FINAL

MEADOWDALE BEACH PARK AND ESTUARY RESTORATION EFFECTIVENESS MONITORING

Year 2 Report

Prepared for
Snohomish County
Surface Water Management

April 2025

Photo Courtesy of Tulalip Tribes

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Year 2 Report

Introduction

In January of 2023, Snohomish County Department of Conservation and Natural Resources (Snohomish County) completed construction of restoration elements of the Meadowdale Beach Park and Estuary Restoration Project. The 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 habitat restoration 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 large 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 debris installation in the estuary and stream further improve habitat conditions.

The 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. The 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 who use estuary habitats and restore fluvial, estuarine, and coastal processes in the project area.

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 conversion 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 (ESA 2022). The monitoring plan was developed with input from a monitoring workgroup of experts convened by Snohomish County. 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 10-year effectiveness monitoring plan includes monitoring during each of the years. The most intensive monitoring occurs in post-construction years 1 (2023), 3 (2025), 5 (2027), and 10 (2032).

This Year 2 post-restoration monitoring report summarizes the monitoring work completed in 2024. Data collected in Year 2 provides valuable information on site adjustment following construction. Detailed analysis of the Year 2 data will be presented as part of the Year 3 data report planned for early 2026.

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, U.S. Geological Survey, and Washington Sea Grant. Snohomish County appreciates the contributions each of these partners has made.

Monitoring Coordination

Monitoring activities were coordinated among partners during quarterly meetings during 2024. These meetings included monitoring updates, planning for upcoming monitoring, and discussion on topical issues that arose during the year. Monitoring meeting notes are available at: https://drive.google.com/drive/u/1/folders/15LX9U7xFWQqgHmJZJ9lbsDSTutcTxqx-.

A monitoring log is maintained to track the quarterly discussion on each monitoring element. The monitoring log is available at: https://drive.google.com/drive/u/1/folders/18alPPSm4JxCSs92kE6pucfnDVUCJNmF8.

Monitoring Area Definitions and Sampling Reaches

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.

These areas are outlined on the map to generally show the boundaries of each monitoring area. These delineations 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**.

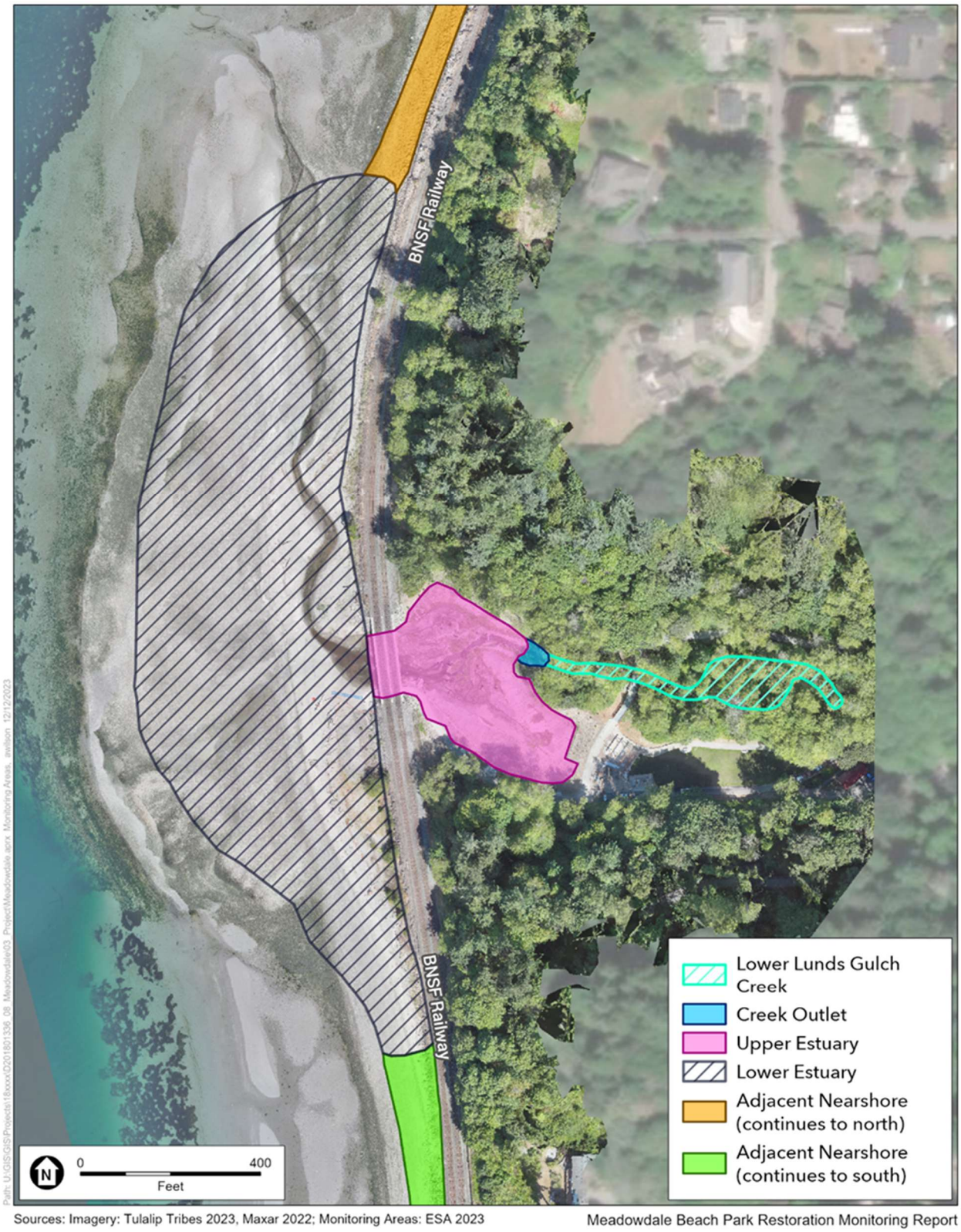

Figure 1. Monitoring Areas

Overview of Monitoring Elements

The monitoring elements identified in the monitoring plan are listed in **Table 1**. The table indicates which monitoring elements were conducted in Year 2 (2024). The table also identifies the organization leading the monitoring. **Table 2** presents the annual schedule for each monitoring element through Year 10 (2032) post-construction. A more detailed schedule is available in the monitoring plan (ESA 2022). The ability of partners to conduct the monitoring described in **Table 2** and ESA (2022) is dependent on funding. The data collection activities for each monitoring element are described in ensuing report sections.

TABLE 1
EFFECTIVENESS MONITORING ELEMENTS

ID	Monitoring Element	Monitoring Partner	Monitoring Conducted in Year 2 Post-Restoration	Comments
Required Per Grant Funding Agreement or Permits				
A	Fish passage conditions	Snohomish County	No	No future monitoring planned; fulfilled grant requirement for monitoring
B	Channel cross-section and profile surveys	Snohomish County	No	
C	Stream habitat in lower Lund's Gulch Creek and creek outlet	Snohomish County	Yes	
D	Large wood retention and recruitment in upper estuary	Snohomish County	Yes	
E	Planted vegetation survival and coverage	Snohomish County	No	Qualitative survey only
Additional Effectiveness Monitoring – With Monitoring Leads Identified, Pending Funding				
F	Sediment dynamics and habitat area in upper estuary and creek outlet	Tulalip Tribes	Yes	
G	Sediment dynamics in lower estuary and adjacent nearshore	Tulalip Tribes	Yes	
H	Fish use	Tulalip Tribes	Yes	
I	Salmon spawning ground surveys	Edmonds Stream Team	Yes	
J	Forage fish egg presence	Snohomish County	Yes	
K	Macroinvertebrate production in the upper and lower estuary	Snohomish County	No	
L	Additional vegetation characterization	Snohomish County	Yes	
M	Photo points	Snohomish County	Yes	
Additional Effectiveness Monitoring – With No Monitoring Leads Identified and No Funding Sought				
N	Extended salmon spawning ground and redd surveys		No	No monitoring lead identified
O	Carbon sequestration in soils		No	No monitoring lead identified
P	Wildlife use		No	No monitoring lead identified
Q	Public use		No	No monitoring lead identified

TABLE 2
ANNUAL SCHEDULE FOR EACH EFFECTIVENESS MONITORING ELEMENT

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	✓		A	A	A	A	A	A	A	A
B	Channel Cross-sections and Profile Surveys	Snohomish County, Tulalip Tribes	✓		A		✓					✓
C	Stream Habitat in Lower Lund's Gulch Creek and Creek Outlet	Snohomish County	✓		✓		✓					✓
D	Large Wood Retention and Recruitment in Upper Estuary	Snohomish County	✓		✓		✓					✓
E	Planted Vegetation Survival and Coverage	Snohomish County	✓		✓		✓					✓
Additional Effectiveness Monitoring – With Monitoring Leads Identified, Pending Funding												
F	Sediment Dynamics and Habitat Area in Upper Estuary and Creek Outlet	Tulalip Tribes	✓	✓	✓	B	B	B	B	B	B	B
G	Sediment Dynamics in Lower Estuary and Adjacent Nearshore	Tulalip Tribes	✓	✓	✓	B	B	B	B	B	B	B
H	Fish Use	Tulalip Tribes	✓	✓	✓	✓	C	C	C	C	C	C
I	Salmon Spawning Ground Surveys	Edmonds Stream Team	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
J	Forage Fish Egg Presence	Snohomish County	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
K	Macroinvertebrate Production in Upper and Lower Estuary	Snohomish County	✓		✓		✓					✓
L	Additional Vegetation Characterization	Snohomish County	✓		✓		✓					✓
M	Photo Points	Snohomish County, Tulalip Tribes	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Additional Effectiveness Monitoring – With No Monitoring Leads Identified and No Funding Sought												
N	Extended Salmon Spawning Ground and Redd Surveys		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
O	Carbon Sequestration in Soils		✓		✓		✓					✓
P	Wildlife Use		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Q	Public Use		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Notes: ✓) Indicates monitoring planned

A) Monitoring element added. Snohomish County will lead the 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).

