Humboldt Redwood™

Class I Stream Aquatic Habitat Trends Monitoring

2018 Annual Report

June 30, 2019

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 2018:

In the Yager/Lawrence Creek WAU, there were improvements in habitat composite scores for bed surface particle size, pool characteristics, and water temperature. However, the composite score for mid-channel canopy cover was lower than the 2015 and baseline records. The 2018 LWD piece frequency score remained even with both the baseline and 2015 records.

In the Mattole River WAU, there were improvements in habitat composite scores for bed surface particle size, pool characteristics and mid-channel canopy cover. However, the composite score for LWD piece frequency remained even with both the baseline and 2015 records. The water temperature composite score was lower than the 2015 score, yet higher than the baseline record.

In the Lower Eel River WAU, for Bear Creek, there were improvements in habitat composite scores for bed surface particle size and water temperature. However, the composite score for mid-channel canopy cover was lower than the 2017 and baseline records. 2018 pool characteristics and LWD piece frequency composite scores remained even with the 2017 records.

In the Bear River WAU, there were improvements in habitat composite scores for bed surface particle size, pool characteristics, and water temperature. However, the composite scores for mid-channel canopy cover and water temperature were lower than the 2015 records. The 2018 LWD piece frequency composite score remained even with the baseline record.

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. 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, Figure 1). 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 WAUs. 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 lists the active monitoring stations, organized by WAU and arranged by drainage area. Currently, there are 44 habitat monitoring sites and 49 temperature monitoring sites.

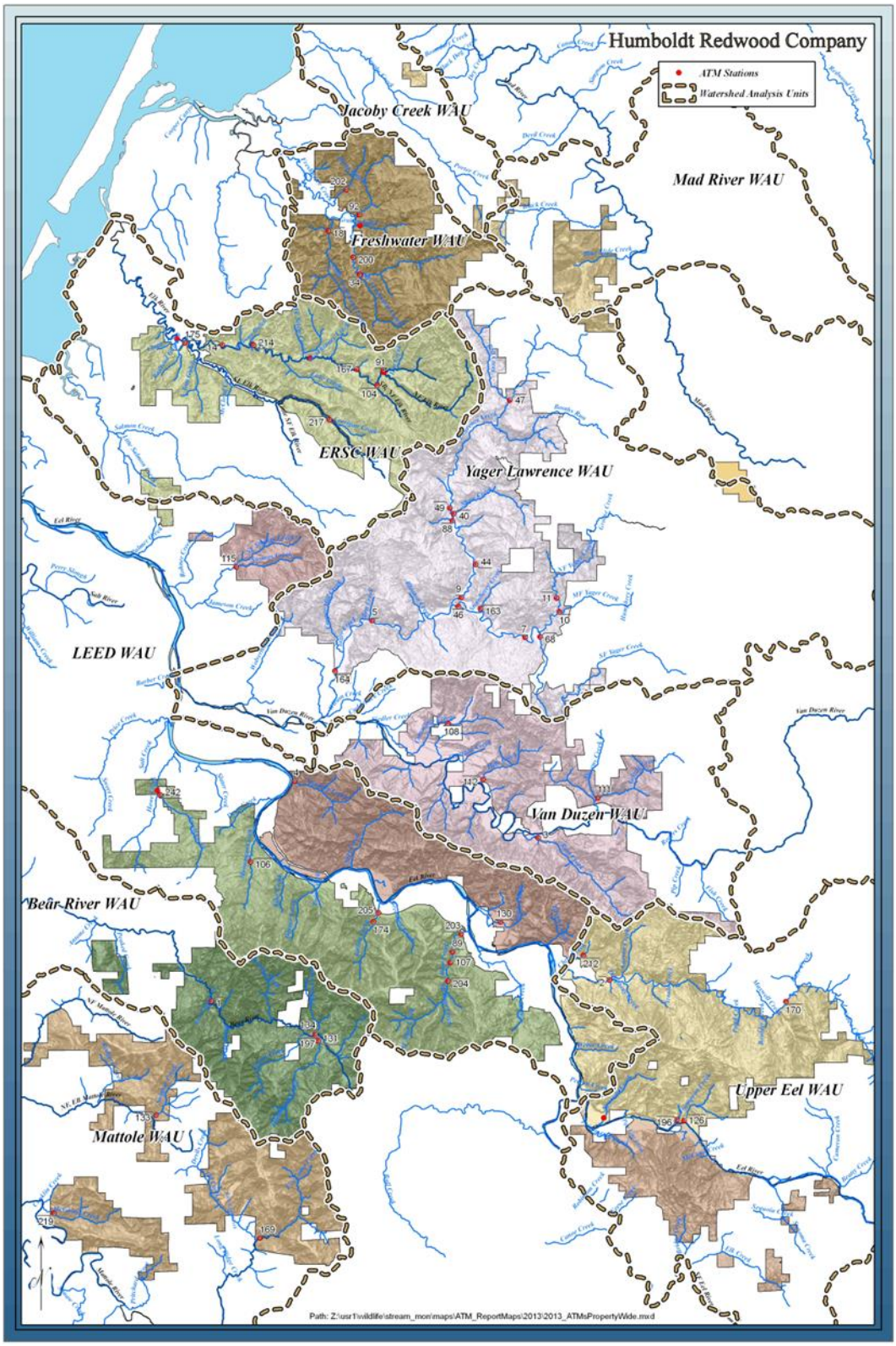

Figure 2. Location map of HRC ATM sites

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 [CDFW]). 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 parameters (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.

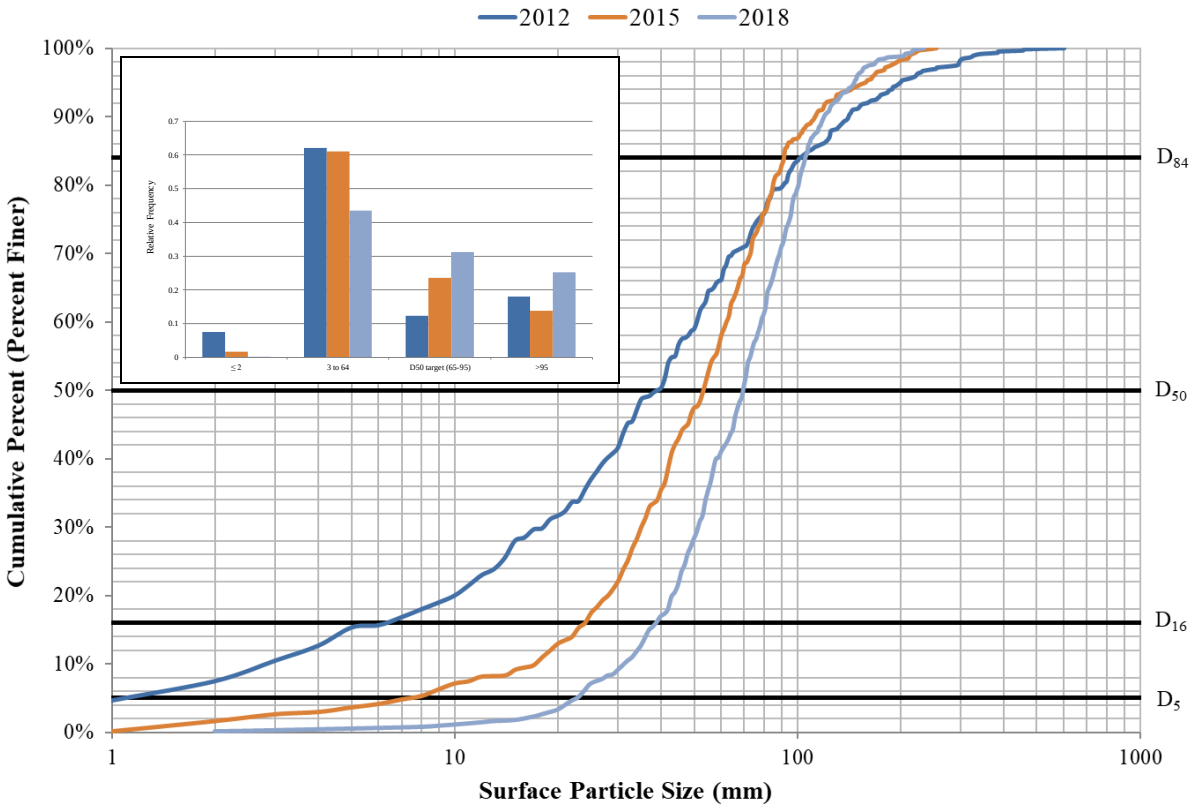

Figure 4. Example of a cumulative frequency (percent finer) plot of the mean surface particle sizes (mm) of three riffles measured within an ATM survey reach

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 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 as reference for the three-dimensional sampling grid encompassing the monitoring reach.

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).

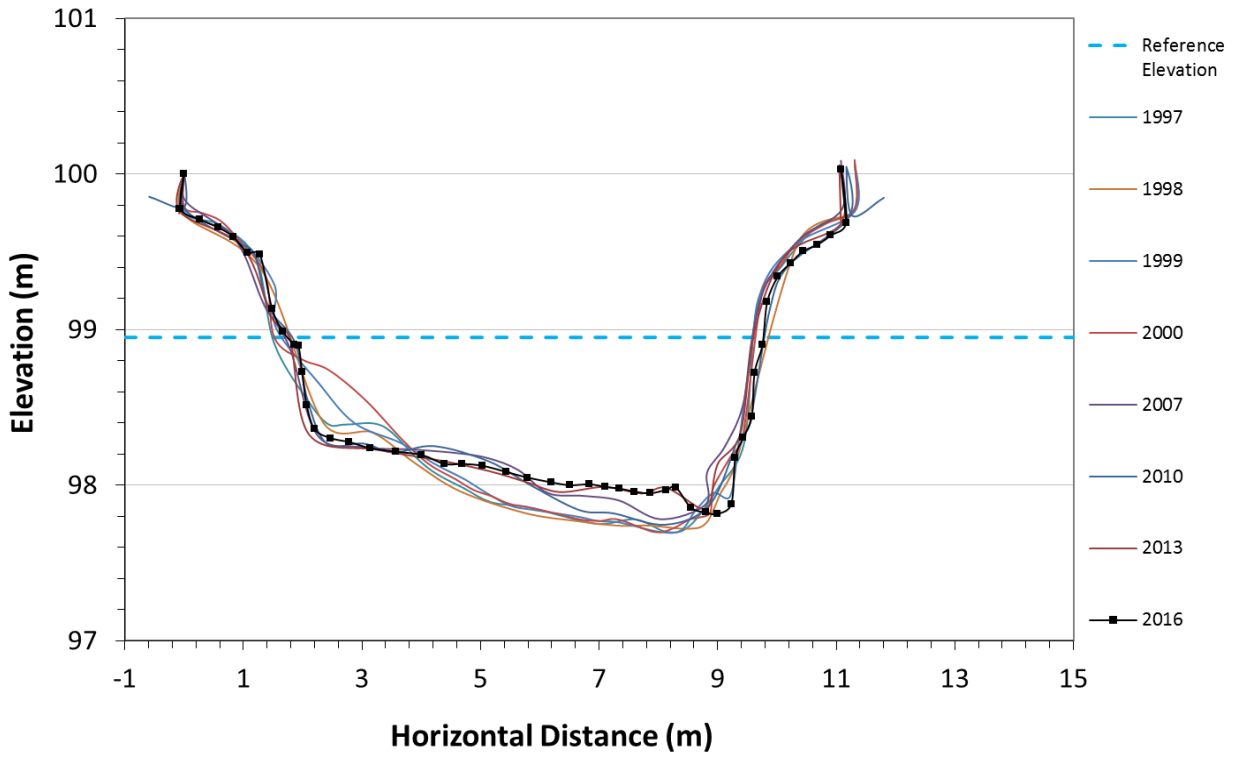

Figure 5. Example of a typical cross-sectional profile within an ATM survey reach

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.

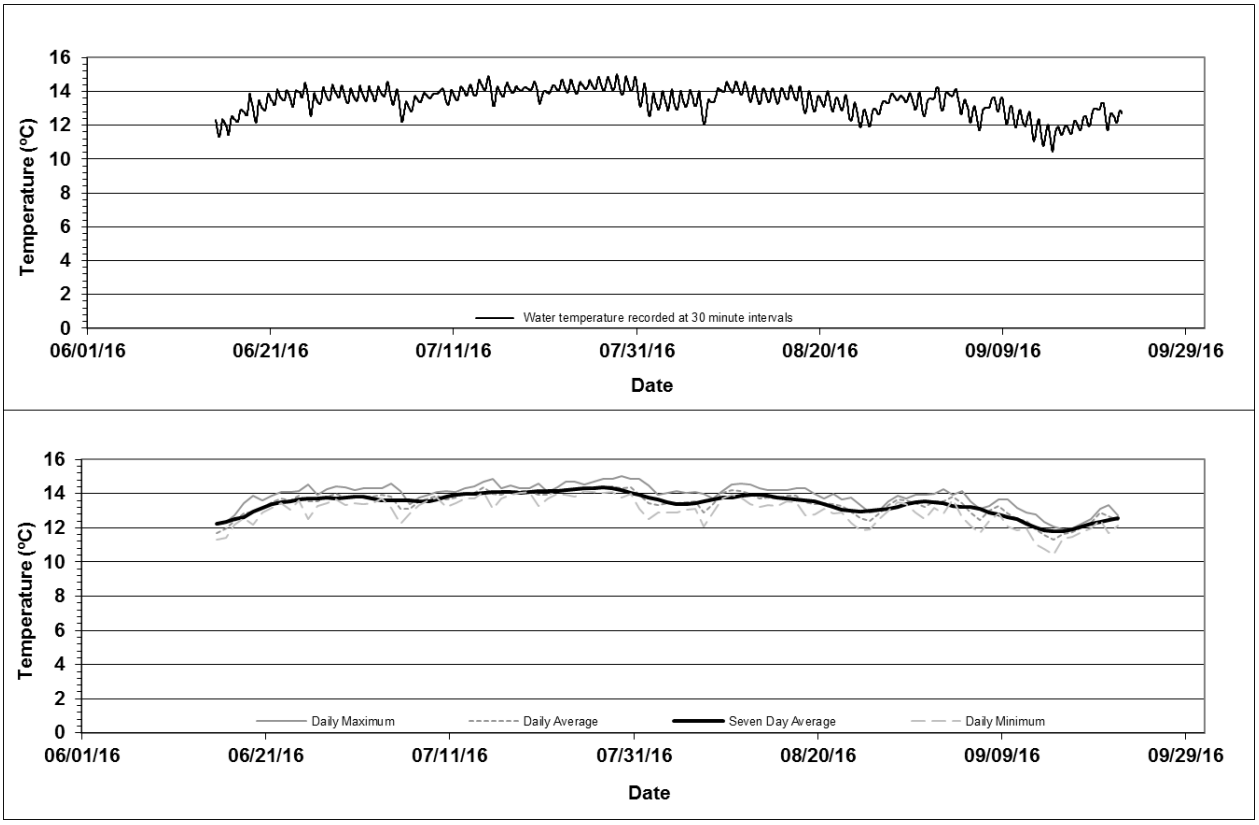

Figure 9. Example of a stream temperature profile generated from a continuously-recording temperature data logger deployed at most ATM stations annually

PROGRAM IMPLEMENTATION - 2018

In this section, we report on program implementation, including field and laboratory 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 2018 and accomplishments against this plan. Pebble count, canopy closure, habitat typing, and streambed surveys were conducted at 16 stations in the Yager Creek, Lawrence Creek, Bear Creek, Bear River, and Mattole River drainages. Temperature instruments were deployed at 49 sites property wide. All fieldwork was completed within the scheduled time period. All data collection occurred prior to any major storm events.

Table 3. 2018 measurement activity in the ATM Program

Watershed	Habitat		Temperature	
	Scheduled	Completed	Scheduled	Completed
Freshwater Creek	None	None	7	7
Elk River	None	None	7	7
Yager Creek	3	3	6	6
Lawrence Creek	3	3	5	5
Van Duzen River	None	None	4	4
Eel River Delta	None	None	2	2
Lower Eel Tributaries	None	None	3	3
Bear Creek	3	3	3	3
Upper Eel Tributaries	None	None	2	2
Larabee Creek	None	None	3	3
Mattole River	3	3	3	3
Bear River	4	4	4	4
TOTAL	**16**	**16**	**49**	**49**

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.

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 2018 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 82 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 measured in 2018. Previous measurements from WAUs not measured in 2018 can be found in previously submitted ATM annual reports.

Table 4. Example watershed report card

2018	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 2018

Precipitation is calculated by the "hydrologic year" that runs from October 1 through September 30th 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 39.11 inches[1] with roughly 90% of the annual precipitation falling as rain during the months of October through May. Rainfall amounts in hydrologic year 2018 (October 1, 2017 to September 30, 2018) were moderately less 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 36.96 inches, approximately 8% lower than the long-term average. Maximum daily rainfall was 1.69 inches, suggesting that peak flows may have been moderate 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 24% greater than the long-term average).

