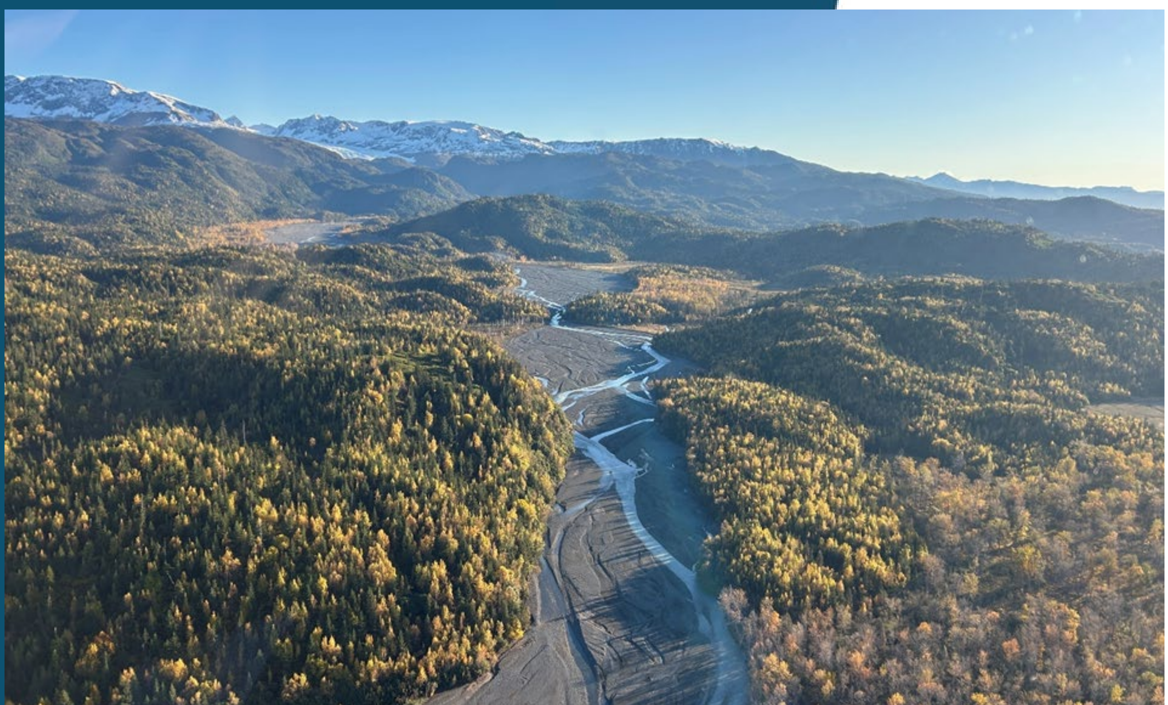
2025 Martin River Aquatic Studies Report

Bradley Lake Hydroelectric Project
Bradley Lake Expansion

FERC No. 8221



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ACRONYMS AND ABBREVIATIONS

°C	degrees Celsius
A	
AEA	Alaska Energy Authority
ADEC	Alaska Department of Environmental Conservation
ADF&G	Alaska Department of Fish and Game
ATU	accumulated thermal unit
AVCT	autonomous video counting tower
B	
BLVD	Bradley Lake Vertical Datum
Bradley Lake Project	Bradley Lake Hydroelectric Project (FERC No. 8221)
C	
cfs	cubic feet per second
D	
DO	dissolved oxygen
DSP	Draft Study Plan
E	
EFMR	East Fork Martin River
El.	Elevation
F	
FERC	Federal Energy Regulatory Commission
fps	feet per second
G	
GPS	Global Positioning System

I

ICD	Initial Consultation Document

J

JUV	juvenile

M

m	meter
mg/L	milligrams per liter

N

NA	not available
NTU	nephelometric turbidity unit

O

OCH	off-channel habitat

P

pH	potential of hydrogen
PRM	Project River Mile
Project	Bradley Lake Expansion Project
PVC	polyvinyl chloride

Q

QA/QC	quality assurance/quality control

U

USDA	United States Department of Agriculture
USFS	United States Forest Service
USGS	United States Geological Survey

W

WFMR	West Fork Martin River

Y

YOY	young-of-year

1.0 INTRODUCTION

1.1 Background

The Alaska Energy Authority (AEA), licensee and owner of the 120-megawatt Bradley Lake Hydroelectric Project (Bradley Lake Project; Federal Energy Regulatory Commission [FERC] No. 8221), is pursuing a FERC license amendment. The purpose of the proposed amendment is to gain authorization to divert seasonal meltwater coming from Dixon Glacier, located at the headwaters of the Martin River, to Bradley Lake and to raise the normal maximum pool elevation at Bradley Lake to increase storage capacity and power production, identified herein as the Bradley Lake Expansion Project (Project).

AEA filed an Initial Consultation Document (ICD) (AEA 2022a) with FERC on April 27, 2022. The ICD describes existing facilities and current Bradley Lake Project operations; characterizes the affected environment; and describes two proposed alternatives for producing energy from Dixon Glacier meltwater. Following the ICD filing, AEA hosted Joint Agency and Public Meetings in Homer, Alaska, on June 14, 2022, to discuss the ICD and receive stakeholder input. In November 2022, AEA filed a Draft Study Plan (DSP) (AEA 2022b) with FERC, which outlined 10 studies based on the two alternatives including the Water Quality Monitoring, Martin River Fish Use, and Aquatic Habitat Characterization studies. Stakeholders filed comments on the DSP in December 2022. Alaska Department of Fish and Game (ADF&G), U.S. Fish and Wildlife Service, and Water Policy Consulting, LLC provided comments to the Martin River aquatic resource studies.

AEA briefly paused the FERC amendment process while it conducted additional feasibility studies and narrowed down the proposed Project alternatives. Based on further investigations, AEA decided to move forward with the Bradley Lake Expansion Project. The proposed Project would include construction of a diversion dam near the toe of the Dixon Glacier; an approximately 4.6-mile-long diversion tunnel bored through the mountain extending from Dixon Glacier to Bradley Lake; diverting water from the Martin River basin to Bradley Lake; approximately 1 mile of new, 16-foot-wide, gravel-surfaced access road from the existing Upper Battle Creek diversion access road to the outlet of the proposed diversion tunnel; and modification of the existing Bradley Lake Dam to raise the normal maximum pool elevation currently at Elevation (El.) 1,180 feet Bradley Lake Vertical Datum (BLVD) by 16 feet (to El. 1,196 feet BLVD). The entire proposed Project is located on state-owned land.

AEA re-initiated the amendment process in 2024 by hosting public meetings in March and April 2024 to review the selected Project alternative, stakeholder comments on the DSP, and AEA's proposed modifications to the DSP.

To develop a baseline understanding of the existing conditions within the Martin River related to water quality, fish habitat, and fish use of available habitat, AEA implemented three studies to be completed during the proposed operations timeframe of May to November, as flows allow after meeting the minimum instream flow requirements, in 2024 and 2025. AEA provided the 2024 annual reports to the agencies and hosted a public meeting on February 12, 2025, to discuss the results. AEA received comments on the 2024 study reports and held meetings on March 28 and April 7 to discuss the comments and several proposed DSP modifications to be implemented in 2025.

This report summarizes the objectives and methodologies detailed in the study plans, reports on the results of the 2025 field efforts, and provides a discussion of baseline Martin River conditions relative to priority fish species for the following 2025 field efforts:

- Water Quality and Habitat Connectivity Monitoring
- Martin River Fish Use

1.2 Modifications to the DSP Implemented in 2025

Based on results of the 2024 studies and consultation with the agencies, the 2025 effort was modified as follows:

- added temperature and flow monitoring to the Water Quality and Habitat Connectivity Monitoring Study at select sites (Swan Lake Outlet, MR1.070, and OCH2.8R) to support an analysis of potential effects of the proposed diversion on Martin River mainstem temperatures;
- added off-channel/tributary discharge and water depth measurements at select off-channel habitats based on the 2024 Aquatic Habitat observations of intermittent surface connections or water depths too shallow to support adult fish passage at some sites;
- added a summer sampling period to the Martin River Fish Use Study per request from ADF&G to coincide with Pink Salmon (*Oncorhynchus gorbuscha*) and Chum Salmon (*O. keta*) adult run timing;
- employed targeted fish sampling to address a comment from ADF&G to document presence and age classes of juvenile Sockeye Salmon (*O. nerka*) in Red Lake, OCH2.8R, and elsewhere;

- supplemented 2024 minnow trapping efforts to include sampling of the Martin River mainstem and associated glacially influenced sites and ensure all targeted areas were trapped for a 24-hour period; and
- employed targeted fish sampling to document potential change in habitat suitability for and presence of Eulachon (*Thaleichthys pacificus*) in the newly formed Martin River channel downstream of the mitigation ponds;

1.3 Site Visit Schedule

On-site monitoring efforts in 2025 took place over three 6- to 8-day trips spaced temporally to cover a range of flow conditions and run timings for adult anadromous salmonids. This included trips in spring (May 21–27), summer (July 29 – August 3), and fall (September 29 – October 6). Goals and methods for the Water Quality and Connectivity Monitoring study were consistent across trips, while those for the Martin River Fish Use Study were specific to species and life stages potentially present during the timeframes sampled and were guided by flow conditions.

2.0 WATER QUALITY AND HABITAT CONNECTIVITY MONITORING

2.1 Background

The proposed Project would divert water from the Dixon Glacier outflow from May to November as flows allow after meeting the minimum instream flow requirements, potentially impacting water quality parameters including water temperature, dissolved oxygen (DO) concentration, turbidity, and potential of hydrogen (pH) in the Martin River. The proposed Project would also alter the system's current flow regime, which may affect connectivity between the Martin River main channel and its collection of tributaries and off-channel habitat (OCH). This study provided baseline data to support the evaluation of the potential effects of the Project on habitat connectivity and water quality with respect to state standards (Table 2.1-1). AEA began implementing the water quality monitoring study in 2023 as described in the DSP (AEA 2022b).

Table 2.1-1 Water quality standards for Alaska freshwater uses.

Pollutant	Criteria*
Dissolved Gas	DO must be greater than 7 milligrams per liter (mg/L) in waters used by anadromous or resident fish. In no case may DO be less than 5 mg/L to a depth of 20 centimeters in the interstitial waters of gravel used by anadromous or resident fish for spawning. For waters not used by anadromous or resident fish, DO must be greater than or equal to 5 mg/L. In no case may DO be greater than 17 mg/L. The concentration of total dissolved gas may not exceed 110 percent of saturation at any point of sample collection.
pH	May not be less than 6.5 or greater than 8.5. May not vary more than 0.5 pH unit from natural conditions.
Temperature	May not exceed 20 degrees Celsius (°C) at any time. The following maximum temperatures may not be exceeded where applicable: Migration routes 15°C Spawning areas 13°C Rearing areas 15°C Egg and fry incubation 13°C For all other waters, the weekly average temperature may not exceed site-specific requirements needed to preserve normal species diversity or to prevent the appearance of nuisance organisms.

Pollutant	Criteria*
Turbidity	May not exceed 25 nephelometric turbidity units (NTUs) above natural conditions. For all lake waters, may not exceed 5 NTUs above natural conditions.

Source: Alaska Department of Environmental Conservation (2020).
*The water quality standards listed in this table include the criteria for the growth and propagation of fish, shellfish, other aquatic life, and wildlife.

2.2 Goals and Objectives

The goals of the Water Quality and Habitat Connectivity Monitoring Study were as follows:

1. Document seasonal fluctuation of water quality parameters in the mainstem and OCH and any exceedances of the Alaska Department of Environmental Conservation (ADEC) water quality standards under the natural flow regime.
2. Document connectivity conditions at tributary mouths to understand seasonal fluctuation in flow contributions.

2.3 Study Area

The study area included the mainstem and associated off-channel, tributary, and lake habitat within the Martin River watershed between the high-tide mark and the confluence of the East Fork Martin River (EFMR) up to the United States Geological Survey (USGS) flow gage, including the West Fork Martin River (WFMR) and Red Lake (Figure 2.3-1).

