Humboldt Redwood™

Class I Stream Aquatic Habitat Trends Monitoring

2019 Annual Report

June 30, 2020

Project Description:

Title: Class I Stream Aquatic Habitat Trends Monitoring

Purpose: Habitat Conservation Plan Aquatic Monitoring

Dates Initiated: February 1999 (HCP §6.3.5.3 Class I Aquatic Trend Monitoring Program; October 1999 (NCRWQCB Bear Creek Monitoring Plan, NCRWQCB North Fork Elk River Monitoring Plan)

Projected End Date: Ongoing

Project Manager: Keith Lackey

Executive Summary:

Long-term monitoring of fish-bearing (Class I) streams was initiated with adoption of the Habitat Conservation Plan (HCP) in 1999 with the goal to collect data to determine if salmonid habitat conditions across the property meet or are trending towards Aquatic Properly Functioning Conditions (APFC). The Pacific Lumber Company had an ongoing stream monitoring program when the HCP was adopted in 1999, and many of the existing sites were included in the newly created Aquatic Trends Monitoring (ATM) program. Sites were selected with the advice and approval of HCP signatory agencies and the North Coast Regional Water Quality Control Board (NCRWQCB). Representative stream reaches included in the ATM program were chosen for a variety of factors that included access, distribution, gradient, percentage of HCP coverage in the watershed, and watershed interest. Currently, habitat conditions are assessed at 44 sites and stream temperature is recorded at 49 sites.

Unlike *effectiveness* monitoring, *trend* monitoring is not intended to evaluate specific management practices. Trend monitoring results may, over time, corroborate the findings of effectiveness monitoring but are also strongly influenced and constrained by inherent watershed conditions and processes, apart from management, including drainage area, geology and geomorphology, topography, vegetation, and climate. Due to improvements in timber harvest practices required by the California Forest Practice Rules and Humboldt Redwood Company's (HRC) HCP, recovery of aquatic habitat, where currently impaired, is expected to occur over time to the extent provided for by inherent watershed conditions. HRC's ATM program is designed to test this hypothesis as it tracks watershed trends over time.

ATM sites are distributed across HRC's ownership and situated in all eight (8) HCP-designated Watershed Analysis Units (WAU). Monitoring sites are currently more tightly clustered in three watersheds of special interest - Elk River, Freshwater Creek, and Bear Creek - to better understand conditions of impairment and trends. All three of these watersheds, listed as impaired water bodies under section 303(d) of the Federal Clean Water Act, provide important aquatic habitat for salmonids including coho, and are currently of particular interest to the NCRWQCB.

HRC simplifies the presentation of habitat status by taking a pass/fail approach to the APFC target criteria, resulting in habitat composite scores for each WAU. The following is a brief summary of survey results in 2019:

In the Van Duzen WAU, the greatest improvements in habitat composite scores were observed in bed surface and mid-channel canopy cover. However, the composite scores for LWD piece frequency and stream temperature were lower than the 2016 and baseline records. The 2019 pool characteristics score remained even with the 2016 record, yet lower than the baseline record. No juvenile coho salmon were observed within any of the Van Duzen ATM stations in 2019, although steelhead of various size classes were found in every pool snorkeled.

In the Lower Eel River WAU, for Bear Creek, results of habitat composite scores from 2019 remained stable from the previous year in 2018. Canopy cover in the Bear Creek watershed continued to show the least improvement of all other monitored habitat parameters when measured against baseline (2004) records. No juvenile coho salmon were observed within any of the Bear Creek ATM stations in 2019, although steelhead of various size classes were found in every pool snorkeled.

For the remaining ATM stations in the Lower Eel River WAU, results of habitat composite scores from 2019 suggest no habitat improvements since 2016. Pool characteristic scores in 2019 declined (-9%) and LWD scores declined (-200%). However, canopy cover and water temperature have consistently produced perfect habitat scores over the last two survey years. No juvenile coho salmon were observed within any of the remaining Lower Eel River ATM stations in 2019, although steelhead of various size classes were found in every pool snorkeled.

Reviewed:

Director, Forest Science

Sal Chinnici

Project Manager/ Primary Author

Aquatic Biologist

Keith Lackey

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INTRODUCTION

HRC manages nearly 210,000 acres of redwood and Douglas-fir forests in Humboldt County, California for long-term production of forest products with a high level of environmental stewardship. These timberlands, located in the erosive sedimentary terrain of the northern coast of California, have been extensively roaded and periodically logged since the 1860's. Intensive watershed and property-wide studies have documented ecological impacts from past management activities. One hundred and fifty years of management has increased sedimentation to streams and disturbed riparian forests as documented throughout the Pacific coast region. Streams within the timberlands are important freshwater spawning and rearing habitat for salmonids including coho (*Oncorhynchus kisutch*), Chinook (*Oncorhynchus tshawytscha*) and steelhead (*Oncorhynchus mykiss*). These species (covered under the HRC HCP) have been federally listed as threatened within much of coastal northern California, including watersheds where HRC has ownership, due in part to impairment of freshwater habitat.

PROGRAM OVERVIEW

Beginning in 1999 with the establishment of a multi-species HCP, first the Pacific Lumber Company, and then HRC beginning in July of 2008, has managed the timberlands utilizing new sediment control and riparian forest management strategies to improve the aquatic habitat for covered species. HRC's current forest practices are designed to protect and restore aquatic habitats by reducing timber harvest-related erosion rates and sediment supply to the stream and to manage riparian forests to enhance their ecological values. Management activities are guided by the Aquatics Conservation Plan (ACP), part of the HCP (Section 6.3), developed with state and federal agencies, and through various permits issued by the NCRWQCB.

HRC has been steadily working to reduce sediment with a combination of state-of-the-art road construction practices, a commitment to reconstruction or decommissioning of older roads, and use limitations that prevent damage to roads and prevent sediment delivery to streams. Harvest-related sediment is controlled through geologic hazard identification and geologist field investigation during timber harvesting plan (THP) layout. Riparian forests are left relatively undisturbed to provide shade and large woody debris to streams. The company's silvicultural policies utilize uneven-aged silviculture and exclude harvest of any remaining large old growth trees on the property that meet HRC's Old Growth Tree Policy.

The primary goal of the ACP is to maintain, or achieve over time, a properly functioning aquatic habitat condition that will ensure the long-term viability of anadromous salmonids that utilize rivers and streams on the property, many of which are considered keystone to regional recovery efforts. To assess progress towards this goal, an APFC matrix of habitat variables defining important freshwater habitat characteristics for salmonids compiled by the National Marine Fisheries Service (NMFS) is referenced in the HCP. APFC criteria were derived from laboratory and field research conducted throughout the Pacific Northwest, and while they define generalized target values, they have not been calibrated for HRC lands necessarily. Similar criteria have also been developed by the NCRWCB to meet requirements of the Clean Water Act (NCRWCB 2004).

MONITORING PROGRAM DESIGN

Long-term monitoring of fish-bearing (Class I) streams was initiated with adoption of the HCP in 1999 with the goal to collect data to determine if salmonid habitat conditions across the property meet, or are trending towards, APFC matrix target conditions during the 50-year span of the HCP (1999-2049). The basic design of this monitoring program is to repeatedly measure the habitat characteristics of stream reaches within the portion of watersheds utilized by anadromous salmonids. Permanent sites are located within "response reaches" that contain less than 4% gradient (Montgomery and Buffington, 1998) on fish-bearing streams (Class I streams). Sites are distributed throughout HRC property. All of these streams currently or historically provided habitat for anadromous salmonids, including coho and Chinook salmon and steelhead trout, although species dominance has traditionally varied within the watersheds.

Figure 1. Class I stream, Elk River

A sampling site is a stream reach that is at least 30 channel widths long. The sampling length of most sites is approximately 200 to 400 meters (approximately 600 to 1200 feet) in length. The location of the sampling reach is permanently benchmarked to facilitate repeated measurement.

TREND MONITORING SITES

HRC's ownership includes land in nine major drainages including the Yager, Lawrence, Freshwater and Larabee Creeks, and the Bear, Elk, Eel, Van Duzen, and Mattole Rivers. Ownership is generally blocked within these basins. HRC owns most of the area in some watersheds while company ownership is a small portion of others. To facilitate analysis of this extensive property, HRC has divided its ownership into eight Watershed Analysis Units (WAU). Watershed analysis has been completed on each of these areas, including Freshwater Creek, Elk River, Van Duzen River, Yager/Lawrence, Upper Eel, Lower Eel and Eel Delta, Bear River, and Mattole River watersheds. These WAUs were delineated, in part using the boundaries of the state of California's Planning Watersheds. A description of the location, physical characteristics, major watercourses, and dominant vegetation within each WAU in great detail can be found in the Watershed Analysis documents prepared for each watershed.

A site location map of currently active ATM sites is provided in Figure 2 which shows the active monitoring stations, organized by WAU and arranged by drainage area. Currently, there are 44 habitat monitoring sites and 49 temperature monitoring sites.

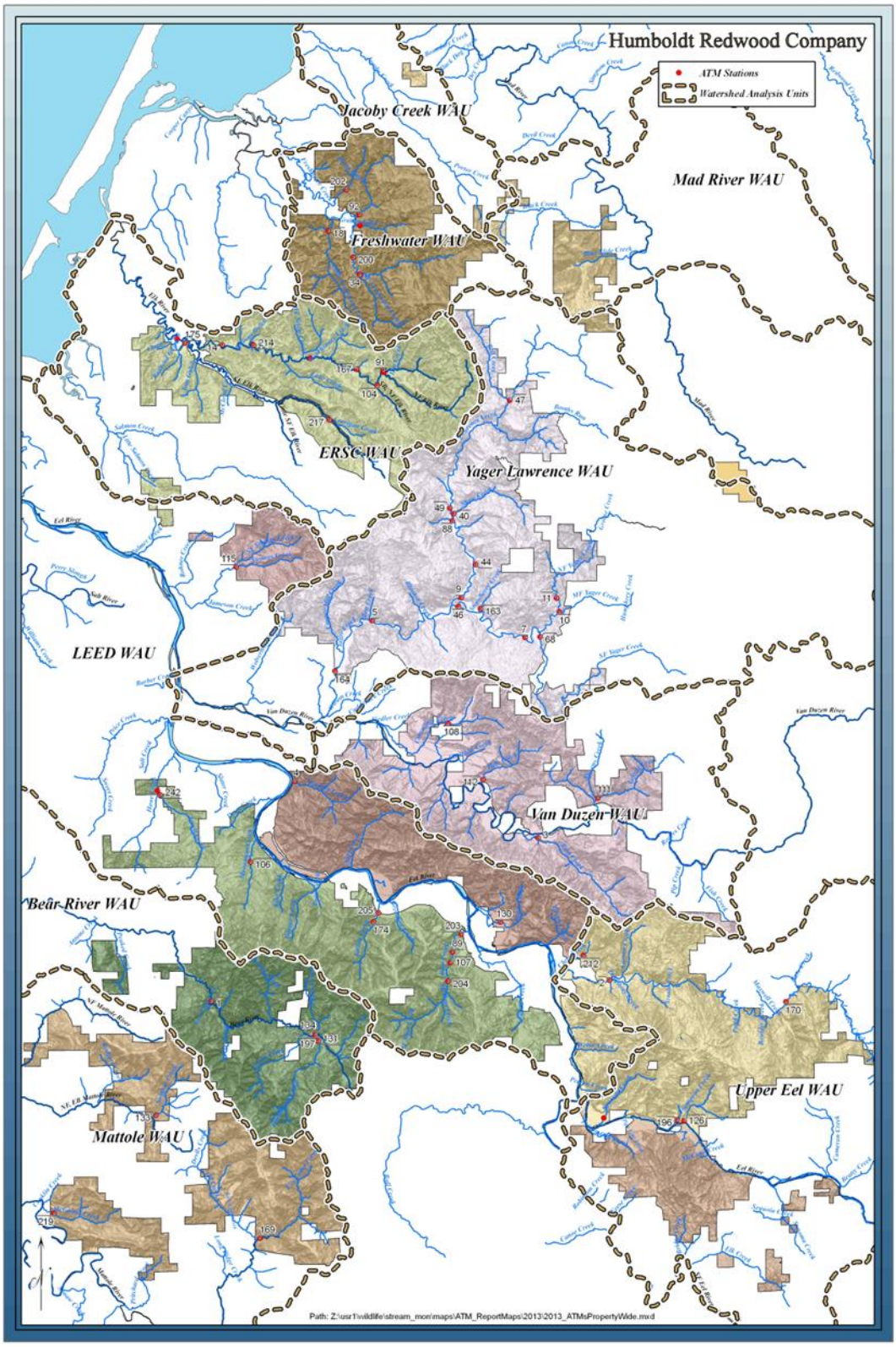

Figure 2. Location map of HRC ATM sites

Table 1. Site statistics and sampling rotation of active ATM sites. Cells marked with an "X" indicate current monitoring activities and rotation year in which monitoring will be conducted

Station ID	Stream Name	Upstream Watershed Acreage[1]	Upstream Area (mi^2)	Township Range Section	Reach Gradient (%)	Elevation (ft)	Temperature (Annual)	Stream Habitat Parameters	Rotation Schedule		
									2019	2020	2021
HUMBOLDT BAY WAU											
	Freshwater Creek Drainage										
34	Freshwater Creek	5,609	8.8	04N 01E 15	0.9	190	X (+Air)	X		X	
15	South Fork Freshwater Creek	2,019	3.2	04N 01E 15	1.7	183	X	X		X	
200	Freshwater Creek	7,911	12.4	04N 01E 10	0.4	134	X	X		X	
19	Graham Gulch	1,588	2.5	04N 01E 03	1.4	95	X	X		X	
92	Cloney Gulch	2,968	4.6	04N 01E 03	0.9	85	X	X		X	
202	McCready Gulch	1,084	1.7	05N 01E 34	2.3	111	X	X		X	
18	Little Freshwater Creek	2,980	4.7	04N 01E 04	0.8	65	X	X		X	
	Elk River Drainage										
104	South Branch NF Elk River	1,207	1.9	04N 01E 35	2.8	360	every 10 years (next = 2022)			X	
167	North Fork Elk River	7,230	11.3	04N 01E 34	2.1	262	X	X		X	
162	North Fork Elk River	8,738	13.7	04N 01E 28	0.6	134	X	X		X	
214	North Fork Elk River	12,302	19.2	04N 01E 30	0.2	80	X	X		X	
217	South Fork Elk River	4,030	6.4	03N 01E 3	1.6	510	X	X		X	
175	South Fork Elk River	12,200	19.1	04N 01W 26	0.0	39	X	X		X	
166	Elk River	26,393	41.2	04N 01W 26	0.1	39	X	X		X	
YAGER WAU											
	Lawrence Creek Drainage										
47	Lawrence Creek	7,477	11.7	03N 02E 04	3.5	1111	X				
49	Lawrence Creek	18,332	28.6	03N 02E 19	1.1	587	X	X			X
40	Shaw Creek	3,431	5.4	03N 02E 19	1.4	577	X	X			X
88	Corner Creek	1,252	2.0	03N 02E 30	8.7	567	X				
9	Lawrence Creek	26,676	41.7	02N 02E 06	0.2	432	X (+Air)	X			X
	Yager Creek Drainage										
11	North Fork Yager Creek	29,869	46.7	02N 02E 02	1.0	596	X				
10	Middle Fork Yager Creek	5,985	9.4	02N 02E 02	1.7	577	X				
68	South Fork Yager Creek	6,807	10.6	02N 02E 10	2.0	551	X (+Air)				
7	Yager Creek	44,060	68.8	02N 02E 10	0.8	511	X	X			X
46	Yager Creek	48,394	75.6	02N 02E 06	0.5	429	X	X			X
5	Yager Creek	80,623	126.0	02N 01E 11	1.3	246	X	X			X
VAN DUZEN WAU											
111	Grizzly Creek	7,181	11.2	01N 02E 01	1.6	390	X (+Air)	X	X		
3	Root Creek	3,771	5.9	01N 02E 15	0.3	314	X	X	X		
112	Hely Creek	2,306	3.6	01N 02E 05	1.7	239	X	X	X		
108	Cummings Creek	1,894	3.0	02N 02E 30	2.5	383	X	X	X		

Table 1 (continued). Site statistics and sampling rotation of active ATM sites. Cells marked with an "X" indicate current monitoring activities and rotation year in which monitoring will be conducted

Station ID	Stream Name	Upstream Watershed Acreage[1]	Upstream Area (mi^2)	Township Range Section	Reach Gradient (%)	Elevation (ft)	Temperature (Annual)	Stream Habitat Parameters	Rotation Schedule		
									2019	2020	2021
EEL RIVER WAU											
	Upper Eel River Drainage										
126	Thompson Creek	2,463	3.8	01S 03E 29	4.1	154	X	X		X	
122	Newman Creek	1,878	2.9	01S 02E 25	2.3	131	X	X		X	
	Larabee Creek Drainage										
170	Larabee Creek	39,709	62.0	01S 03E 12	0.4	738	X	X		X	
212	Chris Creek	835	1.3	01W 02E 35	0.9	180	X	X		X	
2	Larabee Creek	53,633	83.8	01S 02E 01	0.9	137	X (+Air)	X		X	
	Lower Eel River Drainage										
106	Middle Monument Creek	2,851	4.5	01N 01E 18	2.8	154	X	X	X		
174	Middle Jordan Creek	2,791	4.4	01N 01E 26	3.5	164	X	X	X		
205	Lower Jordan Creek	2,895	4.5	01N 01E 26	2.2	120		X	X		
130	Shively Creek	1,403	2.2	01N 02E 28	0.9	157	X	X	X		
	Bear Creek Drainage										
204	Bear Creek	4,302	6.7	01S 02E 06	3.8	320		X	X	X	X
107	Bear Creek	5,026	7.9	01N 02E 31	1.7	232	X (+Air)	X	X	X	X
203	Bear Creek	5,449	8.5	01N 02E 31	1.4	120	X	X	X	X	X
	Eel River Delta Drainage										
171	Stitz Creek	2,519	3.9	01N 01E 15	--	148	X				
242	Atwell Creek	2,747	4.3	01N 01W 3	1.5	170	X	X	X		
BEAR RIVER WAU											
131	Harmonica Creek	2,625	4.1	01S 01E 16	1.6	1302	X	X			X
134	Pullen Creek	1,673	2.6	01S 01E 16	1.7	1302	X	X			X
197	Bear River	1,935	3.0	01S 01E 16	1.4	1280	X (+Air)	X			X
1	Bear River	15,103	23.6	01S 01W 12	1.0	924	X	X			X
MATTOLE RIVER WAU											
133	Sulphur Creek	2,452	3.8	01S 01W 27	2.1	1105	X	X			X
169	Upper NF Mattole River	5,507	8.6	02S 01E 19	2.2	596	X (+Air)	X			X
219	McGinnis Creek	3,789	5.9	02S 01W 35	1.2	135	X	X			X

METHODS

Sampling Schedule

ATM sites in Bear Creek within the Lower Eel – Eel Delta (LEED) WAU have been sampled each year at the request of the NCRWQCB. Habitats at the remaining ATM sites are re-surveyed every three (3) years, except for ATM site 104 within the Elk River drainage, which will be monitored once every nine (9) years per verbal request from staff at California Department of Fish and Wildlife (Nick Simpson, pers comm, 2016). See Table 1 above for the general habitat monitoring schedule. Water temperature is monitored annually at nearly all ATM stations, including some stations where habitat sampling has been discontinued.

Habitat sampling frequency is increased following significant storm events. Out-of-sequence sampling is triggered by the occurrence of a 10-year flood in either the Eel River or the Van Duzen River as measured at USGS gages at Scotia (11477000) and Bridgeville (11478500), respectively. Monitoring may also be triggered by a 25-year recurrence precipitation event as recorded at National Weather Service weather stations at either Scotia or Eureka. Both flood and precipitation events were exceeded in Freshwater and Elk River in December 2002 and have not been observed since.

Sampling Methods

Each ATM site consists of a stream reach that is at least 30 channel widths long. Table 2 lists the primary parameters reported in the ATM program, and references HRC's detailed measurement protocols (Standard Operating Protocols) for collecting data. Methods are summarized very briefly here.

Table 2. Parameters measured in the HRC ATM monitoring program

Characteristic	Measurement Parameters	Standard Operating Protocol
Channel dimensions	Channel gradient Channel width Cross-sectional area	SOP-15: *Aquatic trends monitoring site selection, monumenting and documentation* SOP-31: *Surveying with total station*
Particle-size distribution within bed surface substrate	Particle-size classes: (D_5, D_{16}, D_{50}, D_{85})	SOP-13: *Surface and sub-surface sediment sampling*
Pool dimensions and wood association	Pool area Pool spacing Residual pool depth % Pools associated with wood	SOP-14: *Stream Habitat Typing*
LWD frequency and distribution	Frequency (# pieces/100 ft.) Total piece count	SOP currently in progress
Water temperature	Maximum Weekly Average Temperature MWAT (˚C)	SOP-09: *Temperature instrumentation and deployment*
Riparian canopy cover	% Canopy cover over the stream (mid-channel canopy cover) % Canopy cover in the riparian forest (riparian overstory canopy cover)	SOP-12: *Stream and riparian canopy cover measurement*

Bed Surface Particle Size

Pebble count measurements collected at riffles are used to assess the APFC matrix target for D_{50} (diameter of the median [50th of 100] particle) and three additional size classes ($D_{5,}$ D_{16}, D_{85}). These sediment measures can be tracked over time to determine whether bedload sediments in a watercourse are generally becoming coarser or finer, in response to in-channel erosion and changes in sediment loading rates from hillslope sources including cumulative effects from management activities.

Figure 3. Measuring particle size (mm) of the streambed surface

The first three (3) riffles are sampled within each monitoring reach by transecting back and forth over the entire riffle within the active channel. The intermediate axes of 200 pebbles are measured at each riffle (Figure 3). The median particle size is determined for each of the D parameters, although APFC target values have only been established for D_{50}. Results are reported as mean values within the APFC report card, as well as cumulative particle size frequency plots (Figure 4), which serve to provide a visual aid for improved interpretation. Over time, it is expected that trends will develop that will suggest an overall fining or coarsening of the channel substrate towards APFC target values to the extent provided for by inherent watershed conditions.

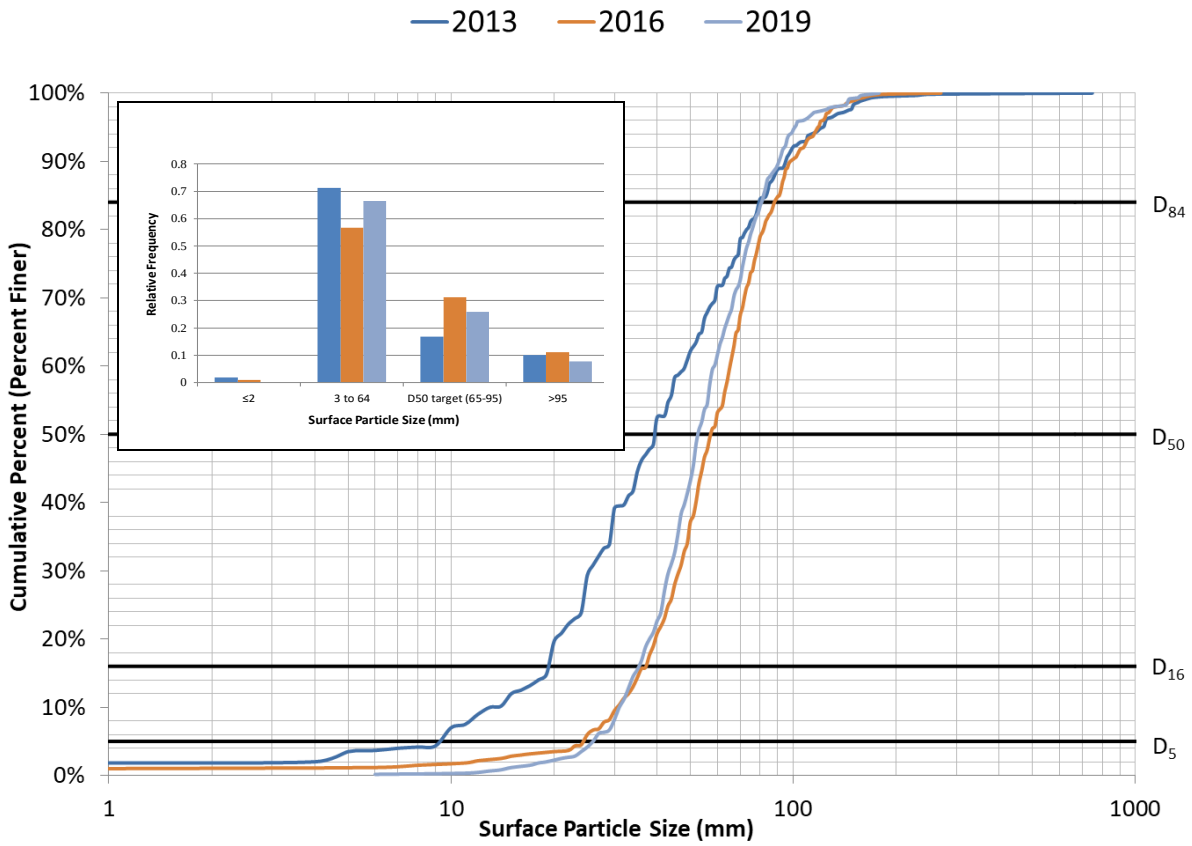

Figure 4. Example of a cumulative frequency (percent finer) plot of the mean surface particle sizes (mm) of three riffles measured within an ATM survey reach

Channel Dimensions

Cross-sectional streambed surveys are conducted to determine streambed elevation and area changes over time (Figure 5). Adjustments in channel dimensions may be sensitive to sediment and LWD loading within the stream channel and are expected to be correlated to habitat type characteristics. Streambed profiles indicate changes in channel dimensions and streambed scour or fill. Streambed topography is measured using standardized total station survey techniques (Topcon Positioning Systems, Inc.). This instrument was first deployed in 2003 to increase the accuracy and repeatability of streambed surveys that had previously been measured with an auto level. Permanent critical points (left/right bank cross-section pins) are installed at each monitoring station.