Total annual rainfall at the NWS station in Scotia, CA in HY2018 was 33.80 inches, which is approximately 40% lower than the long-term average for this station. The maximum peak flow measured at the gaging station at the Eel River near Scotia equaled 101,000 cubic feet per second (cfs), with a corresponding maximum daily mean of 81,400 cfs occurring on March 7, 2018. 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 (Figure 10).

Annual peak flows (cms) 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)

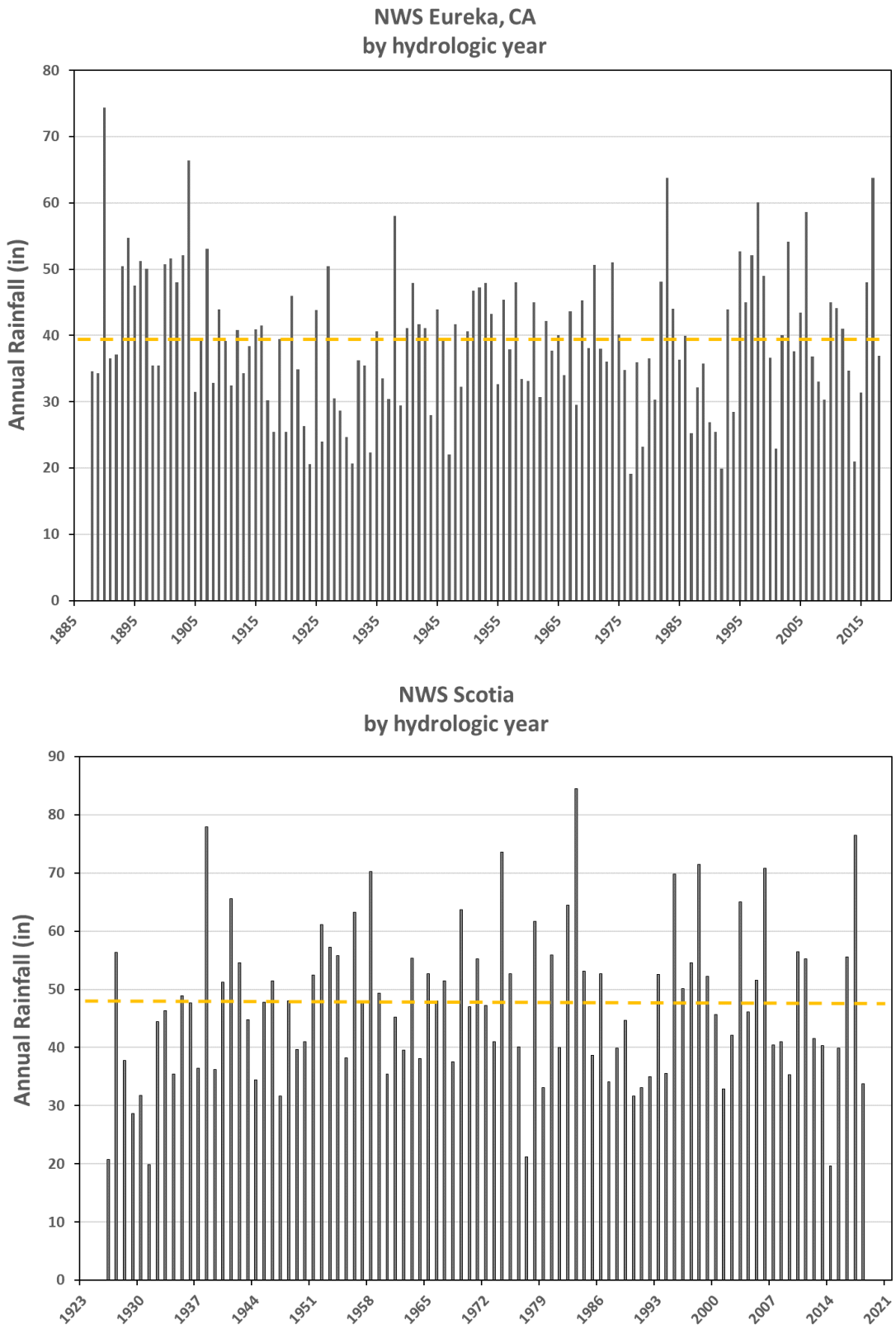

Figure 10. Annual rainfall by hydrologic year at Eureka and Scotia, CA. Dotted lines represent the running averages (all years)

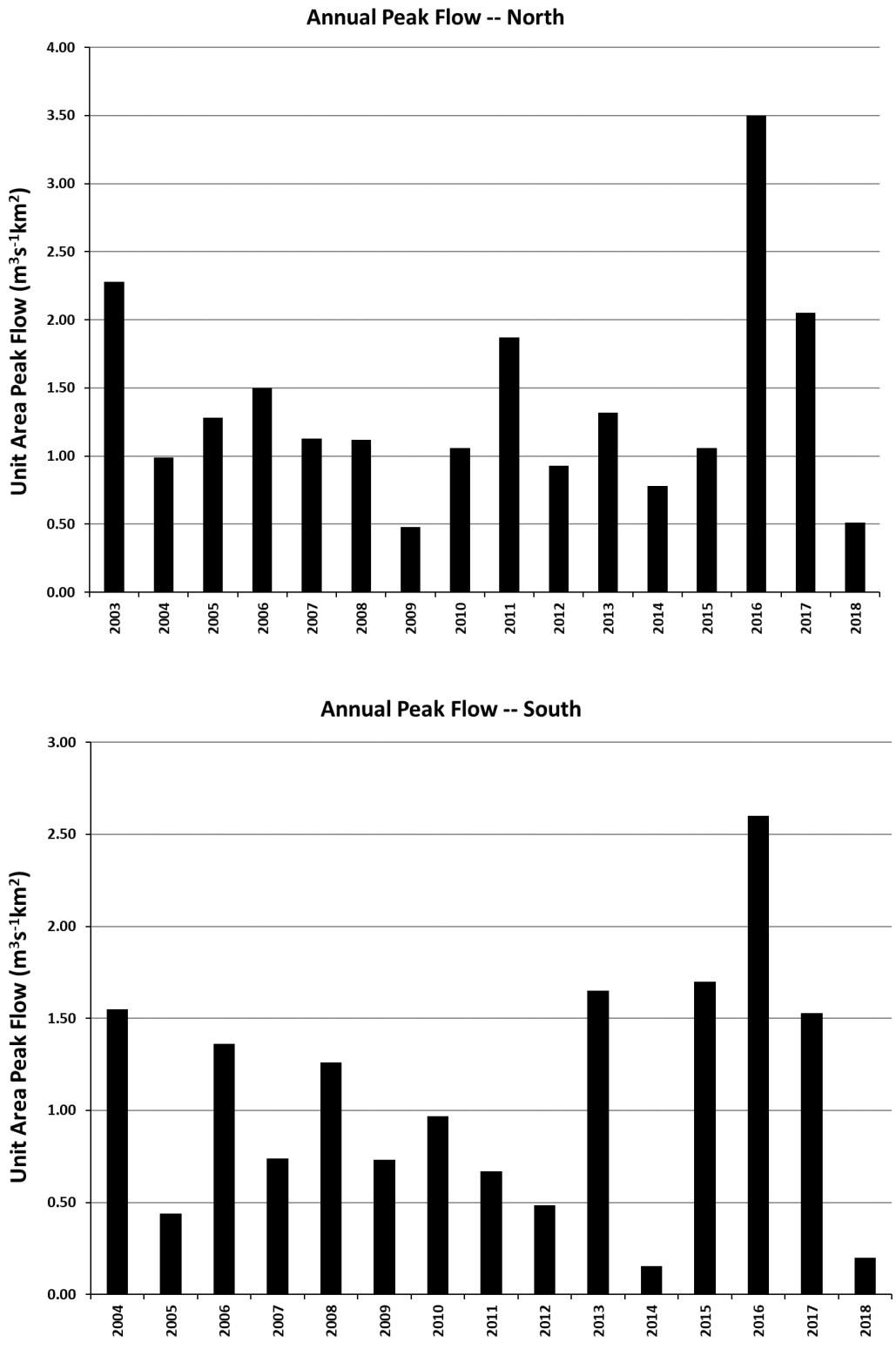

Figure 11. Reference streamflow sites are represented by Graham Gulch (site 505) in Freshwater Creek (north) and by Bear Creek (site 530) in the south

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 2018 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	2016	2017	2018
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

YAGER-LAWRENCE WAU

The Yager-Lawrence WAU is located northeast of the town of Carlotta, CA and drains an upstream area of approximately 96,472 acres or 150.7 square miles (Figures 12 & 13). Lawrence Creek is a 26, 932-acre (42 square mile) tributary that joins Yager Creek within the WAU area. Yager Creek flows into the Van Duzen River at approximately 5.0 miles from its confluence with the Eel River, which travels an additional 13.7 miles to the Pacific Ocean. The Yager-Lawrence WAU has elevations ranging from 80 feet at the mouth of Yager Creek to over 3,200 feet along the highest ridges.

Approximately 36% of the WAU is within HRC ownership, 63% is held by other private ownerships, and 1% is under public ownership. HRC's 34,605-acre ownership is concentrated in the tributary of Lawrence Creek, and along the mainstem of Yager Creek, extending only a short distance upstream of the Middle and North Forks.

The geology of the WAU is heavily dominated by the Yager and Franciscan assemblages with a small portion in the Wildcat formation. Ongoing rock uplift associated with tectonic plate interactions along the north coast of California produces a base level fall resulting in a regional pattern of fluvial incision over geologic timescales. Interpretations of existing historical channel conditions in the WAU should be broadly cast in the context of this incision. In the WAU, gradients associated with the mixed bedrock and alluvial stream network adjust to the alluvium they carry as well as the bedrock in which they incise.

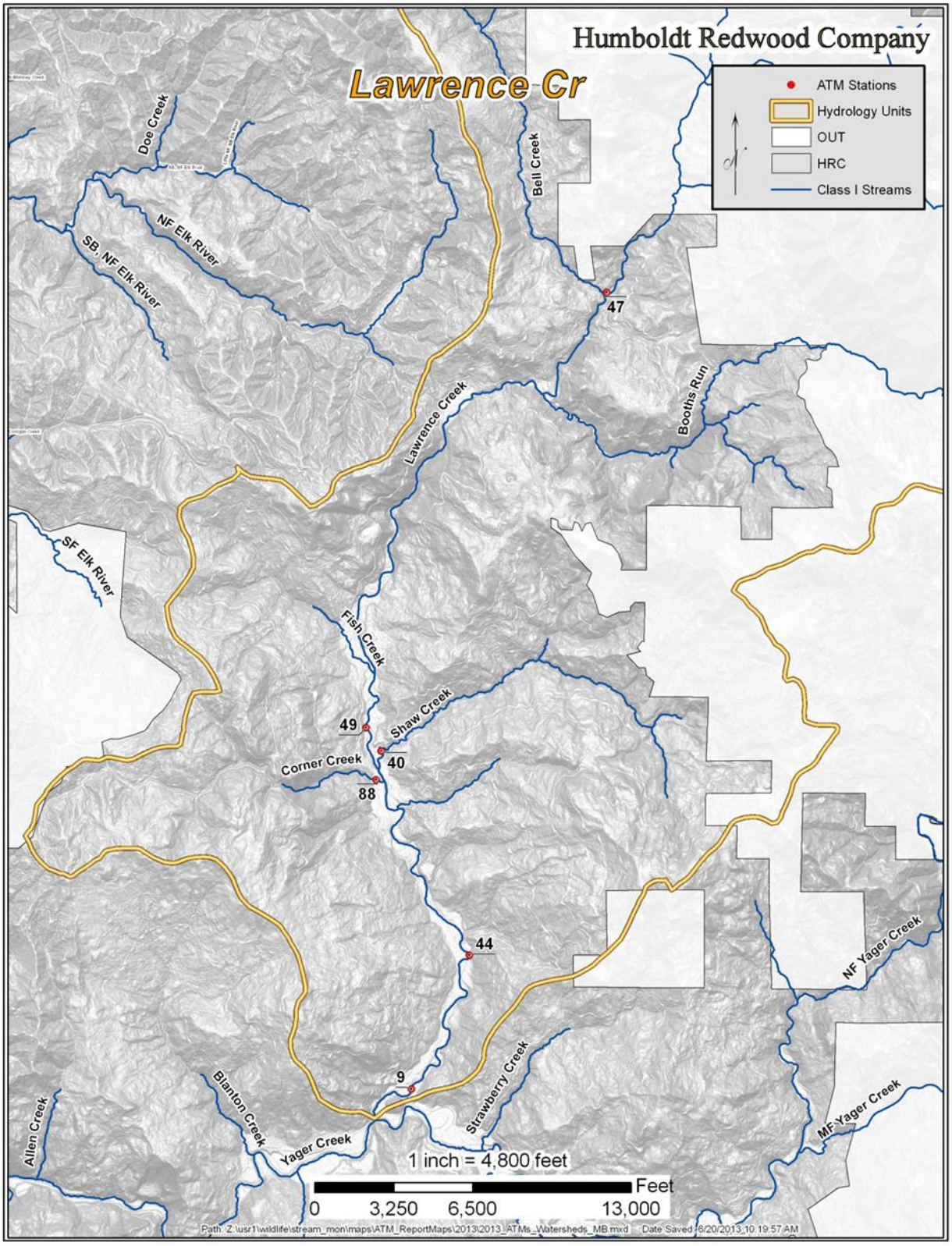

Figure 12. Location map of ATM sites in Lawrence Creek

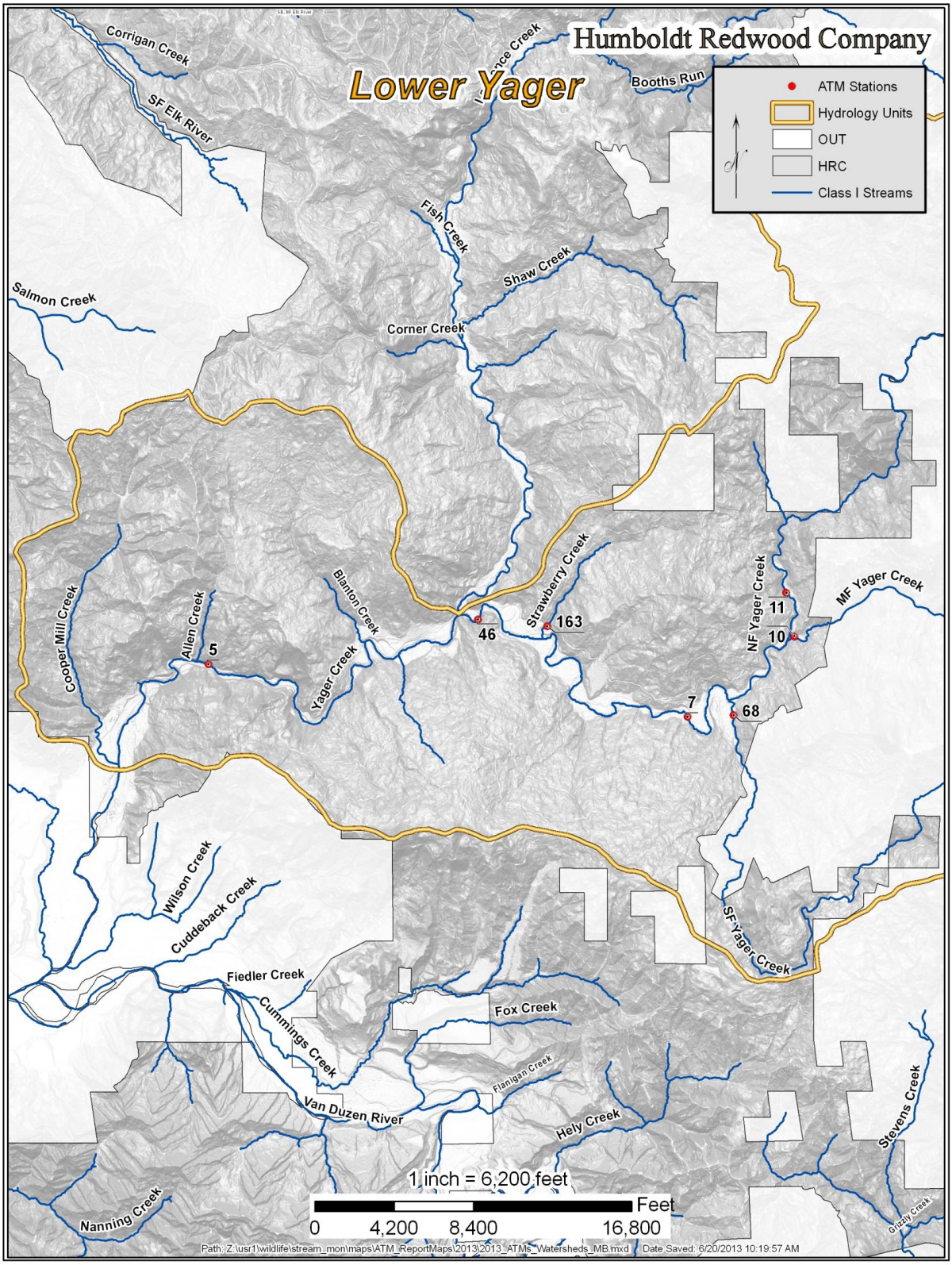

Figure 13. Location map of ATM sites in Lower Yager Creek

ATM 049 Upper Lawrence Creek

ATM 040 Shaw Creek

ATM 009 Lower Lawrence Creek

ATM 007 Yager Creek

ATM 046 Yager Creek

ATM 005 Yager Creek

Figure 14. ATM sites within the Yager/Lawrence Creek WAU

ATM Site 049 – Mainstem Lawrence Creek [Coastal Belt: Yager Terrane (TKy)]

Data for all ATM parameters at site 049 (Figure 14) are summarized in the APFC report card found in Table 6. D_{50} APFC targets were met at this site in 2018, as data suggest a coarsening of substrate particles across 3 of 4 size classes (Figure 15). Pool measures indicate an increase in pool spacing away from the target value, yet an increase in the average residual pool depth. Total LWD pieces increased by 1, although piece frequency remained static since 2015. Water temperature met the APFC target, while mid-channel canopy cover decreased slightly within the reach, failing to meet the target for the seventh consecutive survey year.

