

2026 COLQUITZ RIVER MONITORING REPORT

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Abstract

The Colquitz River watershed supports one of the largest urban coho salmon (*Oncorhynchus kisutch*) populations in Greater Victoria, yet key drivers of population dynamics remain poorly understood. To address this, Peninsula Streams & Shorelines implemented an integrated monitoring program including smolt trapping, PIT tag arrays, adult escapement monitoring, and redd surveys, alongside historical data collected by provincial biologists from the 1970s–1980s. Smolt counts showed high interannual variability, with 4,009 individuals in 2024, 88 in 2025, and 2,660 in 2026, likely reflecting a combination of spawner abundance, environmental conditions, water quality impacts, and sampling limitations. PIT detections indicated a minimum smolt-to-return rate of 5.9%, within expected ranges, with a high proportion of jacks observed. Adult escapement in 2025 was estimated at approximately 200 fish but remains uncertain due to incomplete data. Long-term escapement data suggest a possible decline, though statistical support is weak. Flow analyses showed no clear relationship with spawner abundance using simple metrics, but earlier sustained high-flow events were moderately associated with higher returns. Redd surveys confirmed active spawning across multiple reaches, including restored habitats. Overall, results suggest that coho population dynamics in the Colquitz are shaped by multiple interacting factors, including hydrology, water quality, and life-history variability. However, limited data restrict definitive conclusions, emphasizing the need for continued long-term monitoring to inform effective restoration and management.

Acknowledgements

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Overview

The Colquitz Watershed is one of the most ecologically important urban watersheds in Greater Victoria, supporting the region's largest urban salmon run and providing critical habitat for a wide range of wildlife through diverse ecosystems, including freshwater streams, wetlands, and estuarine habitats. Flowing through the municipality of Saanich, the Colquitz faces ongoing challenges such as habitat loss, pollution, invasive species, and the impacts of climate change. Despite increasing urbanization, the Colquitz remains critical for native fish populations, particularly Coho salmon and Coastal cutthroat trout. Coho salmon rely on the Colquitz River and its tributaries for spawning and juvenile rearing habitat, while coastal cutthroat trout, a species of concern, inhabit these waters year-round, requiring cold, clean, well-oxygenated water and complex habitat for survival.

Over the last decade, Peninsula Streams & Shorelines has partnered with the District of Saanich, as well as many local community groups and volunteers, to address these issues through hands-on restoration, habitat enhancement projects, and community engagement throughout the watershed. Extensive instream and riparian habitat has been restored within the Colquitz River and its tributaries, including Swan Creek, Goward Springs, Gabo Creek, and several other smaller creeks.

In 2023, this long-standing collaboration was strengthened by a three-year grant from the BC Salmon Restoration and Innovation Fund (BC-SRIF), enabling the expansion of restoration efforts and the implementation of a comprehensive salmonid monitoring program. Through this work, and with the continued support of partners and volunteers, more than 1,200 m of instream habitat and over 3000 m² of riparian habitat have been restored within the Colquitz Watershed to date. These efforts have supported a relatively strong coho run despite the highly impacted nature of the watershed. However, increasing pressures associated with climate change, including more frequent summer drought conditions and changes to fall spawning flows, continue to pose challenges (Capital Regional District, 2024; Cinnamon, 2020).

Ongoing monitoring is essential to evaluate how salmonid populations are responding to both restoration efforts and environmental stressors within the watershed. Long-term datasets, including smolt outmigration, spawner returns, and water quality, provide critical insight into population trends, survival, and habitat use. These data allow for the identification of key limiting factors and help guide management by informing where restoration efforts can be most effective. By linking monitoring

outcomes with targeted restoration actions, management strategies can be refined over time to better support resilient fish populations in an increasingly urbanized system impacted by climate change.

Smolt Monitoring



1.0 Introduction

1.1 Historical Smolt Monitoring

Throughout the 1970s and 80s, BC government biologists ran a smolt trap in the lower Colquitz, quantifying outmigrating Coho smolts and collecting incidental coastal cutthroat trout data (R. Ptolemy, D.R. Clough, personal communication). Provincial biologists compared these counts with previous year summer baseflow (L/s) and summer baseflow % of long term mean annual discharge (%LT MAD) as a means of analyzing and understanding the impact of summer flows on juvenile coho in their first summer post-hatch (Table 1).

No strong linear relationship was detected between smolt abundance and either previous summer baseflow or previous summer % LT MAD. However, when smolt counts were plotted against summer baseflows, the relationship appears to follow a bell-shaped curve (Figure 1.), with smolt abundance peaking at intermediate flow levels. Quadratic models provided a better fit to the data than linear models, suggesting a potential summer flow “sweet spot” for juvenile coho rearing conditions. But, given the limited sample size (n = 7), this pattern should be interpreted with caution, unfortunately, there is not enough data to determine whether this relationship is actually valid.

Table 1. Colquitz smolt catch summary from provincial gov't smolt trap, operated from 1976-1983.

Year	Coho	CCT	Baseflow Year	Summer Baseflow (L/s)	Summer Baseflow (%LT MAD)
1976	901	496	1975	53	9
1977	291	252	1976	68	11
1978	97	49	1977	7	1.2
1979	4460	256	1978	35	6
1980	1165	475	1979	18	3
1981	719	-	-	-	-
1982	6415	824	1981	34	5.6
1983	683	609	1982	77	13

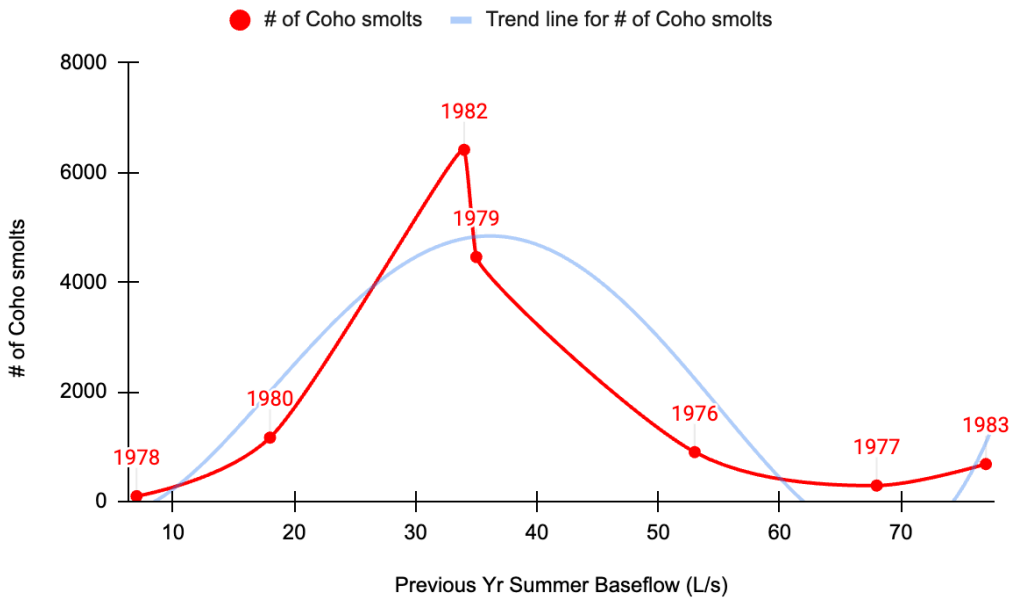


Figure 1. Smolt counts from 1976-1983 plotted against previous summer baseflows.

Conversely, when historical Coastal Cutthroat Trout (CCT) counts were examined in relation to previous summer baseflows there appeared to be a more linear relationship (Figure 2). While there is a weak positive relationship between previous summer baseflow (%LT MAD) and CCT counts the following spring ($r = 0.325$, $R^2 = 0.106$), the relationship was not statistically significant ($p = 0.477$). Higher summer baseflow may be associated with increased CCT abundance, but the effect is small and uncertain. Given the limited sample size ($n = 7$), the results should be interpreted with caution, as a few atypical years may strongly influence the trend.

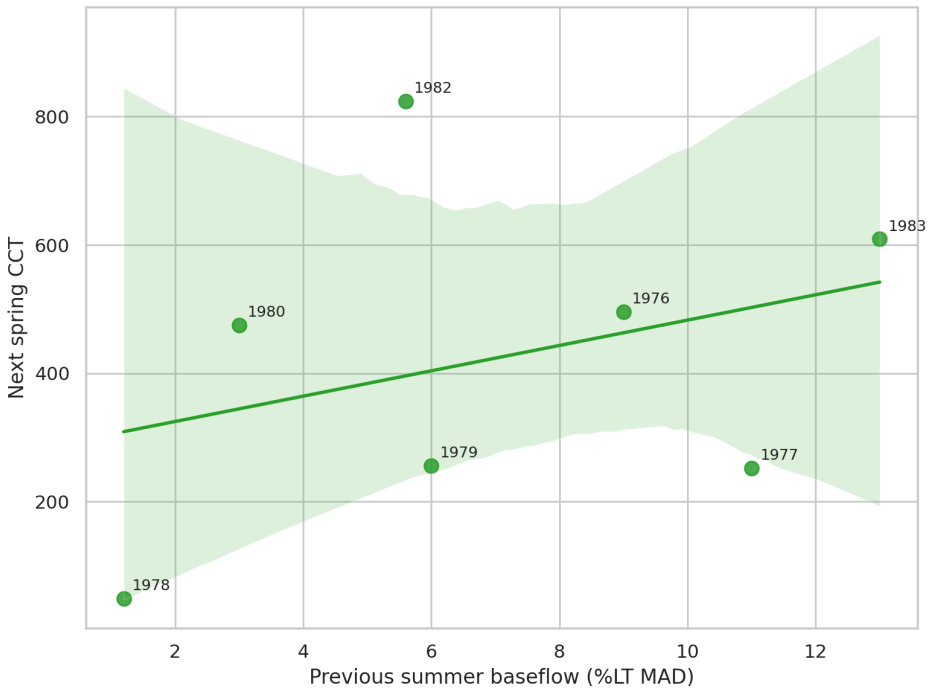


Figure 2. Relationship between CCT counts and previous summer baseflow presented as %LTMAD.

In addition to this data, historical records from Provincial Fish and Wildlife reports documented weekly Coho smolt data in Colquitz from 1980 to 1983 (D.R. Clough, personal communication; Table 2). Based on this historical temporal spread, and on PSS-collected smolt data, described below, the peak window for Colquitz smolt outmigration appears to consistently be the last week of April and the first week of May.

Table 2: Colquitz River weekly Coho smolt catch summary, operated from 1976-1983.