Monitoring Elements Sampled In Year 2

Stream Habitat in Lower Lund's Gulch Creek and Creek Outlet (Monitoring Element C)

Snohomish County conducted a wadeable stream habitat survey in August 2024. Snohomish County staff are preparing a data summary for that work that is planned to be available in March 2025. The work was conducted using the Snohomish County State of our Waters methodology (State of Our Waters Monitoring Program). The habitat mapping adds to data collected pre-restoration in 2009 and 2021 as well as post restoration data collected in 2023. The data will provide information to document stream habitat adjustments following the restoration. It is expected that the stream will adjust due to the changed (lowered) elevations in the estuary that the stream channel flows into and the placement of large woody debris in the stream channel. The aquatic habitat monitoring occurred between the bridge near the Park Ranger's house and the upper estuary.

Snohomish County collected two benthic macroinvertebrate samples in August 2024. Snohomish County staff are preparing a data summary for that work that is planned to be available in March 2025. The work was conducted using the Snohomish County State of our Waters methodology (State of Our Waters Monitoring Program). Two composite benthic macroinvertebrate samples were collected. An upper creek sample was collected from eight locations spanning from upstream of the pedestrian bridge near the park ranger's house downstream to the new pedestrian bridge. A lower creek sample was collected from eight locations spanning from the new pedestrian bridge downstream to the new railroad bridge. Composite samples were collected from 8 ft^2 of stream bottom (8 - 1 ft^2 Surber samples combined) and locations of collection were distributed throughout the reach length (bottom to top) in riffle habitat.

The Year 2 monitoring results prepared by Snohomish County are provided in Appendix A. Stream habitat surveys and benthic macroinvertebrate sampling will also be conducted in years 3 (2025), 5 (2027), and 10 (2032). The Year 3 monitoring report will include an analysis of findings from the data collected in years 1, 2, and 3.

Large Wood Retention and Recruitment in Upper Estuary (Monitoring Element D)

Snohomish County inventoried large woody debris in the upper estuary in August 2024. Snohomish County staff are preparing a data summary for that work that is planned to be available in March 2025.

The Year 2 monitoring results prepared by Snohomish County are provided in Appendix A. Large woody debris surveys will also be collected in years 3 (2025), 5 (2027), and 10 (2032). The Year 3 monitoring report will include an analysis of findings from the data collected in years 1, 2, and 3.

Planted Vegetation Survival and Coverage (Monitoring Element E)

Snohomish County hired ESA to conduct a qualitative assessment of vegetation in spring 2024. The purpose of the survey was to document the general health and condition of installed and volunteer plants and presence of invasive species to provide maintenance recommendations.

The survey was conducted in April 2024 and concluded that the overall health of planted vegetation is good. Following is a summary of observations included in the memorandum prepared to summarize the observations (ESA 2024a).

- *Upper Estuary Vegetation Health*: Throughout the upper estuary (east of the railroad bridge) plants are establishing well and volunteer plants are beginning to fill in between installed plants, especially in the lower elevation areas of the planting area, which receive regular inundation.
- *Lower Estuary Vegetation Health*: Throughout the lower estuary (west of the railroad bridge, facing the beach) vegetation health is good; however, it appears that these areas do not receive regular watering. The planting area south of the creek appears sparsely vegetated, but the vegetation present appears healthy.
- *Invasive and Non-Native Species*: Invasive vegetation cover was minimal throughout the site.
- *Trash and Vandalism*: In general, the mitigation site is well kept and mostly free from trash and vandalism.

The memorandum included some management recommendations which are presented below.

- The removal of the high visibility fencing around the southern planting area of the upper estuary may make the vegetation more susceptible to being trampled and limit its establishment and growth. ESA recommends either a WDFW-acceptable fence or additional signage to protect planted area.
- Canada thistle should be removed manually, either by digging up young plants or by cutting established plants as low as possible. Himalayan Blackberry should be removed manually by cutting the plant and then digging up the root crowns, as the plants observed are still young.
- Consider fencing around young cedars in the north riparian buffer to protect the trees from wildlife browse as they are establishing.
- Assess irrigation system on north bank of stream just upstream of the railroad bridge where the spruce and willows have died. Given that this is a very specific area of dead plantings, it seems that there must be a specific reason for the plant mortality. Replant this area as well.
- Young plants were observed surrounded by mulch rings and marked with orange flagging that did not appear to be a part of Year 1 plantings. Information about any additional plantings since fall 2023 should be recorded so that they can be included in Year 2 monitoring counts.

Later in the year, additional plant survival and invasive species issues were identified and addressed. These issues and the maintenance responses to address them are described in the Adaptive Management Issues and Recommendations section at the end of this document.

Sediment Dynamics and Habitat Area in Upper Estuary and Creek Outlet (Monitoring Element F) and Lower Estuary 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 designed to accommodate increased water levels with sea-level rise provides space for the site to adjust. The monitoring will help inform the size and design of future restoration projects to accommodate creek outlet, estuary, and sediment dynamics.

The Tulalip Tribes conducted drone flights of the upper estuary, creek outlet, and lower estuary area in May and October 2024. The drone flights provide georectified aerial orthophotos and a digital surface model (DSM). To supplement the drone DSM information, horizontal and vertical positioning data were collected along transects using RTK-GPS. Surface substrate sizes along the transects are also visually characterized. The centerlines of channels through the upper estuary were mapped using the topographic data collected in October.

In late 2024, the Tulalip Tribes initiated a sediment particle tracking study. The study will continue into 2025. The study will investigate sediment movement throughout the estuary following storm events. One hundred pieces of sediment in the gravel and cobble size classes will be fitted with passive integrated transponder tags (or PIT tags). By relocating sediment particles after known storm events, information can be gained to understand sediment transport within the restoration area. This can also indicate the potential for the restoration site to deliver sediment to adjacent nearshore beaches near the tidal channel outlet.

To date, the pre- and post-restoration data analysis has not been conducted except for the summary information presented in the Year 1 Monitoring Report (ESA 2024b). The Tulalip Tribes plan to have pre- and post-restoration data analysis of the digital surface models, substrate composition, and sediment particle tracking completed by Fall 2025 and available for the Year 3 report. The drone and RTK-GPS data collection efforts are planned each year through year 10 post-construction. The priority analysis years for reporting are years 3, 5, and 10.

Fish Use (Monitoring Element H)

The estuary restoration was conducted to improve the quality and quantity of habitats for salmon, trout, and other fish. A primary goal for the restoration was to improve habitat accessibility and quality for juvenile Chinook salmon. Monitoring conducted to document the degree to which juvenile salmon use the site compared to pre-construction will add data on how non-natal habitat restoration and potentially specific elements of the restoration benefit juvenile Chinook salmon.

The Tulalip Tribes conducted fish sampling in the estuary and lowermost reaches of Lund's Gulch Creek in spring 2024 to document juvenile salmonids and other fish using the restored habitats during the spring rearing period. Electrofishing was conducted in eight events between February 22 and June 5, 2024. Electrofishing duration in the events ranged between 13 and 20 minutes. Beach seining was conducted for the first time in 2024 at the same locations as the electrofishing surveys. Beach seining was conducted

every two to four weeks between March and June. Six beach seine sampling events were conducted between March 21 and June 20, 2024. Three beach seine tows were conducted in each sampling event. Fish species are netted, identified to species, held in an aerated bucket, and released after all sampling is conducted. Juvenile chinook and coho are sampled using gastric lavage to evaluate their stomach contents.

The post-restoration sampling in 2024 caught Chinook, coho, chum and pink (*O. gorbuscha*) salmon; coastal cutthroat trout; along with multiple estuary species (**Tables 3 and 4**). Over the five years of sampling (2018 and 2021 through 2024) by the Tulalip Tribes, the following salmonid species were captured each year: Chinook salmon, coho salmon, and coastal cutthroat trout. In 2024, three unmarked sub-yearling Chinook were captured during electrofisher and beach seine sampling. These Chinook observations were in the May sampling events. In electrofishing, 4 unmarked yearling coho were captured between February and April and 8 unmarked sub-yearling coho were captured in May and June. No coho were captured in the beach seine. Pink salmon were the most numerous salmonid captured as beach seine catches exceeded 100 pink salmon in March and April sampling events. Twenty-one chum salmon were captured in the March beach seining. Lower numbers of chum salmon were captured by electrofishing through May. One yearling cutthroat trout was captured in beach seining in May. Cutthroat trout were captured in each electrofishing sampling event between February through June with counts ranging from a high of 26 in February to a low of 6 in June. Multiple species of sculpin were collected using the electrofisher with staghorn sculpin being the most numerous during each sampling event.