Cross-section data suggest varying degrees of channel aggradation and scour since surveys were instituted in 2006 (see Appendix). Aggradation was observed at 4/5 cross-sections between survey years 2015 and 2018. The greatest degree of channel aggradation occurred at cross section 5 where the channel area decreased -2.74m^2. The greatest degree of channel scour occurred at cross-section 2 where the channel area increased +0.56m^2.

A snorkel survey on 6/5/2018 identified juvenile coho in 3 of 5 pools, juvenile Chinook in 4 of 5 pools, and trout in all 5 pools sampled. Other species observed include threespine sticklebacks (*Gasterosteus aculeatus*) and a Foothill yellow-legged frog (*Rana boylii*).

Table 6. Individual site report card for ATM 049, Mainstem Lawrence Creek

Site 049 Lawrence Creek	Parameter	Target Value (# no target)	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Bed Surface	D_{84} (mm)	#	306	207		204			223			220			120			139
	D_{50} (mm)	65-95	128	53		75			98			96			65			73
	D_{16} (mm)	#	16	12		10			20			15			21			31
	D_5 (mm)	#	2	3		1			8			3			9			9
Pool Characteristics	Pool Area (%)	≥25	32	58		43			58			34			51			54
	Pool Spacing (CW/pool)	≤6.0	7.5	4.3		5.8			6.4			6.0			4.3			6.1
	Residual Pool Depth (m)	≥0.91	0.69	0.72		0.70			0.91			0.87			0.79			0.95
	Pools Assoc. w/wood (%)	≥50	100	86		100			100			100			100			100
Large Woody Debris	Total Piece Frequency (#/100 ft)	≥4.0							4.2			3.2			2.7			2.7
	Total Piece Count	#							47			39			40			41
Water Temperature	MWAT (°C)	≤16.8	18.7	19.4		19.8	17.6		17.7	16.0	16.7	16.5	17.5	17.4	17.9	16.8	17.8	16.6
Riparian Overstory	Canopy Over Stream (%)	≥84	46	34		19			67			74			77			73
	Canopy of Rip Forest (%)	≥85	79	100		98						97						

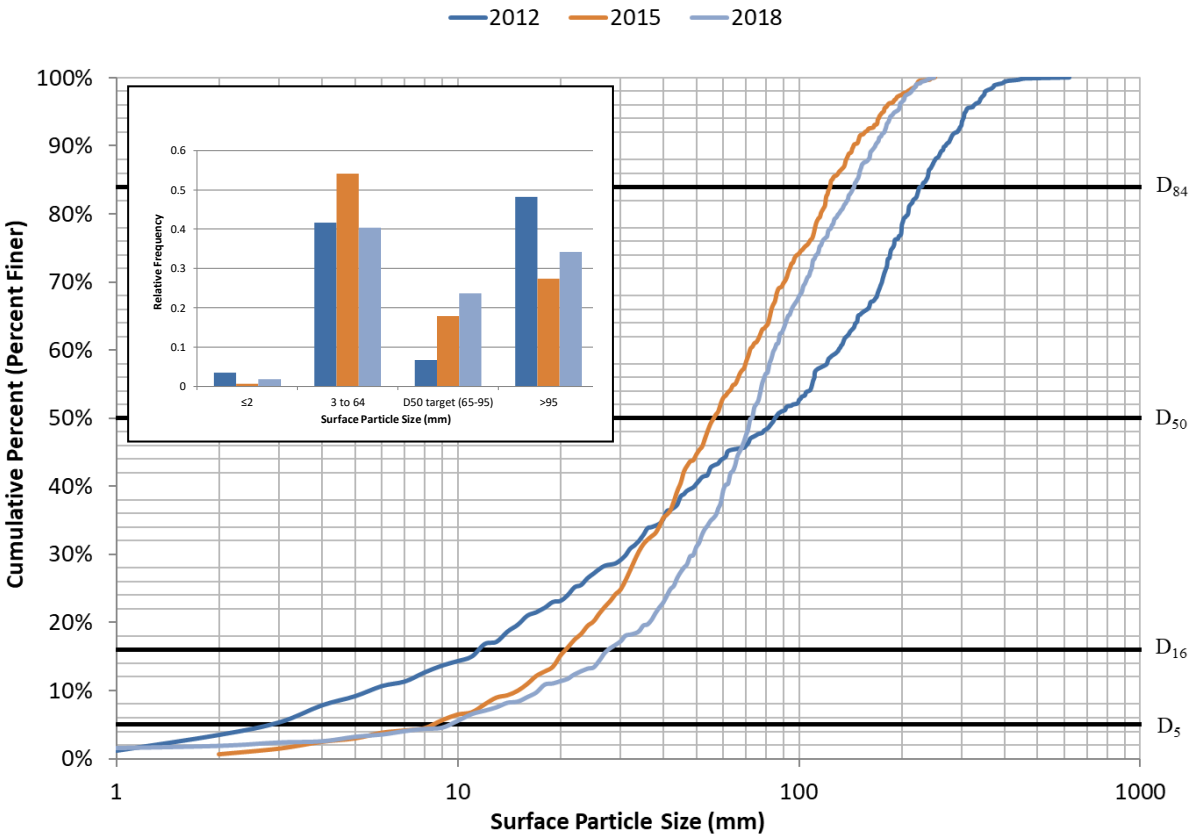

Figure 15. Cumulative frequency plot of the mean surface particle size of three riffles measured within the Lawrence Creek ATM 049 survey reach

ATM Site 040 – Shaw Creek [Coastal Belt: Yager Terrane (TKy)]

Data for all ATM parameters at site 040 (Figure 14) are summarized in the APFC report card found in Table 7. Bed surface parameters remain below APFC targets as data suggest no change in D_{50} values since 2015. Although the D_{84} substrate particle class appeared to coarsen slightly, there was a fining of the D_{16} and D_5 substrate particle size classes (Figure 16). Pool habitats scored the same as in 2015, although values showed an increase across all individual parameters. LWD total piece frequency did not meet the target for the seventh consecutive survey year, even as data suggest an increase in the total number of pieces counted. Temperature and canopy parameters each met their target ranges.

Cross-section data suggest varying degrees of channel aggradation and scour since surveys were instituted in 1998 (see Appendix). Channel scour was observed at 3/5 cross-sections between survey years 2015 and 2018. The greatest degree of channel scour occurred at cross-section 2, where channel area increased +0.20m^2. The greatest degree of channel aggradation occurred at cross-section 1, where channel area decreased -0.38 m^2.

A snorkel survey on 6/4/2018 identified juvenile coho and trout in all 5 of 5 pools sampled. Other observed species include Pacific giant salamanders (*Dicamptodon tenebrosus*).

Table 7. Individual site report card for ATM 040, Shaw Creek

Site 040 Shaw Creek	Parameter	Target Value (# no target)	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Bed Surface	D_{84} (mm)	#	79	71		102			114			89			79			83
	D_{50} (mm)	65-95	31	23		34			45			33			39			39
	D_{16} (mm)	#	14	8		4			11			11			20			16
	D_5 (mm)	#	5	1		1			3			2			7			6
Pool Characteristics	Pool Area (%)	≥25	46	56		52			57			38			54			56
	Pool Spacing (CW/pool)	≤6.0	5.2	4.7		2.7			2.8			5.1			3.8			4.0
	Residual Pool Depth (m)	≥0.91	0.53	0.58		0.52			0.56			0.39			0.59			0.61
	Pools Assoc. w/wood (%)	≥50	100	100		0			80			100			88			100
Large Woody Debris	Total Piece Frequency (#/100 ft)	≥9.0	4.0	7.3		5.7			5.3			5.2			4.1			6.6
	Total Piece Count	#							55			46			32			53
Water Temperature	MWAT (°C)	≤16.8	15.4		15.2	16.0	15.2	14.8	13.8	13.8	14.7	14.5			15.8	14.9	16.5	15.1
Riparian Overstory	Canopy Over Stream (%)	≥92	92	98		95			97			96			100			97
	Canopy of Rip Forest (%)	≥85	93	91		100						98						

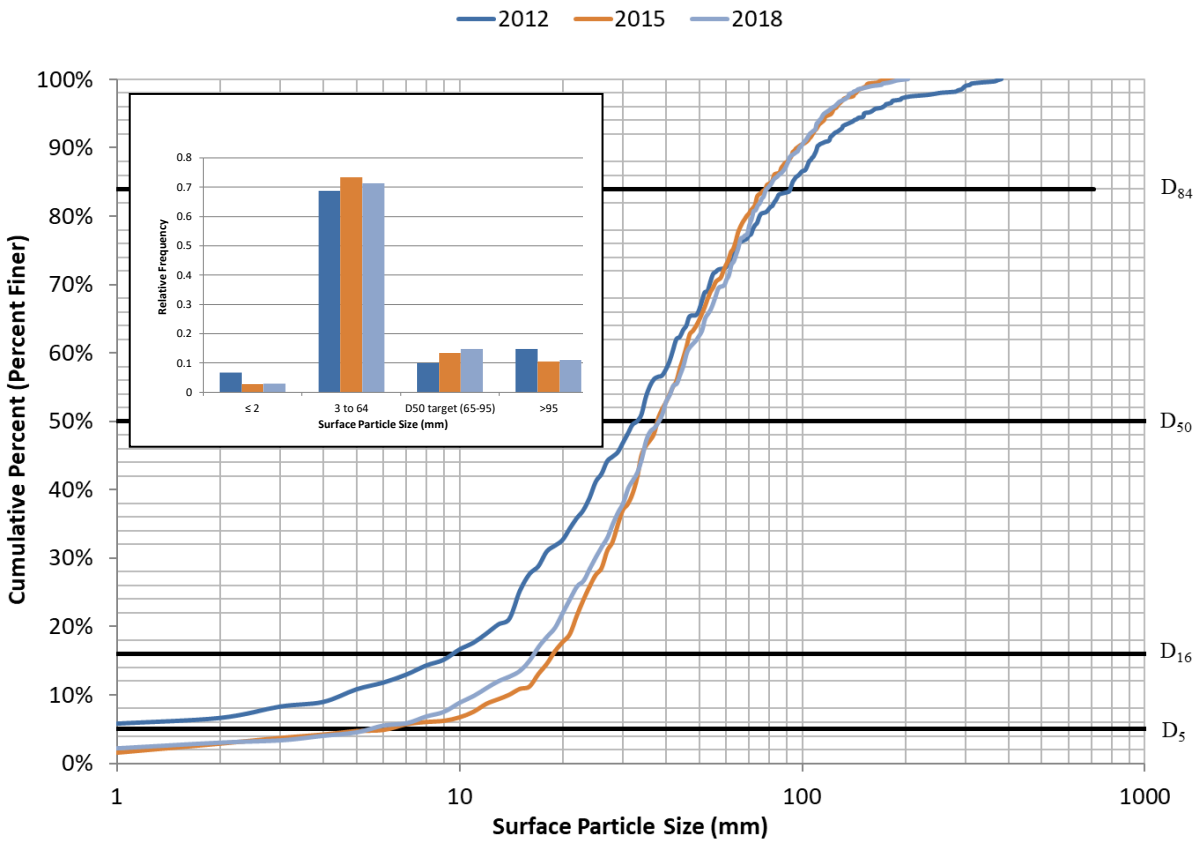

Figure 16. Cumulative frequency plot of the mean surface particle sizes of three riffles measured within the Shaw Creek ATM 040 survey reach

ATM Site 009 – Lawrence Creek [Coastal Belt: Yager Terrane (TKy)]

Data for all ATM parameters at site 009 (Figure 14) are summarized in the APFC report card found in Table 8. Bed surface parameters met the APFC target as the data suggest a substantial coarsening across all the substrate particle size classes (Figure 17). Pool area, pool spacing, and percent pools associated with wood met APFC targets, however residual pool depth did not. LWD piece frequency remained below the target, as the total piece count decreased slightly from the previous survey year. Both over stream canopy cover and stream temperature did not meet APFC targets, remaining outside of the APFC thresholds for several survey years.

Cross-section data suggest varying degrees of channel aggradation and scour since surveys were instituted in 1998 (see Appendix). Aggradation was observed at 4/5 cross-sections between survey years 2015 and 2018. The greatest degree of channel aggradation occurred at cross-section 3, where channel area decreased -0.46m^2. Scour only occurred at cross-section 2, where channel area increased +0.54m^2.

A snorkel survey on 6/7/2018 identified juvenile coho in 1 of 5 pools and trout in all 5 of the 5 pools sampled. Other observed species include Foothill yellow-legged frogs.

Table 8. Individual site report card for ATM 009, Lawrence Creek

Site 009 Lawrence Creek	Parameter	Target Value (# no target)	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Bed Surface	D_{84} (mm)	#	198	117		158			150			90			130			151
	D_{50} (mm)	65-95	95	32		30			57			50			45			86
	D_{16} (mm)	#	16	3		2			16			14			18			42
	D_5 (mm)	#	5	1		1			4			4			4			20
Pool Characteristics	Pool Area (%)	≥25	84	50		33			75			56			62			64
	Pool Spacing (CW/pool)	≤6.0	12.0	5.1		7.2			3.9			2.9			3.7			4.3
	Residual Pool Depth (m)	≥0.91	0.90	0.87		0.93			0.89			0.69			0.35			0.78
	Pools Assoc. w/wood (%)	≥50	67	67		33			60			60			78			86
Large Woody Debris	Total Piece Frequency (#/100 ft)	≥3.2	0.7	2.4		4.3			2.1			2.7			3.1			2.7
	Total Piece Count	#							25			24			58			50
Water Temperature	MWAT (°C)	≤16.8	19.1	19.9		19.7	18.3	18.0	18.2	16.6	17.5	16.9	18.2	17.9	18.9	17.8	18.8	17.9
Riparian Overstory	Canopy Over Stream (%)	≥92	33	47		56			58			80			89			83
	Canopy of Rip Forest (%)	≥85	81	86		96						91						

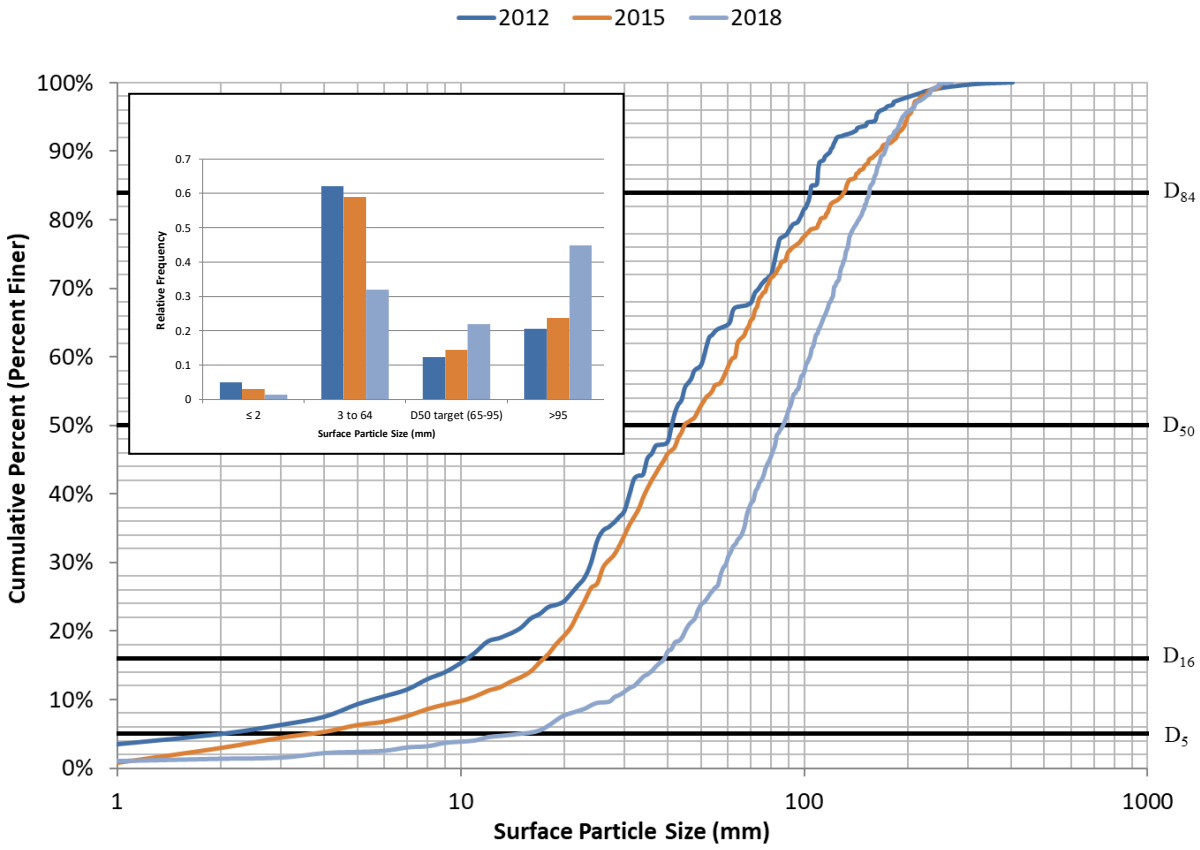

Figure 17. Cumulative frequency plot of the mean surface particle sizes of three riffles measured within the Lawrence Creek ATM 009 survey reach

ATM Site 007 – Yager Creek [Coastal Belt: Yager Terrane (TKy)]

Data for all ATM parameters at site 007 (Figure 14) are summarized in the APFC report card shown in Table 9. Bed surface parameters met the target for the D_{50} substrate particle size class, as the data suggest a coarsening across all particle size classes (Figure 18). Pool area, residual pool depth, and percent pools associated with wood met their respective APFC targets, while pool spacing did not for the second survey year in a row. The LWD piece frequency did not meet the target value, as the total number of LWD pieces decreased in 2018. Water temperature decreased slightly, but still did not meet target values. While over stream and riparian canopy both increased slightly, they did not meet the target values for the seventh consecutive survey year.