Week	1980	1981	1982	1983
March 1–31	10	not trapping	28	39
April 1–7	0	5	85	14
April 8–15	22	16	139	65
April 16–24	51	236	1,060	166
April 25–May 1	273	257	1,248	109
May 2–9	417	184	2,220	45
May 10–17	311	5	1,570	241
May 18–25	86	16	65	4
May 26–June 2	39	not trapping	not trapping	not trapping
June 3–10	44	not trapping	not trapping	not trapping
Total	1253	719	6415	683

1.2 Current Smolt Monitoring

PSS began operating its first full-season smolt trap on the lower Colquitz River in 2024, marking the beginning of a new phase of juvenile salmon outmigration monitoring in the watershed. The smolt trap has now been operated annually through 2026, with plans for continued long-term monitoring. The trap is located in the lower Colquitz, approximately 300 meters upstream of tidal influence, providing an opportunity to monitor juvenile salmon as they transition from freshwater to marine environments.

2.0 Methods

The PSS smolt trap consists of a custom-built wood-framed structure with Aquamesh fence panels spanning the river channel and directing flow into an aluminum box live trap. A 6" flexible hose helps funnel outmigrating fish into the trap box, while sandbags and metal T-posts secure the fencing. Trap installation followed DFO guidance and was informed by field visits with provincial biologists. The trap is checked daily by PSS staff and volunteers, with twice-daily checks during peak flows to ensure fish welfare. During checks, all fish are netted from the trap, identified, measured, and released downstream. Daily checks also include thorough examination of the fence panels for any holes or inefficiencies in the trap.

3.0 Results

Collectively, PSS' daily smolt trap monitoring has resulted in over 700 volunteer hours across the three years of operation, engaging hundreds of volunteers (Table 3).

Table 3: PSS yearly total smolt trap volunteer hours

Year	Total Volunteer Hours
2024	315
2025	244
2026	210

In 2024, 4,009 coho smolts were recorded, with 213 incidental CCT captures. In 2025, only 88 coho smolts were counted, in addition to 57 CCT. In 2024, the one-day record for smolt capture was 517 compared to only 13 in 2025. In 2026, 2,660 smolts and 42 CCT were counted.

Table 4: PSS coho smolt and coastal cutthroat trout counts from 2024, 2025, and 2026 with calculated, previous summer baseflow conditions.

Year	Coho	CCT	Baseflow Year	Summer Baseflow (L/s)	Summer Baseflow (%LT MAD)
2024	4009	213	2023	149.1	14.3
2025	88	57	2024	241.9	23.2
2026	2660	42	2025	559.0	53.6

Flow data used for 2024-2026 data, was supplied by the Capital Regional District, collected from their Colquitz hydrometric station off of Violet Ave (Station 08HA047), approximately 1 km upstream of the smolt trap. Percent long-term mean annual discharge (%LT-MAD) was calculated as the average of annual mean flows from 2018 onward. Mean summer discharge (July–September) was then calculated for each year and expressed as a percentage of LT-MAD.

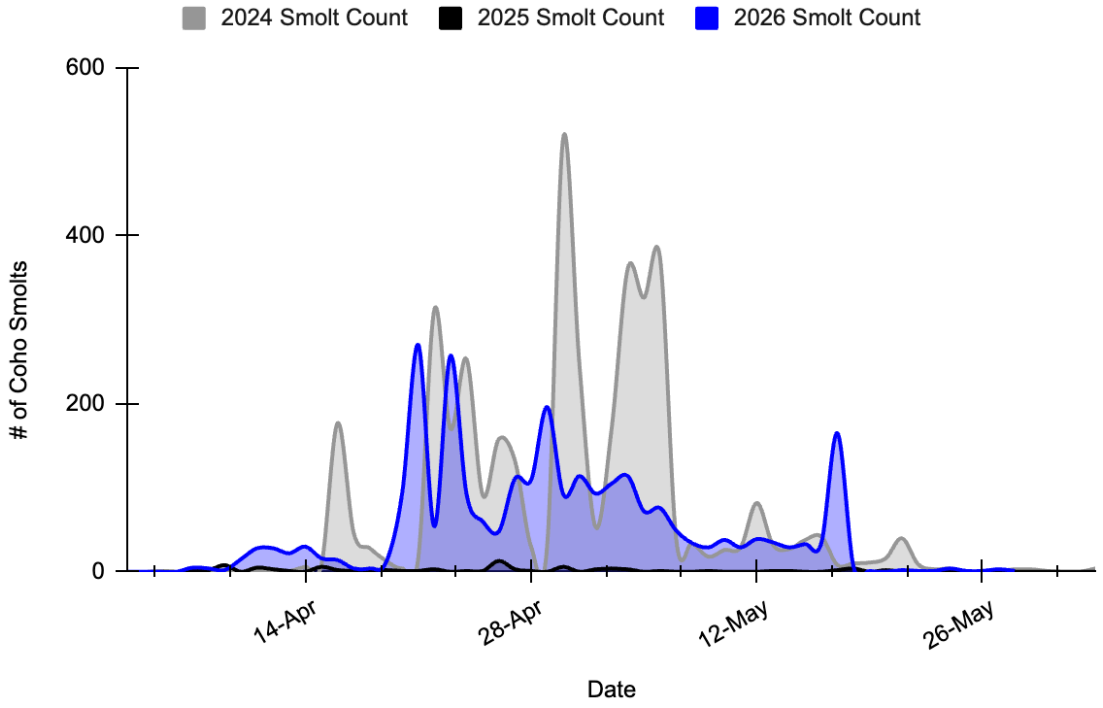


Figure 3. PSS smolt trap coho smolt counts by date, compared between 2024, 2025, and 2026.

4.0 Discussion

Unfortunately, considering that only three complete years of recent smolt data are currently available, it is not yet possible to assess trends between smolt abundance and prior summer flow conditions. However, similar to the historical data, the peak smolt migration appears to occur within the last week of April and first week of May.

Smolt abundance in 2024 appeared promising, reaching levels comparable to those observed in 1979, and initially suggested that restoration and monitoring efforts may be contributing to improved juvenile production. However, this pattern was not sustained, as smolt outmigration was significantly lower in 2025. The reason for this decline remains unclear. When comparing smolt abundance with the corresponding adult spawner returns from the fall two years prior, the strong 2024 smolt year may be partially explained by above-average spawner returns observed in 2022 (465 spawners; the forebears of the 2024 smolt population). In contrast, spawner return data for 2023, which would help interpret the low 2025 smolt counts, is currently unavailable. Similarly, smolt monitoring data from Craigflower Creek, which also drains into Portage Inlet, is not available in 2025 due to the absence of recorded smolt outmigration, limiting the ability to determine whether the decline observed in Colquitz River was part of a broader regional pattern. However, anecdotal evidence and PSS staff observations reported an

extremely low number of redds in 2023, suggesting that low 2025 smolt abundance may be linked to low spawner returns.

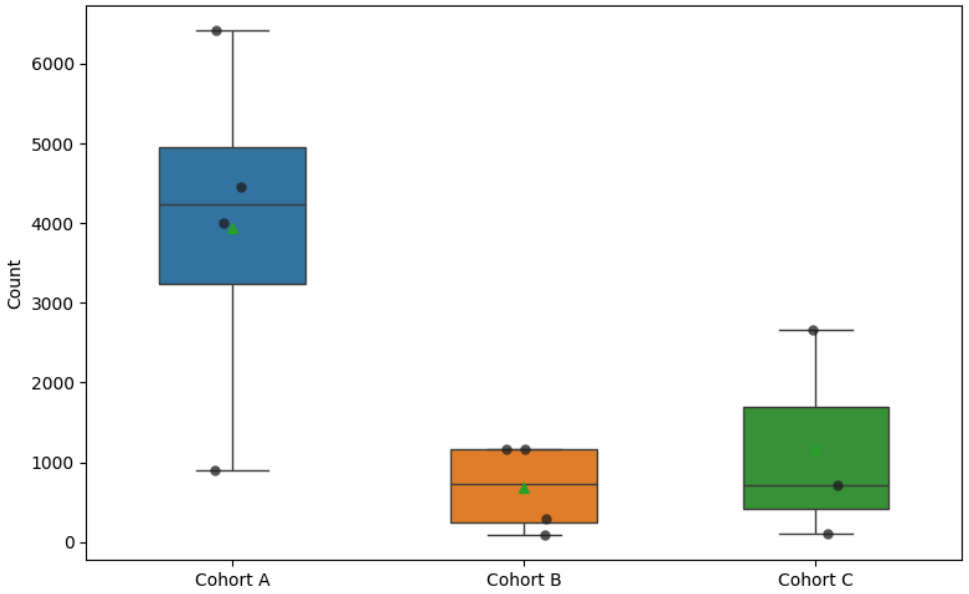


Figure 4. Coho smolt brood year cohorts. Cohort A: 1976, 1979, 1982, and 2024 (n = 4). Cohort B: 1977, 1980, 1983, 2025 (n = 4). Cohort C: 1978, 1981, 2026 (n = 2). Green triangle denotes mean.

Table 5: Colquitz Coho smolt counts by year, color coded according to smolt cohort (A: blue; B: orange, C: green).

Year	Coho Smolts
1976	901
1977	291
1978	97
1979	4460
1980	1165
1981	719
1982	6415
1983	683
2024	4009
2025	88
2026	2660

We also examined whether cohort effects may play a role in the observed differences in smolt abundance (in coho salmon, cohorts roughly occur in three-year intervals because individuals from the same brood year typically complete their life cycle in about three years). However, this explanation is likely limited given the high interannual variability in environmental conditions and the flexible life history of coho salmon (Environment and Climate Change Canada, 2018). While coho are often described as having a three-year life cycle, this pattern is not rigid. The presence of jacks (males returning after only one year at sea) and individuals that rear in freshwater for more than one year means that brood years are not discrete, and overlap among cohorts is expected. This variability is an important component of population resilience, contributing to genetic and life-history diversity, but it also makes it difficult to clearly attribute differences in smolt production to specific cohorts. In this context, the 4,009 smolts observed in 2024 fall within the same cohort (Cohort A; Figure 4.) as the two highest historical smolt counts in 1979 and 1982 (4,460 and 6,415, respectively; Table 5.), whereas the 2025 total of 88 smolts aligns with a lower-producing cohort. Statistical comparisons among cohorts suggest moderate

but inconclusive differences. Mean smolt counts were substantially higher in cohort A (mean = 3,946) relative to the others (means = 677, cohort B; 1158, cohort C). However, this result was not supported by tests appropriate for non-normal data with small sample sizes (Kruskal–Wallis p = 0.113). While the differences between cohorts appear notable and may suggest a potential cohort signal, they should be interpreted cautiously. Given the overlapping life histories and environmental variability influencing survival at multiple life stages, it is not possible to determine whether these patterns reflect true cohort effects or natural variability, nor confirm that they are responsible for the low smolt counts between in 2025.