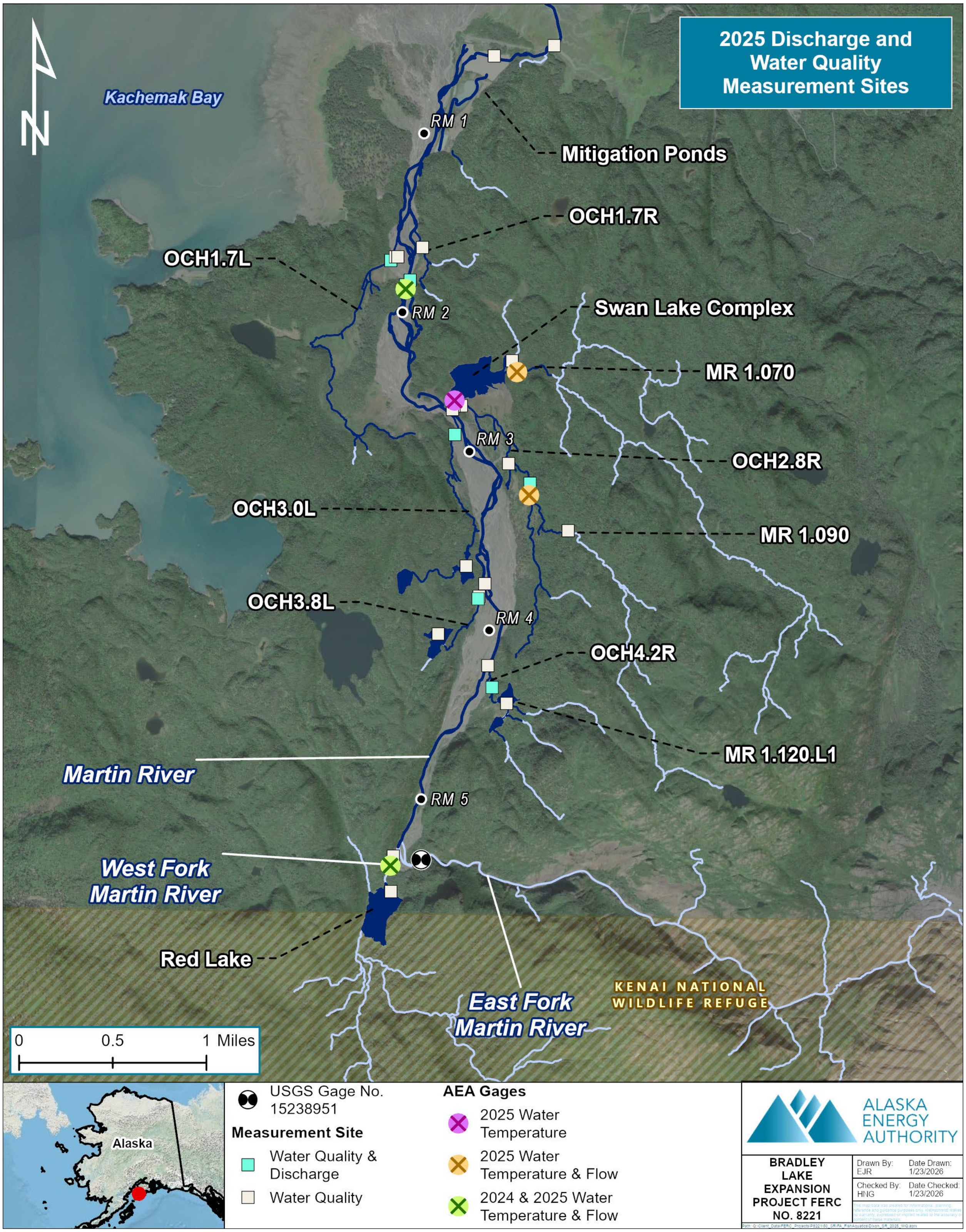

Figure 2.3-1 Water Quality and Habitat Connectivity Monitoring Study area map.

2.4 Methods

2.4.1 Equipment and Procedures

2.4.1.1 Water Quality

Point measurements of water quality were taken with a YSI Pro DSS water quality meter (YSI Incorporated, Ohio, United States) that was professionally calibrated by OCS Technologies (Cleveland, Ohio) in May 2025. The YSI Pro DSS collects time-averaged measurements of water temperature (degrees Celsius [°C]), DO concentration (milligrams per liter [mg/L]) and saturation (percent), specific conductance (microsiemens per centimeter), and pH. The instrument was suspended in the water column until all measurements stabilized, at which point values were recorded. Turbidity was measured using a 60-centimeter (23.6-inch) turbidity tube (Dahlgren et al. 2004) and recorded in centimeters, then converted to nephelometric turbidity units (NTUs) using a conversion chart published by Utah State University (2022). If water clarity exceeded 60 centimeters (the maximum reading for the turbidity tube), NTUs were recorded as less than 5. Point measurements of water quality parameters were collected at locations where discharge was measured or fish were sampled.

Continuous water temperature data were collected in the EFMR, Red Lake Outlet, Swan Lake Outlet, OCH2.8R, MR1.070, and on the Martin River mainstem at the Project River Mile (PRM) 1.9 constriction. EFMR data were provided by the USGS gage (Gage No. 15238951). Monitoring at the other sites involved using calibrated HOBO TidbiT Mx Data Loggers (LI-COR Environmental, Lincoln, Nebraska) set to record temperature at 15-minute intervals. These loggers are accurate to ±0.2°C and have a range of −20°C to 50°C in water. Pre- and post-deployment accuracy checks were performed to screen for defective equipment and qualify data reporting if measurement drift occurred. Accuracy checks were conducted at a minimum of two temperatures (0°C and 20°C). During field visits, the thermistors were audited by taking an independent measure of water temperature. Each logger was placed within a polyvinyl chloride (PVC) casing to insulate from sunlight, and each logger was anchored to the bank (bedrock or stable tree) with vinyl coated cable.

2.4.1.2 Connectivity

We measured discharge with a SonTek FlowTracker1 or FlowTracker2 following the velocity-area method used by USGS hydrologists (Turnipseed and Sauer 2010). Discharge measurement sites were chosen where stream bathymetry was relatively consistent and free of large rocks or woody debris. We strung a measuring tape perpendicular to the direction of flow to designate a cross section, from which the stream was subdivided into multiple segments (ideally 15-30 depending on stream size and complexity) such that no single segment accounted for more than 10 percent of total discharge. Depths and a 45-second averaged velocity were recorded for each segment. Upon completion of the cross section, the FlowTracker2 provided total discharge, total wetted area, wetted width, average wetted depth, percent uncertainty, the largest source velocity, and number of segments sampled. If a tributary went dry before connecting to the mainstem or the depth did not allow a discharge measurement (less than 0.2 foot), only the channel width and depth were recorded.

Ten smaller drainages (MR1.010, MR1.040, MR1.050, MR1.080, MR1.090, MR1.100, MR1.110, MR1.120, MR1.120.10, and MR1.120.20) that were identified as possible tributaries based on LiDAR were ground-truthed and classified as inaccessible to anadromous salmonids during both spring and fall field visits in 2024. We aimed to revisit these sites to confirm their inaccessibility or to document changes that may allow access at some times of year. Inaccessibility parameters were based on those established by the United States Forest Service (USFS 2001) and are outlined in Table 2.4-1.

Table 2.4-1 Passage criterion for Pacific salmon and Dolly Varden

<table>
<tr><th>Criterion</th><th colspan="4">Species</th></tr>
<tr><th></th><th>Sockeye Salmon</th><th>Coho Salmon</th><th>Pink/Chum Salmon [a]</th><th>Dolly Varden</th></tr>
<tr><td>Maximum Fall Height
A blockage may be presumed if fall height exceeds:</td><td>10 feet (3.05 m)</td><td>11 feet (3.35 m)</td><td>a) 4 feet (1.22 m) with deep plunge pools not flooded at high tide
b) 3 feet (0.91 m) without pools</td><td>6 feet (1.83 m)</td></tr>
<tr><td>Pool Depth
A blockage may be presumed if pool depth is less than the following, and the pool is unobstructed by boulders or is bedrock:</td><td colspan="4">1.25 x jump height, except no minimum pool depth for falls:
• <4 feet (1.2 m) in the case of Coho Salmon and steelhead
• <2 feet (0.6 m) in the case of other anadromous fish species</td></tr>
<tr><td>Steep Channel
A blockage may be presumed if channel gradient exceeds the following without resting places for fish:</td><td colspan="2">>225 feet (68.6 m) @ 12% gradient
>100 feet (30.5 m) @ 16% gradient
>50 feet (15.2 m) @ 20% gradient</td><td>>100 feet (30.5 m) @ 9% gradient</td><td>>50 feet (15.2 m) @ 30% gradient</td></tr>
</table>

Source: USFS (2001).
m = meter
[a] Chum Salmon have not been documented in the Martin River.

2.4.2 Data Quality Assurance and Quality Control

We implemented a quality assurance/quality control (QA/QC) protocol to ensure the integrity and accuracy of data collected under this Project. This included multiple levels of QC to monitor data collection efforts and ensure a rigorous and high-quality product. We compiled a data dictionary describing the database entries and attributes to accompany the database and provide an understanding of data elements.

2.5 Results

For in-depth detail of 2023 and 2024 water quality study results, see Kleinschmidt Associates (2025).

2.5.1 Water Quality

Certain OCH complexes were partially or fully inundated with mainstem Martin River water during the summer (OCH2.8R and Swan Lake) and fall (OCH1.7L, OCH1.7R, and OCH3.0L) site visits and, thus, had water quality reflective of glacial influence. Water quality data are reported in context of Alaska state standards for the growth and propagation of fish, shellfish, other aquatic life, and wildlife (Table 2.4-1).

2.5.1.1 Temperature

Two general temperature regimes exist in the aquatic habitat of the Martin River watershed. In the rain- and snow-dominated OCH, maximum temperatures were seen in the summer, with similarly cool temperatures in spring and fall (Figure 2.5-1, Figure 2.5-2). Within these OCH complexes, outflows from lakes (WFMR, Swan Lake Outlet) tended to have the highest temperatures, especially in summer, unless they were inundated by mainstem Martin River flow. In glacial-dominated areas (Martin River mainstem, EFMR, OCH inundated with mainstem water during high flow events), temperatures were highest in the spring (6–7°C) and similarly cold (~2–4°C) in the summer and fall (Figure 2.5-1, Figure 2.5-2).

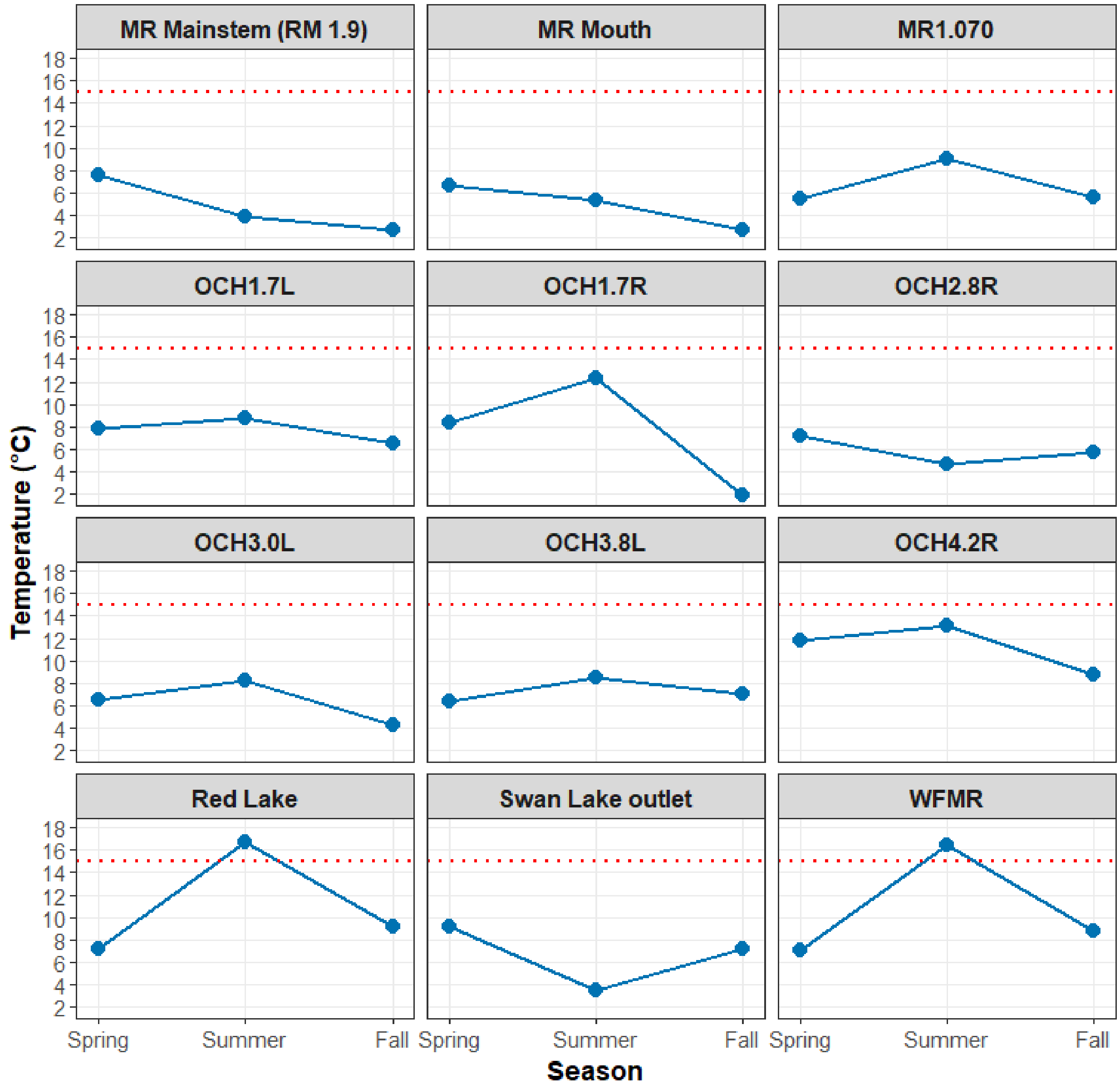

Figure 2.5-1 Point water temperatures from sites visited during each trip. The red dotted line indicates the 15°C ADEC upper threshold for rearing salmonids.