Cross-section data suggest varying degrees of channel aggradation and scour since surveys were instituted in 1998 (see Appendix). Channel scour was observed at 4/5 cross-sections between survey years 2015 and 2018. The greatest degree of channel scour occurred at cross-section 2, where channel area increased +2.24m^2. Substantial aggradation occurred at cross-section 5, which decreased the channel area -6.44m^2. This aggradation likely arose from a landslide within and immediately upstream of the cross-section, resulting in the loss of left right bank pin, which was re-established in 2018.

A snorkel survey on 6/7/2018 identified juvenile coho in 1 of 5 pools, juvenile Chinook in 5 of 5 pools, and trout in all 5 pools sampled. Other observed species include threespine sticklebacks, Foothill yellow-legged frogs, and California roach (*Lavinia symmetrics*).

Table 9. Individual site report card for ATM 007, Yager Creek

Site 007 Yager Creek	Parameter	Target Value (# no target)	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Bed Surface	D_{84} (mm)	#	168	123		107			112			100			103			123
	D_{50} (mm)	65-95	68	57		25			51			75			52			77
	D_{16} (mm)	#	13	19		1			20			14			15			41
	D_5 (mm)	#	1	5		1			7			2			3			18
Pool Characteristics	Pool Area (%)	≥25	37	39		18			31			20			27			33
	Pool Spacing (CW/pool)	≤6.0	4.5	5.6		2.3			2.5			5.2			10.4			10.7
	Residual Pool Depth (m)	≥0.91	0.80	0.76		0.68			0.62			0.76			0.78			1.36
	Pools Assoc. w/wood (%)	≥50	100	100		100			100			100			60			100
Large Woody Debris	Total Piece Frequency (#/100 ft)	≥1.8	1.7	2.3		1.0			1.8			3.0			1.5			0.6
	Total Piece Count	#							18			28			39			19
Water Temperature	MWAT (°C)	≤16.8					21.7	21.9	22.4	20.7	20.4	19.8		21.6	19.8	21.0	22.6	21.6
Riparian Overstory	Canopy Over Stream (%)	≥47	10	19		28			30			38			25			32
	Canopy of Rip Forest (%)	≥85	29	42		60						44			62			66

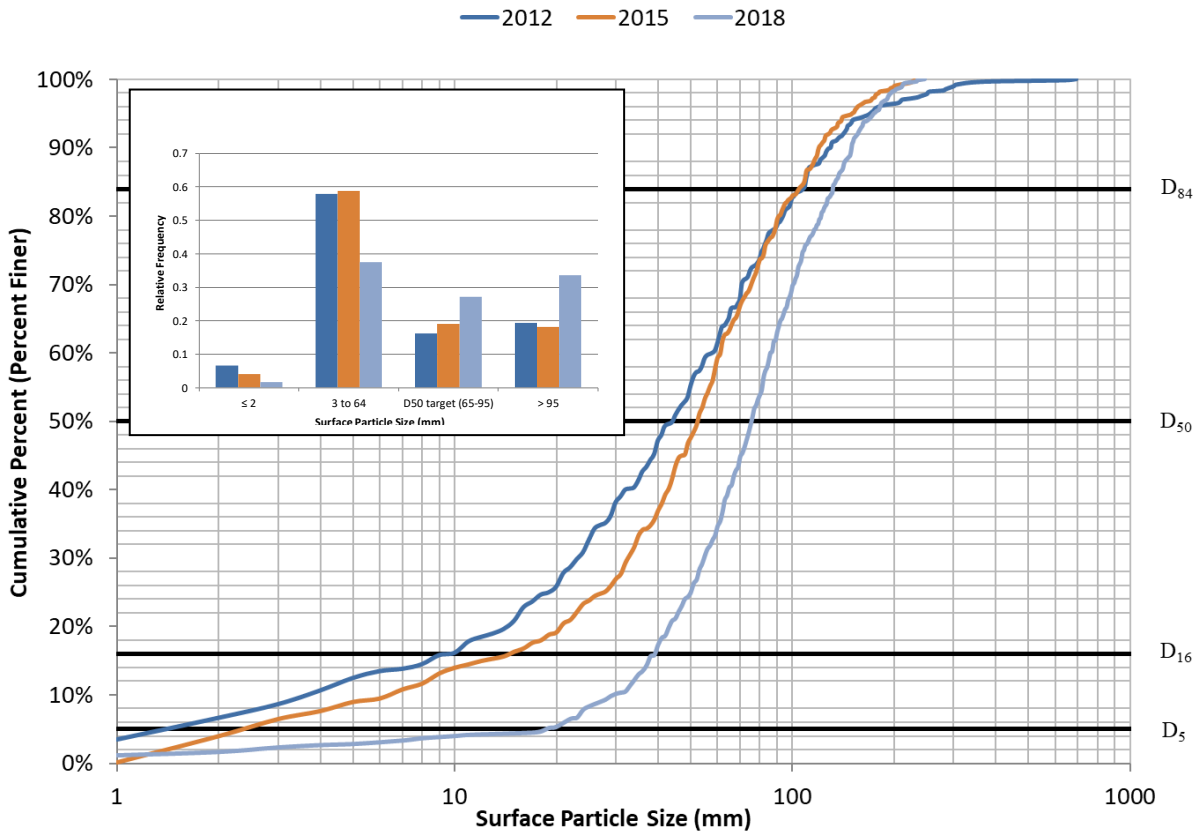

Figure 18. Cumulative frequency plot of the mean surface particle sizes of three riffles measured within the Yager Creek ATM 007 survey reach

ATM Site 005 – Yager Creek [Coastal Belt: Yager Terrane (TKy)]

Data for all ATM parameters at site 005 (Figure 15) are summarized in the APFC report card listed in Table 10. The D_{50} particle size class remained well short of APFC targets in 2018, as D_{84} particles showed a slight fining while D_5 and D_{16} particles showed a slight coarsening (Figure 19). Pool measurements suggest a slight decline in habitat quality, as half of the parameters did not meet the target values in 2018. LWD piece frequency remained far below the targets in this reach for the seventh consecutive survey year. Both stream temperature and over stream canopy cover did not meet their respective targets.

Cross-section data suggest varying degrees of channel aggradation and scour since surveys were instituted in 1997 (see Appendix). Channel scour was observed at 3/5 cross-sections between survey years 2015 and 2018. The greatest degree of channel scour occurred at cross-section 2, where channel area increased +0.60m^2. The greatest degree of aggradation occurred at cross-section 3, where channel area decreased -15.73m^2.

A snorkel survey on 6/7/2018 identified trout and juvenile Chinook in all 5 of 5 pools sampled. Other observed species include Foothill yellow-legged frogs, threespine sticklebacks, and California roach.

Table 10. Individual site report card for ATM 005, Yager Creek

Site 005 Yager Creek	Parameter	Target Value (# no target)	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Bed Surface	D_{84} (mm)	#	746	413		404			322			344			113			72
	D_{50} (mm)	65-95	262	52		52			46			52			33			44
	D_{16} (mm)	#	12	4		2			8			8			8			18
	D_5 (mm)	#	1	1		1			3			2			3			5
Pool Characteristics	Pool Area (%)	≥25	36	30		31			65			25			42			23
	Pool Spacing (CW/pool)	≤6.0	3.8	6.7		6.3			2.2			5.3			4.3			7.6
	Residual Pool Depth (m)	≥0.91	1.59	2.19		1.81			1.00			2.01			1.11			2.11
	Pools Assoc. w/wood (%)	≥50	50	33		0			0			0			14			75
Large Woody Debris	Total Piece Frequency (#/100 ft)	≥2.3	0.2	0.3		1.1			0.2			0.3			0.3			0.3
	Total Piece Count	#							3			4			6			7
Water Temperature	MWAT (°C)	≤16.8	21.7	22.7	20.9	22.1	21.2	21.1	21.4	19.8	20.1	19.7		22.3		20.8	21.4	21.4
Riparian Overstory	Canopy Over Stream (%)	≥74	13	23		7			27			13			25			54
	Canopy of Rip Forest (%)	≥85	89	98		98						93						

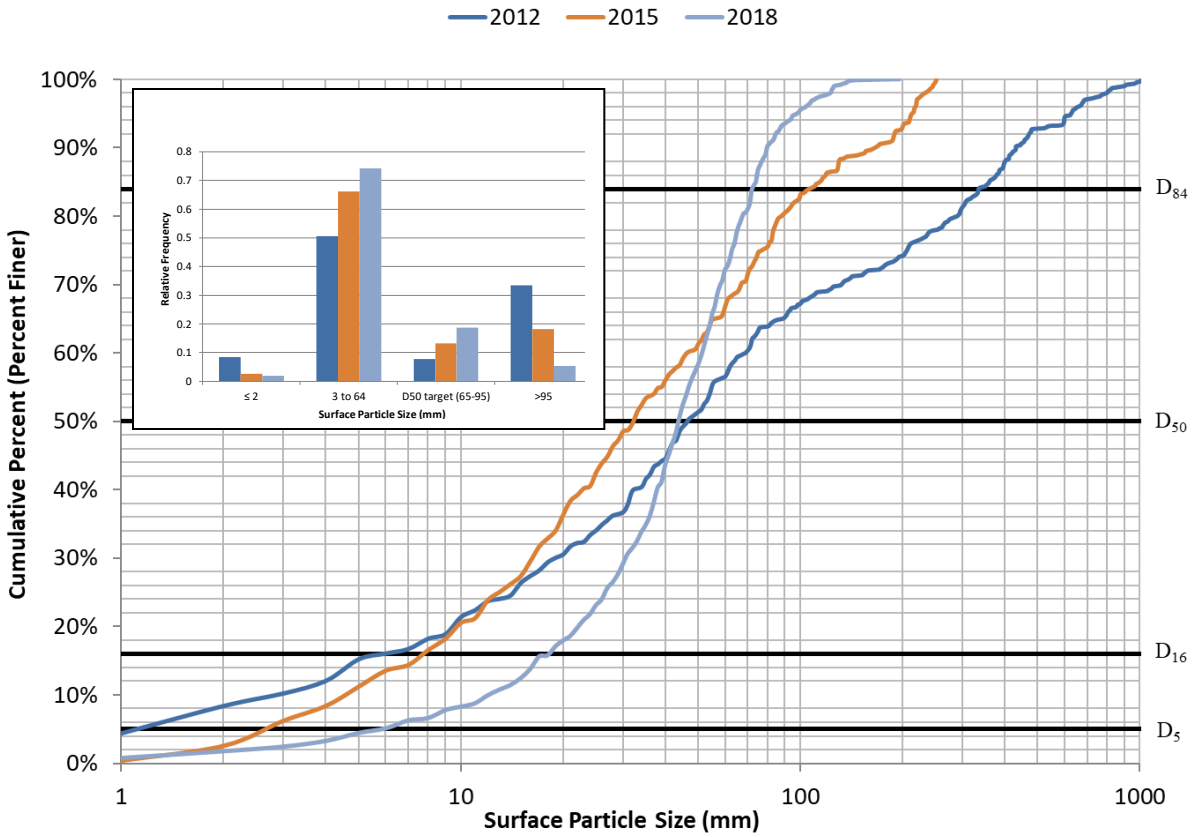

Figure 19. Cumulative frequency plot of the mean surface particle sizes of three riffles measured within the Yager Creek ATM 005 survey reach

ATM Site 046 – Yager Creek [Coastal Belt: Yager Terrane (TKy)]

Data for all ATM parameters at site 046 (Figure 14) are summarized in the APFC report card listed in (Table 11). The D_{50} particle size class met the APFC bed surface target for the first time since 2004, as the data suggest a coarsening across all size classes (Figure 20). Pool measurements suggest favorable habitat conditions as 100% of the APFC targets were met in 2018. LWD piece frequency placed just short of the APFC target, as the total number of pieces decreased since 2015. Over stream canopy cover did not meet the target, as stream temperature exceeded 20℃ for the fourteenth consecutive year.

Cross-section data suggest varying degrees of channel aggradation and scour since surveys were instituted in 1998 (see Appendix). Channel aggradation was observed at 4/5 cross-sections between survey years 2015 and 2018. The greatest degree of channel aggradation occurred at cross-section 2, where channel area decreased -3.64m^2. Here, a sizeable landslide on the left bank resulted in the loss of the cross-section pin and caused the thalweg to migrate toward the right bank. The only location of scour occurred at cross-section 1, where channel area increased +8.84m^2.

A snorkel survey on 6/12/2018 identified juvenile Chinook in 2 of 5 pools and trout in 3 of the 5 pools sampled. Other observed species include threespine sticklebacks, Foothill yellow-legged frogs, and California roach.

