puget Sound Zooplankton Monitoring Program (LLTK and WDFW) • Subtidal Monitoring of Shoreline Restoration Effectiveness (Puget Sound Institute) • Ocean Acidification Resilience across Habitat Types (WDNR) • Add Acidification Parameters to Ecology Monitoring Network (Ecology) • Puget Sound Sand Lance Habitat Characterization and Mapping (WDFW)

- Investigation of nutrients, phytoplankton, and food web interactions, in the Eastern Strait of Juan de Fuca and Admiralty Inlet (Jamestown Tribe)
- West Sound Eelgrass Monitoring Program (WDFW and Suquamish Tribe)
- East Kitsap Forage Fish Monitoring (Suquamish Tribe)
- Washington Sea Grant Crab Team (Washington Sea Grant)
- Forage Fish Habitat Tidal Range (WDFW)

K-12 Education (Institutional Strategy D)

- Citizen science and K-12 education program to monitor local aquatic habitat effects from climate change (WDNR)
- Engaging the Community in Strait Ecosystem Recovery (Jefferson County)

Volunteer Engagement (Institutional Strategy D)

- Citizen science and K-12 education program to monitor local aquatic habitat effects from climate change (WDNR)
- Engaging the Community in Strait Ecosystem Recovery (Jefferson County)
- Evaluate the status of marine birds at greatest risk from oil spills (Seattle Audubon)
- Model Volunteer Program for Oil Spill Response/Assessment (Washington State University Extension)

CHAPTER 7: GEOGRAPHY OF HSIL 1.0 INVESTMENTS

Chapter 4 demonstrates the unique interplay between regional and local recovery efforts that can occur with HSIL funding. Here we identify subawards that focused on local activities within a single LIO. As described in Section 1.4, EPA’s annual funding guidance allowed each LIO to direct approximately \$100,00 of funding each year. Table 27 **shows LIO direct awards made by HSIL in italic text** along with SIAT-directed awards in normal text. Figure 20 is a map showing the number of subawards for each LIO.

Table 27. Subaward distribution by Local Integrating Organization areas

Alliance for A Healthy South Sound
<ul style="list-style-type: none"> • <i>Expanding South Sound Shore Friendly Programs (Pierce Conservation District)</i>⁴⁵ • Mud Bay Habitat Protection (Capital Land Trust)
Hood Canal Coordinating Council
<ul style="list-style-type: none"> • An investigation of nutrients and phytoplankton in Admiralty Inlet and northern Hood Canal (Jamestown S’Klallam Tribe) • <i>Chimacum Creek Restoration and Protection Project - Phase 2 (North Olympic Salmon Coalition)</i> • <i>Hood Canal Bridge Assessment (HCCC)</i> • Hood Canal and Eastern Strait of Juan de Fuca Summer Chum Salmon Recovery Status of Threats (HCCC) • Hood Canal Landscape Assessment & Prioritization Tool (HCCC) • Hood Canal Landscape Assessment & Prioritization Tool - Phase 2 (HCCC) • <i>Integrated Watershed Plan Monitoring and Adaptive Management (HCCC)</i>
Island LIO
<ul style="list-style-type: none"> • <i>Local Coordination to Advance PSNERP-identified projects: Livingston Bay Restoration Feasibility Study (Whidbey Camano Land Trust)</i>⁴⁶ • <i>Kristoferson Creek Fish Passage Improvements (Snohomish Conservation District)</i> • Maylor Point Feeder Bluff Armoring Removal (Northwest Straits Foundation)

⁴⁵ We excluded projects that span more than one LIO geography in this table because we consider those regional efforts. This project was a direct award selected by the Alliance for A Healthy South Sound—even though a portion of the work occurred in the Hood Canal Coordinating Council geography—so we elected to include it here.

⁴⁶ The NTA associated with this project was a regional effort owned by WDFW. This element of that larger proposal was funded through a “Shared Investment Pilot” selected by the LIO rather than a LIO direct award.

