

Final

MEADOWDALE BEACH PARK AND ESTUARY RESTORATION EFFECTIVENESS MONITORING

Year 3 Report

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Snohomish County
Surface Water Management

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Final

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Year 3 Report

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CONTENTS

Year 3 Report

	<u>Page</u>
Introduction	1
Restoration Project Goals and Objectives	2
A Collaborative Monitoring Partnership.....	3
Monitoring Area Definitions and Sampling Locations	3
Overview of Monitoring Elements	6
Required Monitoring Elements	8
Fish Passage Conditions (Monitoring Element A)	8
Channel Cross-Sections and Profile Surveys (Monitoring Element B)	9
Stream Habitat in Lower Lund's Gulch Creek and Creek Outlet (Monitoring Element C); Large Wood Retention and Recruitment in Upper Estuary (Monitoring Element D)	17
Planted Vegetation Survival and Coverage (Monitoring Element E)	30
Additional Monitoring Elements	34
Sediment Dynamics and Habitat Area in Upper Estuary and Creek Outlet (Monitoring Element F) and Adjacent Nearshore (Monitoring Element G)	34
Fish Use (Monitoring Element H)	35
Salmon Spawning Ground Surveys (Monitoring Element I)	42
Forage Fish Egg Presence (Monitoring Element J)	43
Additional Vegetation Characteristics (Monitoring Element L)	45
Photo Points (Monitoring Element M)	49
Summary of Year 3 Monitoring Findings	52
Adaptive Management Issues and Recommendations	53
Fish Passage Conditions	53
Channel Cross-Sections and Profile Surveys	53
Stream Habitat in Lower Lund's Gulch Creek and Creek Outlet	53
Planted Vegetation Survival and Coverage	53
References	54

Figures

Figure 1	Monitoring Areas.....	4
Figure 2	Sampling Reaches.....	5
Figure 3	Cross Section Locations	6
Figure 4	Topographic data points for cross sections (1-24) and longitudinal profiles (2016, 2021, 2023, 2025).....	10
Figure 5	Cross Section Series 1-4	12
Figure 6	Cross Section Series 5-8	13
Figure 7	Cross Section Series 9-11	14
Figure 8	Cross Section Series 13-16	15
Figure 9	Lund's Gulch Creek Longitudinal Profile	16
Figure 10	B-IBI Sample Collection Locations in 2021 and 2023-2025.....	19
Figure 11	Map of 2021 and 2023-2025 Habitat Unit Survey by Year and Habitat Type	20
Figure 12	Lund's Gulch Creek Excavated Embayment Area Looking Upstream Toward the Creek Mouth	22
Figure 13	Time series of B-IBI scores at Lund's Gulch Creek (2005 through 2025).	26
Figure 14	Time series of Percent Tolerant Taxa (%) scores at Lund's Gulch Creek (beginning 2005 through 2025).....	27
Figure 15	Map view of large woody material surveyed in 2025	29
Figure 16	Large Woody Material (flagged) with Rootwads Placed in Lund's Gulch Reach 3.....	29
Figure 17	Vegetation Monitoring Plots, Transects, and Photo Points	31
Figure 18	Proportional Fish Species Composition by Location in Electrofishing Reaches.....	37
Figure 19	CPUE of Salmonids During Electrofishing (by month and sampling reach)	38
Figure 20	Adjacent Nearshore Beach Seining Sampling CPUE	39
Figure 21	Adjacent Nearshore Beach Seining Sampling CPUE – Salmonids Only	39
Figure 22	Salinity Tolerance of Species Across Elevations	48
Figure 23	Photo Points Established Along Beach Transects	50
Figure 24	Photo Points Established in the Upper Estuary, Creek Outlet, and Lower Lund's Gulch Creek.....	51

Tables

Table 1	Sampling Reaches.....	5
Table 2	Effectiveness Monitoring Elements.....	7
Table 3	Pre- and Post-Restoration Aquatic Habitat Mapping By Sampling Reach	18
Table 4	Lund's Gulch Creek Pre-construction and Post-construction Stream Characteristics	21
Table 5	2023 and 2024 Summer Habitat Inventory	23
Table 6	Pool Habitat Indicators and Metrics Calculated by Year	23
Table 7	Stream Temperature Data In Lund's Gulch Creek.....	24
Table 8	Benthic Macroinvertebrate Data Collection Years and Results for 10 Metrics That Contribute to the Final B-IBI Scores (0–100)	25
Table 9	Surface Fine Sediment Composition Among Sampled B-IBI Riffles	27
Table 10	Large Woody Material Inventory	28
Table 11	Electrofishing – Number of Fish Species Captured per Sampling Date	36
Table 12	Beach Seine – Number of Fish Species Captured per Sampling Date	36
Table 13	Electrofishing Results Pre- and Post-Restoration	40
Table 14	Fish Use Monitoring Summary.....	41
Table 15	Salmon Spawning Ground Surveys Monitoring Summary	43
Table 16	Forage Fish Eggs Detected in Surveys.....	44
Table 17	Salinity Tolerance Categories	45
Table 18	Recorded Soil Salinity and Elevation (October 3, 2024).....	46

Table 19 Recorded Species Salinity tolerance 47

Table 20 Summary of Monitoring Results..... 52

Appendices

- A. Fish Passage Conditions
- B. Habitat Unit Survey, April 2023 (Conducted by Tulalip Tribes)
- C. Vegetation Monitoring Data Table
- D. Vegetation Monitoring Transect Photographs and Photo Points
- E. Beach Transects Photo Points
- F. Estuary Transects Photo Points
- G. Stream Transects Photo Points

Acronyms and Other Abbreviations

Abbreviation	Definition
ADA	Americans with Disabilities Act
BFW	bankfull width
B-IBI	Benthic Index of Biotic Integrity
BNSF	Burlington Northern Santa Fe
CPUE	catch per unit effort
DSM	digital surface model
GPS	global positioning system
Meadowdale project	Meadowdale Beach Park and Estuary Restoration project
MTL	mean tide level
NOAA	National Oceanic and Atmospheric Administration
PIT	passive integrated transponder
RTK-GPS	Real-Time Kinematic Global Positioning System
WDFW	Washington Department of Fish and Wildlife

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MEADOWDALE BEACH PARK AND ESTUARY RESTORATION EFFECTIVENESS MONITORING

Year 3 Report

Introduction

In 2023, Snohomish County Department of Conservation and Natural Resources (Snohomish County) completed construction of the Meadowdale Beach Park and Estuary Restoration project (Meadowdale project). The Meadowdale project transformed the site to restore fish passage, improve salmon habitats, increase the site's resilience to climate change, and improve the park experience and safe access to the Puget Sound shoreline.

The primary components of the Meadowdale project were the replacement of an undersized 6-foot-wide culvert with a multi-span railroad bridge to create a 90-foot-wide channel opening at the mouth of Lund's Gulch Creek, the excavation of a 1-acre estuary immediately upstream from the Burlington Northern Santa Fe (BNSF) railroad crossing, and an expanded tidal channel downstream of the railroad crossing. Native riparian planting and large woody material installation in the estuary and stream further improve habitat conditions.

The Meadowdale project restored estuary habitat to benefit salmon originating in Lund's Gulch Creek as well as juvenile salmon migrating to the site from other river systems. One primary objective of the restoration was to improve habitat for rearing by juvenile Chinook salmon (*Oncorhynchus tshawytscha*) which are listed under the Endangered Species Act. In addition to salmon, the project aimed to benefit other fish and wildlife species who use estuary habitats and restore fluvial, estuarine, and coastal processes in the project area.

Project construction began in 2021 with the excavation of much of the enlarged estuary. In 2022, the new railroad bridge was installed, and the rest of the estuary excavation was completed. Important habitat restoration refinements were made in 2023 so that the constructed project more fully matched the engineer's final design.

The Meadowdale project is regionally significant due to the railroad bridge component and the extent of estuary habitat restoration at the site. This is the first restoration in Puget Sound that included replacing a railroad crossing to improve habitat restoration and fish passage in a larger project. Another aspect of regional significance is the repurposing of a substantial portion of the park area near the railroad from a recreational focus to a habitat focus.

Snohomish County and multiple partners are committed to monitoring the site and evaluating the effectiveness of the restoration. A 10-year effectiveness monitoring plan was prepared to guide the

monitoring program as described in the *Meadowdale Beach Park and Estuary Restoration Monitoring Plan* (Monitoring Plan; ESA 2022). The Monitoring Plan was developed with input from a monitoring work group of experts convened by Snohomish County. As this is the first stream mouth restoration project along the Puget Sound shoreline impacted by the BNSF railroad, effectiveness monitoring is particularly important to inform the design of future restoration projects at other stream mouths. In addition, the effectiveness monitoring provides essential information to document the benefits and sustainability of investments by Snohomish County, the grant funding programs that contributed to the restoration, and to BNSF Railway, which controls the right-of-way.

The Monitoring Plan includes monitoring elements and performance standards that are required as part of grant funding and permit agreements for the National Oceanic and Atmospheric Administration (NOAA) Coastal and Marine Habitat Restoration Grant. The Monitoring Plan also identifies several additional monitoring elements focused on other aspects of project effectiveness, some of which are of regional interest and potentially important for future project development and design at other railroad embanked stream deltas at nearshore or estuarine locations.

This Year 3 post-restoration report documents the monitoring work completed in 2025 and evaluates the performance for each of the monitoring elements studied. Data Collected in Year 3 is compared to Year 1 baseline data. This Year 3 Monitoring Report describes the methods used, any deviations from approved methods, and the results of the monitoring at the Meadowdale project site in Year 3 (2025). It also presents analysis and evaluations to determine if the Meadowdale project site is meeting performance standards and includes recommendations for adaptive management at the site and/or revisions to the monitoring methods to better assess on-site conditions. Monitoring will continue at specific intervals over a period of 10 years, as described by the Monitoring Plan.

Restoration Project Goals and Objectives

The restoration goals and objectives inform the meaning of project effectiveness for the Meadowdale project. The following goals and objectives are from the Restoration Design Report (Anchor QEA 2018).

The overarching ecological goal of the project was to restore the estuary of Lund's Gulch Creek, including natural sediment and hydrologic processes in order to provide high-functioning, sustainable rearing habitat for non-natal juvenile Chinook (listed as threatened by the Endangered Species Act), as well as Coho (*O. kisutch*) and chum salmon (*O. keta*), coastal cutthroat trout (*O. clarkii clarkii*), and other fish species within the park setting. Given the setting and the presence of a high-volume railroad line through the project area, a complementary goal of the project was to provide ecological restoration improvements while maintaining compatible recreational uses, particularly improved public access to the beach.

Specific project objectives to achieve the goals included the following:

- Remove approximately 130 linear feet of hard-armored railroad embankment and the undersized (6-foot-wide) culvert.
- Install a multi-span bridge with a 90-foot opening to dissipate flood waters, restore natural sediment transport processes, and allow the creek to meander dynamically over time, creating essential habitat.

- Create approximately 1 acre of tidal estuary habitat.
- Restore approximately 1 acre of nearshore and stream riparian buffers along the shoreline and stream using native trees and shrubs.
- Restore in-stream habitat conditions by placing large woody debris in the lower creek and restored estuary.
- Address public safety (railroad crossing) and beach access issues associated with the undersized culvert, sediment, and flooding.
- Provide Americans with Disabilities Act (ADA)-compliant and year-round access to the beach.
- Enhance the park user experience through provision of diverse natural habitats.
- Enhance environmental education opportunities, including providing interpretive signage.

A Collaborative Monitoring Partnership

The planning and implementation of the monitoring program is a highly collaborative effort among many organizations. Snohomish County convened a monitoring work group to guide monitoring activities. The monitoring work group includes partners from Snohomish County, Tulalip Tribes, Snohomish County Marine Resources Committee, Edmonds Stream Team, Blue Coast Engineering, Environmental Science Associates, U.S. Geological Survey, and Washington Sea Grant. Snohomish County appreciates the contributions each of these partners has made to monitoring efforts.

Monitoring Area Definitions and Sampling Locations

The monitoring plan includes monitoring activities in five distinct areas. From upstream to downstream, the monitoring areas are defined as follows and shown in **Figure 1**:

- **Lower Lund’s Gulch Creek** – Portion of the stream where restoration occurred; the upstream end is the pedestrian bridge near the Park Ranger’s house.
- **Creek Outlet** – Transitional area where the creek widens as it enters the restored upper estuary.
- **Upper Estuary** – Restored tidal estuary landward of the railroad, including the area under the railroad bridge.
- **Lower Estuary** – Estuary waterward of the railroad bridge and including the entire shoreline delta.
- **Adjacent Nearshore** – Adjacent areas north and south of the project area.

The outlined areas on the map are the general boundaries of each monitoring area and are not strict outlines of the extent of sampling. For example, vegetation monitoring in the upper estuary may extend outside of the outline shown in **Figure 1**.

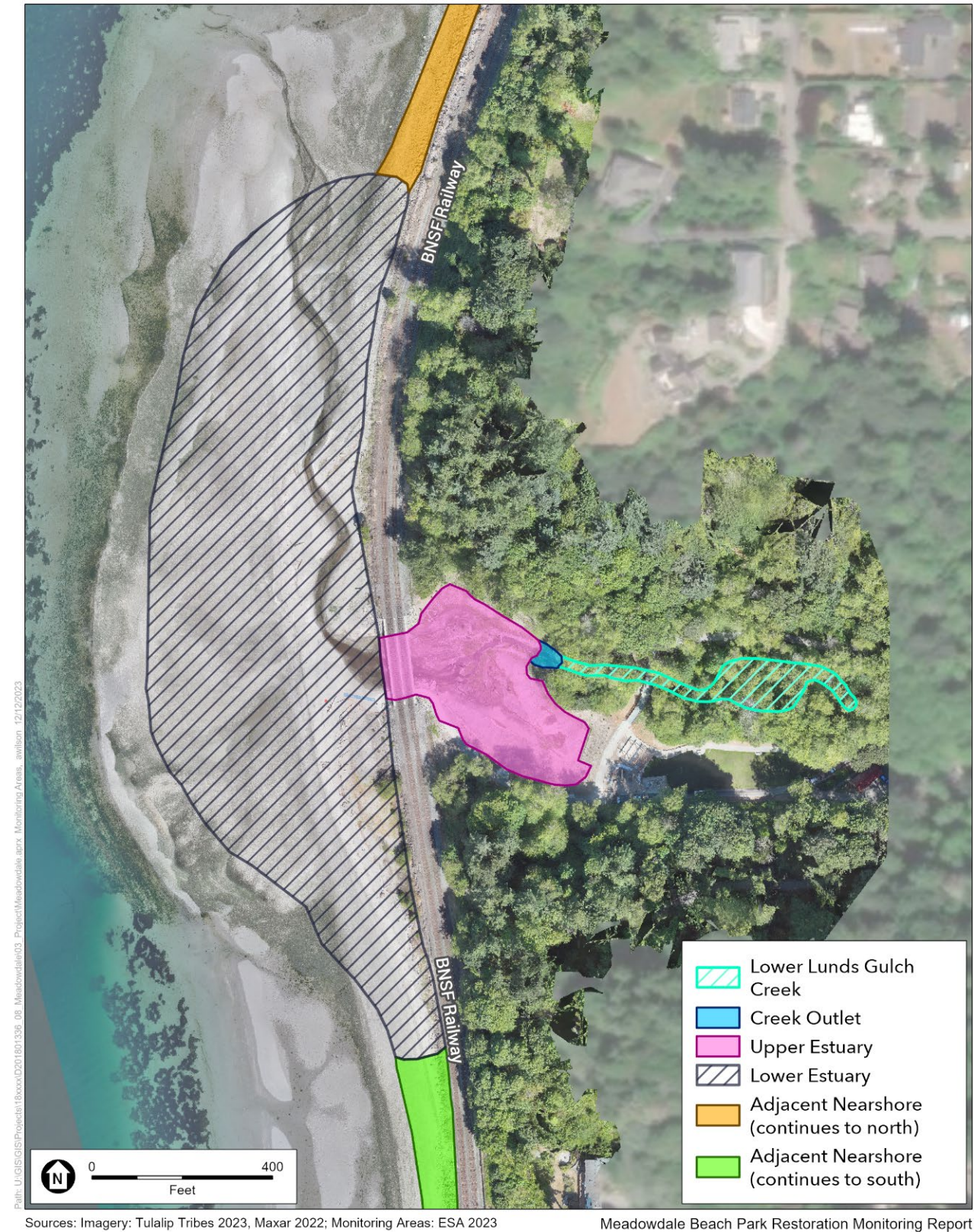


Figure 1
Monitoring Areas

Six consecutive sampling reaches (0-5) were established within the project area and are surveyed continuously for habitat inventory and assessment, and fish use monitoring (**Table 1; Figure 2**). These reaches are geo-morphically and tidally distinct, which influences channel form, project area conditions, and temporal adjustments to the stream. Because post-reach boundaries differed from pre-restoration conditions, pre-restoration data were reassigned to the most closely corresponding post-restoration reach for reporting purposes.

TABLE 1
SAMPLING REACHES

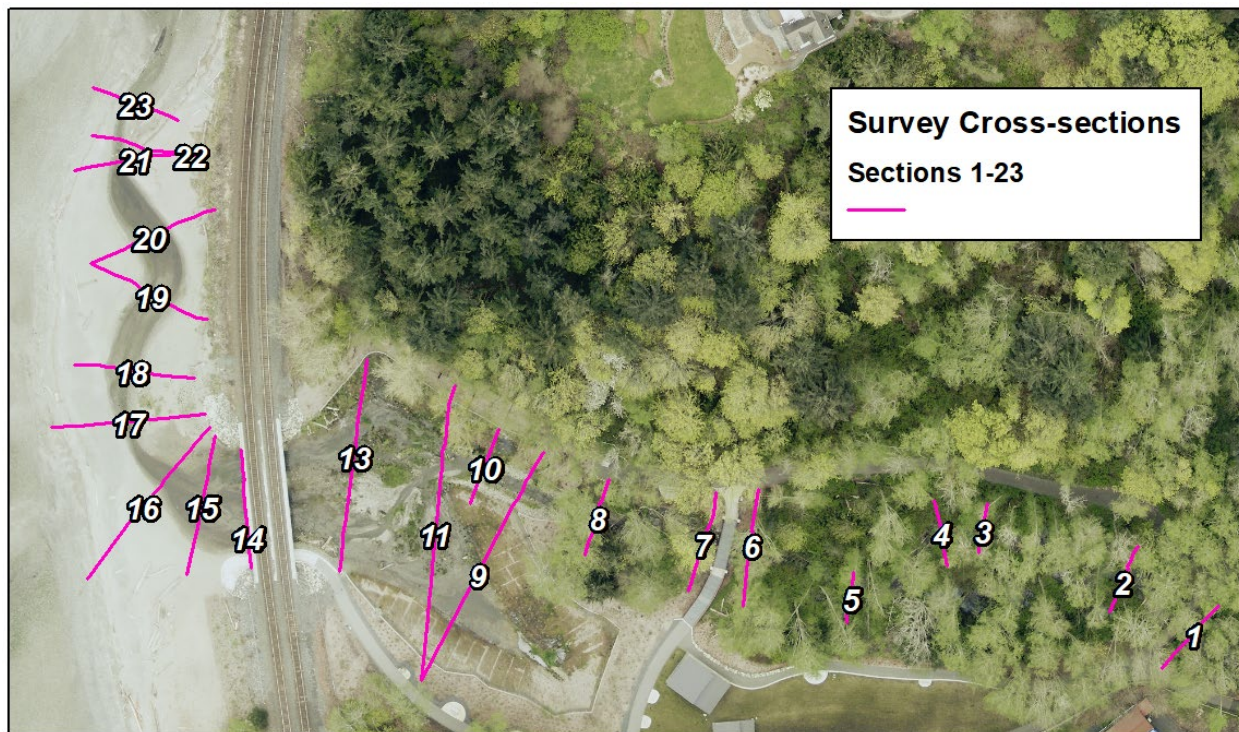
Reach	Post-Restoration Description	Monitoring Area(s) Included
0	Estuary waterward from railroad crossing	Lower Estuary
1	Estuary through railroad embankment up to bottom of creek alluvial fan	Upper Estuary
2	Creek alluvial fan up to stream channel	Upper Estuary and Creek Outlet
3	Lowermost segment of creek channel	Lower Lund's Gulch Creek
4	Middle segment of creek channel	Lower Lund's Gulch Creek
5	Uppermost segment of creek channel	Lower Lund's Gulch Creek



Source: Tulalip Tribes

Figure 2
Sampling Reaches

Twenty-three cross sections were established in Year 1 (2023) of monitoring and are surveyed to collect topographical cross section data and profile surveys of the stream channel (**Figure 3**). Transect 12 is not shown on **Figure 3**, as it was not reproducible for all monitoring years.