Table 11. Individual site report card for ATM 046, Yager Creek

Site 046 Yager Creek	Parameter	Target Value (# no target)	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Bed Surface	D_{84} (mm)	#	122	156		110			105			104			96			108
	D_{50} (mm)	65-95	47	69		38			53			40			52			69
	D_{16} (mm)	#	11	27		7			20			9			25			39
	D_5 (mm)	#	1	7		1			6			2			8			24
Pool Characteristics	Pool Area (%)	≥25	58	67		69			80			31			42			60
	Pool Spacing (CW/pool)	≤6.0	6.3	5.0		4.3			3.5			3.7			4.2			4.4
	Residual Pool Depth (m)	≥0.91	1.26	1.16		0.81			0.92			1.37			1.09			1.06
	Pools Assoc. w/wood (%)	≥50	75	75		0			33			50			57			100
Large Woody Debris	Total Piece Frequency (#/100 ft)	≥1.7	2.7	2.4		1.8			1.1			3.1			1.4			1.1
	Total Piece Count	#							12			48			43			35
Water Temperature	MWAT (°C)	≤16.8			21.5	22.0	21.0	21.1	20.7	20.5	20.1	20.1	21.9	20.3	20.2	20.4	21.5	21.1
Riparian Overstory	Canopy Over Stream (%)	≥64	32	45		42			61			40			69			62
	Canopy of Rip Forest (%)	≥85	73	87		98						81			86			

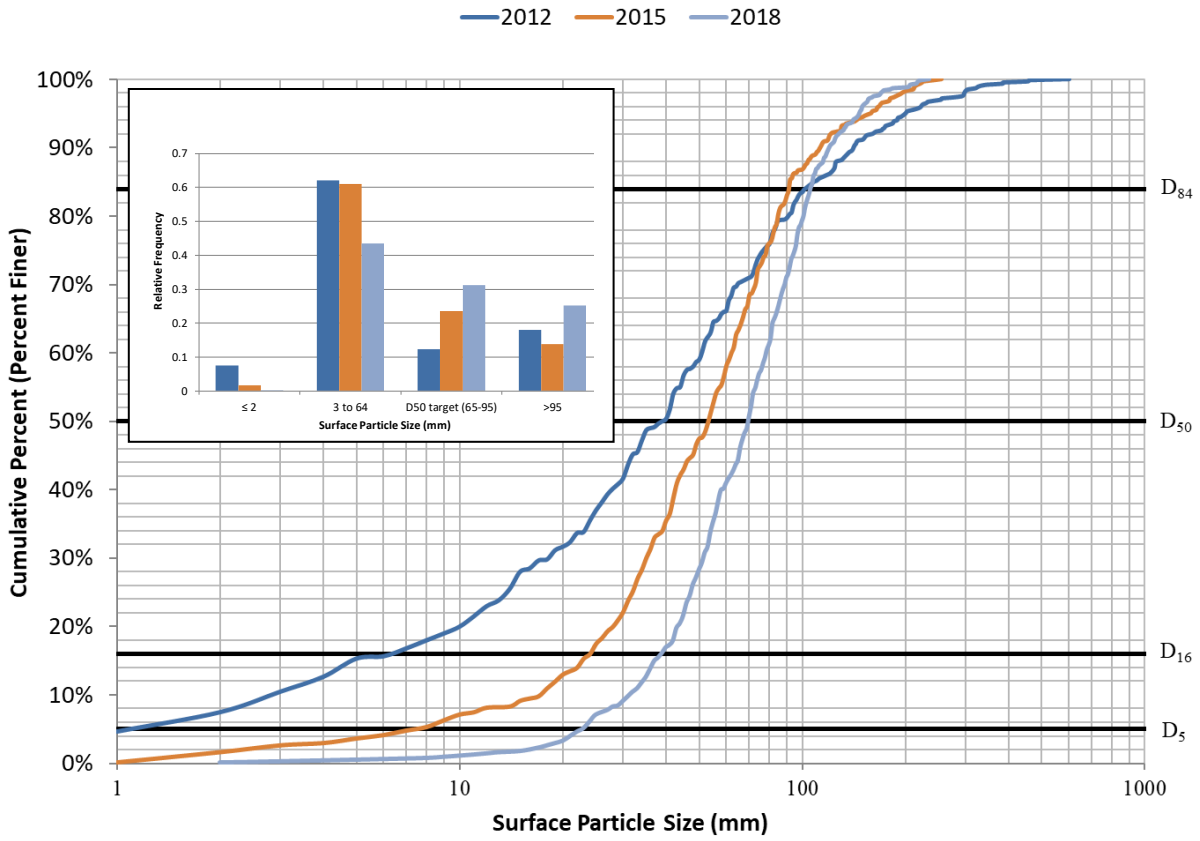

Figure 20. Cumulative frequency plot of the mean surface particle sizes of three riffles measured within the Yager Creek ATM 046 survey reach

Summary of ATM Trends in the Yager/Lawrence WAU

A summary of Yager/Lawrence habitat characteristics from 2018 are summarized in an APFC report card (Table 12). Results of habitat composite scores from 2018 and 2015 are compared to baseline (2003) data (Figure 21). Overall, the greatest improvements were observed in bed surface, pool, and stream temperature habitat composite scores. The greatest deficiencies in habitat parameters were the frequency of LWD within the channel and percent of over stream canopy cover.

The bed surface composite score in 2018 was higher (+186%) than the 2015 score and higher (+152%) than the 2003 baseline record. The 2018 composite score for pools had increased (+6%) since 2015, and since the baseline record (+19%). The 2018 LWD composite score (0.00) remained constant from 2015 (0.00) and the baseline record score (0.00). The 2018 canopy cover habitat composite score was markedly less (-257%) than 2015 and less (-79%) than the baseline score. The 2018 stream temperature composite score was higher (+65%) than the 2015 record and higher (+32%) than the baseline record.

Table 12. The most recent habitat measures for the Yager/Lawrence WAU

Current Status	Parameter	Target Value (# no target)	049 Lawrence Creek	040 Shaw Creek	009 Lawrence Creek	007 Yager Creek	005 Yager Creek	046 Yager Creek
Bed Surface	D_{84} (mm)	#	139	83	151	123	72	108
	D_{50} (mm)	65-95	73	39	86	77	44	69
	D_{16} (mm)	#	31	16	42	41	18	39
	D_5 (mm)	#	9	6	20	18	5	24
Pool Characteristics	Pool Area (%)	≥25	54	56	64	33	23	60
	Pool Spacing (CW/pool)	≤6.0	6.1	4.0	4.3	10.7	7.6	4.4
	Residual Pool Depth (m)	≥0.91	0.95	0.61	0.78	1.36	2.11	1.06
	Pools Assoc. w/wood (%)	≥50	100	100	86	100	75	100
Large Woody Debris	Total Piece Frequency (#/100 ft)	f(CW)	2.7	6.6	2.7	0.6	0.3	1.1
	Total Piece Count	#	41	53	50	19	7	35
Water Temperature	MWAT (°C)	≤16.8	16.6	15.1	17.9	21.6	21.4	21.1
Riparian Overstory	Canopy Over Stream (%)	f(CW)	73	97	83	32	54	62
	Canopy of Rip Forest (%)	≥85				66		
Watershed Area	Upstream Acreage	#	18,333	3,430	26,675	44,059	80,623	48,393
Reach Gradient	Reach Gradient (%)	#	1.1	1.3	0.5	0.8	1.0	0.6

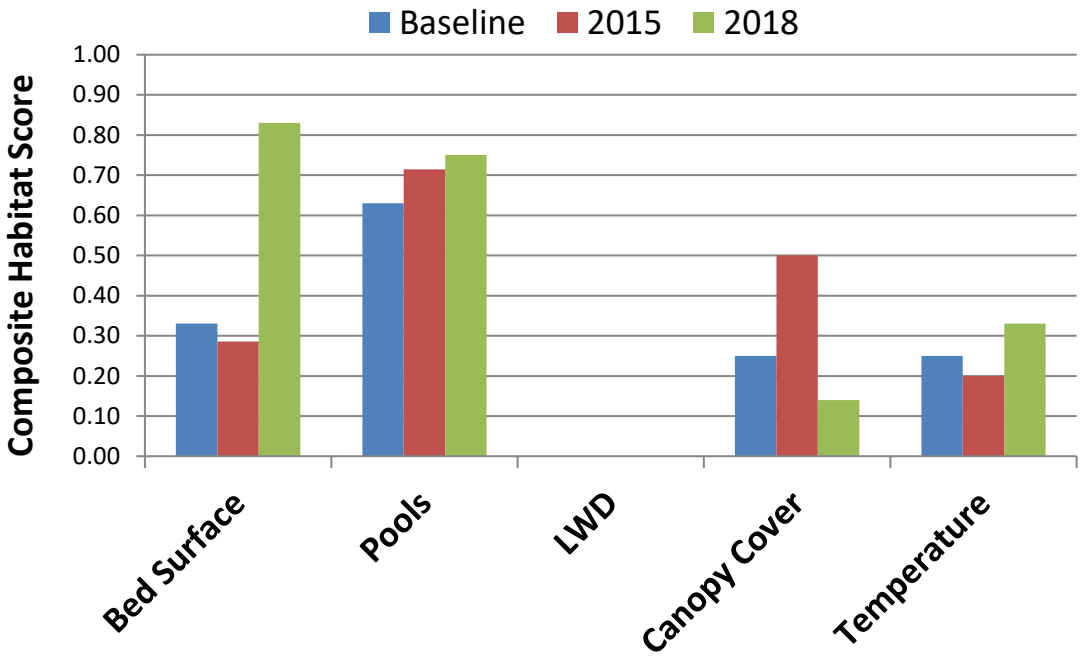

Figure 21. The composite scores for habitat characteristics in the Yager/ Lawrence WAU in 2015 and 2018 relative to baseline (2003) data

MATTOLE RIVER WAU

The Mattole River is located along the northern coast of California within western Humboldt and northern Mendocino Counties and drains an area of 286 square miles (~190,000 acres). Climate is characterized by high intensity rainfall in the winter and dry summers. Annual rainfall averages 60 inches near Petrolia and 115 inches on eastern ridges. The Mattole watershed contains a mixture of dense Douglas-fir forests, deciduous forests (tan oak), and grasslands. The Mattole River WAU encompasses approximately 62,000 acres, of which HRC owns approximately 20%. The WAU is comprised of the major tributary basins: 1) Lower North Fork Mattole River; 2) East Branch North Fork Mattole River and its tributaries (Alwardt and Sulphur Creeks); 3) McGinnis and Pritchard Creek; and 4) Upper North Fork Mattole River that includes Oil Creek and its tributaries and Rattlesnake Creek and its tributaries (Figure 24). Bedrock in the Mattole watershed is dominated by mélange of the Franciscan Coastal rocks that is comprised of pervasively sheared argillite and sandstone (i.e., soft rocks). Due to naturally high erosion rates and the history of logging that severely increased erosion, the EPA in 1994 listed the Mattole River as "impaired" (303d listing).

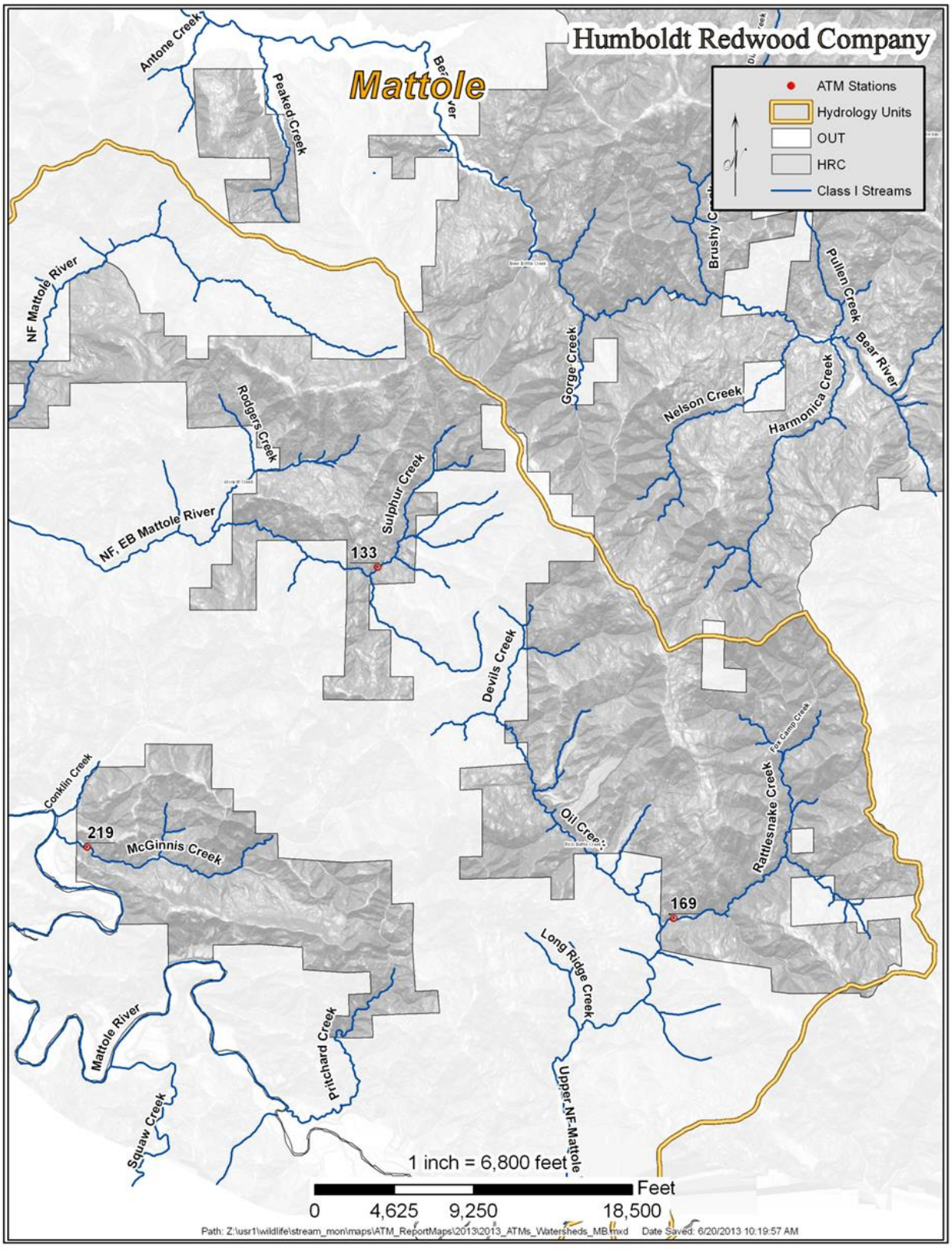

Figure 22. Location map of ATM sites within the Mattole River WAU

ATM 133 Sulphur Creek

ATM 169 Rattlesnake Creek

ATM 219 McGinnis Creek

Figure 23. ATM sites within the Mattole River WAU

ATM 133 - Sulphur Creek [Coastal Belt: Coastal Terrane (TKfs)]

Data for all ATM parameters at site 133 (Figure 23) are summarized in an APFC report card (Table 13). The bed surface APFC target was met in 2018, as the data suggest a coarsening of the substrate across all particle size classes (Figure 24). Pool characteristics became more favorable with 3 of 4 measured parameters meeting their target value. LWD piece counts in 2018 were fewer than twice what were measured in 2015, as total piece frequency did not meet the target for the seventh consecutive survey year. Canopy cover met the target value for the third year in a row and stream temperature met its target in 2018 after failing to meet the target in 2017.

Cross-section data suggest varying degrees of channel aggradation and scour since surveys were instituted in 1998 (see Appendix). Channel scour was observed at 4/5 cross-sections between survey years 2015 and 2018. The greatest degree of channel scour occurred at cross-section 3, where channel area increased +3.47m^2. The only location of aggradation occurred at cross-section 2, where channel area decreased -0.60m^2.

A snorkel survey on 7/17/2018 identified trout in all 5 of 5 pools sampled. Other observed species include Foothill yellow-legged frogs.

Table 13. Individual site report card for ATM 133, Sulphur Creek

Site 133 Sulphur Creek	Parameter	Target Value (# no target)	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Bed Surface	D_{84} (mm)	#	147	131		110			138			144			84			120
	D_{50} (mm)	65-95	71	44		38			69			57			42			67
	D_{16} (mm)	#	8	13		4			21			10			14			23
	D_S (mm)	#	1	1		1			7			3			3			6
Pool Characteristics	Pool Area (%)	≥25	14	17		22			31			17			8			38
	Pool Spacing (CW/pool)	<6.0	11.0	8.2		5.5			3.4			5.7			5.0			3.7
	Residual Pool Depth (m)	≥0.91	0.46	0.49		0.49			0.47			0.47			0.31			0.52
	Pools Assoc. w/wood (%)	≥50	67	75		67			86			50			17			100
Large Woody Debris	Total Piece Frequency (#/100 ft)	≥4.4	4.1	3.8		3.6			3.1			1.7			3.4			1.1
	Total Piece Count	#							33			18			46			15
Water Temperature	MWAT (°C)	≤16.8	19.0	17.9		19.6	16.3	16.5	16.1	15.4	15.4	15.6	16.4	16.2	16.7	16.6	17.2	16.4
Riparian Overstory	Canopy Over Stream (%)	≥87	48	60		18			80			87			95			94
	Canopy of Rip Forest (%)	≥85	83	71		86						94						

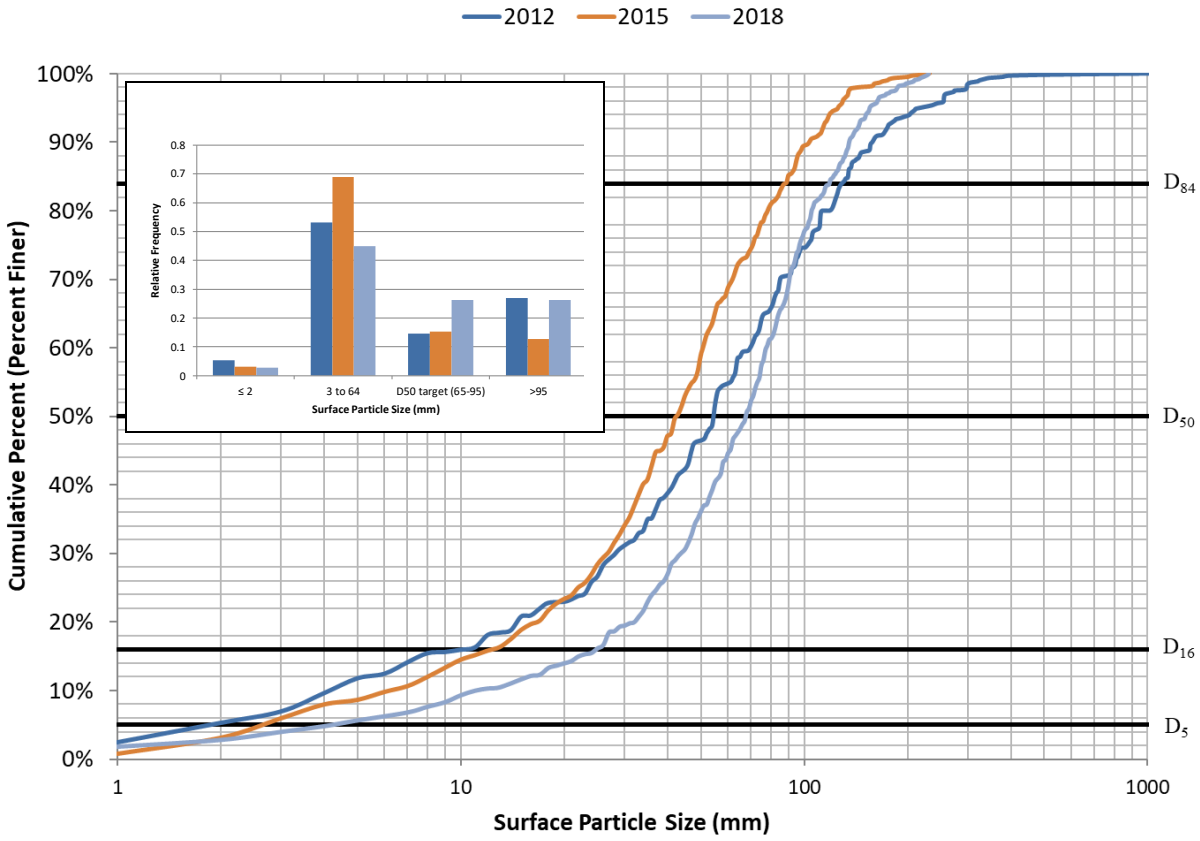

Figure 24. Cumulative frequency plot of the mean surface particle sizes of three riffles measured within the Sulphur Creek ATM 133 survey reach

ATM 169 – Rattlesnake Creek [Coastal Belt: Coastal Terrane (TKfs)]

Data for all ATM parameters at site 169 (Figure 23) are summarized in an APFC report card (Table 14). The bed surface APFC target was not met in 2018, as the data suggest a fining of the substrate across all particle size classes (Figure 25). Pool characteristics appear to have improved slightly, with 3/4 parameters meeting the APFC target values. LWD frequency has been historically very low in this reach, with parameters measuring well below target each survey year. Stream temperature continued to place short of the target for the seventh consecutive survey year, despite canopy cover showing an increase in 2018, meeting the APFC target for the first time on record.