Each reach has a minimum of five (5) permanently benchmarked cross-sections that are measured in years when habitats are surveyed. The cross-sections are measured at each change in topography across

the channel. Cross-sectional area is determined below a reference elevation. This elevation is typically set at a channel feature associated with bank-full depth.

Data processing has been streamlined with electronic data collection, transfer, and processing. HRC has developed an Excel® spreadsheet to process cross-section data from x, y, z coordinates into standard measurements in the x-z plane. An additional spreadsheet computes channel area (m^2), width (m) and depth (m).

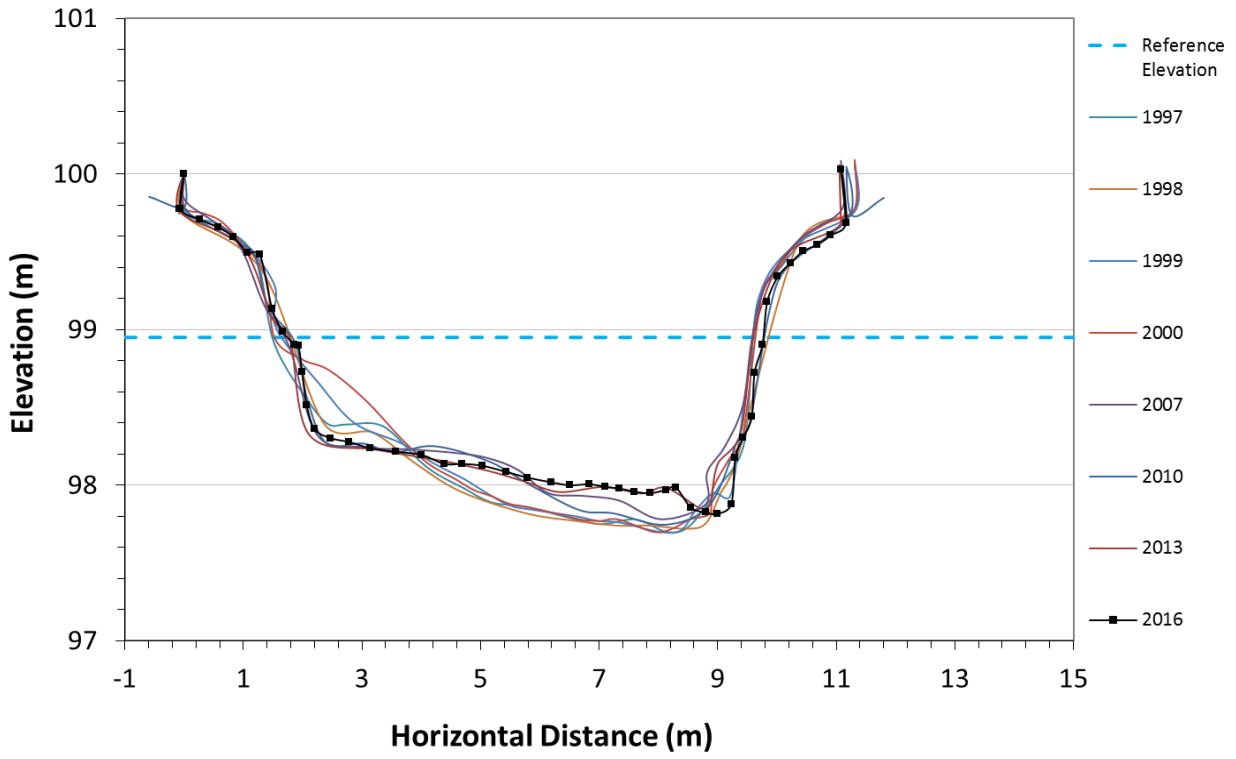

Figure 5. Example of a typical cross-sectional profile within an ATM survey reach

Large Woody Debris

LWD pieces within the bank-full stream channel of each ATM reach are counted to determine the total piece frequency of large wood available for creating fish habitat and molding channel morphology. To constitute a countable piece of LWD, individual pieces must be within the height of the bank-full channel and be a minimum of 20 cm in diameter and 2 meters in length. LWD data address APFC targets which are calculated from site-specific channel dimensions. The percent of pools associated with LWD parameter will continue to be collected as part of pool habitat measurements.

Pools

The primary rearing habitat parameters measured in the ATM program are pool characteristics. HRC conducts habitat typing on stream reaches to assess the frequency (i.e., the percentage of channel length composed of pools), size, and depth of pools. Measurements are performed at each habitat unit in the sampling reach. Habitat units are broken down to pool, riffle, or flat-water categories. Basic physical measurements such as length, width and residual depth are measured and observations of LWD influence are recorded.

Habitat typing addresses APFC matrix targets of pool-to-pool spacing based on bank-full channel width (CW), percent of surface area comprised of pool habitat, number of pools associated with LWD, and average residual pool depth. Residual pool depth is equal to the difference between maximum depth and pool tail crest depth.

Riparian Overstory

Canopy cover measurements (percent) are used to document growth and/or stability of riparian forests, as well as to identify streams that may be subject to higher thermal loading from sunlight. Canopy cover addresses the APFC matrix target for mid-channel canopy closure (Figure 6) and within the riparian forest (Figure 7). The mid-channel canopy cover is measured as an influence of the forest on maintaining cool water temperatures, taken mid-channel at 25m intervals throughout the sampling reach using a convex spherical densiometer (model A).

Figure 6. Pool habitat with overhead canopy

Figure 7. Redwood riparian forest overstory

Overstory canopy closure data in the riparian forest adjacent to the stream channel is also collected using the densiometer on a systematic grid pattern. While overstream canopy closure is measured every ATM survey cycle, beginning in 2015, no riparian forest canopy measurements are required in stands where ≥85% riparian forest closure was documented in the prior ATM survey *unless* significant disturbance (i.e. timber harvest, blow down, landslide, high mortality, fire) is evident.

Water Temperature

Figure 8. Stream temperature logger with protective PVC case

Stream temperature (℃) is tracked during the warmest part of the year (typically June through September). Temperature is monitored with continuous recording data loggers (Onset HOBO® Water Temp Pro v2). Temperature data loggers are inserted into protective PVC cases (Figure 8) and placed in the stream at a location that meets requirements for sufficient mixing, adequate cover, and consistent flows during the summer months to ensure data integrity by reducing the likelihood of thermal stratification. Temperature data are used to calculate the maximum weekly average temperature (MWAT), or the average of the daily mean temperature measured during the warmest seven consecutive days each year. The APFC target value for MWAT at all ATM stations is ≤16.8℃. Figure 9 illustrates a typical temperature profile as measured at ATM stations property wide.

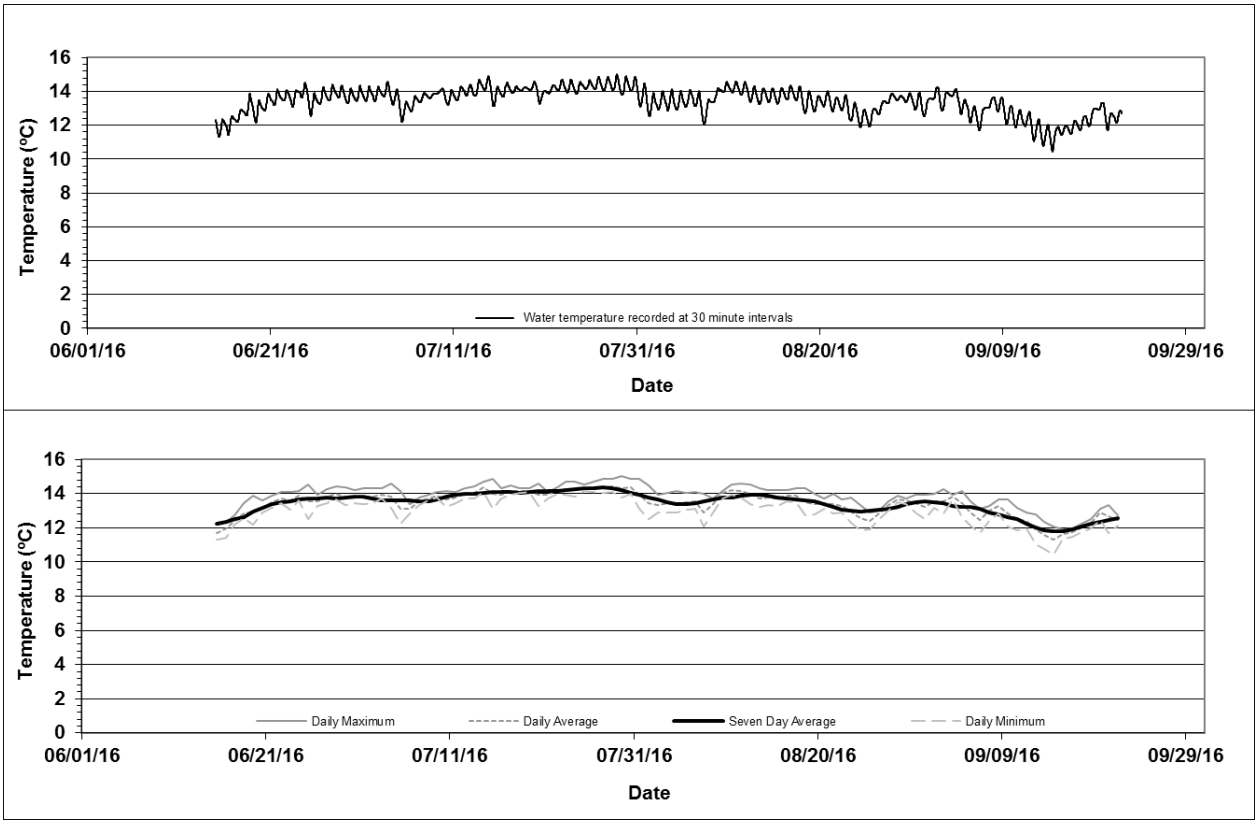

Figure 9. Example of a stream temperature profile generated from a continuously-recording temperature data logger deployed at most ATM stations annually

PROGRAM IMPLEMENTATION - 2019

In this section, we report on program implementation, including field activity, program milestones, quality assurance, and methods implementation. The monitoring program objectives are:

- Complete all yearly scheduled measurement activities.
- Report trends relative to APFC criteria.
- Complete all field data collection procedures in an efficient and timely manner, following all applicable Standard Operating Protocols (SOP).
- Complete all QA/QC goals for each project within the monitoring program.
- Provide data summaries and periodic analyses to HCP Signatory Agencies, NCRWQCB and make publicly available.
- Provide habitat and channel morphology information to the HRC Watershed Analysis Process and THP cumulative effects analyses.

LOCATIONS OF FIELD MEASUREMENTS

Table 3 lists the field activity scheduled for 2019 and accomplishments against this plan. Pebble count, canopy closure, habitat typing, and streambed surveys were conducted at 12 stations in the Van Duzen River, Lower Eel River, and Bear Creek drainages. Stream temperature loggers were deployed at 49 sites property wide, however, 2 were lost in the field due to an unseasonably large storm event in late May and 1 was destroyed due to vandalism. All fieldwork was completed within the scheduled time period. All other habitat data collection occurred prior to any major storm events.

Table 3. 2019 measurement activity in the ATM Program

Watershed	Habitat		Temperature	
	Scheduled	Completed	Scheduled	Completed
Freshwater Creek	None	None	7	6
Elk River	None	None	7	6
Yager Creek	None	None	6	6
Lawrence Creek	None	None	5	5
Van Duzen River	4	4	4	4
Eel River Delta	1	1	2	2
Lower Eel Tributaries	4	4	3	3
Bear Creek	3	3	3	3
Upper Eel Tributaries	None	None	2	2
Larabee Creek	None	None	3	3
Mattole River	None	None	3	3
Bear River	None	None	4	3
TOTAL	**12**	**12**	**49**	**46**

UPDATES TO METHODS

Updates to pebble count analysis methodology were made in 2015 which expanded the parameters to include three (3) additional classes (D_5, D_{16}, and D_{85}). This was initiated as a substitute for the discontinued streambed subsurface particle size monitoring. Fining of the streambed is a concern property-wide and is a process that can be observed through pebble counts alone. If fining of the bed surface is observed, then one can assume that a similar trend is occurring in the subsurface. Results were reported as mean values within the APFC matrix, although an APFC target value has only been established for D_{50}. Additionally, cumulative frequency plots were developed to provide a visual aid for improved interpretation of the particle size distributions.

Method updates in 2014 related to the frequency of riparian canopy cover measurements conducted within a survey reach. The changes instituted in 2015 limit the riparian canopy measurements to only those ATM stations that had observed ≤85% closure during the previous survey year.

APFC targets for LWD are based on a bank-full width, as measurement of LWD is limited to the bank-full channel. These measurement limits require all field observers to consistently identify bank-full throughout each stream reach. This identification has proven to be inconsistent in previous years across individual surveyors. In order to address this issue, the HRC hydrologist and aquatic biologist will mutually delineate bank-full in the field throughout the monitoring reach and periodically re-flag said location prior to LWD surveys so that a greater degree of consistency can be extended into the future. Beginning in 2015, LWD measurements of diameter, length, volume, and key pieces were discontinued. Instead, total LWD pieces were counted within the survey reach to determine the total piece frequency (#/100 feet).

Beginning in 2015, the annual sampling regime in Elk River was changed from an annual to a three-year sampling rotation, as is applied elsewhere property-wide except for Bear Creek. This three-year rotation will provide adequate resolution to detect changes in river processes. Additionally, ATM sites 90 (Upper North Fork), 91 (North Branch North Fork), and 14 (North Fork) were discontinued and ATM site 104 (South Branch North Fork) will be monitored on a nine-year rotation as per a verbal request from staff at CDFW, scheduled to resume in 2022.

Beginning in 2012, snorkel survey counts have been conducted at each active ATM station to document fish species abundance within the first 5 pools of the monitoring reach. These surveys do not, nor do they intended to, estimate total fish populations within each watercourse. Rather, these snorkel surveys serve as an index to infer salmonid spawning success during the previous winter and track the spread of aquatic, non-native invasive species. Beginning in 2019, snorkel survey results will be provided with each annual ATM report.

QUALITY ASSURANCE ACTIVITIES

QA/QC activities have been implemented in the ATM program to varying degrees since 2002. Many of these activities are described within pertinent SOP's. Three stations were revisited in 2019 for QA/QC purposes.

All instruments and equipment used for sampling were inspected and maintained daily. Any instrument repairs and/or calibrations were made either by the manufacturer or following manufacturer guidelines.

Calibration of equipment was done on a regular schedule and upon any mishandling or questionable performance of the instrument.

QA/QC results are presented beginning on page 87 of this document.

PRESENTATION OF RESULTS

Current data derived from long-term stream habitat monitoring stations are provided and a simplified method for tracking habitat conditions and trends is presented below.

The basic compilation of data measured at each ATM station is provided in a "report card", an example of which is illustrated in Table 4. Each of the 44 active ATM stations have up to nine (9) APFC parameters with targets addressing habitat factors related to streambed substrate, pools, LWD, forest canopy and water temperature. The table cell is colored blue if the parameter met or exceeded the APFC target, white if it did not meet the target, green if there are no established APFC targets, and grey if there are no data associated with the parameter. These tables are used as the primary metric in which to evaluate current data collection. Parameters without assigned APFC target values will not be included in the total number of opportunities for success.

The report card groups ATM stations by WAU and provides the measured value for each of the nine parameters from each year of measurement. Stations included in this report were monitored in 2019. Previous measurements from WAUs not monitored in 2019 can be found in previously submitted ATM annual reports.

Table 4. Example watershed report card

2019	Parameter	Target Value (# no target)	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6	Station 7	Station 8	Station 9	Station 10
Bed Surface	D_{84} (mm)	#	66	88	98	98	114	110	94	126	93	77
	D_{50} (mm)	65-95	30	38	28	42	46	56	39	68	65	31
	D_{16} (mm)	#	12	8	2	6	4	20	12	25	9	6
	D_5 (mm)	#	8	1	1	1	1	4	3	4	2	1
Pool Characteristics	Pool Area (%)	≥25	22	61	32	32	26	35	47	37	26	11
	Pool Spacing (CW/pool)	≤6.0	5.0	5.5	3.3	2.6	4.8	3.2	2.6	4.1	3.9	7.3
	Residual Pool Depth (m)	≥0.91	0.42	0.61	0.60	0.57	0.67	0.57	0.49	0.52	0.62	0.53
	Pools Assoc. w/wood (%)	≥50	100	100	100	100	100	100	85	88	100	100
Large Woody Debris	Total Piece Frequency (#/100 ft)	≥5.1	12.9	12.7	6.2	6.3	5.6	7.3	4.7	4.7	8.6	7.4
	Total Piece Count	#	148	145	71	72	65	87	57	46	70	85
Water Temperature	MWAT (°C)	≤16.8		17.9	19.5	18.7	18.1	17.9	15.9	15.5	15.5	17.2
Riparian Overstory	Canopy Over Stream (%)	≥90	24	38	35	26	57	40	97	80	77	83
	Canopy of Rip Forest (%)	≥85	90	96	97	85				96	99	96

HRC synthesizes and simplifies presentation of habitat status by taking a pass/fail approach to the APFC target criteria. A "success" can be considered when a habitat parameter meets or exceeds APFC criteria. Each station/parameter combination is considered an opportunity for "success". If a certain WAU contains ten (10) stations, there are ten (10) opportunities for success for each individual parameter. If here are nine (9) parameters and 10 stations, there are 90 opportunities for success. Note that in Table 4 there are two (2) stations that do not have total LWD piece counts and four (4) stations that do not have riparian forest canopy measurements, reducing the total number of opportunities to 84.

The "Composite Habitat Score" is equal to the success rate, which is calculated as:

$$\text{Composite Habitat Score} = \frac{Number\ of\ Successes}{Number\ of\ Opportunities}$$

Within each WAU report card, the total number of blue cells equals the total number of successes documented for an individual year. This allows for a relatively standardized and streamlined approach to evaluate each watershed. In Table 4, there are 48 successes, yielding a watershed composite habitat score of 0.56 (out of 1.00) for the WAU's ten stations.

One of the benefits of this scoring approach is that there is a great deal of flexibility in computing the habitat score for any number of "groupings". A score can be computed for all parameters at an individual station, for all the stations in a WAU (as shown in Table 4) or for the entire HRC property. We can also create groups of the parameters related to key habitat factors. There is one (1) parameter related to bed surface substrate, four (4) related to pool characteristics, one (1) related to large woody debris, two (2) related to canopy cover, and one (1) related to water temperature. We combine the status of a habitat factor by grouping like-parameters. For example, we group all pool characteristics (n=4) and stations (n=10), providing (n= [4 x 10] = 40) opportunities for success for achieving pool-related goals in the watershed. This type of grouping allows progress in habitat factors to be tracked independently.

The habitat scoring method currently in use is a very flexible presentation of data. A composite score can be computed for any grouping of stations and parameters and the fundamental meaning does not change. This composite can be tracked through time to indicate improvement towards APFC targets. The goal is 100% success in meeting all habitat conditions at all stations or a composite score of 1.0, regardless of groupings.

In summary, the composite habitat score contains the following characteristics:

- The focus is on achieving salmonid habitat goals.
- Habitat status is simple to depict.
- Many parameters that are derived from unique measurement techniques can be considered together.
- All parameters are treated equally.
- The method is relatively insensitive to the different measurement dates for stations and parameters as well as sample size.
- The analysis is not heavily weighted by parameter values at the beginning of the data record or outliers within the data record.
- Large changes in one parameter in one year will have a minimal effect on the composite score**.** The bulk of parameters or all the sites must change to move the score, depending on groupings.
- Intermediate levels of progress may be missed.

The calculation and utilization of composite scoring helps satisfy the need to quantify progress towards achieving habitat goals, but it is not considered a replacement for future statistical analyses of individual parameters as the data record lengthens. We also note that there is likely to be ongoing debate over time as to the appropriateness of specific APFC targets currently in use as scientific information increases. As long as there are specific target levels identified, the method can be accommodated to report status

relative to them. Individual data values will be reported in the results that follow but the habitat scoring approach will also be used extensively.

WATERSHED HABITAT RESULTS

WEATHER IN 2019

Precipitation is calculated by the "hydrologic year" that runs from October 1 through September 30 and is numbered for the year in which it ends. Rainfall data collected at the Woodley Island National Weather Station (NWS) in Eureka, CA, indicate an average total annual rainfall of 39.30 inches[1] with roughly 90% of the annual precipitation falling as rain during the months of October through May. Rainfall amounts in hydrologic year 2019 (October 1, 2018 to September 30, 2019) were moderately greater than average throughout HRC property.

The Eureka long-term National Weather Service station is indicative of climate for HRC property north of the Van Duzen River. Total annual rainfall at the NWS station in Eureka was 43.85 inches, approximately 12% greater than the long-term average. Maximum daily rainfall was 2.56 inches, suggesting that peak flows may have been high in certain watersheds. The previous rainfall year that could be considered relatively large in Eureka was 2006, when rainfall was well above average (58.67 inches or 49% greater than the long-term average).

Total annual rainfall at the NWS station in Scotia, CA in HY2019 was 57.12 inches, which is approximately 21% greater than the long-term average for this station. The maximum peak flow measured at the gaging station at the Eel River near Scotia equaled 272,000 cubic feet per second (cfs), with a corresponding maximum daily mean of 221,000 cfs occurring on February 27, 2019. The previous rainfall year that could be considered relatively large in Scotia was 2006, when rainfall was well above average (70.80 inches or 49% greater than the long-term average). Long-term annual precipitation records at the Woodley Island and Scotia NWS stations are provided in Figure 10.

Annual peak flows that represent the northern extent of HRC property are recorded at Graham Gulch (hydrologic monitoring station 505) in Freshwater Creek, and at Bear Creek (hydrologic monitoring station 530) which represent the southern extent of HRC property (Figure 11). Peak flow is expressed in cubic meters per second per unit area (cms/km^2) at HRC gaging stations. A value of 1 is approximately equal to a bank-full event. Along with rainfall distribution, peak flow magnitude is relatively variable across the range of HRC property.