TABLE 3
ELECTROFISHING CATCHES – NUMBER CAPTURED

Fish Species	22-Feb	7-Mar	21-Mar	4-Apr	23-Apr	7-May	21-May	5-Jun
Sub-yearling Chinook Salmon (unmarked)	0	0	0	0	0	1	1	0
Sub-yearling Coho Salmon (unmarked)	0	0	0	0	0	3	3	2
Yearling Coho Salmon (unmarked)	1	1	2	3	0	0	0	0
Chum Salmon	0	0	2	8	2	1	2	0
Pink Salmon	0	0	1	2	0	0	0	0
Cutthroat Trout	26	13	14	8	19	8	7	6
Prickly Sculpin	19	20	9	14	2	20	16	13
Staghorn Sculpin	170	49	56	97	51	56	161	232
Unknown Sculpin	28	11	44	14	13	22	14	22
Coast Range Sculpin	0	21	0	0	0	0	0	0
Stickleback	2	2	1	3	1	1	3	0
Tidepool Sculpin	0	0	0	10	4	0	0	0
Starry Flounder	5	0	0	1	0	1	0	14
Sharpnose Sculpin	0	0	0	0	0	0	1	0

TABLE 4
BEACH SEINE CATCHES – NUMBER CAPTURED

Fish Species	21- Mar	4-Apr	23-Apr	7-May	21-May	20-Jun
Sub-yearling Chinook Salmon (unmarked)	0	0	0	0	1	0
Chum Salmon	21	0	1	0	0	0
Yearling Cutthroat Trout	0	0	0	0	1	0
Pink Salmon	193	1	104	35	0	0
Buffalo Sculpin	0	0	0	0	0	4
English Sole	0	0	0	7	0	3
Penpoint Gunnel	0	0	0	0	0	1
Prickly Sculpin	0	0	0	0	0	12
Saddleback Gunnel	0	0	0	0	0	7
Sharpnose Sculpin	0	0	1	3	0	2
Shiner Perch	0	0	0	0	4	1
Staghorn Sculpin	0	0	0	9	3	29
Starry Flounder	0	0	0	1	0	3
Stickleback	0	0	1	0	0	0
Unknown Sculpin	0	0	0	2	0	1
Pacific Tomcod	0	0	0	0	0	1

The proportional fish species composition by location in electrofishing reaches is presented in **Figure 2**. Reaches were determined by stream habitat surveys and will remain the same throughout sampling years. **Figure 3** shows the catch per unit effort (CPUE) of salmonids during electrofishing by month and by sampling reach. One Chinook was encountered in Reach 0 on May 21. A second encounter of a possible Chinook (differentiation between Chinook and Chum was uncertain) occurred in Reach 2 on May 7. Coho yearlings were captured between February and April with distributions ranging across only the sampling reaches upstream of the railroad. Coho subyearlings were only documented in May and June. While the timing of coho subyearlings and yearlings differed, both cohorts were only captured in the sampling reaches upstream of the railroad (i.e., reaches 2 through 5). Chum were captured March through May in reaches 0 (downstream of railroad bridge) and 2 (upstream of railroad bridge). Pink were captured in March and April in reaches 0 and 1. Cutthroat trout were captured in every month sampled and in every reach except under the railroad bridge (reach 1).

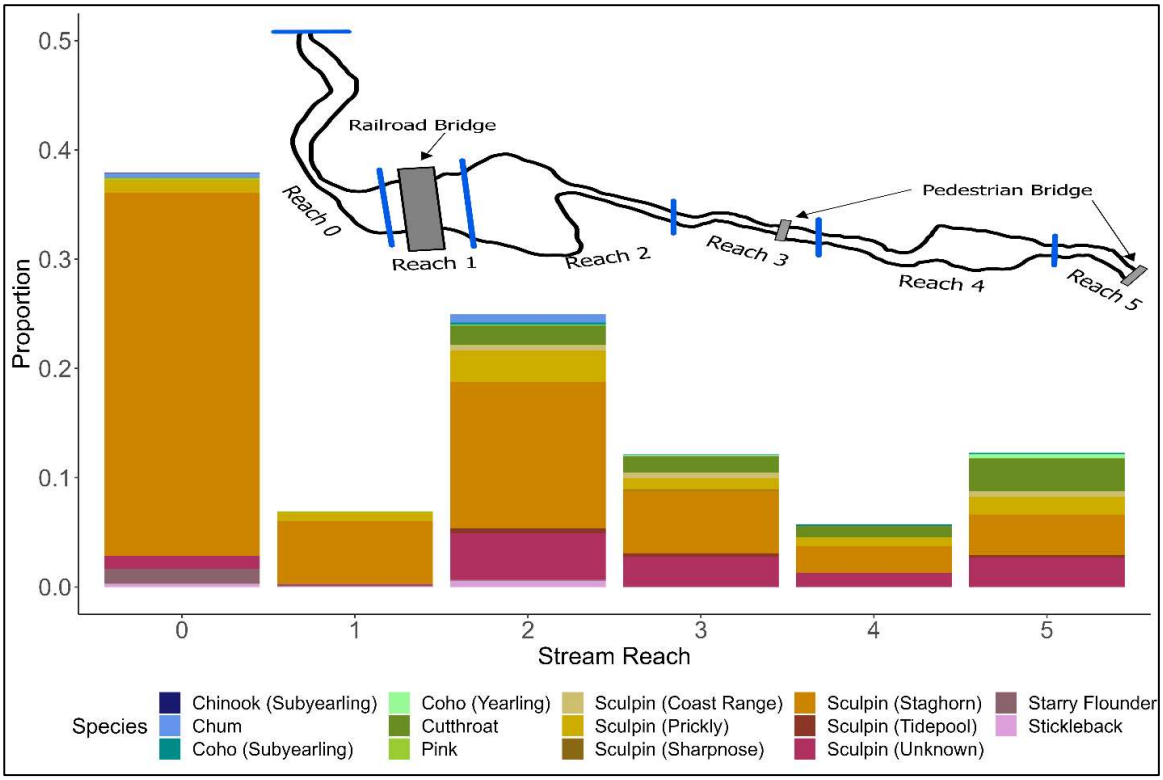

Figure 2. Proportional Species Composition Among Electrofishing Reaches

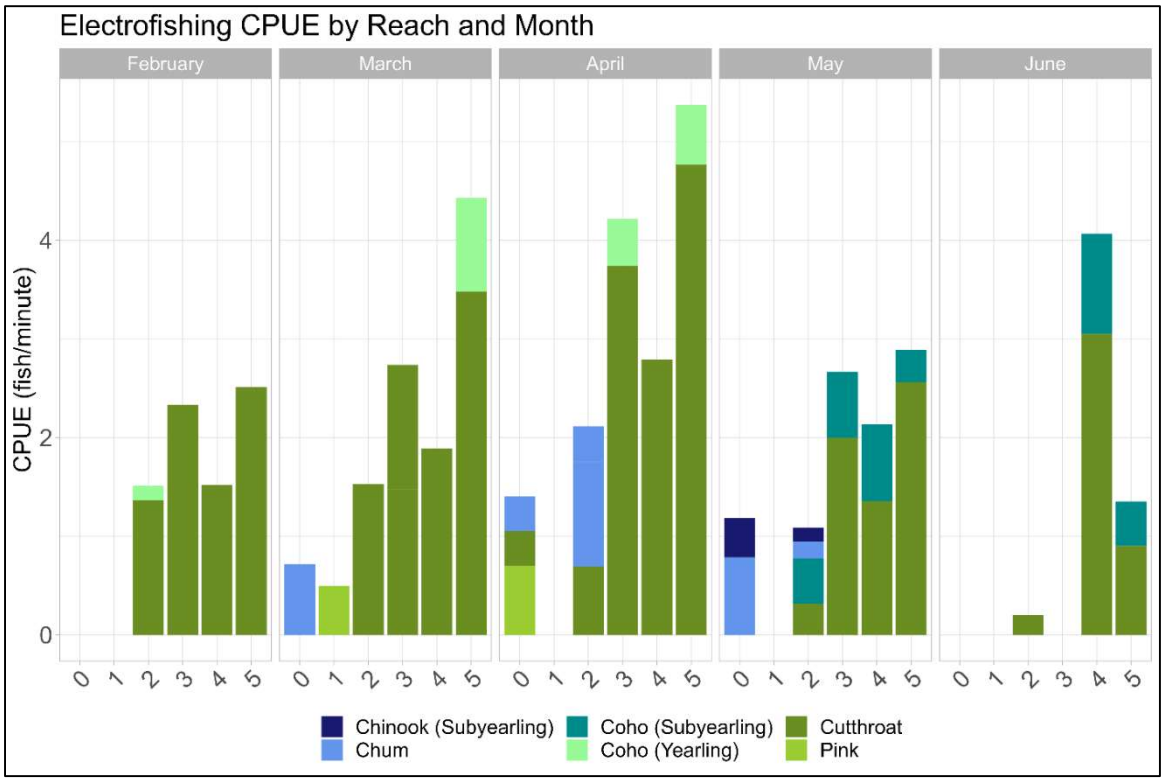

Figure 3. Mean Sampling Event Catch Per Unit Effort (CPUE; fish per minute) of Salmonids Only Using Electrofishing for each Stream Reach Summarized by Month

Figure 4 presents the CPUE from beach seine sampling in reach 0 downstream of the railroad bridge. This includes all species captured. **Figure 5** presents the salmonids-only CPUE from beach seine sampling in reach 0 downstream of the railroad bridge.