San Juan Action Agenda Oversight Group
<ul style="list-style-type: none"> • <i>Advancing Sea Level Rise Adaptation in San Juan County (Friends of the San Juans)</i> • <i>Assessing Pacific Sand Lance Subtidal Habitats and Biomass in the San Juans (Moss Landing Marine Labs)</i> • <i>Policy on Dispersant Use in San Juan County Waters (University of Washington)</i> • <i>Recovery of select freshwater salmonid habitat in the San Juan Islands (San Juan LE)</i> • <i>San Juan County Shoreline Armor Change Analysis 2009 to 2019 (Friends of the San Juans)</i> • <i>Vessel Traffic Risk Consequences in the Salish Sea (San Juan County)</i> • <i>Vessel Traffic Oil Spill Risk Consequences - Expanded Assessment (San Juan County)</i>
Snohomish/Stillaguamish LIO
<ul style="list-style-type: none"> • Balancing Fish, Farms and Floods in King County's Snoqualmie Watershed (King County) • Developing tools for multi-benefit project selection and sequencing in the Snohomish River Basin (Tulalip Tribes) • EMDS Open Platform for Spatial Decision Support for Salmon Recovery (Tulalip Tribes) • Geomorphic Flood Hazard Risk on the Lower Skykomish River (Snohomish County) • Integrating climate resilience into farm-fish-flood project packages in the Snohomish and Stillaguamish River floodplains (Snohomish Conservation District) • <i>Living with Beavers Program (Snohomish Conservation District)</i> • Monitoring effectiveness of multi-benefit floodplain project implementation in Snohomish and Stillaguamish Rivers (Snohomish Conservation District) • North Fork Stillaguamish Integrated Floodplain Management (Snohomish County) • Salmon Life Cycle Model to Support Multi-Benefit Actions and Adaptive Planning in the Stillaguamish Watershed (Snohomish County) • Shoreline armoring monitoring and characterization of chinook salmon rearing capacity in edge habitats of Snohomish-Stillly LIO rivers • <i>Snohomish Estuary Derelict Vessel Removal (Snohomish Marine Resources Committee)</i> • <i>Stillaguamish Floodplain Acquisitions and Restoration (Stillaguamish Tribe of Indians)</i> • Stream and Lakeside Landowner Education and Assistance Program (Snohomish County) • Sustainable Lands Strategy Communication and Outreach (WDFW)

South Central Action Agenda Caucus Group ⁴⁷
<ul style="list-style-type: none"> • <i>Marine Shoreline Technical Assistance (King Conservation District)</i> • <i>Riparian/Land Cover Change Analysis and Decision Support System (Pierce County LE)</i> • <i>South Prairie Creek (River Miles 4.0 to 4.6) Floodplain Project Phase 1 (South Puget Sound Salmon Enhancement Group)</i> • <i>Utilizing passive integrated transponder (PIT) technology to assess juvenile Chinook use of and survival within habitat improvement project (WRIA 9 LE)</i>
Strait Ecosystem Recovery Network
<ul style="list-style-type: none"> • <i>Advancing Western Strait Fish Passage Barrier Removal (North Olympic LE)</i> • <i>Engaging the Community in Strait Ecosystem Recovery (Jefferson County)</i> • <i>Investigation of nutrients, phytoplankton and food web interactions in the Eastern Strait of Juan de Fuca and Admiralty Inlet (Jamestown Tribe)</i> • <i>Phase 2 Municipal Level Climate Action Planning for the North Olympic Peninsula (North Olympic Peninsula Resource Conservation and Development Council)</i> • <i>Revegetating the Elwha (Lower Elwha Klallam Tribe)</i>
West Sound Partners for Ecosystem Recovery
<ul style="list-style-type: none"> • <i>Curley Creek Prioritized Restoration (Mid Sound Fisheries Enhancement Group)</i> • <i>East Kitsap Forage Fish Monitoring (Suquamish Tribe)</i> • <i>Effectiveness Monitoring of regulations regarding shoreline, critical areas, and stormwater requirements (Kitsap County)</i> • <i>Improved Landowner Development Decisions to Protect Critical Areas and Manage Stormwater (Kitsap County)</i> • <i>Shore Friendly Kitsap - Reduction in Marine Shoreline Armoring (Kitsap County)</i> • <i>Strategic West Central Water Type and eDNA Assessment (Wild Fish Conservancy)</i> • <i>West Central Nearshore Restoration Prioritization and Armor Removal (Kitsap County)</i> • <i>West Sound Eelgrass Monitoring Program (Suquamish Tribe)</i>