[1] California Date Exchange Center (http://cdec.water.ca.gov/cgi-progs/profile?s=SCA&type=precip)

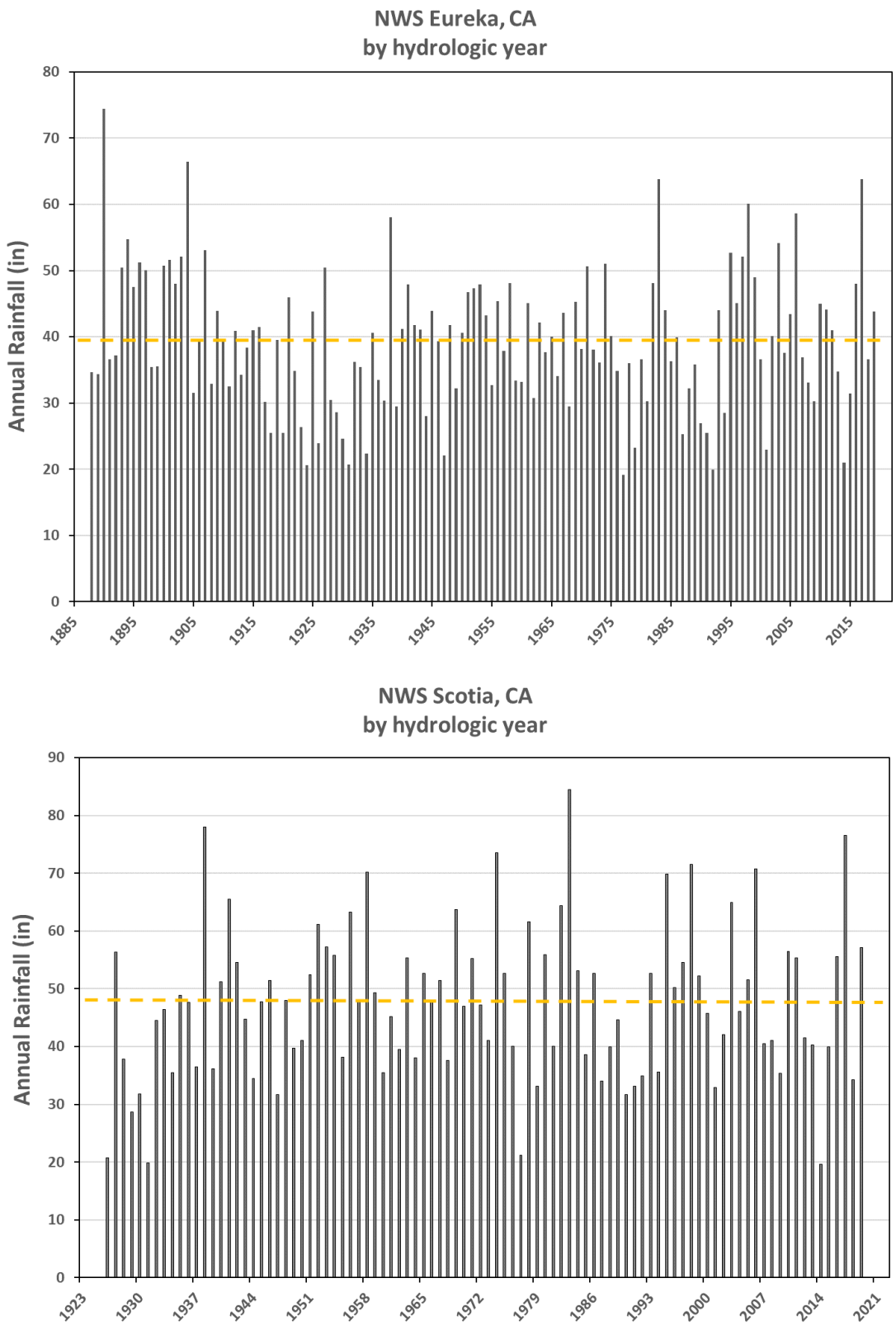

Figure 10. Annual rainfall by hydrologic year at Eureka and Scotia, CA. Dotted lines represent the running averages (all years)

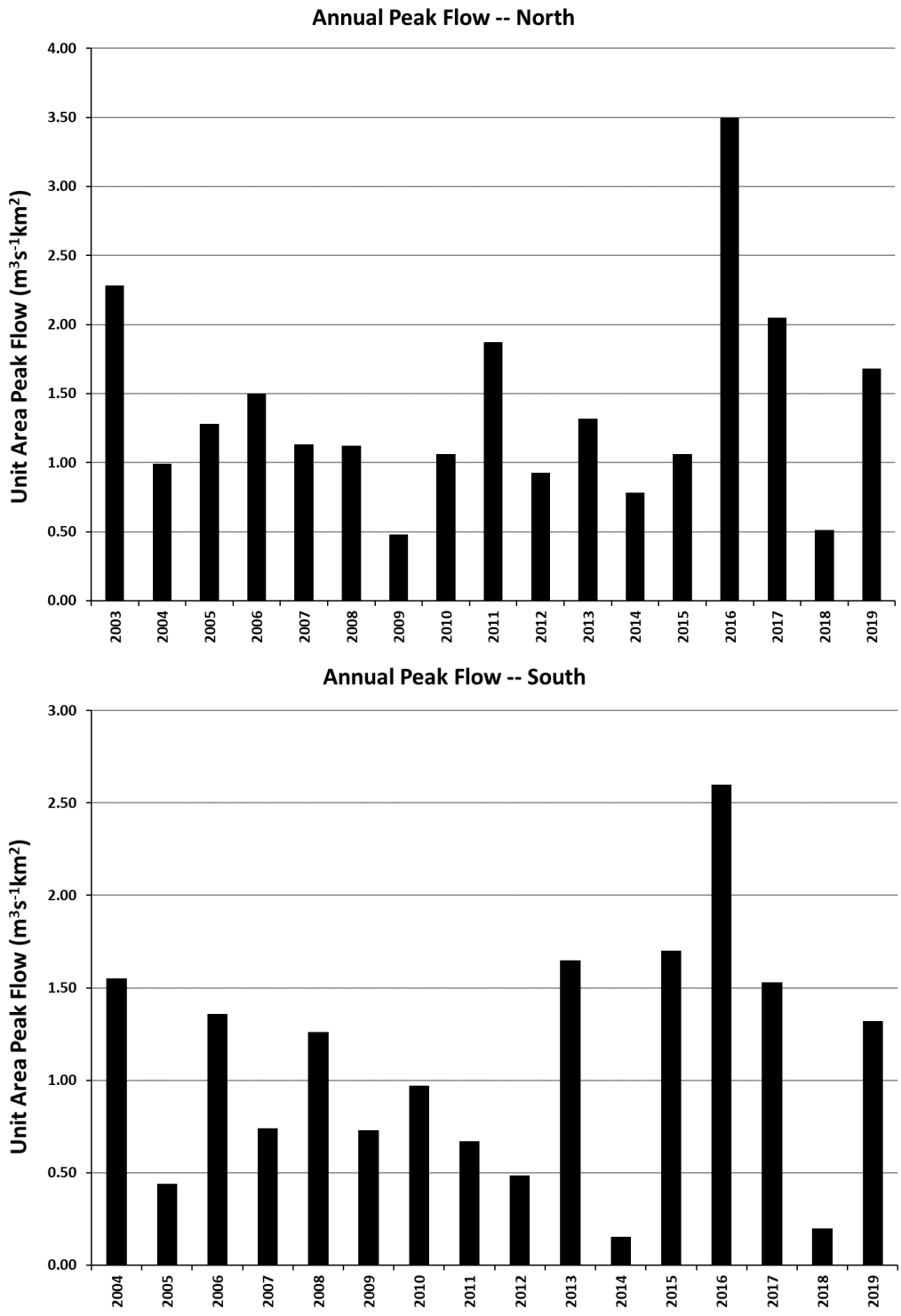

Figure 11. Reference streamflow sites are represented by Graham Gulch (site 505) in Freshwater Creek (north) and by Bear Creek (site 530) in the south

WATERSHED HABITAT STATUS

Table 5 illustrates the most recent collection of aquatic habitat data for each of HRC's eight WAUs. Stream temperature is measured annually in all watersheds within HRC property. The most recent data collected at each ATM site are provided in the form of the composite score card organized by WAU and individual site score cards within each WAU.

Annual variance may be relatively high within certain measured parameters as a result of fluctuation in storm magnitude, inherent sampling error, or unexplained variance that is not easy to determine. It should be noted that even large annual changes often do not persist from year to year, and therefore, only the more long-term deviations should receive greater attention when assessing habitat trends.

The full record of data collection for each ATM site sampled in 2019 including yearly snapshot report cards are provided in this report so that trends and associated sample variability can be assessed for each measured APFC target parameter.

Table 5. Year of most recent habitat data collection by watershed

WAU	2019	2020	2021
Freshwater Creek 015, 018, 019, 034, 092, 202, 200		X	
Elk River **104** **162, 214, 175, 166, 167, 217**		 X	
Yager /Lawrence 049, 040, 009, 007, 046, 005			X
Van Duzen 003, 108, 111, 112	X		
Upper Eel (Larabee, tribs to mainstem Eel River from Newman Cr south) 002, 122, 126, 170, 212		X	
Lower Eel and Eel Delta (tribs to mainstem Eel River north of Perrot Cr) **203, 107, 204** **106, 174, 205, 130, 242**	 X X	 X	 X
Bear River 001, 131, 134, 197			X
Mattole River 133, 169, 219			X

VAN DUZEN WAU

The Van Duzen WAU is centrally located within HRC's ownership, encompassing the lower three miles of Yager Creek and the Van Duzen river watershed excluding the headwaters. Approximately 45 percent of this area is located within HRC ownership.

Figure 12 shows the location of the Van Duzen WAU ATM sites, which are placed in four of the main tributaries that drain to the section of the Van Duzen River between Cumming's Creek and approximately 2.5 miles upstream of the confluence with Grizzly Creek. Habitat parameters were measured at these locations in 2019, and typical conditions are shown in Figure 13.

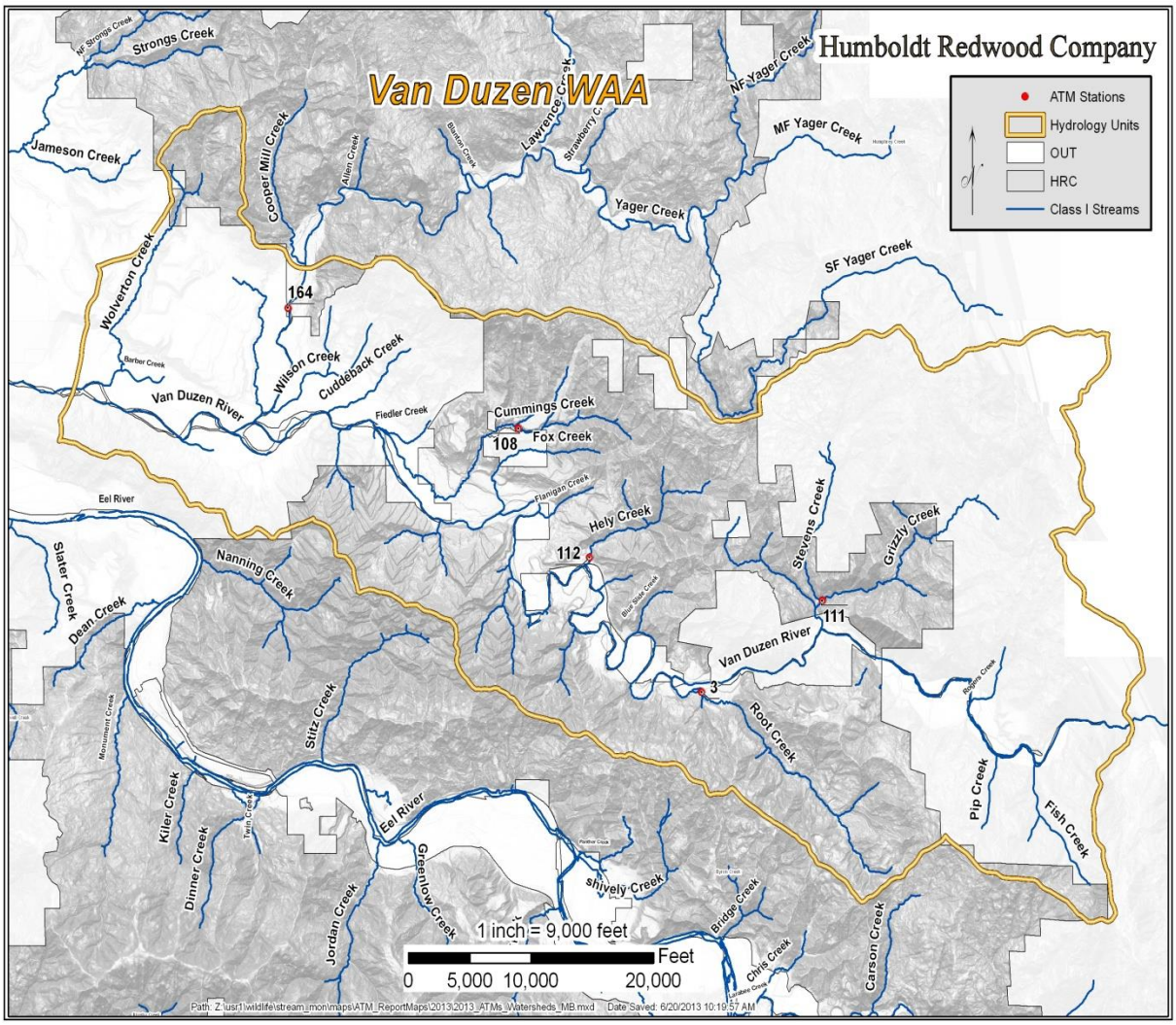

Figure 12. Location map of ATM stations in the Van Duzen WAU

Root Creek Station 003

Cummings Creek Station 108

Grizzly Creek Station 111

Hely Creek Station 112

Figure 13. ATM stations within the Van Duzen River WAU

ATM Station 003 – Root Creek [Underlying Geology: Quaternary age Alluvium (basement rock = Cretaceous to Pliocene age Coastal belt of the Franciscan Complex, specifically the Coastal terrane)]

Data for all ATM parameters at site 003 (Figure 13) are summarized in the APFC report card provided in Table 6. The bed surface APFC target was not met at this site in 2019, as the data suggest a fining of substrate particles within classes D_{84} & D_{50} and a coarsening of the substrates within particle classes D_{16} & D_5 (Figure 14). Pool characteristics remained generally static since 2004, with residual pool depth consistently failing to meet its target criterion. Total LWD pieces decreased by 61% since 2016, as total LWD piece frequency failed to meet the APFC target by a margin of 1.3 pieces per 100 feet of stream channel. Water temperature met the target two years straight since 2017, as mid-channel canopy met the target goal after failing only once in 2016.

Cross-section data suggest varying degrees of channel aggradation and scour since surveys were instituted in 1997 (see appendix). Aggradation was observed at 2/5 cross-sections between survey years 2016 and 2019, the greatest degree of which occurred at cross-section 2 (-0.73m^2). The greatest degree of channel scour occurred at cross-section 5 where the channel area increased +0.44m^2.

A snorkel survey conducted on 6/13/2019 identified juvenile trout in each of the 5 pools sampled (Figure 15). Foothill Yellow-legged frogs (*Rana boylii*) were also observed occupying the stream reach. Juvenile coho salmon have not been detected in this ATM reach since 2013.

Table 6. Individual site report card for ATM station 003, Root Creek

Site 003 Root Creek	Parameter	Target Value (# no target)	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Bed Surface	D_{84} (mm)	#	91	98			75			91			79			89			80
	D_{50} (mm)	65-95	43	46			36			49			41			59			54
	D_{16} (mm)	#	5	4			1			20			20			36			38
	D_5 (mm)	#	1	1			1			1			9			23			26
Pool Characteristics	Pool Area (%)	≥25	50	73			64			50			52			63			60
	Pool Spacing (CW/pool)	≤6.0	7.6	5.2			4.7			4.8			5.0			4.1			4.4
	Residual Pool Depth (m)	≥0.91	0.82	0.70			0.80			0.55			0.73			0.65			0.69
	Pools Assoc. w/wood (%)	≥50	100	83			100			100			83			88			100
Large Woody Debris	Total Piece Frequency (#/100 ft)	≥8.5	6.5							5.5			4.6			10.7			7.2
	Total Piece Count	#	56							40			36			92			57
Water Temperature	MWAT (°C)	≤16.8	15.7	16.3		15.6	15.5	15.1	15.2	14.0	14.6	14.2	16.2	15.4	16.4	15.1	17.2	15.5	16.2
Riparian Overstory	Canopy Over Stream (%)	≥91								100			98			90			93
	Canopy of Rip Forest (%)	≥85	99	100			100						99						

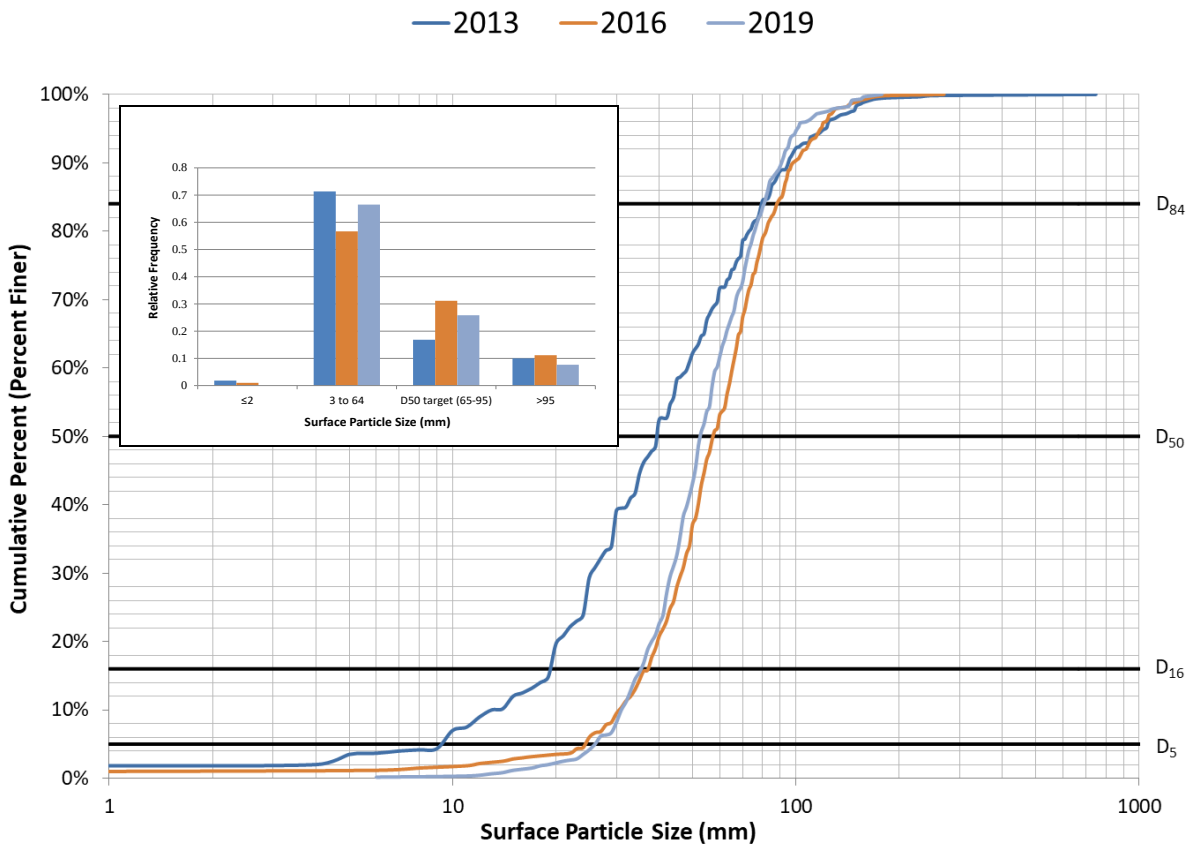

Figure 14. Cumulative frequency plot of the mean surface particle size of three riffles measured within the Root Creek ATM 003 monitoring reach (2013-2019)

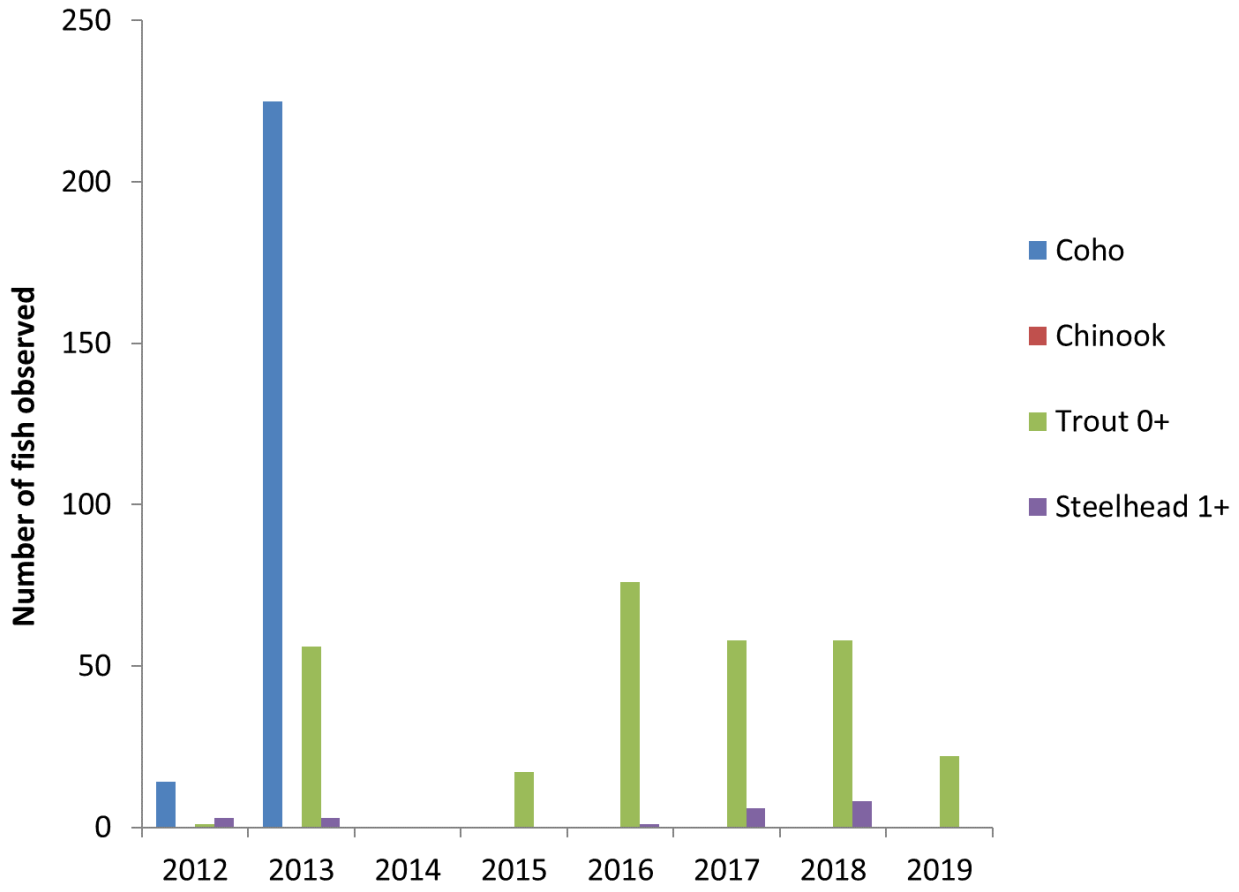

Figure 15. Results of annual snorkel survey fish counts of the first 5 pools within the Root Creek ATM 003 monitoring reach (2012-2019)

ATM Station 108 – Cummings Creek [Underlying Geology: Miocene to Late Pliocene age Wildcat Group]

Data for all ATM parameters at site 108 (Figure13) are summarized in the APFC report card provided in Table 7. The bed surface APFC target was not met at this site in 2019, though the data suggest a coarsening of the substrate across all particle size classes (Figure 16). Pool characteristics suggest a general decline in habitat quality since 2013, though 100% of pools surveyed were either formed by or associated with LWD. The total LWD piece frequency within the surveyed reach fell short of the APFC target by a margin of 4.4 pieces per 100 feet of stream channel, as total LWD pieces decreased 121% since 2016. Water temperature met the target goal for the 17th consecutive year on record, and mid-channel canopy cover met the target for the 4th straight survey year.

Cross-section data suggest varying degrees of channel aggradation and scour since surveys were instituted in 2007 (see appendix). Aggradation was observed at 2/5 cross-sections between survey years 2016 and 2019, the greatest degree of which occurred at cross-section 5 (-0.67m^2). The greatest degree of channel scour occurred at cross-section 3 where the channel area increased +0.14m^2.

A snorkel survey conducted on 6/20/2019 identified trout of various size classes in each of the 5 pools sampled (Figure 17). Also identified was one rough-skinned newt (*Taricha granulosa*). Juvenile coho salmon have yet to be detected in this ATM reach.