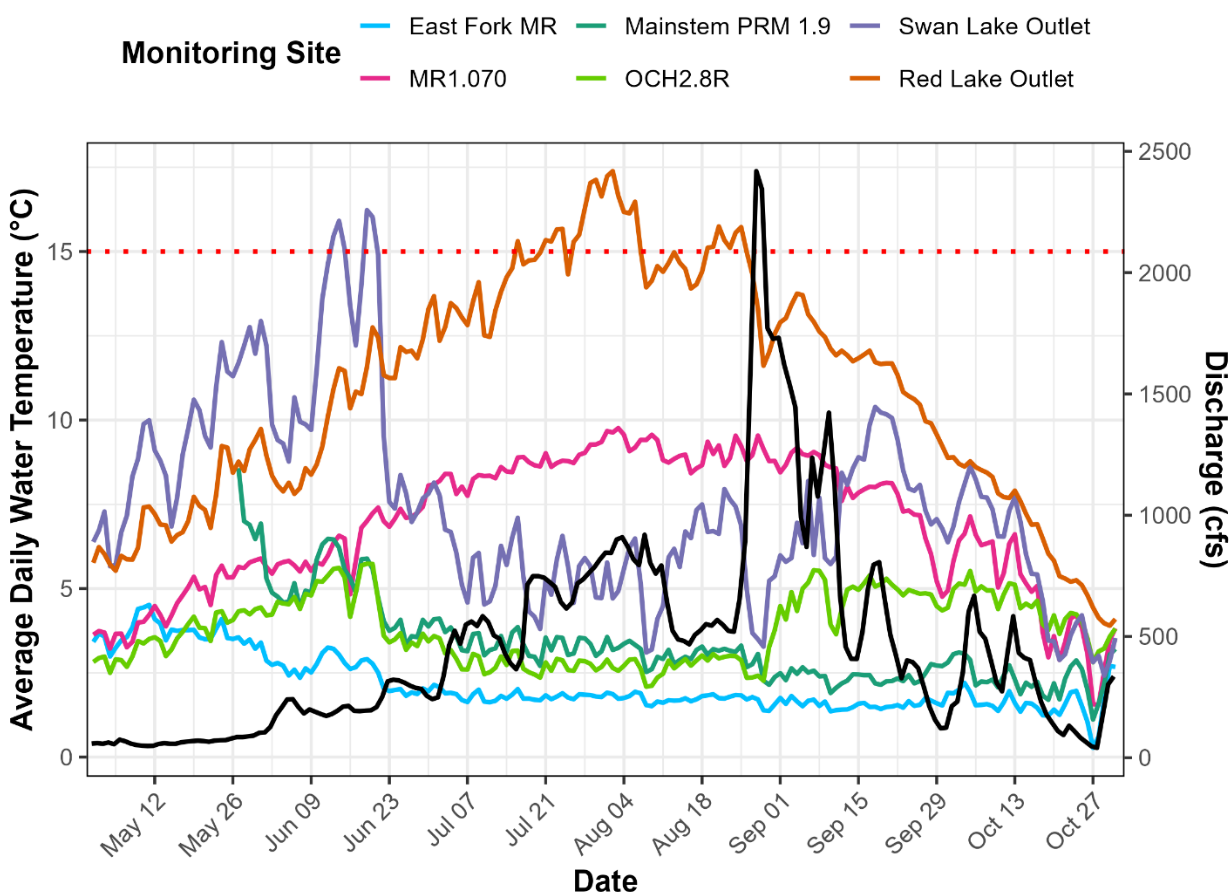

Figure 2.5-2 Average daily water temperatures from the 2025 field season in the EFMR, Martin River mainstem at the PRM 1.9 constriction, OCH2.8R, MR1.070, and the outlets of Red Lake and Swan Lake. The black line shows discharge measured at the PRM 1.9 constriction. The red dotted line indicates the 15°C ADEC upper threshold for rearing salmonids.

There were two exceedances of the ADEC threshold of 15°C for rearing salmonids in our point measurements. Daily average temperatures in the WFMR (16.4°C) and Red Lake (16.7°C) were above this threshold when visited on July 31, and both had rearing juvenile Coho Salmon (*Oncorhynchus kisutch*) present. Based on the continuous temperature data, the Swan Lake Outlet also exceeded the ADEC threshold for rearing salmonid in mid-June, with a maximum instantaneous recorded temperature of 18.5°C and a daily average temperature of 16.2°C on June 19. In 2025, OCH2.8R and Swan Lake were connected to mainstem Martin River flow starting on June 22, resulting in a substantial drop in water temperature that was maintained into the fall (Figure 2.5-2). During the continuous sampling period from May 27 to October 1, daily average temperatures exceeded 15°C for 29 days in the Red Lake Outlet and 5 days in the Swan Lake Outlet. There were no exceedances of the ADEC thresholds established for salmonid migration, spawning, or egg and fry incubation during the relevant timeframes and locations.

2.5.1.2 Dissolved Oxygen

Figure 2.5-3 presents DO concentrations from each site visited in 2025. The red dotted line indicates the 7 mg/L ADEC lower threshold. No DO measurements taken in 2025 fell below the ADEC threshold of 7 mg/L.

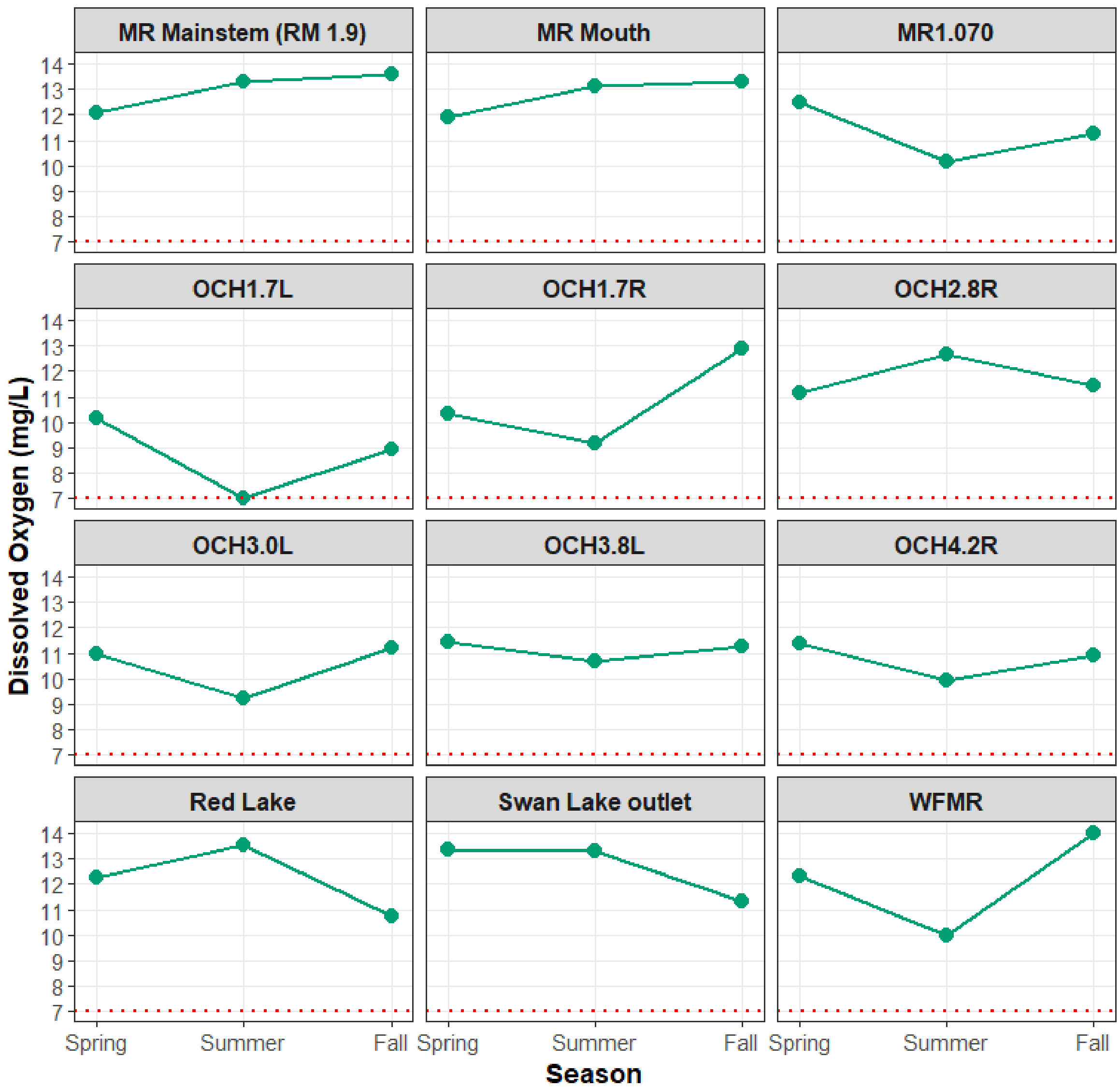

Figure 2.5-3 DO concentrations from sites visited during each trip in 2025.

2.5.1.3 pH

Figure 2.5-4 presents pH measurements from each site visited in 2025. The red dotted lines indicate the upper (8.5) and lower (6.5) ADEC thresholds. There was a single exceedance of the ADEC pH upper limit of 8.5 in 2025. The WFMR had a pH of 8.72 on October 3, while both adult and juvenile Dolly Varden (*Salvelinus malma*) and Coho Salmon were present in the tributary.