These fish use results document that anadromous and resident salmonids as well as other nearshore fish species are using the restored estuary. The two sampling gears are collecting different species in different numbers and at different times of the Spring. Both are providing important data to document fish use of the restored estuary. Continued fish use sampling is planned each year through year 10 post-construction. The priority analysis years for reporting are years 3, 5, and 10. An analysis of pre- versus post-restoration fish use will be conducted as part of the Year 3 monitoring report.

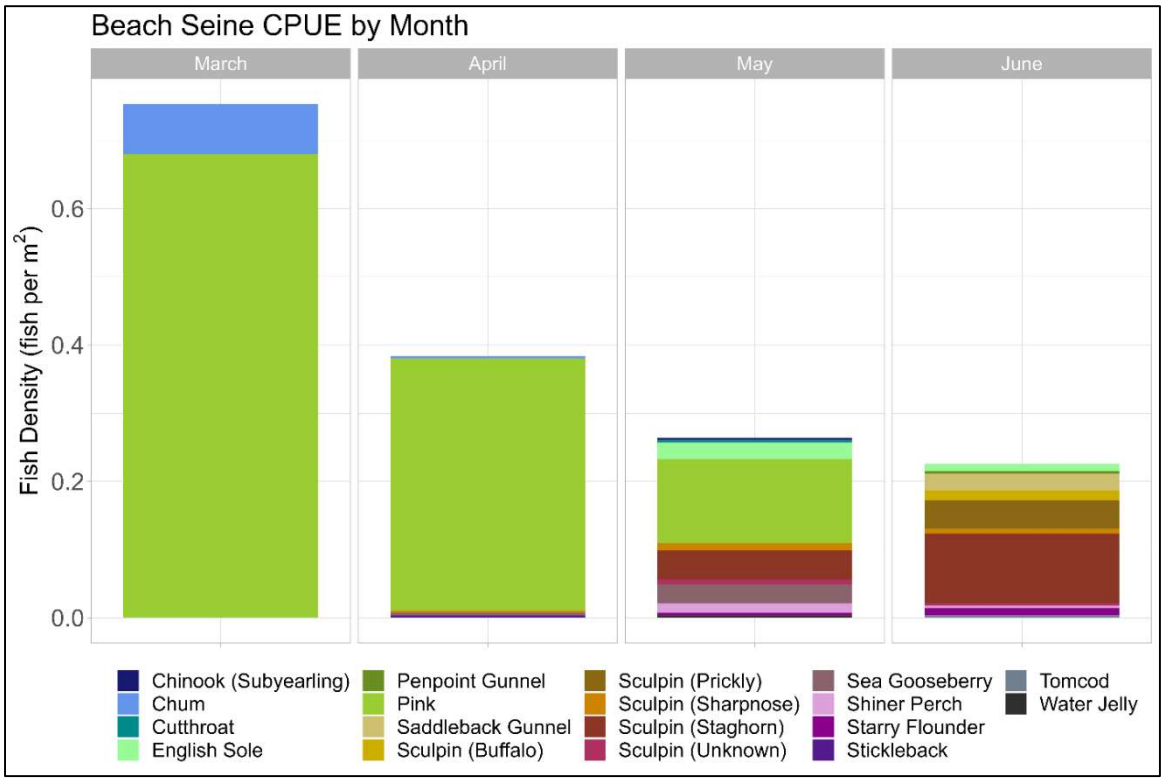

Figure 4. Mean Sampling Event CPUE (fish per square meter) Summarized by Month

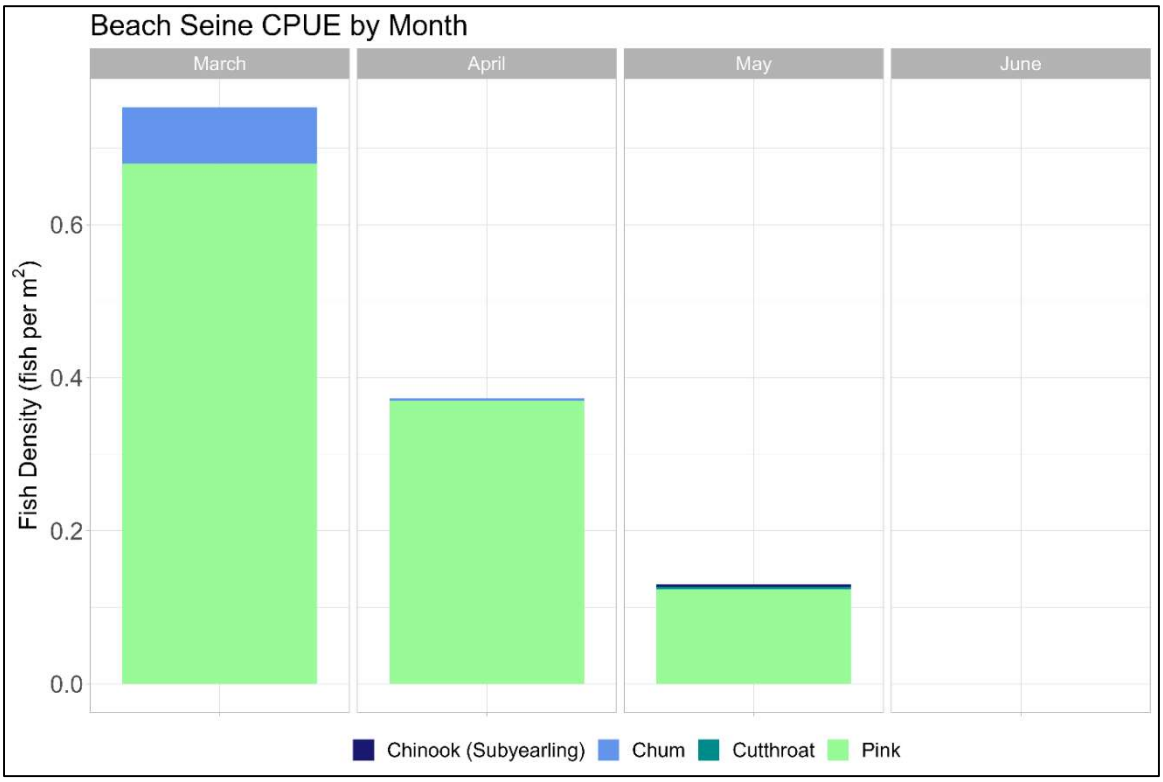

Figure 5. Mean Sampling Event CPUE (fish per square meter) of Salmonids Only Summarized by Month

Salmon Spawning Ground Surveys (Monitoring Element I)

The Edmonds Stream Team, a volunteer citizen science group, conducted on-the-ground surveys for adult salmon in Lund's Gulch Creek in Meadowdale Beach Park from September 28 to December 16, 2024. The surveys covered the area from the beach outlet to Puget Sound to upstream for about 1.4 miles inland of the railroad bridge. Presence/absence of adult salmon, species observed, spawning behavior, habitat condition, and length/sex/spawning status of dead salmon were collected. Joe Scordino, project leader, led the surveys each weekend with students from Meadowdale High School and on periodic weekday/weekend with adult volunteers. Edmonds College students led by Tom Murphy and Park visitors also contributed to the surveys. Signs were posted at the estuary, both bridges, and both Park bulletin boards from October 19 to December 9 requesting that Park visitors report salmon sightings, along with photos if possible. Over 260 reports were received from Park visitors for multiple creek locations along the trail as well as from the two pedestrian bridges, the south edge of the estuary, and the beach. Several hundred photos and videos were received that will be very useful in confirming species identification and sex, location, and salmon behavior.

In late September, the survey crew observed excessive vegetation growing throughout a distributary channel such that there was no open channel of flow in a portion of the estuary upstream of the railroad bridge. Edmonds Stream Team notified Snohomish County and a limited vegetation removal action as described below in the "Adaptive Management Issues and Recommendations section."

The Stream Team is preliminarily estimating (pending further data analysis) about 200 adult salmon, mostly chum salmon, and a few coho salmon, spawned in Lunds Gulch Creek in fall 2024. This was the largest number of chum salmon since the surveys began in 2018. This sampling effort was the topic of a newspaper article (https://myedmondsnews.com/2025/01/2024-surveys-show-record-number-of-salmon-in-shell-creek/) (Scordino 2025). The article includes context on how Lunds gulch Creek is one of two creeks in Edmonds with adult salmon currently returning to spawn.

