



2025 SPRING CHINOOK SALMON SPAWNING SURVEYS ABOVE GREEN PETER DAM

PREPARED FOR



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ACRONYMS AND ABBREVIATIONS

°C	degree Celsius
BiOp	Biological Opinion
cfs	cubic feet per second
CFS	Cramer Fish Sciences
CHS	Chinook salmon
CWT	coded wire tag
EAS	Environmental Assessment Services, LLC
ESA	Endangered Species Act
GPS	global positioning system
km	kilometer(s)
mm	millimeter(s)
MS	Middle Santiam River reaches (e.g., MS 0–MS 3)
NOAA	National Oceanic and Atmospheric Administration
ODFW	Oregon Department of Fish and Wildlife
PSM	prespawn mortality
Q	Quartzville Creek reaches (e.g., Q 1–Q 4)
U.S.	United States
USACE	United States Army Corps of Engineers
USFS	United States Forest Service
USGS	United States Geological Survey

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1.0 Introduction and Background

Pacific salmon (*Oncorhynchus* spp.) are an integral species to the Pacific Northwest, providing significant ecological functions, economic benefits, and cultural significance. Salmon provide nutrient transport to upstream locations, support recreational, commercial, and subsistence fisheries, and are centrally important to Indigenous communities (Crozier et al., 2021). Unfortunately, populations across the region have sharply declined in recent decades due to anthropogenic and environmental factors. These include habitat degradation, overfishing, urbanization leading to increased infrastructure, altered flow regimes, hatchery practices, and climate change (Crozier et al., 2021; Steel et al., 2017; Buckner et al., 2025). The cumulative impact of these stressors contributes to the reduced reproductive success and genetic diversity, leading to the United States (U.S.) Endangered Species Act (ESA) listings for multiple Chinook salmon populations.

Spring Chinook salmon (*Oncorhynchus tshawytscha*) in the Willamette River Basin are listed as threatened under the ESA due to declines in abundance, habitat quality, and connectivity (National Oceanic and Atmospheric Administration [NOAA] Fisheries, 2008). Thirteen U.S. Army Corps of Engineers (USACE) dams and reservoirs have altered natural flow regimes, limited access to historic spawning habitats, and complicated flow management due to competing demands (Kock et al., 2021). Salmon habitat depends on streamflow, depth, temperature, and hydrologic conditions, making it difficult to balance flood control, energy production, conservation, and recreation.

In response to documented population limitations, NOAA completed a Biological Opinion (BiOp) in 2008 for the Willamette River Basin Flood Control Project. The BiOp identified dam passage and habitat limitations as significant constraints on Upper Willamette River spring Chinook viability and recommended a suite of reasonable and prudent alternatives to address these impacts. These reasonable and prudent alternatives included habitat restoration, operational modifications to improve passage conditions, and outplanting of Chinook salmon into historical habitats upstream of dams where passage remains limited (NOAA Fisheries, 2008).

More recent legal and management actions have reinforced these conservation measures. In 2021, the U.S. District Court for the District of Oregon issued an interim injunction requiring USACE to implement measures intended to improve fish passage, water quality, and monitoring across the Willamette Valley Project (*Northwest Environmental Defense Center v. USACE*, 2021). Outplanting efforts began in 2022, with up to 800 spring Chinook salmon released above Green Peter Dam. This outplanting effort included 600 Chinook in the Middle Santiam River and 200 in Quartzville Creek to supplement natural spawning populations and restore connectivity to historically accessible habitats.

Environmental conditions such as low flows and elevated stream temperatures are recognized as key drivers of salmon spawning success throughout the area. Variable climate patterns, intentional flow regimes, and watershed changes have been linked to reduced habitat availability, limited access to cold-water refuge, and increased physiological stressors for salmon during critical and sensitive life stages (Crozier et al., 2021; Steel et al., 2017). To better support the long-term recovery of ESA-listed Chinook salmon in the Willamette Valley, management strategies should continue to attempt to incorporate these hydrologic and thermal trends for long-term planning purposes.

Monitoring outplanting and restoration efforts is essential for ongoing adaptive management. Environmental Assessment Services, LLC (EAS) was contracted in 2025 (Contract No. W9127N25CA024) to conduct spawning ground surveys in the Middle Santiam River and Quartzville Creek. The primary aims and objectives of the study include:

- documenting the spatial and temporal distribution of Chinook salmon redds up to the first natural migration barrier, and
- recovering and collecting biological data from Chinook carcasses including length, sex, egg retention, life history origin (hatchery vs. adfluvial fish), and tag (floy and coded wire tag [CWT]) salvage.

2.0 Methods and Materials

2.1 Middle Santiam River

The Middle Santiam River study area is located within the U.S. Forest Service (USFS) Middle Santiam wilderness and extends from upstream of Giustina private timber lands to the confluence of Bachelor Creek, near the Shedd Camp trailhead. The study area includes the Pyramid Creek confluence and extends upstream 2.2 kilometers (km) past the Pyramid Peak Trail 338 crossing to a sizable log jam that was considered unsafe to traverse. (**Figure 1**).

In 2024, access to the upper Middle Santiam River was limited due to the Pyramid Fire, which burned over 1,300 acres of land and restricted surveys within the area. In 2025, the study area was expanded to further include two additional survey reaches: Pyramid Creek and Middle Santiam River reach (MS) 0. Areas affected by recent fire required survey crews to wear additional safety personal protective equipment, including hard hats and high-visibility vests.

EAS crews that were responsible for surveying reaches from MS 1 to the wilderness boundary at the lower extent of MS 3 were permitted to camp overnight with prior authorization from the USFS. Overnight camping allowed crews to complete surveys safely and efficiently within a single day, hiking out the following day via Forest Service Road 2041. Prior coordination with the Sweet Home USFS office ensured field safety and included access to direct radio communication with USFS dispatch and established emergency exit strategies. Garmin InReach satellite devices were utilized by both overnight and day crews to provide daily progress and safety updates to EAS management.

Access to MS 0 and Pyramid Creek was achieved via the Shedd Camp Trailhead and Forest Service Road 2041. MS 0 and Pyramid Creek were surveyed by a day crew, while MS 1, MS 2, and MS 3 were surveyed by an overnight crew to safely cover the 9.9-km study reach. On two separate occasions, crews surveyed approximately 0.67 km upstream of MS 0 to evaluate whether Shedd Camp Falls, a large waterfall at the upstream end of MS 0, would be considered a fish passage barrier.

A total of 600 adult spring Chinook salmon had been released near the downstream U.S. Geological Survey (USGS) gage by the Oregon Department of Fish and Wildlife (ODFW) between July 20 and August 9, 2025. Spawning ground surveys along the Middle Santiam River were conducted from mid-July through late October. During this 16-week period, EAS crews completed a total of 88 walking surveys across all reaches (**Tables 1 and 2**).

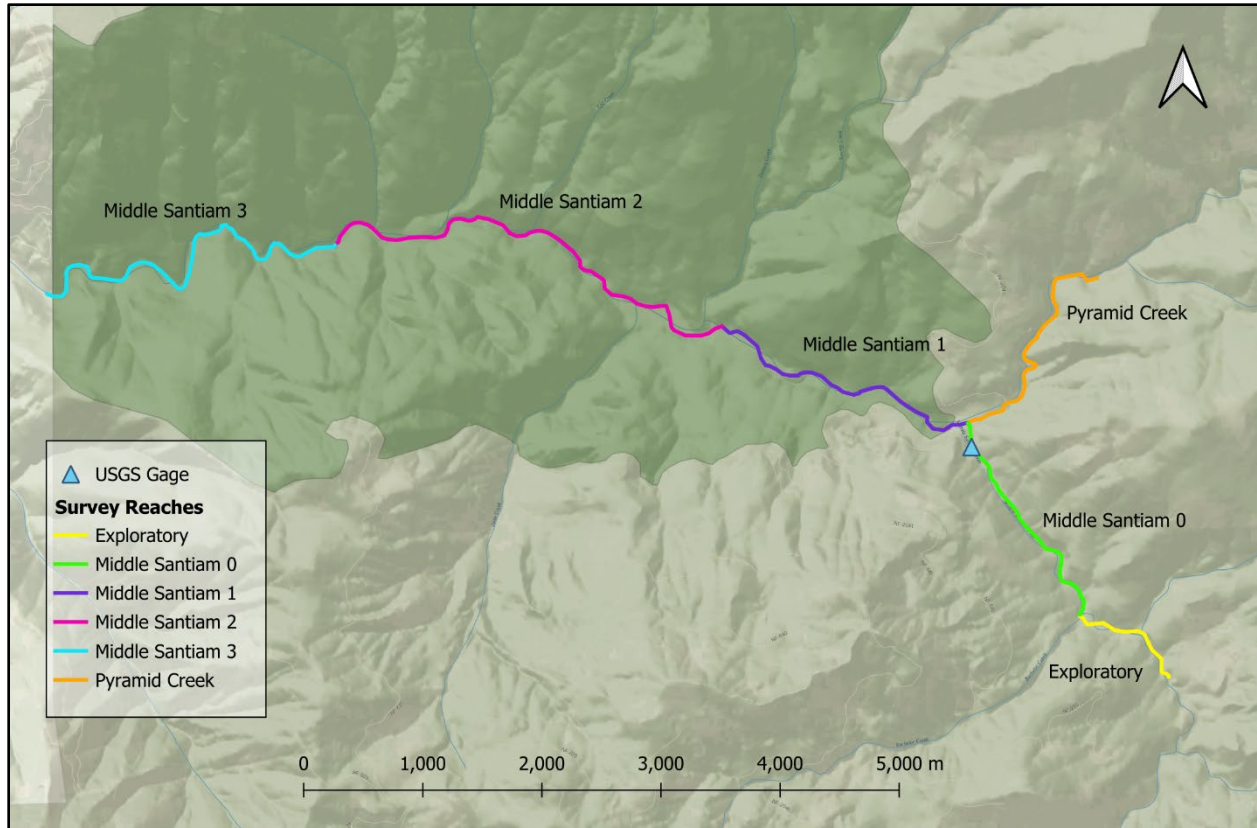


Figure 1 Map of the Middle Santiam Study Area

Table 1 Sampling Weeks, Date Range, and Number of Survey Reaches Completed for the Middle Santiam River in 2025

Week	Date Range	Survey Reaches Completed	Notes
29	07/13/25–07/19/25	6	
30	07/20/25–07/26/25	8	480 CHS Outplanted
31	07/27/25–08/02/25	5	
32	08/03/25–08/09/25	5	120 CHS Outplanted
33	08/10/25–08/16/25	5	
34	08/17/25–08/23/25	5	
35	08/24/25–08/30/25	5	
36	08/31/25–09/06/25	5	
37	09/07/25–09/13/25	7	
38	09/14/25–09/20/25	6	
39	09/21/25–09/27/25	6	Peak Spawn
40	09/28/25–10/04/25	5	
41	10/05/25–10/11/25	5	
42	10/12/25–10/18/25	6	
43	10/19/25–10/25/25	5	High Flow
44	10/26/25–11/01/25	4	

CHS = Chinook salmon

Table 2 Middle Santiam River Survey Reaches and Estimated Lengths

Reach Name	Length (km)
Middle Santiam 0	2.1
Pyramid Creek	2.1
Middle Santiam 1	2.6
Middle Santiam 2	3.8
Middle Santiam 3	3.5

2.2 Quartzville Creek

The Quartzville Creek study area is located within the Cascade Mountain Range and is known as a wild and scenic river corridor. The study area extends from the confluence with Green Peter Reservoir upstream to a known fish barrier located approximately 0.35 km above the first crossing of Quartzville Creek via Forest Service Road 11 (**Figure 2**). Canal Creek, a key tributary, was surveyed from its confluence with Quartzville Creek upstream to the USFS boundary. Both Galena Creek and Boulder Creek were surveyed early in the season but were determined to be unsuitable for spawning Chinook due to low streamflow and were subsequently monitored intermittently through peak spawning. All surveys conducted in the Quartzville Creek study area were completed by daytime crews.