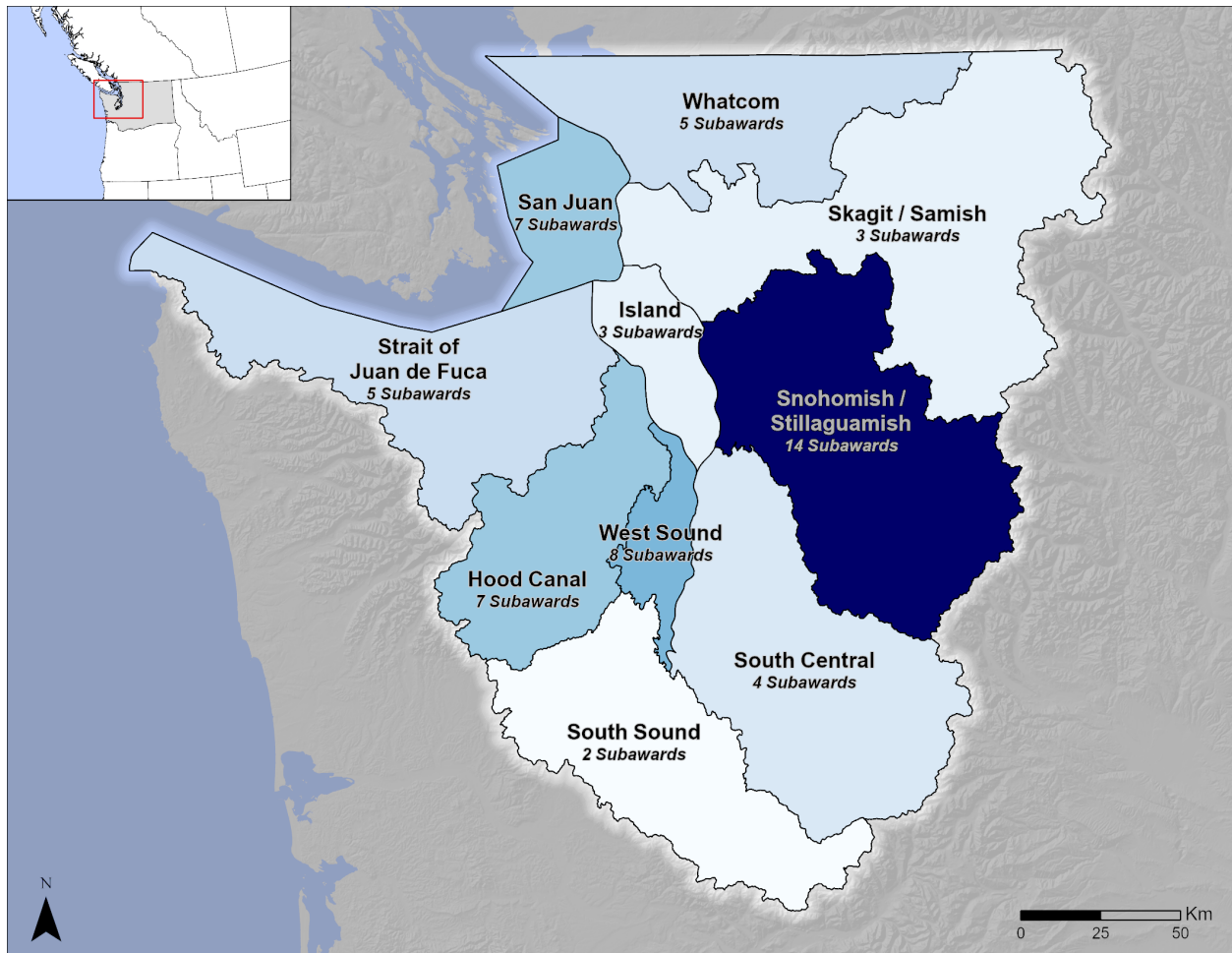
⁴⁷ During the final year of the HSIL 1.0 period, a Puyallup-White River LIO was created out of the South-Central Action Agenda Caucus Group. Two of these projects occurred within that new Puyallup-White geography, and two occurred in the smaller South-Central geography.