Table 7. Individual site report card for ATM station 108, Cummings Creek

Site 108 Cummings Creek	Parameter	Target Value (# no target)	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Bed Surface	D_{84} (mm)	#	69	95			153			136			129			102			105
	D_{50} (mm)	65-95	30	35			39			52			32			57			60
	D_{16} (mm)	#	2	4			1			11			4			22			28
	D_5 (mm)	#	1	1			1			2			1			5			9
Pool Characteristics	Pool Area (%)	≥25	25	55			15			18			9			15			4.6
	Pool Spacing (CW/pool)	≤6.0	4.1	3.3			13.5			3.4			10.0			6.4			16.7
	Residual Pool Depth (m)	≥0.91	0.33	0.44			0.73			0.29			0.55			0.44			0.68
	Pools Assoc. w/wood (%)	≥50	100	100			67			99			67			100			100
Large Woody Debris	Total Piece Frequency (#/100 ft)	≥6.3	13.3	24.5			20.6			7.4			3.5			3.9			1.9
	Total Piece Count	#	145	267			224			58			36			42			19
Water Temperature	MWAT (°C)	≤16.8	15.6	16.0	15.0	15.2	15.8	15.1	15.1	13.8	14.4	13.8	15.3	14.9	15.1	14.3	16.6	14.7	15.7
Riparian Overstory	Canopy Over Stream (%)	≥91								100			98			98			97
	Canopy of Rip Forest (%)	≥85	90	100			84						99						

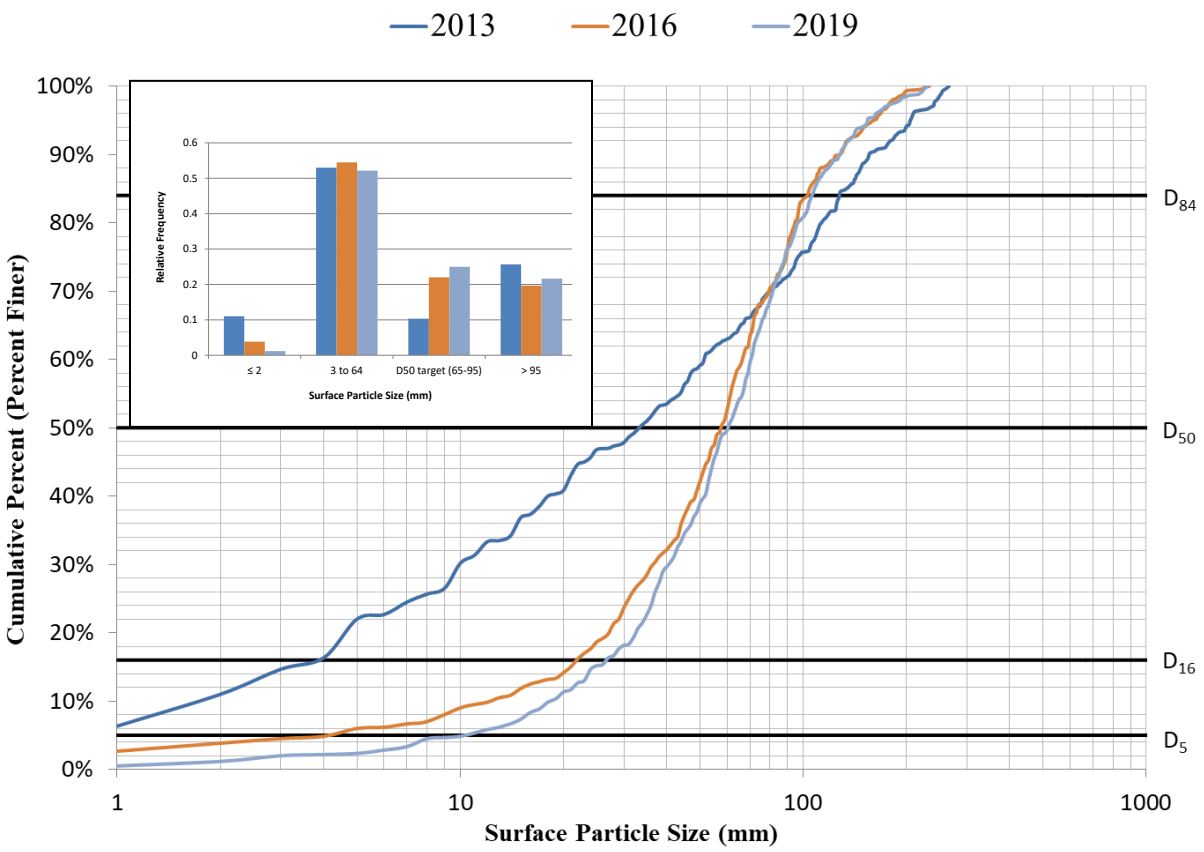

Figure 16. Cumulative frequency plot of the mean surface particle size of three riffles measured within the Cummings Creek ATM 108 monitoring reach (2013-2019)

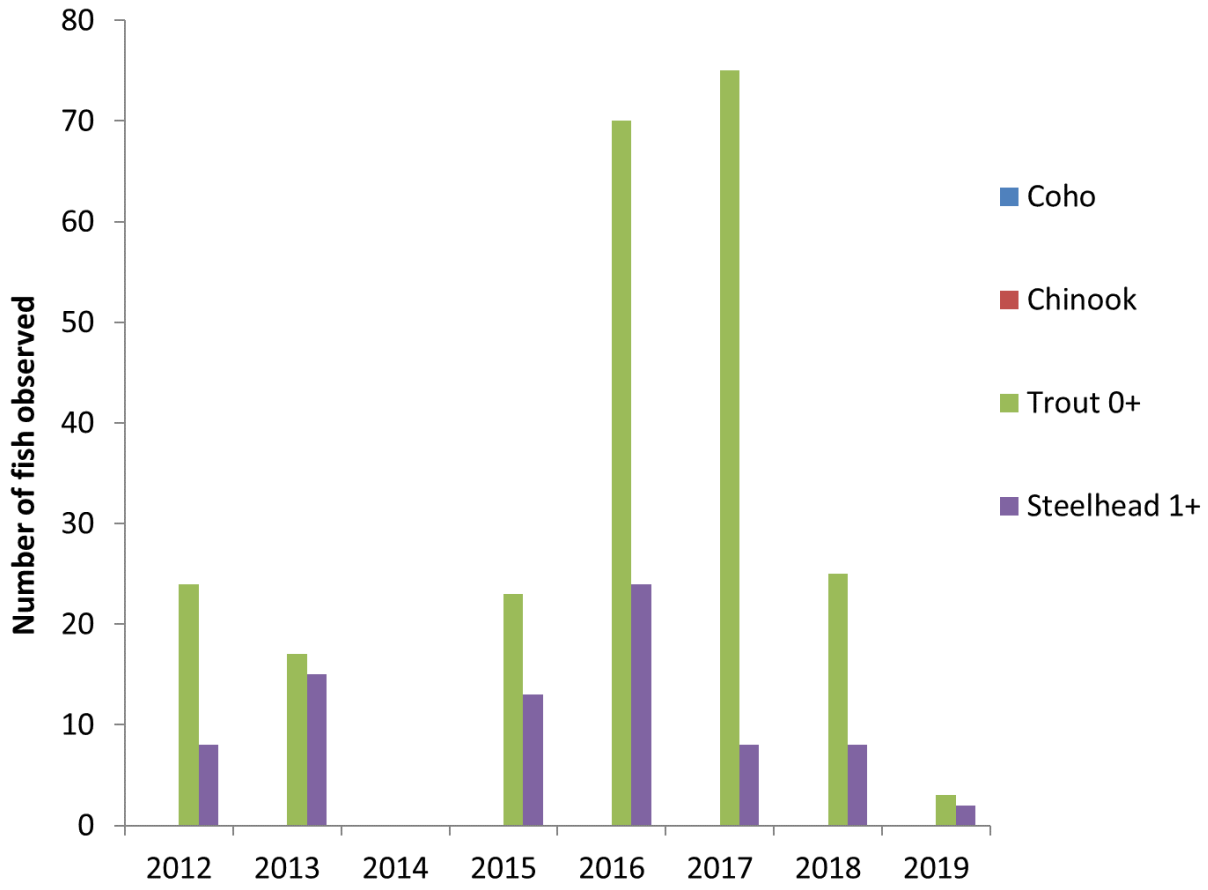

Figure 17. Results of annual snorkel survey fish counts of the first 5 pools within the Cummings Creek ATM 108 monitoring reach (2012-2019)

ATM Station 111 – Grizzly Creek [Underlying Geology: Cretaceous to Pliocene age Coastal belt of the Franciscan Complex (specifically the Yager terrane)]

Data for all ATM parameters at site 111 (Figure 13) are summarized in the APFC report card provided in Table 8. The bed surface APFC target was met in 2019, as the data suggest a coarsening of the substrate across all particle size classes (Figure 18). Pool characteristics remained generally static since 2013, with residual pool depth consistently failing to meet the target criterion. The total LWD piece frequency within the surveyed reach did not meet the APFC target by a margin of 1.2 pieces per 100 feet of stream channel, as total LWD pieces decreased by 78% since 2016. Water temperature failed to meet the target by 0.1 °C while mid-channel canopy cover met the target goal for the 4th consecutive survey year.

Cross-section data suggest varying degrees of channel aggradation and scour since surveys were instituted in 1997 (see appendix). Aggradation was observed at 2/6 cross-sections between survey years 2016 and 2019, the greatest degree of which occurred at cross-section 3 (-3.56m^2). The greatest degree of channel scour occurred at cross-section 4 where the channel area increased +2.02m^2.

A snorkel survey conducted on 6/11/2019 identified trout of various size classes in all 5 pools sampled (Figure 19). No other aquatic species were identified. Juvenile coho salmon have yet to be detected in this ATM reach.

Table 8. Individual site report card for ATM station 111, Grizzly Creek

Site 111 Grizzly Creek	Parameter	Target Value (# no target)	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Bed Surface	D_{84} (mm)	#	116	215			163			197			130			104			126
	D_{50} (mm)	65-95	41	84			54			78			51			61			75
	D_{16} (mm)	#	1	23			8			22			9			36			39
	D_5 (mm)	#	1	7			1			3			1			10			21
Pool Characteristics	Pool Area (%)	≥25	55	27			28			32			28			46			33
	Pool Spacing (CW/pool)	≤6.0	4.8	7.6			7.7			7.5			6.0			3.6			4.3
	Residual Pool Depth (m)	≥0.91	0.70	0.77			0.81			0.68			0.70			0.67			0.65
	Pools Assoc. w/wood (%)	≥50	80	75			100			100			60			78			86
Large Woody Debris	Total Piece Frequency (#/100 ft)	≥4.5	3.2	5.5			5.6			5.2			2.7			5.8			3.3
	Total Piece Count	#	45	78			79			52			37			82			46
Water Temperature	MWAT (°C)	≤16.8	18.5	19.3	18.3	18.7	18.0	17.0	17.1	16.2	15.3	15.3	17.0	15.9	16.0	16.0	17.1	16.4	16.9
Riparian Overstory	Canopy Over Stream (%)	≥86								92			91			96			97
	Canopy of Rip Forest (%)	≥85	92	92			80						96						

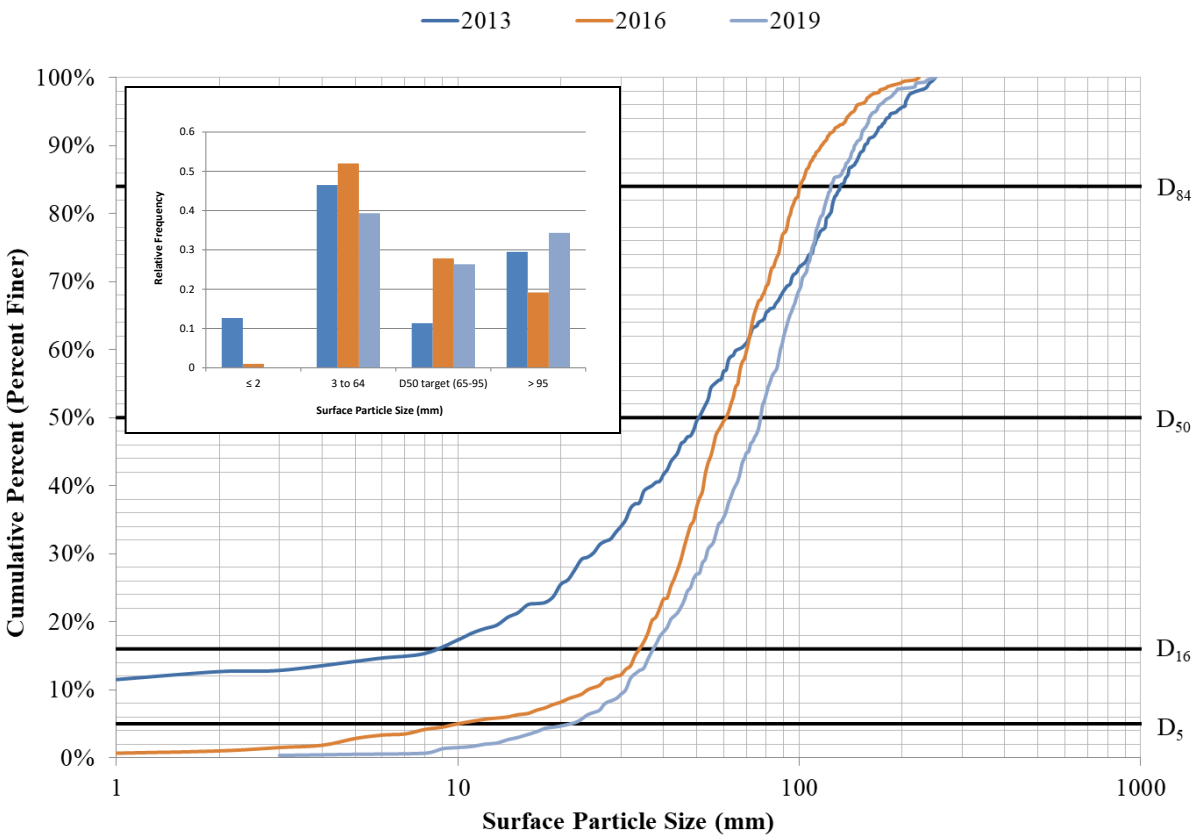

Figure 18. Cumulative frequency plot of the mean surface particle size of three riffles measured within the Grizzly Creek ATM 111 monitoring reach (2013-2019)

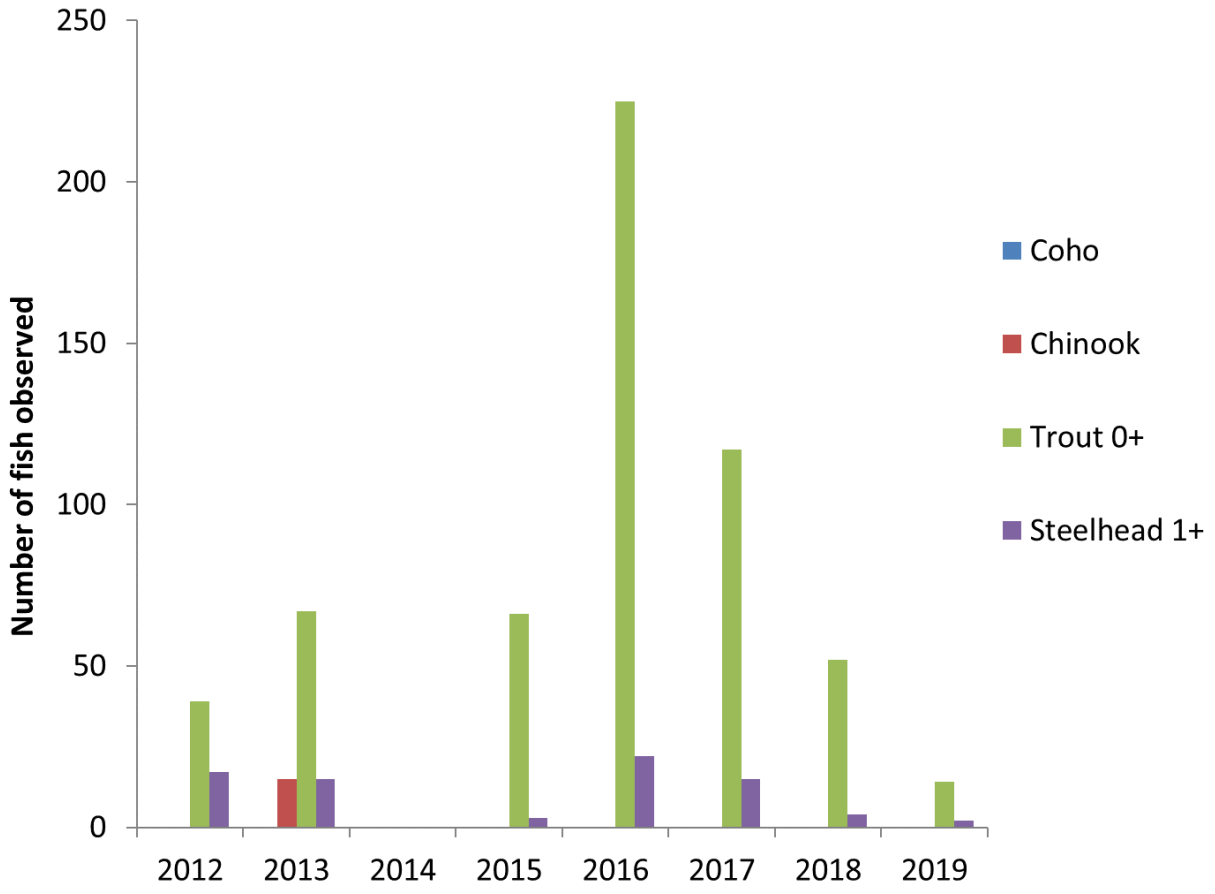

Figure 19. Results of annual snorkel survey fish counts of the first 5 pools within the Grizzly Creek ATM 111 monitoring reach (2012-2019)

ATM Station 112 – Hely Creek [Underlying Geology: Quaternary age Alluvium (basement rock = Miocene to Late Pliocene age Wildcat Group)]

Data for all ATM parameters at site 112 (Figure 13) are summarized in the APFC report card provided in Table 9. The bed surface APFC target was met in 2019 for the first time on record, as the data suggest a coarsening of the substrate across all particle size classes (Figure 20). Pool characteristics remained generally static since 2016, with residual pool depth and pool area consistently failing to meet the target criteria. The total LWD piece frequency within the surveyed reach did not meet the APFC target in 2019, as total LWD pieces decreased by 32% since 2016. Water temperature met the target goal for the 16th consecutive year, though mid-channel canopy cover fell short of the target the 2nd straight survey year.

Cross-section data suggest varying degrees of channel aggradation and scour since surveys were instituted in 2007 (see appendix). Channel scour was observed at 5/5 cross-sections between survey years 2016 and 2019, the greatest degree of which occurred at cross-section 1 (+3.37m^2).

A snorkel survey conducted on 6/12/2019 identified trout of various size classes in all 5 pools sampled (Figure 21). Foothill Yellow-legged frogs were also observed occupying the stream reach. Juvenile coho salmon have not been detected in this ATM reach since 2013.

Table 9. Individual site report card for ATM station 112, Hely Creek

Site 112 Hely Creek	Parameter	Target Value (# no target)	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Bed Surface	D_{84} (mm)	#	67	68			101			82			93			101			108
	D_{50} (mm)	65-95	34	30			38			38			40			63			68
	D_{16} (mm)	#	1	1			2			12			1			33			39
	D_5 (mm)	#	1	1			1			1			1			12			18
Pool Characteristics	Pool Area (%)	≥25	28	33			27			36			15			18			24
	Pool Spacing (CW/pool)	≤6.0	2.9	4.5			5.7			3.3			7.3			5.6			4.6
	Residual Pool Depth (m)	≥0.91	0.39	0.39			0.35			0.31			0.25			0.47			0.38
	Pools Assoc. w/wood (%)	≥50	100	100			100			100			100			100			86
Large Woody Debris	Total Piece Frequency (#/100 ft)	≥7.4		26.1						10.0			3.7			7.4			6.0
	Total Piece Count	#		231						51			32			70			53
Water Temperature	MWAT (°C)	≤16.8		15.8	14.7	14.6	14.6	14.2	14.4	13.3	13.9	13.5	14.9	14.5	15.7	14.3	15.5	14.4	15.2
Riparian Overstory	Canopy Over Stream (%)	≥92								96			91			86			82
	Canopy of Rip Forest (%)	≥85	89	96			80						94						

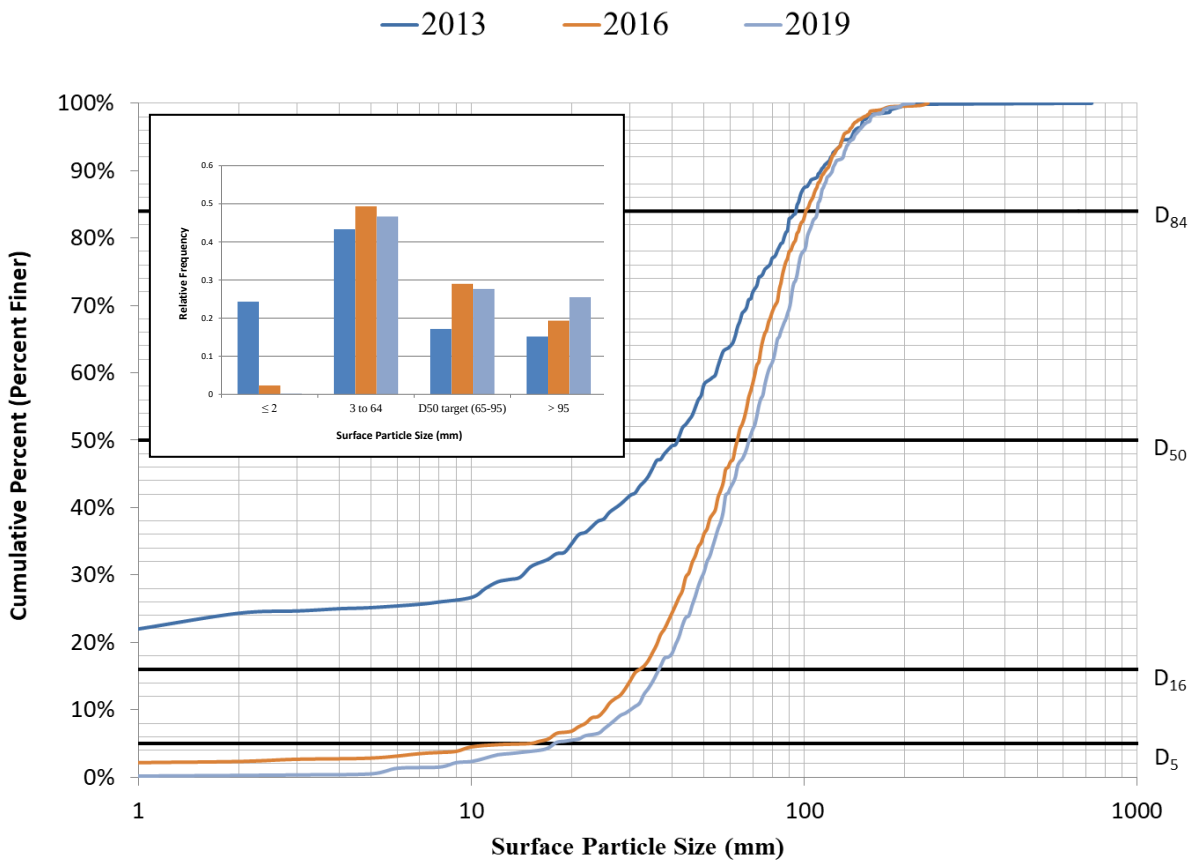

Figure 20. Cumulative frequency plot of the mean surface particle size of three riffles measured within the Hely Creek ATM 112 monitoring reach (2013-2019)

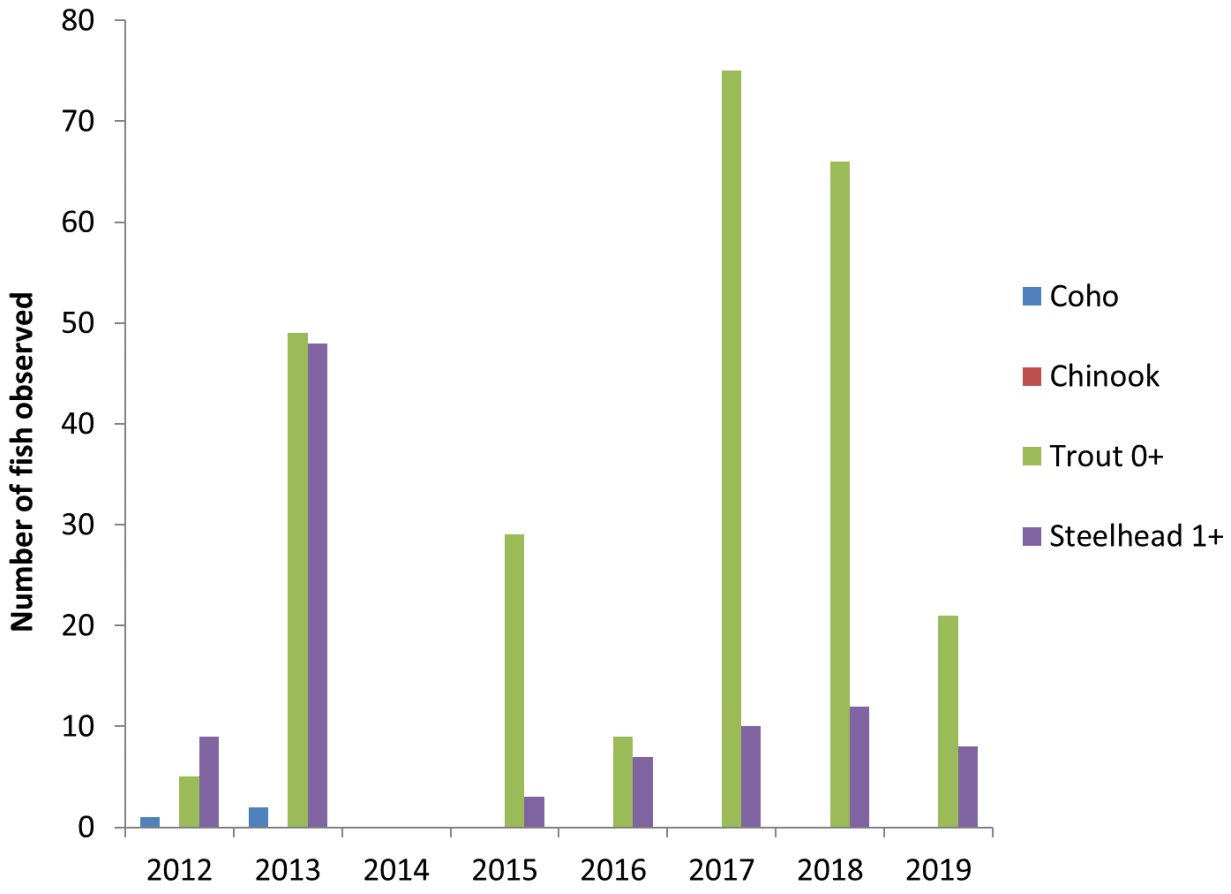

Figure 21. Results of annual snorkel survey fish counts of the first 5 pools within the Hely Creek ATM 112 monitoring reach (2012-2019)

Summary of ATM Trends in the Van Duzen WAU

A summary of the Van Duzen habitat characteristics from 2019 is provided in and APFC report card (Table 10). Results of habitat composite scores from 2019 and 2016 are compared to baseline (2004) data (Figure 22). Overall, the greatest improvements in habitat composite scores were observed in bed surface and mid-channel canopy cover.

The bed surface composite score in 2019 was higher than 2016, but lower (-100%) than the 2004 baseline record. The 2019 composite score for pool characteristics was even with 2016 but lower (-23%) than the baseline record. The 2019 composite score for LWD was 0.0, lower than both 2016 and the baseline records. The 2019 mid-channel canopy cover composite score was higher (+50%) than 2016 and also higher (+12%) than the baseline record. The 2019 water temperature composite score was lower (-33%) than both the 2016 and baseline records.