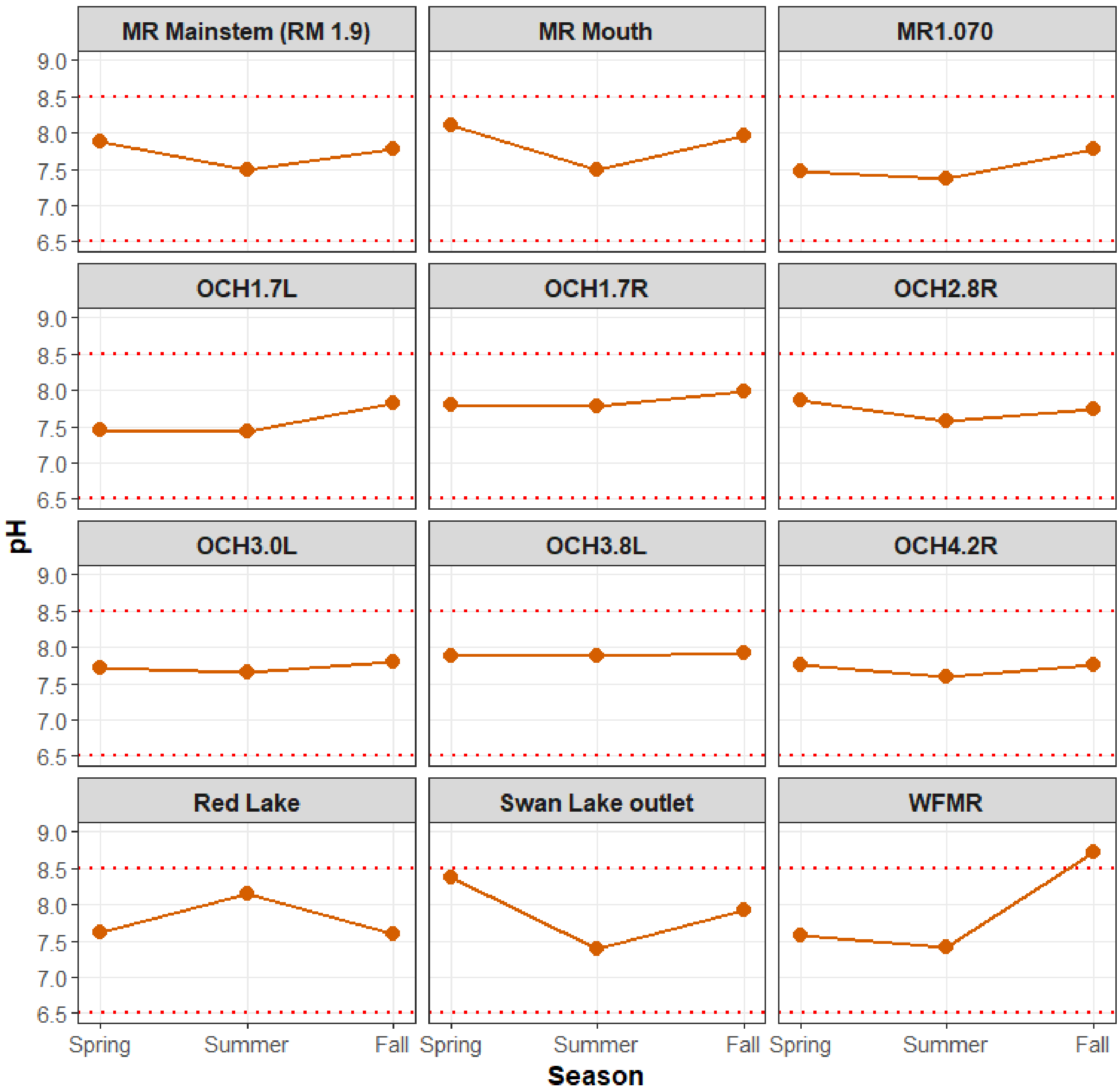

Figure 2.5-4 pH measurements from sites visited during each trip in 2025.

2.5.1.4 Turbidity

Turbidity was measured at less than 5 NTUs in all OCHs in each season, unless the OCH had received mainstem Martin River influence during high flow events. In spring, turbidity was less than 5 NTUs at all sites (including mainstem waters). Summer turbidity was 60 NTUs in the mainstem Martin River, OCH2.8R, and Swan Lake due to mainstem inundation. Fall turbidity measurements varied through the 8-day visit due to precipitation. Prior to a precipitation event from October 4 to 6, the mainstem and OCH1.7R (which had become a side channel to the mainstem) were at 13 NTUs, while the EFMR was at 19 NTUs. Following the rain event, the mainstem, OCH1.7R, OCH3.0L, and the EFMR exceeded 240 NTUs, the maximum reading of the turbidity tube. The other OCH complexes maintained less than 5 NTUs despite the precipitation.

2.5.2 Connectivity

Except for OCH1.7R in spring and summer, all OCHs maintained surface connection to the mainstem during each trip (Table 2.5-1). OCH1.7R received slight inflow from Tributary MR1.030 but went subsurface before its connection with the mainstem Martin River on all days observed outside of the 1 day following rain during fall 2025. The water depths were too shallow (<0.2 foot) across most of a channel cross section to allow collection of discharge measurements with an acceptable level of error. During the fall trip, OCH1.7R was connected to a mainstem Martin River side channel that had flows of 22 cubic feet per second (cfs). Despite its disconnection during most of the year, OCH1.7R supported water quality suitable for salmonids and yielded catch of juvenile Dolly Varden and Coho Salmon.

Several of the OCH complexes were inundated with mainstem Martin River water during some of the field visits: OCH2.8R and Swan Lake during the summer trip, and OCH1.7R, OCH1.7L (partially), and OCH3.0L (following a precipitation event) during the fall trip. Discharge from the OCHs was generally highest in spring and decreased through the summer to fall, though precipitation may temporarily raise flows. While most OCHs maintained surface connection in the fall, depths in the OCH channels near their mouths on September 29 were very low and unlikely to allow volitional passage by adult salmon.

Table 2.5-1 Discharge measurements across three seasons at sites sampled during the 2025 field effort.

Site	Date Visited	Discharge (cfs)	Wetted Width (ft)	Mean (Maximum) Depth (ft)	Total Wetted Area (ft^2)
Spring					
OCH1.7L	5/24	2.2	8.9	NM (0.53)	3.0
MR Mainstem (PRM 1.9)	5/22	82.3	46.7	1.1 (1.7)	49.7
OCH2.8R	5/22	7.6	19.5	0.6 (1.0)	11.3
MR1.070	5/22	3.6	14.7	0.4 (0.6)	5.5
OCH3.0L	5/24	3.2	8.3	NM (0.85)	3.9
OCH3.8L	5/24	1.5	10.6A	NM (0.73)	4.0
OCH4.2R	5/25	0.7	4.7	NM (0.4)	1.2
WFMR	5/22	16.0	16.3	1.1 (1.8)	17.8
EFMR	5/22	61.8	40.0	1.0 (1.8)	40.4
Summer					
OCH1.7L	7/29	1.56	13.3	0.69 (1.1)	9.19
MR Mainstem (PRM 1.9)	7/25	596.0	72.7	1.6 (2.9)	117.5
OCH2.8R	7/25	84	24.0	1.3 (1.8)	32.4
MR1.070	7/30	0.12	5.0	0.15 (0.25)	0.77
OCH3.0L	7/30	2.5	8.0	0.45 (0.8)	3.64
OCH3.8L	7/30	1.5	8.4	0.33 (0.53)	2.75
OCH4.2R	7/31	0.44	4.7	0.28 (0.4)	1.31
WFMR	7/25	3.6	13.0	0.9 (1.4)	11.9
EFMR	7/25	588	68.0	2.5 (3.4)	138.3
Fall[a]					
OCH1.7L[b]	NM	NM	NM	NM	NM
MR Mainstem (PRM 1.9)	10/2	219.2	55.0	1.0 (1.6)	54.73
OCH2.8R	10/2	4.49	20.7	0.92 (1.38)	19.01
MR1.070	9/12	0.31	5.1	0.3 (0.4)	1.7
OCH3.0L	9/30	2.58	10.5	0.49 (0.82)	5.11
OCH3.8L	9/30	0.96	4.9	0.27 (0.4)	1.34
OCH4.2R	9/30	0.38	5.6	0.56 (0.85)	3.13
WFMR	8/29	1.9	14.0	0.7 (1.1)	9.9
EFMR	9/12	751	72.0	2.6 (4.3)	140.2

MR = Martin River; PRM = Project River Mile; EFMR = East Fork Martin River; WFMR = West Fork Martin River; OCH = off-channel habitat; NM = not measurable; NA = not available.

Note: Values are in cfs, and dates of the trips are shown in parenthesis under the column heading.

[a] Note the temporal discrepancy in collection dates: conditions in the EFMR on September 12 were more like those seen in summer, while conditions on the mainstem on October 2 were more consistent with fall.

[b] In fall, OCH1.7L was a backwater of the mainstem with no suitable cross section for discharge measurements.

Precipitation-driven increases in flow were apparent in the mainstem Martin River during the fall 2025 visit following 1.5 inches of rain measured at the Nuka Glacier SNOTEL site (United States Department of Agriculture [USDA] 2025) from October 4 to 6. Prior to this rainfall, discharge at PRM 1.9 was at its lowest (99 cfs on October 1) since June 1. The precipitation event resulted in an increase in discharge to a maximum of 779 cfs on the night of October 5. By October 6, the mainstem fully inundated OCH3.0L and partially inundated a OCH2.8R side channel lower in that complex. While not measured for flow following the rain event, the other OCH complexes appeared to slightly increase in flow, and adult Coho Salmon began to appear in OCH 2.8R, MR1.070, and OCH3.8L, where they had not been seen earlier in the week. The presence of adult salmonids in most OCHs following this rain event suggests that while all OCHs were connected to the mainstem with surface water prior to the rain, the OCH channels at their mouths may have been too shallow to allow the volitional passage of adult salmon. However, 10 Coho Salmon and five Sockeye Salmon were observed on September 29 in the WFMR and OCH2.8R, respectively. While we do not know when Sockeye Salmon may have accessed OCH2.8R, Coho Salmon were first seen on ADF&G’s autonomous video counting tower (AVCT) on September 27, following 1.1 inches of rainfall from September 25 to 26 (USDA 2025). It appears that connectivity for volitional passage of adult salmon in the Martin River watershed is intermittent and follows rain events large enough to deepen channels leading into OCHs.

2.5.2.1 Disconnected Tributaries

The 10 small tributaries confirmed as inaccessible to migratory fishes in 2024 were visited between May 21 and 25, 2025. All but one of these tributaries displayed the same characteristics in 2025 (either dry or very little surface water; gradients in excess of 12 percent; frequent blockages). MR1.090, a tributary to OCH2.8R-SS-1.060, had about 100 meters (109 yards) of stream accessible to anadromous salmonids before a fish barrier.

2.6 Discussion

2.6.1 High Flow Event

The Martin River watershed experienced a high flow event on August 28 and 29, 2025. While no weather stations exist in the Martin River, a SNOTEL site (Site No. 1037) operated on the Nuka Glacier adjacent to the Dixon Glacier recorded 7.6 inches of rainfall for the Bradley Lake area from August 27 to 29 (USDA 2025) (Figure 2.6-1).

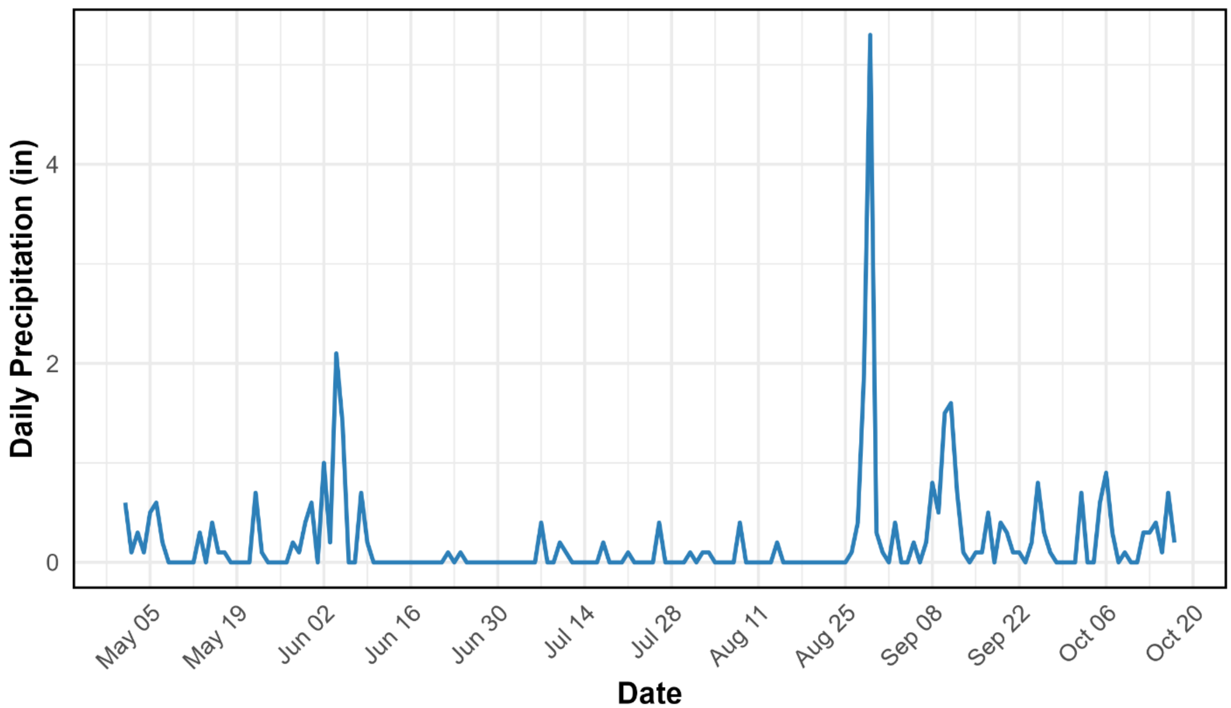

Figure 2.6-1 Daily precipitation for the Nuka Glacier from May 1 to October 15, 2025. Data from USDA (2025).

Discharge in the Martin River increased following this precipitation event from an average of 617 cfs (169 cfs standard deviation) from July 1 to August 25 to a maximum of 2,635 cfs on August 28 (Figure 2.6-2). For comparison, the August 7 high flow event in 2024 resulted in a maximum discharge of 4,209 cfs.