Spawning ground surveys in the Quartzville Creek study area were conducted from late August through October 2025. Initial redd surveys were completed across all survey reaches within the study area from August 24 to 30, 2025 (week 35), to confirm that previous years' redds were not visible prior to adult outplanting. A total of 200 adult spring Chinook salmon were released by ODFW at Miner's Camp on September 24, 2025. Following fish outplanting, weekly spawning surveys began on October 1 (week 40). In total, crews completed 23 walking surveys across the study area over a six-week period (**Tables 3 and 4**).

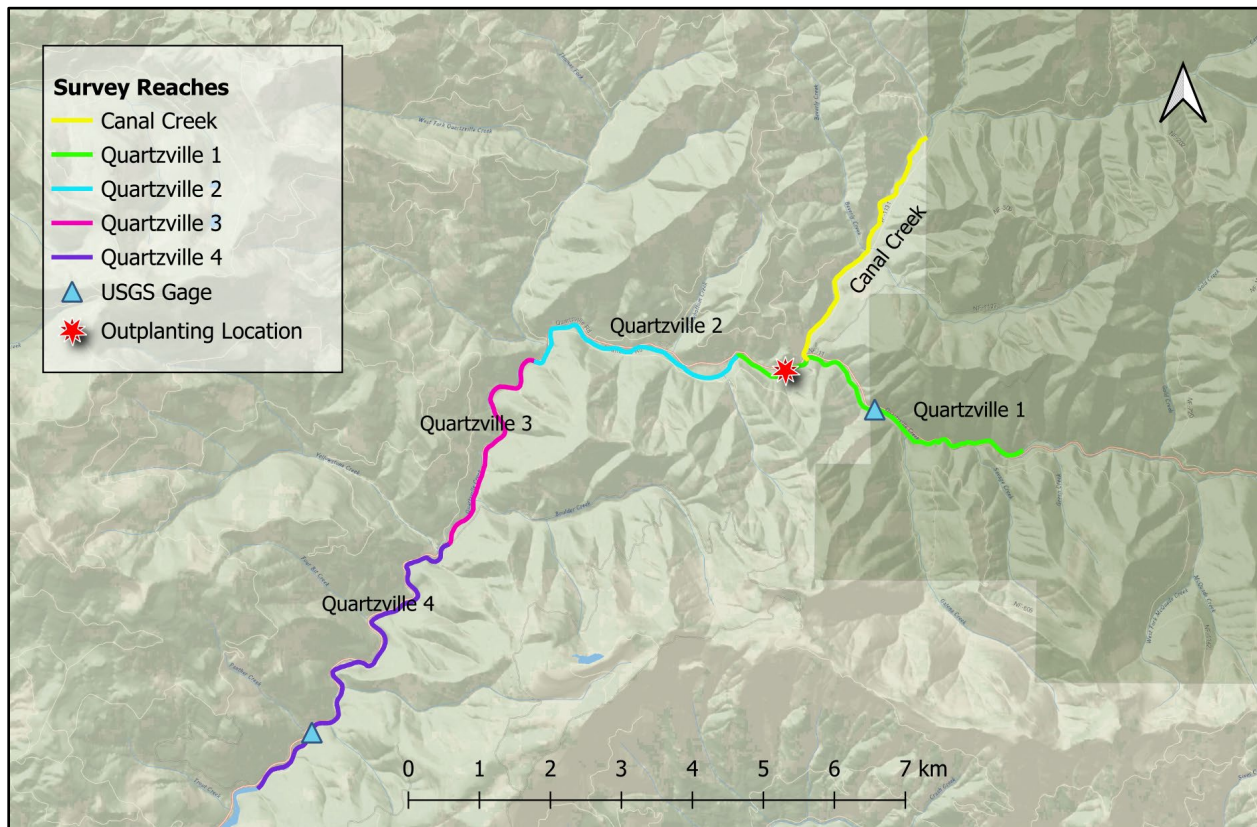
**Figure 2 Map of the Quartzville Creek Study Area**

Table 3 Sampling Weeks, Date Range, and Number of Survey Reaches Completed for Quartzville Creek in 2025

Week	Date Range	Survey Reaches Completed	Notes
35	08/24/25–08/30/25	5	
36	08/31/25–09/06/25	0	
37	09/07/25–09/13/25	0	
38	09/14/25–09/20/25	0	
39	09/21/25–09/27/25	0	200 CHS Outplanted
40	09/28/25–10/04/25	5	Peak Spawn
41	10/05/25–10/11/25	5	End of Spawn
42	10/12/25–10/18/25	4	
43	10/19/25–10/25/25	2	
44	10/26/25–11/01/25	2	High Flow

CHS = Chinook salmon

Table 4 Quartzville Creek Survey Reaches and Estimated Lengths

Reach Name	Length (km)
Quartzville 1	4.7
Canal Creek	3.2
Quartzville 2	3.2
Quartzville 3	3.8
Quartzville 4	5.3

2.3 Spawning Surveys

Surveys consisted of two trained team members and were typically conducted in a downstream direction. During peak spawning periods in Quartzville Creek, surveys were conducted with additional crews in an upstream direction to increase efficiency and provide additional coverage in areas of high spawning activity. Data collected during spawning surveys included counts of live adult spring Chinook salmon, redd observations, and carcass processing. Polarized sunglasses were used to improve in-water detection of fish and redds.

Water visibility was recorded at the start of each survey and categorized as: (1) good, when the bottom of pools and riffles were visible; (2) fair, when the bottom of riffles but not pools were visible; or (3) poor, when the bottom of both pools and riffles were not visible.

During the 2025 survey season, all crew members used OnX applications for navigation and data collection, as it performed more reliably than Garmin eTrex units in steep terrain. The application allowed crews to add waypoints to a shared map layer, navigate survey reaches, and access previously collected data and emergency exit routes while in the field. Global positioning system (GPS) units were set to record coordinates in degrees and decimal minutes. Waypoints for live fish, redds, carcasses, survey entry and exit points, and floy tags were recorded in OnX.

2.4 Adult Observations

For each live adult Chinook salmon observed, crews recorded the number of fish present, an approximate GPS location, habitat type (e.g., pool, riffle, run, or glide), and observed behavior (e.g., holding, migrating, spawning, or guarding). When possible, crews also photographed individuals, determined sex, and noted the presence or absence of an adipose fin. All observations were documented on field datasheets and recorded in OnX using associated waypoint IDs and photographs.

2.5 Carcass Surveys

Carcass collection was conducted concurrently with live fish and redd surveys to assess spawning timing, spatial distribution of outplanted adults, and overall spawning success in both study areas. Recovered carcasses were examined for fin clips, CWT, and floy tags. Biometric data collected included post-orbital to hypural plate length, fork length, sex, and egg retention percentage. When CWTs were detected, snouts were removed, bagged, labeled with a unique identification number, and retained for subsequent analysis by hatchery personnel.

All carcasses were photographed from a lateral perspective. The inside of the body cavity was photographed to confirm sex and document egg retention percentage. After processing, the caudal fin was removed to prevent duplicate counts during subsequent surveys. All carcass data and photographs were recorded on datasheets and in OnX with waypoints assigned to each carcass location.

Prespawn Mortality

Egg retention percentage was assessed for female Chinook salmon carcasses to evaluate spawning success. Egg retention was categorized as 0%, 5–10%, 10–25%, 25–50%, 50–75%, and 100% (**Figure 3**). Female carcasses retaining 50% or more eggs were classified as prespawn mortalities (PSM). Carcasses that were too decomposed or scavenged to accurately estimate egg retention were classified as unknown and excluded from PSM calculations.

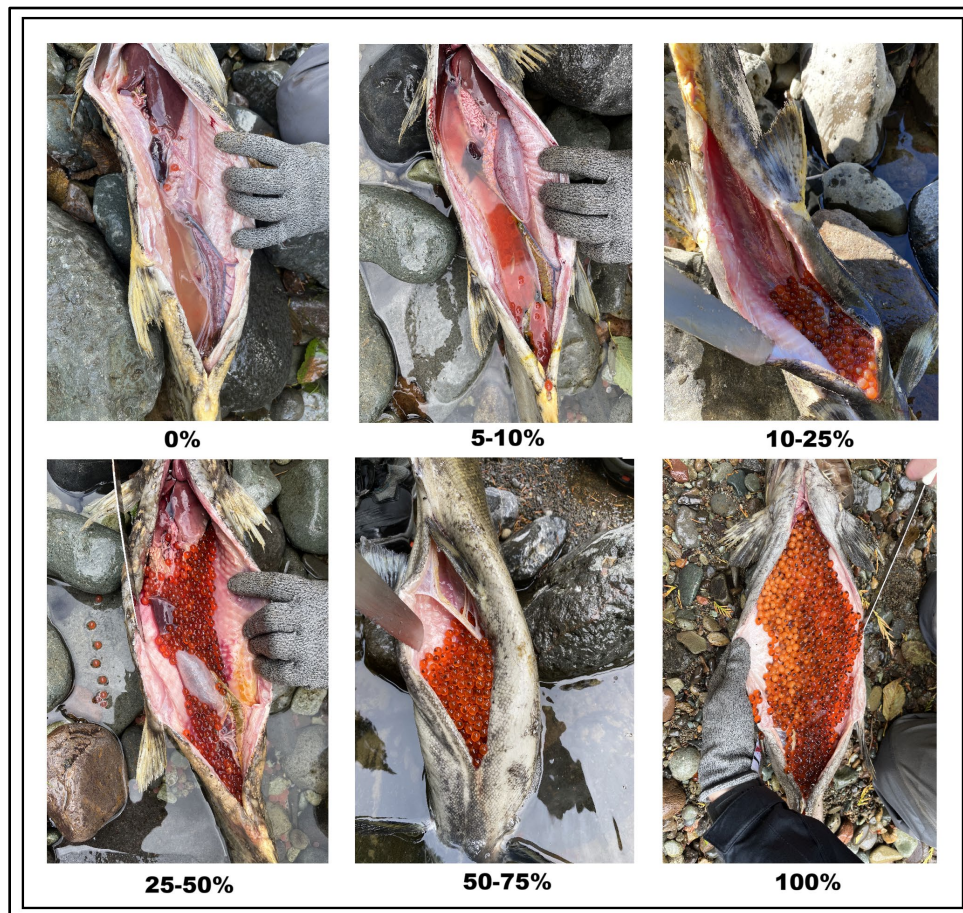


Figure 3 Female Chinook Salmon Egg Retention Percentage Categories

2.6 Redd Surveys

Survey crews were trained in redd identification and enumeration prior to survey initiation. Redds were counted individually, flagged in the field, and assigned unique waypoint IDs in OnX. Redds were considered complete when a distinct pit and mound were visible and gravel appeared clean and evenly sorted. Following methods described by Gallagher and Gallagher (2005), test redds were identified and recorded in OnX for verification during later surveys by different personnel to reduce observer bias. Additionally, redd longevity was monitored throughout the survey season. Redds were classified as degraded when the pit and mound features were no longer visible, gravel was fully covered by periphyton, and sorting was no longer apparent. Once degradation was confirmed by two separate crews, flagging was removed and the final observation date was recorded. Redd density maps were created using QGIS, with redds displayed as a point density heat map generated using the kernel density tool.

Spawning success rates were estimated using previously established methods. EAS crews utilized system-specific redd counts and assumed a 1:1 female-to-male spawning ratio to calculate the maximum possible number of spawning adults. This value was then expressed as a percentage of the known number of outplanted individuals. To refine these estimates, prespawn mortality documented within each system was incorporated. Under the same 1:1 sex ratio assumption, EAS crews estimated the number of individuals that died prior to spawning. Accounting for this mortality allowed survey crews to calculate a maximum spawning success rate under optimal assumptions.

3.0 Middle Santiam River Results

3.1 Adult Observations

Adult Chinook outplanting in the Middle Santiam River occurred during two release events. The first event occurred on July 21, 2025, when 480 adult Chinook salmon were released, followed by a second release of 120 adults on August 7, 2025.

EAS crews observed a total of 924 live adult Chinook salmon over the course of the 2025 Middle Santiam spawning season (**Figure 4; Table 5**). Live adult counts represent observations and do not reflect unique individual abundance. Many observations represented repeat sightings of the same individuals, often occurring in large aggregations. Most live adult observations occurred within MS 2 and MS 3 reaches, where Chinook salmon were frequently observed holding in deep pools.