Unfortunately, most of the coho salmon adults observed were dead and found to have died before spawning. This pre-spawn mortality is an issue throughout the region in urbanized stream systems and has been linked to ozone protector used in car tires (e.g., Dunagan 2020). Testing of tire particles in water and for cause of pre-spawn mortality was not conducted, but it is possible that the coho salmon who died before spawning was due to this water quality issue. Available water quality data from Snohomish County and the Edmonds Stream Team for Lunds Gulch Creek is available at: https://www.snocomrc.org/projects/meadowdale-beach-monitoring/.

Depending on volunteer availability, salmon spawning ground surveys will continue each year. The priority analysis years for reporting are years 3, 5, and 10. An analysis of pre- versus post-restoration salmon spawning data will be conducted as part of the Year 3 monitoring report.

Forage Fish Egg Presence (Monitoring Element J)

The Snohomish County Marine Resources Committee continued monthly beach substrate sample collection in 2024 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. Picnic Point serves as an index site to compare the Meadowdale results to. 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. Instead, surveys move along the beach looking for the best possible substrate for forage fish eggs.

Through August 2024 sampling, no forage fish eggs have been found at Meadowdale since the restoration was complete in January 2023. Data for the remainder of the year is still pending. At Picnic Point, sand lance eggs were documented for the first time in December 2023 and January 2024. The survey is conducted monthly and will be repeated annually through year 10 post-construction.

Additional Vegetation Characteristics (Monitoring Element L)

Snohomish County hired ESA to conduct the gradient monitoring portion of this Monitoring Element in Year 2. Monitoring of vegetation along gradients of elevation, salinity, and tidal inundation will inform how each influences the development of native vegetation communities in the restored estuary. This will inform both the effectiveness of the planting design and provide information to inform the planting versus natural colonization strategy to use in future restoration designs.

The monitoring was conducted in October 2024. The monitoring entailed using the point-line method to record vegetation along transects and record salinity and elevation at equal distance monitoring points along four transects. The transects were established to characterize two low marsh sites and two high marsh sites.

ESA is preparing a data summary for this work that is planned to be available in February 2025. Additional vegetation characteristics monitoring will also be conducted in years 3 (2025), 5 (2027), and 10 (2032). The Year 3 monitoring report will include an analysis of findings from the data collected in years 1, 2, and 3.

Photo Points (Monitoring Element M)

Photo point locations were established throughout the restoration area. The photographs are expected to provide visual documentation of sedimentation, streambank erosion, channel alignments, vegetation establishment, beach changes, etc. Photos were taken when possible by field crews collecting other monitoring data. Photos were taken in multiple directions, often in four directions, to provide 360-degree coverage of the restoration area. Photo points will be collected, as possible, during other monitoring activities through the 10 years of post-construction monitoring.

Adaptive Management Issues and Recommendations

Two primary issues with the restoration effectiveness were identified in Year 2 with actions taken to remediate. The first issue was a non-native plant (water cress) growing throughout a distributary channel such that there was no open channel of flow in a portion of the estuary upstream of the railroad bridge. Joe Scordino observed this during spawning ground surveys and notified the monitoring group. Frank Leonetti led Snohomish County's response to addressing this condition. Frank consulted the Washington Department of Fish and Wildlife (WDFW) and a small maintenance action was permitted using WDFW's pamphlet Hydraulic Project Approval authority for noxious weed removal. Vegetation was removed by hand on October 21, 2024, by Frank and Joe. They removed vegetation in an approximately 40-foot-long by 18- to 24-inch-wide section of channel. This resulted in one large trashcan of vegetation being removed. Frank noted the possibility of needing similar maintenance in the future until conditions mature, such as through tree shading over the estuary, to not be as favorable for invasive species in the channel. He also noted the County's interest in avoiding maintenance unless necessary and minimizing impacts associated with any maintenance. The spawning ground surveys also identified fish passage issues, and excess siltation/sediment issues in the salmon spawning areas.

The second issue was the low survival of beach grass to the south of the beach access path. Monitoring in late 2023 and early 2024 documented the low survival. Snohomish County Parks & Recreation (Parks) worked with WDFW to identify an acceptable maintenance action. Parks replanted 100 plugs of dunegrass and 60 plugs of Puget Sound gumweed. The planting area was in a different location in the park. The planting area provides comparable acreage but in a less traveled portion of the beach. Working with WDFW, Parks also received approval to place a fence made of t-posts and engineers' tape around the planting area. Parks installed the fence in early November and attached signs to communicate to people to stay out of the restored vegetation area. Currently, Parks is not planning to water the plants. Elisa Dawson plans to work with Snohomish County Healthy Forest Project volunteers to try to get the new plantings watered during the summer 2025 to promote plant establishment and survival.

Following are recommendations for upcoming monitoring efforts:

- Frank Leonetti observed channel incision in the creek. He recommends channel cross-sections and profile surveys in 2025 to assess site adjustment following the restoration and whether any adaptive management is advisable.
- The public is very interested in the project and conditions throughout the Lunds Gulch Creek watershed. Water quality sampling conducted by the County and the Edmonds Stream Team is outside of the restoration monitoring program. It is also information that the community is interested in. Water quality sampling will be coordinated between the organizations and County data will continue to be available at the County's State of Our Waters website (https://snohomishcountywa.gov/5365/Stream-Health).
- For the Year 3 Monitoring Report on data collected through 2025, the report submittal date should be set based on when monitoring partners can deliver individual data summary reports that will be used to prepare the full report. This means the Year 3 Monitoring Report should target a draft delivery date in Spring 2026.

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Appendix A
Snohomish County Year 2 Monitoring Results

Stream Habitat

Six consecutive stream segments (0-5 in Figure 1) were defined for the project area and are utilized as part of electrofishing, are geomorphically and tidally distinct, and were surveyed as part of habitat inventory and assessment. Stream segments are described in Table 1, and habitat survey work that overlaps these segments is denoted. Habitat Survey segments are also shown in Figure 1.

Figure 1. 2023 Lund's Gulch Creek stream survey segments.

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 residual pool depth. Habitat surveys also included inventory of large woody material, both natural and placed as part of the restoration. Stream Habitat Surveys were implemented in 2021 prior to project construction using Snohomish County "State of our Waters" stream survey protocols (State of Our Waters). Stream habitat data were also collected in 2009 and 2001 using similar protocols. The 2021 habitat survey repeated the same length and upstream-downstream extent as 2009 and 2001. However, in 2001, different thresholds were used as criteria for qualifying habitat units and woody debris measurement. Data from 2001 can be compared to 2009, 2021, 2023 and 2024, but only using the more conservative 2001 thresholds applied to later years. The 2023 and 2024 habitat surveys were implemented post-construction and had greater upstream-downstream extents, reflecting the greater area and length of treatments. Hence only a fraction of the 2023 and 2024 survey extent would be used to directly compare to 2001 and 2009. Moreover, since very large differences in the stream setting have been created due to the restoration project within the

extents of the 2001, 2009, and 2021 stream surveys (see Figure 1 for the approximate survey extents by year), the results may not be meaningfully compared to 2023 and 2024.

2023 habitat surveys were implemented in April and August. The purpose of the survey in April was to quantify habitat types and area that overlapped the same length of stream where Tulalip Tribes conducted electrofishing for describing fish use.

Table 1. Lund's Gulch Creek stream segments utilized for multiple monitoring objectives.

Segment	Description (the length of each segment is included in Table 3)	2001	2009	2021	2023 (April)	2023 (August)	2024
0	Start at MLLW upstream to end tidal delta				X		
1	Transition from top tidal dela to bottom creek delta	X	X	X	X	X	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
5	Creek with wide floodplain, old stormwater pond				X	X	X

Pre-project monitoring upstream from the railroad culvert extended upstream approximately to the new pedestrian bridge installed as part of the Meadowdale Park enhancements. This creek segment overlapped with segments 2 and 3 (Figure 2). This part of Lund's Gulch Creek overlapped with the new estuary embayment design which included excavation to establish tidal inundation. Hence pre-project monitoring in 2021 was implemented in a stream segment with a pool-riffle planform whereas in 2023 this same segment was steeper (due to excavation) and geomorphically had intentionally been transformed to an alluvial fan planform which had steeper channel profile and mostly riffle habitat (Figure 3). As a result, whereas in 2021, creek contained 8 pools and approximately 25% pool area (Table 2), in 2023 this creek segment contains fewer pools and less pool area (Table 3). This was by design and habitat quantities will be evaluated in future years as more channel adjustment occurs.