Table 10. The most recent habitat measures for the Van Duzen WAU

Current Status	Parameter	Target Value (# no target)	003 Root Cr.	108 Cummings Cr.	111 Grizzly Cr.	112 Hely Cr.
Bed Surface	D_{84} (mm)	#	80	105	126	108
	D_{50} (mm)	65-95	54	60	75	68
	D_{16} (mm)	#	38	28	39	39
	D_5 (mm)	#	26	9	21	18
Pool Characteristics	Pool Area (%)	≥25	60	4.6	33	24
	Pool Spacing (CW/pool)	≤6.0	4.4	16.7	4.3	4.6
	Residual Pool Depth (m)	≥0.91	0.69	0.68	0.65	0.38
	Pools Assoc. w/wood (%)	≥50	100	100	86	86
Large Woody Debris	Total Piece Frequency (#/100 ft)	f(CW)	7.2	1.9	3.3	6.0
	Total Piece Count	#	57	19	46	53
Water Temperature	MWAT (°C)	≤16.8	16.2	15.7	16.9	15.2
Riparian Overstory	Canopy Over Stream (%)	f(CW)	93	97	97	82
	Canopy of Rip Forest (%)	≥85				
Watershed Area	Upstream Acreage	#	3,771	1,893	7,181	2,305
Reach Gradient	% Reach Gradient	#	0.8	3.8	1.7	3.8

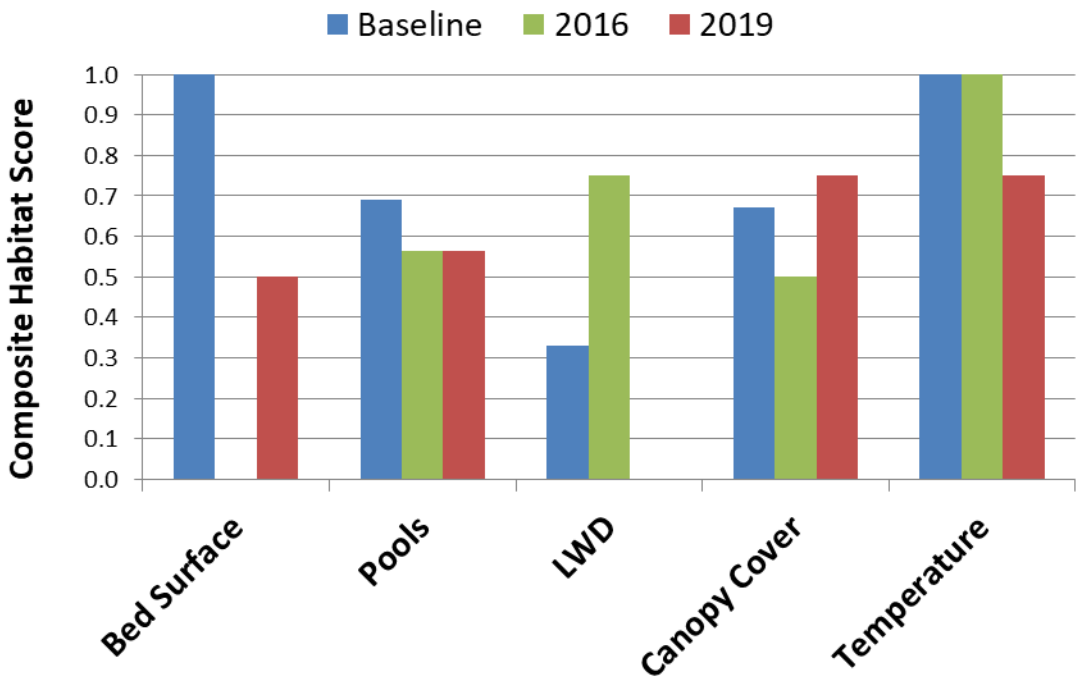

Figure 22. The composite scores for habitat characteristics in the Van Duzen WAU in 2019 and 2016 relative to baseline (2004) data

LOWER EEL RIVER AND LOWER EEL DELTA WAU

HRC has ownership within both major and smaller tributaries that drain to the Eel River from near its confluence with the Pacific Ocean to about 40 miles upstream above the confluence with Devil's Elbow Creek. In total, HRC owns about 17% of the watershed area within this reach. The area is divided into the Lower and Upper Eel River WAUs for Watershed Analysis. The Lower Eel River WAU includes HRC ownership within tributaries to the Eel River south of the Van Duzen River to Perrott Creek and includes both Jordan and Bear Creek. This WAU also includes a region termed the Eel River Delta, which contains several tributaries that drain to the Eel River nearer to its confluence with the Pacific Ocean.

There are eight (8) ATM sites in the Lower Eel WAU, including three in Bear Creek, two in Jordan Creek, and one each in Monument Creek, Shively Creek, and Atwell Creek (Figure 23). Habitat characteristics at the Bear Creek sites are measured annually at the request of the NCRWQCB. Habitats at all other sites are measured every three years. Typical site conditions are shown in Figures 24 and 25.

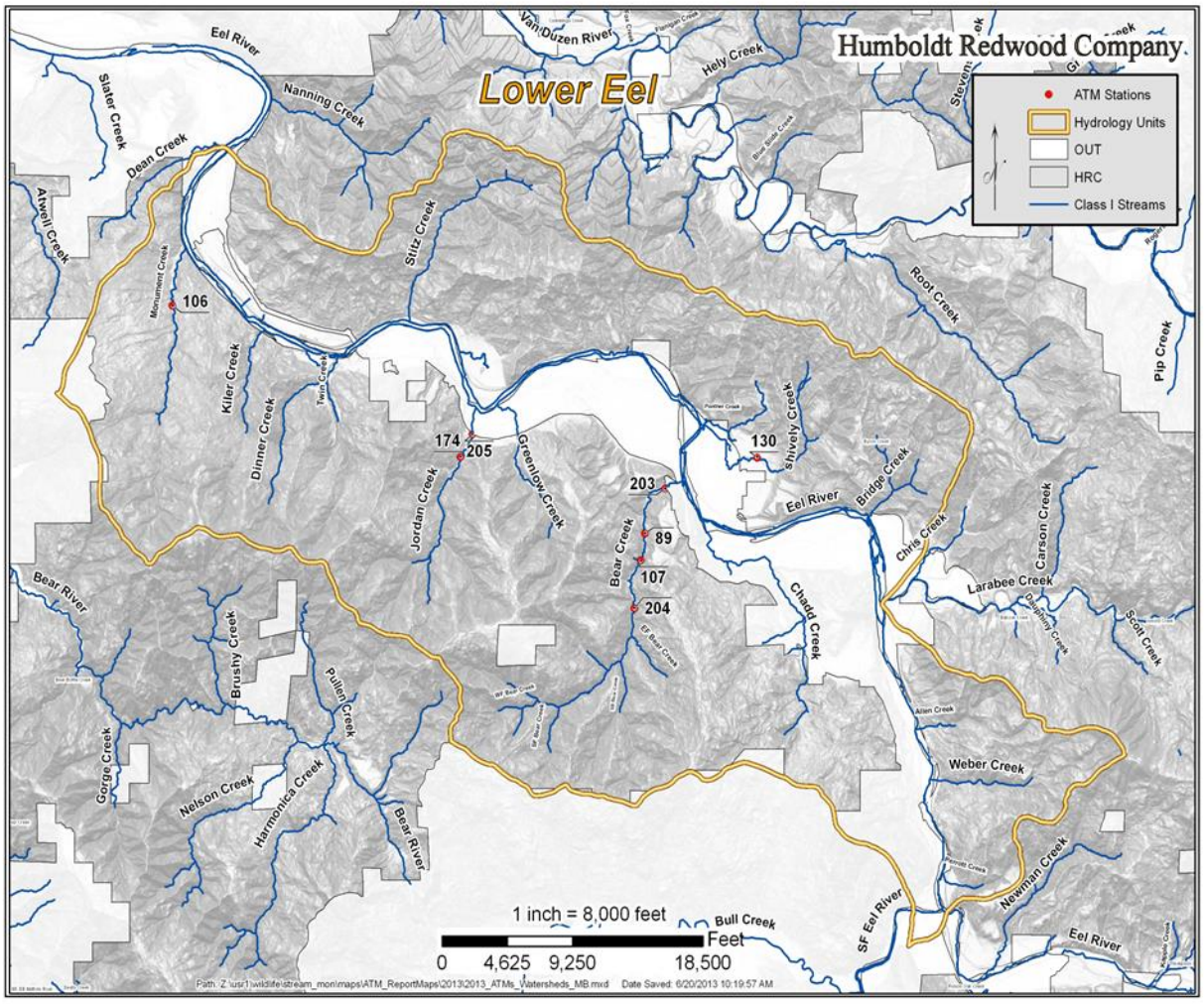

Figure 23. Location map of ATM stations in the Lower Eel River WAU

Bear Creek Station 203

Bear Creek Station 204

Bear Creek Station 107

Figure 24. Bear Creek ATM stations within the Lower Eel River WAU

Jordan Creek Station 205

Jordan Creek Station 174

Monument Creek Station 106

Shively Creek Station 130

Atwell Creek Station 242

Figure 25. ATM stations within the Lower Eel River WAU

ATM Station 203 – Lower Bear Creek [Underlying Geology: Alluvium (Qal) underlain by Undifferentiated Wildcat Group (Qtw)]

Data for all ATM parameters at site 203 (Figure 24) are summarized in the APFC report card provided in Table 11. The bed surface APFC target was met in 2019, even as the data reflect a fining of the substrate across most particle size classes (Figure 26). Pool characteristics remained generally static since 2015, with residual pool depth consistently failing to meet its target criterion. LWD piece frequency met the APFC target for the 8th consecutive year, as total LWD pieces decreased (-39%) since 2018. Water temperature was short of meeting the target for the 3rd year in a row, as mid-channel canopy cover remained short of the target for the 9th consecutive year.

Cross-section data suggest varying degrees of channel aggradation and scour since surveys were instituted in 2004 (see appendix). Aggradation was observed at 3/5 cross-sections between survey years 2018 and 2019, the greatest degree of which occurred at cross-section 5 (-0.92m^2). The greatest degree of channel scour occurred at cross-section 4 where the channel area increased +0.73m^2.

A snorkel survey conducted on 8/19/2019 identified trout of various size classes in all 5 pools sampled (Figure 27). Foothill Yellow-legged frogs were also observed occupying the stream reach. Juvenile coho salmon have not been detected in this ATM reach since 2013.

Table 11. Individual site report card for ATM station 203, Bear Creek

Site 203 Bear Creek	**Parameter**	**Target Value** (# no target)	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Bed Surface	D_{84} (mm)	#	66	88	98	98	114	110	94	126	93	77	83	45	110	94	110	108
	D_{50} (mm)	65-95	30	38	28	42	46	56	39	68	65	31	33	19	66	48	66	66
	D_{16} (mm)	#	12	8	2	6	4	20	12	25	9	6	7	6	38	14	40	29
	D_5 (mm)	#	8	1	1	1	1	4	3	4	2	1	2	2	19	2	27	12
Pool Characteristics	Pool Area (%)	≥25	22	61	32	32	26	35	47	37	26	11	13	17	32	30	25	40
	Pool Spacing (CW/pool)	≤6.0	5.0	5.5	3.3	2.6	4.8	3.2	2.6	4.1	3.9	7.3	7.5	3.3	3.0	2.7	3.1	1.9
	Residual Pool Depth (m)	≥0.91	0.42	0.61	0.60	0.57	0.67	0.57	0.49	0.52	0.62	0.53	0.60	0.42	0.55	0.61	0.56	0.52
	Pools Assoc. w/wood (%)	≥50	100	100	100	100	100	100	85	88	100	100	100	100	100	82	100	100
Large Woody Debris	Total Piece Frequency (#/100 ft)	≥5.1	12.9	12.7	6.2	6.3	5.6	7.3	4.7	4.7	8.6	7.4	7.1	8.1	11.3	6.8	6.4	5.8
	Total Piece Count	#	148	145	71	72	65	87	57	46	70	85	112	128	178	108	102	92
Water Temperature	MWAT (°C)	≤16.8		17.9	19.5	18.7	18.1	17.9	15.9	15.5	15.5	17.2	17.2	17.7	16.8	17.6	17.1	17.1
Riparian Overstory	Canopy Over Stream (%)	≥90	24	38	35	26	57	40	97	80	77	83	83	70	87	85	79	83
	Canopy of Rip Forest (%)	≥85	90	96	97	85				96	99	96	91					

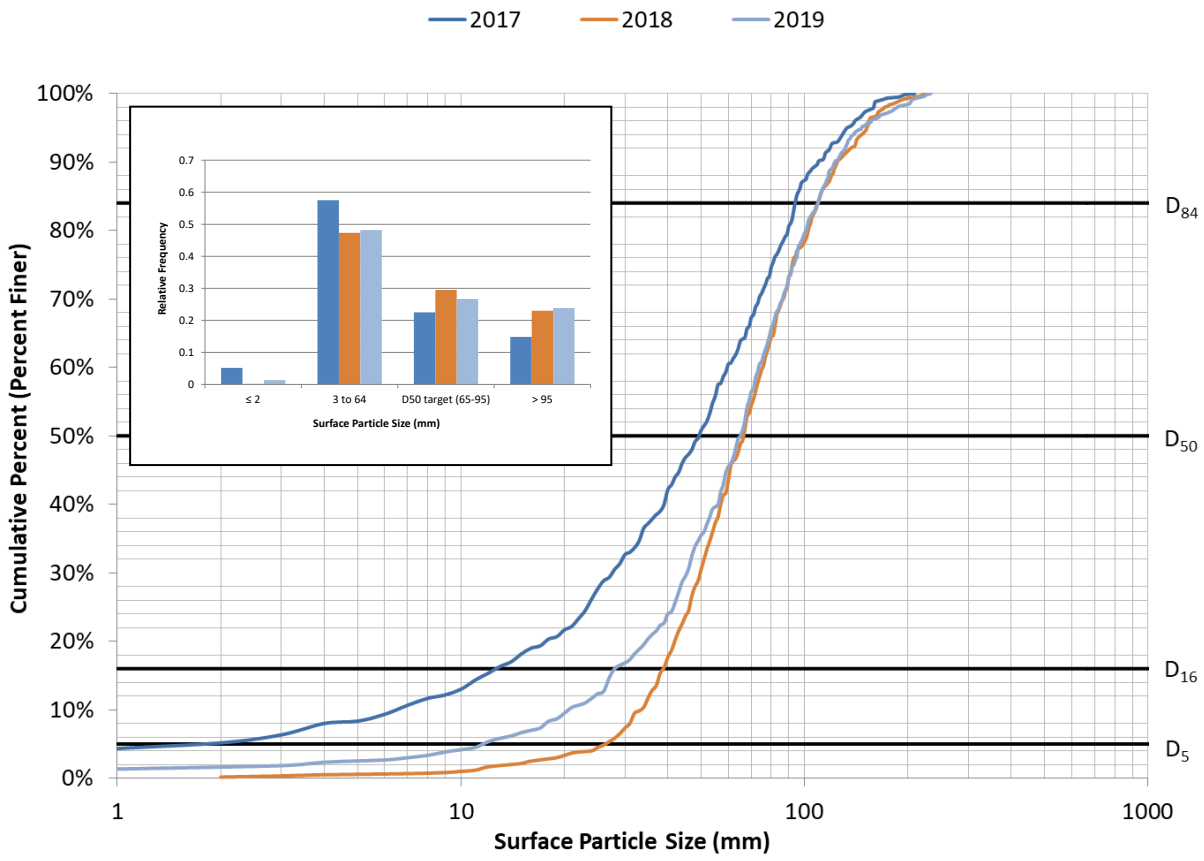

Figure 26. Cumulative frequency plot of the mean surface particle size of three riffles measured within the Bear Creek ATM 203 monitoring reach (2017-2019)

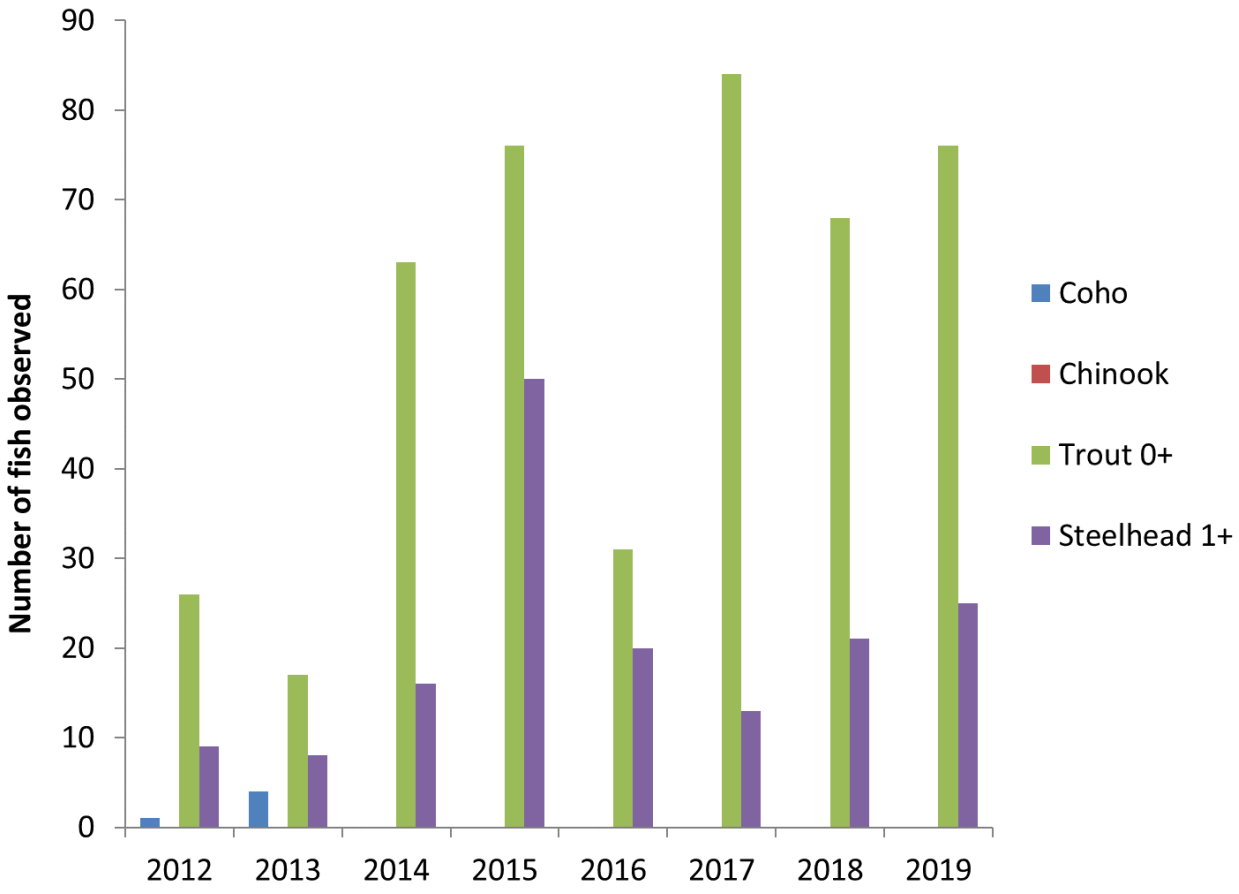

Figure 27. Results of annual snorkel survey fish counts of the first 5 pools within the Bear Creek ATM 203 monitoring reach (2012-2019)

ATM Station 204 – Mid-Upper Bear Creek [Underlying Geology: Coastal Belt: Coastal Terrane (TKfs)]

Data for all ATM parameters at site 204 (Figure 24) are summarized in the APFC report card found in Table 12. The bed surface APFC target was met in 2019, even as the data suggest a fining of the substrate across most particle size classes (Figure 28). Pool characteristics remained generally static since 2016, with residual pool depth consistently failing to meet its target criterion. LWD piece frequency met the APFC target for the 5th straight year, as total LWD pieces increased (+47%) since 2015. Water temperature met the target for the 4th year in a row, as mid-channel canopy cover stayed short of the APFC target for the 2nd straight year.

Cross-section data suggest varying degrees of channel aggradation and scour since surveys were instituted in 2004 (see appendix). Aggradation was observed at 2/5 cross-sections between survey years 2018 and 2019, the greatest degree of which occurred at cross-section 4 (-1.35m^2). The greatest degree of channel scour occurred at cross-section 5 where the channel area increased +0.74m^2.

A snorkel survey conducted on 8/20/2019 identified trout of various size classes in all 5 pools sampled (Figure 29). Foothill Yellow-legged frogs were also observed occupying the stream reach. Juvenile coho salmon have not been detected in this ATM reach since 2014.

Table 12. Individual site report card for ATM station 204, Bear Creek

Site 204 Bear Creek	**Parameter**	**Target Value** (# no target)	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Bed Surface	D_{84} (mm)	#	118	135	108	143	161	133	128	170	173	123	120	101	116	142	142	115
	D_{50} (mm)	65-95	37	51	24	53	54	62	51	76	64	52	47	45	69	66	80	67
	D_{16} (mm)	#	4	14	2	8	7	17	13	28	14	15	11	11	35	15	32	35
	D_5 (mm)	#	1	1	1	3	1	5	4	11	3	1	2	3	16	5	14	11
Pool Characteristics	Pool Area (%)	≥25	23	39	21	38	22	16	28	38	27	21	36	14	28	31	28	34
	Pool Spacing (CW/pool)	≤6.0	7.7	9.9	3.1	2.7	6.7	5.1	10.8	4.4	3.9	4.1	3.8	4.9	3.8	3.0	3.1	3.4
	Residual Pool Depth (m)	≥0.91	0.39	0.39	0.67	0.70	0.66	0.45	0.47	0.61	0.62	0.61	0.58	0.44	0.53	0.49	0.46	0.54
	Pools Assoc. w/wood (%)	≥50	100	100	100	100	100	100	83	100	83	86	75	67	88	80	100	100
Large Woody Debris	Total Piece Frequency (#/100 ft)	≥4.4	7.6	11.4	10.9	9.0	3.4	7.1	9.4	3.3	5.8	6.5	3.5	5.6	12.1	5.3	5.4	8.1
	Total Piece Count	#	105	158	151	124	71	62	130	33	63	85	49	78	170	74	77	113
Water Temperature	MWAT (°C)	≤16.8						17.3							15.1	16.3	15.2	15.5
Riparian Overstory	Canopy Over Stream (%)	≥90	7	10	34	11	23	53	73	79	51	75	63	64	85	90	79	80
	Canopy of Rip Forest (%)	≥85	79	77	90	85				96	93	94	90	96				

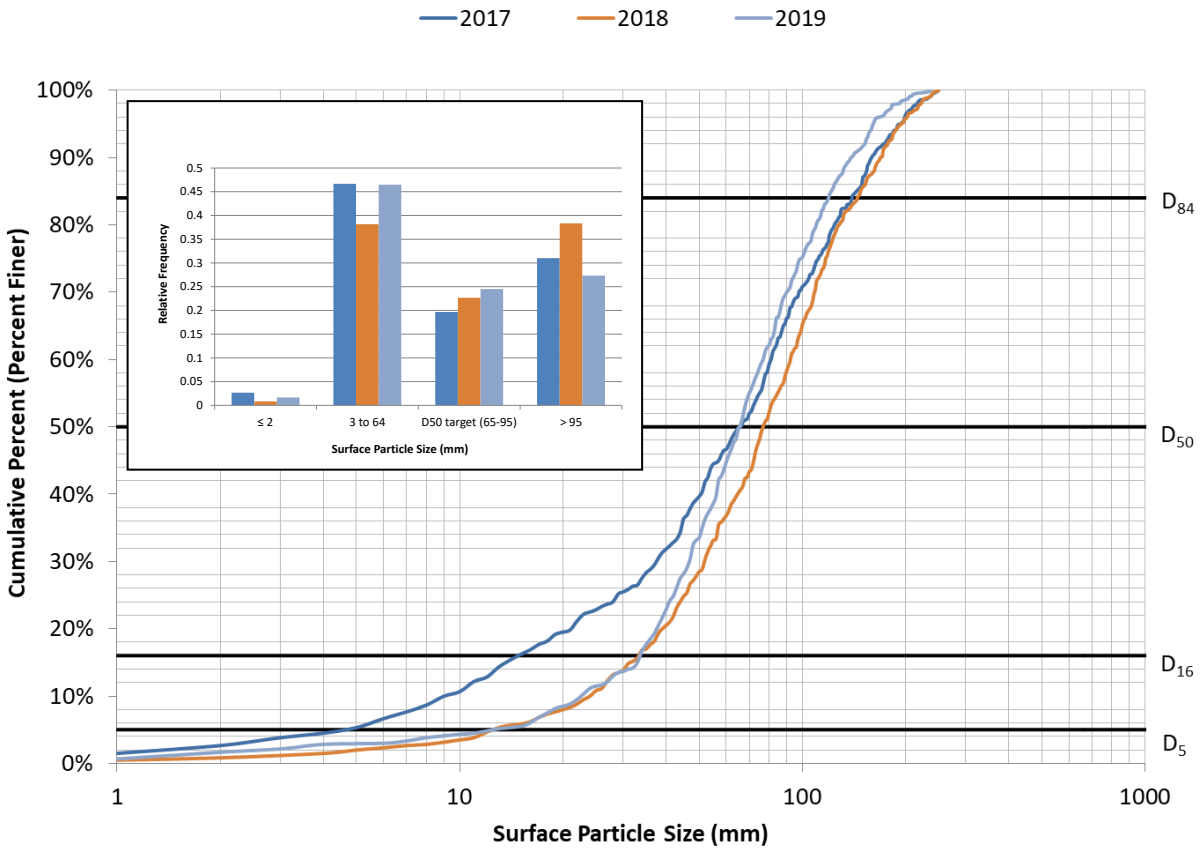

Figure 28. Cumulative frequency plot of the mean surface particle size of three riffles measured within the Bear Creek ATM 204 monitoring reach (2017-2019)