Survey week 37 yielded the highest number of live adult observations, with 149 fish recorded throughout the study area (**Table 5**), representing 25.7% of the total number of Chinook salmon outplanted in the Middle Santiam River in 2025. Following outplanting, the number of live adult observations increased through week 37 and declined rapidly thereafter. During week 38, 121 adults were observed, decreasing to 106 observations in week 39, and 19 in week 40.

No adult Chinook salmon were observed in the minor tributaries during the survey period. Jude Creek appeared to contain a potential fish passage barrier approximately 0.30 km upstream of its confluence with the Middle Santiam River. Other minor tributaries lacked sufficient streamflow and habitat to support spawning.

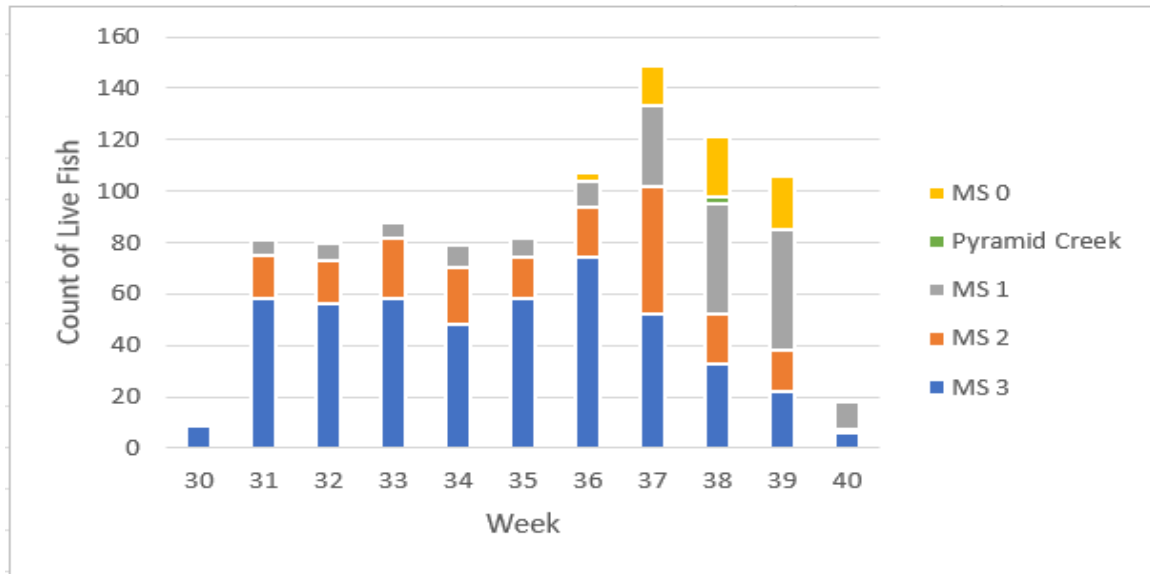


Figure 4 Middle Santiam River Live Fish Counts per Survey Week

Table 5 Middle Santiam River Live Fish Count per Survey Week, by Reach

Week	MS 0	MS 1	MS 2	MS 3	Pyramid Creek	Total
29	0	0	0	0	0	0
30	0	0	0	9	0	9
31	1	6	17	58	0	82
32	1	7	17	56	0	81
33	0	6	24	58	0	88
34	0	9	22	48	0	79
35	1	8	16	58	0	83
36	3	10	20	74	0	107
37	16	31	50	52	0	149
38	23	43	19	33	3	121
39	21	47	16	22	0	106
40	1	11	1	6	0	19
41	0	0	0	0	0	0
42	0	0	0	0	0	0
43	0	0	0	0	0	0
44	0	0	0	0	0	0
Totals	67	178	202	474	3	924

3.2 Carcass Recoveries

A total of 257 Chinook salmon carcasses were recovered during the 2025 Middle Santiam spawning season, representing 42.8% of all adults outplanted. Carcass recoveries occurred most frequently in MS 1. The highest number of collected carcasses was documented during survey week 39, when 105 were recovered (**Figure 5**). One jaw with skin was found in an exploratory survey above MS 0. This was included in MS 0 data as a carcass with unknown sex. Carcass recovery surveys began in week 31 and continued through week 42, following the completion of spawning activity. After week 39, carcass availability declined, with only six carcasses recovered during week 42 (**Table 6**).

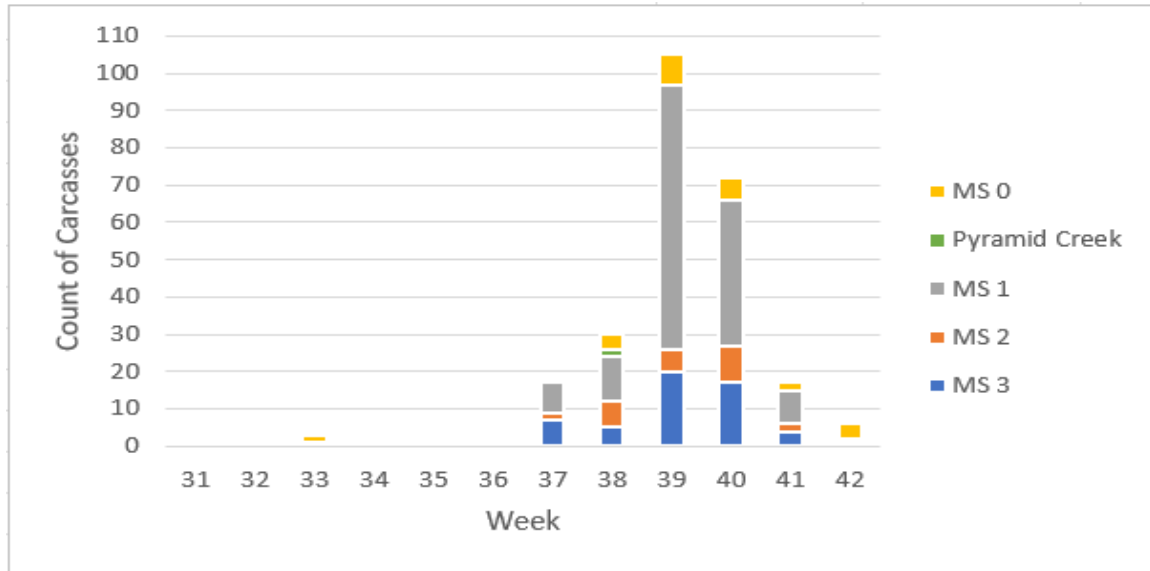


Figure 5 Middle Santiam River Carcass Counts per Survey Week

Table 6 Middle Santiam Carcass Recovery Count per Survey Week, by Reach

Week	MS 0	MS 1	MS 2	MS 3	Pyramid Creek	Total
29	0	0	0	0	0	0
30	0	0	0	0	0	0
31	0	0	0	0	0	0
32	1	0	0	0	0	1
33	2	0	0	1	0	3
34	0	0	1	1	0	2
35	0	1	1	1	0	3
36	0	1	0	0	0	1
37	0	8	2	7	0	17
38	4	12	7	5	2	30
39	8	71	6	20	0	105
40	6	39	10	17	0	72
41	2	9	2	4	0	17
42	4	0	1	0	1	6
43	0	0	0	0	0	0
44	0	0	0	0	0	0
Totals	27	141	30	56	3	257

The sex ratio of recovered carcasses was approximately 0.8:1, with 91 females and 112 males identified. An additional 54 carcasses were too degraded to determine sex and were classified as unknown. Of these 257 carcasses recovered, 60 were heavily scavenged and could not be measured. No adfluvial Chinook salmon were observed during the 2025 season. Thirteen individual floy tags were recovered without associated carcasses.

Sex ratios varied among reaches, with females outnumbering males in MS 0, MS 2, and MS 3, while males outnumbered females in MS 1. Mean fork length was 778 millimeters (mm) for females (range: 640–875 mm; n=91) and 750 mm for males (range: 625–860 mm; n=112) (**Table 7**).

Table 7 Minimum, Mean, and Maximum Carcass Fork Length (mm) in the Middle Santiam River

Reach	Sex	n =	Carcass Fork Length (mm)		
			Min	Mean	Max
Middle Santiam 0	F	10	655	757.0	875
	M	8	665	750.8	809
	Unk	9	--	--	--
Middle Santiam 1	F	43	640	748.6	845
	M	77	625	750.0	860
	Unk	21	715	764.2	820
Middle Santiam 2	F	12	680	765.4	830
	M	11	660	731.3	775
	Unk	7	760	760.0	760
Middle Santiam 3	F	26	673	735.5	825
	M	16	680	756.9	834
	Unk	14	765	765.0	765
Pyramid Creek	F	0	--	--	--
	M	0	--	--	--
	Unk	3	--	--	--

Female Chinook salmon carcasses with 50% or greater egg retention were classified as PSM. Of the 91 female carcasses processed, egg retention could be determined for 73 individuals. A total of 25 females retained 50% or more eggs, while 48 retained less than 50%. This resulted in an estimated female PSM rate of 34.2% (**Table 8**).

Table 8 Prespawn Mortality for Female Chinook Carcasses in the Middle Santiam River

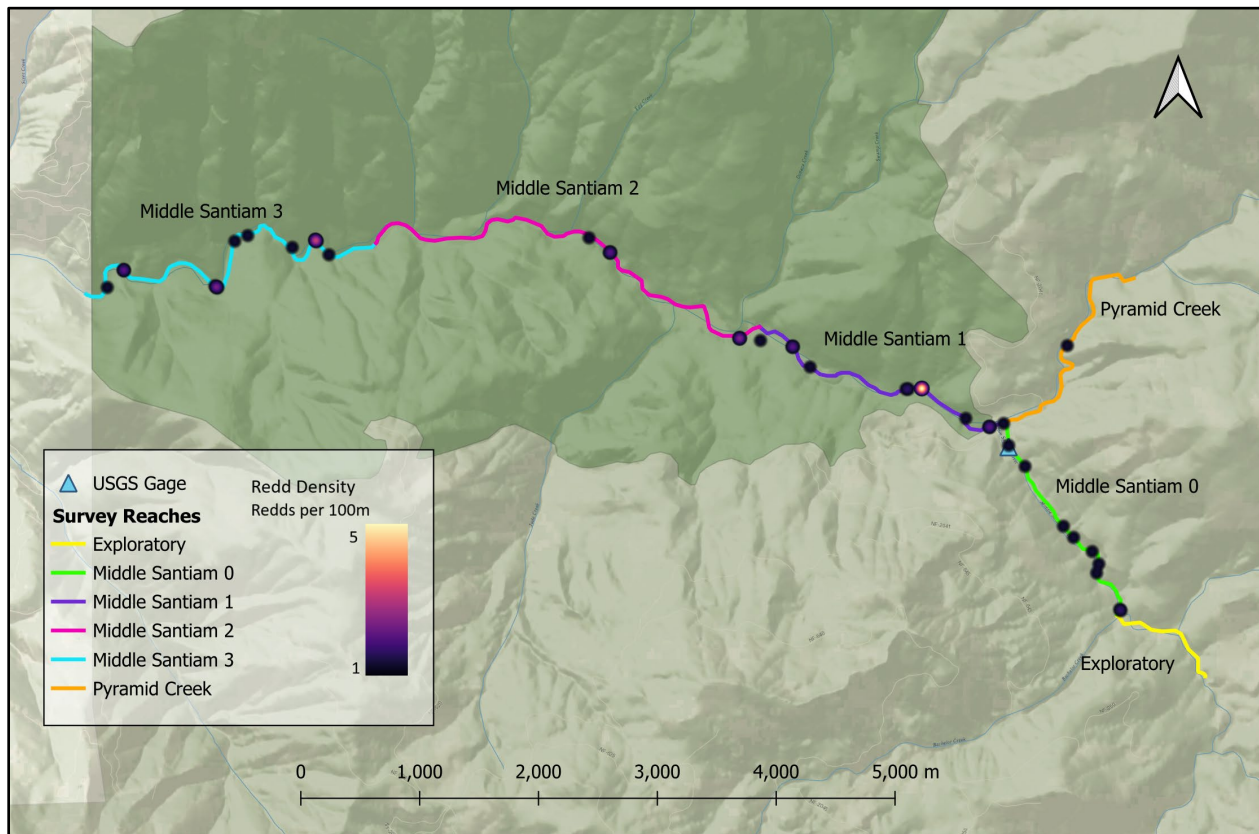
Egg Retention %	Yes	No	Prespawn Mortality %
> 50	25	48	34.2%

3.3 Redd Enumeration

A total of 60 redds were observed and counted during the 2025 spawning season throughout the upper Middle Santiam River (**Table 9; Figure 6**). Redd construction began in week 37 and continued through week 40 (**Figure 7**). Redd longevity averaged 27 days. The majority of redds were located in MS 1 (23 redds) and MS 3 (19 redds), representing 70% of the total. High redd superimposition was recorded in both MS 1 and MS 3, indicating that spawning habitat in the Middle Santiam River is limited and inconsistently distributed. A limited number of fish utilized MS 2 for spawning, while MS 1 and MS 3 contained few distinct areas where most redds were concentrated. Using the PSM of 34.2% in combination with the recovery of 257 carcasses and observation of 60 redds, the estimated spawning success rate in the Middle Santiam was 30.4%.