Interannual differences in smolt abundance may have been influenced by variation in environmental conditions, particularly water temperature and flow, which are known key drivers of smolt migration. Water temperatures on matched calendar days differed significantly between 2024 and 2025 (paired t-test), with 2025 being on average 0.63 °C cooler than 2024. Daily differences ranged from 3.5 °C cooler in 2025 to 1.5 °C warmer, with a median difference of 0.5 °C cooler. Although it appears that 2025 water temperatures were slightly cooler than 2024, these relatively small temperature differences are unlikely to account for the substantial difference in smolt abundance observed between years.

Flow conditions also differed between years. In 2025, a pronounced flow pulse occurred in the final week of March, immediately prior to smolt trap installation. This event may have influenced the timing or magnitude of outmigration, or resulted in the initial migration pulse occurring before the trap was operational. When examining overall seasonal flow conditions (March 15–June 15), discharge expressed as percent long-term mean annual discharge (%LTMAD) was actually higher in 2025 (43.4%) than in 2024 (29.0%), suggesting that overall flow during the migration window was not limiting. However, short-term flow events, particularly those occurring prior to monitoring, may still have affected smolt movement and capture efficiency. With only several years of data available, it is not possible to determine whether these differences in flow conditions meaningfully contributed to the observed variation in smolt abundance.



Figure 5. Coho smolt mortalities at the smolt trap, following heavy rainfall in 2024.

Reduced smolt counts in 2025 may have been influenced by episodic water quality events during the outmigration period. In May 2025, two mortality events were documented at the smolt trap, during which a total of 12 coho smolts and one coastal cutthroat trout were found dead. The fish exhibited symptoms consistent with urban runoff mortality syndrome, (Figure 5; Tian et al., 2021), a condition associated with exposure to toxic stormwater contaminants. Both mortality events occurred following rainfall after a prolonged dry period, suggesting a potential “first flush” effect, where contaminants that accumulate on roads and other impervious surfaces are rapidly washed into streams during the rainfall events.

One contaminant of particular concern in urban watersheds is 6PPD-quinone (6PPD-Q), a highly toxic chemical formed when the tire additive 6PPD reacts with ozone in the atmosphere. During rainfall, 6PPD-Q can be transported from road surfaces into nearby streams through stormwater runoff, where even low concentrations can be harmful to salmonids. Supporting the potential role of 6PPD-Q in these mortality events, PSS sampling at a stormwater outfall near the smolt trap has detected concentrations as high as 1,320 ng/L, while instream concentrations have reached approximately 30 ng/L; reported lethal thresholds for coho salmon smolts and older life stages are approximately 95 ng/L.

Although only a small number of mortalities were directly observed at the trap, additional individuals may have been affected upstream during migration and would not have been detected by monitoring efforts. Therefore, episodic urban runoff events, including potential exposure to 6PPD-Q and other stormwater contaminants, may have contributed to reduced smolt survival and the lower observed outmigration numbers in 2025.

Overall, the low smolt counts observed in 2025 were likely the result of multiple interacting factors rather than a single driver. Reduced spawner returns in 2023 may have limited juvenile production, while episodic water quality events, particularly first-flush runoff associated with 6PPDQ, may have further reduced survival during outmigration. There is also some indication of cohort-related variability, although the degree of impact of this is likely low given year to year variability in environmental conditions and variations in return timing of spawners (i.e. jacks).

Similar to coho, levels of CCT caught in the smolt trap appear to decrease from the levels recorded in the 70s and 80s (Tables 1 & 4). CCT are similarly sensitive to 6PPDQ as coho and require cool well oxygenated riffles and pools to thrive (Shankar et al., 2025). As such, the impacts outlined that could be potentially driving lower coho smolt counts like low summer baseflows and exposure to contaminants, are likely similarly being felt by both the resident and searun CCT populations in Colquitz.

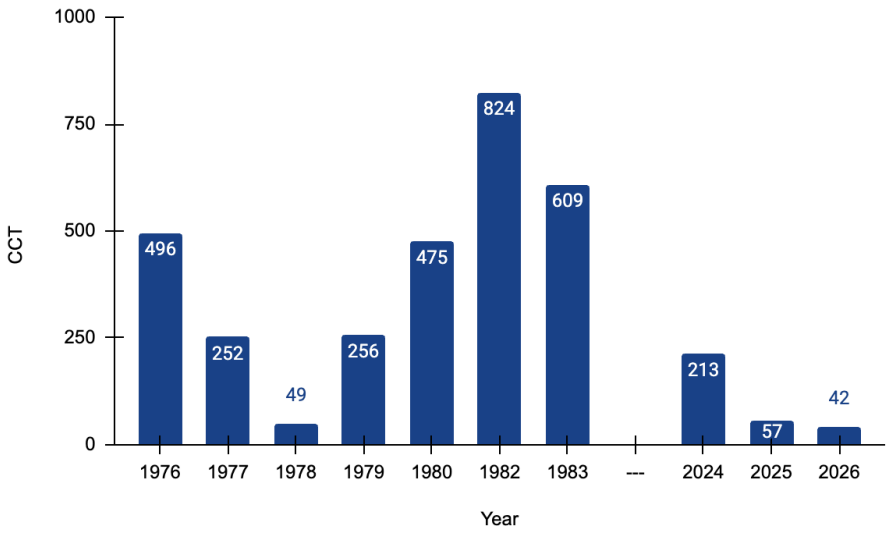


Figure 6. Incidental Coastal Cutthroat Trout captures in spring Coho smolt traps from 1976-1983; 2024-2025.

At a broader scale, it is important to note that spring flow conditions in the Colquitz River generally appear sufficient to support smolt outmigration, suggesting that flow during the migration

window is not a primary limiting factor under typical conditions. Instead, system-level constraints may play a more important role in determining overall smolt production. In particular, the relatively short length of accessible and productive rearing habitat within the Colquitz watershed may limit the number of juveniles that can be supported, thereby constraining smolt output. While this does not explain interannual variability, it may set an upper bound on population size and highlights the importance of ongoing habitat restoration aimed at increasing the extent and quality of rearing habitat.

Collectively, the limited sample size and lack of complete supporting data restrict our overall interpretation of impacts on Colquitz smolt and CCT population numbers. Continued long-term monitoring is required to determine whether the high smolt production observed in 2024 and 2026 represent a meaningful trend or natural variability, and to better understand the factors influencing year-to-year changes in smolt abundance, ultimately highlighting the importance of developing long-term datasets and reinforcing the need to prioritize continued monitoring efforts. Sustained smolt trapping, alongside flow monitoring, will be essential for identifying interannual trends, evaluating hypotheses, and improving our understanding of the factors influencing juvenile coho production in the Colquitz system, as well as understanding the impacts of our ongoing restoration efforts.

Array Monitoring

1.0 Introduction

In September 2024, PSS installed two stationary Passive Integrated Transponder (PIT) tag detection arrays on the lower Colquitz River, with support from Biomark and volunteers. The system consists of two in-stream antenna arrays, positioned approximately 40 m apart, and a land-based control unit. Each array spans the width of the river and is securely anchored and buried within the substrate to remain stable during high flow events while minimizing visibility and disturbance.





Both arrays are connected to a series of electronic components housed within a metal box located on the streambank. The box contains the system's data logger and power supply, including four 12V batteries that convert incoming AC power to the DC power required for array operation. The array configuration is supplied with donated electricity through a partnership with Pacific Forestry Centre, enabling continuous, year-round operation. To support data reliability, the system also conducts regular automated self-tests to confirm that the antennas are functioning properly and that recorded detections represent active monitoring periods.

2.0 Methods

PIT tagging occurs regularly throughout smolt trapping season and during summer monitoring. During tagging, fish greater than 70 mm are anaesthetized with buffered MS-222 and implanted with 12 mm PIT tags using specialized injection equipment. Tagged fish were held for at least 30 minutes in oxygenated, aerated recovery buckets and released downstream. Additional tagging occurred opportunistically using seining, electrofishing, and minnow trapping to broaden the sample across habitats and times.



3.0 Results

Array installation consisted of three volunteer events, two of which focused on digging out the trenches for the array, and the final event on actual installation of the two arrays. In total, these resulted in approximately 150 volunteer hours, including over 30 individuals.

During the 2024 smolt trap season, a total of 372 coho smolts were PIT tagged. In 2025, no smolts were tagged due to very low smolt outmigration (88 individuals). PIT tagging resumed in 2026, with approximately 300 smolts tagged to date. Since its installation in September 2024, the PIT array has recorded 22 detections across the 2024 and 2025 fall spawning seasons. Based on the 372 smolts tagged in 2024, this corresponds to an apparent return rate of approximately 5.9% for the 2024 smolt outmigration year. Of the 22 detected individuals, 12 (54.5%) were recorded during the fall of 2024 (Figure 8). As these fish were tagged as smolts in spring 2024 and returned within the same year, they are assumed to be jack males exhibiting early maturation.