Whatcom LIO
<ul style="list-style-type: none"> • Develop Data and Support for Floodplain Management Strategies (Whatcom County) • <i>Drainage-Based Management Planning (Whatcom County)</i> • <i>Numerical Groundwater Model to Support Stream Flow Management Needs (PUD #1)</i> • <i>Regional (WRIA 1-Wide) Water Supply and Management Plan (PUD #1)</i> • WRIA 1 Integrated Program Outreach and Engagement (Whatcom PUD)

The Skagit/Samish watershed lacks a LIO, but HSIL funded three local projects there:

- North Sound Riparian Modeling and Monitoring (Skagit River System Cooperative)
- Skagit HDM Priority Projects (WDFW)
- 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)

Figure 20. Number of subawards in each LIO area



Map by Kevin Bogue, Puget Sound Institute

CHAPTER 8: KEY FINDINGS AND RECOMMENDATIONS

- Several of the projects in the HSIL 1.0 portfolio built upon earlier efforts funded by their predecessor, the Marine and Nearshore LO, 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.
- 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.
- Funding support from HSIL 1.0 ensured three programs could continue as they transitioned away from grant funding. The Puget Sound Zooplankton Monitoring Program, Shore Friendly, and the Sea Grant Green Crab Team have since 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.
- LIO direct awards resulted in funding for Action Agenda priorities like K-12 curriculum development, volunteer engagement, and oil spill research. These types of projects are not well aligned with the HSIL 2.0 funding model.
- Multiple IS—Land Development and Cover, Shoreline Armoring, and Chinook—emphasize the importance of understanding and improving implementation of existing regulations to ensure that remaining habitat is protected as intended by law. We recommend regional partners continue to encourage jurisdictions throughout the region to conduct effectiveness and compliance monitoring by providing funding and technical support. Since a 2023 solicitation for these types of projects did not generate proposals, we also recommend HSIL consider collaborating with regional recovery partners to investigate barriers jurisdictions face when initiating this type of work. Understanding specific roadblocks is necessary before designing technical assistance programs that could increase uptake of funding opportunities.
- It is crucial that the National Hydrography Dataset continue to receive updates to improve locational accuracy. This authoritative dataset is best available science for regulatory purposes and is a core data layer for many decision support tools. High Resolution Change Detection data products have proven to be extremely useful for regulatory effectiveness monitoring and should also continue to be updated. We recommend that HSIL collaborate with the PSEMP Spatial Data Work Group to identify additional opportunities to improve geospatial platforms managed by state agencies. In addition, there is work to be done to

evaluate how tools developed with HSIL funding are being used in the context of land use planning. There may be opportunities to expand to new geographies.