Table 9 Middle Santiam River Redd Counts per Reach, by Survey Week

Week	MS 0	MS 1	MS 2	MS 3	Pyramid Creek	Total Redds
29	0	0	0	0	0	0
30	0	0	0	0	0	0
31	0	0	0	0	0	0
32	0	0	0	0	0	0
33	0	0	0	0	0	0
34	0	0	0	0	0	0
35	0	0	0	0	0	0
36	0	0	0	0	0	0
37	0	3	0	1	0	4
38	4	6	3	4	1	18
39	2	12	5	14	0	33
40	3	2	0	0	0	5
41	0	0	0	0	0	0
42	0	0	0	0	0	0
43	0	0	0	0	0	0
44	0	0	0	0	0	0
Totals	9	23	8	19	1	60

**Figure 6 Map of Redds per 100 Meters in the Middle Santiam River Study Area**

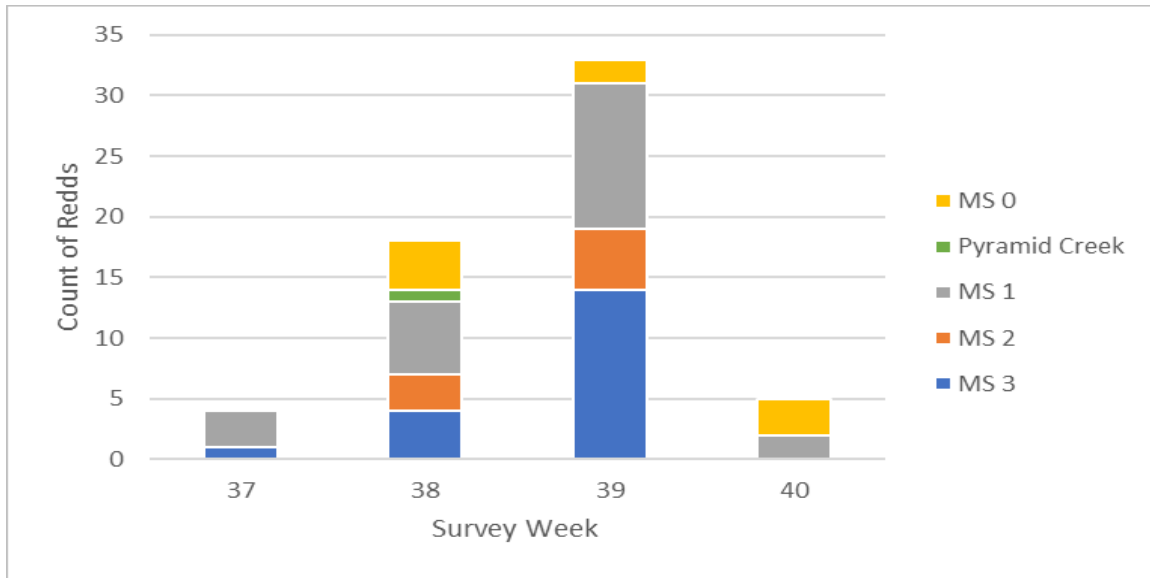


Figure 7 Middle Santiam River Redd Counts per Survey Week

4.0 Quartzville Creek Results

4.1 Adult Observations

All live adult Chinook salmon were observed during week 40 of the 2025 Quartzville Creek surveys. During this period, a total of 32 adults were recorded, with 29 in Quartzville Creek reach (Q) 1 and three in Q 2 (**Table 10**). This represents 16% of the total outplanted fish. Adults were released on September 27, and weekly surveys began five days later on October 1. Most observed adults exhibited guarding and competing behaviors, primarily in Q 1, where the majority of redds were constructed. Only four fish were determined to be migrating: three in Q 2 and one in Q 1. No additional live adults were observed during the remainder of the survey period (**Figure 8**).

Table 10 Quartzville Creek Live Fish Counts per Survey Week, by Reach

Week	Q 1	Canal Creek	Q 2	Q 3	Q 4	Total
35	0	0	0	0	0	0
36	0	0	0	0	0	0
37	0	0	0	0	0	0
38	0	0	0	0	0	0
39	0	0	0	0	0	0
40	29	0	3	0	0	32
41	0	0	0	0	0	0
42	0	0	0	0	0	0
43	0	0	0	0	0	0
44	0	0	0	0	0	0
Totals	29	0	3	0	0	32

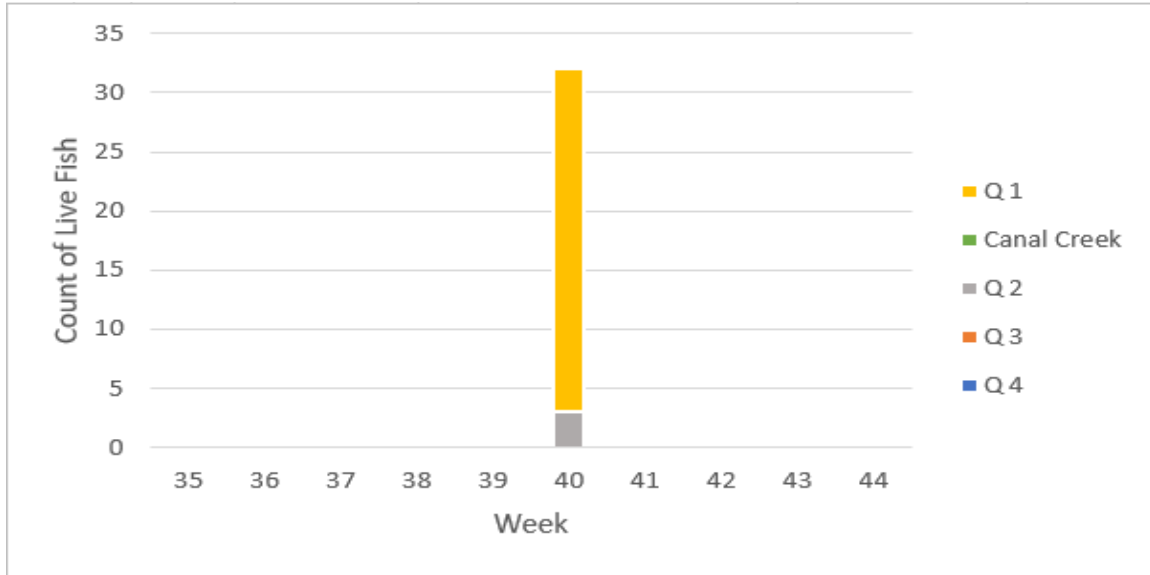


Figure 8 Quartzville Creek Live Fish Counts by Survey Week

4.2 Carcass Recoveries

During the 2025 Quartzville Creek spawning season, carcasses were first observed alongside redds during week 40, immediately following outplanting (**Figure 9**). EAS crews processed 51 carcasses in Q 1 and seven in Q 2, with no carcasses recovered in other reaches. During week 41, an additional 36 carcasses were recovered in Q 1 and three in Q 2 (**Table 11**).

Overall, carcasses recovered by EAS crews represent 49% of the total adults outplanted in 2025. The sex ratio of carcasses in Q 1 was approximately 2:1 female to male (52 females, 26 males), while in Q 2 the ratio was 1:1 (4 females, 4 males).

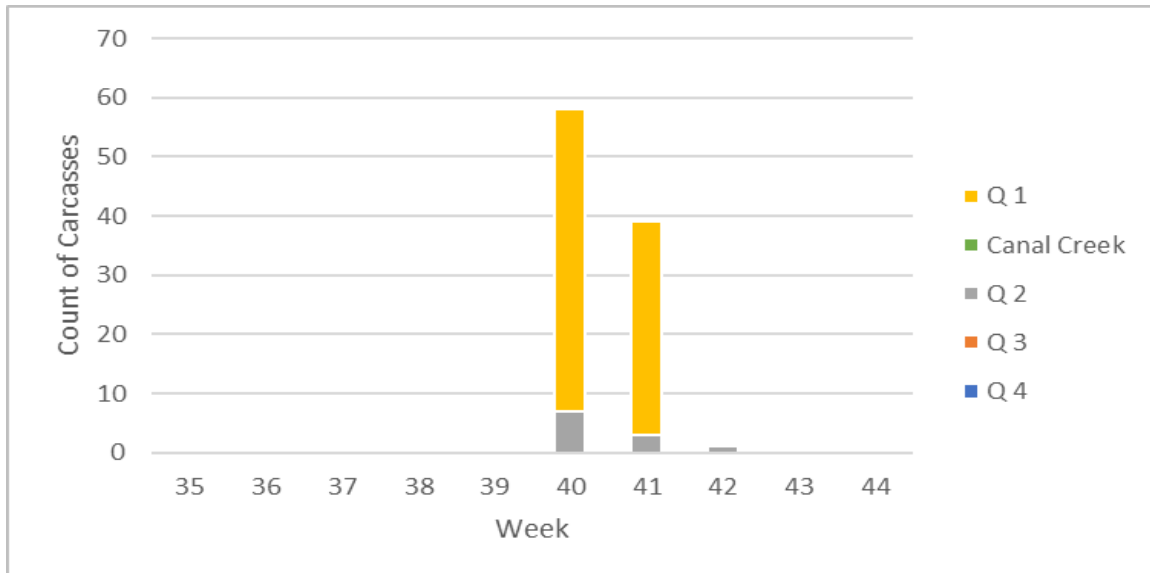


Figure 9 Quartzville Creek Carcass Counts per Survey Week

Table 11 Quartzville Creek Carcass Recovery per Survey Week, by Reach

Week	Q 1	Canal Creek	Q 2	Q 3	Q 4	Total
35	0	0	0	0	0	0
36	0	0	0	0	0	0
37	0	0	0	0	0	0
38	0	0	0	0	0	0
39	0	0	0	0	0	0
40	51	0	7	0	0	58
41	36	0	3	0	0	39
42	0	0	1	0	0	1
43	0	0	0	0	0	0
44	0	0	0	0	0	0
Totals	87	0	11	0	0	98

The average fork length for females in Quartzville Creek was 772 mm (range: 650–890 mm; n=56), while males averaged 750 mm (range: 660–890 mm; n=30) (**Table 12**). Of the carcasses processed, 12 could not be measured or sexed due to their deteriorated condition.

Table 12 Minimum, Mean, and Maximum Carcass Fork length (mm), in Quartzville Creek

Reach	Sex	n =	Carcass Fork Length (mm)		
			Min	Mean	Max
Quartzville 1	F	52	650	771.6	890
	M	26	660	748.3	890
	Unk	9	--	--	--
Canal Creek	F	0	--	--	--
	M	0	--	--	--
	Unk	0	--	--	--
Quartzville 2	F	4	720	804	890
	M	4	720	788	890
	Unk	3	--	--	--
Quartzville 3	F	0	--	--	--
	M	0	--	--	--
	Unk	0	--	--	--
Quartzville 4	F	0	--	--	--
	M	0	--	--	--
	Unk	0	--	--	--

A total of 56 female carcasses were processed during 2025 surveys, though 10 were unable to be assessed for egg retention due to scavenging. Crews found that 35 of the processed females had less than 50% of their eggs remaining, while 11 were estimated to have 50% or more retention, classifying them as PSM. Overall, the estimated PSM rate was 23.9% (**Table 13**).