Source: Snohomish County

Figure 3
Cross Section Locations

Overview of Monitoring Elements

The monitoring elements and monitoring schedule identified in the Monitoring Plan are shown in **Table 2**. The table indicates whether the monitoring element is required either by a grant funding agreement or permit, is an additional non-required monitoring element, or is an unfunded non-required monitoring element. The unfunded monitoring elements are further explained in the Monitoring Plan and may be conducted in future years if funding becomes available (ESA 2022).

TABLE 2
EFFECTIVENESS MONITORING ELEMENTS

ID	Monitoring Element	Monitoring Partner	Post-Construction Monitoring Year									
			Year 1 (2023)	Year 2 (2024)	Year 3 (2025)	Year 4 (2026)	Year 5 (2027)	Year 6 (2028)	Year 7 (2029)	Year 8 (2030)	Year 9 (2031)	Year 10 (2032)
Required Per Grant Funding Agreement or Permits												
A	Fish Passage Conditions	Snohomish County	X	A	A	A	A	A	A	A	A	A
B	Channel Cross-sections and Profile Surveys	Snohomish County, Tulalip Tribes	X		A		X					X
C	Stream Habitat in Lower Lund's Gulch Creek and Creek Outlet	Snohomish County	X	A	X		X					X
D	Large Wood Retention and Recruitment in Upper Estuary	Snohomish County	X	A	X		X					X
E	Planted Vegetation Survival and Coverage	Snohomish County	X		X		X					X
Additional Effectiveness Monitoring – With Monitoring Leads Identified, Pending Funding												
F	Sediment Dynamics and Habitat Area in Upper Estuary and Creek Outlet	Tulalip Tribes	X	X	X	B	B	B	B	B	B	B
G	Sediment Dynamics in Lower Estuary and Adjacent Nearshore	Tulalip Tribes	X	X	X	B	B	B	B	B	B	B
H	Fish Use	Tulalip Tribes	X	X	X	X	C	C	C	C	C	C
I	Salmon Spawning Ground Surveys	Edmonds Stream Team	X	X	X	X	X	X	X	X	X	X
J	Forage Fish Egg Presence	Snohomish County	X	X	X	X	X	X	X	X	X	X
K	Macroinvertebrate Production in Upper and Lower Estuary	Snohomish County	X	A	X		X					X
L	Additional Vegetation Characterization	Snohomish County	X		X		X					X
M	Photo Points	Snohomish County, Tulalip Tribes	X	X	X	X	X	X	X	X	X	X
Additional Effectiveness Monitoring – With No Monitoring Leads Identified and No Funding Sought												
N	Extended Salmon Spawning Ground and Redd Surveys		X	X	X	X	X	X	X	X	X	X
O	Carbon Sequestration in Soils		X		X		X					X
P	Wildlife Use		X	X	X	X	X	X	X	X	X	X
Q	Public Use		X	X	X	X	X	X	X	X	X	X

Notes:

Current monitoring year is highlighted

X – Monitoring schedule per Monitoring Plan.

A – Additional monitoring not included in Monitoring Plan schedule. Snohomish County will lead additional monitoring.

B – Tulalip Tribes will continue to conduct drone flights and transect surveys in fall and spring, but do not plan to analyze sediment dynamics after Year 3 (2025). Time-lapse cameras in upper and lower estuary will continue as long as funded, but likely not past Year 8 (2030).

C – Tulalip Tribes will continue fish use sampling through 2026 but may not have funding to continue this work after Year 4 (2026).

Required Monitoring Elements

The monitoring elements included in this section of the Monitoring Plan are required by a grant funding agreement or permit. Documentation of the implementation and effectiveness of the site restoration is required by permits and approvals issued by federal, state, and local regulatory agencies, in addition to monitoring requirements under the awarded Coastal and Marine Habitat Restoration Grant (NOAA-NMFS-HCPO-2020-2006306).

Fish Passage Conditions (Monitoring Element A)

A key aspect of the restoration design was to replace the undersized culvert crossing through the railroad embankment with a five-span railroad bridge to restore unrestricted fish passage typical of a coastal estuary. Prior to restoration, the crossing through the railroad embankment was a 94-foot-long, 6-foot-wide box culvert, where only 4.6 feet of the width was a low-flow concrete channel for the creek and 1.5 feet was a ledge used by pedestrians to walk to and from the beach. The restoration project removed the box culvert and replaced it with a railroad bridge and a 90-foot-wide opening for the estuary.

Many estuaries can provide conditions that are only intermittently accessible to fish moving against the direction of flow – especially small fish such as juvenile salmon. Fish passage conditions at Meadowdale Beach Park were evaluated to ensure fish passage was restored.

Fish passage conditions were not required to be monitored beyond Year 1. However, in monitoring Years 2 and 3, excessive vegetation growth, especially of watercress (*Nasturtium officinale*), was observed across the upper estuary channels, restricting fish movement upstream to Lund's creek. Fish Passage Conditions were qualitatively monitored in Year 3 to track the growth of the watercress and ensure that favorable conditions are maintained.

Methods

Excessive vegetation growth was assessed qualitatively during site visits in the spring and summer. Photographs taken during each site visit were used to compare the site conditions between visits, and before and after vegetation removal (**Appendix A**).

Results and Discussion

Monitoring Goal: To document that the restored estuary habitats provide fish passage conditions.

After site visits conducted on April 22, June 11, and July 23, 2025, it was recommended that several large areas of watercress (*Nasturtium officinale*) be removed from within the channel and adjacent areas. Representatives from the Washington Department of Fish and Wildlife (WDFW) were present during the July 23 site visit to observe the conditions of the channel and provide additional guidance on vegetation removal. Excessive vegetation was physically blocking the estuary channels as well as slowing water velocity and contributing to the accumulation of sediment, limiting the depth of the channels.

Vegetation removal occurred during the week of August 25, 2025, and complied with the WDFW pamphlet Hydraulic Project Approval for the removal of aquatic plant control and removal (WDFW 2015). While watercress is not listed as an invasive or noxious weed in Snohomish County, within the

upper estuary restoration area it is acting as an invasive weed by growing in a dense mat that outpaces and inhibits the growth of planted and native species. After the removal of the watercress, adequate water velocity and depth was observed in the estuary channels. However, watercress is a fast-growing plant and may require removal over several growing seasons to control. Additionally, as planted native vegetation increases in cover, the watercress will be less likely to dominate the estuary channels, as watercress prefers sunny, freshwater conditions.

The original monitoring goal was fulfilled, and data was collected in Year 1 as described in the Monitoring Plan. However, as the watercress presents an unforeseen challenge to maintaining fish passage conditions, ongoing maintenance and additional monitoring will be needed.

Channel Cross-Sections and Profile Surveys (Monitoring Element B)

The channel cross-sections and profile monitoring document the major transformation of stream and estuary habitat throughout the project. Prior to restoration, the estuary extended only a few feet upstream of the railroad culvert in a narrow stream channel. Downstream of the railroad crossing, the estuary channel at the time of construction was directed nearly straight out into Puget Sound. Following restoration, the lower stream channel was converted into a wide estuary upstream of the railroad to provide expanded aquatic habitat and space for further expansion with projected sea-level rise. Upstream of the estuary, large wood was placed to increase habitat complexity over time as physical processes act on the stream. Downstream of the railroad crossing, the channel was rerouted to a northerly direction that is supported by coastal processes acting on the site. The restoration provided expanded aquatic habitat in all areas compared to pre-restoration conditions.

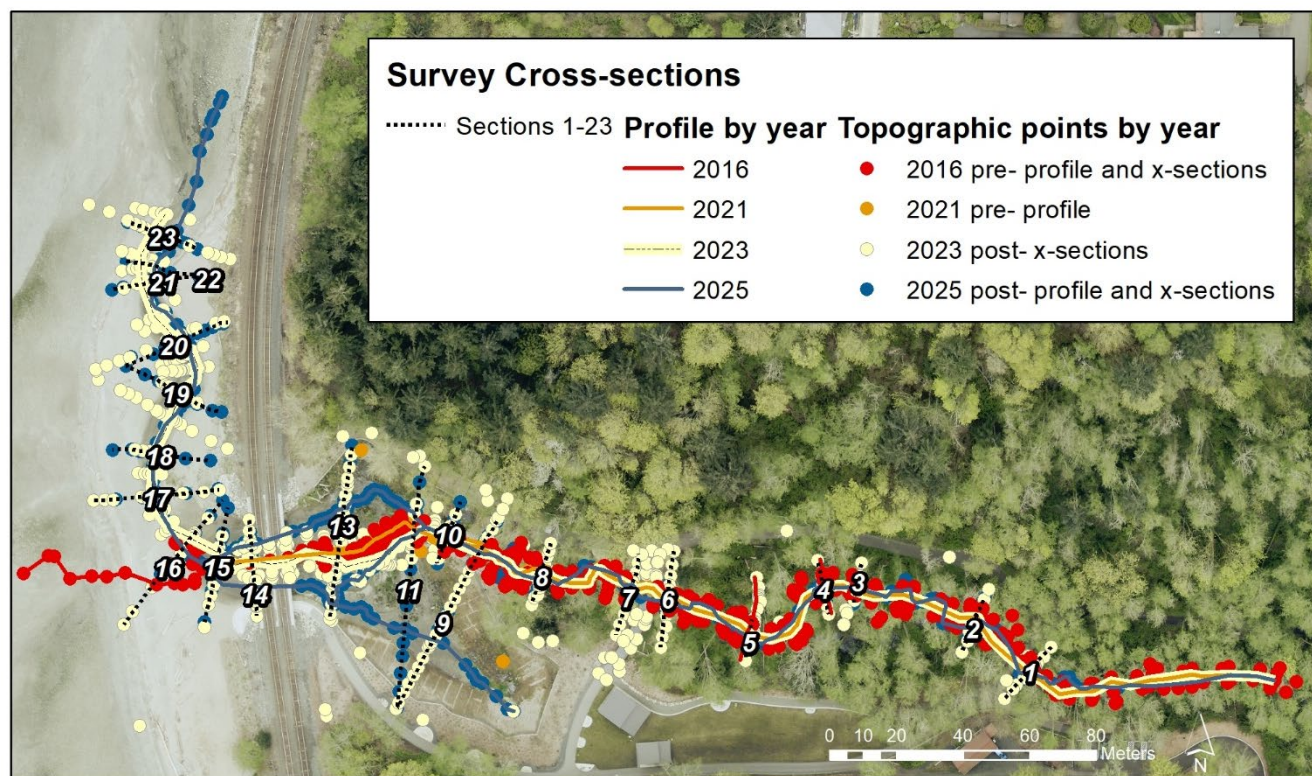
Monitoring data collected is compared to the baseline data established in Year 1. The Monitoring Plan listed that channel cross-sections and profile surveys be collected in Years 5 and 10 to document the adjustment of the channel and profile in the creek outlet, upper estuary, and lower estuary monitoring areas. Additional monitoring was recommended for Year 3 to assess site adjustment and provide adaptive management if needed, as channel incision was observed in Year 2.

Methods

Channel cross-sections and transect surveys were completed using a Real-Time Kinematic Global Positioning System (RTK-GPS) along transects throughout the creek outlet, upper estuary, and lower estuary monitoring areas. The creek outlet and upper estuary transects span the entire restoration area. Transects were established and surveyed in the creek outlet and upper estuary by Snohomish County and compared to data collected in Year 1 by the Tulalip Tribes. As-built post construction survey data was also provided by Anchor QEA.

In 2025, a topographic survey of cross sections and a longitudinal profile of the stream bed length was repeated within the project area from approximately mean lower low tidal elevation up to the pedestrian bridge crossing Lund's Gulch Creek in the vicinity of the Park Ranger's house. Topographic data was collected prior to project restoration as part of the topographic baseline (2016) and specifically within the lower stream channel (2021) prior to initial clearing, grubbing, and construction. Post-construction topographic elevations were collected in 2023 as part of the as-built inventory at specific cross section

locations along with many other supplemental elevation locations. The 2016, 2021, and 2023 topographic points were used where feasible to determine 2025 cross section locations as well as the longitudinal profile. All relevant topographic points by year are highlighted in **Figure 4**, as are lines depicting the cross sections and longitudinal profiles by year. As in **Figure 3**, cross section 12 is not shown on **Figure 4** as it was not reproduceable for all years.



Source: Snohomish County

Figure 4

Topographic data points for cross sections (1-24) and longitudinal profiles (2016, 2021, 2023, 2025)

Results and Discussion

Monitoring Goal: To document channel conditions in the restored estuary and ensure that fish passage conditions are maintained.

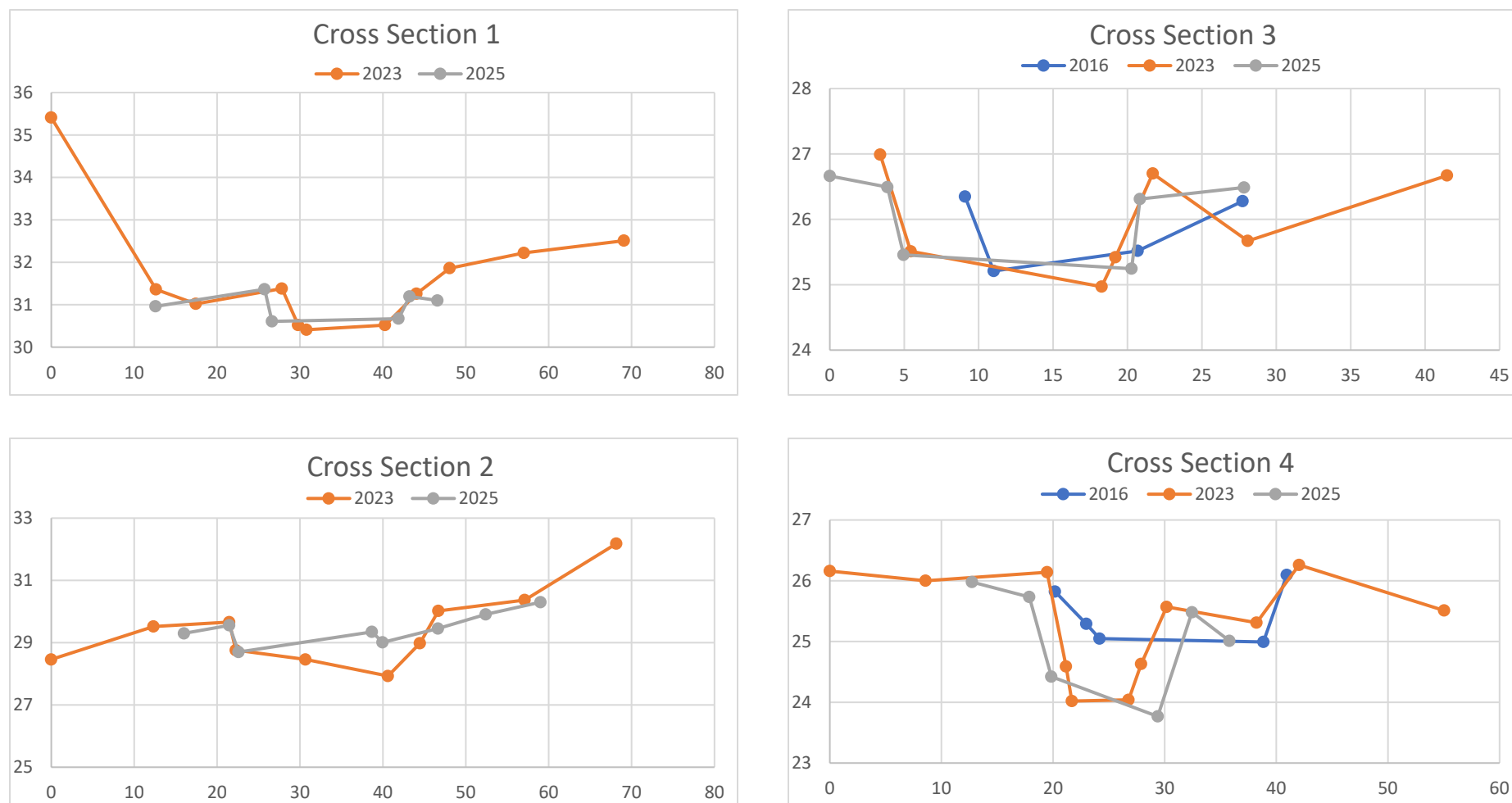
Cross section distance and topographic point elevations were plotted for the monitored years, as available. Topographic point data sometimes varied by a few feet (from the cross-section line) between years but were close enough in proximity to plot all years together in **Figures 5 through 8** from upstream to downstream. Cross sections 1-8 (**Figures 5 and 6**) are upstream from any excavation of the tidal embayment, whereas cross sections 9-14 (**Figures 7 and 8**) overlap with the excavated area (both the embayment and railroad prism). Locations downstream from and including cross sections 15-24 were graded into a sinuous channel flowing northward out to Puget Sound, as in **Figure 4**. Separately, longitudinal stream profiles for 4 years (2016, 2021, 2023, 2025) are plotted together in **Figure 9**.

Cross sections 1-3 (**Figure 5**), in the upper part of the stream, do not show much variation in the elevation of the channel over time. These locations are upstream from a distance of approximately 1,200 feet (on the x-axis in **Figure 9**) shown on the longitudinal profiles which also show limited variability in channel elevation over time in the upper creek. This indicates that little channel change or adjustment has occurred over time or since placement of large woody debris as part of stream restoration. Cross sections 4-7 (**Figures 5 and 6**) show more interannual variability in the streambed elevation among years and are generally lower in elevation than observed in 2016. This indicates that there is greater fluctuation in channel elevation or gravel deposition along the channel distance (profile) spanned by these cross sections. Additionally, field observations included notable channel incision downstream from the new pedestrian bridge (Cross-section 7; **Figure 6**) and at other locations where the streambed has decreased in elevation – either exposing previously buried woody debris or leaving some newly placed woody debris at higher elevations and less functional relative to the adjusted streambed elevation today. This decrease in streambed elevation is most notable in the stream longitudinal profiles (2016-2025) between distance 900-1150 feet (**Figure 9**), where the streambed elevation is lower than in pre-project years (2016, 2021), though no embayment excavation was present in this part of the project. Cross-sections 9-13 (**Figure 7**) between longitudinal profile distances 600-900 feet (**Figure 9**) overlap with the embayment excavation which is revealed in these cross-section elevation differences between 2016 and 2023/2025. These cross-sections and profile elevations show more subtle changes between 2023 and 2025 post-excavation, though fewer profile points from 2023 make direct comparisons to 2025 changes in the profile more uncertain.