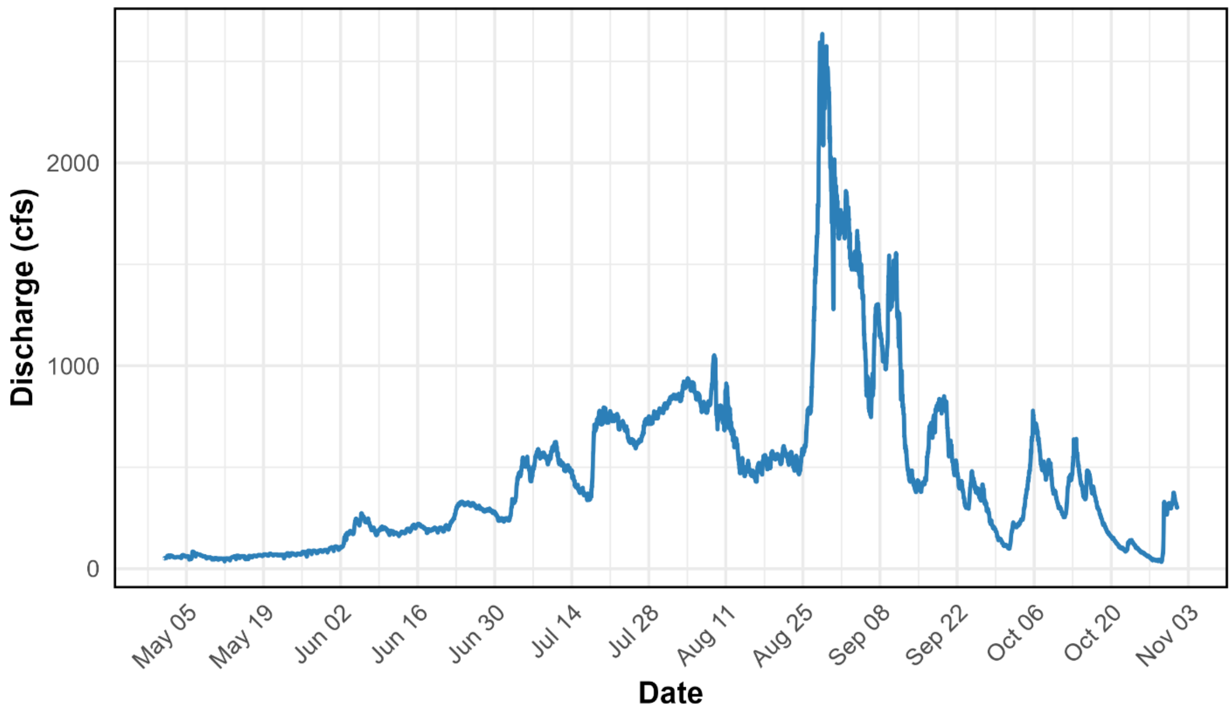

Figure 2.6-2 Martin River discharge measured at the PRM 1.9 constriction from May 1 to November 1, 2025.

Similar to the high flow event in August 2024, the 2025 high flow event resulted in considerable changes to the location of the mainstem channels and inundated many OCH complexes, indicated by a large increase in the relative composition of fines in the sediment of OCH and the turbidity of Swan Lake and the source lake for OCH4.2R and MR1.120.L1. Some of those changes include the following:

- The migration of the main channel at PRM 1.7 to the west, resulting in the inundation of the previous OCH1.7L mouth and turning that OCH into a backwater (Photo 2.6-1).
- The cutting of a channel at the head of OCH1.7R, such that it was an active side channel of the mainstem during the fall trip at flows of approximately 100 cfs.
- The cutting of a channel at the head of OCH3.0L, which was dry at the start of the fall trip, but wetted following the precipitation event, resulting in inundation of the entire OCH (Photo 2.6-2).
- The deposition of multiple feet of fines in the previous mouth of OCH 3.8L, resulting in the OCH channel directing northwest along a bedrock cliff through young willows to a new confluence with the mainstem (Photo 2.6-3).

Photo 2.6-1 The confluence of OCH1.7L (left) and the mainstem (far right) on September 29, 2025. The mainstem channel migrated west (left in the frame) since the summer, inundating the previous mouth of OCH1.7L, and turning the large pool along the bedrock cliff into a backwater. Multiple feet of fines deposited during the August 28 to 29 high flow event are visible in the lower righthand corner.

Photo 2.6-2 Just upstream of the mouth of OCH3.0L on October 5, 2025, during its inundation by mainstem flow at its head.

Photo 2.6-3 The confluence of OCH3.8L and the mainstem on October 5, 2025. The previous mouth was roughly 10 meters to the east (right of the frame), but a large deposit of fines in its place forced the OCH3.8L channel west through patchy willows along a bedrock cliff.

In the context of impacts to salmonids, the deposition of fines across OCHs falling within the mainstem floodplain (all OCHs but Red Lake/WFMR and MR1.070) appears to have covered many of the stretches of suitable spawning gravel, with areas like OCH4.2R seeing virtually all suitable spawning gravel covered in inches of glacial silt, and no live adult salmonids or spawning activity observed.

These impacts of the high flow events in both 2024 and 2025 underline the exceptionally dynamic nature of the Martin River watershed and the unpredictability of channel locations, connections between OCH and the mainstem, and habitat availability for aquatic fauna under baseline conditions. Species diversity and abundance in aquatic systems tend to be negatively correlated with disturbance (Resh et al. 1988) because frequent or intense physical disturbance like high flow events can simplify habitat structure, reduce refugia, and limit recolonization opportunities (Warren et al. 2015).

2.6.2 Multi-year Trends

Water quality measurements generally followed similar trends to data collected in 2023 and 2024. The main exceptions are OCH-localized water quality impacts of the stochastic flooding events, in which turbidity increases and temperature decreases substantially in the typically clear-water OCH. The movement of bedload associated with these flooding events also affected the spatial distribution of flow, with the mainstem following new cut channels and inundating different areas of OCH through both 2024 and 2025.

Few exceedances of the ADEC criteria suggest that OCHs in the Martin River watershed provide suitable habitat for Pacific salmon and other resident fish species, while the low temperatures and seasonally high flows in the mainstem and associated waters likely preclude these areas from continual habitation.

3.0 MARTIN RIVER FISH USE

3.1 Background

The proposed Project would divert water from the Dixon Glacier outflow from May to November as flows allow after meeting the minimum instream flow requirements (AEA 2022a), resulting in reduced flows that are likely to directly and indirectly affect fish habitat downstream. Therefore, AEA funded multiple years of fish studies aimed at describing the current distribution and abundance of fishes in the Martin River watershed. These data are intended to serve as baseline data to support the evaluation of the potential effects of the Project on fishes in the system.

3.2 Goals and Objectives

The goals of the Martin River Fish Use Study in 2025 were to continue and supplement monitoring efforts implemented in 2024 and address new questions posed by stakeholders. The specific objectives included the following:

1. Characterize the distribution and relative abundance of fishes in the Martin River. Fill gaps in information including the presence of rearing Sockeye Salmon and the potential for spawning of Eulachon in the system.
2. Operate an AVCT at Red Lake Outlet to document adult salmon entering Red Lake from June through October.
3. Document salmonid spawning across the watershed, with a specific focus on species and timeframes not observed or sampled in 2024, including Pink Salmon and Chum Salmon.

3.3 Study Area

The study area included the mainstem and associated off-channel, tributary, and lake habitat within the Martin River watershed between the high-tide mark and the confluence of the EFMR with the WFMR, including Red Lake. Areas sampled are outlined in Figure 3.3-1.

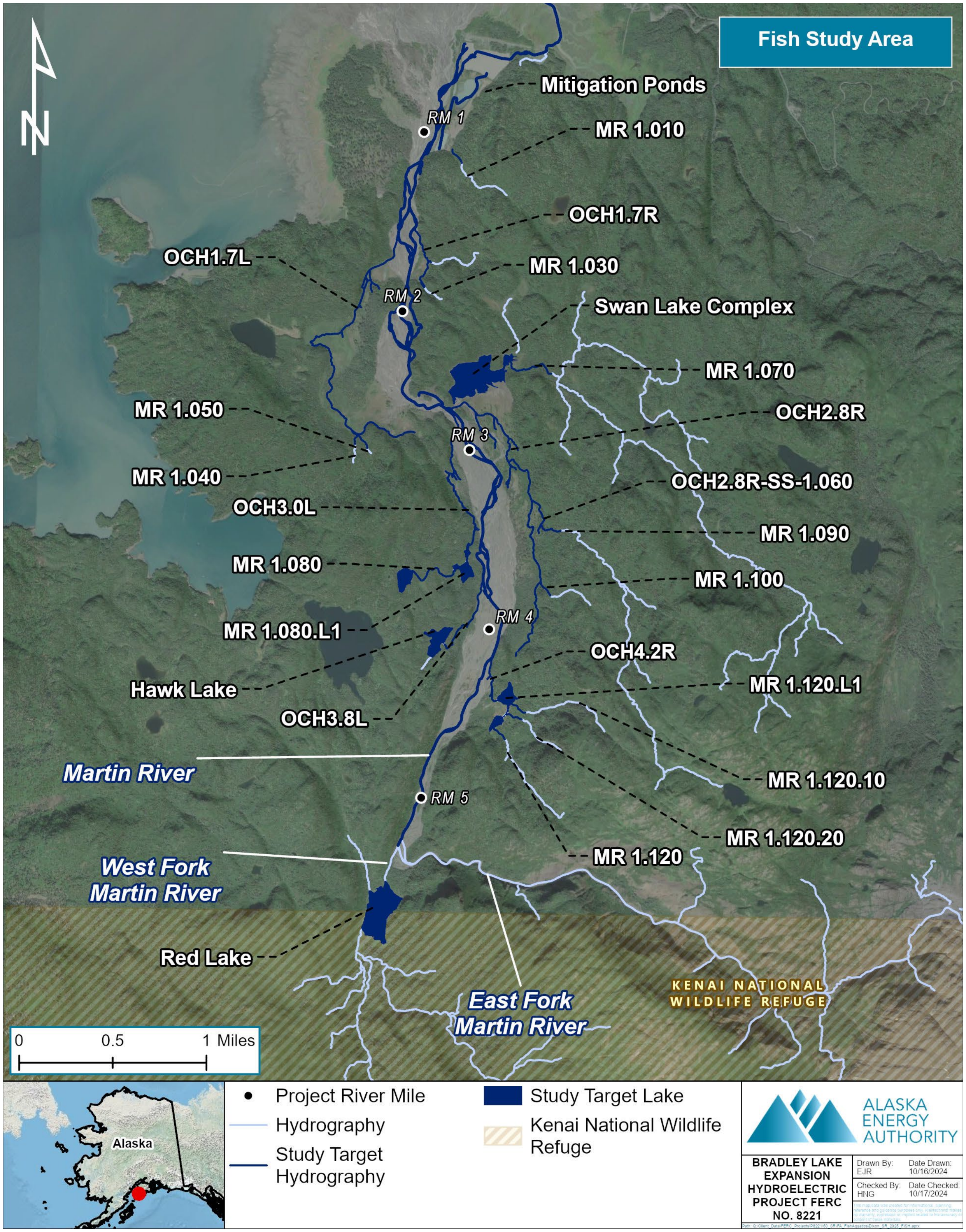

Figure 3.3-1 Martin River Fish Use Study area map.

3.4 Methods

3.4.1 Equipment and Procedures

3.4.1.1 Juvenile and Resident Fish Sampling

Gee-type minnow traps (44.5 x 22.8 centimeters, or 17.5 x 9 inches) with 2.5-centimeter (1-inch) openings and 6-millimeter (0.24-inch) mesh were baited with commercially preserved salmon eggs and fished overnight (typically 20- to 24-hour sets) to capture juvenile and resident fish. Traps were deployed in areas with sufficient depth to completely cover the trap to avoid exposure to vandalism by bears or other animals. Where possible, the crew evenly distributed traps throughout a sample reach, but if suitable habitat was limited, trap deployment density and distribution varied to ensure each trap was fully submerged. Dip nets were used to capture young-of-year (YOY) fish too small for minnow traps or species not typically prone to capture in minnow traps (e.g., Sockeye Salmon). Net styles included larger triangular dip nets (45 centimeters [17.7 inches] at the open end with 6-millimeter [0.24-inch] mesh) and small aquarium dip nets (10-centimeter [3.9-inch] circular net with 4-millimeter [0.16-inch] mesh).

All captured fish were transferred to dark-colored buckets with clean water from the location of capture. Individual fish were identified to species and measured (fork length) in 10-millimeter (0.39-inch) size bins. Some fish were then transferred into clear vinyl sachets or an acrylic viewing chamber for photo documentation.