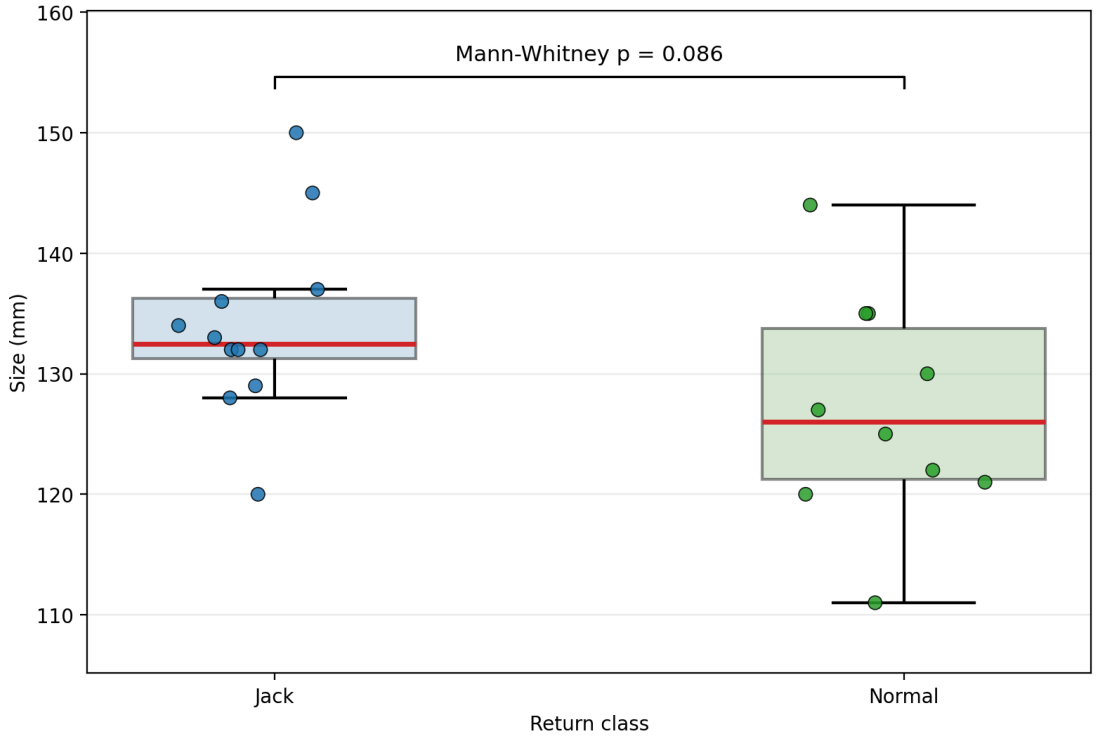


Figure 7. Fork Length (mm) comparison at the time of tagging as smolts, between fish that were detected in the same year as tagging (presumed Jacks) or the year after tagging (Full Adults or "Normal").

Fork length at time of tagging was compared between individuals later classified as jacks and those presumed to follow a standard three-year life history (Figure 7). Individuals identified as jacks had a slightly greater fork length at time of tagging (median = 132.5 mm) compared to the three-year cohort (median = 126.0 mm). However, this difference was not statistically significant (Mann–Whitney U test, p = 0.086; jack n = 12, normal n = 10).

4.0 Discussion

The estimated smolt-to-return rate of 5.9% represents a minimum PIT-based return estimate, rather than a fully corrected smolt-to-adult return rate (SAR). Smolt-to-adult return rates (marine survival) for Coho salmon are highly variable, ranging from <1% in poor years to approximately 15–20% in strong years, with many populations commonly falling within roughly 2–8% depending on environmental conditions and cohort strength (Campbell et al., 2014). Within this context, the observed return rate of 5.9% falls within the expected range and suggests that marine survival for this cohort was broadly typical. Additional years of monitoring will be required to assess whether marine survival in the Colquitz population is increasing, decreasing, or remaining stable over time.

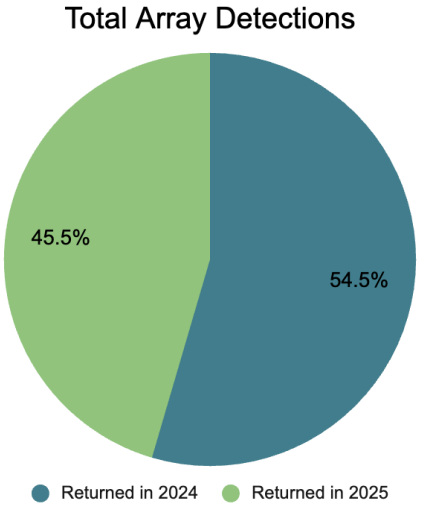


Figure 8: 372 smolts were tagged in 2024. 22 tagged fish returned to Colquitz to spawn in the Fall of 2024 and 2025. Of those 22 tagged fish that returned, 54.5% returned the same year they left. These are presumed to be early maturing jacks.

The proportion of returning individuals classified as jacks, also known as precocious males (54.5%), was surprisingly high relative to typical values reported for coho salmon populations, which are often on the order of ~5–20%, though this can vary among systems (King et al., 2023). Higher proportions have been documented in some populations, including cases where jacks comprise a substantial fraction of returning males (King et al., 2023). Similarly, Carnation Creek on southwestern Vancouver Island has also been reported to exhibit a high proportion of precocious male returns (R. Ptolemy, P. Tschaplinksi, personal communication). The occurrence of jacks is known to be influenced by both genetic and environmental factors, with evidence suggesting that families sired by jacks may exhibit higher rates of early male maturation. Environmental conditions affecting growth and energetic status can also influence maturation timing. Consequently, it is possible that population specific genetic characteristics may contribute to a higher propensity for early maturation in Colquitz coho, although this has not been directly assessed. Regardless of the underlying mechanism, it is notable that over half of the detections were from individuals tagged as smolts earlier in the same year.

It was also explored whether individuals later identified as jacks differed in size at the time of tagging. This was founded on the hypothesis that these jacks would already be larger and more developed as smolts, or were potentially 2-year smolts who had stayed longer in freshwater before their out migration. While jacks tended to be slightly larger on average (median = 132.5 mm) than individuals presumed to follow a standard three-year life history (median = 126.0 mm), this difference was not statistically significant (Mann–Whitney U test, $p = 0.086$). The small sample sizes (jack n = 12, non-jack n = 10) limit statistical power, and there is insufficient evidence to conclude that size at tagging differed between groups.

Overall, these results point to an incomplete and still poorly understood characterization of the Colquitz coho population structure. Continued PIT tagging, along with long-term operation and maintenance of detection arrays, will be essential to better resolve patterns in the proportion of jacks, their spatial distribution within the watershed, and the duration of freshwater residency prior to

spawning. This information is particularly important for informing restoration planning, as it may highlight the importance of downstream habitats that are often under-prioritized. As such, ongoing monitoring will play a critical role in ensuring that restoration efforts are effectively targeted to the areas and life history strategies most in need of support.

Escapement Monitoring



Colquitz Adult Fence

1.0 Introduction

In Cuthbert Holmes Park, behind Tillicum Mall in Saanich, a fish fence spans the width of the Colquitz River, just upstream of its estuary. From 2013 to 2022 community groups, like Salmon in the City and Esquimalt Anglers, operated the fence every fall, checking it multiple times a day to count spawning coho, and release them upstream. In 2023, the approach was switched to an underwater camera system to minimize fish handling, filming fish as they were funneled through the fence. For the fall of 2023 and 2024, the camera and footage were operated and processed by Salmon in the City as well as local organization, World Fisheries Trust. In 2025, responsibility of the fence and estimation of coho return numbers via camera were handed over to PSS. DFO Stock Assessment has supported these projects since 2013, including the collected data in their stock assessment report.

2.0 Methods

On October 10, 2025 an underwater camera, supplied by DFO, was installed directly adjacent to an opening cut in the center of the fish fence, along with a light for nighttime footage capture. The camera was then connected via ethernet cable to a computer housed in a lock box roughly 50 m away. Footage was processed by Netcam Studio software which chunked it into 30 minute videos. These videos were then uploaded to YouTube where they were accessible to community volunteers for watching and counting the number of coho that passed through the fence. All volunteers were required to read over a video processing protocol, after which they gained access to the video playlist and a communal database for uploading data. While watching footage, volunteers would record the timestamps of fish passage in the video and tally the total number.

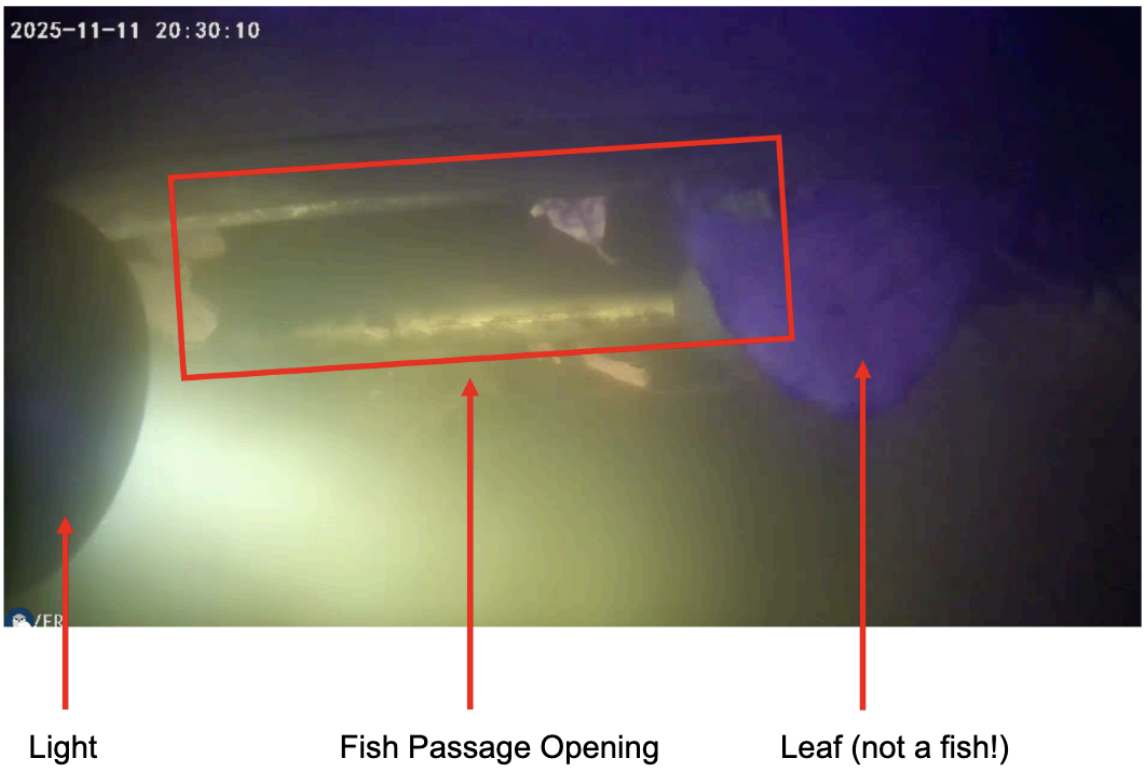


Figure 9. Screenshot of Colquitz underwater footage, portraying orientation of opening in fence, light and appearance of debris and leaf litter.

Given its urban location, the Colquitz river struggles with flashy flows, high turbidity, and large amounts of debris and garbage (Figure 9). Consequently, camera footage visibility was often extremely poor. During periods of heavy rain and high turbidity, conditions were too cloudy to see any passing fish. Similarly, debris and garbage frequently covered the lens of the camera, obstructing view. As a result, footage was extremely poor quality over several periods of time. The high amount of debris passing through also proved to be a challenge when viewing footage. Some volunteers employed the use of free motion detection software, DVR scanner, using the following settings: Kernel Size = 15x15, Threshold Sensitivity = 2.0, Set Region to opening of the fence in the footage. This allowed for more efficient footage processing with only flagged motion detected clips needing to be reviewed.