Cross-section data suggest varying degrees of channel aggradation and scour since surveys were instituted in 2004 (see Appendix). Channel scour was observed at 5/5 cross-sections between survey years 2015 and 2018. The greatest degree of channel scour occurred at cross-section 4, where channel area increased +3.54m^2.

A snorkel survey on 7/16/2018 identified trout in all 5 pools sampled. Other observed species include Foothill yellow-legged frogs.

Table 14. Individual site report card for ATM 169, Rattlesnake Creek

Site 169 Upper NF Mattole River	Parameter	Target Value (# no target)	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Bed Surface	D_{84} (mm)	#	228	177		203			172			257			135			124
	D_{50} (mm)	65-95	89	61		58			78			83			64			58
	D_{16} (mm)	#	12	10		8			17			10			24			17
	D_5 (mm)	#	1	1		1			7			3			9			6
Pool Characteristics	Pool Area (%)	≥25	22	33		28			26			22			45			35
	Pool Spacing (CW/pool)	<6.0	5.5	3.5		5.7			4.7			5.1			2.3			3.4
	Residual Pool Depth (m)	≥0.91	0.55	0.55		0.45			0.49			0.54			0.81			0.49
	Pools Assoc. w/wood (%)	≥50	83	56		0			0			0			39			100
Large Woody Debris	Total Piece Frequency (#/100 ft)	≥5.7	1.7	2.8		1.9			0.5			1.1			1.3			0.4
	Total Piece Count	#	20						5			10			13			4
Water Temperature	MWAT (°C)	≤16.8	20.3	20.6		21.7	18.3		18.0	16.3	16.3	16.9	17.8	18.5	18.3	18.0	18.3	17.6
Riparian Overstory	Canopy Over Stream (%)	≥89	13	15		85			57			73			72			91
	Canopy of Rip Forest (%)	≥85	17	34		57						68			19			46

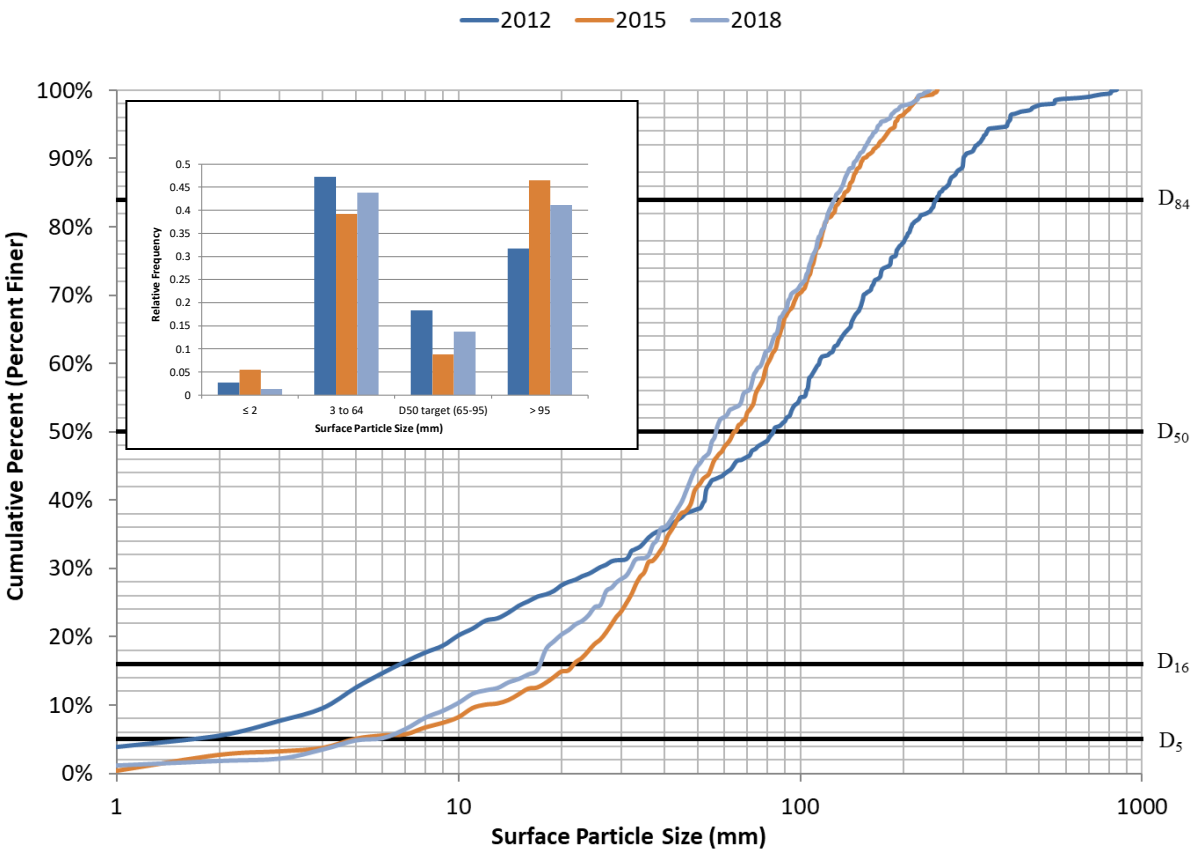

Figure 25. Cumulative frequency plot of the mean surface particle sizes of three riffles measured within the Rattlesnake Creek ATM 169 survey reach

ATM 219 – McGinnis Creek [Undifferentiated Wildcat Group (QTw)]

Data for all ATM parameters at site 219 (Figure 25) are summarized in an APFC report card (Table 15). The bed surface APFC target was met in 2018, as the data suggest a coarsening of the substrate across all particle size classes (Figure 26). Pool characteristics appear to have improved slightly, with 3/4 parameters meeting the APFC target values. LWD piece frequency came close but did not meet the target despite the total number of pieces more than doubling what was counted in 2015. Canopy cover sufficiently met the target goal, as stream temperature met the target by 0.3℃.

Cross-section data suggest varying degrees of channel aggradation and scour since surveys were instituted in 2006 (see Appendix). Channel aggradation was observed at 2/5 cross-sections between survey years 2015 and 2018. The greatest degree of channel aggradation occurred at cross-section 2, where channel area decreased -5.57m^2. The greatest degree of channel scour occurred at cross-section 1, where channel area increased +4.31m^2.

A snorkel survey on 7/11/2018 identified trout in 5 of 5 pools and a single juvenile coho in 1 of the 5 pools sampled. Other observed species include Foothill yellow-legged frogs and prickly sculpin (*Cottus asper*).

Table 15. Individual site report card for ATM 219, McGinnis Creek

Site 219 McGinnis Creek	Parameter	Target Value (# no target)	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Bed Surface	D_{84} (mm)	#				69			101			105			69			113
	D_{50} (mm)	65-95				33			47			56			29			74
	D_{16} (mm)	#				13			15			22			10			41
	D_5 (mm)	#				10			4			7			3			22
Pool Characteristics	Pool Area (%)	≥25				28			32			13			15			29
	Pool Spacing (CW/pool)	<6.0				4.5			2.9			8.1			4.3			3.8
	Residual Pool Depth (m)	≥0.91				0.47			0.51			0.68			0.38			0.56
	Pools Assoc. w/wood (%)	≥50				83			50			33			86			100
Large Woody Debris	Total Piece Frequency (#/100 ft)	≥4.58							2.2			4.3			1.8			4.2
	Total Piece Count	#							23			47			23			56
Water Temperature	MWAT (℃)	≤16.8			17.1	19.0	17.9	17.4	16.2	15.2	15.8	15.7	17.9	16.0	16.9	16.2	17.9	16.5
Riparian Overstory	Canopy Over Stream (%)	≥88							95			81			91			95
	Canopy of Rip Forest (%)	≥85					78					95						

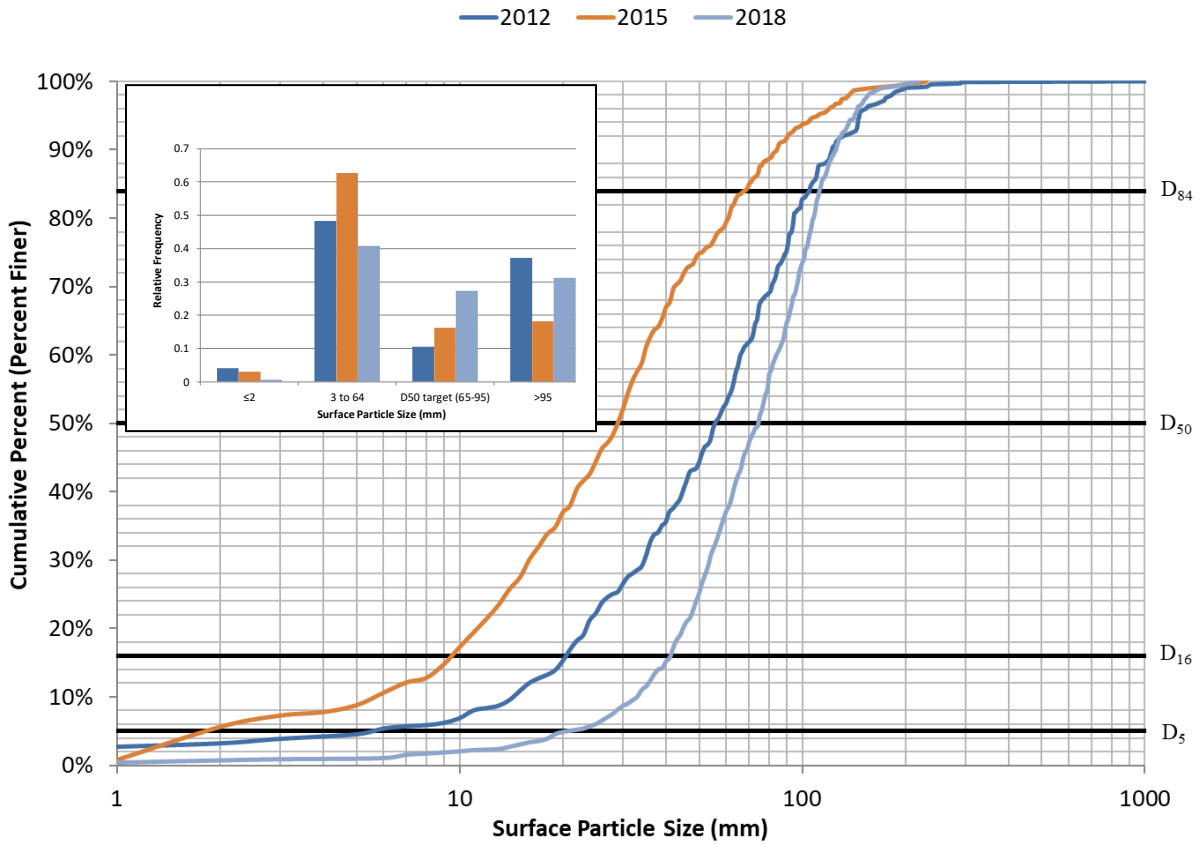

Figure 26. Cumulative frequency plot of the mean surface particle sizes of three riffles measured within the McGinnis Creek ATM 219 survey reach

Summary of ATM Trends in the Mattole River WAU

A summary of the Mattole habitat characteristics from 2018 is provided in an APFC report card (Table 16). Results of habitat composite scores from 2018 and 2015 are compared to baseline (2003) (Figure 27). Overall, the greatest improvements in habitat composite scores were observed in pools and canopy cover.

Bed surface composite scores in 2018 were substantially lower than the baseline record and yet higher than the 2015 score. The 2018 composite score for pools was higher (+79%) than 2015 and higher (+12%) than the baseline record. The 2018 LWD composite score (0.00) returned to 2015 and baseline records (0.00). The canopy cover composite score in 2018 was higher (+127%) than 2015 and higher (+12%) than the baseline score. The stream temperature composite score in 2018 was higher (+103%) than 2015 and higher than the baseline record score (0.00).

Table 16. The most recent habitat measures for the Mattole River WAU

Current Status	Parameter	Target Value (# no value)	133 Sulphur Creek	169 Rattlesnake Creek	219 McGinnis Creek
Bed Surface	D_{84} (mm)	#	120	124	113
	D_{50} (mm)	65-95	67	58	74
	D_{16} (mm)	#	23	17	41
	D_{5} (mm)	#	6	6	22
Pool Characteristics	Pool Area (%)	≥25	38	35	29
	Pool Spacing (CW/pool)	≤6.0	3.7	3.4	3.8
	Residual Pool Depth (m)	≥0.91	0.52	0.49	0.56
	Pools Assoc. w/wood (%)	≥50	100	100	100
Large Woody Debris	Total Piece Frequency (#/100 ft)	f(CW)	1.1	0.4	4.2
	Total Piece Count	#	15	4	56
Water Temperature	MWAT (°C)	≤16.8	16.4	17.6	16.5
Riparian Overstory	Canopy Over Stream (%)	f(CW)	94	91	95
	Canopy of Rip Forest (%)	≥85		46	
Watershed Area	Upstream Acreage	#	2,451	5,508	3,788
Reach Gradient	Reach Gradient (%)	#	2.1	2.2	1.2

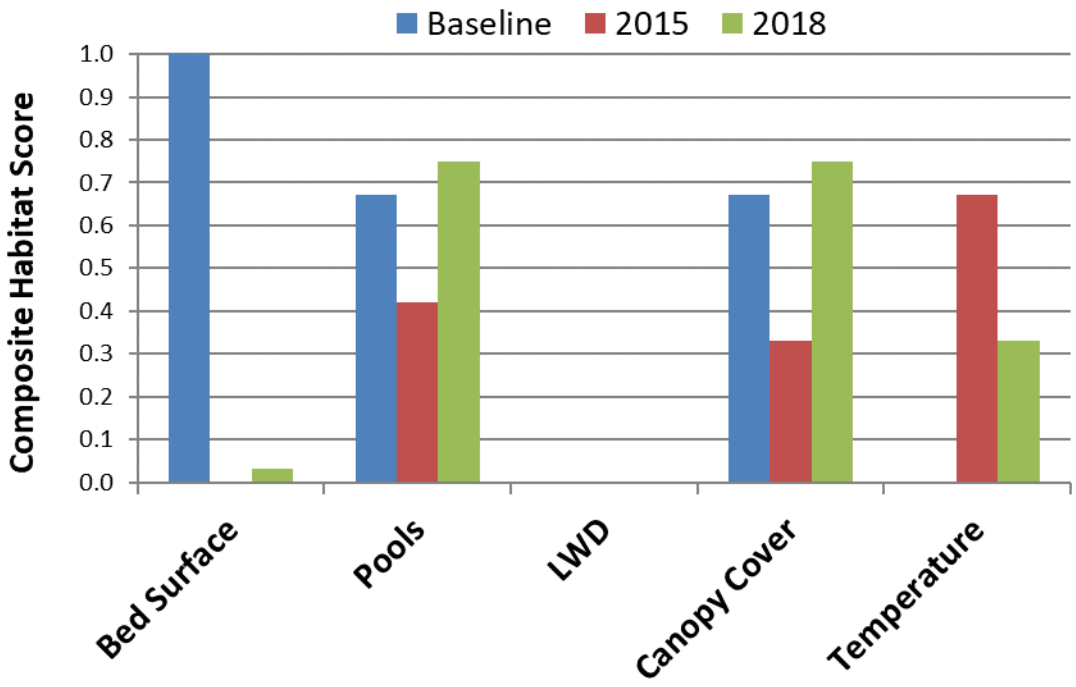

Figure 27. The composite scores for habitat characteristics in the Mattole River WAU in 2015 and 2018 relative to baseline (2003) data

BEAR CREEK – LOWER EEL WAU

HRC ownership encompasses both major and minor Eel River tributaries that span its confluence with the Pacific Ocean to approximately 40 miles south (upstream of the confluence with Devil's Elbow Creek). Within this reach, HRC owns approximately 17% of the total watershed, an area of which is divided into two distinct sections: The Lower and Upper Eel River WAUs. The Lower Eel River WAU includes HRC ownership within tributaries to the Eel River south of the Van Duzen River to Perrott Creek and encompasses both Jordan and Bear Creek (Figure 28). This WAU also includes a region termed the Eel River Delta which encompasses several tributaries that drain into the Eel River nearer to its confluence with the Pacific Ocean. Sediments within Bear Creek are derived primarily from the Coastal Belt of the Franciscan Complex with a small segment of the lower portion of the watershed (near the confluence with the Eel River) underlain by the Wildcat Group.