Snorkeling was used to identify and count fish in circumstances where capture methods were not a viable option, like deep or complex habitat. Juvenile Sockeye Salmon tend to rear in lake habitat and are not prone to capture in benthic minnow traps due to their pelagic, planktivorous nature (Edmundson and Mazumder 2001). In 2024 sampling, no juvenile Sockeye Salmon were captured in the Martin River watershed despite the continued presence of an adult run documented by ADF&G's AVCT. Therefore, we used snorkeling to observe juvenile Sockeye Salmon in areas where spawning adults were observed in 2024.

3.4.1.2 Spawning Fish Sampling

3.4.1.2.1 Eulachon

To determine spawning habitat suitability for Eulachon, we collected transects of three velocity measurements (left bank, mid-channel, right bank) for multiple cross sections spread temporally across our week-long site visit in late May. This timeframe aligned with Eulachon runs in Cook Inlet (ADF&G 2025a) and likely gave us the best opportunity of observing Eulachon using the Martin River. We targeted areas in the lower Martin River (downstream of the gravel ponds) and documented any likely barriers based on flow and depth. Eulachon's swimming ability is limited such that sustained flows more than 1.2 feet per second (fps) restrict upstream passage (Spangler 2020). We used a SonTek FlowTracker1 with the velocity sensor set in the water column where flow appeared the slowest (generally closer to the substrate). To document the presence of Eulachon, we conducted multiple upstream walking surveys of roughly 500 meters (547 yards) from the mean high tide line and planned to dipnet or seine any observed fish.

3.4.1.2.2 Salmonids

To document spawning activity of adult salmon and Dolly Varden, we conducted upstream walking surveys of all connected OCHs and helicopter-based visual surveys of the mainstem Martin River and all lakes connected to tributaries. If fish were observed from the helicopter, we verified these observations on the ground if conditions allowed. We recorded any observations of fish, redds, or carcasses with GPS coordinates. The summer trip was scheduled specifically to coincide with spawning runs of Pink and Chum Salmon in nearby systems. We also aimed to document whether Sockeye Salmon that spawn in OCH may stage in these areas through the summer like those that migrate to and stage in Red Lake. For situations where adult fish were observed but could not be readily identified to species, a bag seine (25 x 4 feet with 2-inch stretch mesh) or triangular dip net (45 centimeters [17.7 inches] at the open end with 6-millimeter [0.24-inch] mesh) was used to capture the fish. Each captured fish was sexed and identified to species. Water clarity was estimated with a turbidity tube, and surveyors wore polarized glasses to improve visibility.

3.4.1.3 Red Lake Spawning Run Monitoring

To document the migration of adult salmonids into Red Lake, ADF&G operated their AVCT for the fourth consecutive year. For specifics on their methods, see Blackmon and Otis (2023, 2024).

3.4.2 Data Quality Assurance and Quality Control

See Section 2.4.2 for details on data QA/QC.

3.5 Results

For in-depth detail of 2024 fish study results, see Kleinschmidt Associates (2025).

3.5.1 Juvenile Fish

Catch from minnow trapping in OCH generally confirmed the trends in distribution and abundance documented in 2024 (see Kleinschmidt Associates 2025): juvenile Dolly Varden were the most abundant and widespread salmonid captured in minnow traps (*n* = 284), followed by Coho Salmon (*n* = 111). However, the addition of dipnetting and limited seining during 2025 sampling resulted in the capture of additional species (juvenile Sockeye Salmon) and YOY of all salmonid species present. We also minnow trapped suitable areas in the mainstem Martin River and the EFMR, which were not sampled in previous years. Overall catch for juvenile salmonids with these additional sampling methods and locations is as follows:

- Coho Salmon (*n* = 316) were the most numerous, constituting 48.9 percent of catch;
- Dolly Varden (*n* = 298) were similarly abundant, at 46.1 percent of catch; and
- Sockeye Salmon (*n* = 32) constituted 5.0 percent of catch.

It is important to note that sampling in 2025 targeted anadromous salmonids and their suitable habitat rather than Dolly Varden, which can inhabit higher gradient and colder portions of the Martin River watershed. Sixty-five Three-spined Stickleback (*Gasterosteus aculeatus*) and 12 Ninespine Stickleback (*Pungitius pungitius*) were captured, most of which were dipnetted in the flooded marsh grass near the mainstem mouth, but few Three-spined Stickleback were captured in mainstem waters as far upstream as PRM 4.6. Three freshwater sculpin (*Cottus* spp.) and two Pacific Staghorn Sculpin (*Leptocottus armatus*) were also captured in 2025. Both Pacific Staghorn Sculpin were captured in a side slough to the mouth that was tidally influenced.

3.5.1.1 Off-channel Habitat Sampling

Dipnetting in OCH during the spring and summer trips revealed that YOY Dolly Varden were common in the margins of flowing tributaries and were observed in OCH2.8R, MR1.070, OCH3.0L, and OCH3.8L. YOY Coho Salmon frequented slower-moving waters and any deeper pools with structure and were captured in all OCHs aside from OCH1.7L and OCH1.7R. YOY Sockeye Salmon were captured only in Red Lake and OCH2.8R (Photo 3.5-1, Photo 3.5-2; Table 3.5-1). Snorkeling in Red Lake in the spring yielded observations of two schools (50 to 70 individuals per school) of ages 1+ and 2+ Sockeye Salmon (estimated size range of individuals within school: 50–100 millimeters fork length). Three juvenile Sockeye Salmon dipnetted from one of these schools ranged in size from 50–80 millimeters fork length.

While no YOY salmonids were captured in OCH1.7L and OCH1.7R, and in 2025 they did not appear to host any spawning habitat, large numbers of age 1+ Coho Salmon and Dolly Varden were captured in OCH1.7L, and fewer in OCH1.7R, suggesting that these sites serve as summer rearing or resting habitat. Juvenile fish presence in these OCHs may be a product of volitional outmigration, or perhaps deposition during high-flow events.

Table 3.5-1 Salmonid sub-adult life stages (YOY and juvenile) observed at Martin River study sites during spring, summer, or fall sampling in 2024 and/or 2025.

Site	Fish Presence	Dolly Varden		Coho Salmon		Sockeye Salmon	
		YOY	JUV	YOY	JUV	YOY	JUV
Martin River Mainstem							
Martin River Mouth & Floodplain	Yes		✓		✓	✓	
PRM 1-2	Yes		✓		✓		
PRM 2-3	Yes		✓				
PRM 3-4	Yes		✓				
PRM 4-5	Yes		✓				
Off-channel Complex OCH1.7R							
OCH1.7R-SS-1	Yes		✓		✓		
Tributary MR1.030	Yes		✓		✓		
Off-channel Complex OCH1.7L							
OCH1.7L-SS-1	Yes		✓		✓		
Tributary MR1.070/Swan Lake Complex							
Tributary MR1.070	Yes	✓	✓	✓	✓		
Upper Swan Lake	Yes		✓		✓		
Lower Swan Lake	Yes	✓	✓	✓	✓		
Off-channel Complex OCH2.8R							
OCH2.8R-SS-1	Yes	✓	✓	✓	✓	✓	
Off-channel Complex OCH3.0L							
OCH3.0L-SS-1	Yes	✓	✓	✓	✓		
Lake MR1.080.L1	Yes		✓		✓		

Site	Fish Presence	Dolly Varden		Coho Salmon		Sockeye Salmon	
		YOY	JUV	YOY	JUV	YOY	JUV
Off-channel Complex OCH3.8L							
OCH3.8L-SS-1	Yes	✓	✓	✓	✓		
Hawk Lake	No						
Off-channel Complex OCH4.2R							
OCH4.2R-SS-1	Yes		✓	✓	✓		
Lake MR1.120.L1	Yes		✓		✓		
Red Lake Complex							
West Fork Martin River	Yes		✓	✓	✓		
Red Lake	Yes		✓	✓	✓	✓	✓

YOY = young-of-year; JUV = juvenile

Note: Juvenile includes ages 1+ and/or 2+ fish. Sites are listed downstream to upstream.

Photo 3.5-1 YOY Coho Salmon (orange arrows), Sockeye Salmon (red arrows), and Dolly Varden (blue arrow) captured in a clear-water, spring-fed channel in the OCH2.8R complex on August 2, 2025. Note the remnants of a yolk sac still visible on the Coho Salmon (blue ovals).

Photo 3.5-2 YOY Sockeye Salmon captured in Red Lake on July 31, 2025.

3.5.1.2 Mainstem Sampling

Minnow trapping and dipnetting of the mainstem and mainstem-associated habitat (EFMR, floodplain of the mouth, etc.) yielded catch of juvenile Dolly Varden, Coho Salmon, and both species of stickleback. Traps spread throughout the Martin River from the mouth to the USGS gage on the EFMR generally had catch density and number of species decrease with distance from the mouth of the Martin River. Only Dolly Varden were captured in each river mile of the mainstem, while Coho Salmon were captured up to PRM 2 (Table 3.5-1). Most fish caught in mainstem-associated waters were captured in the floodplain or sloughs near the mouth, which hosted the most suitable habitat, with higher flows during summer and fall trips resulting in a lacework of slow flowing, deeper side channels with flooded marsh grass east of the main channel (Photo 3.5-3, Photo 3.5-4). In the few pools along the mainstem that were generally associated with bedrock constrictions and cliff faces, Dolly Varden tended to be present, and a few Three-spined Stickleback were captured upstream of the floodplain at the river mouth to PRM 4.6. During the summer sampling effort, a side channel to the EFMR that was draining into the WFMR (59.69744° North/151.00229° West) was trapped overnight, resulting in the capture of three Dolly Varden and four Coho Salmon (two YOY, two age 1+). While the area sampled reflected the water quality of the EFMR (cold and turbid), it was within the lower channel of the WFMR in slow-water habitat. Based on the location, it is likely that these Coho Salmon were outmigrants from the Red Lake complex. Trapping in the EFMR upstream of the WFMR confluence during all three trips yielded no catch.

Photo 3.5-3 Two age classes of juvenile Coho Salmon, Three-spined Stickleback, and Ninespine Stickleback captured in the flooded marsh grass near the mouth of the Martin River on August 2, 2025.

Photo 3.5-4 Upstream view of the Martin River mouth spreading over the tidal floodplain at PRM 0.4 on August 3, 2025.

In 2025, summer flows inundated OCH2.8R and Swan Lake, providing an opportunity to sample habitat with water quality that reflected the mainstem (3.4°C, 60 NTUs measured on August 2 in Swan Lake) but had low velocities and sufficient deeper habitat. A single trap fished overnight in the Swan Lake Outlet during these conditions yielded 29 Dolly Varden and 34 Coho Salmon, and a YOY Coho Salmon was dipnetted adjacent to the trap location (Photo 3.5-5, Photo 3.5-6).

Photo 3.5-5 A YOY (~30 millimeters) and age 1+ (~70 millimeters) Coho Salmon captured in the Swan Lake Outlet on August 3, 2025.

Photo 3.5-6 Upstream view of the OCH2.8R complex from Swan Lake, with the Martin River mainstem in the background on August 3, 2025.

3.5.1.3 Red Lake Fish Parasite

During summer sampling of Red Lake, some captured juvenile Coho Salmon and Sockeye Salmon exhibited labored swimming and struggled to evade capture in dip nets, and four fish were found dead. Water temperature and DO at the time were 16.7°C and 13.53 mg/L, respectively. Visual observation of both the live and dead fish revealed bloating and exophthalmia (popeye), in which the eyes protrude unnaturally from the head (Photo 3.5-7).

Photo 3.5-7 Coho Salmon with exophthalmia next to healthy Coho Salmon captured in Red Lake on July 31, 2025.

Following consultation with Ted Otis of ADF&G, six juvenile Coho Salmon and three YOY Sockeye Salmon were collected under ADF&G's fish collection permit for transportation to the ADF&G Pathology Laboratory in Anchorage. Pathological examination confirmed a heavy systemic infestation of larval digenean trematodes (metacercariae), primarily within the musculature, cranial tissues, and body cavities (ADF&G 2025b). Necropsy and histopathology documented extensive tissue damage, including granulomatous and necrohemorrhagic myositis, coelomitis/peritonitis, hemorrhage, and inflammation, with parasite burdens exceeding 20 metacercariae per fish in some cases. Molecular sequencing identified the parasites as strigeid trematodes (family Strigeidae), most closely aligned with *Apatemon* or related genera. Bacterial, viral, and BKD testing were negative, indicating parasites as the primary etiological agent. Gas emboli observed in some fish suggested a possible contribution of gas bubble disease, potentially related to supersaturated DO conditions or transport effects, but this was considered secondary to the severe parasitic infection (Photo 3.5-8). While no fish trapping took place in Red Lake during the fall trip, multiple walking surveys of the WFMR and Red Lake northeastern shoreline yielded no observations of juvenile fish exhibiting symptoms of infection.