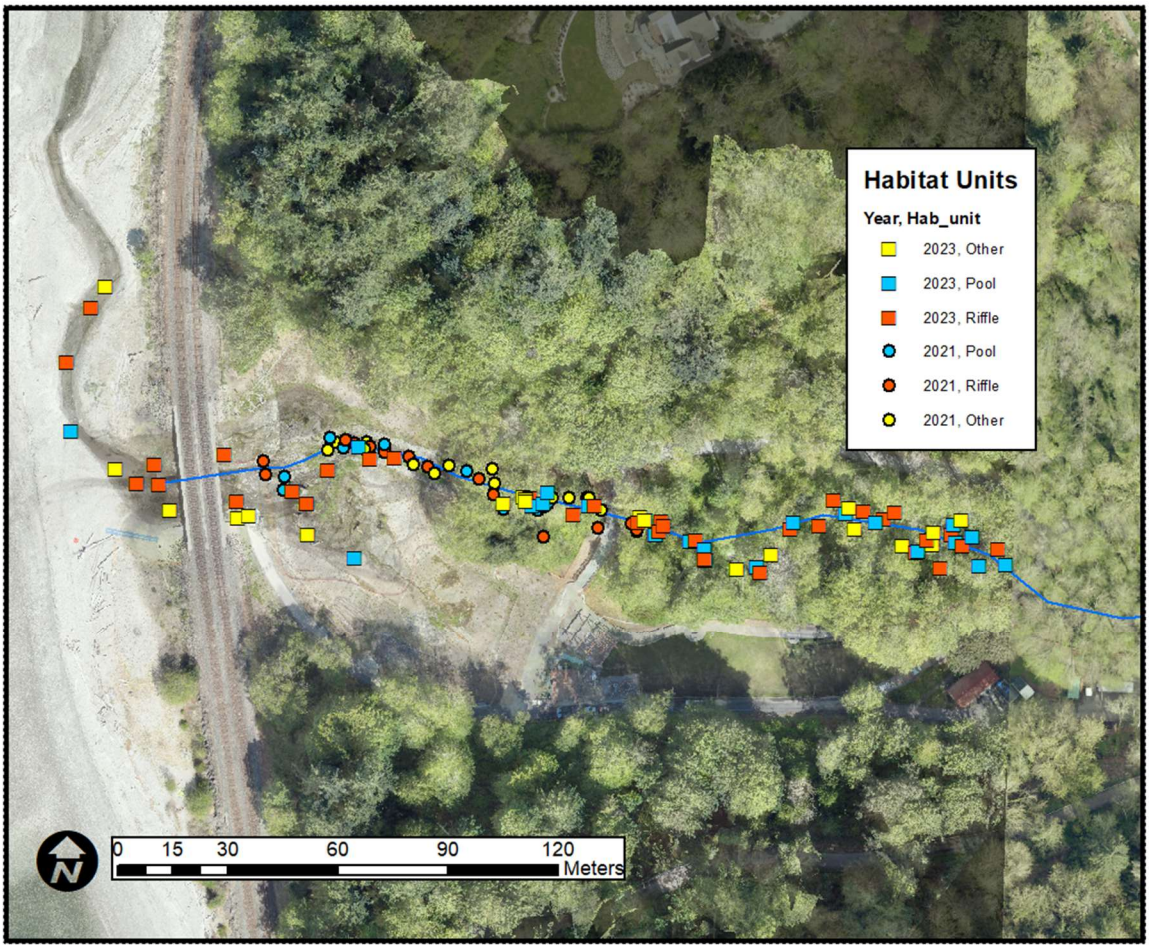

Figure 2. Map of 2021 and 2023 habitat unit survey by year and habitat type.

Table 2. 2021 Pre-project habitat inventory.

2021 Habitat Survey (Segments 2&3)[a]	
Segment Length (m)	137.95
Pool Count	8
Pool Area (m^2)	60.6
Average Pool Max Depth (m)	0.35
Average RPD (m)	0.27
Riffle Count	13
Riffle Area (m^2)	143.12
Other Count	12
Other Area (m^2)	39.29
Pool Percent Area	24.9%
Riffle Percent Area	58.9%
Other Percent Area	16.2%

Note: a) additional information on bankfull width, channel length, gradient, pool frequency, and pool spacing will be added in Year 3 report.

Figure 3. Lund's Gulch Creek excavated embayment area looking upstream toward the creek mouth (with trees), the alluvial fan with riffle habitat in creek segment 2, with large woody material placed in the embayment area. Woody material is inundated at higher tidal elevation.

In 2023, one year post project implementation, habitat conditions were surveyed in all project segments (0-5) in order to quantify habitat unit type and area in support of fish use monitoring. Segments 0-2 spanned the tidal delta, the excavated embayment and the newly forming alluvial fan associated with the creek mouth above tidewater. In these segments, pools were scarce, as expected and habitat areas was dominated by riffles and other habitat units too shallow to qualify as pools. The majority of pool habitat was located in creek segments 3-5 in Lund's Gulch Creek proper and also where the majority of instream large woody material restoration had been conducted. These stream segments contained more pools and a greater percent of pool habitat area. These differences may correlate with information on fish use, reported elsewhere.

In summer 2023, habitat inventory was conducted again in order to establish a year 1 condition during summer low flow conditions when most stream habitat surveys are conducted. This survey was implemented in stream segments 2-5, the creek portion upstream from tidal inundation.

Table 3. 2023 spring habitat inventory for Tulalip Tribe electrofishing (reported elsewhere) segments.

2023 Spring Habitat Survey 4/20/2023							
Segment #	0	1	2	3	4	5	Total
Segment Length (m)	90.3	135.2	80.8	47.8	52.75	130.1	**536.95**
Pool Count	1	1	1	4	6	9	**22**
Pool Area (m^2)	118.95	86.4	5.25	19.43	43.71	71.98	**345.72**
Pool frequency (per km)							**40.9**
Average Pool Max Depth (m)							**0.36**
Average RPD (m)							**0.29**
Riffle Count	3	4	5	4	6	13	**35**
Riffle Area (m^2)	165.68	365.52	214.37	57.2	31.1	200.23	**1034.1**
Other Count	2	4	0	5	2	7	**20**
Other Area (m^2	72.28	175.14	0	23.79	10.2	41.6	**323.01**
Pool Percent Area	33.3%	13.8%	0.4%	19.4%	51.5%	22.9%	**20.3%**
Riffle Percent Area	46.4%	58.3%	99.6%	57.0%	36.6%	63.8%	**60.7%**
Other Percent Area	20.3%	27.9%	0.0%	23.7%	12.0%	13.3%	**19.0%**

Note: a) additional information on bankfull width, channel length, gradient, pool frequency, and pool spacing will be added in Year 3 report.

Table 4 shows the summary of habitat conditions surveyed in summer 2023 and 2024. Compared to the spring-time survey in 2023, the number of pools had declined, whereas the number of riffles and other habitat units increased. The decrease in the number of pools likely resulted from a combination of shallower water depth in summer due to lower flow, but also due to an increase in fine sediment that filled some pools. This observation was unexpected and was likely due to persistent supply of fine sediment from upstream that was transported at relatively lower flows in spring and summer, at discharge levels unable to effectively scour the fine sediment out of the pools. Hence, pools filled with fine sediment. There were at the same time more wood-formed pools observed affiliated with placed wood material. The function of large wood to help scour pool habitat will be evaluated in the future. Survey results of habitat units in 2024 were very similar to 2023. These first 2 years of results form a good baseline for future evaluation f changing habitat conditions.

Table 4. 2023 and 2024 summer habitat inventory.

Summer Low-flow 8/22/2023 Segments 2-5 - 311.5 m survey			
	Pool	Riffle	Other
Count #	15	30	27
AVG Area (m^2)	13.5	16.2	4.8
Total Area (m^2)	203	486	136
% of Total Habitat	24.6	58.9	16.5
AVG Max Depth (m)	0.34	0.12	0.19
Avg RPD (m)	0.27		
Frequency (per km)	46		

Pool Type		
	Backwater	Primary
AVG Max Depth	0.3	0.35
Pool Count	3	12
AVG RPD	0.26	0.27
total area	114.36	88.64
AVG Area	38.12	7.39
% of total Habitat	13.86%	10.74%
Wood Formed Pools	1	10

Summer Low-flow 8/20/2024 Segments 2-5 - 302 m survey			
	Pool	Riffle	Other
Count #	16	35	28
AVG Area (m^2)	18.7	19.9	8.26
Total Area (m^2)	299	698	231.5
% of Total Habitat	24.3	56.8	18.8
AVG Max Depth (m)	0.35	0.13	0.18
Avg RPD (m)	0.27		
Frequency (per km)	53		

Pool Type		
	Backwater	Primary
AVG Max Depth	0.3	0.36
Pool Count	3	13
AVG RPD	0.24	0.28
total area	221	78
AVG Area	74	6.0
% of total Habitat	18%	6.4%
Wood Formed Pools	0	11

Stream Temperature

In Lund's Gulch Creek, stream temperature was recorded and stored continuously at 30-minute intervals using remote thermistors in summer during the time period when the core summer rearing Washington State water quality standard 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 Meadowdale Park ranger residence in all years. Additional stream temperature sampling was implemented at 52nd Avenue in two years – approximately 1.8 miles farther upstream from the Ranger bridge near the headwaters of the creek.