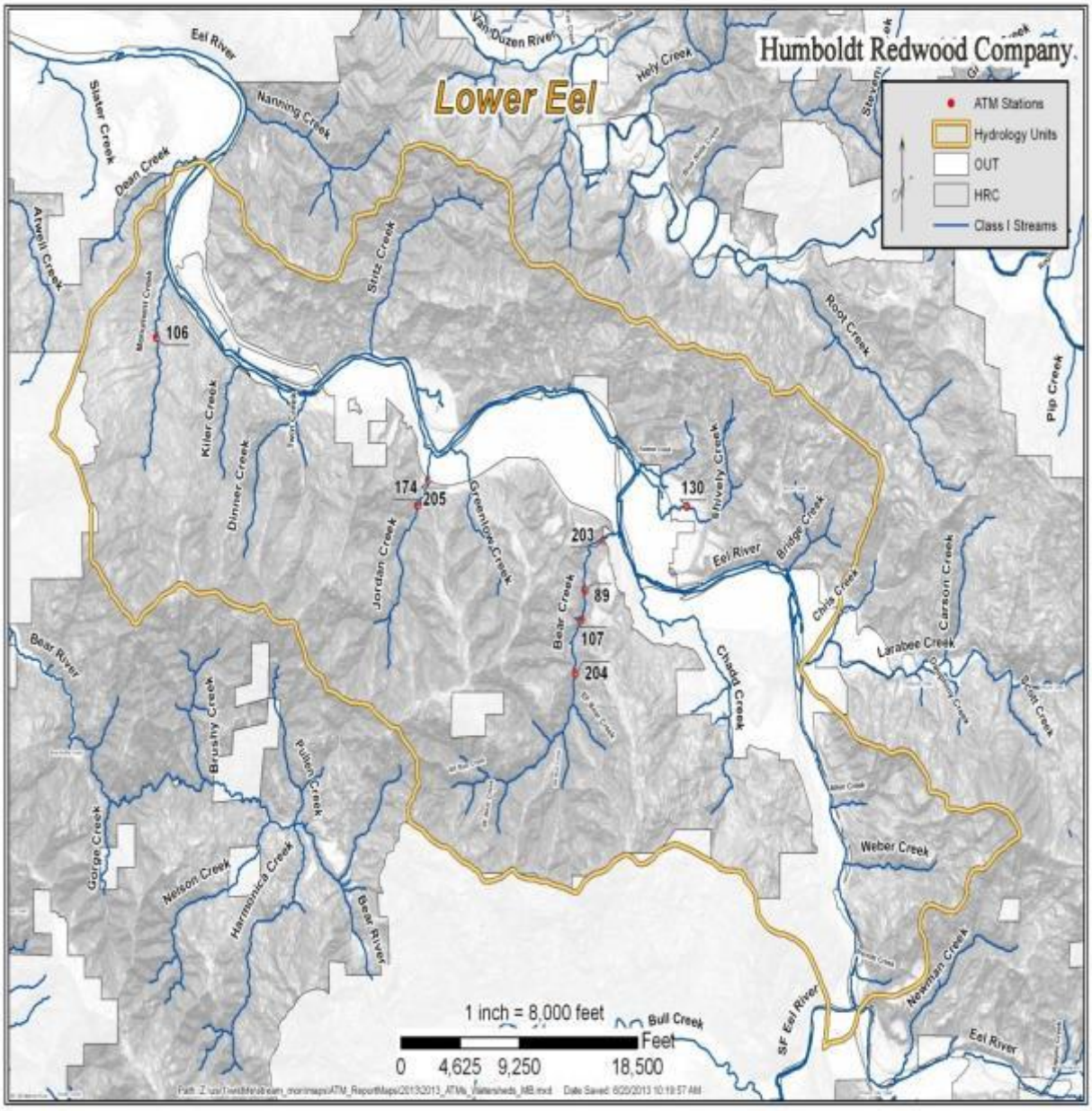

Figure 28. Location map of ATM sites within the Bear Creek/Lower Eel WAU

ATM 204 Bear Creek

ATM 203 Bear Creek

ATM 107 Bear Creek

Figure 29. ATM sites within the Bear Creek/Lower Eel WAU

ATM Site 203 – Lower Bear Creek [Alluvium (Qal) underlain by Undifferentiated Wildcat Group (Qtw)]

Data for all ATM parameters at site 203 (Figure 29) are summarized in the APFC report card found in Table 17. The bed surface APFC target was met in 2018, as the data suggest a coarsening of the substrate across all particle size classes (Figure 30). Pool habitats remained static, with 3/4 parameters meeting the target values. LWD piece frequency met the target for the seventh consecutive year. Over stream canopy cover in 2018 placed short of the target value for the seventh consecutive year. Stream temperature did not meet the target for the second consecutive year.

Cross-section data suggest varying degrees of channel aggradation and scour since surveys were instituted in 2004 (see Appendix). Channel aggradation was observed at 4/5 cross-sections between survey years 2015 and 2018. The greatest degree of channel aggradation occurred at cross-section 4, where channel area decreased -0.67m^2. The only location of channel scour occurred at cross-section 1, where channel area increased +0.17m^2.

A snorkel survey on 6/19/2018 identified trout in all 5 of the 5 pools sampled. Other observed species include Foothill yellow-legged frogs.

Table 17. Individual site report card for ATM 203, Lower 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**
Bed Surface	D_{84} (mm)	#	66	88	98	98	114	110	94	126	93	77	83	45	110	94	110
	D_{50} (mm)	65-95	30	38	28	42	46	56	39	68	65	31	33	19	66	48	66
	D_{16} (mm)	#	12	8	2	6	4	20	12	25	9	6	7	6	38	14	40
	D_5 (mm)	#	8	1	1	1	1	4	3	4	2	1	2	2	19	2	27
Pool Characteristics	Pool Area (%)	≥25	22	61	32	32	26	35	47	37	26	11	13	17	32	30	25
	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
	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
	Pools Assoc. w/wood (%)	≥50	100	100	100	100	100	100	85	88	100	100	100	100	100	82	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
	Total Piece Count	#	148	145	71	72	65	87	57	46	70	85	112	128	178	108	102
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
Riparian Overstory	Canopy Over Stream (%)	≥90	24	38	35	26	57	40	97	80	77	83	83	70	87	85	79
	Canopy of Rip Forest (%)	≥85	90	96	97	85				96	99	96	91				

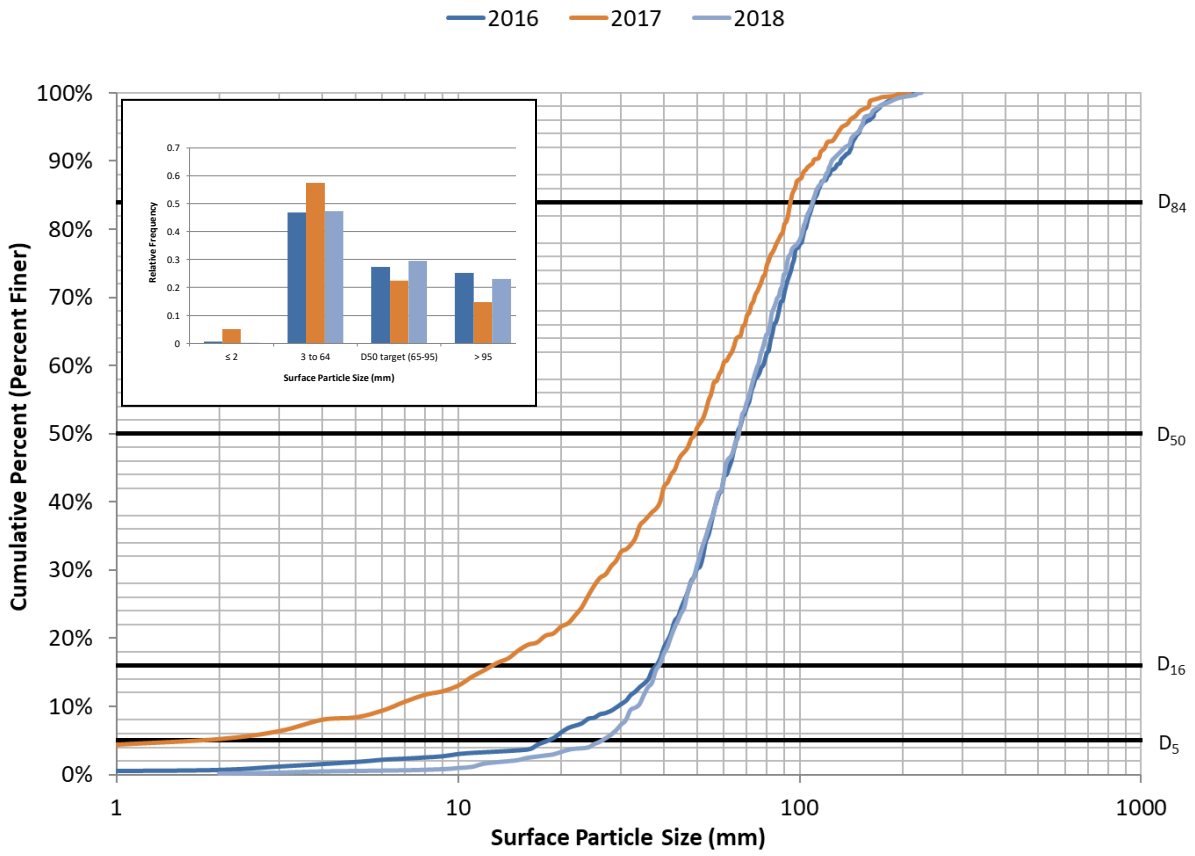

Figure 30. Cumulative frequency plot of the mean surface particle sizes of three riffles measured within the Bear Creek ATM 203 survey reach

ATM Site 107 – Middle Bear Creek [Coastal Belt: Coastal Terrane (TKfs)]

Data for all ATM parameters at site 107 (Figure 29) are summarized in an APFC report card (Table 18). The bed surface APFC target was met in 2018, as the data suggest a coarsening of the substrate across all particle size classes (Figure 31). Pool habitats remained static, with 3/4 parameters meeting the target values. LWD piece frequency met the target for the third consecutive year. Over stream canopy cover in 2018 placed short of the target value for the seventh consecutive year. Stream temperature met the target in 2018 after placing short of the target by 0.01 °C in 2017.

Cross-section data suggest varying degrees of channel aggradation and scour since surveys were instituted in 1998 (see Appendix). Channel aggradation was observed at 4/6 cross-sections between survey years 2015 and 2018. The greatest degree of channel aggradation occurred at cross-section 2, where channel area decreased -0.67m^2. The only location of channel scour occurred at cross-section 4, where channel area increased +0.50m^2. No change in channel area occurred at cross-section 1 between 2015 and 2018.

A snorkel survey 6/20/2018 identified trout in all 5 of the 5 pools sampled. Other observed species include Foothill yellow-legged frogs.

Table 18. Individual site report card for ATM 107, Mid-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
Bed Surface	D_{84} (mm)	#	113	110	100	110	109	160	129	124	154	131	116	104	79	116	123	127
	D_{50} (mm)	65-95	46	44	42	30	36	67	62	57	69	37	43	43	34	68	66	73
	D_{16} (mm)	#	9	10	8	3	7	14	22	19	16	5	11	7	10	36	24	37
	D_5 (mm)	#	1	1	1	1	1	1	5	3	2	1	2	2	3	14	7	20
Pool Characteristics	Pool Area (%)	≥25	9	23	50	19	14	22	16	20	25	45	19	27	7	28	29	28
	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
	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
	Pools Assoc. w/wood (%)	≥50	100	100	100	100	100	100	100	100	100	89	67	86	100	100	89	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
	Total Piece Count	#	129	213	179	94	119	76	75	115	49	95	85	83	55	129	122	106
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
Riparian Overstory	Canopy Over Stream (%)	≥90	31	42	31	26	28	56	53	97	90	83	79	77	54	78	88	65
	Canopy of Rip Forest (%)	≥85	73	86	90	73	81				98	99	90	89				

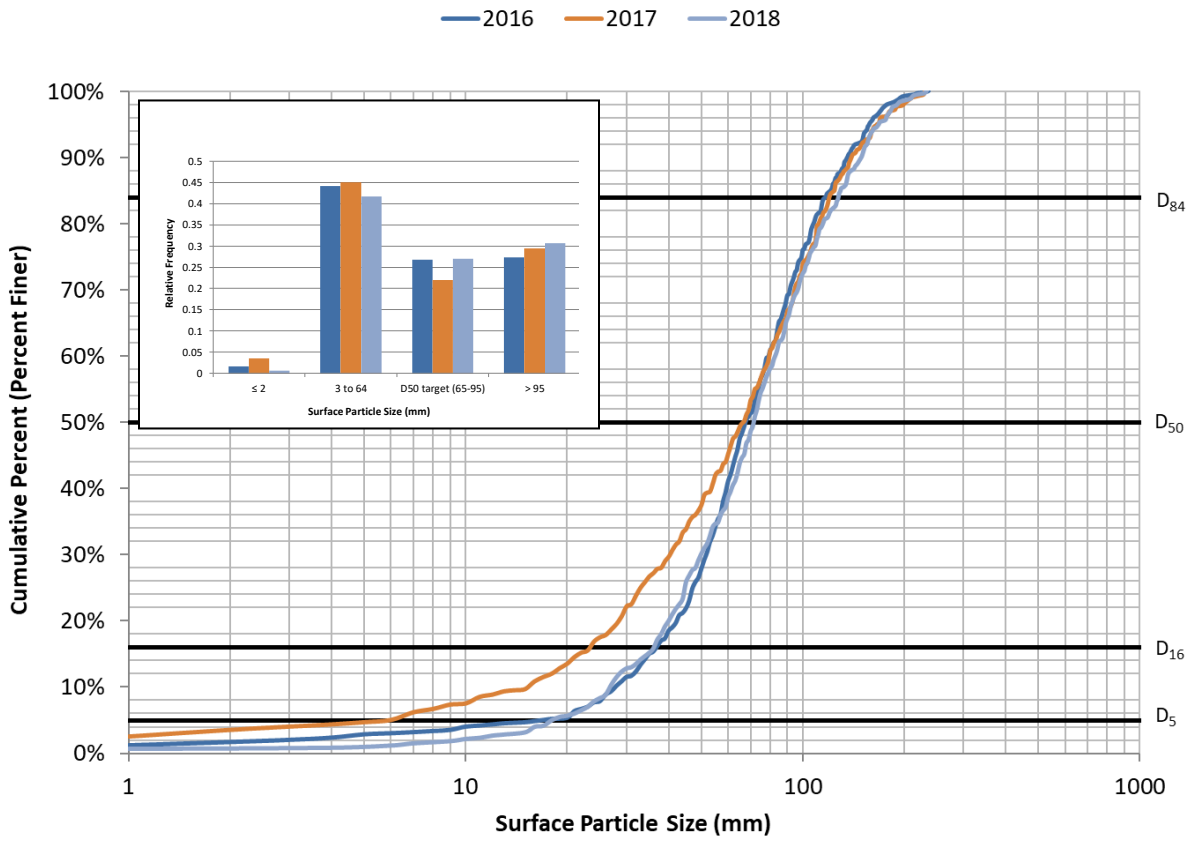

Figure 31. Cumulative frequency plot of the mean surface particle sizes of three riffles measured at the Bear Creek ATM 107 survey reach

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

Data for all ATM parameters at site 204 (Figure 29) are summarized in an APFC report card (Table 19). The bed surface APFC target was met in 2018, as the data suggest a coarsening of the substrate across most particle size classes (Figure 32). Pool habitats remained static, with 3/4 parameters meeting the target values. LWD piece frequency met the target for the fourth consecutive year. Over stream canopy cover in 2018 placed short of the target value after briefly meeting the target in 2017. Stream temperature met the target in 2018 for the third straight year.