As sediment transport from channel changes upstream and overall sediment supply delivers gravel and sand to the excavated embayment (and the alluvial fan formation within the embayment), elevation and filling of the embayment is expected to occur. This depositional process is currently more obvious in Cross-sections 14-16 and downstream from longitudinal profile distance 600 feet, downstream from the new BNSF bridge where channel elevations have increased due to stream sediment delivery and/or longshore sediment transport, presumably into the sinuously constructed channel. In summary:

- There is little channel change in the upstream part of Lund's Gulch Creek near the Ranger bridge.
- There is channel lowering in the vicinity of the new pedestrian bridge which can undermine streambank stability and lead to more erosion and an imbalance in channel slope from upstream to downstream of the pedestrian bridge.
- There is sediment aggradation as well as expected channel switching on the alluvial fan that is growing in the excavated embayment (an effective sediment sink); and,
- There is downstream sediment deposition beachward of the BNSF railroad bridge relative to as-built elevations that is likely controlled by tidal backwatering and limits transport of sediment out of the embayment.

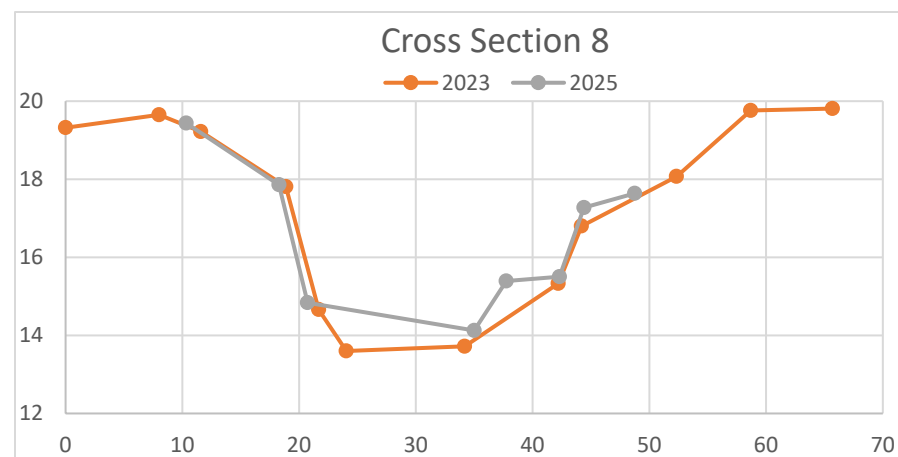
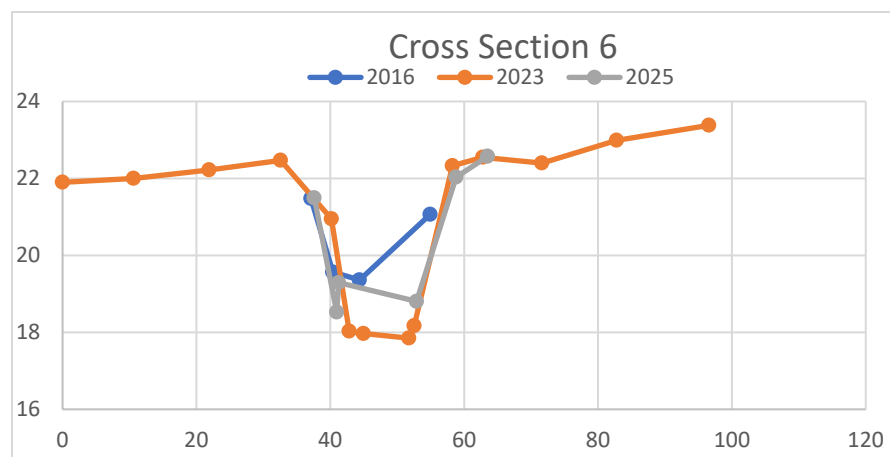
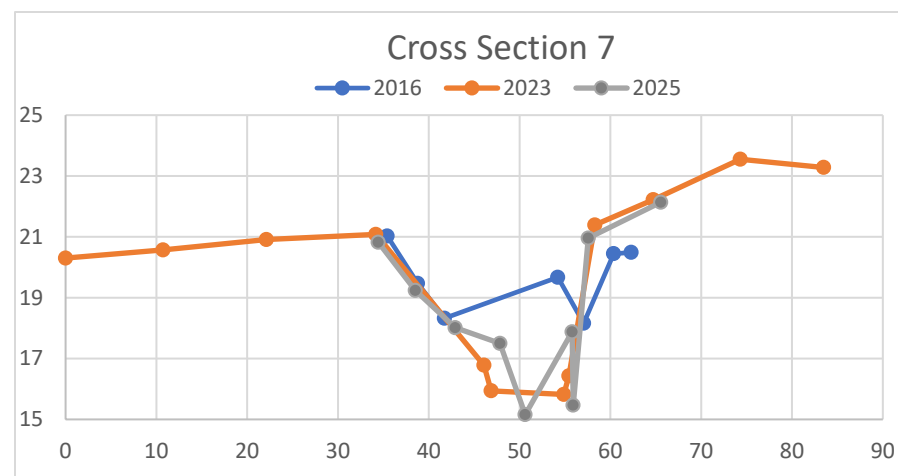
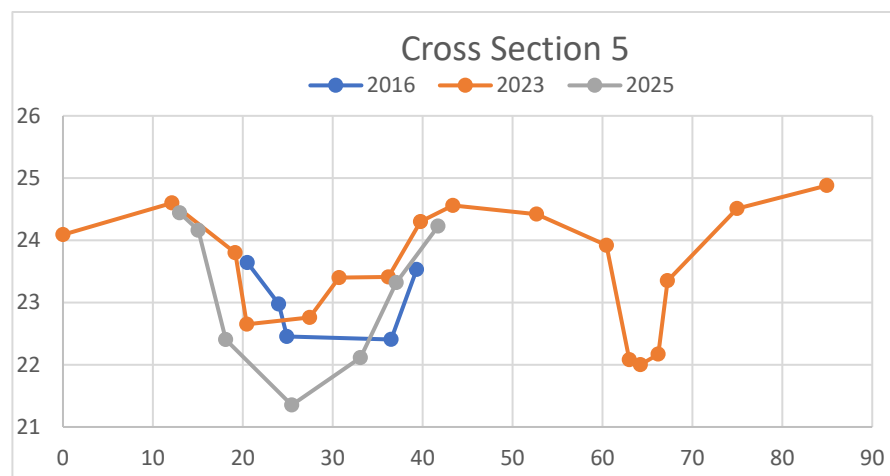
Future monitoring of channel and sediment elevations will determine whether the upstream erosion (in stream) and downstream deposition (embayment and beach channel) processes continue or reach equilibrium and whether these channel and sediment processes have an influence on the size, elevation or habitat area within the embayment. Cross section and elevation data provides insight into the stream and coastal processes within the site and documents that fish passage conditions are maintained.



Source: Snohomish County

Figure 5
Cross Section Series 1-4

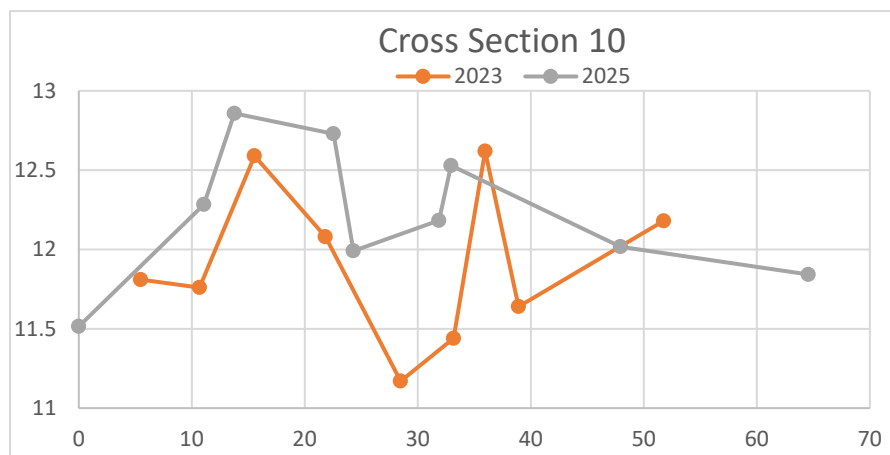
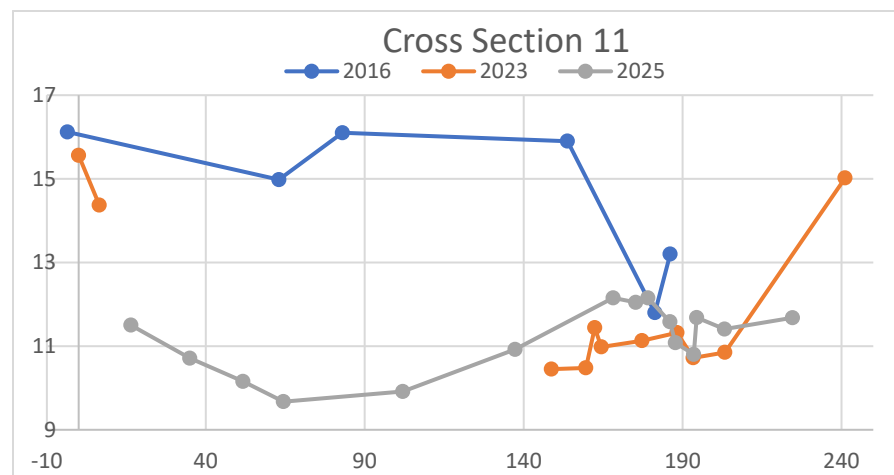
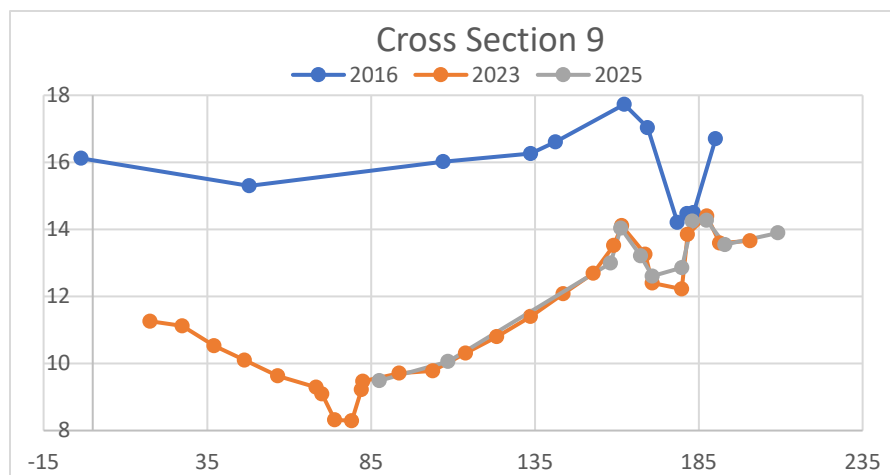
Shown from upstream to downstream. Y-axis in all Sections are Elevations in feet in NAVD88 (datum); X-axis in all Sections are Horizontal Distance in feet.



Source: Snohomish County

Figure 6
Cross Section Series 5-8

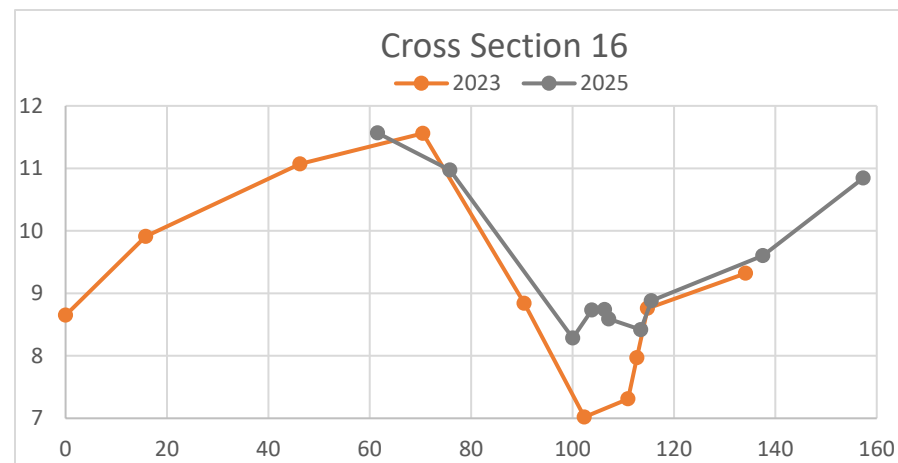
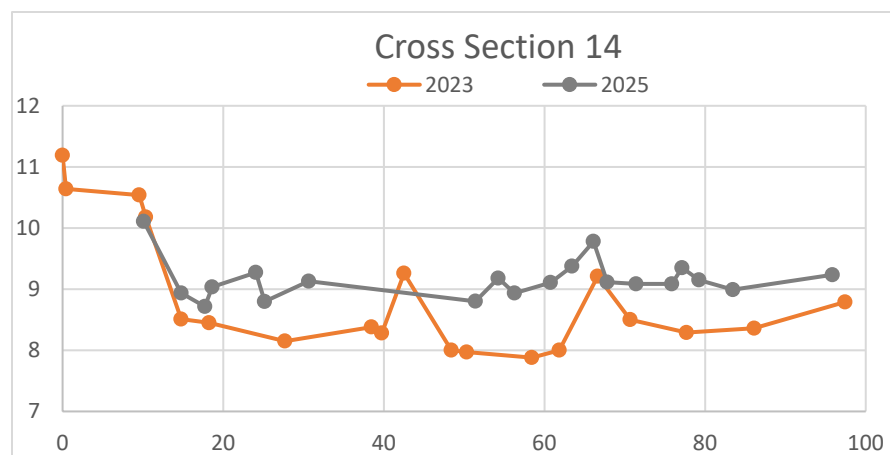
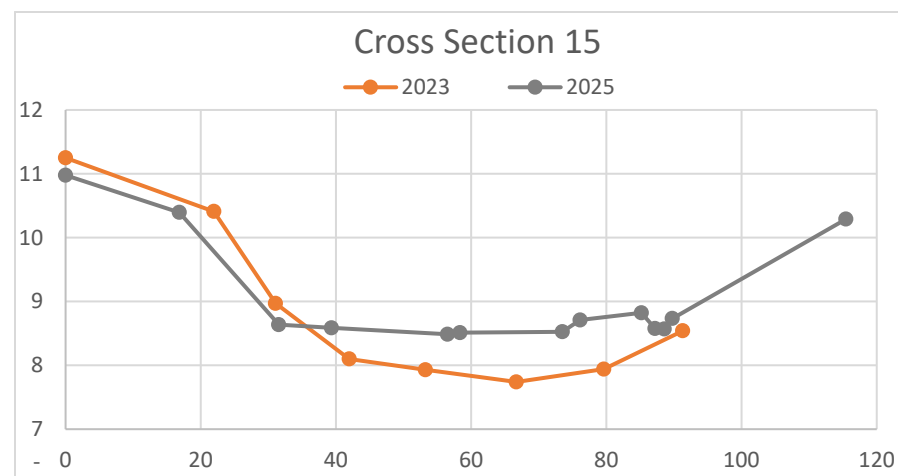
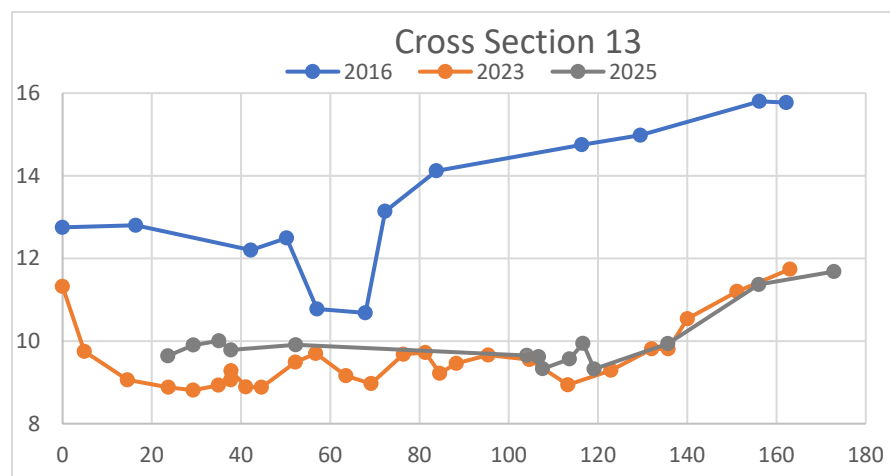
Shown from upstream to downstream. Y-axis in all Sections are Elevations in feet in NAVD88 (datum); X-axis in all Sections are Horizontal Distance in feet.



Source: Snohomish County

Figure 7
Cross Section Series 9-11

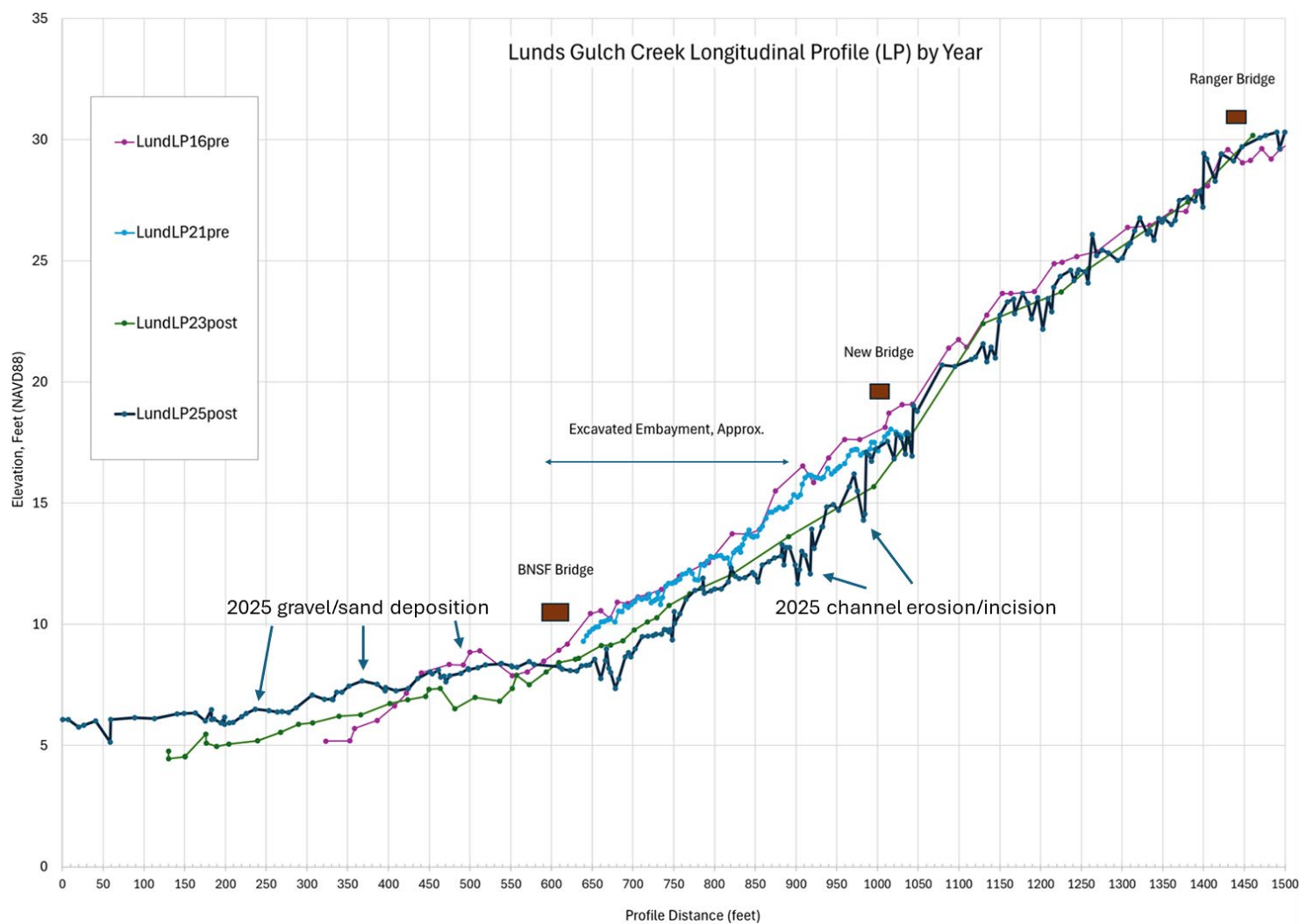
Shown from upstream to downstream. Y-axis in all Sections are Elevations in feet in NAVD88 (datum); X-axis in all Sections are Horizontal Distance in feet. Cross section 12 is intentionally not shown as the cross section was not reproduceable for all years.