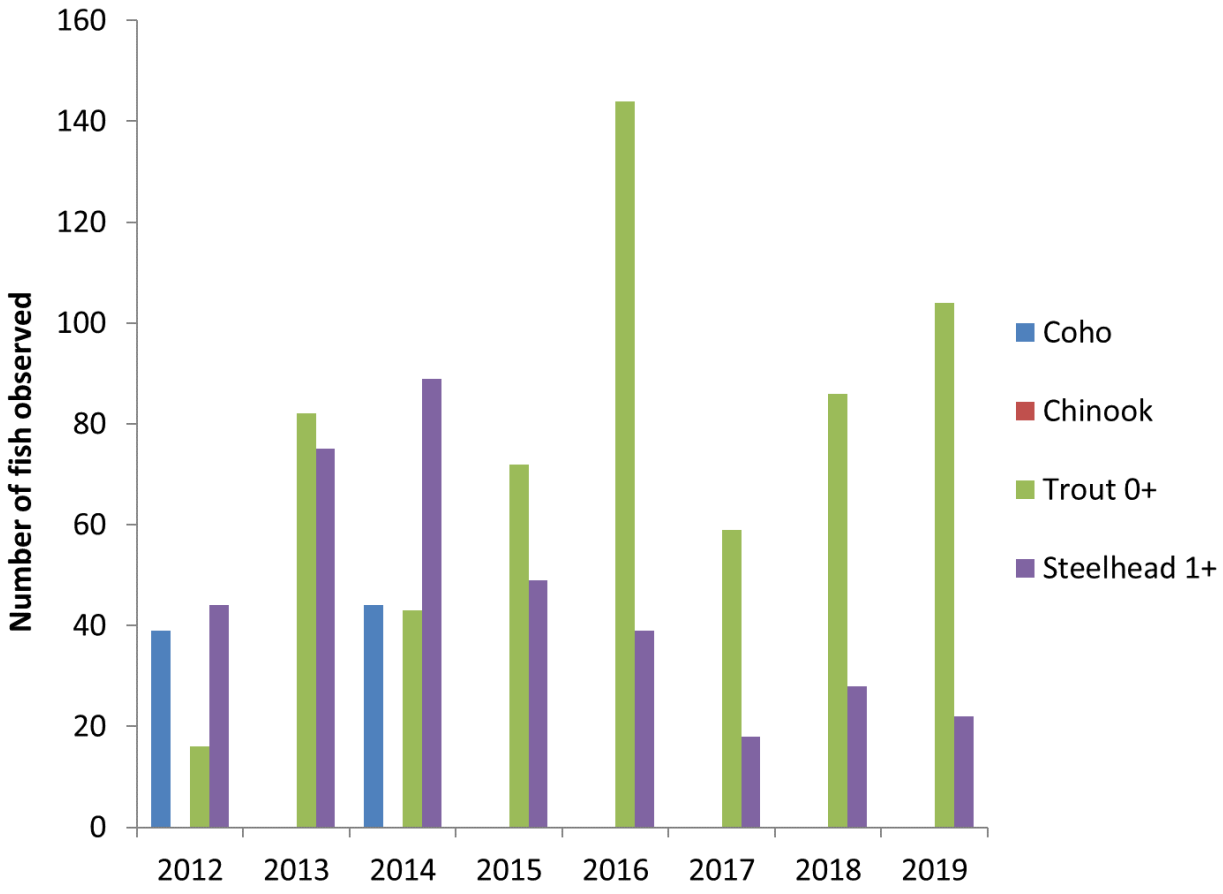

Figure 29. Results of annual snorkel survey fish counts of the first 5 pools within the Bear Creek ATM 204 monitoring reach (2012-2019)

ATM Station 107 – Middle Bear Creek [Underlying Geology: Coastal Belt: Coastal Terrane (TKfs)]

Data for all ATM parameters at site 107 (Figure 24) are summarized in the APFC report card provided in Table 13. The bed surface APFC target was met in 2019, even as the data reflect a fining of the substrate across all particle size classes (Figure 30). Pool characteristics remained generally static since 2016, with residual pool depth consistently failing to meet its target criterion. LWD piece frequency met the APFC target for the 4th year in a row, even as total LWD pieces decreased (-7%) since 2018. Water temperature met the target for the 2nd year straight, although mid-channel canopy cover remained short of the APFC target for the 8th consecutive year.

Cross-section data suggest varying degrees of channel aggradation and scour since surveys were instituted in 1998 (see appendix). Scour was observed at 4/6 cross-sections between survey years 2018 and 2019, the greatest degree of which occurred at cross-section 3 (+1.78m^2). Cross-sections 1 and 4 experienced no net change in channel area between survey years 2018 and 2019.

A snorkel survey conducted on 8/19/2019 identified trout of various size classes in all 5 pools sampled (Figure 31). Foothill Yellow-legged frogs were also observed occupying the stream reach. Juvenile coho salmon have not been detected in this ATM reach since 2014.

Table 13. Individual site report card for ATM station 107, Bear Creek

Site 107 Bear Creek	**Parameter**	**Target Value** (# no target)	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Bed Surface	D_{84} (mm)	#	113	110	100	110	109	160	129	124	154	131	116	104	79	116	123	127	116
	D_{50} (mm)	65-95	46	44	42	30	36	67	62	57	69	37	43	43	34	68	66	73	66
	D_{16} (mm)	#	9	10	8	3	7	14	22	19	16	5	11	7	10	36	24	37	28
	D_{5} (mm)	#	1	1	1	1	1	1	5	3	2	1	2	2	3	14	7	20	11
Pool Characteristics	Pool Area (%)	≥25	9	23	50	19	14	22	16	20	25	45	19	27	7	28	29	28	35
	Pool Spacing (CW/pool)	≤6.0	11.3	3.8	7.9	4.1	4.4	4.6	5.1	4.5	4.9	2.6	7.4	4.3	10	3.4	3.4	3.0	2.7
	Residual Pool Depth (m)	≥0.91	0.72	0.54	0.50	0.52	0.45	0.48	0.45	0.33	0.61	0.56	0.56	0.45	0.39	0.42	0.63	0.61	0.51
	Pools Assoc. w/wood (%)	≥50	100	100	100	100	100	100	100	100	100	89	67	86	100	100	89	100	100
Large Woody Debris	Total Piece Frequency (#/100 ft)	≥5.1	9.2	15.2	12.8	6.7	8.5	3.2	7.1	11.3	15.1	8.9	6.1	5.9	3.9	9.2	7.7	7.5	7.1
	Total Piece Count	#	129	213	179	94	119	76	75	115	49	95	85	83	55	129	122	106	99
Water Temperature	MWAT (°C)	≤16.8	18.7	19.6	17.5	18.8	18.0	17.9	17.3	15.2	15.1	14.8	16.6	16.8		16.2	16.9	16.1	16.1
Riparian Overstory	Canopy Over Stream (%)	≥90	31	42	31	26	28	56	53	97	90	83	79	77	54	78	88	65	76
	Canopy of Rip Forest (%)	≥85	73	86	90	73	81				98	99	90	89					

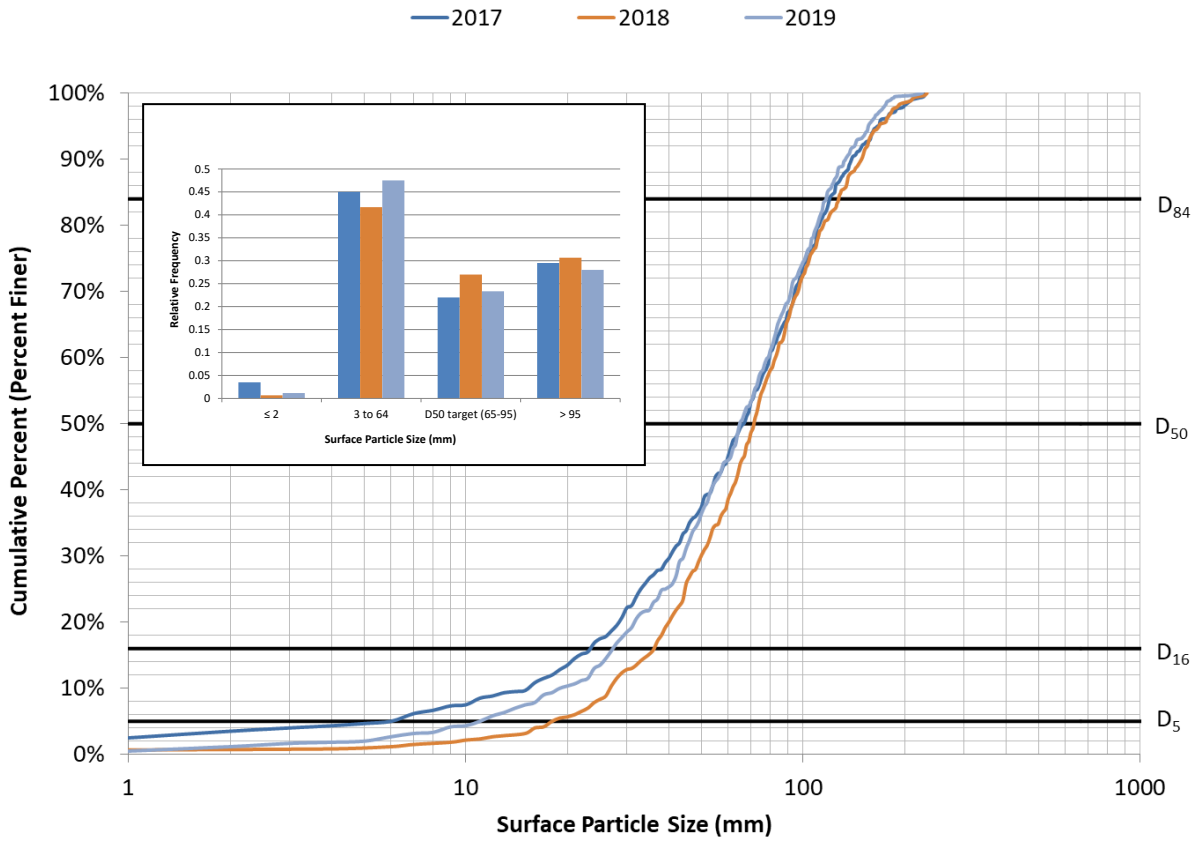

Figure 30. Cumulative frequency plot of the mean surface particle size of three riffles measured within the Bear Creek ATM 107 monitoring reach (2017-2019)

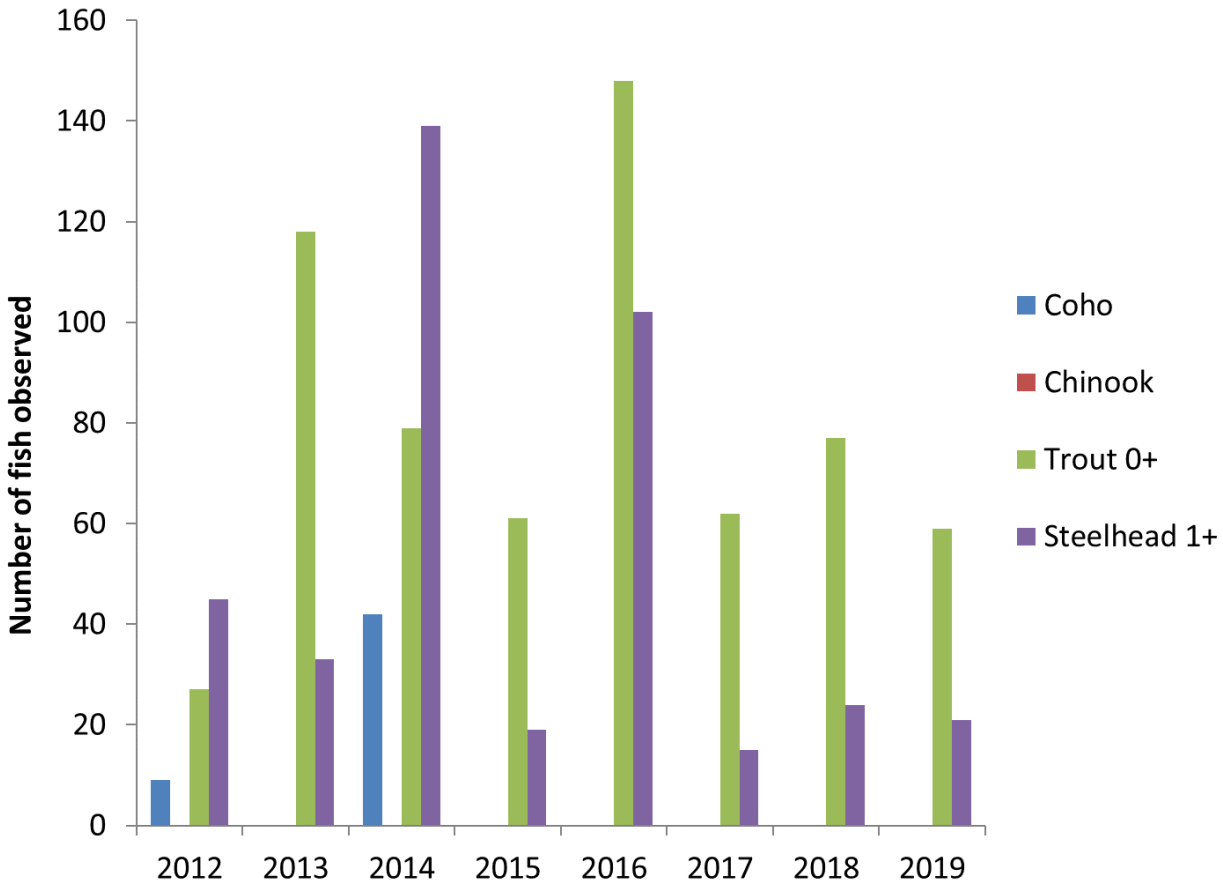

Figure 31. Results of annual snorkel survey fish counts of the first 5 pools within the Bear Creek ATM 107 monitoring reach (2012-2019)

ATM Station 205 – Jordan Creek [Underlying Geology: Quaternary age Alluvium (basement rock = Cretaceous to Pliocene age Coastal belt of the Franciscan Complex, specifically the Coastal terrane)]

Data for all ATM parameters at site 205 (Figure 25) are summarized in the APFC report card provided in Table 14. The bed surface APFC target was not met in 2019, as the data reflect a fining of the substrate across most particle size classes (Figure 32). Pool characteristics remained generally static since 2016, with residual pool depth and pool area consistently failing to meet the target criteria. LWD piece frequency met the APFC target for the 2nd straight survey year, even as total LWD pieces decreased (-6%) since 2016. Water temperature was not measured at this site due to repeated site vandalism, although water temperatures have generally been below (cooler than) the target threshold in years measured. Mid-channel canopy cover met the APFC target for the 2nd straight survey year.

Cross-section data suggest varying degrees of channel aggradation and scour since surveys were instituted in 2004 (see appendix). Aggradation was observed at 3/5 cross-sections between survey years 2016 and 2019, the greatest degree of which occurred at cross-section 5 (-2.36m^2). The greatest degree of channel scour occurred at cross-section 2 where the channel area increased +2.3m^2.

A snorkel survey conducted on 7/3/2019 identified trout of various size classes in all 5 pools sampled (Figure 33). No other aquatic species were identified. Juvenile coho salmon were detected in the ATM reach as recently as 2018.

Table 14. Individual site report card for ATM station 205, Jordan Creek

Site 205 Jordan Creek	Parameter	Target Value (# no target)	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Bed Surface	D_{84} (mm)	#		111			130			87			105			112			113
	D_{50} (mm)	65-95		39			35			31			35			65			60
	D_{16} (mm)	#		9			5			7			6			30			24
	D_5 (mm)	#		1			1			3			1			13			8
Pool Characteristics	Pool Area (%)	≥25		7						2			20			15			23
	Pool Spacing (CW/pool)	≤6		5.8						18.3			4.6			4.9			2.8
	Residual Pool Depth (m)	≥0.91		0.28						0.26			0.35			0.37			0.39
	Pools Assoc. w/wood (%)	≥50		1						0			0			100			100
Large Woody Debris	Total Piece Frequency (#/100 ft)	≥4.13		3.80			4.20			3.20			4.80			4.90			4.70
	Total Piece Count	#		34			38			26			46			73			69
Water Temperature	MWAT (°C)	≤16.8	17.0	18	16.2	16.8	15.8	15.4	15.0						16.0				
Riparian Overstory	Canopy Over Stream (%)	≥84								60			75			92			94
	Canopy of Rip Forest (%)	≥85											81			95			

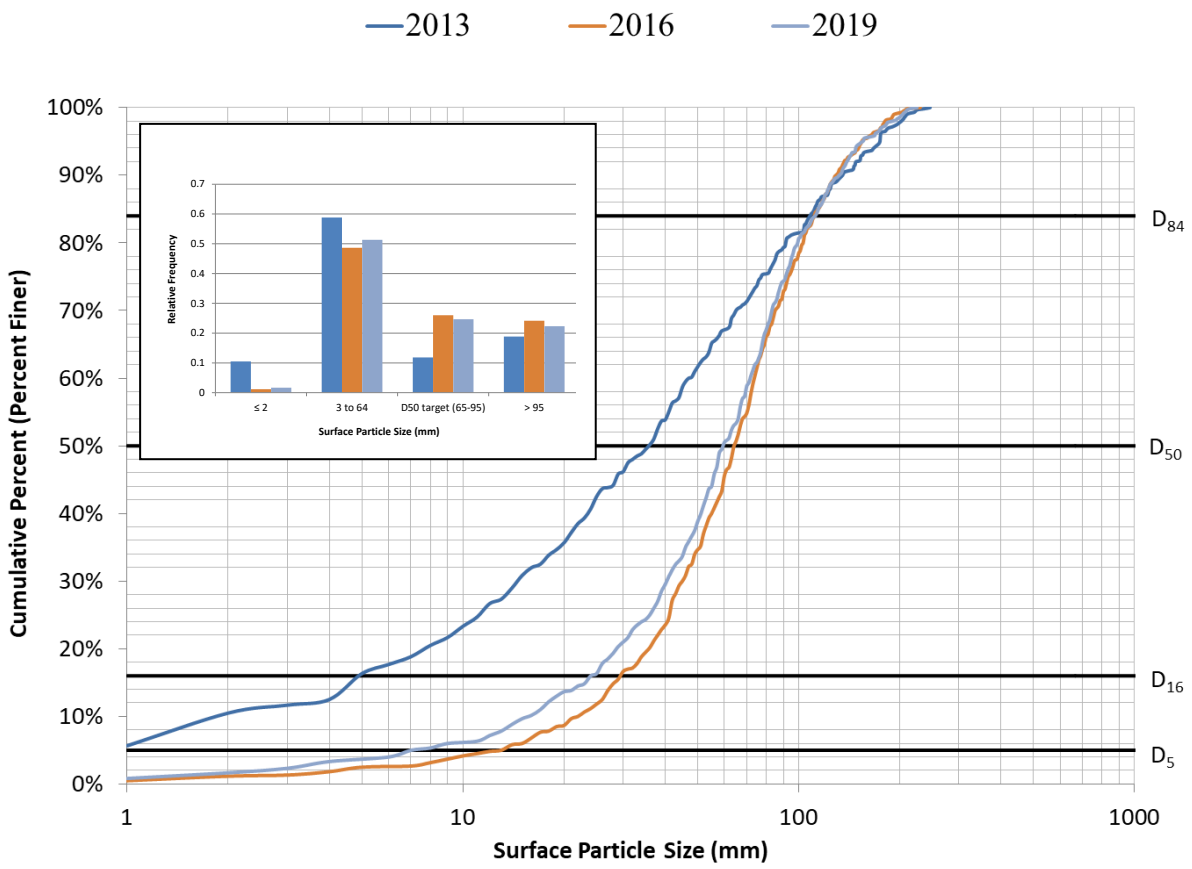

Figure 32. Cumulative frequency plot of the mean surface particle size of three riffles measured within the Jordan Creek ATM 205 monitoring reach (2013-2019)

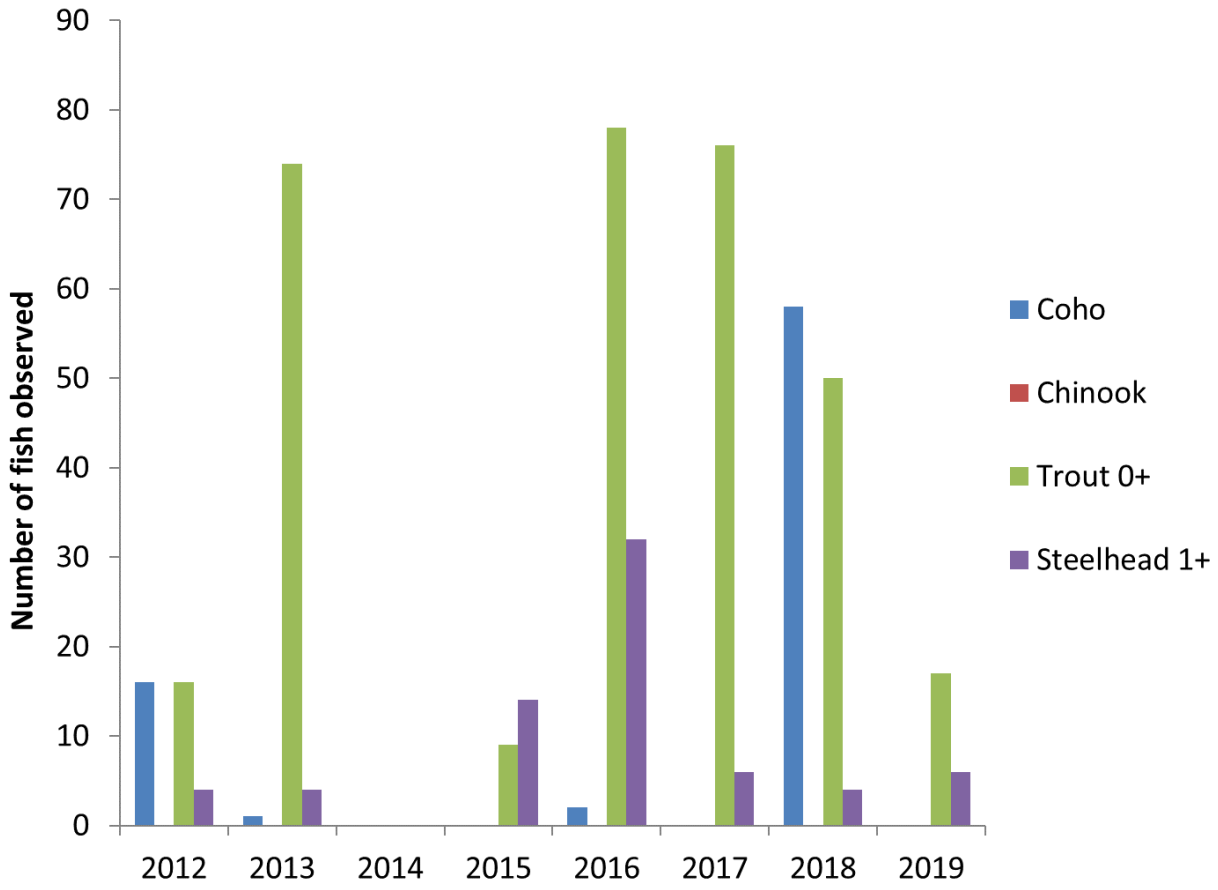

Figure 33. Results of annual snorkel survey fish counts of the first 5 pools within the Jordan Creek ATM 205 monitoring reach (2012-2019)

ATM Station 174 – Jordan Creek [Underlying Geology: Cretaceous to Pliocene age Coastal belt of the Franciscan Complex (specifically the Coastal terrane)]

Data for all ATM parameters at site 174 (Figure 25) are summarized in the APFC report card provided in Table 15. The bed surface APFC target was not met in 2019, as the data reflect a fining of the substrate across most particle size classes (Figure 34). Pool characteristics remained generally static since 2016, with residual pool depth consistently failing to meet its target criterion. LWD piece frequency did not meet the target for the first survey year on record, falling short by a margin of 0.17 pieces per 100 feet of stream channel. Water temperature met the APFC target for the 16th consecutive year and mid-channel canopy cover met the APFC target for the 4th survey year in a row.

Cross-section data suggest varying degrees of channel aggradation and scour since surveys were instituted in 2004 (see appendix). Aggradation was observed at 2/5 cross-sections between survey years 2016 and 2019, the greatest degree of which occurred at cross-section 5 (-16.29m^2). The greatest degree of channel scour occurred at cross-section 1 where the channel area increased +2.26m^2 .

A snorkel survey conducted on 7/5/2019 identified trout of various size classes in all 5 pools sampled (Figure 35). No other aquatic species were identified. Juvenile coho salmon were detected in this ATM reach as recently as 2018.