Table 13 Prespawn Mortality for Female Chinook Carcasses in Quartzville Creek

Egg Retention %	Yes	No	Prespawn Mortality %
>50	11	35	23.9%

No adfluvial Chinook salmon were observed during the 2025 Quartzville Creek survey season. Crews recovered three floy tags without associated carcasses or live fish in the vicinity. Of the 98 carcasses processed, 13 contained CWTs.

4.3 Redd Enumeration

Most redds were constructed within approximately 1.3 km of the outplanting site (**Figure 10**). A total of 40 redds were documented during the 2025 Quartzville Creek survey season, with the majority observed during week 40 (**Figure 11**). Redds were concentrated in Q 1, which accounted for 92.5% of all redds observed, while Q 2 accounted for the remaining 7.5%. In Q 1, 34 completed redds were flagged during week 40, with an additional three documented during week 41 (**Table 14**). Reach Q 2 yielded three complete redds, all of which were flagged during week 40. The average redd longevity was 18 days.

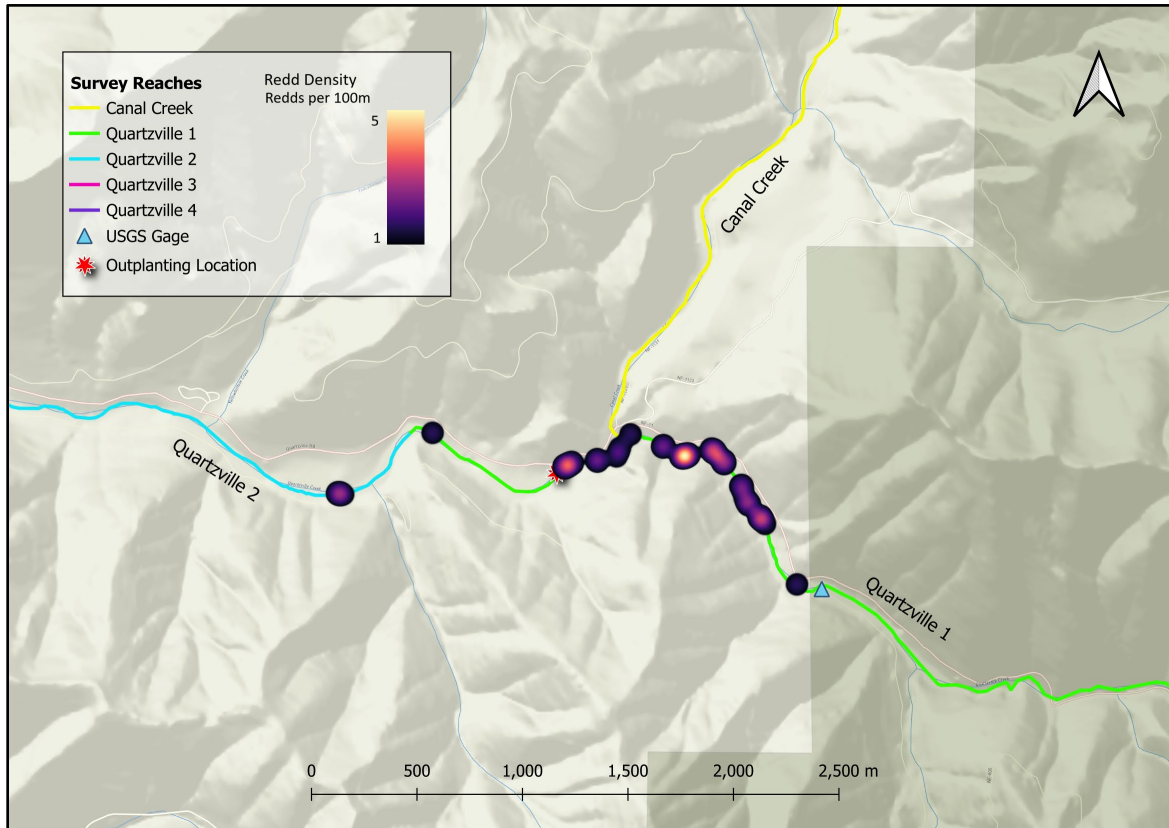


Figure 10 Map of Redds per 100 Meters in Quartzville Creek

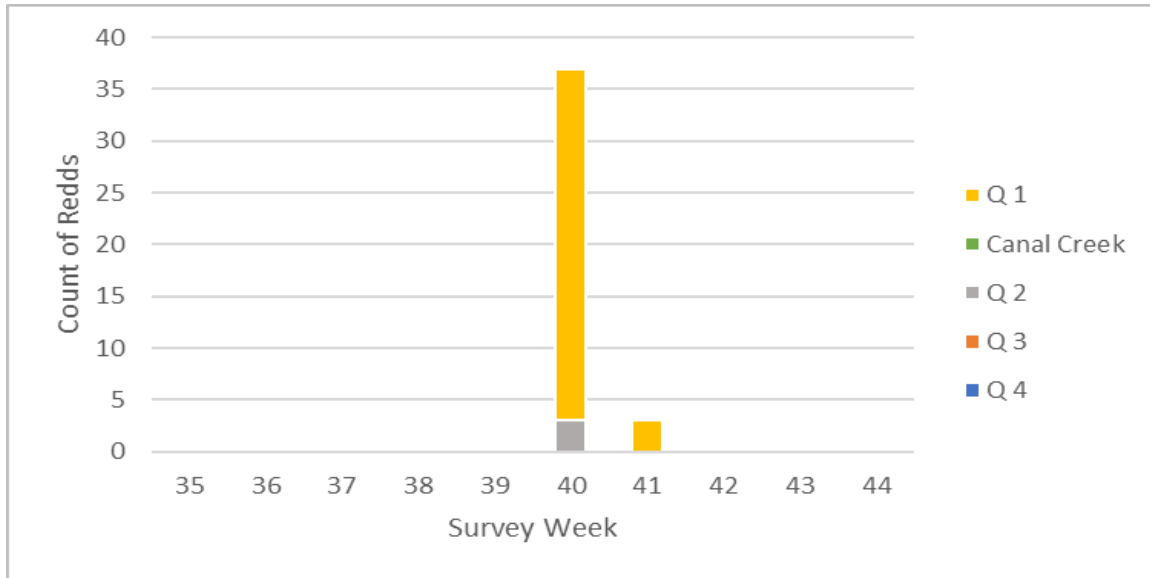


Figure 11 Quartzville Creek Redd counts per Survey Week

Table 14 Quartzville Creek Redd Counts per Reach, by Survey Week

Week	Q 1	Canal Creek	Q 2	Q 3	Q 4	Total Redds
35	0	0	0	0	0	0
36	0	0	0	0	0	0
37	0	0	0	0	0	0
38	0	0	0	0	0	0
39	0	0	0	0	0	0
40	34	0	3	0	0	37
41	3	0	0	0	0	3
42	0	0	0	0	0	0
43	0	0	0	0	0	0
44	0	0	0	0	0	0
Totals	37	0	3	0	0	40

Redds were not observed in Canal Creek during the 2025 survey season. Furthermore, redds were not documented in reaches Q 3 or Q 4, consistent with observations from 2023 and 2024 projects (EAS, 2024; CFS, 2025). During 2022 surveys, only one individual redd was encountered in both Q 3 and Q 4 (**Table A-1**). Surveys concluded during statistical week 44. Reaches Q 1 and Q 2 were surveyed on October 29; however, elevated flow, reduced water clarity, and the absence of discernible redd structures indicated that previously observed redds were no longer visible (**Figure 12**). Using the PSM of 23.9% in combination with the recovery of 98 carcasses and observation of 40 redds, it was estimated that the spawning success rate in Quartzville Creek was 52.6%.

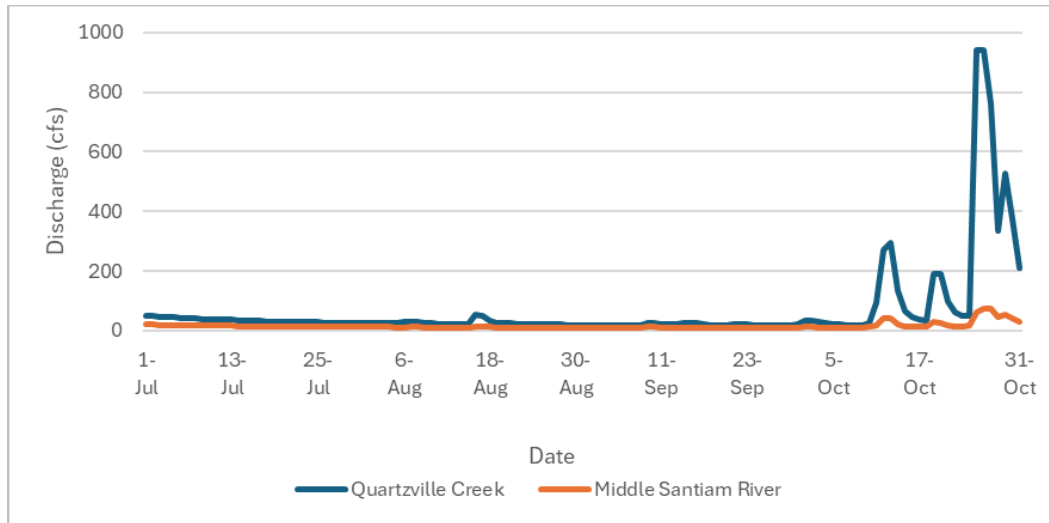


Figure 12 Maximum Daily Discharge (cfs) in 2025 for Quartzville Creek (blue) and Middle Santiam River (orange), Data Recorded by USGS Gages 14185900 and 14185600

5.0 Discussion

5.1 Survey Effort

Survey efforts in the Middle Santiam and Quartzville Creek study areas took place upstream of Green Peter Dam in the Willamette River Basin (**Figure 13**). The 2025 spawning season was not affected by weather, elevated streamflow, or wildfire, as compared to previous years. EAS crews maintained full access to the Middle Santiam study area from July through October. Due to the required survey mileage and the remote nature of the Middle Santiam River, overnight crews were utilized to improve logistical efficiency. This approach increased carcass recovery and redd detection in reaches MS 1 through MS 3, as crews were able to complete surveys and continue recovery efforts while hiking out the following day.

Two surveys were conducted upstream of Shedd Camp Falls at the beginning of reach MS 0 to verify the effectiveness of the assumed fish barrier. No spawning activity was documented; however, crews located a single Chinook salmon jaw and skin approximately 1.0 km upstream of the start of MS 0. Although no redds or live fish were observed, these findings indicate the potential for fish presence above Shedd Camp Falls. Future surveys should include this reach during peak spawning to confirm whether spawning activity occurs upstream of the falls. Tributaries, including Jude Creek and Donaca Creek, were evaluated throughout the survey period and were determined to have insufficient streamflow to allow Chinook passage. During weeks 29, 30, 37, 38, and 42, additional surveys were conducted to recover carcasses prior to scavenging and to verify suspected test redds identified during earlier surveys (**Table 1**). During week 44, approximately five weeks after peak spawning, surveys in Pyramid Creek were suspended due to the absence of live fish and negligible streamflow.

Survey conditions in the Middle Santiam River in 2025 contrasted with those in 2024. The Pyramid Fire in 2024 prevented access to reach MS 0 and Pyramid Creek, and survey initiation was delayed until after the majority of spawning had occurred. Crews were able to survey the Middle Santiam study area only three times in 2024 and did not observe any live adult Chinook salmon. A total of 36 carcasses were collected and 17 redds were documented in the Middle Santiam River during the 2024 season (Cramer Fish Sciences [CFS], 2025).

In Quartzville Creek, low streamflow in 2025 allowed uninterrupted survey coverage throughout the spawning season. A zero-redd survey was conducted during week 35; however, Quartzville Creek was not surveyed again until the week of October 1, when 200 adult Chinook salmon were outplanted. Outplanting was delayed due to low female returns to the ODFW Foster Fish Facility. Spawning commenced immediately following release and concluded three weeks later, during week 42. Surveys in Canal Creek were subsequently suspended due to the absence of live fish and spawning activity. During week 43, surveys in reaches Q 3 and Q 4 were also suspended after no live fish, carcasses, or redds were observed.