Table 5 includes the sample year and maximum stream temperatures observed – the single day summer maximum and the 7-day average (7-DADMax). In all years sampled, the calculated 7DADMax

temperature exceeded the water quality standard and did so for 5-19 days among years. This translates to approximately 6-17% of the summer sample period.

Table 5. The standard temperature criterion for evaluation of temperature exceedance of the 7-day average daily maximum (7-DADMax) is 16 degrees Celsius, per Ecology.

Year	Date Range	Maximum Temperature, Celsius (C)	7-DADMax, C*	Days Exceeding Temperature Criteria**	Percent Exceedance Time**	Average 7DADMax, C****
Lund's Gulch Creek at Ranger's Bridge (Latitude 47.8598, Longitude -122.332, Elevation 29 ft)						
2009	5/15-10/15	18.3	17.4	12	14.1	15.0
2015	6/29-10/28	17.4	17.1	14	16.5	15.3
2016	6/6-10/10	16.9	16.3	10	11.8	15.1
2017	6/1-10/10	16.8	16.2	5	5.9	15.1
2021	6/1-9/30	18.7	17.5	19	22.4	15.3
2022	5/17-9/26	17.2	17.0	14	16.5	15.3
2023	4/20-10/18	17.3	16.7	7	8.2	15.2
2024	6/18-10/3	17.3	16.5	13	15.3	15.2
Lund's Gulch Creek at 52nd Avenue (Latitude 47.8487, Longitude -122.304, Elevation 390 fFt)						
2009	6/3-10/13	23.2	20.2	70	82.4	16.9
2024	6/18-8/16[1]	19.9	18.9	44	85	17.6

Notes

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

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

****Average 7DADMax is the 85-day average of the running 7DADmax calculated for each of the 85 days. [1]Unless fewer than 85 days.

For context, the 7-DADmax temperature standard is routinely exceeded in many streams, even those with relatively good forested stream buffer conditions and shading over the stream surface. In fact, Lund's Gulch creek benefits from sources of cold groundwater that flow into the stream all summer and keep it relatively cool. Additional tree planting and park management over time will likely improve forested buffer conditions and stream shading. Overall stream conditions in terms of temperature are very supportive of fish use, growth and survival in summer.

Benthic Macroinvertebrates (B-IBI)

Benthic macroinvertebrate collection was completed before project implementation in 2021 and following completion of restoration work in 2023 and 2024. All years of benthic macroinvertebrate collection prior to restoration typically was started just upstream from the pre-project railroad culvert. 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.

Post-restoration, In 2023 and 2024, the 2021 location was also sampled, but it is now characterized as an alluvial fan and is contained within the excavated embayment area (circled in Figure 4). A second B-IBI collection was made in 2023 and 2024 upstream from the extent sampled in 2021 (and previous years). This new collection for 2023 and 2024 is fully contained within the creek channel where LWD has been placed but is completely upstream from any floodplain or embayment excavation. Collection effort used the same field procedures as described in the Snohomish County State of Our Waters Monitoring Program. Benthic macroinvertebrates were collected from 8 ft^2 of stream bottom (8 - 1 ft^2 Surber samples combined) and locations of collection were distributed throughout the reach length (bottom to top) in riffle habitat. Benthic macroinvertebrate samples were stored in a Nalgene jar as they were collected and preserved in 95% denatured ethanol. Locations of each benthic macroinvertebrate collection from 8 riffles per composited sample in 2021, 2023, and 2024 are shown in Figure 4.

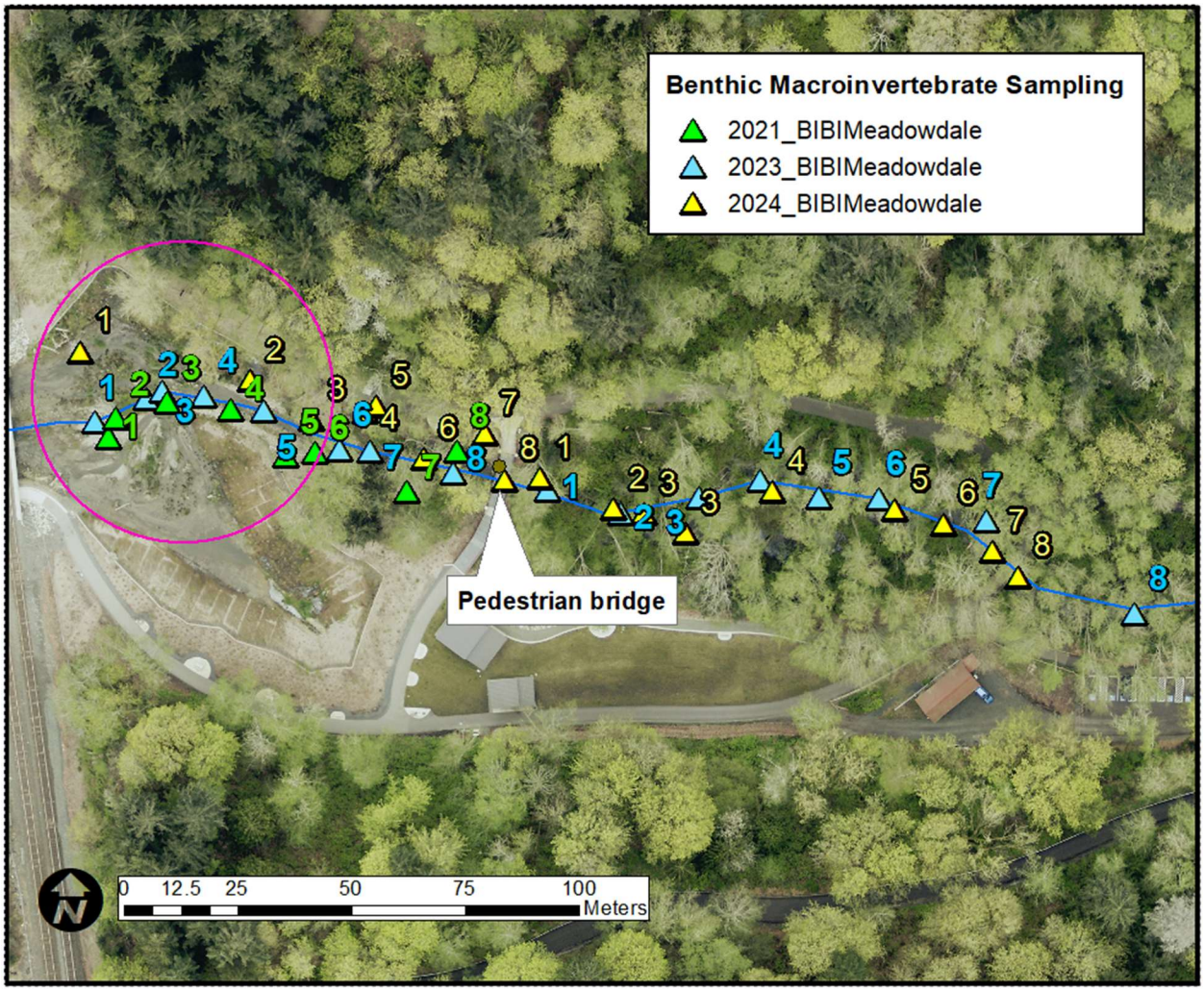

Figure 4. B-IBI sample collection locations in 2021 (green) and 2023 (blue) and 2024 (yellow). 1-8 sequential Surber sample quadrats (downstream-upstream) were composited into one sample for analysis.

B-IBI scores and index metric component are reported in Table 6 for recent and past collections. As stated above, sampling conducted in 2005-2021 was closest to the mouth of the creek, but upstream

from the original railroad culvert. Therefore, BIBI scores from 2005-2021 are more likely to be similar to the newly sampled LUNDS-Upper location east of the new pedestrian bridge (shown in Figure 4).

The BIBI scores in 2023 and 2024 in the upper stream segment are plotted with and are very similar to all past years (Figure 5), though scores were potentially depressed in 2005-2008. As mentioned, sampling during these years was based on $3ft^2$ instead of $8ft^2$, so the smaller sample area could yield fewer and rarer invertebrate taxa, which could account for lower scores in those years (highlighted with red triangle and dashed line in Figure 5). Generally, scores are near, or higher than, 60 (Green line in Figure 5) which equates to a good or better biological condition on a scale of 0-100. Recent BIBI scores for sampling conducted on the alluvial fan where the excavated embayment is located were depressed relative to the upstream collection. This location was both excavated and received new gravel and cobble substrate with restoration and 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 overlap with sampled Surber quadrats may explain the lower scores presently. However, benthic invertebrate composition and variability associated with shifting alluvial fan locations compared to non-fan locations is not well-understood.

Variation in B-IBI scores among 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 also can lead to changes in supply and delivery of fine sediment from upstream areas. Fine sediment was not characterized as part of B-IBI sampling in 2005-2016 but is part of recent data collection. See below.