Table 15. Individual site report card for ATM station 174, Jordan Creek

Site 174 Jordan Creek	**Parameter**	**Target Value** (# no target)	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Bed Surface	D_{84} (mm)	#	131			154			122			90			103			105
	D_{50} (mm)	65-95	33			33			48			34			61			56
	D_{16} (mm)	#	2			7			10			7			30			24
	D_5 (mm)	#	1			1			5			1			11			7
Pool Characteristics	Pool Area (%)	≥25	15						17			24			39			27
	Pool Spacing (CW/pool)	≤6	4.5						4.5			3.3			1.9			2.5
	Residual Pool Depth (m)	≥0.91	0.49						0.43			0.45			0.39			0.43
	Pools Assoc. w/wood (%)	≥50	88						80			50			81			67
Large Woody Debris	Total Piece Frequency (#/100 ft)	≥4.87	26.30						8.24			7.90			8.50			4.70
	Total Piece Count	#	337						79			70			109			60
Water Temperature	MWAT (°C)	≤16.8	17.6	16.2	16.8	15.8	15.4	15.0	13.7	13.8	13.6	14.9	15.4	15.8	14.5	15.3	14.5	15.0
Riparian Overstory	Canopy Over Stream (%)	≥77							99			85			96			94
	Canopy of Rip Forest (%)	≥85	56									89						

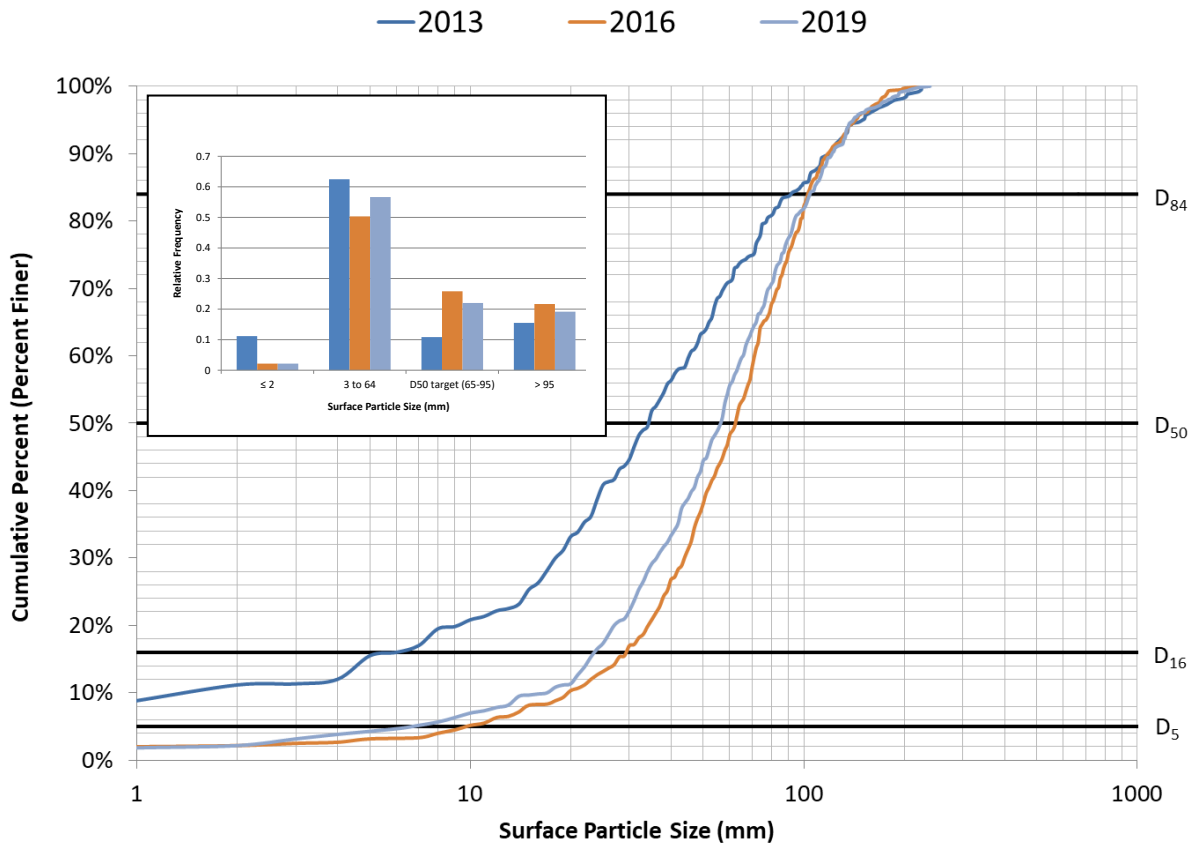

Figure 34. Cumulative frequency plot of the mean surface particle size of three riffles measured within the Jordan Creek ATM 174 monitoring reach (2013-2019)

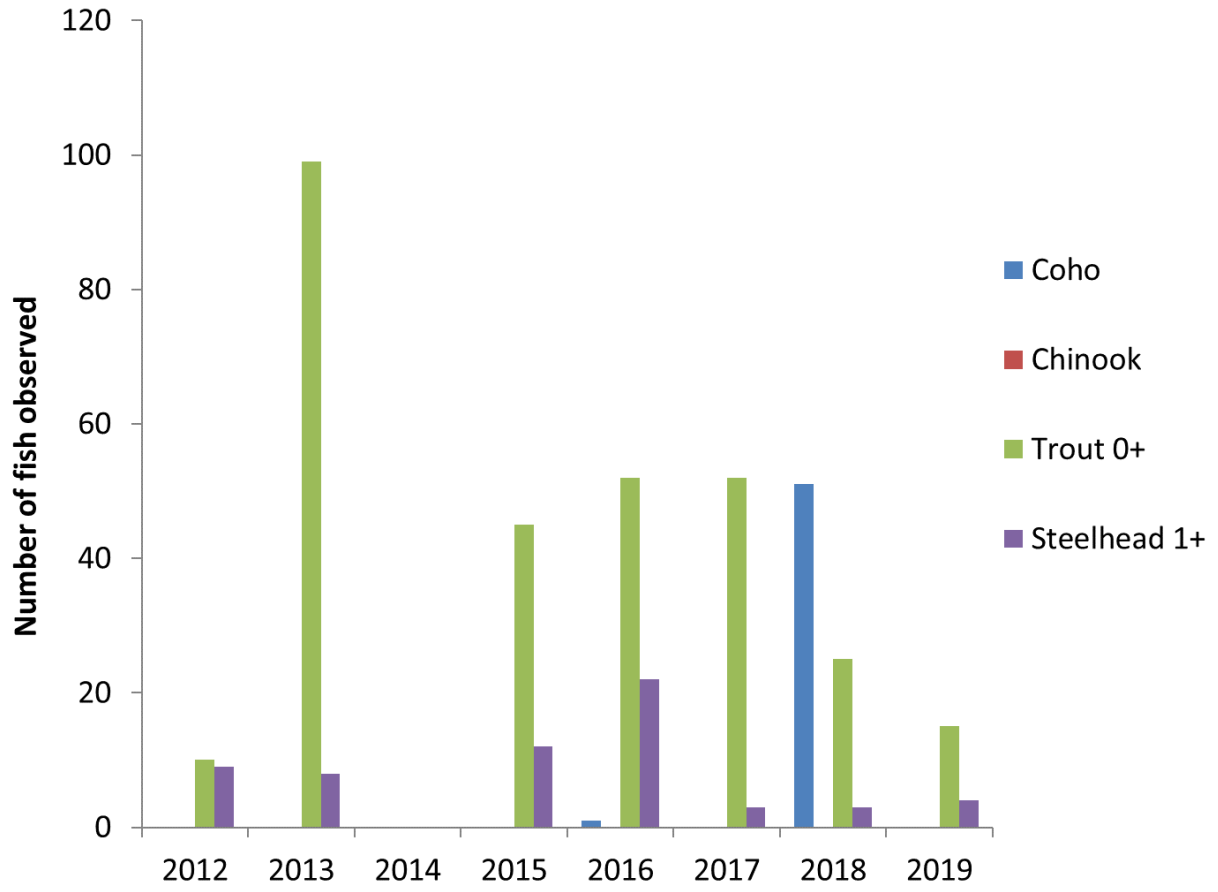

Figure 35. Results of annual snorkel survey fish counts of the first 5 pools within the Jordan Creek ATM 174 monitoring reach (2012-2019)

ATM Station 106 – Monument Creek [Underlying Geology: Cretaceous to Pliocene age Coastal belt of the Franciscan Complex (specifically the Coastal terrane)]

Data for all ATM parameters at site 106 (Figure 25) are summarized in the APFC report card provided in Table 16. The bed surface APFC target was not met in 2019, though the pebble count data reflect a coarsening of the substrate across all particle size classes (Figure 36). Pool characteristics remained generally static since 2016, with residual pool depth, pool spacing, and pool area consistently failing to meet the target criteria. LWD piece frequency did not meet the target in 2019, failing by a margin of 0.9 pieces per 100 feet of stream channel as total LWD pieces decreased (-37%) since 2016. Water temperature met the APFC target for the 2nd straight survey year as mid-channel canopy cover met the target goal for the 4th survey year in a row.

Cross-section data suggest varying degrees of channel aggradation and scour since surveys were instituted in 1997 (see appendix). Aggradation was observed at 3/5 cross-sections between survey years 2016 and 2019, the greatest degree of which occurred at cross-section 3 (-1.16m^2). The greatest degree of channel scour occurred at cross-section 4 where the channel area increased +1.23m^2.

Snorkel surveys have been suspended since 2017 (Figure 37) due to challenges associated with preventing livestock from entering the ATM stream channel monitoring reach. Juvenile coho salmon have yet to be detected in this ATM reach.

Table 16. Individual site report card for ATM station 106, Monument Creek

Site 106 Monument Creek	**Parameter**	**Target Value** (# no target)	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Bed Surface	D_{84} (mm)	#	273	214			123			169			114			119			121
	D_{50} (mm)	65-95	107	77			50			69			33			56			64
	D_{16} (mm)	#	22	10			13			12			6			19			30
	D_5 (mm)	#	4	1			5			1			2			5			10
Pool Characteristics	Pool Area (%)	≥25	26	28			31			15			14			10			22
	Pool Spacing (CW/pool)	≤6	5.2	3.2			4.1			10.6			8.9			10.3			6.1
	Residual Pool Depth (m)	≥0.91	0.44	0.44			0.62			0.47			0.42			0.30			0.56
	Pools Assoc. w/wood (%)	≥50	100	90			83			100			33			67			80
Large Woody Debris	Total Piece Frequency (#/100 ft)	≥4.87		8.00						6.00			4.80			5.40			3.97
	Total Piece Count	#		87						58			43			59			43
Water Temperature	MWAT (°C)	≤16.8	16.8	17.2	15.6	16.5	16.2	16.2	15.7	14.2	14.9	14.3	16.4	16.1	16.6	15.2	17.0	15.5	16.1
Riparian Overstory	Canopy Over Stream (%)	≥77								99			83			89			93
	Canopy of Rip Forest (%)	≥85	97	99			100						96						

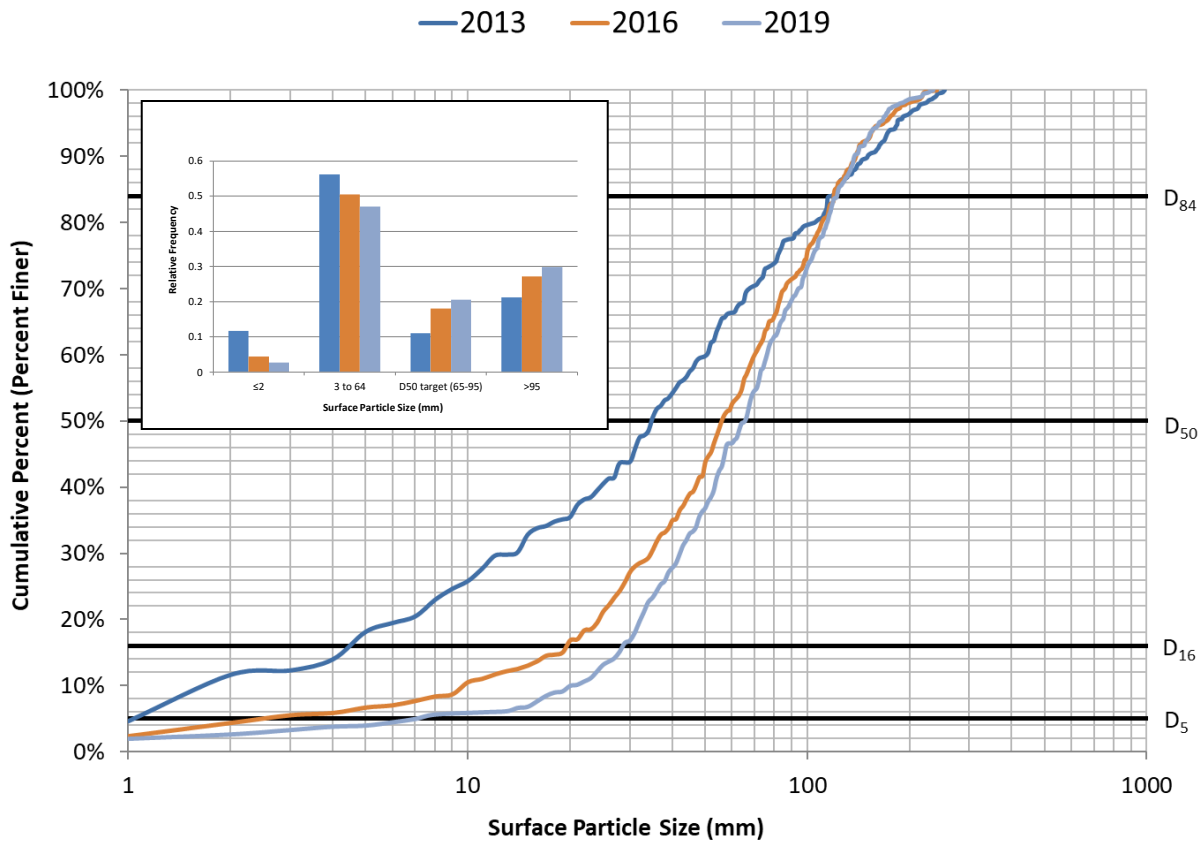

Figure 36. Cumulative frequency plot of the mean surface particle size of three riffles measured within the Monument Creek ATM 106 monitoring reach (2013-2019)

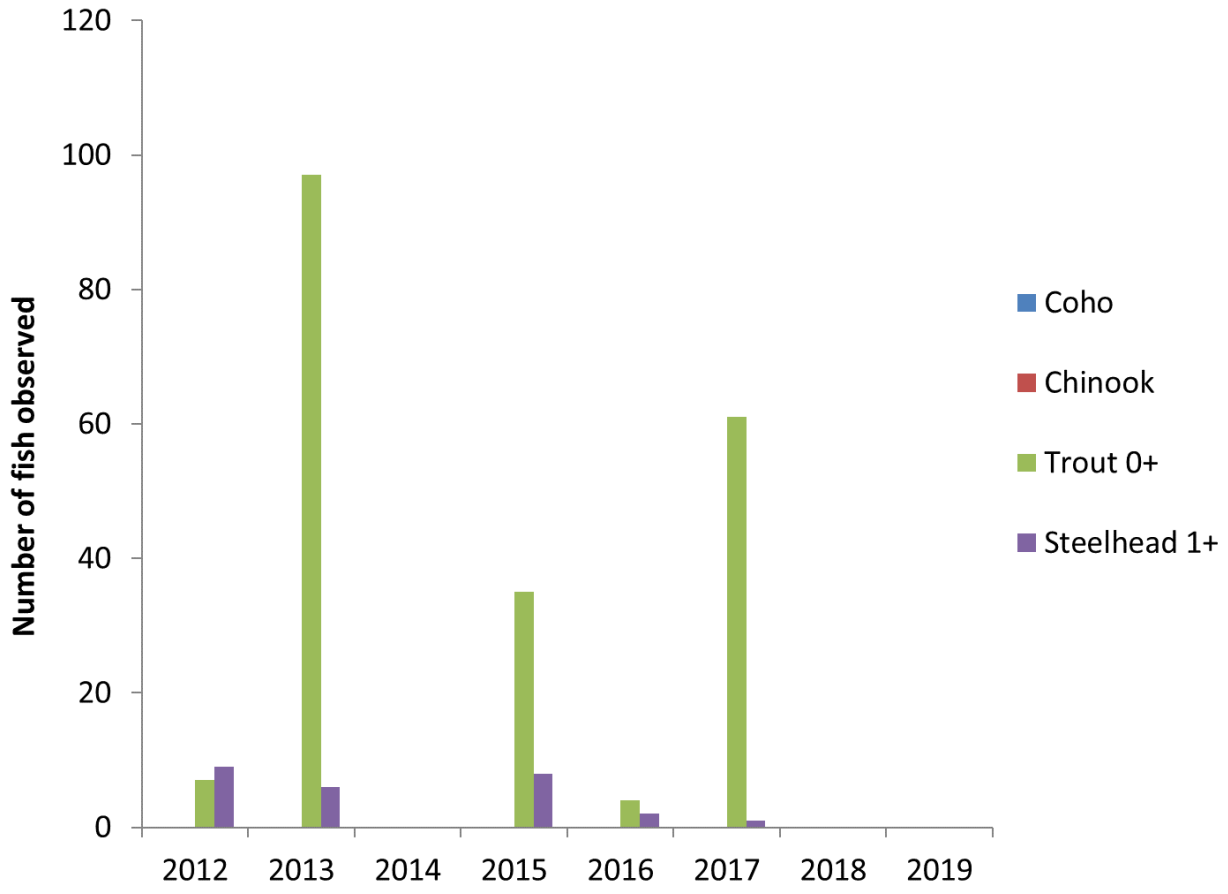

Figure 37. Results of annual snorkel survey fish counts of the first 5 pools within the Monument Creek ATM 106 monitoring reach (2012-2017) (surveys were not done in 2018 and 2019)

ATM Station 130 – Shively Creek [Underlying Geology: Quaternary age Alluvium (basement rock = Cretaceous to Pliocene age Coastal belt of the Franciscan Complex, specifically the Coastal terrane)]

Data for all ATM parameters at site 130 (Figure 25) are summarized in the APFC report card provided in Table 17. The bed surface APFC target was not met in 2019, even as the data reflect a coarsening of the substrate across most particle size classes (Figure 38). Pool characteristics remained generally static since 2016, with residual pool depth consistently failing to meet its target criterion. LWD piece frequency did not meet the APFC target in 2019, as total LWD pieces decreased (-81%) since 2016. Water temperature met the APFC target for the 4th survey year in a row, as mid-channel canopy cover met the target goal for the 3rd survey year in a row.

Cross-section data suggest varying degrees of channel aggradation and scour since surveys were instituted in 2007 (see appendix). Aggradation was observed at 3/5 cross-sections between survey years 2016 and 2019, the greatest degree of which occurred at cross-section 3 (-0.59m^2). The greatest degree of channel scour occurred at cross-section 1 where the channel area increased +0.4m^2.

A snorkel survey conducted on 8/8/2019 identified trout of various size classes in all 5 pools sampled (Figure 39). Foothill Yellow-legged frogs were also observed occupying the stream reach. Juvenile coho salmon were detected in this ATM reach as recently as 2016.

Table 17. Individual site report card for ATM station 130, Shively Creek

Site 130 Shively Creek	**Parameter**	**Target Value** (# no target)	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Bed Surface	D_{84} (mm)	#	88	65			79			74			71			67			77
	D_{50} (mm)	65-95	40	25			39			39			34			45			51
	D_{16} (mm)	#	1	1			2			12			10			28			29
	D_5 (mm)	#	1	1			1			3			1			19			13
Pool Characteristics	Pool Area (%)	≥25	35	39			45			41			22			51			59
	Pool Spacing (CW/pool)	≤6	7.4	5.2			6.0			4.9			5.6			3.7			3.4
	Residual Pool Depth (m)	≥0.91	0.62	0.63			0.57			0.47			0.43			0.46			0.59
	Pools Assoc. w/wood (%)	≥50	100	100			89			80			86			89			100
Large Woody Debris	Total Piece Frequency (#/100 ft)	≥4.87	3.20	3.90						4.10			2.70			3.20			1.91
	Total Piece Count	#	29	35						41			29			29			16
Water Temperature	MWAT (°C)	≤16.8	15.9	16.8	15.7	16.0	15.9	15.7	15.6	14.3	15.0	15.0	16.5	15.8	17.1	15.7	16.4	15.9	16.3
Riparian Overstory	Canopy Over Stream (%)	≥77											97			95			98
	Canopy of Rip Forest (%)	≥85	100	100			98						97						

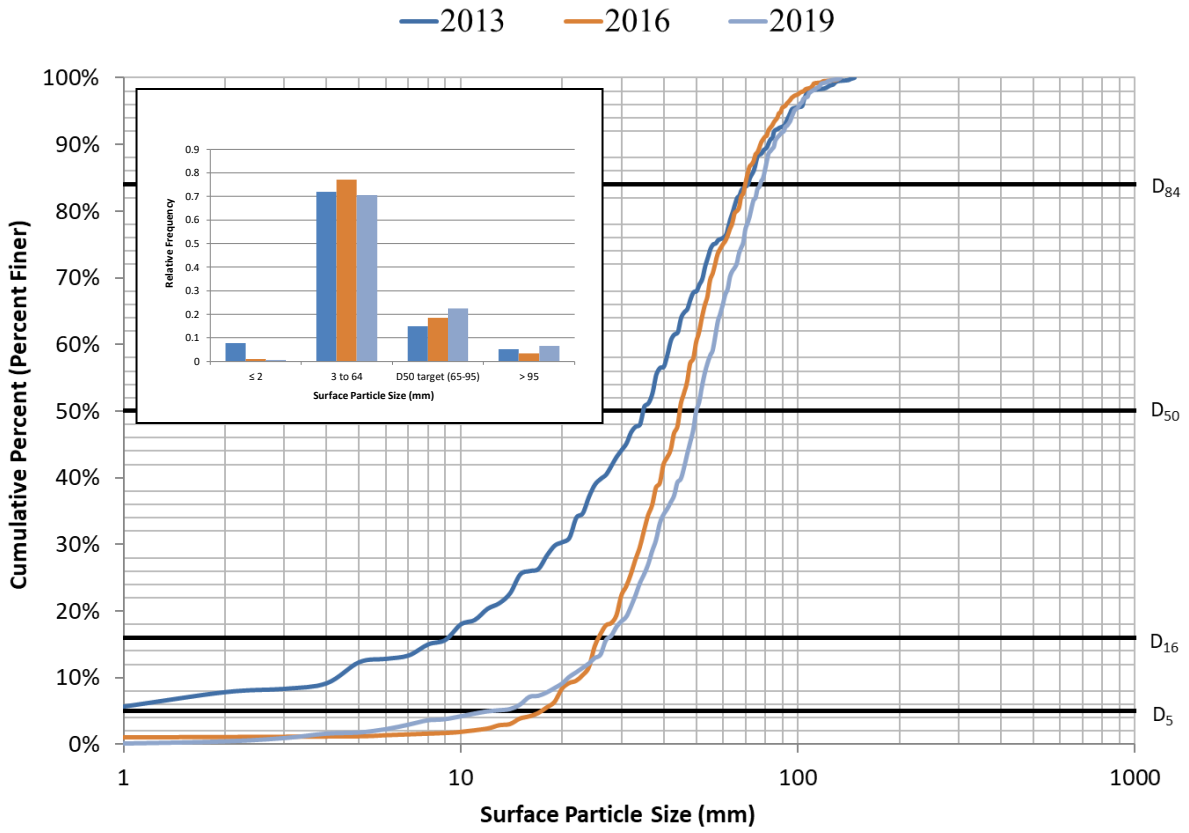

Figure 38. Cumulative frequency plot of the mean surface particle size of three riffles measured within the Shively Creek ATM 130 monitoring reach (2013-2019)

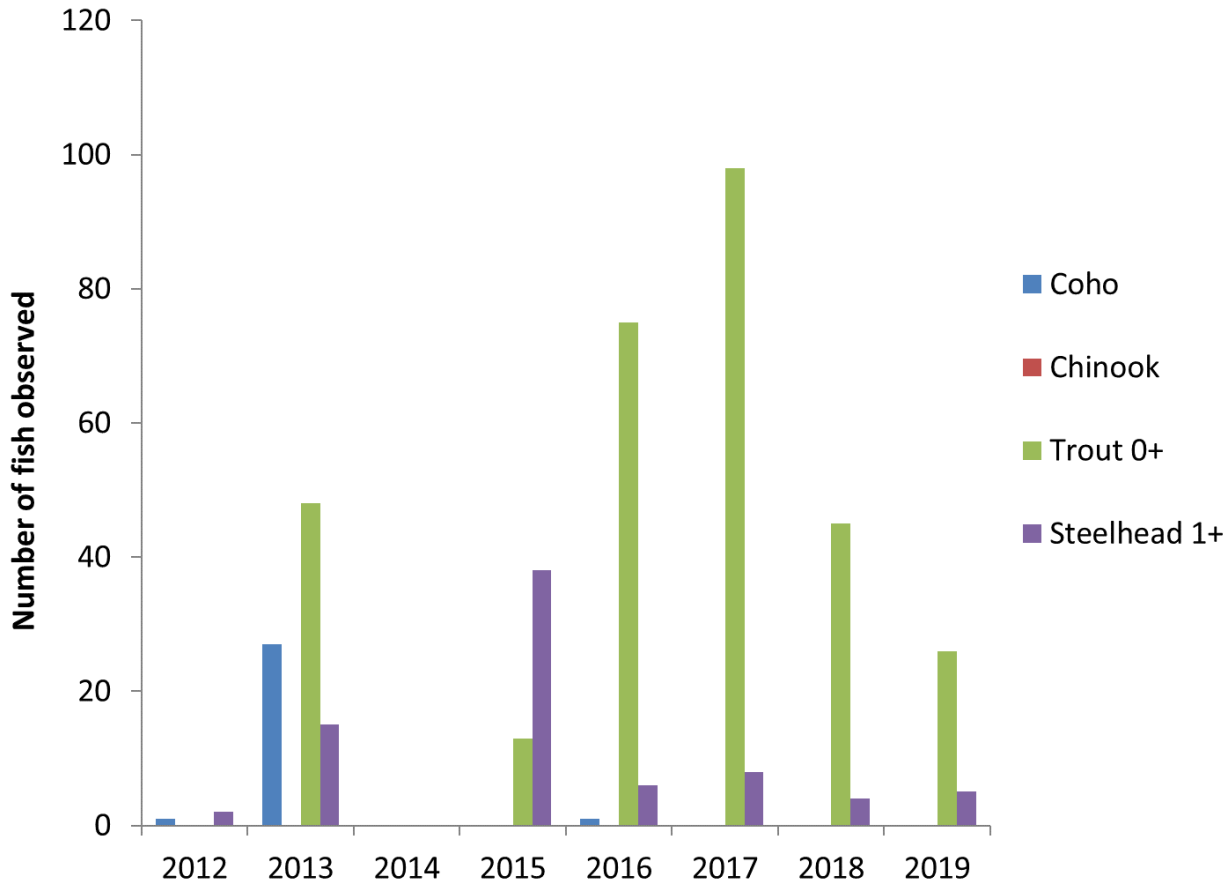

Figure 39. Results of annual snorkel survey fish counts of the first 5 pools within the Shively Creek ATM 130 monitoring reach (2012-2019)

ATM Station 242 – Atwell Creek [Underlying Geology: Miocene to Late Pliocene age Wildcat Group]

Data for all ATM parameters at site 242 (Figure 25) are summarized in the APFC report card provided in Table 18. The bed surface APFC target was met in 2019, as the pebble count data reflect a coarsening of the substrate across all particle size classes (Figure 40). Pool characteristics reflect a slight overall decline in habitat characteristics since 2016, as residual pool depth failed to meet its target criterion for the fifth consecutive survey year. Total LWD pieces decreased -44% since 2016 as total LWD piece frequency did not meet the APFC target for the fourth time in the last five survey years. Water temperature has consistently met the APFC target and mid-channel canopy cover met the APFC target for the fourth time in the last four survey years.