Source: Snohomish County

Figure 8
Cross Section Series 13-16

Shown from upstream to downstream. Y-axis in all Sections are Elevations in feet in NAVD88 (datum); X-axis in all Sections are Horizontal Distance in feet.



Source: Snohomish County

Figure 9

Lund's Gulch Creek Longitudinal Profile

Profile along channel length by year relative to bridges and approximate extent of embayment excavation.

Stream Habitat in Lower Lund’s Gulch Creek and Creek Outlet (Monitoring Element C); Large Wood Retention and Recruitment in Upper Estuary (Monitoring Element D)

The project converted the lowermost portion of Lund’s Gulch Creek to expand the estuary. The project also placed large woody material in lower Lund’s Gulch Creek and the upper estuary. These materials are expected to increase habitat complexity through pool formation, gravel sorting, and providing instream cover for fish to hide in. Monitoring of the aquatic habitat conditions in the restoration area upstream to the bridge near the Park Ranger’s house was conducted to document how effective the installed stream components were for improving habitat conditions for salmon.

Methods

Aquatic habitat monitoring in the stream and estuary included habitat mapping, stream temperature monitoring, and benthic invertebrate sampling. This sampling was conducted by Snohomish County.

Habitat Mapping

Stream habitat surveys included measurement of habitat units defined as pools, riffles or other habitats (glides/run) that did not qualify as pools based on a residual pool depth criterion of 0.2 m. Habitat surveys included measurement of streambank armor (such as riprap or bridge footing) and bank erosion (length). Surveys included inventory of large woody material, both natural and placed as part of the restoration. Other monitoring included stream macroinvertebrate sampling to characterize stream health and continuously recording stream temperature probes during summer (placed near the Park Ranger bridge), to describe the suitability of stream temperature compared to the Washington State stream temperature water quality standard as described below.

Stream Habitat Surveys were implemented in 2021 prior to project construction using Snohomish County “State of our Waters” stream survey protocols (Snohomish County 2019). Stream habitat data were also collected in 2009 using virtually identical protocols. The 2021 pre-project habitat survey repeated the same approximate length and upstream-downstream extent as 2009 (starting 1 meter upstream from the original railroad culvert. However, in 2023, 2024 and 2025, the downstream and upstream extents were extended to match the restoration length along the beach, delta, and creek up to the pedestrian bridge near the Park Ranger’s house and to match the extent of the electrofishing effort (**Appendix B**). **Table 3** shows the approximate survey extents by year. Very large differences in the stream setting have been created due to the difference in extent of the 2009 and 2021 stream surveys, so the survey results from these pre-project years are not meaningfully comparable to 2023, 2024 and 2025 spatial extents. For example, pre-project stream survey data and summary metrics collected upstream from the original railroad culvert will need to be compared to current (restored) stream conditions farther upstream, as the area immediately upstream from the original railroad culvert has been excavated to form the new tidal embayment - a different channel and habitat type from the original stream.

Habitat surveys for 2023 were conducted in April and August. The purpose of the survey in April was to quantify habitat types and area that overlapped where Tulalip Tribes conducted electrofishing for describing fish use. Results for April 2023 electrofishing are reported in **Appendix B**. August 2023

stream survey data are included with the expanded survey extents for surveys conducted in 2023 through 2025 and are evaluated in comparison to the summer survey results from 2009 and 2021, as feasible.

TABLE 3
PRE- AND POST-RESTORATION AQUATIC HABITAT MAPPING BY SAMPLING REACH

Reach	Description	Pre-Restoration		Post-Restoration			
		2009	2021	2023 (April)	2023 (August)	2024	2025
0	Start at MLLW upstream to end tidal delta			X			
1	Transition from top tidal delta to bottom creek delta	-	-	X			
2	Creek alluvial fan/delta – larger substrate	X	X	X	X	X	X
3	Creek adjustment zone – incision/expansion	X	X	X	X	X	X
4	Creek with narrow floodplain			X	X	X	X
5	Creek with wide floodplain, old stormwater pond			X	X	X	X

Stream Temperature

In Lund’s Gulch Creek, stream temperature was recorded continuously at 30-minute intervals using remote thermistors in summer when the Washington State water quality standard for core summer salmonid rearing was applicable. For this creek, 16 degrees Celsius is the stream temperature standard, calculated as the seven-day average of the daily maxima, above which water quality would be considered impaired. Stream temperature was monitored near the pedestrian bridge closest to the Park Ranger’s house in all monitoring years. Additional stream temperature sampling was implemented at 52nd Avenue in two prior years – approximately 1.8 miles farther upstream from the Ranger bridge near the headwaters of the creek.

Benthic Macroinvertebrates (B-IBI)

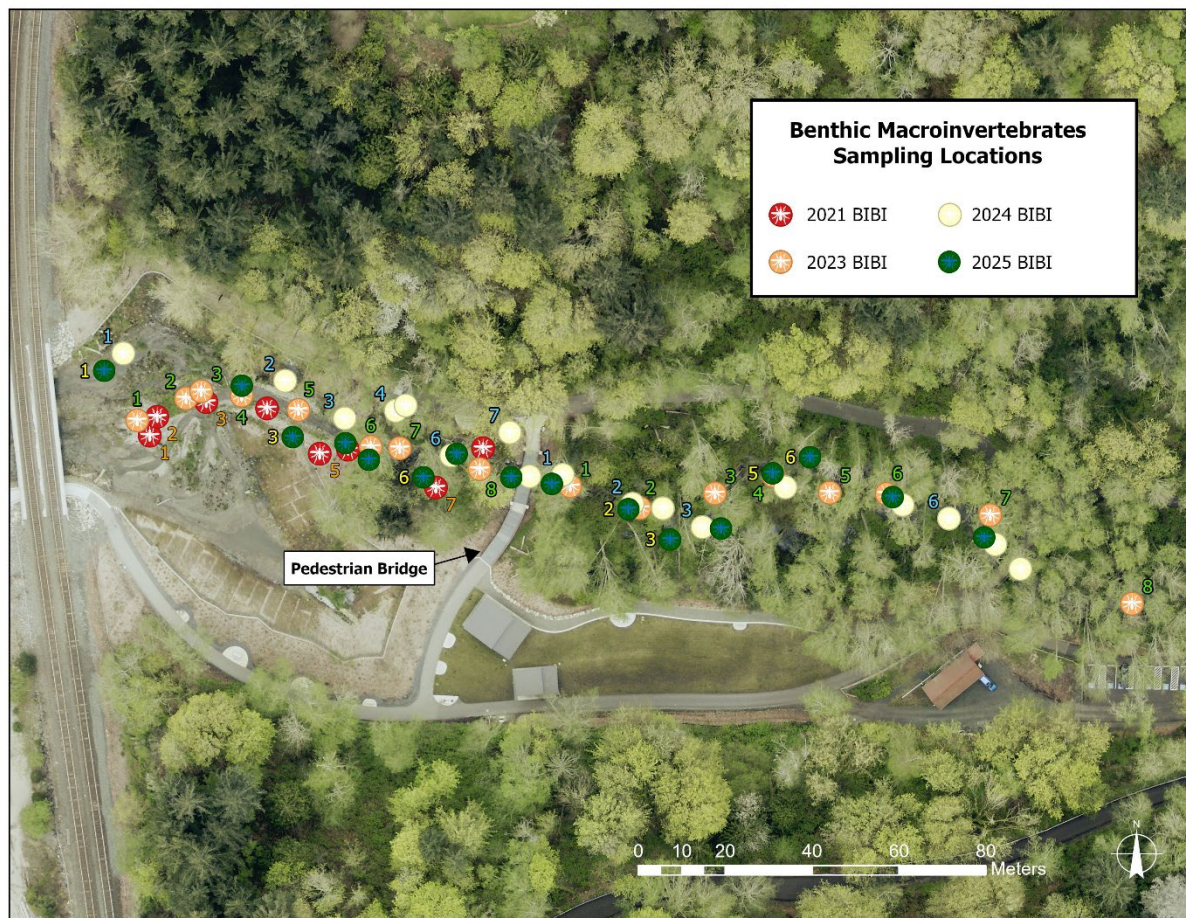
Benthic macroinvertebrate collection was completed before project implementation in 2021 and following completion of restoration work in 2023, 2024 and 2025. The Benthic Index of Biotic Integrity (B-IBI) score and biometrics that are components of the index were analyzed to determine condition in the Lund’s Gulch Creek project area. Ten biometrics were examined to offer some insight into community change and related causes. For instance, a dramatic decline in Ephemeroptera, Plecoptera, or Trichoptera taxa (e.g. mayflies, stoneflies, and caddisflies) signals an impact to sensitive benthic invertebrate species, whereas an increase in pollution tolerant taxa signals presence of a disturbance to stream habitat and food base for benthic invertebrates. Biometrics serve as diagnostic tools for pre- and post-project comparison of community health using benthic invertebrates as indicators.

All years of benthic macroinvertebrate collection prior to restoration (including 2021) started immediately upstream from the pre-project railroad culvert, referred to now as Lower Lund’s Gulch. Some earlier years of benthic macroinvertebrate collection prior to 2021 are also available, and results have been re-analyzed based on current taxonomic lists and analysis conventions so that past results are harmonized with current

results. The exception is that collection of benthic macroinvertebrates prior to 2012 were collected from a smaller streambed area, which can affect the number of benthic invertebrate species encountered.

The stream area sampled pre-construction (through 2021) is now the excavated embayment and is no longer spatially representative of the creek where pre-construction sampling has been conducted. Therefore in 2023-2025, two B-IBI samples were collected: one upstream from the embayment excavation representing the creek where large woody material has been placed (now referred to as Upper Lund's Gulch), which is intended to be similar to sampling prior to 2023, and one along the new alluvial fan contained within the excavated embayment area immediately upstream from the new railroad bridge (now referred to as Lower Lund's Gulch).

The collection effort used the field procedures described in the Snohomish County State of Our Waters Monitoring Program (Snohomish County 2019). Benthic macroinvertebrates were collected from 8ft² of stream bottom (8 - 1 ft² Surber samples combined) and locations of collection were distributed throughout the reach length in riffle habitat. Benthic macroinvertebrates were stored in a Nalgene jar and preserved in 95% denatured ethanol. **Figure 9** shows the locations of each benthic macroinvertebrate collection from 8 riffles per composited sample in 2021, 2023, 2024 and 2025.



Source: Snohomish County

Figure 10
B-IBI Sample Collection Locations in 2021 and 2023-2025.

Large Woody Material

Both placed and naturally recruited large woody material were inventoried by counting the number of pieces present in the stream. These counts were then combined with measurements of the stream's bankfull width (BFW) and the length of each survey area to calculate the number of large woody material pieces per channel width. The Year 3 (2025) survey extended through sampling reaches 1 through 5, which are located upstream of the railroad crossing. A pre-restoration survey in 2021 covered only reaches 2 and 3. At that time, reach 2 started immediately upstream of the railroad crossing.

Results and Discussion

Habitat Mapping

Monitoring Goal: Document stream habitat complexity following restoration. Pre-project monitoring upstream from the original railroad culvert extended upstream approximately to the new pedestrian bridge installed as part of the Meadowdale project. This part of Lund's Gulch Creek overlapped with the new estuary embayment design which included excavation to establish tidal inundation. Surveyed habitat units for pre- (2021), and post- (2023-2025) restoration can be seen in **Figure 11**. **Table 4** summarizes survey length and general channel characteristics including streambank conditions for all years.

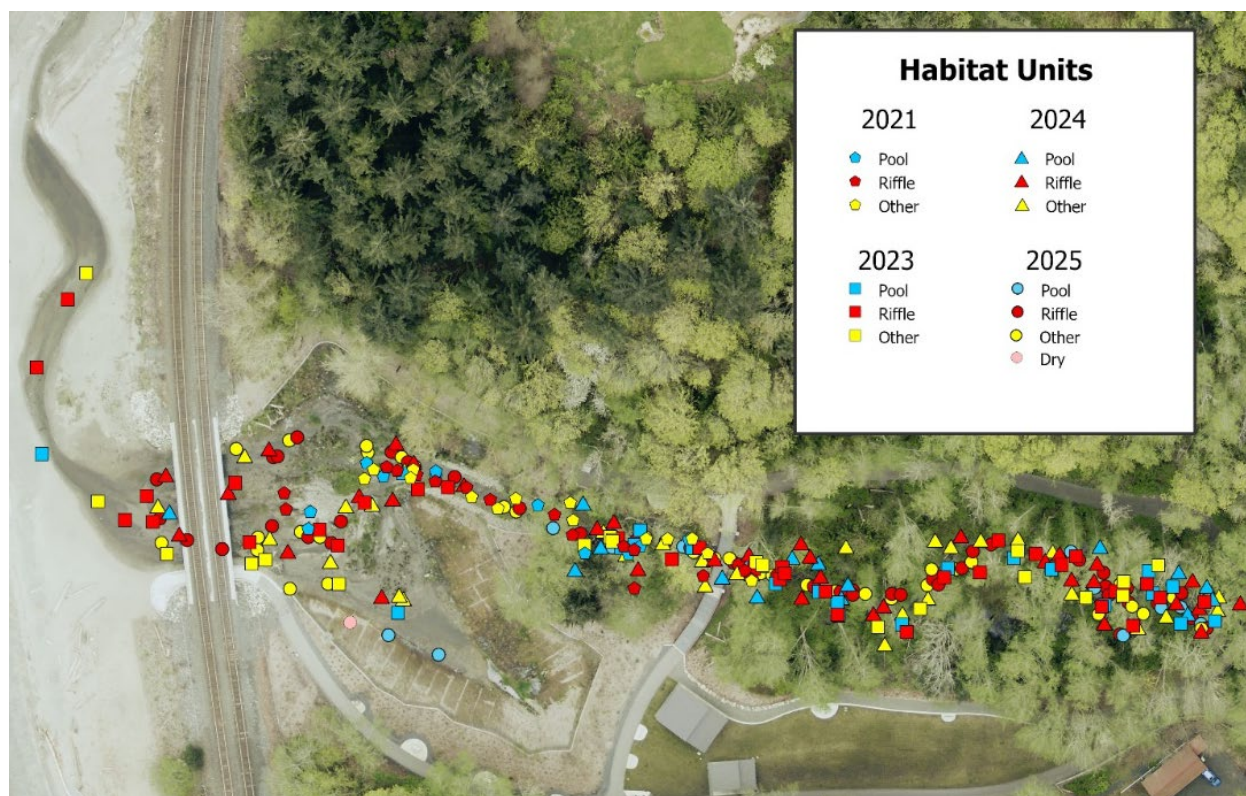


Figure 11

Map of 2021 and 2023-2025 Habitat Unit Survey by Year and Habitat Type

TABLE 4
LUND'S GULCH CREEK PRE-CONSTRUCTION AND POST-CONSTRUCTION STREAM CHARACTERISTICS

Characteristic	Pre-Construction		Post-Construction ^a		
	2009	2021	2023	2024	2025
Survey Length (m)	124	137.95	311.45	302	310.91
Average BFW (m)	4.1	4.48	6.57	6.35	5.02
Avg. Bankfull depth (m)	0.3	0.52	0.66	0.64	0.55
Avg. Wet Width (m)	1.7	2.13	2.37	3.02	2.31
Average Gradient %	1.5	1.06	2.1	-	2.3
Armored Streambank %	28.5	32.4	10.4	6.3	6.1
Unstable Streambank %	6.4	6.8	7.8	8.0	6.3

Note:

a. Survey extents for post-construction years are different than pre-construction years

Pre-project monitoring in 2009 and 2021 was implemented in a stream reach with a pool-riffle planform and contained higher amounts of streambank armor (riprap) that covered 28-32% of streambanks as measured between years. This riprap had likely been historically placed to maintain a stream alignment with the railroad culvert and reduce channel migration away from the railroad culvert inlet. As part of restoration, most, but not all, of the riprap was removed upstream from the railroad and the stream channel is now largely unencumbered by this type of modification. In 2023-2025, the quantity of streambank armor as a percentage of the total stream length is much less. New rounded rock streambank armor that was placed at the new pedestrian bridge counts toward total streambank armor as does some remnant locations of riprap. Unstable (eroding) streambanks are only modestly higher overall and primarily associated with one stream location, as discussed as part of the cross section and stream profile changes. **Figure 12** shows the excavated embayment where stream surveys in 2009 and 2021 were located. The excavated and lowered embayment creates a steeper profile between the excavation and the unexcavated creek upstream. This embayment is now transformed, by design, to an alluvial fan planform due to sediment transport from the creek upstream and sediment storage in the embayment.



Figure 12

Lund's Gulch Creek Excavated Embayment Area Looking Upstream Toward the Creek Mouth

In 2009 and 2021, prior to restoration, there was a relatively lower level of pool habitat that ranged from 15-25% in the creek (**Table 5**) and pool spacing (the distance between pools) was generally greater when closer spacing between pools is preferred (**Table 6**). On average, riffle habitat was greatest as a percentage of total habitat among all years surveyed. In 2023, one year post project implementation, habitat conditions were surveyed in all project reaches (0-5) to quantify habitat unit type and area in support of fish use monitoring. Reaches 0-2 spanned the tidal delta, the excavated embayment and the newly formed alluvial fan associated with the creek mouth above tidewater. Pool habitats preferred by juvenile salmonid fish were distributed between the outlet channel, embayment, and upstream creek, where the majority of instream large woody material was placed. These stream reaches contained more pools and a greater percentage of pool habitat area in 2023 and 2024 partly due to larger pool areas within the excavated embayment and outlet immediately downstream from the railroad bridge. A greater distance of creek was also measured upstream, which contributed to the increase in observed pools, as well as riffles and other habitat units (**Figure 11, Table 5**).