3.0 Results

3.1 2025 PSS Camera Operation

Of the footage that has been processed, volunteers have recorded a total of approximately 111 fish. A significant amount of footage was unable to be processed, due to murkiness from high turbidity associated with heavy precipitation, or debris obscuring the camera's field of view. The 111 fish recorded were from a particularly clear period from November 5th to 17th.

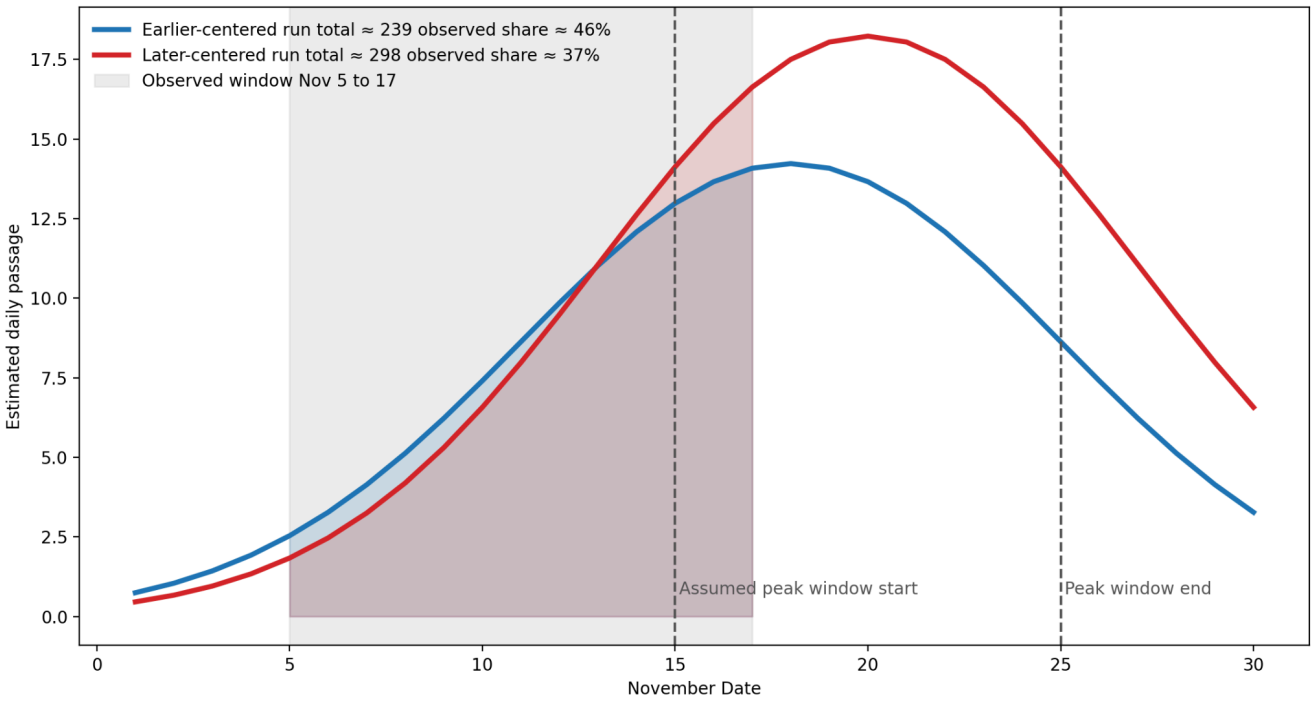


Figure 10. Illustration of Coho run timing and total return estimate based on two different assumptions: an earlier peak of return or a later pearl of return.

We estimated total coho spawner return for 2025 by assuming the run followed an approximately normal, bell-shaped distribution, with timing spanning early October to late December and peaking in mid to late November. This assumption was supported by redd survey data, which recorded the highest number of redds on November 17. Camera observations made by volunteers documented 111 fish between November 5 and November 17, a period capturing the late ascending limb of the run. To estimate total return, this observed count was expanded using assumed run-timing proportions. Based on field observations suggesting peak migration occurred between November 15 and 25, the monitoring window likely captured approximately 50–60% of the run, yielding an estimated total of 185–222 fish. Alternatively, a simple bell-curve timing model suggests the monitored period may represent closer to 33–46% of the run, corresponding to a higher estimate of roughly 244–333 fish. Considering these approaches, a practical working estimate is approximately 200–260 fish, with a broader uncertainty range of about 185–330 fish (Figure 10). For the purposes of this report, a single estimate of 200 fish was selected.

3.2 All Colquitz Spawner Data, 2013-2025

When all Colquitz adult escapement data are combined, the revised nonparametric tests point toward a negative trend, but the evidence is weak (Figure 11). The rank-based tests indicate a downward direction but are not significant (Spearman $\rho = -0.545$, $p = 0.083$; Kendall $\tau = -0.382$, $p = 0.121$; Mann–Kendall $p = 0.119$). This suggests a possible decline in adult escapement over time, but the statistical support is not strong enough to confidently confirm a monotonic trend given the small sample size, $n = 11$, and highly variable data.

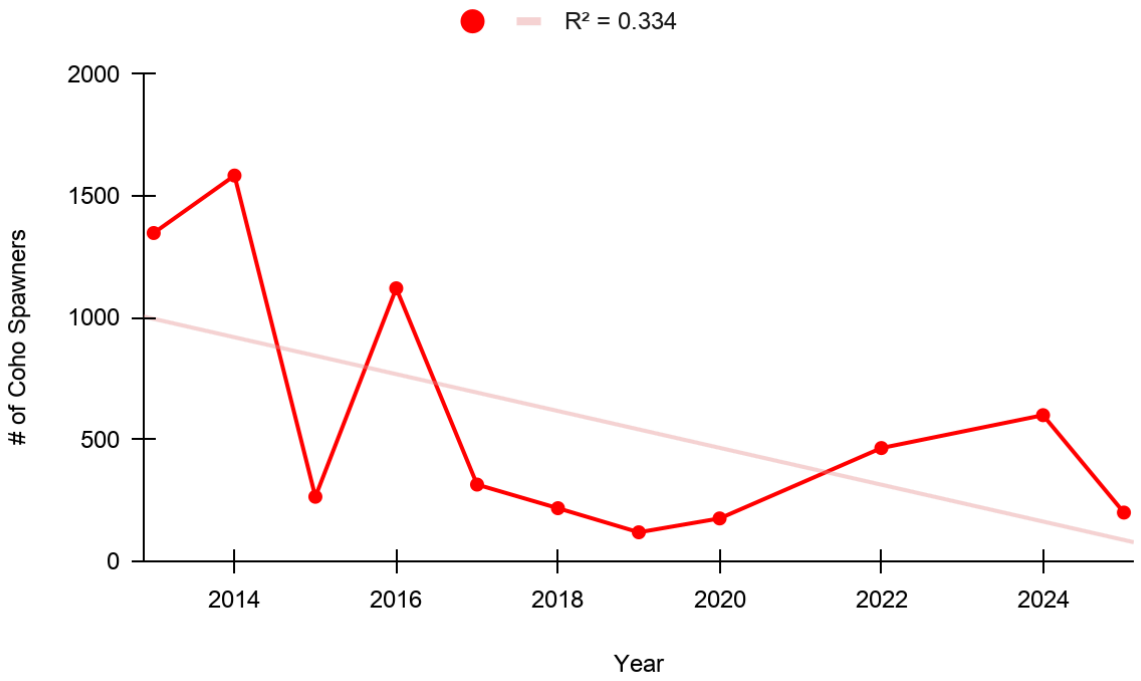


Figure 11. Linear trend of Coho spawner return counts from 2013-2025.

Table 6: Total number of returning Coho counted at the Cuthbert Holmes fish fence over the years.

Year	# of Coho	Notes
2013	1348	
2014	1584	
2015	265	
2016	1121	
2017	315	
2018	218	
2019	119	
2020	176	
2021		Cut short due to heavy otter predation
2022	465	
2023		Missing data
2024	600*	Incomplete footage processing, rough estimate, but anecdotally noted as a good return
2025	200*	Incomplete footage, calculated estimate.

4.0 Discussion

4.1 2025 PSS Camera Operation

This project represents the first year that Peninsula Streams Society (PSS) independently operated the Colquitz River fish fence camera system and coordinated volunteer-based video processing. Despite substantial data limitations, the system provided a preliminary estimate of approximately 200–250 returning adult coho in 2025, based on observed counts during a clear mid-November window and an assumed run timing distribution. This estimate falls within the range of lower-return years historically observed at this site, though it remains highly uncertain due to incomplete detection and large gaps in usable footage .

Observed fish passage between November 5 and 17 aligned with the expected peak migration period, which was supported by redd survey data showing peak redd counts around November 17. This suggests that the camera system was able to capture a portion of peak spawning activity. However, extended periods of unusable footage earlier and later in the run prevented a full characterization of migration timing, and the assumption that this window represents approximately 35–40% of the total return introduces additional uncertainty.

Volunteer engagement was a major strength of this program, with over 30 volunteers contributing more than 200 hours to video processing and reviewing hundreds of video files. However, the total volume of footage collected continuously over roughly two months far exceeded what could realistically be processed manually. Even with motion detection tools used to prioritize clips, processing demands remained high and contributed to incomplete data coverage.

Data quality was primarily limited by environmental conditions. The Colquitz River's urban setting results in highly variable flows, elevated turbidity, and frequent debris, all of which significantly reduced visibility. Periods of heavy rainfall rendered footage unusable, and debris and garbage often obstructed the camera lens. During extreme flow events, including an atmospheric river in late November 2025, conditions prevented access to maintain the camera, resulting in further data gaps. Additional challenges included camera malfunctions, repositioning issues, and an overall setup that was vulnerable to obstruction.

The final return estimate also relies on several simplifying assumptions, including a symmetric, bell-shaped migration pattern and consistent detection probability, neither of which could be verified given the incomplete dataset. As a result, the 2025 estimate should be interpreted as a rough approximation rather than a precise count.

Despite these limitations, this first year of operation provided valuable insights into both the strengths and constraints of a camera-based monitoring approach. Several targeted improvements are planned for future seasons, including upgrades to camera housing and mounting to reduce debris interference, refinement of camera placement, and development of more efficient workflows for processing large volumes of footage. A key enhancement under consideration is the installation of a fabricated camera box designed to standardize fish passage conditions. This structure would guide fish through the frame in a consistent orientation and provide a uniform, high-contrast background, improving visibility under variable conditions. By creating more consistent footage, this setup is also expected to increase the effectiveness of motion detection software, allowing for more reliable filtering of relevant clips and substantially reducing the volume of footage requiring manual review by community scientists and staff.