- Although regional partners have been successful in obtaining legislative appropriations for Floodplains by Design and Shore Friendly, there remains a need for funding to support important program elements not eligible for capital funding. Program elements like education and outreach, relationship building, grant application support, and reach scale planning are prerequisites for development of the capital restoration projects funded by these programs.
- Regional partners should consider investigating barriers to more consistent implementation of social marketing principles during the development of new incentive programs or expansion of existing programs, then identify strategies to address those barriers. Since the Stewardship and Education LO did not have a clear successor in EPA's revised funding model, there may be a gap in social marketing expertise accessible to local organizations.
- Local jurisdictions are stretched thin and lack capacity to take on major climate planning and implementation efforts without outside support. Subawardees found that use of intermediary agents (e.g., regional organizations like the North Olympic Peninsula Resource Conservation and Development Council, UW's Climate Impacts Group, or the Floodplains by Design network as well as consultants) helped to address capacity issues. The support intermediary agents provide can bridge the gap between smaller jurisdictions and state/federal government resources; build connections among neighboring entities; and expands regional capacity in grant writing and administration.
- We identify several opportunities for future cross SIL collaboration on topics such as: brownfield redevelopment; incorporation of stormwater requirements into regulatory effectiveness work; sea level rise risk to on-site sewage systems; and design of floodplain, wetland, and estuary restoration projects to achieve nutrient reduction benefits. In addition, riparian decision support tools and models developed with HSIL funding may be useful to the new Climate Resilient Riparian Systems Lead.

ACRONYMS AND ABBREVIATIONS

3FI	Farm, Fish, Flood Initiative
ANeMoNe	Acidification Nearshore Monitoring Networks
BNSF	Burlington Northern Santa Fe
CAO	Critical Areas Ordinance
CIG	Climate Impacts Group
Commerce	Washington Department of Commerce
Corps	U.S. Army Corps of Engineers
DNR	Washington Department of Natural Resources
Ecology	Washington Department of Ecology
EIA	Ecological Integrity Assessments
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
ESRP	Estuary and Salmon Restoration Program
FbD	Floodplains by Design
FEMA	Federal Emergency Management Agency
FLIP	Floodplains Integrated Planning
GMA	Growth Management Act
HCCC	Hood Canal Coordinating Council
HPA	Hydraulic Project Approval
HDM	Hydrodynamic Modeling
HRCD	High Resolution Change Detection

HSIL	Habitat Strategic Initiative Lead
IFM	Integrated Floodplain Management
IS	Implementation Strategy
LAP	Landscape Assessment and Prioritization Tool
LE	Lead Entity
LiDAR	Light Detection and Ranging
LIO	Local Integrating Organization
LLTK	Long Live the Kings
LO	Lead Organization
M&AM	Monitoring and adaptive management
MART	Multi-Agency Review Team
MRC	Marine Resources Committee
MSDG	Marine Shoreline Design Guidelines
NEP	National Estuary Program
NHD	National Hydrography Dataset
NOAA	National Oceanic and Atmospheric Administration
NODC	North Olympic Peninsula Resource Conservation and Development Council
NTA	Near-Term Action
NWSF	Northwest Straits Foundation
OA	Ocean Acidification
PIT	Passive Integrated Transponder
PSEMP	Puget Sound Ecosystem Monitoring Program

PSNERP	Puget Sound Nearshore Ecosystem Restoration Project
PSP	Puget Sound Partnership
PUD	Public Utility District
SEPA	State Environmental Policy Act
SIAT	Strategic Initiative Advisory Team
SIL	Strategic Initiative Lead
SLR	Sea Level Rise
SLS	Sustainable Lands Strategy
SMA	Shoreline Management Act
SMP	Shoreline Master Program
SPTH	Site-Potential Tree Height
SSMSP	Salish Sea Marine Survival Project
TNC	The Nature Conservancy
UGA	Urban Growth Area
USFWS	U.S. Fish and Wildlife Service
USGS	United States Geological Survey
WDFW	Washington Department of Fish and Wildlife
WDNR	Washington Department of Natural Resources
WRIA	Water Resource Inventory Area
WSU	Washington State University

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