By 2024, the amount of pool area increased primarily due to a larger pool area in the creek outlet and embayment. The percentage of pool area was highest among all years, though pool count declined from 18 to 16 pools. The quantity of total surveyed habitat areas in 2024 was also likely higher due to a higher summer flow that led to wider stream habitat measurements in 2024, which were on average 1.6m, 2.2m, 2.4m, and 1.8m in survey years 2021, 2023, 2024, and 2025 respectively. Post-restoration, in 2023-2025, there were more backwater pools, indicating more channel and habitat diversity. These pools contribute to the reduction in pool spacing in 2023 and 2024 (**Table 6**). Pool depths were very similar across all years (**Table 6**).

TABLE 5
2023 AND 2024 SUMMER HABITAT INVENTORY

Year	Survey Length (m)	Pool Count	Pool Area Total/Average (m ²)	Riffle Count/ Total Area (m ²)	Other Count/ Total Area (m ²)	Pool Percent Area	Riffle Percent Area	Other Percent Area
2009	124	5	40.7 / 8.14	14 / 170.81	8 / 55.7	15.24	63.92	20.85
2021	137.95	8	60.6	13 / 143.12	12 / 39.3	24.9	58.9	16.2
2023	311.5	18	326.3 / 18.1	31 / 759.8	28 / 183.1	25.7	59.8	14.4
2024	302	16	710 / 44.4	35 / 698.2	29 / 438.8	38.4	37.8	23.8
2025	310.9	12	202.8 / 16.9	46 / 432.4	37 / 217	23.8	50.7	25.5

TABLE 6
POOL HABITAT INDICATORS AND METRICS CALCULATED BY YEAR

Year	Survey Length (m)	Pool Count (Primary / Backwater)	Wood -formed Pools (rip rap pools)	Max Depth (average m)	RPD – (average m)	Frequency (per KM)	Pool Spacing (CW)
2009	124	5 / 0	4 (1)	0.38	0.32	40.6	5.96
2021	137.95	7 / 1	2 (4)	0.35	0.27	58	3.85
2023	311.5	15 / 3	13 (0)	0.35	0.28	57.8	2.63
2024	302	14 / 2	11 (1)	0.36	0.28	53	2.97
2025	310.9	8 / 4	8 (1)	0.33	0.27	38.6	5.16

In 2025, habitat survey results changed more significantly, likely due to lower stream flow, because fewer habitat units qualified as pools, particularly in the embayment and the railroad bridge outlet. The reduction in number and total area of pools reduced the total percent pool area to less than 25% and pool frequency decreased along the channel length as the spacing between pools increased. These changes in measured habitat area likely resulted from a combination of shallower water depth in summer due to lower flow, but also due to an increase in sediment that filled some pools, particularly in the embayment which is where sand and silt naturally deposit.

More wood-formed pools were observed affiliated with placed woody material. The function of large wood in creating and maintaining deep pool habitat will be evaluated in the future. One potential concern is that this function could be reduced if the stream channel gradually deepens over time, a process known as channel incision. If the streambed incises below the elevation of placed woody material, then the wood may be less effective at scouring pools due to less contact with the streambed. Survey results of habitat units in 2024 were very similar to 2023. Wood formed pools surveyed in 2025 decreased in number (Table 6). These changes in sediment and gravel size and/or scour from woody material within the channel will be evaluated over time and are further informed by changes in channel cross-sections and longitudinal profiles discussed earlier.

Stream Temperature

Table 7 shows the maximum stream temperatures observed each sample year – the single day summer maximum and 7-DADMax. In all years, except 2025, the 7-DADMax temperature exceeded the water quality standard for 5-19 days of each year, which is approximately 6-17% of the summer sample period.

For context, the 7-DADmax temperature standard is routinely exceeded in many streams, even with forested stream buffer conditions and shading over the stream surface, and stream temperature typically increases in a downstream direction as streams become wider. In contrast, Lund’s Gulch Creek near the pedestrian bridge near the Ranger’s house benefits from sources of cold groundwater that flow into the stream from the deep ravine upstream throughout the summer. This keeps the creek relatively cool in comparison to the upstream sampling location at 52nd Avenue, which was warmer in maximum and 7-DADMax temperature. Overall, stream conditions in terms of temperature are very supportive of fish use, growth, and survival in summer months.

TABLE 7
STREAM TEMPERATURE DATA IN LUND’S GULCH CREEK

Year	Date Range	Maximum Temperature, Celsius (C)	7-DADMax*	Number of Days Exceeding Temperature Criteria**	Percent Exceedance Time**	Average 7-DADMax****
Lund’s Gulch Creek at Ranger’s Bridge (Latitude 47.8598, Longitude -122.332, Elevation 29 feet)						
2009	5/15-10/15	18.3°C	17.4°C	12	14.1%	15.0°C
2015	6/29-10/28	17.4°C	17.1°C	14	16.5%	15.3°C
2016	6/6-10/10	16.9°C	16.3°C	10	11.8%	15.1°C
2017	6/1-10/10	16.8°C	16.2°C	5	5.9%	15.1°C
2022	5/17-9/26	17.2°C	17.0°C	14	16.5%	15.3°C
2023	4/20-10/18	17.3°C	16.7°C	7	8.2	15.2
2024	6/18-10/3	17.3°C	16.5°C	13	15.3	15.2
2025	6/18-10/8	16.7°C	15.9°C	7	6.2	14.8
Lund’s Gulch Creek at 52nd Avenue (Latitude 47.8487, Longitude -122.304, Elevation 390 feet)						
2024	6/3-10/13	23.2	20.2	70	82.4	16.9
2025	6/18-8/16***	19.9	18.9	44	85	17.6

Notes:

* 7-DADMax is defined as the seven-day average of daily temperature maxima.

** Days and percentage of days based on 85-day summer core temperature period for all years. Except *** is 54 days, which increases percent exceedance time relative to other years. Sensor dried out due to low flow.

**** Average 7-DADMax is the 85-day average of the running 7-DADMax calculated for each of the 85 days, unless fewer than 85 days.

Benthic Macroinvertebrates (B-IBI)

Monitoring Goal: Document improved benthic invertebrate community compared to pre-project conditions based on metrics such as taxa density, number of taxa, taxa diversity, and taxa richness.

B-IBI scores and index metric components for all sampled years are reported in **Table 8**. As stated above, sampling conducted in 2005-2021 was closest to the mouth of the creek, but upstream from the original railroad culvert. B-IBI scores from 2005-2008 were collected from a smaller area of benthos than subsequent collections. Lower Lund’s Gulch Creek (2012-2021) B-IBI Scores were similar to the Upper

Lund's Gulch Creek collections (2023-2025), so these are plotted together in **Figure 13** to depict scores from the creek channel over time. The B-IBI scores in 2023, 2024 and 2025 in the upper stream segment are similar to pre-project conditions in the lower stream segment, which fluctuate around the "good" condition category (score of 60 out of 100). Lower B-IBI scores from 2005-2008 are attributed to the smaller area of benthos (3ft²) collected compared with years beginning in 2012 (8ft²). A smaller sample area would result in collection of fewer invertebrate taxa, accounting for lower scores in earlier monitoring years (highlighted with a red triangle and dashed line in **Figure 13**).

TABLE 8
BENTHIC MACROINVERTEBRATE DATA COLLECTION YEARS AND RESULTS FOR 10 METRICS THAT CONTRIBUTE TO THE FINAL B-IBI SCORES (0–100)

Site Name	Date Collected	B-IBI Score (1–100)	Taxa Richness	Ephemeroptera Taxa	Plecoptera Taxa	Trichoptera Taxa	Intolerant Richness	Clinger Richness	Long-Lived Richness	Percent Tolerant	Percent Predator	Percent Dominant (Top 3 taxa)
Lund's Gulch Creek (near mouth, upstream from railroad culvert)	8/15/2005*	54.9	35	2	6	4	15	12	5	6.8	9.1	50.7
	9/4/2008*	32.8	25	1	4	3	13	9	3	5.99	4.4	71.2
	09/12/2012	68.7	42	4	5	5	17	15	5	2.21	17.2	46.9
	09/28/2015	78.9	40	6	7	7	20	18	9	4.50	15.6	46.3
	08/15/2016	53.5	32	3	4	6	12	12	5	5.06	14.4	66.1
	06/23/2021	58.7	36	3	6	4	14	13	5	9.60	12.5	49.9
LUNDS - Upper	07/18/2023	61.4	36	5	4	5	15	11	4	11.8	15.5	48.5
LUNDS - Upper	8/20/2024	63.8	41	5	5	6	17	14	4	9.5	8.7	47.7
LUNDS - Upper	8/26/2025	58.23	31	6	5	3	13	13	4	4.06	9.59	52.9
LUNDS - Lower	07/18/2023	43.9	36	2	4	5	12	11	3	45.7	5.97	48.1
LUNDS - Lower	8/20/2024	46.8	33	3	5	5	12	14	3	47.0	5.2	48.3
LUNDS - Lower	8/26/2025	54.97	35	4	5	3	12	15	5	31.2	7.16	43.1

Notes:

* 2025 and 2008 samples were 3ft²; thereafter samples were 8ft²

Following construction of the restoration site in 2022, the Lower Lund's Gulch Creek B-IBI results from the alluvial fan within the embayment demonstrated a lower B-IBI score compared to the Upper Lund's Gulch Creek and is plotted separately in **Figure 13**. This location was excavated (See cross sections 9-13; **Figures 7 and 8**) and received new stream gravel and cobble substrate during restoration, it is rapidly changing in terms of additional sediment deposition from upstream, shifting channel configuration, and colonization by vegetation. These disturbances along with some very limited tidal inundation may explain the current lower scores. Percent tolerant taxa at Lower Lund's Gulch Creek prior to construction was much lower than post-construction conditions (**Figure 14**). Percent tolerant taxa is a biometric that describes benthic invertebrate taxa tolerant to a variety of physical conditions in a stream including increased temperature, increased fine sediment, and changes in flow patterns. Prior to construction, the lower Lund's Gulch Creek reach had a low percentage of pollution tolerant taxa, the same range as

current conditions in 2023-2024 in upper Lund's Gulch Creek. The dramatic increase of pollution tolerant taxa in the benthic community (post-project) from the downstream channel indicates recent disturbance from channel restoration. A reduction in pollution tolerant taxa in lower Lund's Gulch Creek reach is expected to occur in post-project years and may resemble those in the upper Lund's Gulch Creek reach overtime.

B-IBI scores began recovering in lower Lund's Gulch Creek from 2023-2025 (**Figure 13**). The most recent year of monitoring (2025) showed B-IBI results almost identical between the upper- and lower Lund's Gulch Creek reaches. Variation in B-IBI scores between years could be due to natural variation and/or hydrologic conditions such as flooding that disturbed and scoured the streambed in years prior to sampling. Flow conditions that vary annually can also lead to changes in supply and delivery of fine sediment from upstream areas.

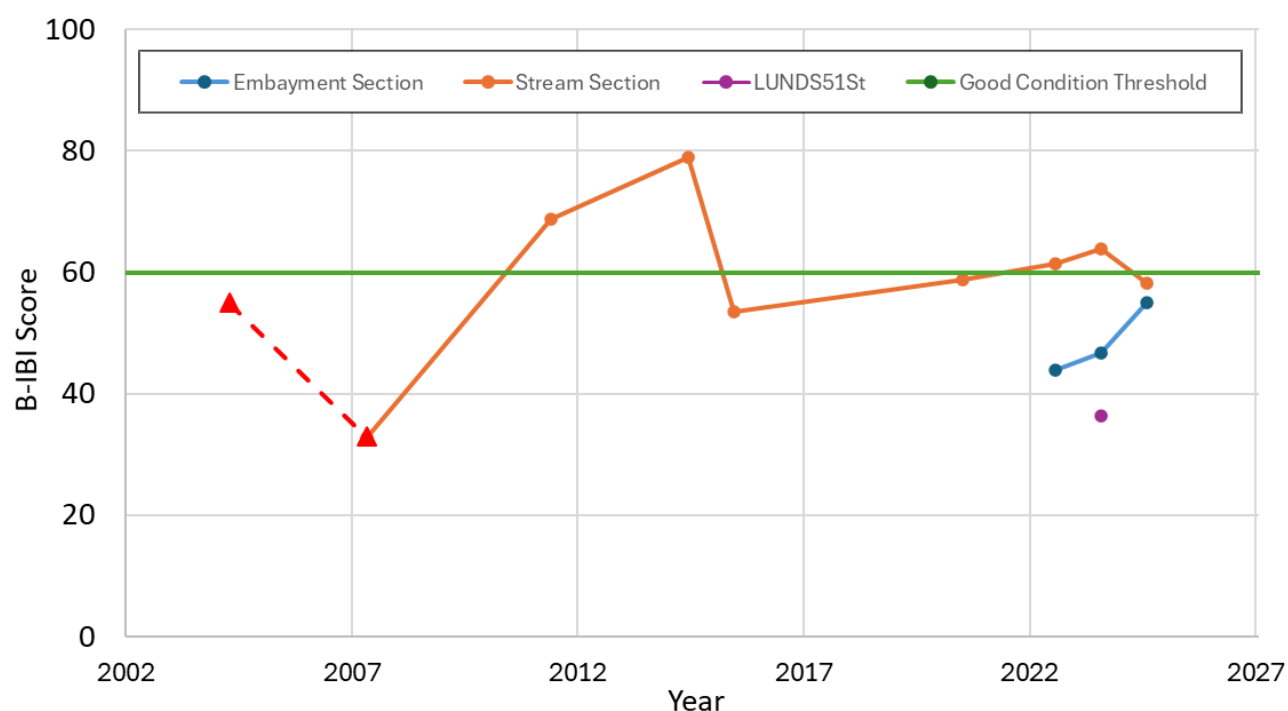


Figure 13

Time series of B-IBI scores at Lund's Gulch Creek (2005 through 2025).

Fine sediment was not characterized as part of B-IBI sampling in 2005-2016, but is part of recent data collection. The percent gravel surface covered in sand or silt was evaluated using the 25-point grid quadrat within the center of each Surber sample (200 points total evaluated) within riffles. The percentage fine sediment composition by year is shown for the Lund's Gulch Creek (Upper) and Embayment (Lower) locations in **Table 9**. Generally, fine sediment decreased over time in riffles and was not a prominent component of streambed surface substrate in summer, though sub-surface sampling was not conducted. Fine sediment associated with pool or other habitat units was not evaluated.

TABLE 9
SURFACE FINE SEDIMENT COMPOSITION AMONG SAMPLED B-IBI RIFFLES

Location	Sand and Silt %			
	2021	2023	2024	2025
Lund's Gulch Creek - Upper	11.5	8.5	6.0	1.0
Lund's Gulch Creek - Lower	N/A	5.5	7.0	3.5

There was a dramatic increase in pollution tolerant taxa as a characteristic of the benthic invertebrate community in the lower Lund's Gulch Creek reach following construction (**Figure 14**). Signs of physical habitat and food base disturbance are associated with appearance of species tolerant to disturbance or pollution. Expectations for community recovery in the lower Lund's Gulch Creek reach would resemble the range of past conditions and current conditions in the upper Lund's Gulch Creek reach.

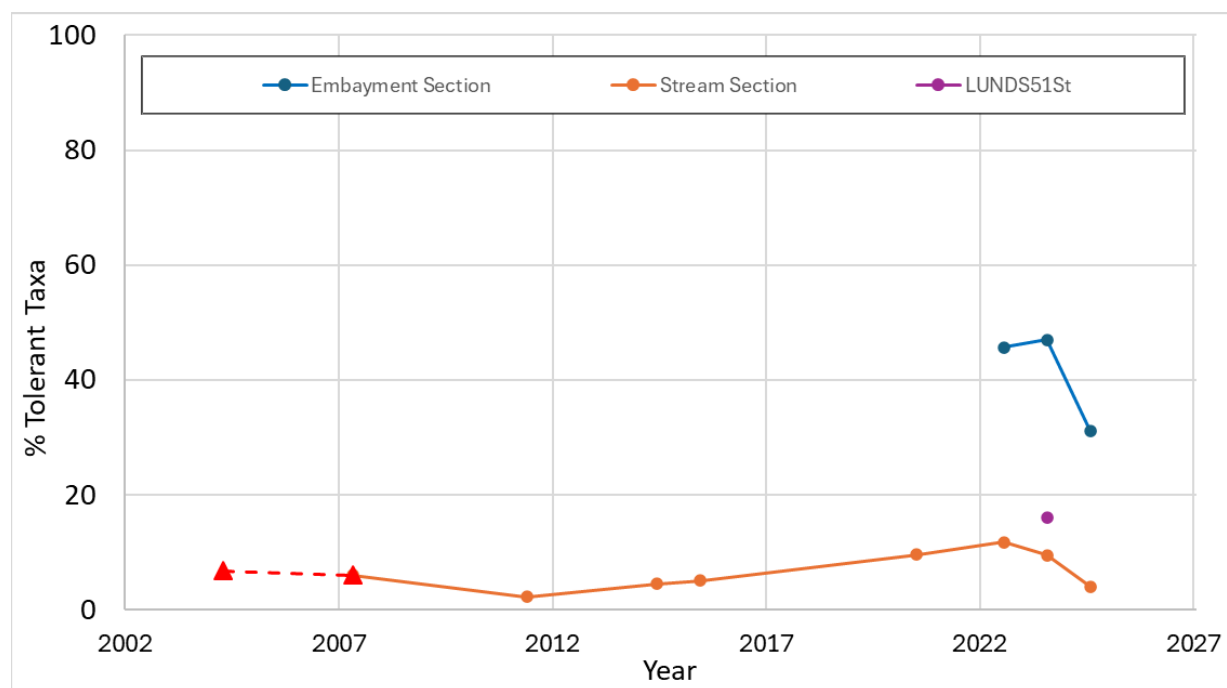


Figure 14

Time series of Percent Tolerant Taxa (%) scores at Lund's Gulch Creek (beginning 2005 through 2025).

Large Woody Material

Monitoring Goals:

- **Lund's Gulch Creek downstream of Park Ranger's house - document retention of large wood places during restoration and additional large wood retention and recruitment following restoration.**
- **Upper estuary - document retention of large wood places during restoration and additional large wood retention and recruitment following restoration.**

Woody material in Lund's Culch Creek was either placed as part of the Meadowdale project or was recruited naturally. In 2009 and 2021 only natural woody material or material placed as part of a much older stream restoration effort was present. Wood pieces greater than 2m length and greater than 10 cm diameter were counted. Pre-restoration, in creek reaches 2 through 4, 17 pieces of wood were counted in 2009, and 30 pieces of wood were counted in 2021. Overall, wood was relatively sparse and widely spaced during these pre-restoration years. This contrasts with conditions observed in 2023, 2024, and 2025, when the restoration project added substantial amounts of wood across creek reaches 2 through 5 (**Table 10**). The restoration nearly doubled the number of wood pieces in the creek (**Figure 15**). Most of the added wood consisted of large conifer trees with rootwads, which are particularly effective at shaping stream habitat (**Figure 16**). In 2025, the number of naturally occurring wood pieces also increased as a result of windfall, bank erosion, and other natural processes. Changes in the amount and function of woody material in the creek will continue to be monitored over time. In particular, the effects of the large, installed wood pieces with rootwads on habitat formation and the number of pools in the creek will be evaluated, as overall wood levels are now estimated to be close to those expected under natural conditions.