Cross-section data suggest varying degrees of channel aggradation and scour since surveys were instituted in 2007 (see appendix). Aggradation was observed at 2/5 cross-sections between survey years 2016 and 2019, the greatest degree of which occurred at cross-section 1 (-0.66m^2). The greatest degree of channel scour occurred at cross-section 3 where the channel area increased +0.59m^2.

A snorkel survey conducted on 7/12/2019 identified trout of various size classes in all 5 pools sampled (Figure 41). Foothill Yellow-legged frogs were also observed occupying the stream reach. Juvenile coho salmon were detected in this ATM reach as recently as 2018.

Table 18. Individual site report card for ATM station 242, Atwell Creek

Site 242 Atwell Creek	**Parameter**	**Target Value** (# no target)	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Bed Surface	D_{84} (mm)	#			123			123			110			106			121
	D_{50} (mm)	65-95			44			54			36			63			70
	D_{16} (mm)	#			7			9			3			30			38
	D_{5} (mm)	#			1			1			1			13			20
Pool Characteristics	Pool Area (%)	≥25			29			26			6			31			38
	Pool Spacing (CW/pool)	≤6			5.8			8.0			17.1			5.0			4.4
	Residual Pool Depth (m)	≥0.91			0.54			0.52			0.48			0.63			0.43
	Pools Assoc. w/wood (%)	≥50			67			75			0			83			43
Large Woody Debris	Total Piece Frequency (#/100 ft)	≥4.87			5.50			4.30			4.30			2.00			1.39
	Total Piece Count	#			52			52			46			19			13
Water Temperature	MWAT (°C)	≤16.8	15.8	16.8	17.1	15.2	15.7	14.3		15.1	16.7	16.4	16.5	15.7	16.5	15.9	16.7
Riparian Overstory	Canopy Over Stream (%)	≥77						100			82			89			89
	Canopy of Rip Forest (%)	≥85			100						92						

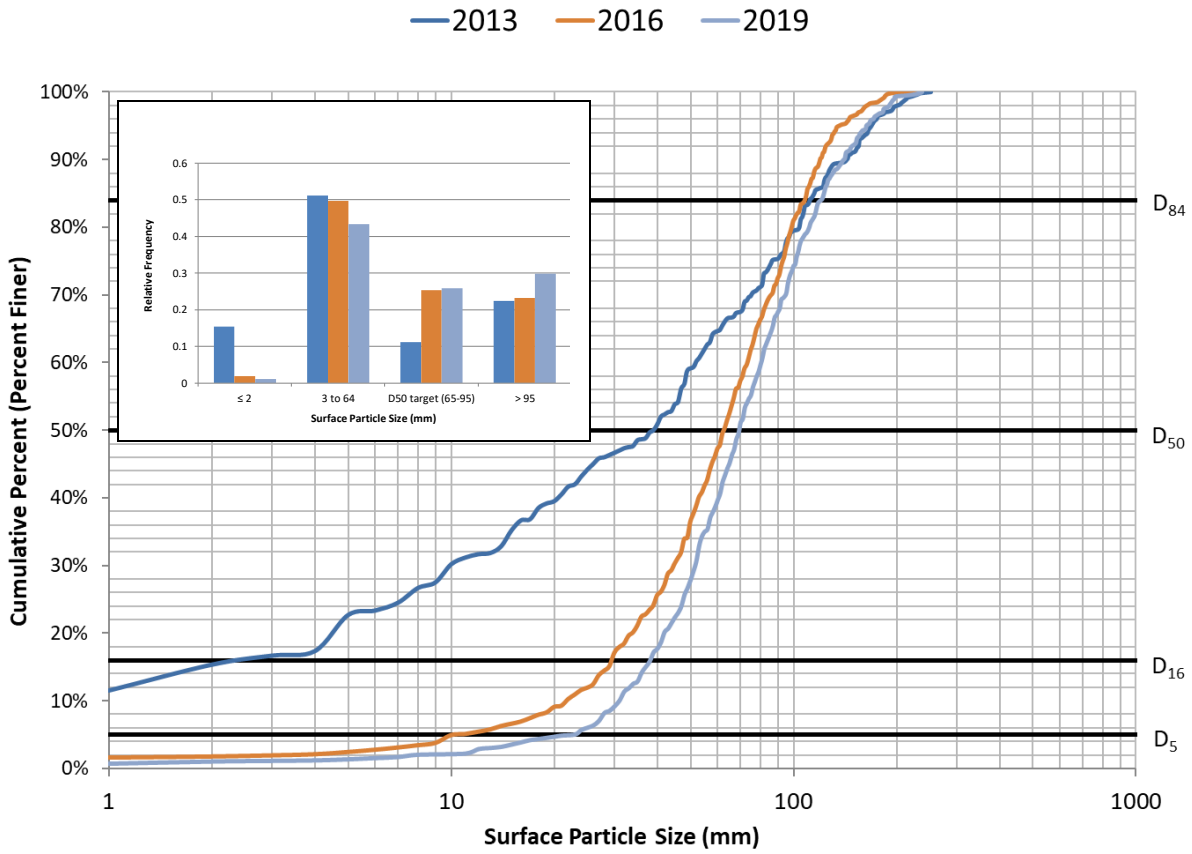

Figure 40. Cumulative frequency plot of the mean surface particle size of three riffles measured within the Atwell Creek ATM 242 monitoring reach (2013-2019)

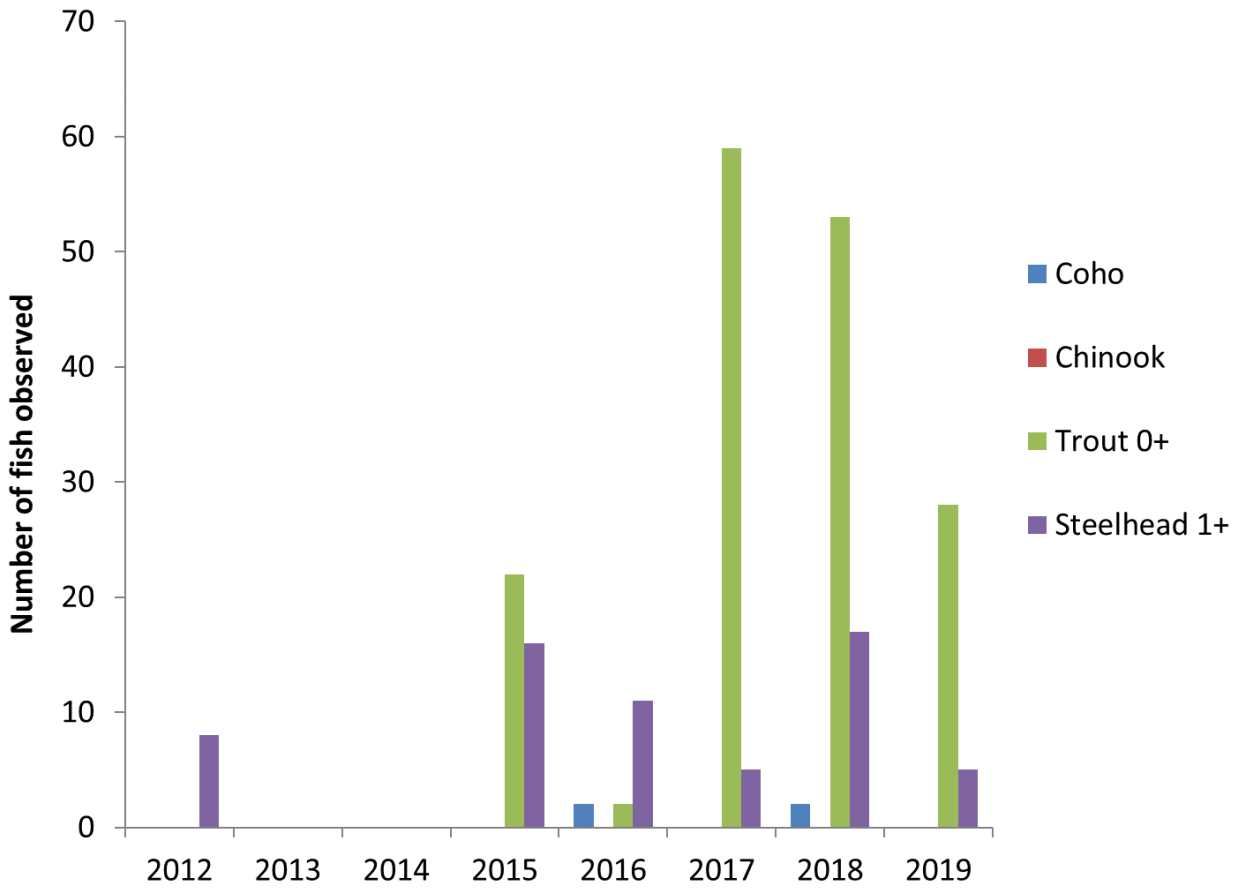

Figure 41. Results of annual snorkel survey fish counts of the first 5 pools within the Atwell Creek ATM 242 monitoring reach (2012-2019)

Summary of ATM Trends in the Lower Eel River WAU

A summary of the Lower Eel River habitat characteristics from 2019 is provided in and APFC report card (Table 19).

For Bear Creek, results of habitat composite scores from 2019 and 2018 are compared to baseline (2004) composite scores (Figure 42). All habitat scores in 2019 remained stable from the previous year in 2018. Canopy cover in the Bear Creek watershed continued to show the least improvements in 2019.

For the remaining ATM stations in the Lower Eel River WAU, results of habitat composite scores from 2019 and 2016 are compared to baseline (2004) composite scores (Figure 43). There were no habitat composite score improvements since 2016. Pool characteristic scores in 2019 declined (-9%) and LWD scores declined (-200%) since 2016.

Table 19. Most recent habitat measures for the Lower Eel River WAU

Current Status	Parameter	Target Value (# no target)	203 Lower Bear Cr	107 Mid-Bear Cr	204 Mid-Upper Bear Cr	242 Atwell Cr	106 Monument Cr	174 Jordan Cr	205 Jordan Cr	130 Shively Cr
Bed Surface	D_{84} (mm)	#	108	116	115	121	121	105	113	77
	D_{50} (mm)	65-95	66	66	67	70	64	56	60	51
	D_{16} (mm)	#	29	28	35	38	30	24	24	29
	D_{5} (mm)	#	12	11	11	20	10	7	8	13
Pool Characteristics	Pool Area (%)	≥25	40	35	34	38	22	27	23	59
	Pool Spacing (CW/pool)	≤6.0	1.9	2.7	3.4	4.4	6.1	2.5	2.8	3.4
	Residual Pool Depth (m)	≥0.91	0.52	0.51	0.54	0.43	0.56	0.43	0.39	0.59
	Pools Assoc. w/wood (%)	≥50	100	100	100	43	80	67	100	100
Large Woody Debris	Total Piece Frequency (#/100 ft)	f(CW)	5.8	7.1	8.1	1.4	4.0	4.7	4.7	1.9
	Total Piece Count	#	92	99	113	13	43	60	69	16
Water Temperature	MWAT (°C)	≤16.8	17.1	16.1	15.5	16.7	16.1	15.0		16.3
Riparian Overstory	Canopy Over Stream (%)	f(CW)	83	76	80	89	93	94	94	98
	Canopy of Rip Forest (%)	≥85								
Watershed Area	Upstream Acreage	#	5,449	5,026	4,302	2,748	2,852	2,792	2,896	1,404
Reach Gradient	Reach Gradient (%)	#	1.6	1.8	3.8	1.0	2.8	3.5	2.2	1.0

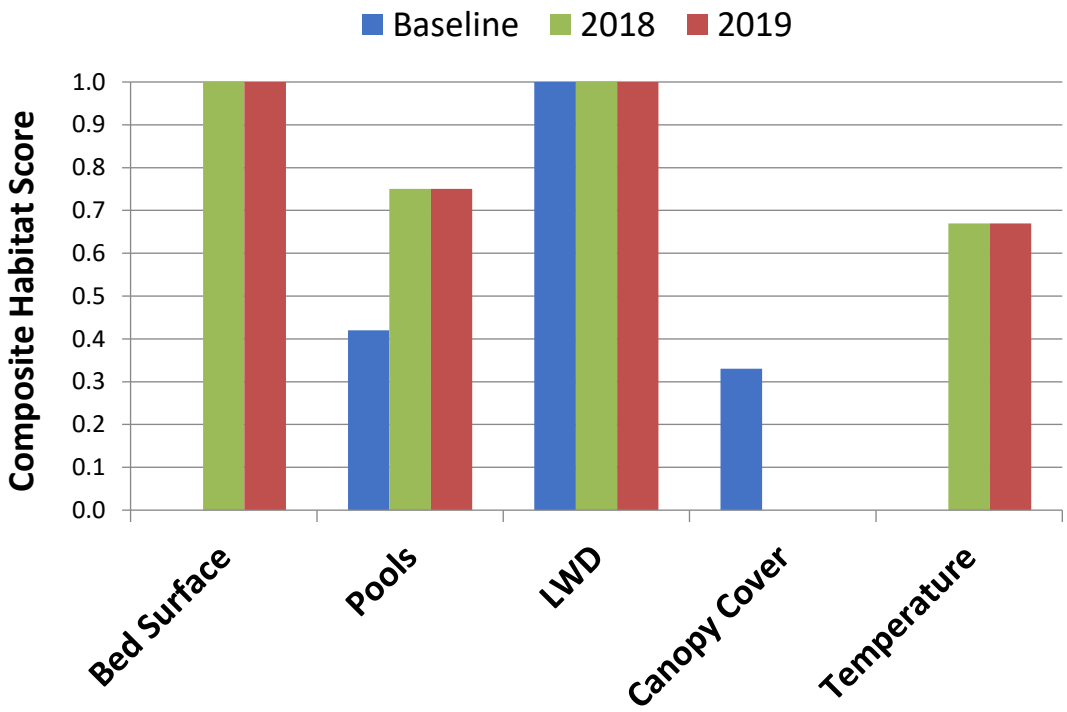

Figure 42. The composite scores for habitat characteristics in Bear Creek (Lower Eel River WAU) in 2019 and 2018 relative to baseline (2004) data

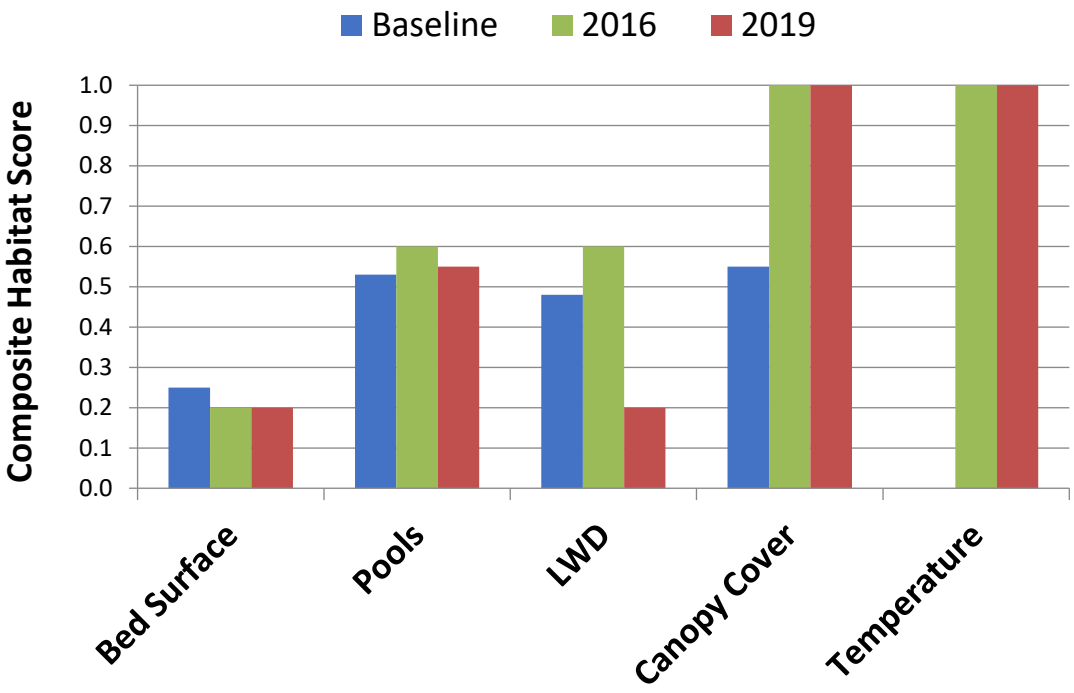

Figure 43. The composite scores for habitat characteristics in the Lower Eel River WAU (Jordan Creek, Monument Creek, Shively Creek, and Atwell Creek) in 2019 and 2016 relative to baseline (2004) data

QUALITY ASSURANCE / QUALITY CONTROL

Three of the twelve (3/12) ATM sites measured in 2019 were re-measured to assess the quality and reproducibility of ATM data collection. Data collection at 12/12 sites, including QA/QC, was conducted by the same two-person field crew in 2019. QA/QC sites were re-measured within 2 weeks of the initial measurement. The number of pools surveyed during the QA/QC visit at each site also remained consistent with the original survey and surface sediment (pebble count) re-measurement took place at the same locations at each site. Results of the 2019 QA/QC are provided in Table 20.

Initial vs. QA/QC surface D_{50} particle measurements were highly consistent at ATM stations 107, 130, and 112 (standard deviation of the mean (+/-) 1mm, 0.5mm, 0.5mm, respectively). Pool characteristic comparisons were consistent at all three sites, resulting in identical pass/fail scores across all pool habitat parameters. LWD counts were also highly consistent, resulting in identical pass/fail scores of initial vs. QA/QC counts. Mid-channel canopy QA/QC measurements reflect consistent, repeatable results utilizing the current data collection methods. All current data collection methods in 2019 have demonstrated the ability to produce reliable results, highlighting the flexibility of the pass/fail approach to the APFC score card rating system currently utilized in this report.

Table 20. QA/QC data collection measures for three (3) ATM stations in 2019

2019 QA/QC	Parameter	Target Value (# no target)	107 Bear Creek	107.1 Bear Creek	130 Shively Creek	130.1 Shively Creek	112 Hely Creek	112.1 Hely Creek
Bed Surface	D_{84} (mm)	#	116	125	77	77	108	106
	D_{50} (mm)	65-95	66	68	51	52	68	67
	D_{16} (mm)	#	28	27	29	30	39	38
	D_5 (mm)	#	11	10	13	16	18	17
Pool Characteristics	Pool Area (%)	≥25	35	28	59	58	24	16
	Pool Spacing (CW/pool)	≤6.0	2.7	2.7	3.4	3.3	4.6	5.1
	Residual Pool Depth (m)	≥0.91	0.51	0.58	0.59	0.52	0.38	0.32
	Pools Assoc. w/wood (%)	≥50	100	100	100	89	86	100
Large Woody Debris	Total Piece Frequency (#/100 ft)	f(CW)	7.1	5.8	1.9	2.4	6.0	3.4
	Total Piece Count	#	99	81	16	20	53	30
Water Temperature	MWAT (°C)	≤16.8	16.1		16.3		15.2	
Riparian Overstory	Canopy Over Stream (%)	f(CW)	76	86	98	96	82	85
	Canopy of Rip Forest (%)	≥85						

ATM METHODS REVISITED

Bed Surface

Analyses of the QA/QC measures indicate adjustment to protocols is warranted to achieve greater consistency and confidence in measurements. Bed surface surveys include the measurement of 600 pebbles in three riffles using a systematic approach. Refinements to sampling protocol include exclusion of boulders (> 254mm), systematic sampling that includes a grid process for measuring an entire riffle, and minimum spacing based on the largest particle size. These specified procedures allow for more consistent implementation of methods.

Bed Subsurface

Bed subsurface measurement is conducted by collecting three pool tail-out bulk sediment samples with a shovel. Difficulties with consistent measurement of the subsurface are due to 1) limitations in the ability to sample large substrate with a shovel, 2) heterogeneity of sediment distribution in pool tail-outs, and 3) a relatively small sample size collected from each site. Due to the inherent variability of this measure, HRC has discontinued the collection and processing of bulk sediment samples. This change was made in consultation with the HCP Agencies (2014).

Pool Habitat Delineation

HRC added criteria for consistent delineation of pools in 2013. Current pool criteria require a pool to have a minimum surface area of 3 m^2 for streams with a wetted width of < 3 m and must be at least one half the wetted channel widths. For streams with a wetted width of > 3 m, a pool must have a minimum surface area of 6 m^2 and a width of at least one half the wetted channel widths. This change reduces subjectivity (surveyor bias) when considering determination of marginal pool habitat in favor of established minimum criteria.

In-stream Large Wood

APFC targets for LWD are based on a bank-full width, as measurement of LWD is limited to the bank-full channel. These measurement limits require all field observers to consistently identify bank full as they move through each stream reach. This identification can be complicated in areas with braided channels (i.e. ATM 174, Jordan Creek), or areas where the bank-full width cannot be observed from the thalweg (i.e. ATM 164, Yager Creek). Previous LWD sampling techniques highlighted the challenges in evaluating trends for wood in streams. New methods for LWD data collection minimized these

challenges by reducing the effects of observer bias such as the inconsistent identification of bank-full boundaries.

Bank-full width is used to calculate APFC targets for length, diameter, and total LWD volume. Previous inconsistencies were identified within the ATM dataset due to bank-full widths being collected on an annual basis at different locations. For example, bank-full widths collected during habitat delineation on an annual basis varied as much as ±75% for the same ATM reaches from year to year. This variation in bank-full width was the result of measurement errors and changes in measurement locations, as previous methods called for measurements to be taken at standard distances and not at locations that are representative of average channel conditions.

To increase consistency, a standard bank-full width was calculated for each ATM reach using a combination of permanent cross-sections and habitat measurements. Standardized bank-full widths do not include areas outside the active main channel (i.e. braided reaches). The standard bank-full width was then applied to LWD data collected since 2005 and wood loading characteristics subsequently re-calculated for consistent comparison over time. The standard bank-full width for each ATM reach will be revisited periodically and adjusted if significant changes in stream channel warrant.

Beginning in 2015, LWD pieces were counted, and distances were recorded as to the location of each piece. Measurements of diameter, length, volume, and determination of number of key pieces were discontinued except during extended wood surveys which are to be conducted once every 6 years. Designation of extended wood survey reaches were determined during watershed analysis revisit and limited to reaches where wood is critical in habitat development. This change was made in consultation with the HCP Agencies (2014).

Riparian Canopy

Also beginning in 2015, riparian forest canopy closure measurements were limited to ATM riparian stands where less than 85% canopy closure was recorded in the prior ATM survey. No riparian canopy closure measurements were required in stands with 85% or more riparian canopy closure documented in the prior ATM survey unless a significant disturbance has occurred since last surveyed (e.g. harvest, blow-down, landslide, fire, disease, or insect mortality). This change was made in consultation with the HCP Agencies (2014).

Juvenile Salmonid Surveys

Occupancy surveys have been conducted at ATM locations since 2012 and later formally added to the standard ATM protocol in 2014 after consultation with the HCP signatory agencies. These surveys may provide anecdotal insight to the spawning success during the previous winter and may provide insight as to the rate of colonization by non-native, invasive aquatic species in watercourses within HRC's ownership. It is anticipated that the long-term results from these surveys helps to corroborate the results from the habitat monitoring portion of the ATM program.

Elk River ATM Stations

Changes specific to ATM monitoring in Elk River were submitted as part of the Elk River Watershed Analysis Revisit and implemented in consultation with HCP signatory agencies (2014). These changes include:

1. A reduction in ATM stations from ten (10) to seven (7)

2. A reduction in ATM site visit rotation from an annual to a three-year cycle (stream temperature and juvenile salmonid surveys will continue on an annual basis)

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APPENDICES

Appendix A Cross-section Plots (on CD)