Overall, while the 2025 estimate remains uncertain, the system successfully captured peak migration activity and demonstrated the potential of a non-invasive, community-supported monitoring approach. With targeted improvements, this method has strong potential to produce more reliable estimates of spawner returns in future years.

4.2 All Colquitz Spawner Data, 2013-2025

All collective spawner data for Colquitz suggests a decline in coho spawner returns. The direction of the trend is consistent across both parametric and nonparametric methods and moderate in strength, but the overall statistical support remains somewhat uncertain due to the limited sample size and interannual variability. However, it is important to note that this observed trend may not be fully reliable due to differences in data collection methods and data completeness across years. Earlier years relied on more invasive approaches, (e.g. physically handling and counting fish), which likely produced more accurate counts. In contrast, more recent years have shifted toward less invasive methods (e.g., underwater camera monitoring), which improve fish welfare but may introduce greater uncertainty in counts due to visibility issues, and missed detections. Furthermore, the 2024 and 2025 values are based on estimations from incomplete footage processing and therefore may not reflect true totals; there is also a gap in the dataset for 2023. As a result, while the data suggest a declining trend, it should be interpreted with caution and not treated as definitive evidence of change. Ultimately, this highlights the need for consistent, reliable, and non-invasive methods of quantifying adult escapement in the Colquitz River on an annual basis, an objective that may be supported through pursuing the installation of a fabricated camera box system to better assess population trends, evaluate the effectiveness of restoration efforts, and inform long-term management decisions.

Flow is known to directly impact Coho spawner returns (Lovellford et al., 2020), consequently, impacts of different flow metrics from the CRD Colquitz flow station were analyzed in relation to the 2013-2025 spawner datasets. To test whether spawner number was related to median fall (Sep - Dec) flow of that year, both a parametric Pearson correlation and a nonparametric Spearman rank correlation were used. The Pearson correlation was $r = -0.1667$ with $p = 0.6681$, indicating a very weak negative linear relationship that was not statistically significant. The Spearman correlation, $p = 1.0$, indicated no detectable relationship either. The simple linear regression had an R-squared of 0.0278, meaning median fall flow explained only about 2.8% of the variation in spawner counts. Overall, these results suggest there is no clear or statistically meaningful relationship between median fall flow and spawner number in this dataset, though the small sample size means the test has limited power.

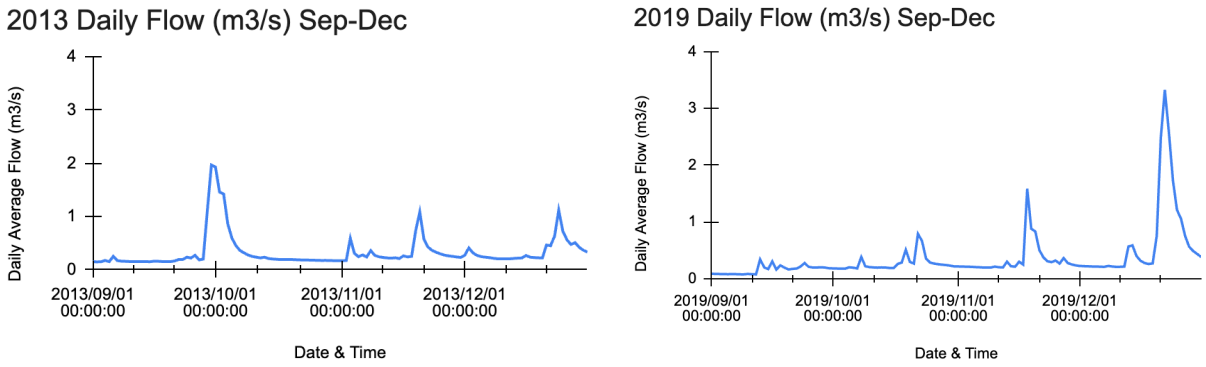


Figure 12. Example of flow profiles between a higher spawner year (2013: 1,384 coho), and a low spawner year (2019: 119 coho) based on these graphs it was noticed that it appears a peak flow event is happening earlier in high return years, compared to a late peak in low return years.

However, when examining fall flow graphs (e.g. Figure 12), it was noticed that years with lower numbers of returning spawners appeared to have high flow spikes later in the season; late November or early December. This observation is consistent with previous work suggesting that coho spawning activity is often triggered following initial seasonal peak discharge events (Lovellford, 2020). Consequently, it was hypothesized that high flow events earlier in the season may result in a longer time window of available and elevated flow conditions, allowing more time for spawning, and thus higher spawner numbers. To assess whether the timing of the first sustained fall flow event was related to spawner abundance, we used the earliest 6-day exceedance event for each year, where a sustained-high flow event was defined as six consecutive fall days with daily flow greater than 2 × that same year's summer median flow. The timing variable was the day of year out of 365 corresponding to the last (sixth) day of that first sustained flow event. Using the 9 years with both event timing and spawner data, there was a moderate negative relationship between flow event timing and spawner number. The Spearman rank correlation was rho = -0.6276, with p = 0.0704, suggesting that years with earlier qualifying fall flow events tended to have higher spawner counts, although this relationship was not statistically significant. The parametric Pearson correlation showed a similar but weaker pattern, with r = -0.4788 and p = 0.1923. A simple linear regression gave an R-squared of 0.2292, meaning event timing explained about 22.9% of the variation in spawner counts, with an estimated slope of about -11.7 spawners per day. Overall, the results suggest a potential trend where earlier sustained fall flow events may be associated with higher spawner numbers, but given the small sample size, this should be interpreted as suggestive rather than conclusive (Figure 13).

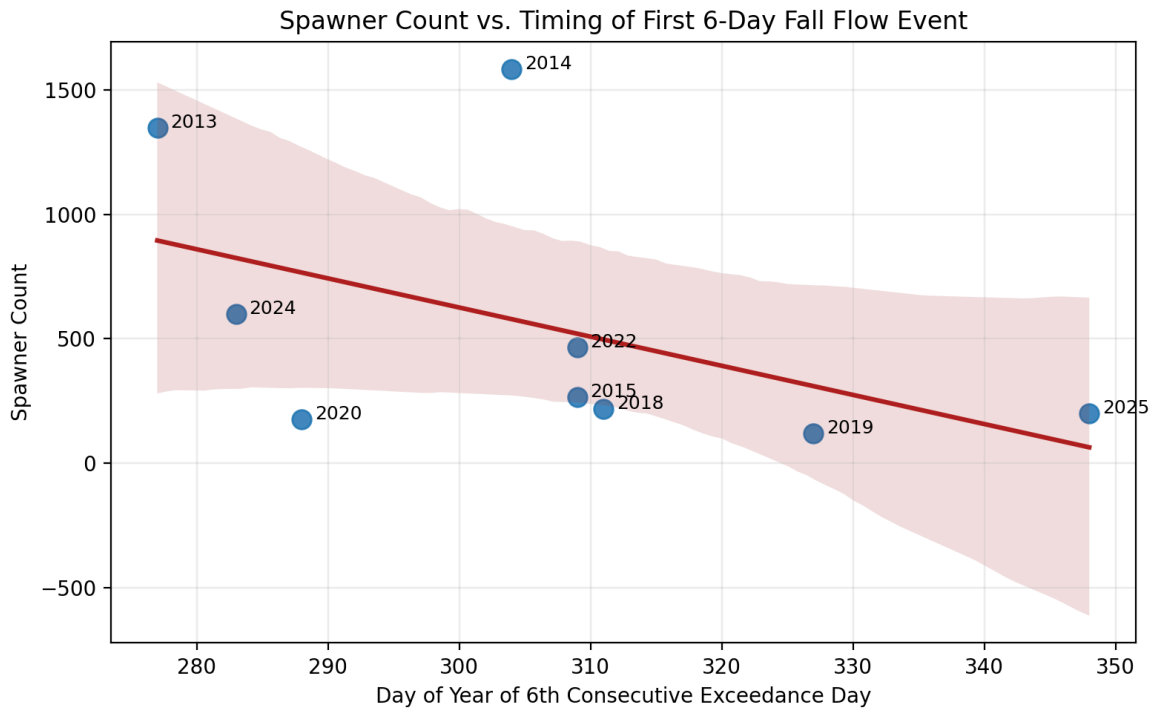


Figure 13. Trend of Coho spawner count per year plotted against the day of the year out of 365 upon completion of a sustained six consecutive days of elevated flow (greater than x2 respective year summer median).

Similarly, given the rationale that earlier sustained high flow events elevate spawner numbers, providing longer periods of favorable conditions, the number of sustained high flow events (6 consecutive days of x2 summer median of that respective year) was analyzed in relation to the number of spawners for that year. There was a weak positive relationship between the number of sustained fall flow events and spawner abundance, but it was not statistically significant. Both Pearson ($r = 0.28$, $p = 0.46$) and Spearman ($\rho = 0.32$, $p = 0.41$) correlations indicated only a slight tendency for years with more flow events to have higher spawner counts. Regression analysis showed that sustained flow events explained just 7.9% of the variation in spawner numbers ($R^2 = 0.08$), and although the slope suggested an increase of ~176 spawners per additional event, this result is not reliable given the high variability and small sample size. Overall, there is not enough evidence to conclude that the number of sustained flow events is a key driver of spawner returns in this dataset (Figure 14).