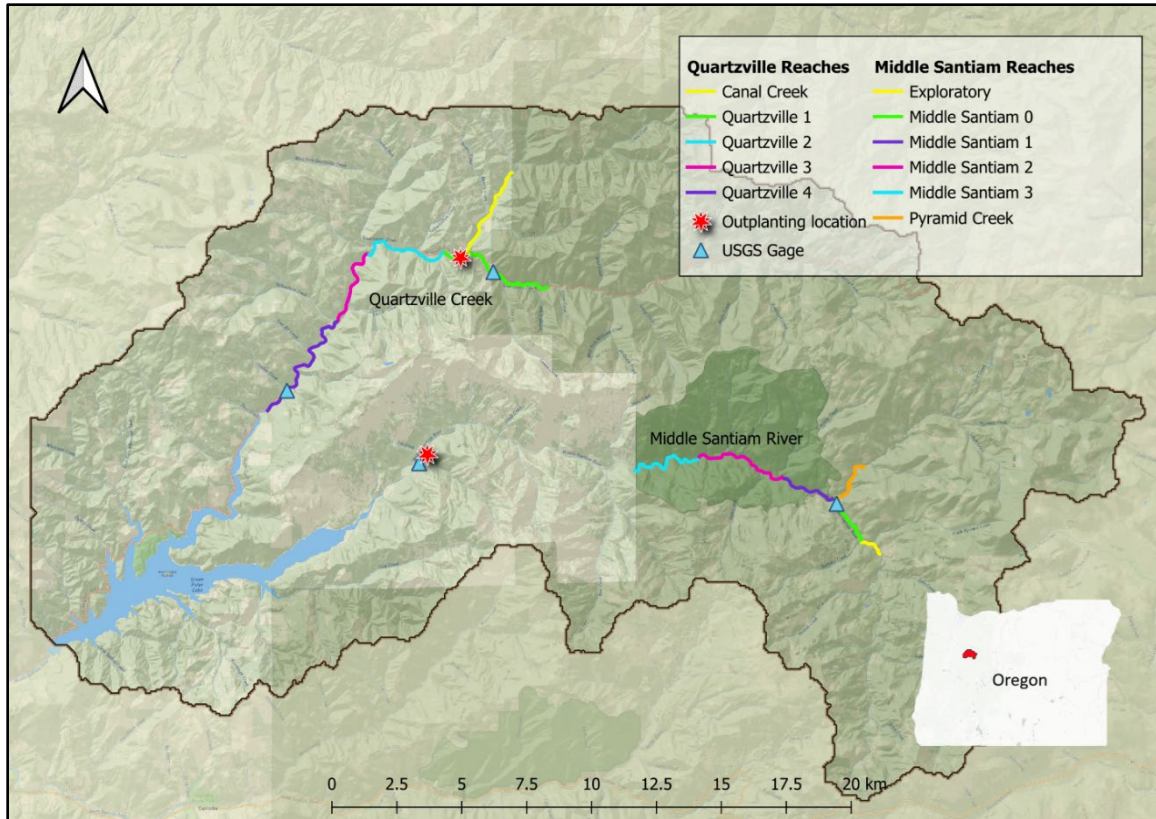


Figure 13 Map of the Study Areas for Quartzville Creek and the Middle Santiam River During the 2025 Spawning Season

5.2 Carcass Recovery and Prespawn Mortality

Carcass recovery in the Middle Santiam River during 2025 was influenced by low streamflow, thermal conditions, survey design, and depredation. Reduced streamflow (**Figure 12**) likely enhanced carcass detection and recovery within survey reaches by limiting downstream movement of Chinook salmon. However, significant depredation and scavenging also influenced carcass recovery findings, as multiple carcasses exhibited evidence of predation and several were reduced to skeletal remains. Partial remains complicated interpretation of PSM estimates where poor condition impacted the EAS crew's ability to determine sex and spawning status. It is important to note that the PSM estimate in the Middle Santiam system was affected by many variables; 54 carcasses were determined to have an unknown sex, 18 females were determined to have unknown egg retention, and 10.7 km of river were unable to be surveyed due to land access restraints. Additionally, EAS was contracted through another project to perform snorkel surveys in the lower reaches of the Middle Santiam River. As part of that work, another five carcasses and one floy tag were recovered near the rotary screw trap site at the head of the reservoir (CFS, 2026; **Figure A-1**). Of these five carcasses, three were determined to be PSM females. These findings were outside of the contracted study area and are not included in the PSM estimates for this report. Observations of Chinook excavating redds and competing just below the Middle Santiam River study boundary provide further examples of spawning activity outside the contracted survey area (**Figure 13**).

PSM in 2025 was likely influenced by both thermal and hydrologic stressors within both systems (**Figures 14 and 15**). The Pyramid Fire halted 2024 surveys, preventing annual comparisons. Elevated water temperatures are strongly linked to increased PSM in Chinook salmon, especially with prolonged exposure at these temperatures (Crozier et al., 2021; Bowerman et al., 2018). While upstream USGS gage data suggest moderate conditions, shallow, sun-exposed reaches were likely warmer and more variable. Downstream temperatures exceeding 20.0 °C (**Figure A-2**) approached sublethal thresholds, increasing stress, delaying movement, prolonging holding, and elevating overall mortality risk (Keefer and Caudill, 2026). Low streamflow in the Middle Santiam River likely limited access to cooler habitats (**Figure A-3**),

increasing cumulative thermal exposure and contributing to higher PSM. Reduced flows may have also decreased thermal buffering, limited habitat diversity, and concentrated fish in suboptimal areas. Observed fish and amphibian mortalities with fungal growth in the system further indicate widespread physiological stress.

Patterns of carcass distribution indicate that fish holding behavior and habitat characteristics played a key role in their recovery. Adults were frequently observed concentrated in deeper pools and large aggregations, likely responding to elevated water temperatures and limited streamflow (**Figure 14**), consistent with observations where prespawn adults exhibited prolonged holding and limited movement under thermally stressful conditions (Naylor et al., 2025). These aggregations may increase individual stress through overcrowding, elevate disease transmission risk, and intensify exposure to localized temperature extremes. Tributary habitats provided limited spawning opportunity during the 2025 surveys, as continuous low flow restricted access and reduced overall spawning distribution. Minimal evidence of fish use in Pyramid Creek and no evidence of use in Jude Creek or Donaca Creek indicates that spawning activity was largely confined to mainstem habitats under these observed flow conditions. One scavenged partial carcass was discovered on an exploratory survey above Shedd Camp Falls. There were no other indicators of spawning activity above MS 0.

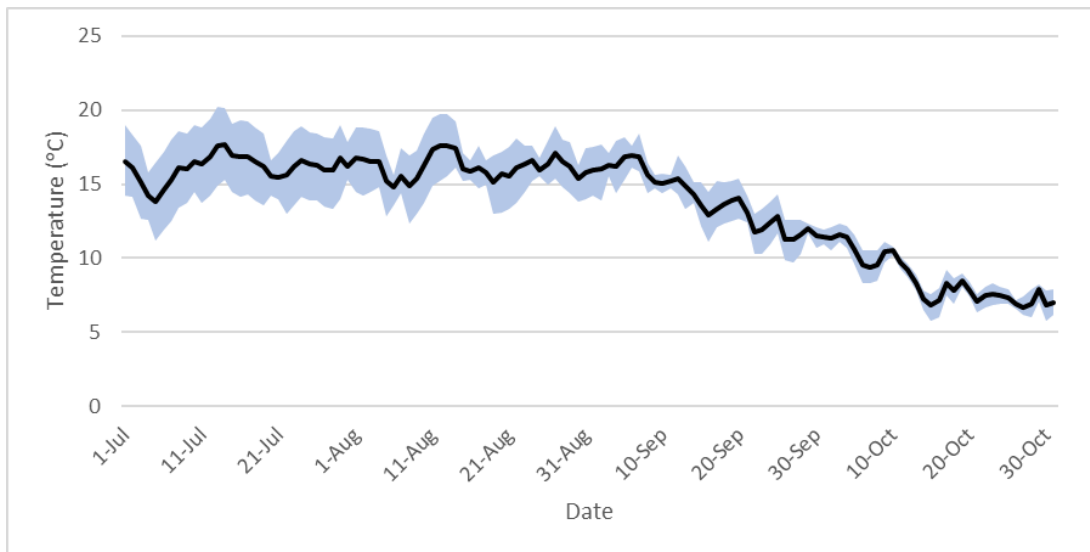


Figure 14 Middle Santiam River Daily Temperature Range (blue ribbon) and Daily Mean Temperatures (black line), Data Recorded by USGS Gage 14185600

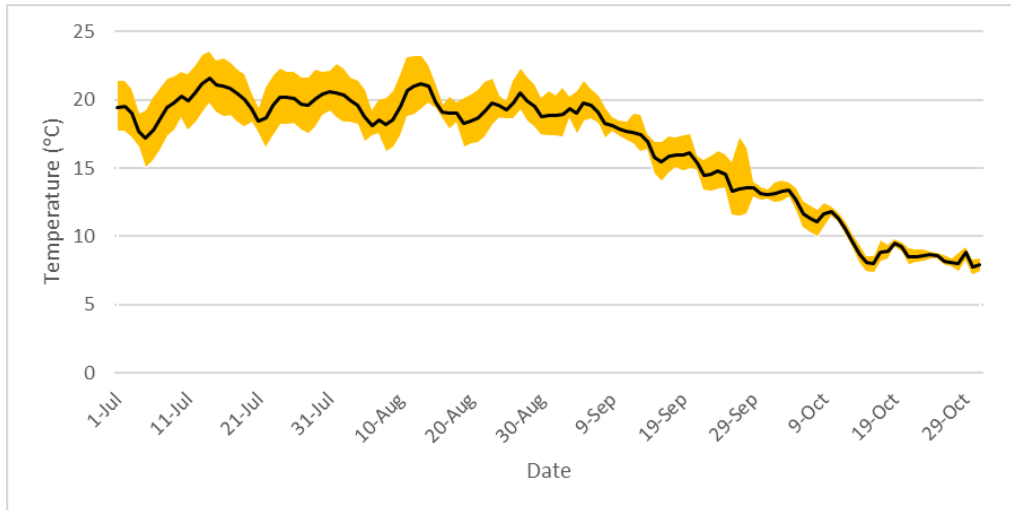


Figure 15 Quartzville Creek Daily Temperature Range (yellow ribbon) and Daily Mean Temperatures (black line), Data Recorded by USGS Gage 14185900

In contrast, carcass distribution in Quartzville Creek indicates that adults largely remained near original outplanting locations, with most recovered in upper reaches (e.g., Q 1 and Q 2), likely influenced by outplant timing and stream conditions. In 2025, minimal adult returns delayed release, and females were gravid and ready to spawn at their outplanting, resulting in spawning near release sites, similar to patterns observed in 2023 and 2024 (EAS, 2024; CFS, 2025). PSM within Quartzville Creek was comparable between 2024 and 2025 (21.7% vs. 23.9%). Environmental conditions, particularly low streamflow (**Figure A-4**), likely further constrained distribution as shallow bedrock sections with low water levels may have created stressful passage conditions and limited access to suitable spawning gravel. Additionally, it is worth noting that walking surveys limit the ability to see into the deep pools in the slot canyons in Q 3 and Q 4. CFS snorkel crews reported seeing eight live fish and three carcasses in the lower Q 4 section and below the contracted study area (CFS, 2026).

Within both systems, hydrologic constraints and thermal exposure influenced carcass recovery patterns and elevated PSM rates during the 2025 study. This underscores the value of continued monitoring of spatial temperature variability, flow fluctuations, and fish distribution, particularly during prespawn holding, to better understand drivers of PSM and inform adaptive management under increasingly variable late summer and fall flows.

5.3 Redd Distribution and Abundance

In 2024, surveys in the Middle Santiam River were largely not viable due to the Pyramid Fire. Despite the fire, environmental conditions during the 2024 and 2025 spawning seasons were broadly comparable in terms of discharge and daily mean water temperature (**Figures A-3** and **A-5**). Both years exhibited prolonged periods of low-flow, warm-water conditions, which have been known to influence adult salmon behavior and increase physiological stress (Bowerman et al., 2018).