Photo 3.5-8 A YOY Sockeye Salmon collected at Red Lake on August 3, 2025, dissected by ADF&G Pathology Laboratory in Anchorage. The white specks visible in the body cavity are grub-like larval (metacercarial stage) flukes (digenean trematodes; ADF&G 2025b).

3.5.2 Spawning Activity

3.5.2.1 Non-Salmonids

No Eulachon were observed in the Martin River watershed, and all velocity measurements exceeded the 1.2 fps threshold (Spangler 2020), with most exceeding 1.5 fps (range: 1.4–2.2 fps). A relatively high gradient riffle about 100 meters (109 yards) upstream of the high tide line had the characteristics of a fish passage barrier for Eulachon (all velocity measurements greater than 2.0 fps).

Gravid female Three-spined Stickleback and males in spawning colors were captured during the spring visit, and YOY stickleback were observed in Red Lake, Swan Lake, and the mouth of the Martin River, indicating active use of the system for spawning and rearing by this species.

3.5.2.2 Salmonids

Summer spawning surveys from July 29 to August 3 yielded no observations of adult Pink or Chum Salmon in the Martin River watershed. Pink Salmon spawning was observed in the adjacent Battle Creek (hundreds of individuals and redds visible from the air and confirmed on the ground), indicating that sampling took place during the appropriate spawning window for this species.

Fall spawning surveys in the Martin River watershed from September 29 to October 6 resulted in the observation of adult Coho Salmon, Sockeye Salmon, and Dolly Varden, and redds of Coho Salmon and Dolly Varden (Figure 3.5-1). Summer and fall surveys of the Martin River mainstem suggested that little if any suitable spawning habitat exists (based primarily on high flow, as plenty of suitable substrate was present). No adult salmonids were observed spawning in the mainstem, and only one adult salmonid (presumed to be a Coho Salmon) was observed holding in a mainstem pool near PRM 5.0. It appears that the main channel is used primarily as a migratory route to reach suitable spawning habitat in OCH/tributary complexes.

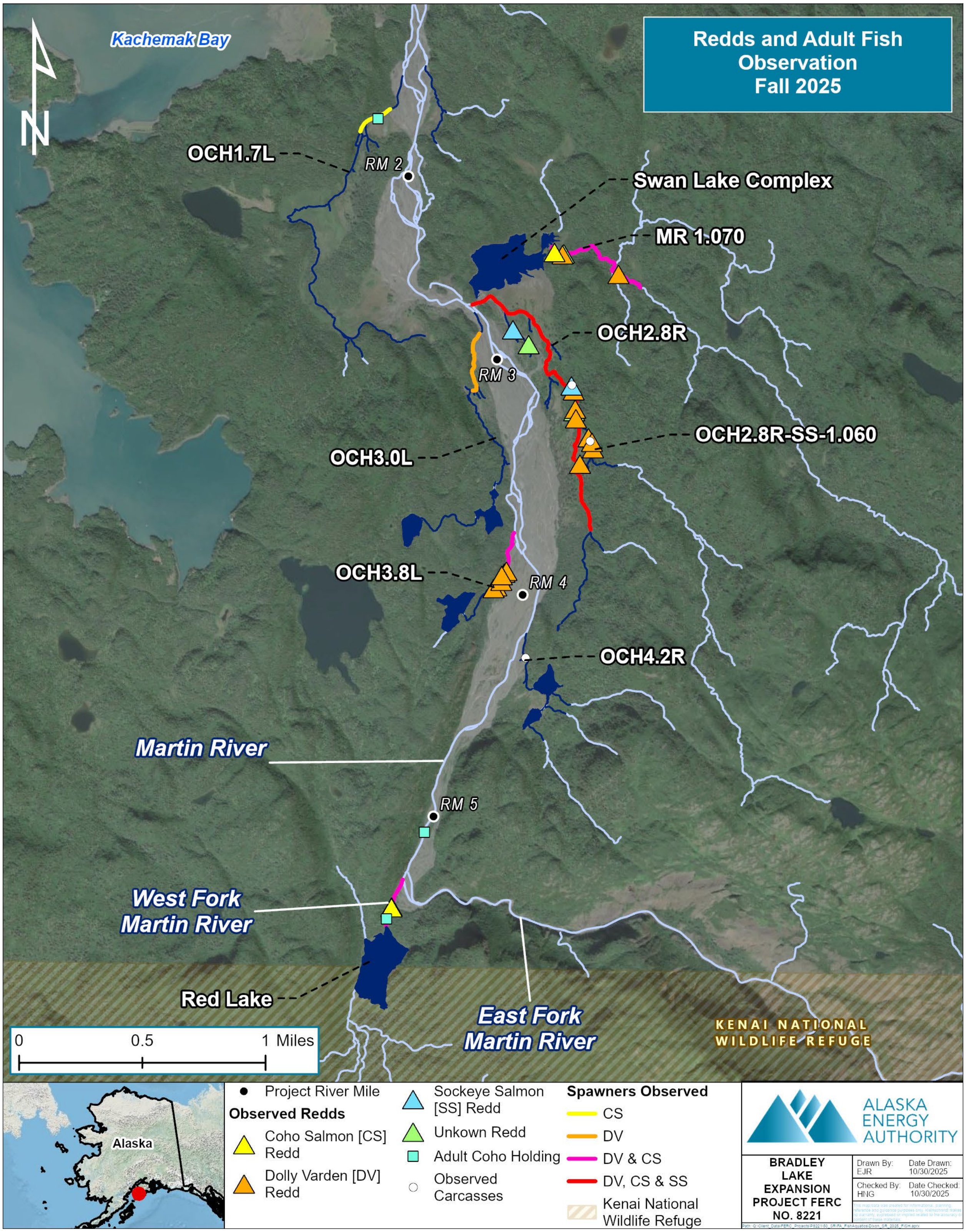

Figure 3.5-1 Locations of adult salmonid spawners and their redds during surveys from September 29 to October 6, 2025.

Eight total Sockeye Salmon (seven alive and one carcass) and two redds were observed in OCH2.8R, beginning on the first day of fall surveys on September 29 (Photo 3.5-9). Throughout multiple subsequent surveys, three of the carcasses from these fish were found and were believed to be preyed on by river otters (*Lontra canadensis*). Groups of Sockeye Salmon were observed in Red Lake by helicopter, with fish milling in shallow water along the southern shoreline. Seven carcasses (six bucks, one hen) were found along the northeastern shoreline during a walking survey. One buck and one hen were dissected, and their reproductive organs offered evidence (evacuated skein and atrophied testes) that they had spawned prior to their death.

Photo 3.5-9 A female Sockeye Salmon and a collection of juvenile Coho Salmon and Dolly Varden observed in OCH2.8R on October 5, 2025.

During the September 29 survey, adult Coho Salmon were only observed in the WFMR, with 10 individuals milling downstream of a large beaver dam that had been constructed prior to our summer trip in late July. The water levels in other previously productive Coho Salmon spawning reaches (MR1.070, OCH2.8R) were very low and questionable for volitional passage. Helicopter-based surveys of the system identified large schools of Coho Salmon (40+ individuals) milling in OCH1.7L. While a small section of suitable spawning gravel was identified at the mouth of OCH1.7L in 2024, this area had been scoured by the August 2025 high flow event and was part of the mainstem channel during the fall 2025 survey. Therefore, no known spawning habitat remained in OCH1.7L, but its deepened connection to the mainstem (see Photo 2.6-1) presumably resulted in easy access for adult salmon to one of the largest deep pools in the system. We suspect the adult Coho Salmon observed in OCH1.7L were holding until flows in OCHs with suitable spawning habitat increased enough to allow access to spawning areas. One additional holding pool was documented near PRM 5, where the mainstem hosted a deeper pool along a bedrock cliff (Figure 3.5-1). Most encountered fish had well-developed secondary sexual characteristics (e.g., spawning colors and kypes). After rain moved in from October 4 to 6, Coho Salmon were observed in OCHs outside of the WFMR, with 13 live adults and two carcasses across MR1.070 (three alive), OCH2.8R (seven alive and one carcass), OCH3.8L (three alive), and OCH4.2R (one carcass). Only two confirmed redds were observed: one in MR1.070 and one in the WFMR. Ten additional Coho Salmon had also arrived in the WFMR during this rain event.

Adult Dolly Varden and their spawning activity were observed in MR1.070, OCH2.8R, OCH3.0L, OCH3.8L, and the WFMR. On September 29, a school estimated at over 200 individuals (size range 150–460 millimeters; Photo 3.5-10) was milling below the beaver dam on the WFMR. Given the range in sizes observed and the absence of Dolly Varden over roughly 200 millimeters (7.87 inches) throughout summer and spring sampling, it appears that both resident and sea-run fish were present, and some were in spawning colors.

Photo 3.5-10 A portion of the large school of Dolly Varden staged below the beaver dam on the WFMR on October 1, 2025.

Outside of the school in the WFMR, 57 Dolly Varden and 22 redds were observed throughout OCHs in the Martin River watershed. Many redds hosted three or more fish, often with one larger (~250–350 millimeters) female over the redd and a collection of males (~140–300 millimeters) chasing and biting one another (Photo 3.5-11). Two smaller males (138 and 142 millimeters), both of which produced sperm with palpitation of their body cavities, were found alive but injured just downstream of active redds, with puncture wounds in their abdomens.

Photo 3.5-11 A pair of Dolly Varden observed spawning in the WFMR October 5, 2025. At least two other smaller males were present just downstream of the pair.

3.5.2.3 Red Lake Spawning Run Monitoring

The AVCT operated from May 22 to November 4 in 2025 and documented 1,500 Sockeye Salmon, 214 Coho Salmo, and over 855 Dolly Varden moving into Red Lake, the highest escapement recorded to date for each species (Table 3.5-2). Since the beginning of this monitoring in 2022, Sockeye Salmon have generally been the most abundant adult salmonid migrating into Red Lake, followed by Coho Salmon and Dolly Varden, but there are several caveats to consider when interpreting the Red Lake escapement data, including intermittent use of lighting, and weather- and flow-related outages, which are explained in detail in Blackmon and Otis (2023, 2024)

Table 3.5-2 Annual adult fish counts from ADF&G's monitoring station at the outlet of Red Lake.

Species	Run Year			
	2022[a]	2023[b]	2024	2025
Sockeye Salmon	681	66	1,197	1,500
Coho Salmon	48	205	182	214
Pink Salmon	5	0	0	0
Dolly Varden	53	58	88	855[c]

[a] 2022 does not include night counts.
[b] Multiple recording lapses occurred in 2023.
[c] Dolly Varden counts in 2025 ceased on September 30 and are underrepresenting the total run.

Similar to previous years, 2025 daily Sockeye Salmon counts peaked near mid-June (Figure 3.5-2), while Coho Salmon counts peaked around rainfall events from late September to early October (Figure 3.5-3). The Dolly Varden count in 2025 far exceeded those in previous years, with most fish arriving in two pulses: one coincided with the adult Sockeye Salmon run (143 Dolly Varden counted from May 22 to July 12) and the other with the Coho Salmon run (701 Dolly Varden counted from September 12 to 30). Counting ceased for Dolly Varden on September 30 due to difficulty in keeping track of milling fish in front of the AVCT, but ADF&G estimated over 1,000 Dolly Varden migrated past the AVCT in 2025.