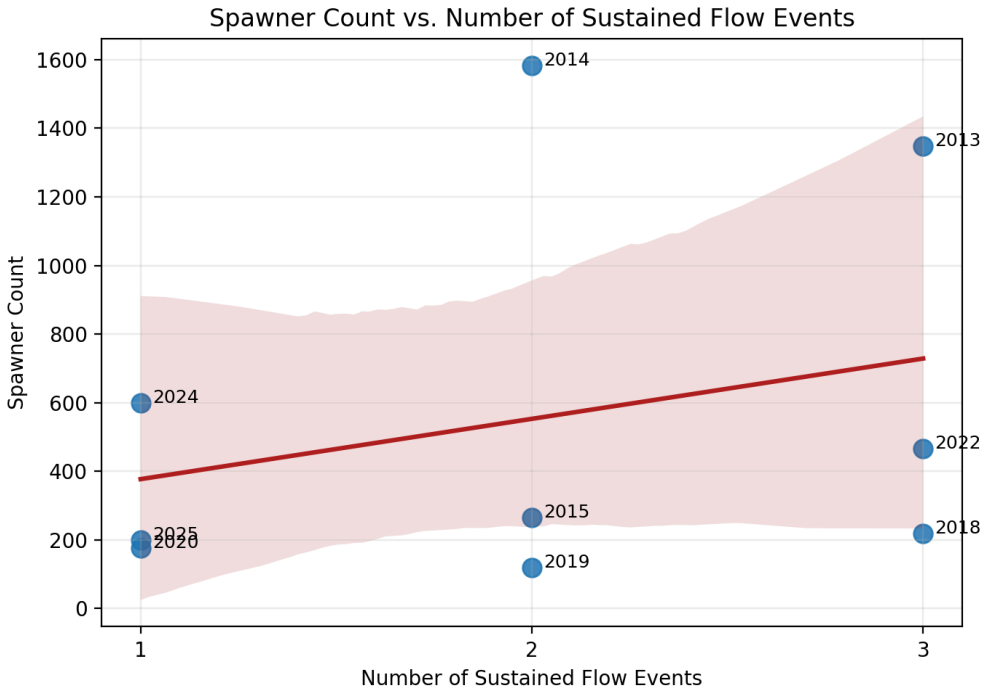


Figure 14. Trend of Coho spawner count per year plotted against the number of sustained high flow events (six consecutive days of elevated flow, greater than x2 respective year summer median). from September through December.

These potential trends may help explain interannual anomalies, such as the low spawner return observed in 2025. Despite expectations of a strong return based on high smolt production in 2024, the first sustained period of elevated flow in 2025 occurred in early December, substantially later than in most other years. This delay may have compressed the migration window and limited access to upstream habitat, potentially contributing to reduced spawning success.

Across all analyses, there is no strong or statistically significant evidence linking spawner abundance to any single flow metric. However, a consistent pattern emerges that may warrant further investigation: spawner returns appear more closely aligned with the timing of sustained migration conditions than with overall flow magnitude. Years with earlier onset of sustained elevated flows tended to have higher spawner counts, while later onset years were generally associated with lower returns. Although these relationships were not statistically significant and are based on a limited sample size (~8 years), the pattern is consistent across analyses and is biologically plausible. One possible interpretation is that earlier flow conditions may provide a longer and more accessible migration window, whereas delayed conditions could compress migration timing or limit access to upstream habitat. However, given the small dataset and high interannual variability, these findings should be considered exploratory rather than conclusive. Additional years of monitoring will be required to determine whether these patterns persist and to better understand the role of flow timing in shaping spawner returns.

Redd Monitoring Program





1.0 Introduction

In the fall of 2025, PSS initiated a new, volunteer-led program focused on localizing and monitoring Coho salmon spawning activity throughout the Colquitz River watershed. This program consisted of weekly, streamside walks along three separate, ~1.5 km long reaches of the Colquitz river and its tributaries, conducted by small teams of volunteers. On their walks, volunteers recorded the GPS location and condition of Coho redds, the number of spawning salmon present, and noted any obstructions or habitat quality concerns. These walks often occurred in public parks, and thus frequently resulted in engagement with community members who were informed on spawning locations and the importance of salmon spotting safely and in a non-disruptive manner. This program successfully highlighted the exact locations of numerous spawning hotspots, many of which were previous PSS restoration sites. The collected data allowed us to gauge the success and use of our prior restoration efforts, and also helped to identify future sites in need of enhancement.

2.0 Methods

Three reaches were created as walking routes for volunteer teams to conduct streamside redd monitoring. These reaches were selected based on previous community knowledge of Coho spawning sites, location of previous and potential future PSS restoration sites, as well as general stream visibility from the shore. The reaches were as follows (Figure 15), from downstream to upstream:

1. Reach: Colquitz - Cuthbert Holmes Park
2. Reach: Swan Creek and Colquitz - Hyacinth Park
3. Reach: Colquitz - Copley East Park and Gabo Creek

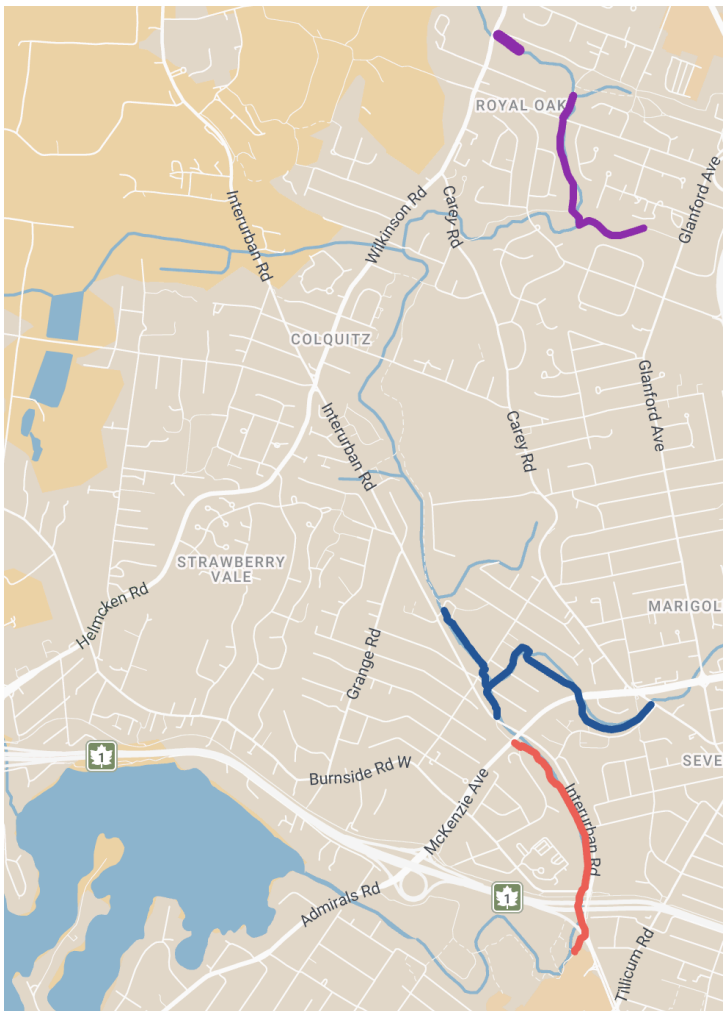


Figure 15. Map of all redd surveyed reaches. Reach 1, orange; reach 2, blue; reach 3, purple.

Reach 1 consisted of an approximately 1 km long stretch from Cuthbert Holmes Park, where the Colquitz is still tidally influenced, up to McKenzie Avenue.

Reach 2 consisted of an approximately 1.5 km long stretch along the Colquitz from McKenzie Ave, upstream through Hyacinth Park to Hyacinth Rd, and Swan Creek, a tributary of Colquitz.

Reach 3 consisted of an approximately 1 km long stretch of the Colquitz River through Copley East Park, up to Lindsay St and Wilkinson, beyond which spawning has not been observed. The reach also included Gabo Creek, a tributary of Colquitz.

Walks were conducted weekly by teams from each reach starting in mid October and running through til the end of December. Volunteer teams consisted of 3 to 5 people with one leader who was trained by PSS staff in redd identification, data collection, and appropriate salmon spotting techniques to minimize disruption. Each team went out once weekly, resulting in 3 walks conducted per week. To remain accessible to volunteers and team leads, walks were conducted on days on which leaders were available, resulting in a random weekly walk schedule that was, for the most part, on different days from week to week.

On these walks, volunteers would record and map the location of salmon redds. GPS coordinates were recorded for each observed redd, and the location was flagged with survey tape with a unique redd ID (based on date observed and total number observed) generated for each observed redd. Teams recorded the number of coho present, if they were actively spawning, their overall condition (e.g. any fungal growth, how degraded their bodies were, etc), as well as the age of the redd based on how fresh or faded it appeared. Any notes on potential obstructions to fish passage were recorded as well as any notes on carcass presence or observations of other wildlife. Weather, previous rainfall, stream flow, and stream turbidity and visibility, were all also recorded as metadata. Photos of redds and spawning salmon were also taken.

All data and photos were uploaded to a shared database, where volunteers and PSS staff could view sites observed to have spawning activity as well as a tally of total spawning coho recorded.

3.0 Results

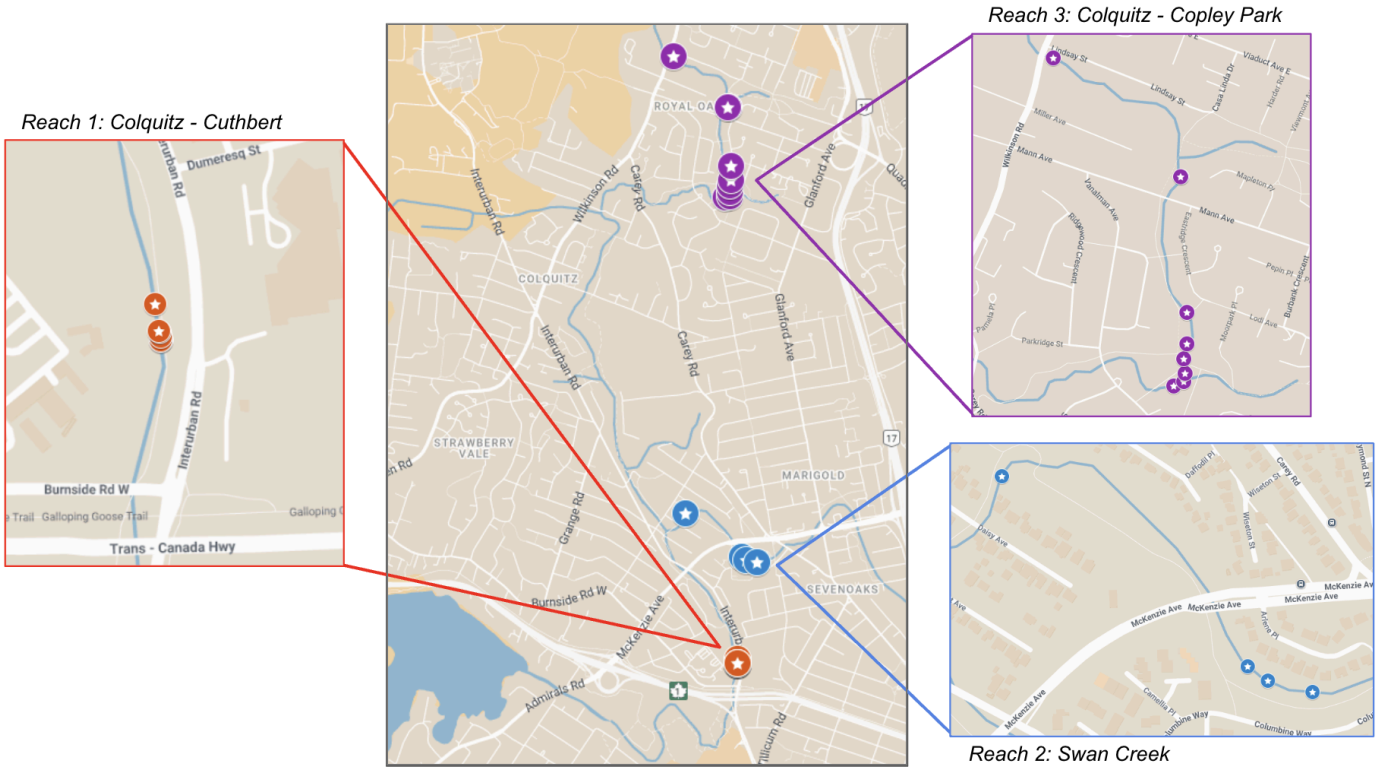


Figure 16. Redd hotspots identified by volunteers on weekly redd survey walks, across three ~1km reaches of the Colquitz.