The physical structure of the Middle Santiam River appears to impact the availability and distribution of suitable spawning habitat, particularly during low-flow years, reflecting broader historical changes in the Willamette Valley where river channels, floodplains, wetlands, and riparian habitats have been significantly altered and reduced from their natural conditions (Allen et al., 1999). Wide valleys, shallow runs and riffles interspersed with only a few deep pools, and gorge sections with large boulders potentially inhibit preferred habitat. Shallow, riffle-dominated reaches, including MS 1, the upper portions of MS 2, and sections of MS 3, experience reduced water depth during low-flow years. This limits access to gravel and potentially restricts adult movement between pools and other spawning sites. Within MS 2, broad, shallow, cobble flats transition into steep, boulder-dominant sections, creating long stretches with limited spawning opportunity when combined with low streamflow. Observed redd superimposition in MS 1 and MS 3 suggest adults were concentrated in the relatively few suitable habitat pockets, resulting in spatial limitations and potentially increased competitive interactions (**Figure 6**).

Within the Quartzville Creek study area, Flow conditions during the 2025 spawning season were generally lower than those observed in 2022 and 2023 (**Figure A-4**). Average discharge at peak spawning was approximately 19 cubic feet per second (cfs), compared with 30 cfs in previous years, and precipitation-driven flow increases occurred only after the majority of spawning had concluded. Lower flows, combined with warm-water conditions (**Figures A-6 and 15**), likely influenced spawning site selection and holding behavior. These hydrologic and thermal constraints are consistent with patterns observed for PSM and carcass recovery, where limited connectivity and habitat availability can concentrate adults and increase stress.

Spawning activity was largely confined to Q 1 and Q 2, with the highest concentration of redds in the lower extent of Q 1 (**Figure 10 and Table 14**). Historical survey observations indicate that previous years exhibited more dispersed spawning, including the use of Q 4 and Canal Creek (CFS, 2023, 2025; EAS, 2024). In 2025, redd distribution was not observed more than 1.7 km away from the outplanting site, similar to findings from CFS in 2024 (**Figure A-7**), illustrating limited habitat usage within the system. Superimposition of redds and increased competition sightings in Q 1 suggest that lower streamflow and delayed outplanting may have further restricted adult dispersal and intensified competition among spawning fish.

Immediate spawning in Quartzville Creek was observed following adult releases in 2023, 2024, and 2025 (**Figure A-7**), which indicate that fish were mature at the time of their outplanting. In contrast, earlier releases in 2022 allowed more time for downstream dispersal from the outplanting location prior to peak spawning (CFS, 2023). The concentration of redds in 2025 likely reflects both the timing of adult releases and restricted habitat availability under low-flow conditions. Future monitoring would benefit from integrated habitat assessments in both the Middle Santiam River and Quartzville Creek to better evaluate spawning habitat limitations under variable environmental conditions. Expanding spatial coverage, including the 10.7 km downstream of MS 3, and increasing effort during peak spawning and carcass recovery periods could improve data coverage. Enhanced coordination among survey crews, ODFW, and USACE during outplanting events, including field presence during releases and the first week post-outplanting, would further improve understanding early fish distribution, holding behavior, and immediate spawning response.

In 2025, outplanted spring Chinook salmon successfully spawned in both systems; however, spawning distribution was spatially restricted, with redds highly concentrated near the release location in Quartzville Creek. Alongside increased PSM, these patterns coincided with low-flow, warm-water conditions, and delayed outplanting, indicating that hydrologic and thermal factors influenced Chinook spawning timing, distribution, and habitat use. Although escapement targets were achieved through outplanting efforts, limited dispersal and highly concentrated redd construction highlight the sensitivity of these systems to interannual variation in water flow and temperature. Consistent survey methodologies provide valuable interannual comparison and contribute to understanding responses under variable environmental conditions. Continued implementation of standardized spawning surveys across the Willamette Basin remains essential for evaluating population status, spatial distribution, PSM, and long-term escapement trends. Sustained monitoring, coupled with integration of spawning, habitat, flow, and temperature, will strengthen analyses and support adaptive management, justify restoration priorities, and assist in recovery planning for Upper Willamette River spring Chinook salmon.

6.0 Acknowledgements

EAS would like to thank the USACE for the funding and coordination that went into the successful completion of spawning ground surveys above Green Peter Dam in 2025. We would also like to thank the ODFW South Santiam Hatchery staff for their efforts with adult outplants in the Middle Santiam River and Quartzville Creek. Furthermore, the USFS Sweet Home Ranger District provided emergency access routes and communication strategies for our crew working in the Pyramid Fire burn scar. We would like to thank them for their support throughout the 2025 survey season.

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**Appendix A. Supplemental Redd, Carcass, Temperature,
and Discharge Data from Quartzville Creek and the Middle
Santiam**

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Table A-1 2022 Redd Data in Quartzville Creek (CFS, 2022)

Reach	Week						Total
	36	37	38	39	40	41	
Quartzville 1	0	0	26	12	10	0	48
Canal Creek	--	0	1	9	4	0	14
Quartzville 2	--	0	4	3	1	2	10
Quartzville 3	--	1	0	0	0	0	1
Quartzville 4	--	0	0	1	0	0	1

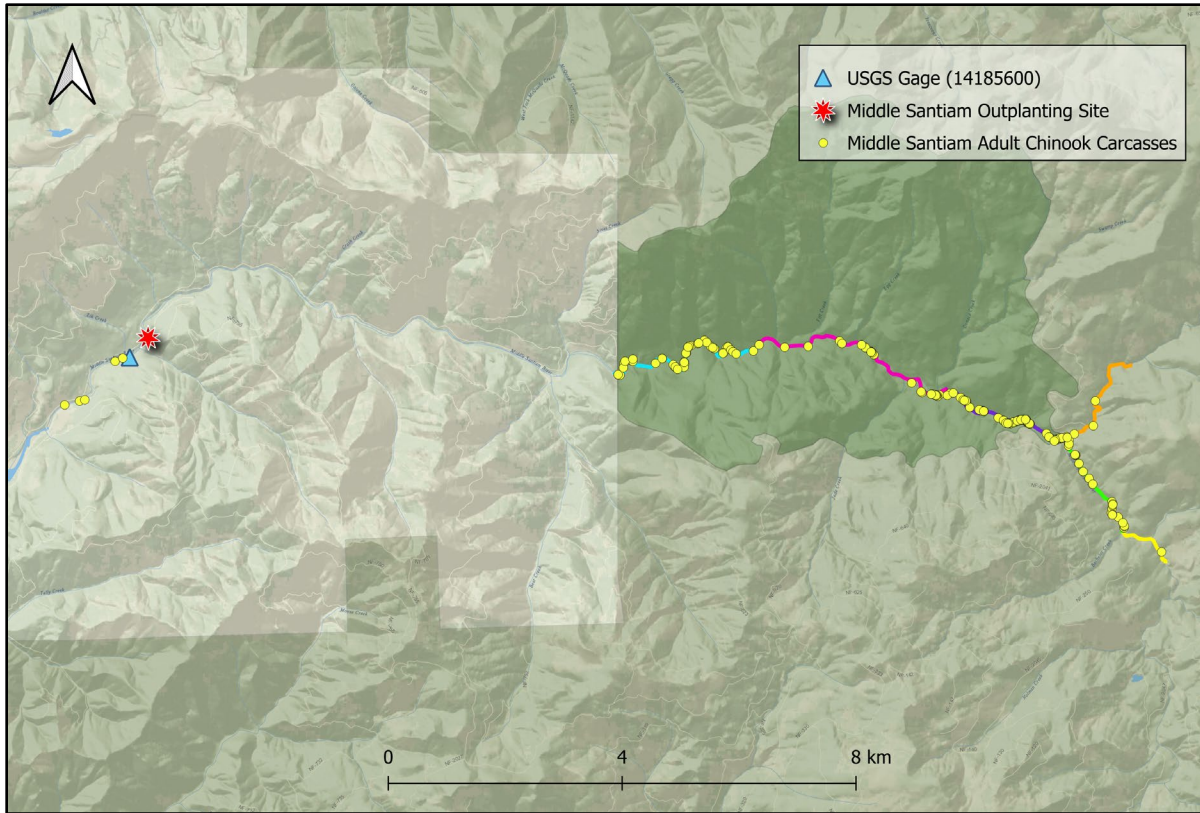


Figure A-1 Distribution of Adult Chinook Carcasses Recovered by EAS Personnel on the Middle Santiam River in 2025

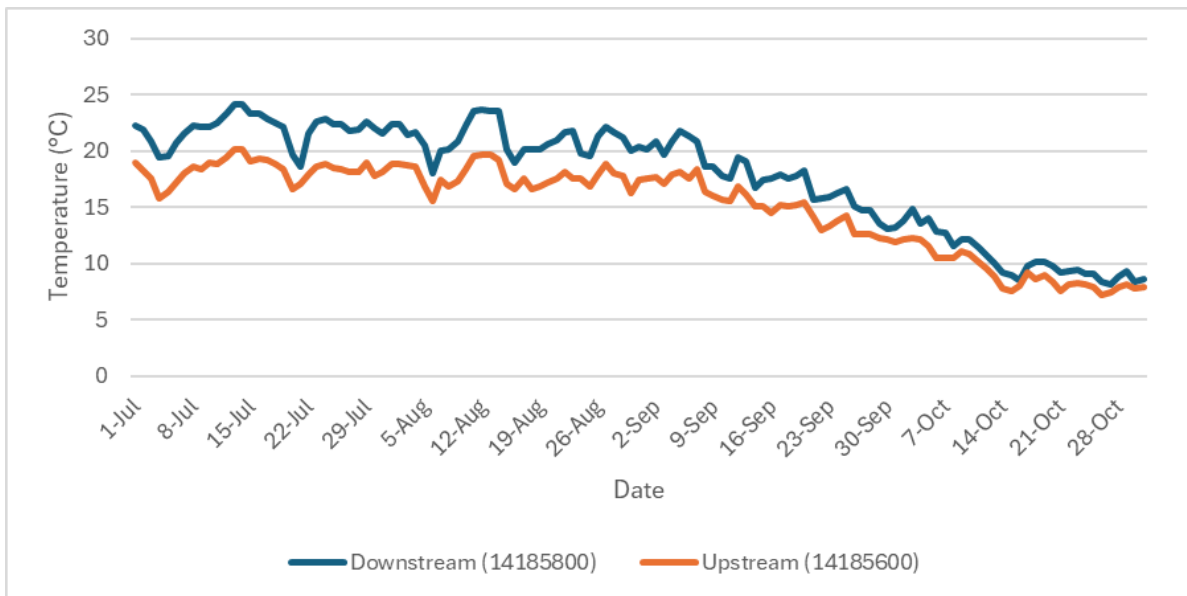


Figure A-2 Temperature Differentiation Between the Upstream and Downstream Gages in the Middle Santiam River