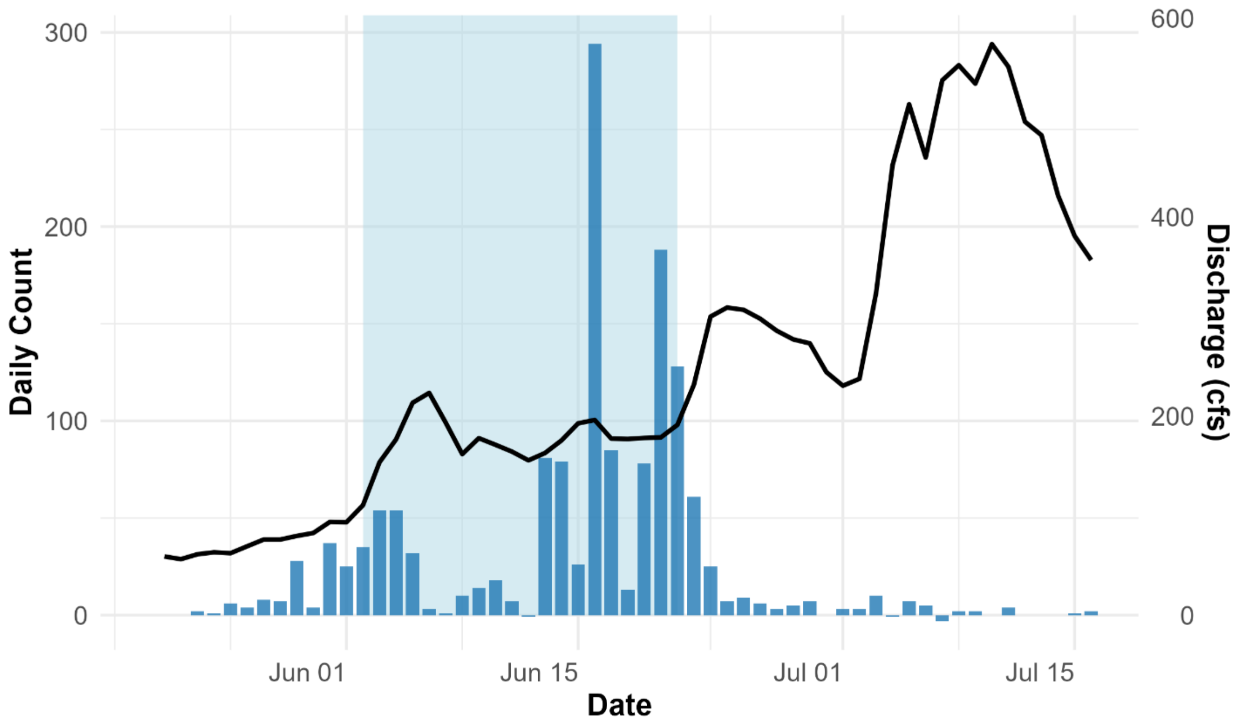

Figure 3.5-2 2025 daily counts of Sockeye Salmon at the Red Lake AVCT and EFMR discharge. The blue shading shows the timeframe within which 80 percent of the run was observed (June 2–21).

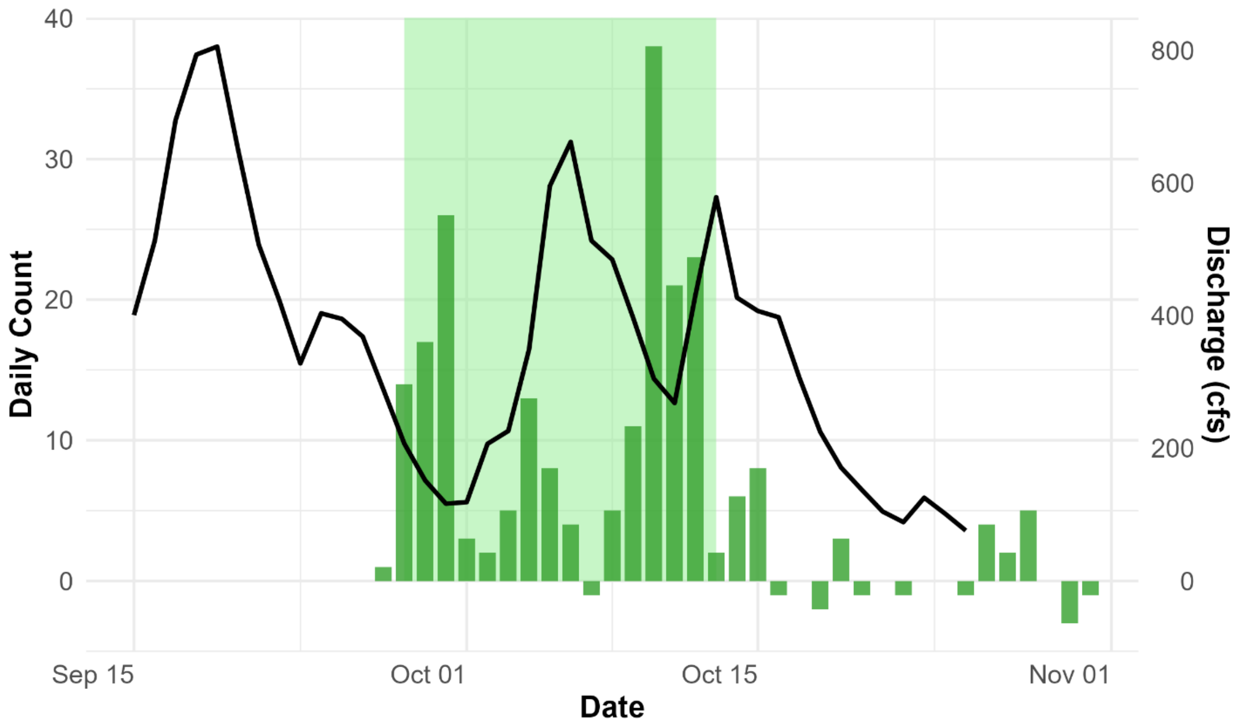

Figure 3.5-3 2025 daily counts of Coho Salmon at the Red Lake AVCT and EFMR discharge. The green shading shows the timeframe within which 80 percent of the run was observed (September 28 – October 13). Negative counts reflect fish moving downstream at the AVCT and are removed from the total count.

3.5.2.4 Spawning Habitat and Changes in Habitat Condition

At the start of our fall trip, water levels in OCHs across the Martin River watershed were low, with very shallow conditions at most OCH mouths and a minimum discharge of 99 cfs at the PRM 1.9 constriction on October 1 (see Section 2.5.2 for more information on connectivity). Additionally, channel changes and the deposition of fines across OCH were evident from a high-water event on August 28 and 29 (see Section 2.6.1 for details on the high flow event). Much of the area in OCH2.8R that hosted suitable salmonid spawning gravel had been covered in what appeared to be inches to feet of fines. OCH3.8L appeared to have multiple feet of fines deposited where it previously connected to the mainstem, and flow diverted west along bedrock walls through dense willow patches to a new confluence with the mainstem. OCH4.2R appeared to have multiple inches of fines deposited on areas that previously hosted suitable spawning gravel and in pool habitat that had turned to silty, shallow run habitat. Upon our arrival, OCH1.7R was connected to the mainstem at the head of the complex, with 21.96 cfs flowing through its channel on October 2. The main channel of the Martin River hugged the west side of the floodplain at PRM 1.7, inundating the area that previously served as the mouth of OCH1.7L, and turning the previous large slack water of lower OCH1.7L into a backwater pool of the main channel, where a large school of adult Coho Salmon were observed milling early in the fall trip.

A series of rainstorms from October 4 to 6 resulted in the Martin River mainstem flow increasing to a maximum discharge of 779 cfs at the PRM 1.9 constriction on October 5. This increased flow wetted side channels to the mainstem that were dry earlier in the week, including 1) a channel flowing into lower OCH2.8R in which adult Sockeye Salmon and Dolly Varden had been observed the previous day, and 2) the complete inundation of OCH3.0L, where Dolly Varden spawning activity had been observed. These re-connections resulted in cold, very turbid water inundating areas that were currently hosting salmonid spawning and could impact the viability of any redds in those areas through erosion or deposition of sediment.

The observed changes in both OCH and the location of the Martin River mainstem further underline the natural state of the Martin River watershed as a dynamic glacial outwash plain in which stochastic flood events result in substantial changes to channel configuration and fish habitat.

3.6 Discussion

3.6.1 Juvenile Sockeye Salmon Distribution

Various fish sampling efforts in previous years had yielded no documentation of YOY Sockeye Salmon and limited capture of juvenile Sockeye Salmon (Otis 2016) in the Martin River watershed, despite the known use of Red Lake by adult fish. This prompted a more concerted effort to capture or observe these fish during the spring 2025 sampling effort and led to the capture of YOY Coho Salmon and Sockeye Salmon along the vegetated edges of the Red Lake Outlet and the northeastern shoreline of Red Lake.

Given the smaller size of Red Lake when compared to other lakes draining to Kachemak Bay that are used by Sockeye Salmon for spawning and rearing, there was uncertainty as to whether Red Lake Sockeye Salmon opt to rear in the system for multiple years or assume a life cycle more typical of sea-type Sockeye Salmon and out-migrate as YOY to rear in estuarine habitat (Heifetz et al. 1989). Snorkeling observation in Red Lake in May 2025 indicated that some juvenile Sockeye Salmon do rear in Red Lake for multiple years.

While sampling in the sloughs of the Martin River mouth along the high tide line in the spring, we captured smolted YOY Sockeye Salmon of unknown origin. These fish may be from small populations elsewhere in upper Kachemak Bay (Fox River or Sheep Creek) and accessed the side sloughs to the Martin River mouth during high tide. These also could be Red Lake fish that traveled downstream to the Martin River mouth and surrounding estuarine habitat soon after emerging, which is not uncommon in Alaska (McPherson 1987) and has been shown to result in increased growth for juvenile Sockeye Salmon in other systems when compared to their freshwater-rearing conspecifics (Heifetz et al. 1989). It is unlikely that these juveniles came from OCH2.8R, as 2025 summer observations of YOY Sockeye Salmon along with the colder thermal regime in OCH2.8R suggest that YOY had not yet emerged from the gravel by late May. Either way, the presence of YOY Sockeye Salmon in both Red Lake and sloughs of the Martin River mouth speak to the behavioral plasticity of these salmon and their ability to find and use suitable habitats across a spatially and temporally dynamic channel network.

3.6.2 Fish Presence in Inundated OCH

Throughout the 2025 sampling season, different OCH complexes experienced varying levels of mainstem flow inundation due to high flow events and new flow paths cut from the mainstem. With flow at its summertime average, OCH2.8R was directly connected to the mainstem at its head, and a channel cut during the 2024 high flow event cut from mid-OCH2.8R to Swan Lake deposited some of this flow into Swan Lake, resulting in water quality consistent with the mainstem (Figure 2.5-2). During the same timeframe, a side channel to the EFMR cut adjacent to ADF&G's AVCT, inundating the lower WFMR with cold, turbid water. Near the river mouth where the channel exited the former mitigation ponds, higher flows inundated acres of marsh grass and interlacing tidal channels. Sampling of these areas under mainstem influence yielded catch of Dolly Varden, Coho Salmon, and both stickleback species, with the highest catch for a single 24-hour minnow trap set seen in the Swan Lake Outlet during its summer inundation. These catches indicate that despite the cold (~2–4°C) and turbid conditions, salmonids were actively using these areas, suggesting that slower, deeper water, which is known preferred habitat for juvenile Coho Salmon (ADF&G 2019; Beecher et al. 2002) and largely absent within the mainstem channel, may be the primary limiting factor in juvenile salmonid use of the mainstem Martin River.

3.6.3 Thermal Impacts on Fish Development

The Martin River watershed hosts a diverse collection of habitats, from its glacial mainstem to shallow, marshy lakes, between which aquatic fauna can find myriad temperature conditions that transition in space and time both predictably (warmer water in OCH and colder glacial water in the mainstem) and stochastically (inundation of OCH with mainstem flow driving summer temperatures down). Water temperature plays an important role in the development and bioenergetics of fish and the productivity of aquatic systems, so these varying conditions result in diverse habitat conditions and qualities that are reflected in the salmonid populations of the Martin River.

Sampling for YOY salmonids during spring and summer visits illustrated the difference in both emergence timing and size of Dolly Varden, Coho Salmon, and Sockeye Salmon from the same cohorts. In spring, only Red Lake hosted YOY Sockeye Salmon, and Red Lake, the WFMR, and OCH4.2R hosted YOY Coho Salmon. In our summer trip, YOY Coho Salmon were present in all sampled OCHs aside from OCH1.7L and OCH1.7R, while YOY Sockeye Salmon appeared in OCH2.8R and Red Lake. Fish captured in summer at sites without fish captures during spring were noticeably smaller than the same age class from Red Lake, the WFMR, or OCH4.2R. This is not a surprise given these three areas have consistently had the highest water temperatures observed in the watershed (Figure 2.5-1). Warmer temperatures lead to faster egg development and earlier emergence—reaching the required accumulated thermal units (ATUs) more quickly (~700 for Dolly Varden, 700–800 for Coho Salmon, and 900–1,000 for Sockeye Salmon; Kraus 1999). This suggests the YOY observed in OCHs during the summer surveys had not yet emerged during the spring sampling in late May, likely due to cooler thermal conditions in their natal OCHs. Further, some of the YOY captured in the summer had visible remnants of their yolk sac (Photo 3.5-1), indicating they recently emerged from the gravel. The watershed's diverse thermal regime appears to create a broad emergence window, from early May to late July for Coho Salmon and Sockeye Salmon.

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