Through these surveys, a total of 22 redds were recorded, with 7 in reach 1, 6 in reach 2, and 9 in reach 3. Out of the 22 recorded redds, 14 were located in previous PSS restorations sites, indicating success of our prior work at creating viable spawning habitat and supporting Coho populations.

From these observations, we were able to identify four main spawning hotspots (Figure 16), locations where multiple redds were often overlapping or in close proximity to each other on one given patch of spawning gravel. These hotspots will be prioritised for future PSS enhancement work in 2026. In addition to the redds, a total of 79 actively spawning coho salmon were observed Figure 17).

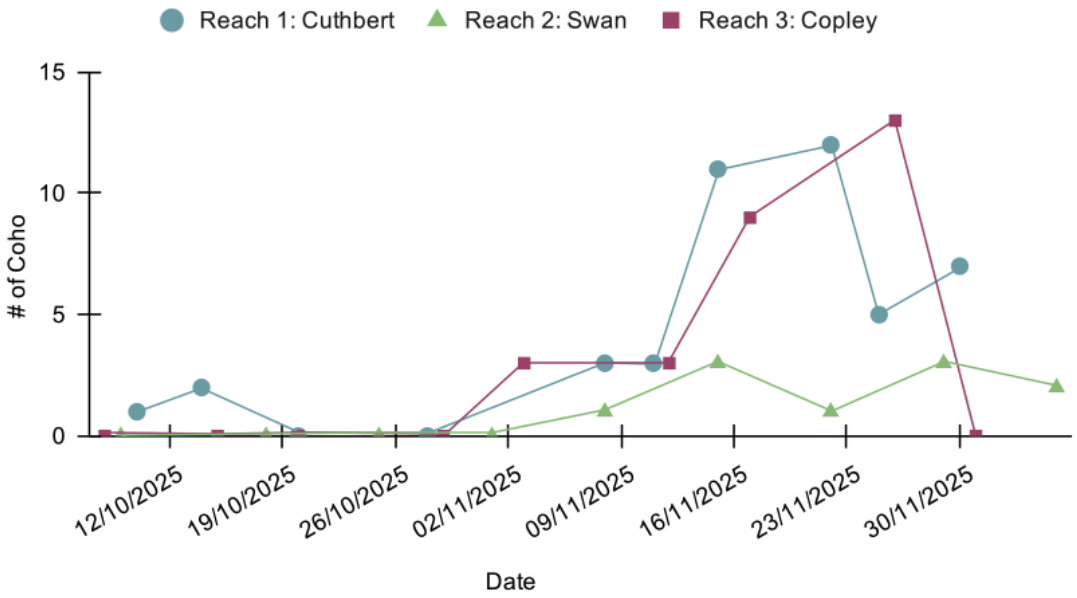


Figure 17. Active spawners counted on weekly redd mapping walks.

3.0 Discussion

The redd monitoring program covered approximately 4 km of spawning habitat within the Colquitz River watershed. Through these surveys, we were able to confirm that previous restoration sites, particularly throughout Copley East Park and Swan Creek were being actively used by and supporting coho salmon populations. Additionally, by localizing spawning hotspots, we successfully identified four sites in need of spawning gravel nourishment to ensure there is ample substrate for future spawning.

These redd monitoring walks would not have been possible without our dedicated volunteers and team leaders. Together, they amassed a total of 187.4 volunteer hours and 127 volunteers. These walks also frequently engaged community members who inquired about the walks as they were being conducted. Through these interactions, our volunteers were able to share information on the importance of protecting salmon populations and how to minimize disruptions to the spawners.

Table 7. Total redd monitoring volunteer participation, by month.

Month	# of Volunteers	Total Volunteer Hours
October	50	63.65
November	56	92.25
December	21	31.5

Given that it was our first time trialing this program, there were several limitations and lessons learned throughout the process. Notably, given that checks were only conducted weekly, and often on irregular days and times to remain flexible to the team leaders' schedule, the data collected were likely underestimations of total numbers. The total number of spawners observed in particular, 79, is likely a gross underestimation as those were only those recorded during the roughly 2 hour walks that occurred within each reach once a week. Often, spawner numbers will be high following heavy rains and resultant

high flows. Depending on when the walks were conducted, these spikes in returns could be missed if the walks were conducted on days in which minimum precipitation and consequent lower flows were observed. Previous research has also suggested that higher average streamflow during the fall spawning season may be associated with fewer redds, indicating a potential negative relationship between flow conditions and spawning success (Losee et al., 2025). However, in the Colquitz system, this relationship could not be evaluated due to limited data (one year) and poor visibility associated with flashy, stormwater-driven flows and high turbidity. Continued redd monitoring over multiple years will be necessary to better assess how streamflow influences spawning activity in the Colquitz system.



Similarly, the number of observed redds is also likely an underestimate. This is due in part to the weekly frequency of checks, but also due to the conditions of the stream. With the frequent heavy rains observed in the fall and the urban nature of the Colquitz river system, high turbidity is common with large amounts of precipitation. Consequently, in weeks of heavy rain, it was extremely difficult for teams to observe the stream beds for redds and thus challenging to collect data on quantity and location of spawning activity.

Despite these challenges, these surveys were still able to successfully identify Coho spawning locations. Going forward, we are working to further improve the redd monitoring program. Walks will be shifted to weekly, regularly timed walks to improve site comparability. Additionally, during peak spawning, usually at the end of November through early December, the frequency of walks will be increased to several times a week; additionally, walkers will be consistent throughout the whole monitoring period to ensure standardization in observations. Ultimately, we are excited to continue this program forward and develop a multi-year dataset of spawner hot spots, effectively monitoring the long term distribution of Colquitz River coho spawning and PSS restoration site use over time.

Conclusion

Collectively, the monitoring programs conducted in the Colquitz River watershed, including smolt trapping, PIT tag array detections, adult escapement monitoring, flow analysis, and redd surveys, provide an initial but still incomplete understanding of the population dynamics of coho salmon within this highly urbanized system. While each dataset offers valuable insight independently, their combined interpretation highlights several key emerging patterns, as well as substantial data limitations that constrain definitive conclusions.

Across multiple analyses, a recurring theme is the importance of environmental conditions, particularly flow, in shaping salmon population dynamics. While simple metrics such as median fall discharge did not show clear relationships with spawner abundance, more biologically relevant

indicators, such as the timing of sustained high-flow events, suggest a potentially meaningful pattern. Specifically, years in which the first sustained fall flow event (defined as six consecutive days exceeding twice the summer median flow) occurred earlier in the season tended to be associated with higher spawner returns. Although this relationship was not statistically significant, it was moderately strong and consistent across analytical approaches, indicating that flow timing, rather than magnitude alone, may play an important role in facilitating successful migration and spawning.

In contrast, relationships between smolt production and environmental drivers remain unclear, largely due to limited contemporary data. Historical datasets suggest a potential nonlinear relationship between summer baseflow and smolt abundance, with indications of an optimal flow level for juvenile rearing. However, with only two recent years of smolt data available, it is not yet possible to determine whether this pattern persists under current watershed conditions. Similarly, large interannual variation in smolt counts, such as the contrast between 4,009 smolts in 2024 and 88 in 2025, appears to reflect a combination of factors, including variability in spawner returns, episodic water quality impacts, potential cohort effects, and possible sampling limitations.

Water quality also emerges as a critical and potentially underappreciated factor influencing salmon survival in the Colquitz system. Observations of mortality events consistent with urban runoff toxicity, coupled with measured concentrations of contaminants such as 6PPD-quinone, suggest that episodic water quality impairments may contribute to reduced survival during key life stages. This highlights that, while habitat restoration has improved physical habitat availability in many areas, water quality conditions may still represent an important limiting factor, particularly during storm-driven runoff events in an urban watershed context.

Despite extensive restoration efforts and evidence of habitat use, such as redds observed in restored reaches and active spawning across multiple sites, the available data do not yet allow for a clear determination of whether the system is currently limited by habitat quantity, habitat quality, or broader environmental conditions. Instead, the findings suggest that multiple interacting factors are likely influencing population dynamics, with their relative importance varying among years.

A central conclusion emerging from this work is that current datasets are insufficient to robustly resolve these relationships. Many of the observed patterns, particularly those related to flow timing, smolt production, and survival, are suggestive but inconclusive due to small sample sizes, inconsistent data coverage, and methodological variability across years . As such, the most important outcome of this analysis is not a definitive explanation of population trends, but rather a clear identification of key knowledge gaps. Continued and expanded long-term monitoring will therefore be essential. Sustained smolt trapping, improved adult escapement estimation (e.g., through refined camera systems), ongoing PIT tagging, and continued redd monitoring will be critical for building the multi-year datasets required to detect trends, evaluate hypotheses, and reduce uncertainty. Integrating these biological datasets with consistent flow and water quality monitoring will further strengthen the ability to identify limiting factors and assess the effectiveness of restoration efforts over time.

Ultimately, the Colquitz River represents a complex and dynamic urban watershed, where salmon populations are influenced by a combination of habitat conditions, hydrology, water quality, and life-history variability. Developing a robust, long-term monitoring framework is therefore fundamental to informing adaptive management and ensuring that restoration efforts are effectively targeted to support resilient and self-sustaining coho salmon populations in the future.

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