TABLE 10
LARGE WOODY MATERIAL INVENTORY

Year	Survey Length (m)	Average Bankfull Width (m)	Number of Channel Widths	LWD Piece Count	LWD Pieces per Channel Width	LWD Frequency (Pieces per km)
2009 Total	124	4.1	30.24	17	0.56	137.1
2021 Total	137.95	4.48	30.77	30	0.97	217.5
2023 Natural	311.45	6.57	47.4	63	1.2	202.3
2023 Placed	311.45	6.57	47.4	50	1.05	160.5
2023 Total	311.45	6.57	47.4	107	2.26	343.5
2024 Natural	302	6.35	47.6	62	1.3	205
2024 Placed	302	6.35	47.6	50	1.05	165.6
2024 Total	302	6.35	47.6	112	2.35	370.9
2025 Natural	310.91	5.02	61.9	80	1.3	257.3
2025 Placed	310.91	5.02	61.9	50	0.8	160.8
2025 Total	310.91	5.02	61.9	130	2.1	418.1



Figure 15
Map view of large woody material surveyed in 2025



Figure 16
Large Woody Material (flagged) with Rootwads Placed in Lund's Gulch Reach 3

Planted Vegetation Survival and Coverage (Monitoring Element E)

The restoration included the planting of vegetation to reestablish a native plant community in the restoration area. Several performance standards were established in the grant agreements funding the restoration. Vegetation survival and coverage monitoring was conducted by Environmental Science Associates (ESA) on behalf of the County.

Methods

Vegetation monitoring parameters assessed during Year 3 included plant survival, vegetation coverage, and vegetation composition in the marsh and riparian planting areas. Surveys were conducted at mean low tide for the estuarine areas and freshwater wetland. Surveys were conducted on August 22, 2025, after most of the growing season had passed but before vegetation had senesced, to capture the full extent of plant growth for the year. Vegetation monitoring methods were consistent with those outlined in the Monitoring Plan (ESA 2022). Data collected in Year 3 was compared to baseline data collected in Year 1.

In June 2023, prior to Year 1 vegetation monitoring, ESA biologists established vegetative plots, transects, and representative photo points on the site based on those recommended in the Monitoring Plan (ESA 2022) (**Figure 17**). Five permanent, 33-foot diameter sampling plots were established in planting areas, labeled Vegetation Plot (VP) 1 through VP-7. The plots were evaluated for percent cover and community composition. In each sampling plot, every species with more than 5% cover was recorded. The percent cover of each vegetation class (herbaceous, shrubs, trees) and the total cover of native and invasive species was calculated based on the percent cover of each species recorded.

In addition to vegetation plots, 12 permanent 50-foot-long transects were established in vegetation planting areas, labeled Vegetation Transect (VT) 1 through VT-12 (**Figure 17**). Transect VT-9 (saltmarsh habitat) is only 44 feet long to prevent overlap with VT-12 (riparian habitat) and to contain the transect to one habitat type. At least one transect was established within each of the vegetation community types shown on the design plans included in the Monitoring Plan: high saltmarsh, low saltmarsh, freshwater wetland, and riparian.

In the saltmarsh planting area, six one-meter quadrat sampling plots were established along each transect (VT-1 through VT-6). Quadrat locations were selected using a random number generator to determine the center point of each quadrat along the transects. The Monitoring Plan calls for the same permanent transects to be used during all sampling events, but to vary quadrat locations from one monitoring year to the next. However, as recommended in the Year 1 Monitoring Report the same quadrat locations were used for Year 3 monitoring and will continue to be used in subsequent years. The percent cover of each species rooted within each quadrat was recorded. This percentage was extrapolated as a representative percentage of the overall saltmarsh habitat plant survival, native volunteer vegetation, and invasive areal coverage for the estuary and beach planting areas. Only emergent plant stems within the quadrats were counted; overhanging plants are not counted toward survival.

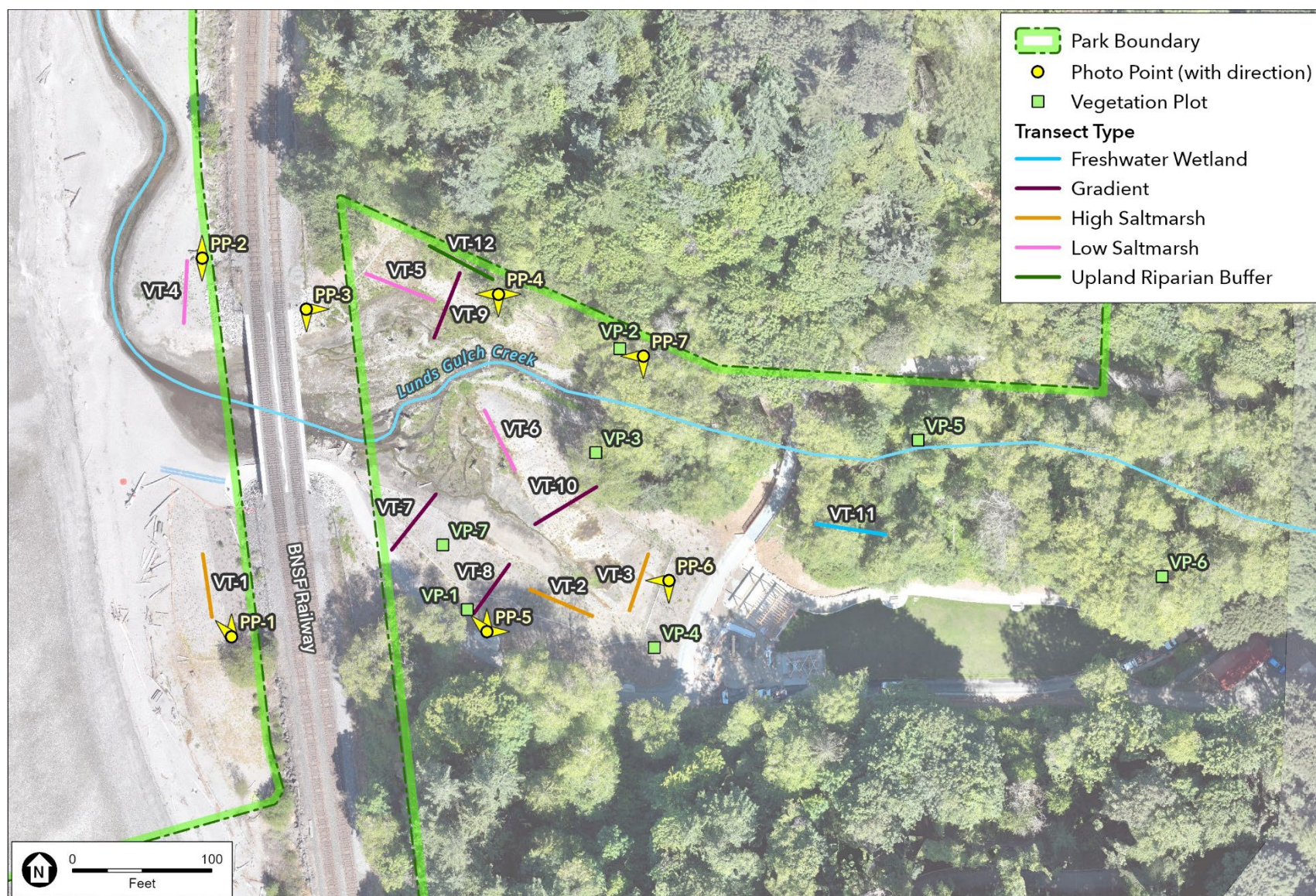


Figure 17
Vegetation Monitoring Plots, Transects, and Photo Points

Along the gradient transects and in the upland riparian buffer (VT-7 through VT-12), the line-intercept method was used to record vegetation cover and composition. The percent cover along VT-11 is used as representative cover of the freshwater wetland area; the percent cover along VT-12 is used as representative percentage of the overall upland riparian buffer. The percent cover of native and invasive species along the gradient transects (VT-7 through VT-10) was combined with the percent cover of native and invasive species for the quadrats in VT-1 through VT-6 and was extrapolated as a representative percentage of the overall vegetation coverage in the estuary.

Results and Discussion

The Year 3 vegetation survey quantified percent cover of vegetation within quadrats along marsh transects, and by line intercept along transects in the upland riparian buffer, freshwater wetland, and on gradient transects that cross both high and low marsh planting areas. Overall, the vegetation planted on-site appears healthy, and volunteer vegetation has colonized many areas throughout the site. Wildlife browse was observed on the northern and eastern edges of the site. However, as the vegetation on site has continued to mature and increase in cover, herbivory does not appear to be impacting the health of the site overall. All vegetation monitoring data is included in **Appendix C**. Photos taken from the end of each transect, as well as from established photo points are included in **Appendix D**. The locations of monitoring plots, transects, and photo points is shown on **Figure 16**. Vegetation monitoring is planned for future monitoring Years 5 and 10.

Performance Standard: Achieve 50-70% cover of native vegetation species planted per design at designated representative monitoring plots within 5 years post-construction and sustain for the lifetime of the project.

This performance standard is met.

The average areal cover for all monitoring plots (VP-1 through VP-7), including all vegetation strata (trees, shrubs, and herbaceous), is approximately 189% (**Appendix C**). This is an increase from Year 1 (2023) average cover across all strata, which was 99%. For Year 3 monitoring, broken down by stratum, the average tree cover for all monitoring plots was 59%, the average shrub cover was 76%, and the average herbaceous cover was 30%. The monitoring plot with the highest percent cover was VP-5, due in part to having tree cover from preexisting trees. All plots had a total vegetative cover of over 100% due to overlapping strata.

Performance Standard: Reduce non-native vegetation species to less than 20% cover within 5 years post-construction.

This performance standard is met.

Non-native invasive species cover is less than 20% of the overall project site, averaging 12.4% across both vegetation plots and transects. Monitoring plots VP-1 and VP-4 and transect VT-6 each had invasive cover over 20% due to larger patches of jewelweed (*Impatiens capensis*) and hairy willowherb (*Epilobium hirsutum*). Additionally, as noted in the fish passage section of this report, watercress is acting as an invasive species on the site, growing in large dense patches that outcompete other native species

even though it is not listed as an invasive or noxious weed in Snohomish County. Watercress is particularly captured in VT-9, where it makes up 27.8% of the transect cover.

Performance Standard: Within identified planting areas, native riparian vegetation species cover shall be at least 25% by Year 3.

This performance standard is not met.

The percent cover for the only riparian transect, VT-12, was 9.4%, which is below the Year 3 performance standard of 25% cover. The plants that are growing along the transect appear robust and healthy, and no obvious mortality was observed either along the transect or within the riparian area generally. However, the plantings along the transect are somewhat sparse and are planted below existing trees. The riparian area may need additional in-planting to meet the Year 5 performance standard of 50% cover.

Performance Standard: Native herbaceous cover within designated estuary and beach areas shall be at least 50% by Year 3.

This performance standard is met.

The average percent cover of native vegetation for the combined marsh and beach transects (VT-1 through VT-6) is 79.1%. All transects are individually above the 50% performance standard with the exception of VT-1 on the southern portion of the beach, which has 25% cover. This area was replanted in Year 2, but receives direct sun exposure without irrigation, and has little protection from the public. The transect with the highest percent cover is VT-3, located on the southeastern portion of the planting area, with 103.7% native vegetation cover. Additionally, the gradient transects (VT-7 through VT-10) located across the marsh planting areas, have an average of 175.3% native vegetation cover.

Additional plantings and/or irrigation are recommended along VT-1 on the southern portion of the beach, but additional plantings are not required as the performance standard for the estuary and beach areas is met.

Performance Standard: Invasive, non-native plant species are maintained at levels below 20% total cover within planted areas.

This performance standard is met.

As discussed above, non-native invasive species cover is less than 20% of the overall project site, with an average of 12.4% cover across both vegetation plots and transects. While meeting the performance standard, this is an increase in cover of non-native vegetation from Year 1, due to larger patches of invasives along the stream channels within the lower marsh planting areas.

Additional Monitoring Elements

To further evaluate the effectiveness and sustainability of the Meadowdale project, additional monitoring elements are being studied beyond those committed to or required by grants and permits. This section describes the findings of these additional investigations.

Sediment Dynamics and Habitat Area in Upper Estuary and Creek Outlet (Monitoring Element F) and Adjacent Nearshore (Monitoring Element G)

Sediment erosion and deposition patterns in the upper estuary and creek outlet will inform how the site is evolving as coastal and fluvial processes act on the area. The wide estuary was designed to accommodate increased water levels with sea-level rise and provides space for the site to adjust. Monitoring will help inform the size and design of future restoration projects to accommodate creek outlet, estuary, and sediment dynamics.

Methods

The Tulalip Tribes conducted drone flights of the restoration area that provided georectified aerial orthophoto and a digital surface model (DSM). To supplement the drone DSM information, horizontal and vertical positioning data were collected using RTK-GPS. Data were collected along 6 to 8 transects running in one direction with 1 to 2 additional transects running approximately perpendicular to the railroad embankment.

In late 2024, the Tulalip Tribes initiated a sediment particle tracking study that will continue through 2026. The study is investigating sediment movement throughout the estuary following storm events. Initially, 100 pieces of gravel- or cobble-sized (3-12 inches in diameter) sediment were fitted with passive integrated transponder (PIT) tags in 2024, and a second batch of PIT tagged sediment was deployed in fall 2026. After known storm events, the PIT tagged sediment is located to track how far and the direction they moved. The data collected will inform how sediment travels through the restored estuary and whether the restoration area helps supply sediment to adjacent nearshore beaches near the tidal channel outlet.

Results and Discussion

Drone and transect topographic data were collected in May and August 2025. To supplement the drone DSM information, horizontal and vertical positioning data were collected along transects using RTK-GPS. Surface substrate sizes along the transects were also visually characterized. The centerlines of channels through the upper estuary were mapped using the topographic data collected in August.

The 2025 data is compared to baseline data for the restoration area established in Year 1 (2023). Similar data collection is planned each year through Year 10 post-construction. Each year, the data will be analyzed to evaluate channel alignment changes, inundation area changes, and areas experiencing sediment erosion or deposition. The analysis of this data was not complete at the time of this report and will be updated in an addendum when available.

Fish Use (Monitoring Element H)

A primary purpose for the estuary restoration was to improve the quality and quantity of habitats for salmon, trout, and other fish, and especially to improve habitat accessibility and quality for juvenile Chinook salmon. Monitoring and documenting the use of the site by juvenile salmon compared to pre-restoration use will provide information on how non-natal habitat restoration benefits juvenile Chinook salmon.

Methods

The Tulalip Tribes conducted fish sampling in the estuary and lowermost reaches of Lund's Gulch Creek between February and May 2025 to document juvenile salmonids and other fish using the restored habitats during the spring rearing period. Electrofishing and beach seining were conducted in 9 events between February 10 and June 3, 2025. Electrofishing duration ranged between 13 and 20 minutes for each event. Three beach seine tows were conducted in each sampling event and were conducted at the same locations as the electrofishing surveys. For both electrofishing and beach seining sampling, after fish were netted, they were held in an aerated bucket, identified to species, and released after sampling was completed. Additionally, juvenile Chinook and Coho salmon were sampled using gastric lavage to evaluate their stomach contents.

Results and Discussion

The post-restoration sampling in 2025 caught Chinook, Coho, chum, and pink salmon (*O. gorbuscha*); coastal cutthroat trout; along with multiple estuary species including prickly sculpin (*Cottus asper*), Pacific staghorn sculpin (*Leptocottus armatus*), tidepool sculpin (*Oligocottus maculosus*), sharpnose sculpin (*Clinocottus acuticeps*), three-spined stickleback (*Gasterosteus aculeatus*), English sole (*Parophrys vetulus*), shiner perch (*Cymatogaster aggregata*), and additional species of sculpin that were not able to be identified. (**Tables 11 and 12**).

Electrofishing captured 24 Chinook and beach seining did not capture any Chinook. This represents a substantial increase compared to previous years. Year 3 monitoring was conducted during an odd-numbered year, so no pink salmon were encountered, as expected. A total of 13 unmarked sub yearling and yearling Coho were collected, with 11 captured by electrofishing and 2 by beach seining. Chum were the most abundant salmonid captured, with 335 from electrofishing and 355 individuals overall, representing a notable increase from prior years. Cutthroat trout were also abundant throughout the monitoring period, with consistent catches recorded during each sampling event. Additional estuary fish captured included a variety of sculpin species, starry flounder (*Platyichthys stellatus*), English sole, shiner perch, and stickleback.

TABLE 11
ELECTROFISHING – NUMBER OF FISH SPECIES CAPTURED PER SAMPLING DATE

Fish Species	10-Feb	26-Feb	11-Mar	25-Mar	8-Apr	23-Apr	7-May	20-May	3-Jun
Sub-yearling Chinook Salmon (unmarked)	0	0	0	1	16	2	5	0	0
Sub-yearling Coho Salmon (unmarked)	0	0	11	7	10	13	14	31	20
Yearling Coho Salmon (unmarked)	0	2	1	0	2	0	0	0	0
Chum Salmon	0	6	25	38	99	129	37	1	0
Cutthroat Trout	20	13	14	22	19	33	20	22	20
Prickly Sculpin	2	16	4	2	15	19	30	14	20
Pacific Staghorn Sculpin	60	140	77	83	76	57	29	32	61
Unknown Sculpin	0	29	2	0	51	2	9	18	4
Stickleback	0	0	0	1	0	2	0	0	0
Tidepool Sculpin	0	0	0	0	0	3	0	0	0
Starry Flounder	0	1	0	2	0	0	0	0	3
Sharpnose Sculpin	2	0	0	0	0	0	0	0	0

TABLE 12
BEACH SEINE – NUMBER OF FISH SPECIES CAPTURED PER SAMPLING DATE

Fish Species	10-Feb	26-Feb	11-Mar	25-Mar	8-Apr	23-Apr	7-May	20-May	3-Jun
Yearling Coho Salmon (unmarked)	0	0	0	0	0	0	0	2	0
Chum Salmon	0	0	1	0	2	17	0	0	0
English Sole	0	0	0	0	0	0	1	0	1
Sharpnose Sculpin	0	0	0	1	0	0	0	0	0
Shiner Perch	0	0	0	0	0	0	0	2	0
Staghorn Sculpin	0	2	0	2	2	1	1	0	8
Unknown Sculpin	0	0	0	0	0	0	0	0	2

The proportional fish species composition by location in electrofishing reaches is presented in **Figure 18**. Reaches were determined by stream habitat surveys and remain the same throughout sampling years. Chinook were captured in Reaches 0 and 2, which is consistent with where Chinook were captured in previous monitoring years. Coho were captured throughout the sampling reaches, except in reaches 1 and 4. Cutthroat trout were only present in the upstream reaches (Reaches 2 through 5) and were not present in Reach 0 or 1.