Table 6. 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 (0-100)	Taxa Richness	Ephemeroptera Taxa	Plecoptera Taxa	Trichoptera Taxa	Intolerant Richness	Clinger Richness	Long-Lived Richness	Percent Tolerant	Percent Predator	Percent Dominant, Top 3
LUNDS (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 - Lower	07/18/2023	43.9	36	2	4	5	12	11	3	45.7	5.97	48.1
LUNDS - Upper	07/18/2023	61.4	36	5	4	5	15	11	4	11.8	15.5	48.5
LUNDS-Lower	8/20/2024	46.8	33	3	5	5	12	14	3	47.0	5.2	48.3
LUNDS - Upper	8/20/2024	63.8	41	5	5	6	17	14	4	9.5	8.7	47.7

Note: *2005 and 2008 samples were $3ft^2$; thereafter samples were $8ft^2$.

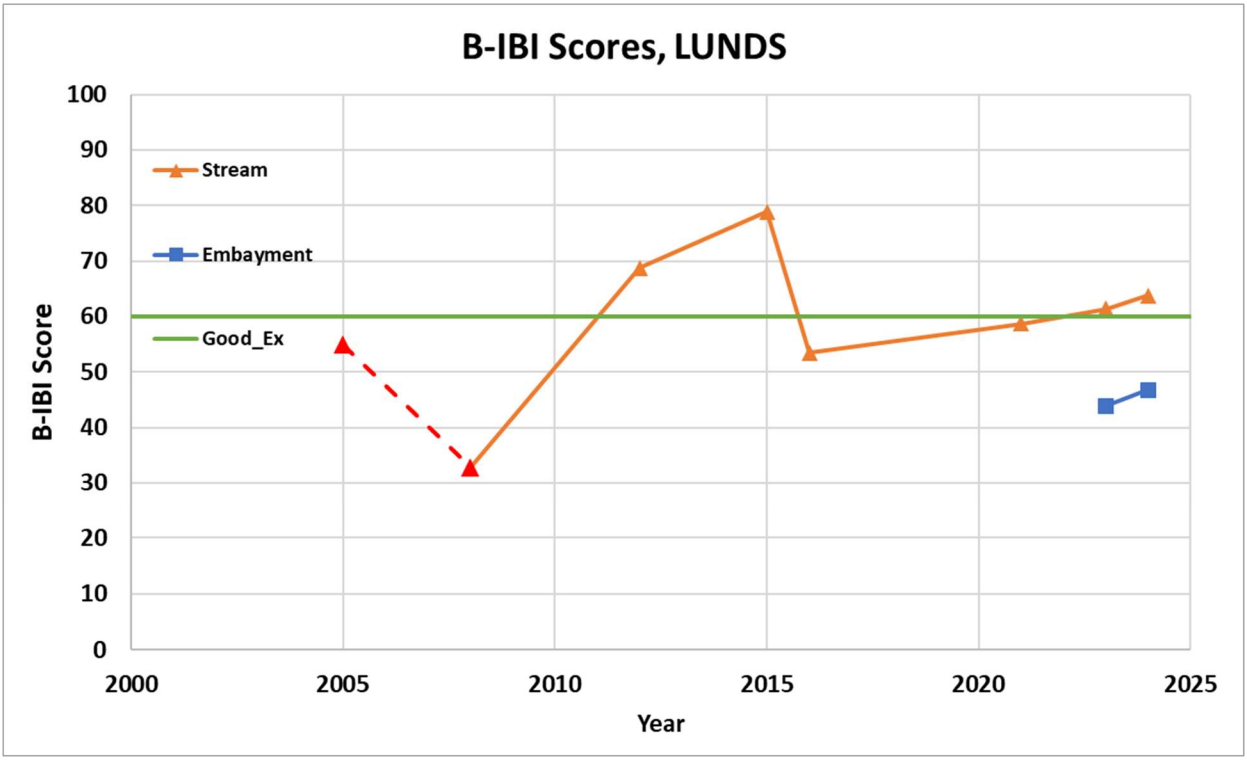

Figure 5. Time series of B-IBI scores at Lund's Gulch Creek.

Large Woody Material

Woody material in Lund's Culch Creek was either placed as part of the restoration project (identified in Figure 6) or occurred naturally. In 2021 only natural woody material or material placed as part of a much older restoration effort was present. In creek segments 2 and 3 there were two pieces of wood. Woody debris spacing and frequency was low (Table 7), particularly compared to woody material enumerated in 2023 and 2024 that was part of the restoration project and included stream segments 2-5. Woody material placed as part of the restoration nearly doubled the natural wood count and placed pieces were large conifer trees with rootwads (Figures 3 and 7). Survey results in 2023 and 2024 were very similar. The influence of these large, placed pieces on creek habitat formation and abundance of pools, in particular will be evaluated as wood quantity is estimated to be near that of a natural condition. The abundance of woody material and changes in quantity and functions will be evaluated over time.

Table 7. Lund's Gulch Creek large woody material inventory.

Meadowdale LWD Summary for 2021, 2023, 2024						
Year	Survey Length (m)	AVG BFW (m)	CW	LWD Piece Count	LWD Pieces per CW	LWD Frequency (Pieces per km)
2021 Total	137.95	4.48	30.77	2	0.06	14.5
2023 Natural	311.45	6.57	47.4	57	1.2	183
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

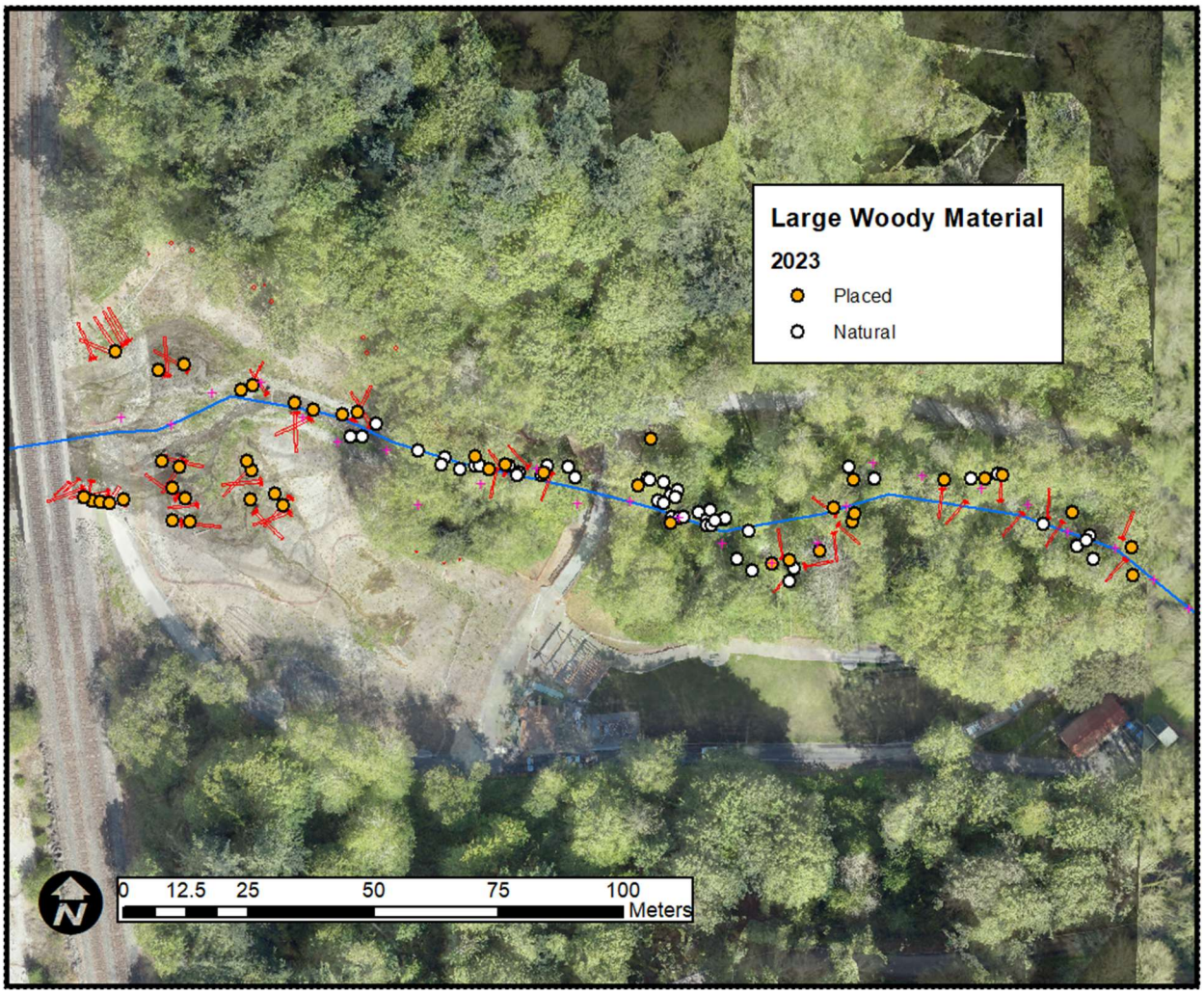

Figure 6. Map view of large woody material surveyed in 2023. Placed pieces in 2024 (not shown) are the same as in 2023.

Figure 7. Large Woody material (flagged) with rootwads placed in Lund's Gulch Creek in creek segment 3.