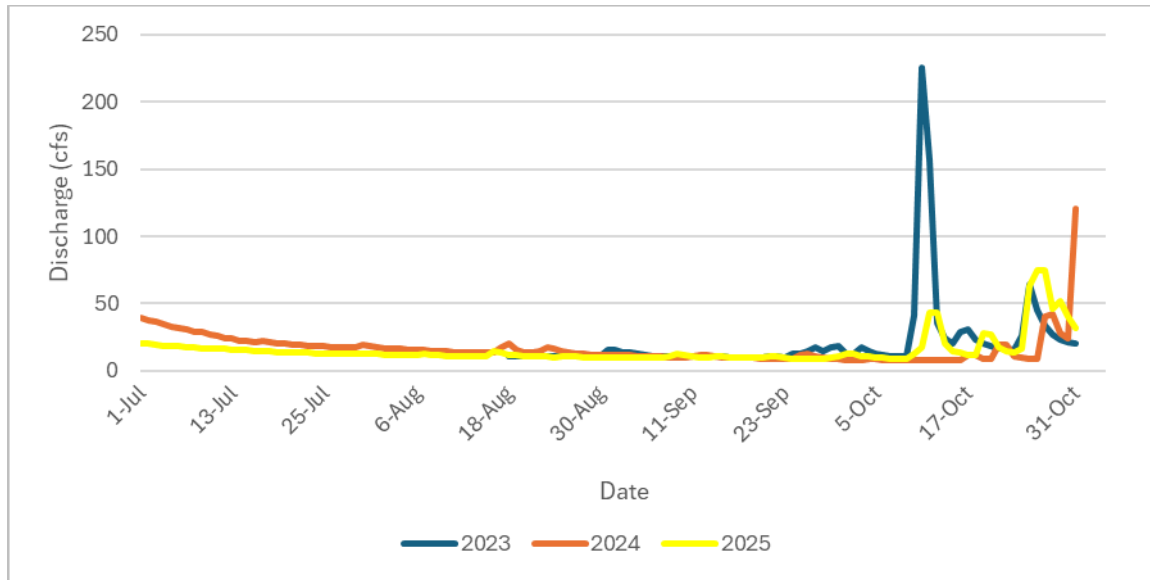


Figure A-3 Middle Santiam River USGS Gage 14185600 Max Discharge (cfs) by Day Displayed for 2023–2025 (Some Gage Data Unavailable)

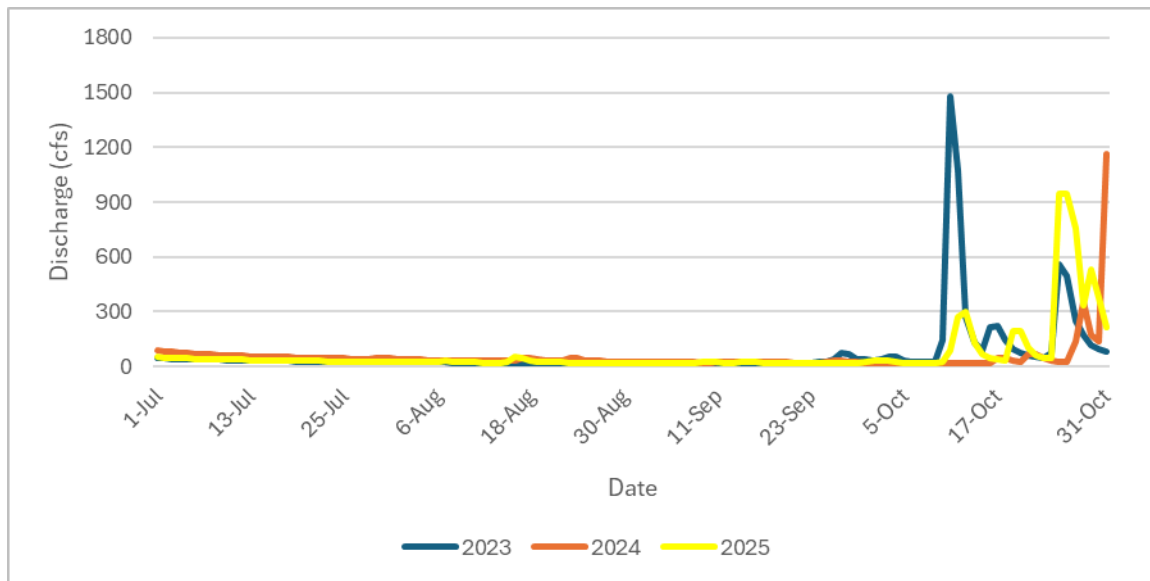


Figure A-4 Quartzville Creek USGS Gage 14185900 Max Discharge (cfs) by Day Displayed for 2023–2025

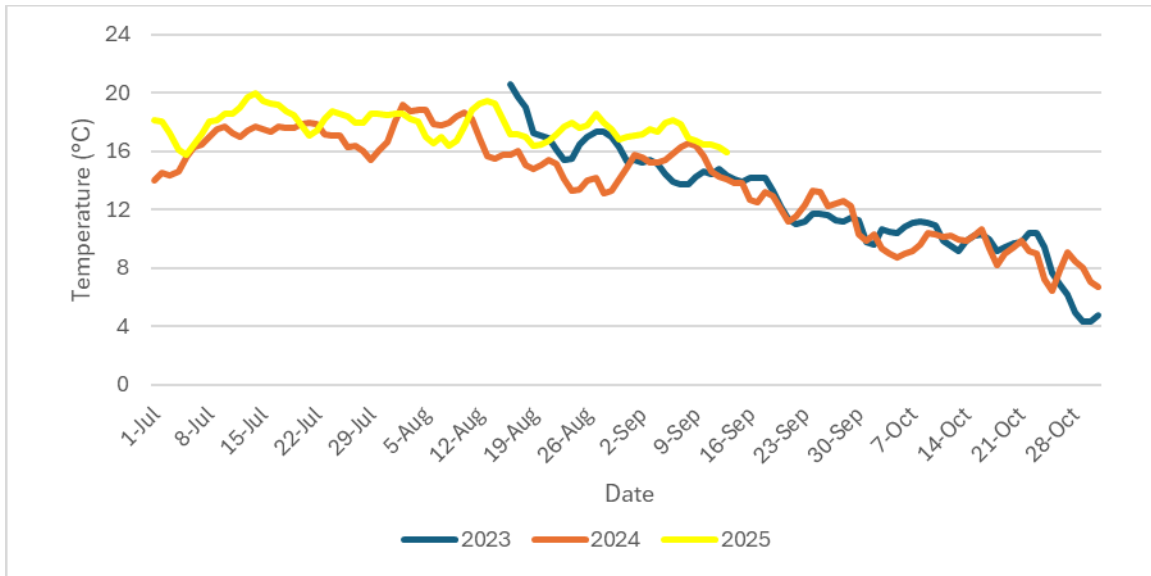


Figure A-5 Middle Santiam River USGS Gage 14185600 Average Water Temperature (°C) Displayed for 2023–2025 (Some Gage Data Unavailable)

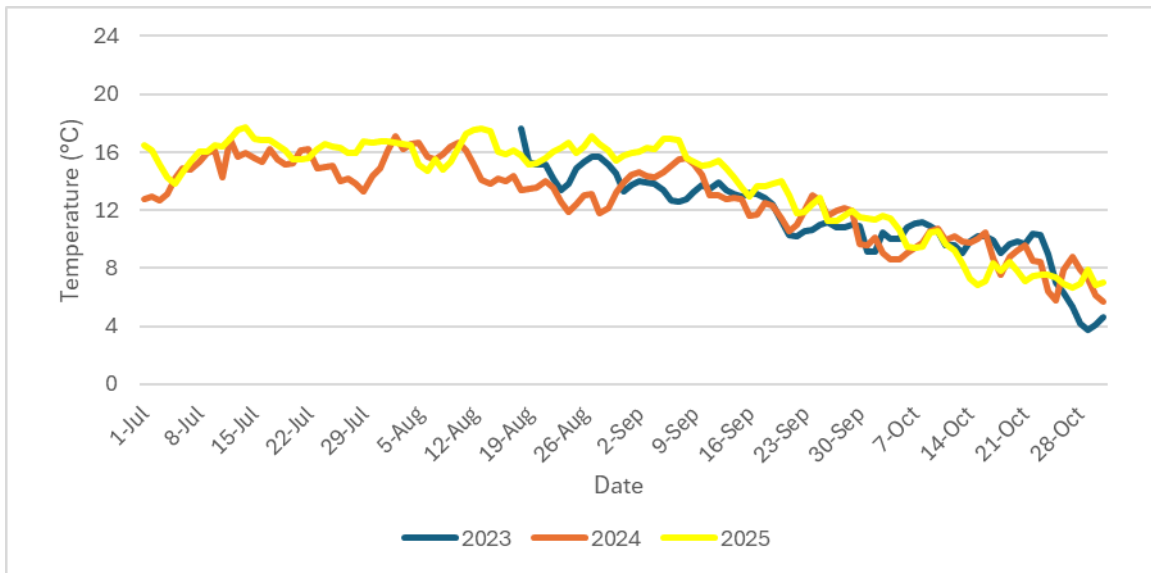


Figure A-6 Quartzville Creek USGS Gage 14185900 Average Water Temperature (°C) Displayed for 2023–2025 (Some Gage Data Unavailable)

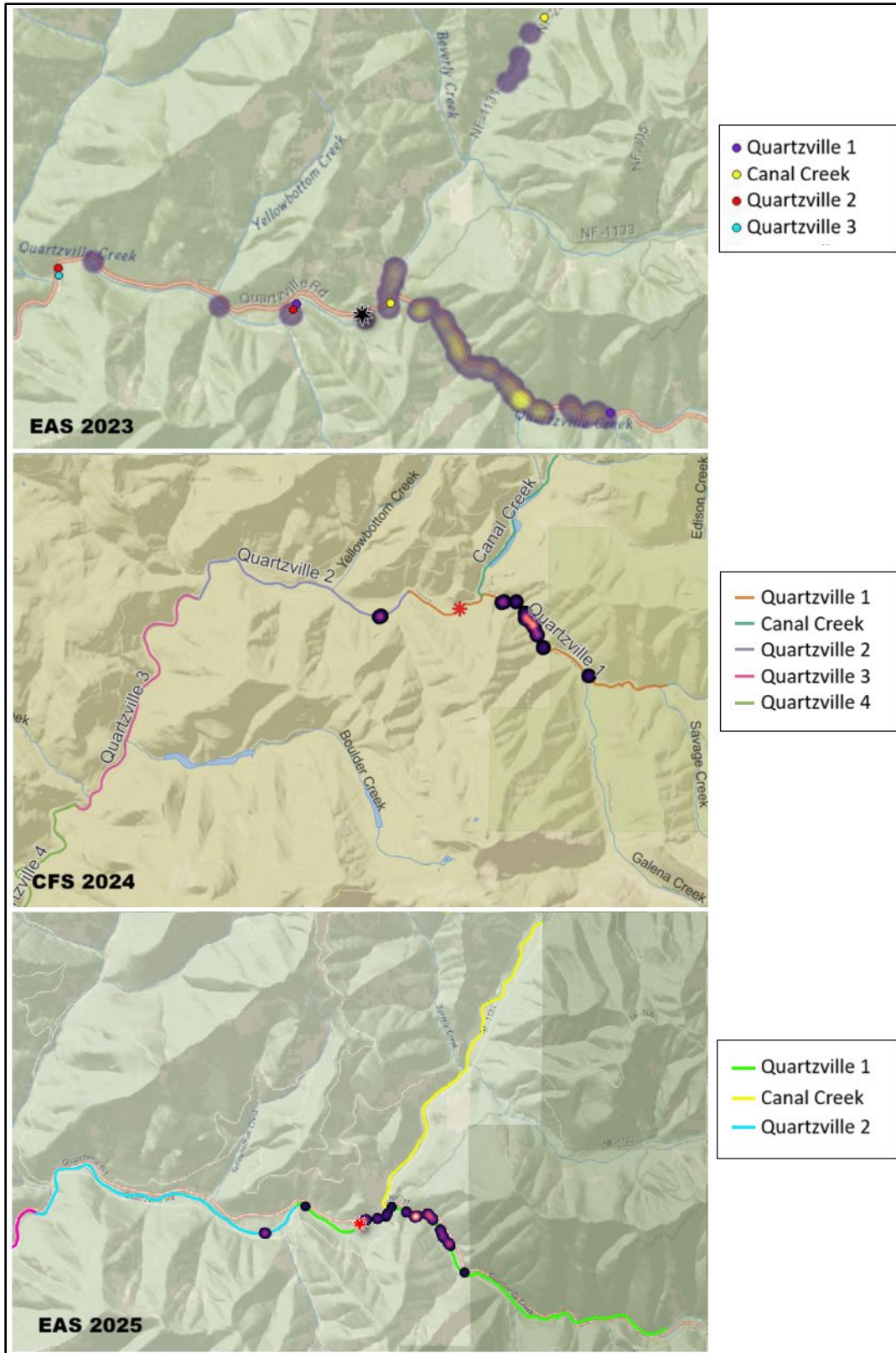


Figure A-7 Redd Distribution from 2023, 2024, and 2025 Quartzville Creek Surveys Conducted by EAS and CFS