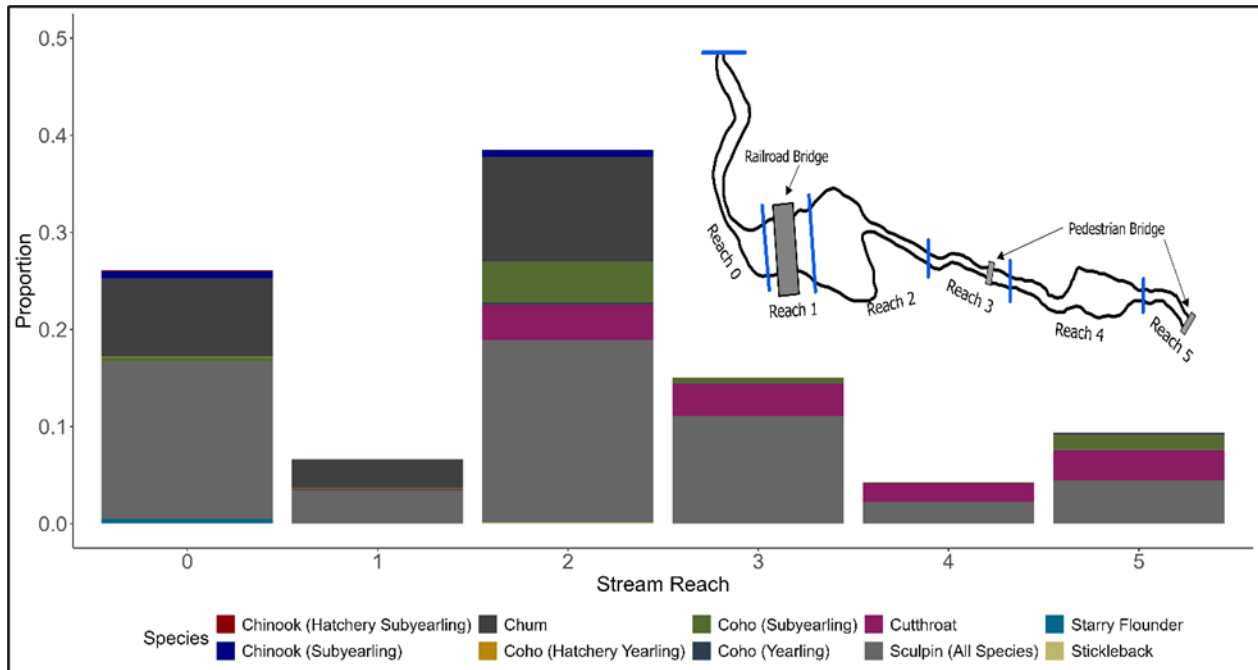
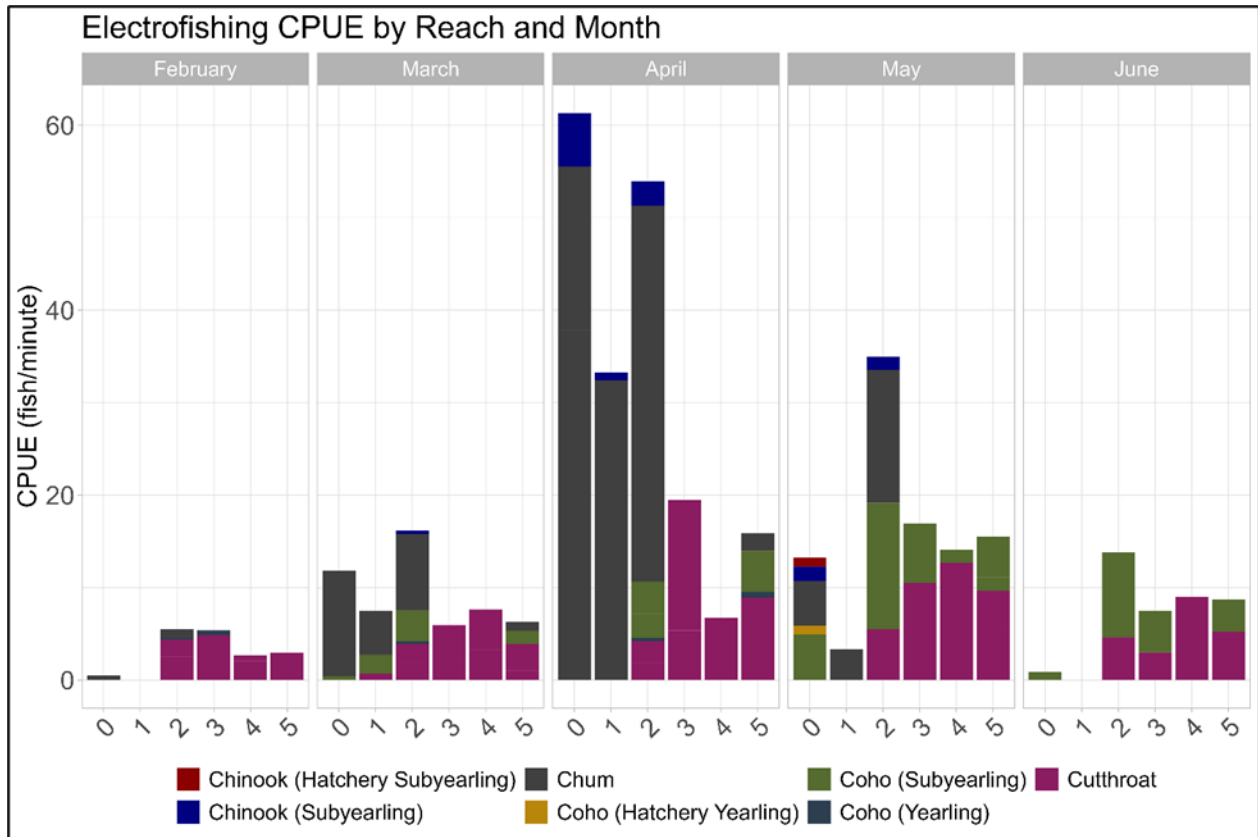


Figure 18

Proportional Fish Species Composition by Location in Electrofishing Reaches

The catch per unit effort (CPUE) of salmonids during electrofishing by month and by sampling reach is presented in **Figure 19**. Chum were captured February through May in Reach 0 (intertidal reach; downstream of the railroad bridge), Reach 1 (under the railroad bridge) and Reach 2 (upstream of the railroad bridge). Cutthroat trout were captured in every sampling month and in every reach except in Reaches 0 and 1.

Chum and cutthroat trout were present in all sampling months, Coho were present starting in March, and Chinook were present primarily in April and May. The sampling with the highest overall counts were for chum in April in Reaches 0-2.

**Figure 19**

CPUE of Salmonids During Electrofishing (by month and sampling reach)

Figure 20 presents the CPUE from beach seine sampling in the adjacent nearshore, west of the railroad bridge. This includes all species captured. **Figure 21** presents the salmonids-only CPUE from beach seine sampling in the adjacent nearshore, west of the railroad bridge.

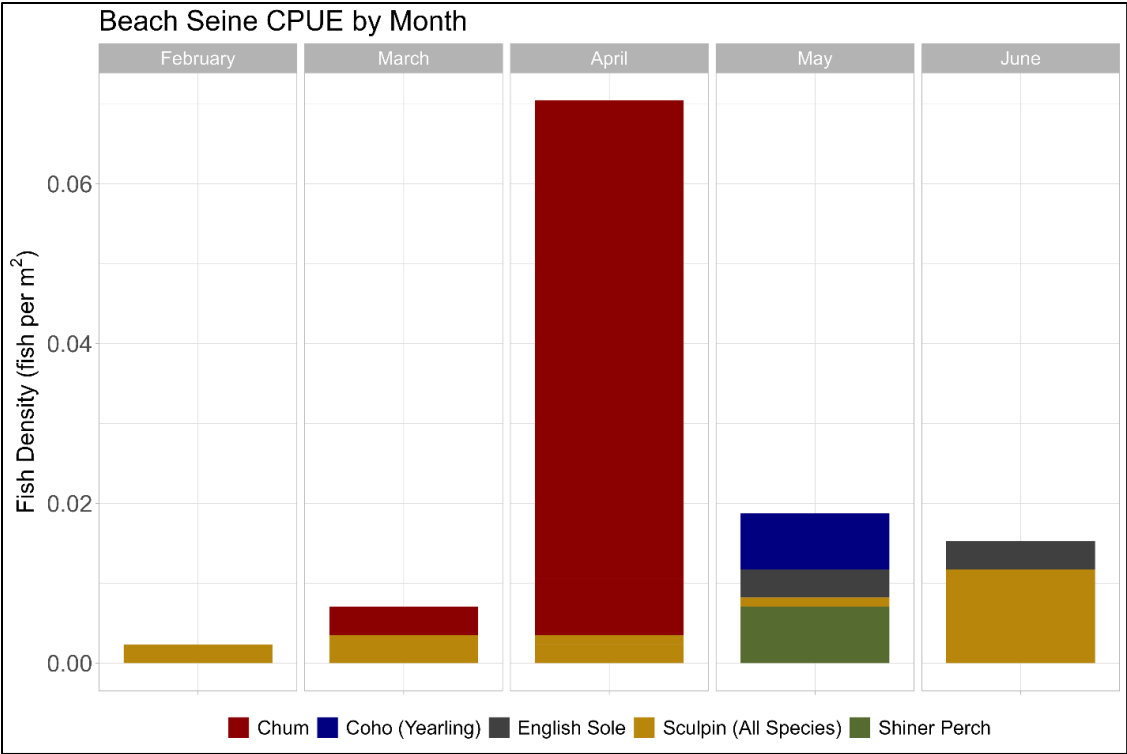


Figure 20
Adjacent Nearshore Beach Seining Sampling CPUE

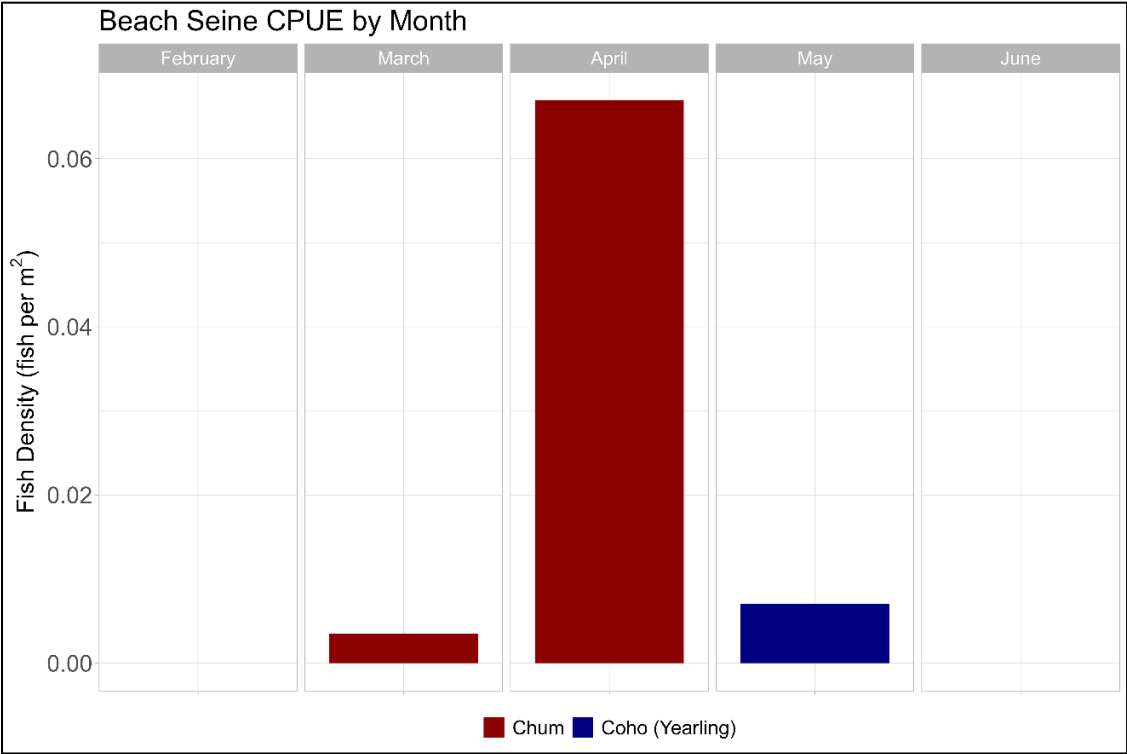


Figure 21
Adjacent Nearshore Beach Seining Sampling CPUE – Salmonids Only

Fish use pre- and post-restoration, as documented by electrofishing events in 2018 and 2021 through 2025, is shown in **Table 13**.

TABLE 13
ELECTROFISHING RESULTS PRE- AND POST-RESTORATION

Species	Pre-Restoration		Mid-Restoration	Post-Restoration		
	2018 (n=9)	2021 (n=14)	2022 (n=9)	Year 1 (2023) (n=6) ^a	Year 2 (2024)	Year 3 (2025)
Chinook Salmon	7	1	3	1	2	24
Coho Salmon	62	6	66	30	15	111
Chum Salmon	16	0	144	346	15	335
Pink Salmon	0	0	2	0	3	0
Coastal Cutthroat Trout	81	61	188	89	101	183
Pacific Staghorn Sculpin	36	1	8	97	872	615
Prickly Sculpin	7	17	32	39	113	122
Coastrange Sculpin	71	133	4	0	21	0
Tidepool Sculpin	0	1	1	1	14	3
Sharprose sculpin	0	0	0	3	1	2
Unidentified Sculpin	611	252	96	154	168	115
Three-spined Stickleback	0	0	1	1	13	3
Starry Flounder	0	0	1	0	21	6

Note:

n = number of sampling events

a = In 2023 sampling was conducted in all reaches in 5 sampling events. Sampling in a 6th event was conducted in one reach and included in the overall count.

These fish use results demonstrate that anadromous and resident salmonids, as well as other nearshore fish species, are using the restored estuary. Different species and quantities are collected by each of the sampling methods. Both efforts provide important data to document fish use of the restored estuary. Continued fish use sampling is planned each year through Year 10 post-construction dependent on funding. The priority analysis years for reporting are Years 3, 5, and 10.

The questions and hypotheses for the fish use monitoring element, as established in the Monitoring Plan and the summary of findings based on Year 3 sampling is shown in **Table 14**.

TABLE 14
FISH USE MONITORING SUMMARY

Monitoring Questions and Hypotheses	Summary of Findings
Question: Are non-natal juvenile Chinook salmon using the restored habitats (lower estuary, upper estuary, creek outlet, and lower Lund's Gulch Creek)? If so, which portions of the project area or specific habitat features are they using more frequently or in greater numbers?	
<i>Hypothesis:</i> Juvenile Chinook salmon will occupy the site in higher numbers compared to pre-construction numbers.	Juvenile Chinook salmon were captured all years of sampling, both pre- and post-construction. Post-construction numbers from Year 3 are higher than pre-construction.
<i>Hypothesis:</i> Juvenile Chinook salmon will occupy portions of the estuary providing cover habitat, such as large wood, deep pools, or large substrate.	In Year 3, Chinook salmon were caught in the estuary in Reaches 0 and 2.
Question: Are non-natal juvenile Chinook salmon using the restored habitats more than the adjacent nearshore habitats?	
<i>Hypothesis:</i> More juvenile Chinook salmon will be captured in the restored habitats compared to the adjacent nearshore habitats.	In Year 3, Chinook salmon were caught in Reach 0, closest to the mouth of the estuary, and in Reach 2, upstream of the railroad bridge.. No Chinook were caught in adjacent nearshore habitats
<i>Hypothesis:</i> The seasonality of juvenile Chinook presence in the restored habitats and adjacent nearshore habitats will be the same.	This hypothesis cannot be properly evaluated as no Chinook were caught in adjacent nearshore habitats.
Question: Is there a seasonal timing and/or size difference between non-natal Chinook salmon in the restored habitats compared to the adjacent nearshore habitats?	
<i>Hypothesis:</i> The seasonality of juvenile Chinook salmon presence in the restored habitats and adjacent nearshore habitats will be the same.	This hypothesis cannot be properly evaluated as no Chinook were caught in adjacent nearshore habitats.
<i>Hypothesis:</i> Juvenile Chinook salmon in the restored habitats will be larger than those in the adjacent nearshore habitats.	This hypothesis cannot be properly evaluated as no Chinook were caught in adjacent nearshore habitats.
Question: Are other salmon and trout (i.e., not Chinook salmon) using the restored habitats?	
<i>Hypothesis:</i> Juveniles and adults of other salmon and trout species will be documented using the restored habitats.	Yes, other salmon and trout species captured in 2025 included Coho salmon, chum salmon, and coastal cutthroat trout.
Question: What river system(s) do juvenile Chinook salmon using the restored habitats originate from?	
<i>Hypothesis:</i> Juvenile Chinook salmon from multiple river systems, including north and south of the site, will use the restored habitats.	Chinook tissue samples were collected but results were not available at the time of this report. Results will be included as an amendment when available.
Question: Are other nearshore fish, including juvenile and adult forage fish, using the restored habitats?	
<i>Hypothesis:</i> A diverse community of nearshore fish species—other than salmon and trout—will occupy restored habitats in the upper estuary and lower estuary.	Yes, several nearshore species, including starry flounder and multiple sculpin species, were captured in 2025.
<i>Hypothesis:</i> Juvenile forage fish such as surf smelt, Pacific sand lance, Pacific herring, eulachon, and northern anchovies will occupy restored habitats in the upper estuary and lower estuary.	No forage fish were captured in 2025 fish use sampling.

Salmon Spawning Ground Surveys (Monitoring Element I)

The purpose of conducting salmon spawning ground surveys is to document the changes in the number of adult salmon returning to spawning grounds in Lund's Gulch Creek after restoration.

Methods

The Edmonds Stream Team, a citizen science and student volunteer group based in Edmonds, conducted on-the-ground surveys for adult salmon in Lund's Gulch Creek in Meadowdale Beach Park from September 30 to December 4, 2025. The surveys covered the area from the creek's beach outlet into Puget Sound to about 1.4 miles upstream, inland of the railroad bridge (upper point of known spawning activity). Presence/absence of adult salmon, species observed, spawning behavior, habitat condition, and length/sex/spawning status of dead salmon were collected.

Surveys were conducted on weekends with experienced students from Meadowdale High School and conducted periodic weekday surveys with trained adult volunteers. Signs were posted at the estuary, both bridges, and the Park bulletin board requesting that Park visitors report salmon sightings, along with photos if possible. A total of 119 reports were received from Park visitors for multiple creek locations along the trail, from the two pedestrian bridges, the south edge of the estuary, and the beach. Several hundred photos and videos were received that were very useful in confirming species identification and sex, location, and duplicate sightings.

Results and Discussion

The Stream Team estimates that a minimum of 119 adult salmon, 93% chum salmon and 7% Coho salmon, occurred in Lund's Gulch Creek during the fall 2025 spawning season. The peak number of spawning salmon occurred during the week of November 3 to November 9, 2025 and the last pair of spawning chum salmon were observed on November 28, 2025.

Adult salmon passage through the estuary (upstream of the railroad bridge) to the creek occurred exclusively in one channel that formed on the north side of the estuary. This contrasts with the two to three channels allowing adult salmon passage through the estuary in previous years.

The questions and hypotheses for the salmon spawning monitoring element, as established in the Monitoring Plan, and the summary of findings based on Year 3 sampling is shown in **Table 15**.

TABLE 15
SALMON SPAWNING GROUND SURVEYS MONITORING SUMMARY

Monitoring Questions and Hypotheses	Summary of Findings
Question: Are anadromous salmonid adults holding in the restored habitats?	
<i>Hypothesis:</i> Restored estuary habitats will create holding habitats for anadromous Coho, chum, and cutthroat trout adults returning to spawn.	Adult Coho and chum salmon spawned upstream of the restored estuary habitat, but no specific observations of fish holding in the estuary habitat were recorded in 2025.
Question: Are there increases in the number of anadromous salmonid adults in Lund's Gulch Creek?	
<i>Hypothesis:</i> Increased numbers of anadromous Coho, chum, and cutthroat trout adults will be documented in stream spawning surveys.	The number of adult Coho salmon increased from 6 in 2022, 7 in 2023, to 9 fish in 2025. The number of adult chum salmon increased overall from 48 in 2022, 11 fish in 2023, to 110 in 2025.
Question: Among the adult salmon returning to the stream, are there fewer observations of injuries from predator attacks?	
<i>Hypothesis:</i> Fewer adult salmon in the creek will have visible injuries from predator attacks.	No predation on adult salmon was observed during the 2025 surveys.

Forage Fish Egg Presence (Monitoring Element J)

The purpose of monitoring and documenting forage fish egg presence is to inform the benefits of the project beyond salmonid use, as forage fish are not only important food for salmon, but are also an important food source for other fish, marine mammals, and birds.

Methods

The Snohomish County Marine Resources Committee collects beach substrate samples to detect forage fish egg presence. Forage fish egg presence samples were collected following the protocols specified by WDFW (2021). Samples are collected from two sites, one at Meadowdale Park and one at Picnic Point. At both sites the same protocols are followed, and samplers complete two samples/stations. At the Meadowdale project site, one sample is collected on the north side of the beach on the berm forming the outer margin of the estuary channel and one sample is collected on the south side of the beach. There are no defined GPS points or landmarks that are used as the starting point for the 100-foot sample zone, surveyors move along the beach looking for the best possible substrate for forage fish eggs. The survey is conducted monthly and will be repeated annually through Year 10 post-construction.

Results and Discussion

No forage fish were detected in Year 3 at the restoration site in monthly samples collected January through December 2025. Forage fish egg data collected by the Snohomish County Marine Resources Committee since September 2020 is presented in **Table 16**. The sampling did not occur for parts of 2021 and 2022 due to project construction. The only sampling dates with eggs identified in recent monitoring efforts were sand lance eggs detected in December 2021 and January 2022 and surf smelt eggs detected in January through March 2022. Previously, sand lance eggs were also documented by WDFW in November 2003 (WDFW 2023).

TABLE 16
FORAGE FISH EGGS DETECTED IN SURVEYS

Month and Year	Surf Smelt			Sand Lance		
	Meadowdale North	Meadowdale South	Picnic Point	Meadowdale North	Meadowdale South	Picnic Point
September 2020	0	0	0	0	0	0
October 2020	0	0	0	0	0	0
November 2020	0	0	0	0	0	0
January 2021	0	0	0	0	0	0
February 2021	0	0	0	0	0	0
March 2021	0	0	0	0	0	0
April 2021	0	0	0	0	0	0
May 2021	0	0	0	0	0	0
June 2021	0	0	0	0	0	0
November 2021	0	0	0	0	0	0
December 2021	0	0	1	0	1	0
January 2022	0	1	0	3	0	1
February 2022	1	0	0	0	0	0
March 2022	2	0	0	0	0	0
April 2022	0	0	0	0	0	0
January 2023	0	0	0	0	0	0
February 2023	0	0	0	0	0	0
March 2023	0	0	0	0	0	0
April 2023	0	0	0	0	0	0
May 2023	0	0	0	0	0	0
June 2023	0	0	0	0	0	0
July 2023	0	0	0	0	0	0
August 2023	0	0	0	0	0	0
September 2023	0	0	0	0	0	0
October 2023	0	0	0	0	0	0
November 2023	0	0	0	0	0	0
December 2023	0	0	0	0	0	2
January 2025	0	0	0	0	0	0
February 2025	0	0	0	0	0	0
March 2025	0	0	0	0	0	0
April 2025	0	0	0	0	0	0
May 2025	0	0	0	0	0	0
June 2025	0	0	0	0	0	0
July 2025	0	0	0	0	0	0
August 2025	0	0	0	0	0	0
September 2025	0	0	0	0	0	0
October 2025	0	0	0	0	0	0
November 2025	0	0	0	0	0	0
December 2025	0	0	0	0	0	0

Additional Vegetation Characteristics (Monitoring Element L)

Methods

Vegetation characterization and monitoring methods are consistent with those outlined in the Monitoring Plan (ESA 2022). In Year 1 (2023) of monitoring, ESA installed four gradient transects (VT-7, VT-8, VT-9, and VT-10) between 44 and 50 feet in length and perpendicular to the restored channel of Lund’s Gulch Creek (**Figure 16**). The endpoints of the transects are marked with orange capped T-posts, and the locations and elevations were collected with an RTK-GPS. Transects were established equally between vegetation communities, with two transects located in high marsh planting areas (VT-7 and VT-8), and two transects located in low marsh planting areas (VT-9 and VT-10), as defined in the Monitoring Plan

Elevation and soil salinity were collected at each end point of the gradient transects, as well as every 10 feet along the transects. Sample points are named for the distance from the lowest elevation end point of the transect (Sample Point 0, Sample Point 10, etc.). Soil salinity was collected using a Hanna GroLine direct soil conductivity tester. Soil salinity was measured approximately three inches below the surface.

The line-intercept method (Bonham 1989; Coulloudon et al. 1999) was used to record the species and cover of vegetation along the transect. Observed species were compared to the planting list and as-built plan of installed plants to determine if species were planted intentionally or are volunteer species. Species were assigned a category of salinity tolerance ranging from “Very Sensitive” to “Very Tolerant” based on either the peak salinity experienced in a typical growing season for each species, or the maximum salinity tolerated, depending on available species-specific information (Hutchinson 1991; CalFlora 2026). The categories of salinity tolerance and the corresponding salinity ranges are described in **Table 17**.

TABLE 17
SALINITY TOLERANCE CATEGORIES

Salinity Tolerance Category	Salinity Range (mS/cm)
Very Sensitive	0 – 1
Sensitive	1 – 8.9
Moderately Sensitive	8.9 – 17
Moderately Tolerant	17 – 24.7
Tolerant	24.7 – 32
Very Tolerant	Over 32
Source: Hutchinson 1991	

Results

Vegetation monitoring and soil salinity sampling occurred on August 22, 2025. Photos taken during monitoring are included in **Appendix D**. Soil salinity was recorded between 1:00 PM and 3:20 PM. The tide was between approximately 0 and 6 feet MLLW during the monitoring, with a low tide of -1.38 feet at 10 AM (NOAA 2026).

The recorded soil salinity and corresponding elevations for each sample point are shown in **Table 18**. Soil salinity was recorded between 0.0 and 0.95 mS/cm. The salinity generally decreased as elevation increased. As the maximum soil salinity value was between 0 and 2 mS/cm, the soil within the estuary site would be considered non-saline according to United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) classification (USDA 2011). While the site may have periods of increased salinity due to high tides and influence from the adjacent shoreline, the site appears to have a baseline of low salinity at low tides. It is likely that soil salinity at this site would not inhibit vegetation except for those species categorized as “Very Sensitive”.

TABLE 18
RECORDED SOIL SALINITY AND ELEVATION (OCTOBER 3, 2024)

Sample Point	Elevation (NAVD)	Salinity (mS/cm)
VT-7		
0	9.58	0.14
10	9.94	0.95
20	10.39	0.21
30	10.89	0.06
40	12.29	0.01
47	13.44	0
VT-8		
0	9.94	0.20
10	10.38	0.15
20	11.12	0.02
30	11.74	0.17
40	13.66	0.06
50	15.83	0.01
VT-9		
0	10.33	0.20
10	10.33	0.10
20	10.33	0.27
30	10.81	0.17
40	11.77	0.13
44	11.99	0.06
VT-10		
0	9.92	0.21
10	10.63	0.15
20	10.89	0.07
30	11.66	0.12
40	12.39	0.02
50	13*	0.01
* Elevation estimated due to equipment error		

A total of 33 species were recorded across the four transects. Of the recorded species, 12 were planted in the restoration site, and 21 are naturally recruited volunteer species, including 6 species that are listed as noxious weeds by Snohomish County (Snohomish County 2025). A full record of the vegetation transect data is included as **Appendix C**. A summary of the species observed on site, whether they are native or invasive, whether they were planted or volunteer, and their assigned category of salinity tolerance is described in **Table 19**. Of the intentionally planted species, all categories of salinity tolerance are represented and consist of two “Sensitive” species, three “Moderately Sensitive” species, one “Moderately Tolerant” species, three “Tolerant” species, and two “Very Tolerant” species. All categories of salinity tolerance are represented by the volunteer species.

TABLE 19
RECORDED SPECIES SALINITY TOLERANCE

Salinity Tolerance	Species Common Name	Species Scientific Name	Native / Invasive	Planted/Volunteer
Very Sensitive	Jewelweed	<i>Impatiens capensis</i>	Invasive	Volunteer
	Scouler's Willow	<i>Salix scouleriana</i>	Native	Planted
Sensitive	Red alder	<i>Alnus rubra</i>	Native	Volunteer
	Field horsetail	<i>Equisetum arvense</i>	Native	Volunteer
	Watercress	<i>Nasturtium officinale</i>	Native ^a	Volunteer
	Black Cottonwood	<i>Populus balsamifera</i>	Native	Volunteer
	Creeping buttercup	<i>Ranunculus repens</i>	Native	Volunteer
	Cut-leaf blackberry	<i>Rubus laciniatus</i>	Invasive	Volunteer
	Salmonberry	<i>Rubus spectabilis</i>	Native	Planted
	Panicled bulrush	<i>Scirpus microcarpus</i>	Native	Planted
Moderately Sensitive	Hairy willowherb	<i>Epilobium ciliatum</i>	Native	Volunteer
	Giant horsetail	<i>Equisetum telmateia</i>	Native	Volunteer
	Swordleaf rush	<i>Juncus ensifolius</i>	Native	Volunteer
	Rice cutgrass	<i>Leersia oryzoides</i>	Native	Volunteer
	Swordfern	<i>Polystichum munitum</i>	Native	Planted
	Himalayan blackberry	<i>Rubus armeniacus</i>	Invasive	Volunteer
	Trailing blackberry	<i>Rubus ursinus</i>	Native	Volunteer
	Sitka willow	<i>Salix sitchensis</i>	Native	Planted
	Hardstem bulrush	<i>Schoenoplectus acutus</i>	Native	Planted
	White clover	<i>Trifolium repens</i>	Native	Volunteer
Moderately Tolerant	Orange eye butterflybush	<i>Buddleja davidii</i>	Invasive	Volunteer
	Red fescue	<i>Festuca rubra</i>	Native	Volunteer
	Bird's-foot trefoil	<i>Lotus corniculatus</i>	Native	Volunteer
	Maritime rabbit's-foot grass	<i>Polypogon maritimus</i>	Invasive	Volunteer
	Silverweed	<i>Potentilla anserina</i>	Native	Planted

Salinity Tolerance	Species Common Name	Species Scientific Name	Native / Invasive	Planted/Volunteer
Tolerant	Lyngbye's sedge	<i>Carex lyngbyei</i>	Native	Planted
	Bull thistle	<i>Cirsium vulgare</i>	Invasive	Volunteer
	Tufted hair grass	<i>Deschampsia caespitosa</i>	Native	Planted
	Common rush	<i>Juncus effusus</i>	Native	Volunteer
	Douglas aster	<i>Symphotrichum subspicatum</i>	Native	Planted
Very Tolerant	Coastal saltgrass	<i>Distichlis spicata</i>	Native	Volunteer
	Beach strawberry	<i>Fragaria chiloensis</i>	Native	Planted
	American three-square	<i>Schoenoplectus americanus</i>	Native	Planted

Notes: Invasive species are highlighted in orange, volunteer native species are highlighted in blue.

a. while not listed as an invasive species, watercress is acting invasively on the site

With the relatively small sample size of data in this collection, all categories of salinity tolerance appear to be well distributed throughout all elevations, as shown in **Figure 22**. The range of soil salinity measured was relatively small and is likely not the limiting factor for any of the species present on site.

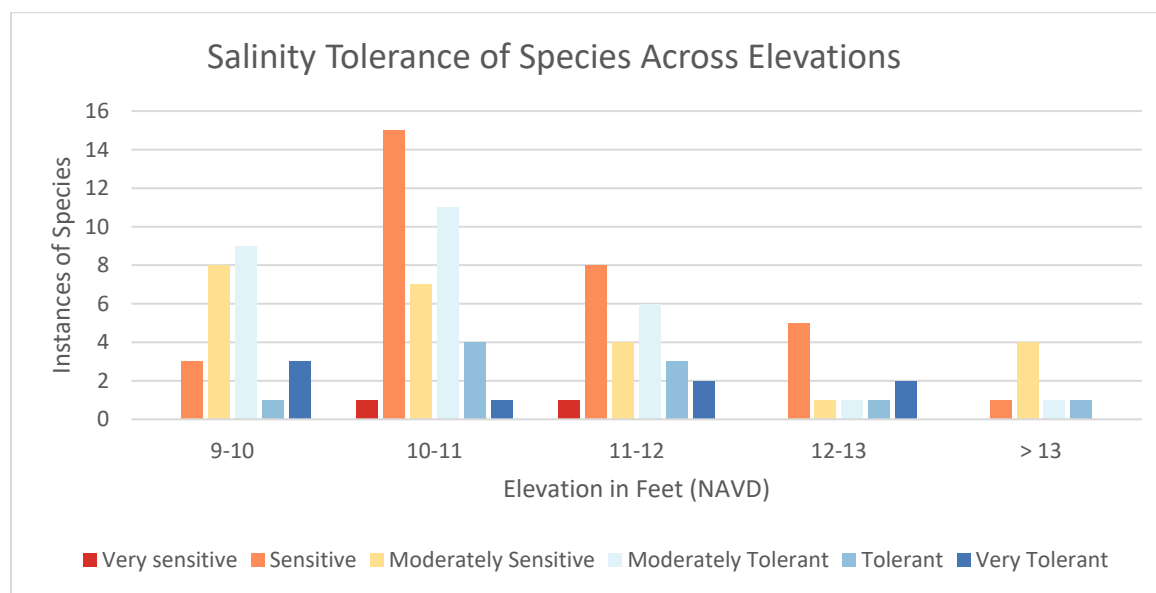


Figure 22

Salinity Tolerance of Species Across Elevations

Additional vegetation monitoring and characterization of the site in subsequent years may show changes in the extent and diversity of both planted and naturally recruited volunteer species throughout the estuary. As the site continues to develop, data collected in further years may continue to illustrate how elevation and salinity influence the vegetation communities and provide helpful information for the continued maintenance of this site and plans for future similar estuarine sites.

Photo Points (Monitoring Element M)

Photo point locations were established throughout the restoration area as shown in **Figures 23 and 24**. The photographs are expected to provide visual documentation of sedimentation, streambank erosion, channel alignments, vegetation establishment, beach changes, and other qualitative site conditions.

Methods

Photos were taken, when possible, by field crews collecting other monitoring data. Photos were taken in multiple directions, often in three or four directions, to provide 360-degree coverage of the restoration area. Photo points will be continue to be collected during other monitoring activities through the 10 years of post-construction monitoring.

Results and Discussion

Photos were collected at photo points during Year 1 (2023), Year 2 (2024), and Year 3 (2025). Photo points on the beach are included in **Appendix E**, photo points within the estuary are included in **Appendix F**, and photo points along the stream are included in **Appendix G**. Some photo points on the beach include photos taken pre-construction in 2021.



Sources: Imagery: Tulalip Tribes 2023. Maxar 2022:

Meadowdale Beach Park Restoration Monitoring Report

Figure 23
Photo Points Established Along Beach Transects



Sources: Imagery: Tulalip Tribes 2023, Maxar 2022; Photo Points: Snohomish County 2023

Meadowdale Beach Park Restoration Monitoring Report

Figure 24

Photo Points Established in the Upper Estuary, Creek Outlet, and Lower Lund's Gulch Creek

Summary of Year 3 Monitoring Findings

The Year 3 post-restoration monitoring program was successfully implemented. A summary of the results by monitoring element are shown in **Table 20**. All monitoring elements comparing post-restoration conditions to pre-restoration conditions show that performance standards are being met and conditions are improving following restoration.

While the performance standard for Fish Passage Conditions was met in Year 1, and there is no applicable performance standard for Year 3, continued removal of watercress on the site may be required to maintain fish passage through the estuary channels. The coverage and survival for planted vegetation is overall meeting required performance standards, except for cover of native vegetation in the riparian area which is below the required 25% cover for Year 3.

TABLE 20
SUMMARY OF MONITORING RESULTS

Result	Monitoring Element	Notes
	Fish Passage Conditions	Watercress is acting invasively and growing densely within estuary channels. Conditions restored in Year 3 but will need additional removal in subsequent years.
	Channel Cross-section and Profile Surveys	Current cross sections show little change in the upstream portion of Lund's Gulch Creek, some erosion downstream of the pedestrian bridge, and sediment aggradation in the alluvial fan. Further monitoring will evaluate site progress.
	Stream Habitat and Benthic Macroinvertebrate Populations	Channel and habitat diversity has increased from pre-restoration conditions. Macroinvertebrate B-IBI scores have recovered from the disturbance of the restoration construction.
	Large Wood Retention and Recruitment in Upper Estuary	More large wood is present than in pre-restoration conditions, both as placed pieces and naturally recruited pieces.
	Planted Vegetation Survival and Coverage	Overall achieved 50% cover of native vegetation and low coverage (<20%) of non-native vegetation. Riparian area below required coverage.
	Sediment Dynamics and Habitat Area	Baseline measurement.
	Fish Use	At least ten fish species captured in electrofisher sampling, including Chinook, Coho, and chum salmon and coastal cutthroat trout
	Salmon Spawning Surveys	Both Coho and chum survey numbers have increased compared to pre-restoration conditions.
	Forage Fish Egg Presence	No forage fish eggs were detected in Year 3. Mid-construction, surf smelt and sand lance eggs were detected. Pre-construction, no forage fish eggs were documented.
Notes: RED = element needs management YELLOW = on track or not yet known GREEN = met performance standards/ monitoring goals		

Adaptive Management Issues and Recommendations

Fish Passage Conditions

Watercress is acting as an invasive weed in the estuary by growing in a dense mat that outpaces and inhibits the growth of planted and native species, though it is not listed as an invasive or noxious weed in Snohomish County. Watercress removed in 2025 restored adequate velocity and flow to the estuary stream channels. However, watercress is a fast-growing plant and may require removal over several growing seasons to control. Additionally, as planted native vegetation increases in cover, the watercress will be less likely to dominate the estuary channels, as watercress prefers sunny, freshwater conditions.

In 2024 and 2025 watercress was removed from the site in compliance with the WDFW pamphlet Hydraulic Project Approval for the removal of aquatic plant control and removal (WDFW 2015). Maintenance of the estuary channels may require further coordination with WDFW.

Channel Cross-Sections and Profile Surveys

Channel incision and erosion has been observed downstream of the pedestrian bridge that represents a nick point moving upstream, and potentially under the bridge. Channel cross-sections should continue to be monitored to assess site adjustment following the restoration and if any adaptive management is advisable.

Stream Habitat in Lower Lund's Gulch Creek and Creek Outlet

Related to the channel incision and erosion, woody material that was placed as part of the restoration is now, in some areas, perched higher above the streambed than originally intended. As the stream continues to incise, there is a risk of these wood pieces becoming less functional. This should be a focus within the large woody material monitoring in the next monitoring years in order to develop any action recommendations, if needed, that would address grade control or wood function.

Planted Vegetation Survival and Coverage

Overall vegetation on the site is meeting Year 3 performance standards. However, the site is not currently meeting the performance standard for native riparian vegetation species cover of at least 25% by Year 3. There is only one transect in the riparian planting area and it had only 9.4% native vegetation cover. This is largely due to the fact that the riparian area is planted under large pre-existing trees on the northern boundary of the site. The riparian area may need additional in-planting to meet the Year 5 performance standard of 50%. Hearty shade tolerant species such as salal (*Gaultheria shallon*) may be a good option to increase cover in the area.

While the estuary and beach planting areas are meeting Year 3 performance standards, the southern portion of the beach planting area near VT-1 had only 25% native vegetation cover and may benefit from additional plantings and/or regular irrigation.

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