Cross-section data suggest varying degrees of channel aggradation and scour since surveys were instituted in 2004 (see Appendix). Channel aggradation was observed at 4/5 cross-sections between survey years 2015 and 2018. The greatest degree of channel aggradation occurred at cross-section 2, where channel area decreased -0.76m^2. The only location of channel scour occurred at cross-section 3, where channel area increased +0.30m^2.

A snorkel survey on 7/10/2019 identified trout in all 5 of the 5 pools sampled. Other observed species include Foothill yellow-legged frogs.

Table 19. Individual site report card for ATM 204, Mid-Upper 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
Bed Surface	D_{84} (mm)	#	118	135	108	143	161	133	128	170	173	123	120	101	116	142	142
	D_{50} (mm)	65-95	37	51	24	53	54	62	51	76	64	52	47	45	69	66	80
	D_{16} (mm)	#	4	14	2	8	7	17	13	28	14	15	11	11	35	15	32
	D_5 (mm)	#	1	1	1	3	1	5	4	11	3	1	2	3	16	5	14
Pool Characteristics	Pool Area (%)	≥25	23	39	21	38	22	16	28	38	27	21	36	14	28	31	28
	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
	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
	Pools Assoc. w/wood (%)	≥50	100	100	100	100	100	100	83	100	83	86	75	67	88	80	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
	Total Piece Count	#	105	158	151	124	71	62	130	33	63	85	49	78	170	74	77
Water Temperature	MWAT (°C)	≤16.8						17.3							15.1	16.3	15.2
Riparian Overstory	Canopy Over Stream (%)	≥90	7	10	34	11	23	53	73	79	51	75	63	64	85	90	79
	Canopy of Rip Forest (%)	≥85	79	77	90	85				96	93	94	90	96			

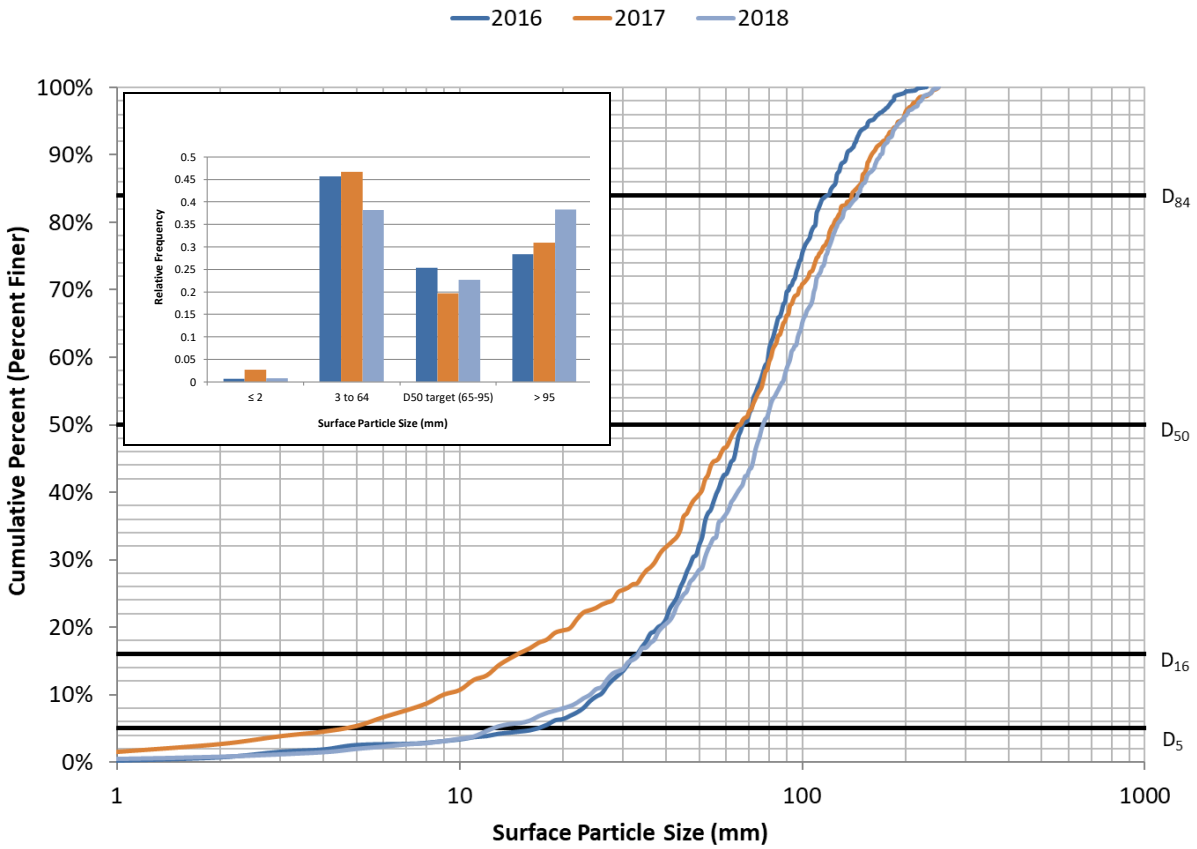

Figure 32. Cumulative frequency plot of the mean surface particle sizes of three riffles measured at the Bear Creek ATM 204 survey reach

Summary of ATM Trends for Bear Creek in the Lower Eel WAU.

A summary of the Bear Creek habitat characteristics from 2018 is provided in an APFC report card (Table 20). Results of habitat composite scores from 2017 and 2018 are compared to baseline (2004) data (Figure 33). Overall, identical scores were observed in 2018 relative to 2017. However, improvements were made in the bed surface, pools, and temperature parameters relative to baseline records.

The bed surface composite scores for 2018 and 2017 were each 0.67, up from the baseline record of 0.00. The 2018 and 2017 composite score for pools had increased (+79%) relative to the baseline record. The LWD composite scores for 2018, 2017, and the baseline record were 1.0. Canopy cover composite scores for 2018, 2017, and the baseline record were also 1.0. The 2018 and 2017 stream temperature composite scores were each 0.33, up from the baseline record (0.00).

Table 20. The most recent habitat measures for Bear Creek in the Lower Eel WAU

Current Status	Parameter	Target Value (# no target)	203 Lower Bear Cr	107 Mid-Bear Cr	204 Mid-Upper Bear Cr
Bed Surface	D_{84} (mm)	#	110	127	142
	D_{50} (mm)	65-95	66	73	80
	D_{16} (mm)	#	40	37	32
	D_5 (mm)	#	27	20	14
Pool Characteristics	Pool Area (%)	≥25	25	28	28
	Pool Spacing (CW/pool)	≤6.0	3.1	3.0	3.1
	Residual Pool Depth (m)	≥0.91	0.56	0.61	0.46
	Pools Assoc. w/wood (%)	≥50	100	100	100
Large Woody Debris	Total Piece Frequency (#/100 ft)	f(CW)	6.4	7.5	5.4
	Total Piece Count	#	102	106	77
Water Temperature	MWAT (°C)	≤16.8	17.1	16.1	15.2
Riparian Overstory	Canopy Over Stream (%)	f(CW)	79	65	79
	Canopy of Rip Forest (%)	≥85			
Watershed Area	Upstream Acreage	#	5,449	5,026	4,302
Reach Gradient	Reach Gradient (%)	#	1.6	1.8	3.8

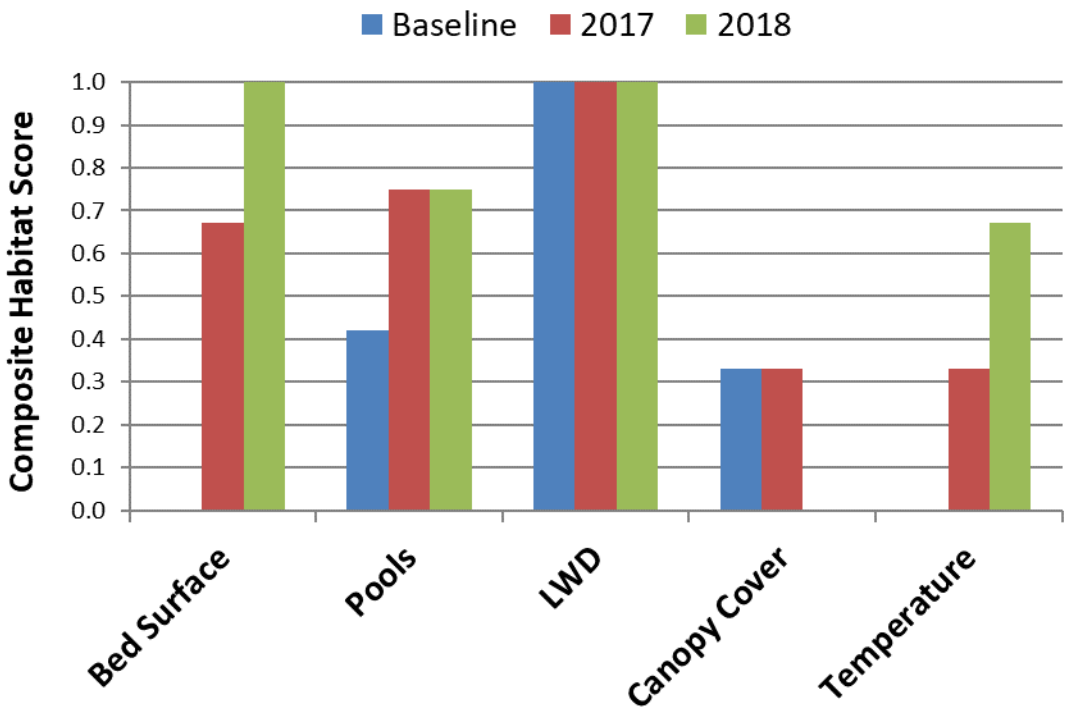

Figure 33. The composite scores for habitat characteristics in the Lower Eel WAU in 2017 and 2018 relative to baseline (2004) data

BEAR RIVER WAU

HRC ownership is based primarily in the upper portion of the Bear River watershed (ownership = 16,537 acres, 31% of total basin) between the headwaters and the confluence with Peaked Creek. Major tributaries within HRC property include Harmonica Creek, Pullen Creek, Nelson Creek, Brushy Creek, Gorge Creek, and Beer Bottle Creek (Figure 34).

The Bear River watershed lies in a tectonically active region of the coast range characterized by very steep terrain and deeply incised drainage basins. Tectonic uplift has caused rapid incision of the Bear River system resulting in steep hillslopes and deep canyons. Steep slopes composed of sheared bedrock materials, which are often prone to landslides, in combination with high rainfall and intense seismic activity results in high rates of natural sediment production.

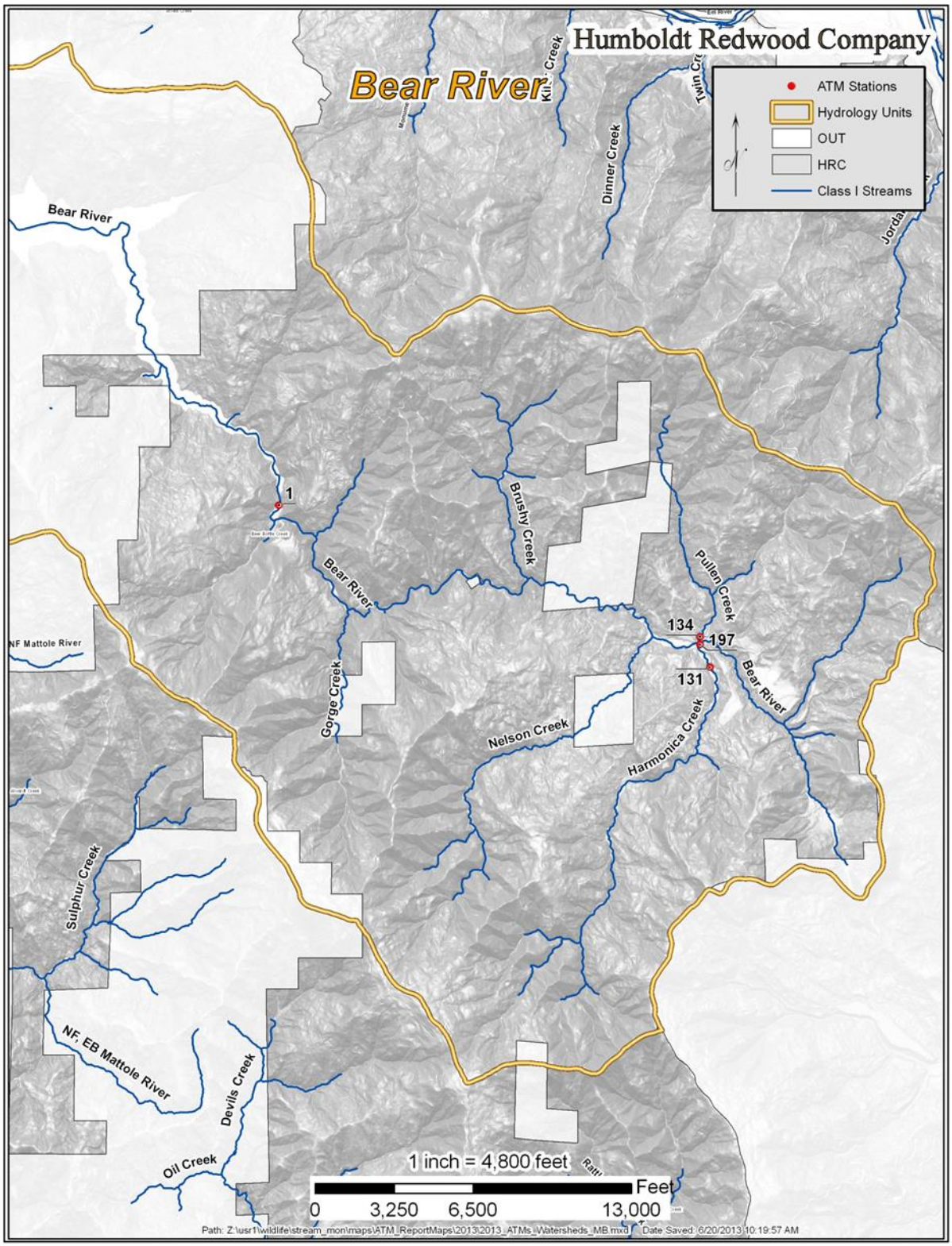

Figure 34. Location map of ATM sites in Bear River

ATM 131 Harmonica Creek

ATM 134 Pullen Creek

ATM 197 Upper Bear River

ATM 001 Lower Bear River

Figure 35. ATM sites within the Bear River WAU

ATM Site 131 – Harmonica Creek [Coastal Belt: Yager Terrane (TKy)]

Data for all ATM parameters at site 131 (Figure 35) are summarized in an APFC report card (Table 21). The bed surface APFC target was met in 2018, as the data suggest a coarsening of the substrate across all particle size classes (Figure 35). Pool habitats showed a slight decline from 2015, with only 1/4 parameters meeting the target values. LWD piece frequency did not meet the target for the seventh consecutive survey year. Over stream canopy cover in 2018 placed short of the target value and stream temperature met the target in 2018 for the third straight year.

Cross-section data suggest varying degrees of channel aggradation and scour since surveys were instituted in 1997 (see Appendix). Channel scour was observed at 4/5 cross-sections between survey years 2015 and 2018. The greatest degree of channel scour occurred at cross-section 4, where channel area increased +2.85m^2. The only location of channel aggradation occurred at cross-section 2, where channel area decreased -0.54m^2.

A snorkel survey on 6/15/2018 identified trout in all 5 of the 5 pools sampled. Other observed species include Foothill yellow-legged frogs.

Table 21. Individual site report card for ATM 131, Harmonica Creek

Site 131 Harmonica Creek	Parameter	Target Value (# no target)	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Bed surface	D_{84} (mm)	#	141	101		101			131			141			99			112
	D_{50} (mm)	65-95	65	35		32			59			60			51			67
	D_{16} (mm)	#	24	9		6			15			9			20			40
	D_5 (mm)	#	8	4		2			6			2			6			22
Pool Characteristics	Pool Area (%)	≥25	8	12		17			29			9			30			13
	Pool Spacing (CW/pool)	≤6.0	12.9	8.1		3.5			7.7			13.7			10.0			11.2
	Residual Pool Depth (m)	≥0.91	0.66	0.41		0.42			0.53			0.62			0.51			0.54
	Pools Assoc. w/wood (%)	≥50	50	100		80			80			67			67			67
Large Woody Debris	Total Piece Frequency (#/100 ft)	≥7.4	5.7	4.8		4.3			3.5			3.5			2.3			5.0
	Total Piece Count	#							37			43			14			44
Water Temperature	MWAT (°C)	≤16.8			16.7	19.0	16.7	16.9	17.0	15.0	14.7	15.5	16.3		17.0	16.7	16.5	15.3
Riparian Overstory	Canopy Over Stream (%)	≥91	32	39		37			44			70			65			77
	Canopy of Rip Forest (%)	≥85	60	70		92						84						82

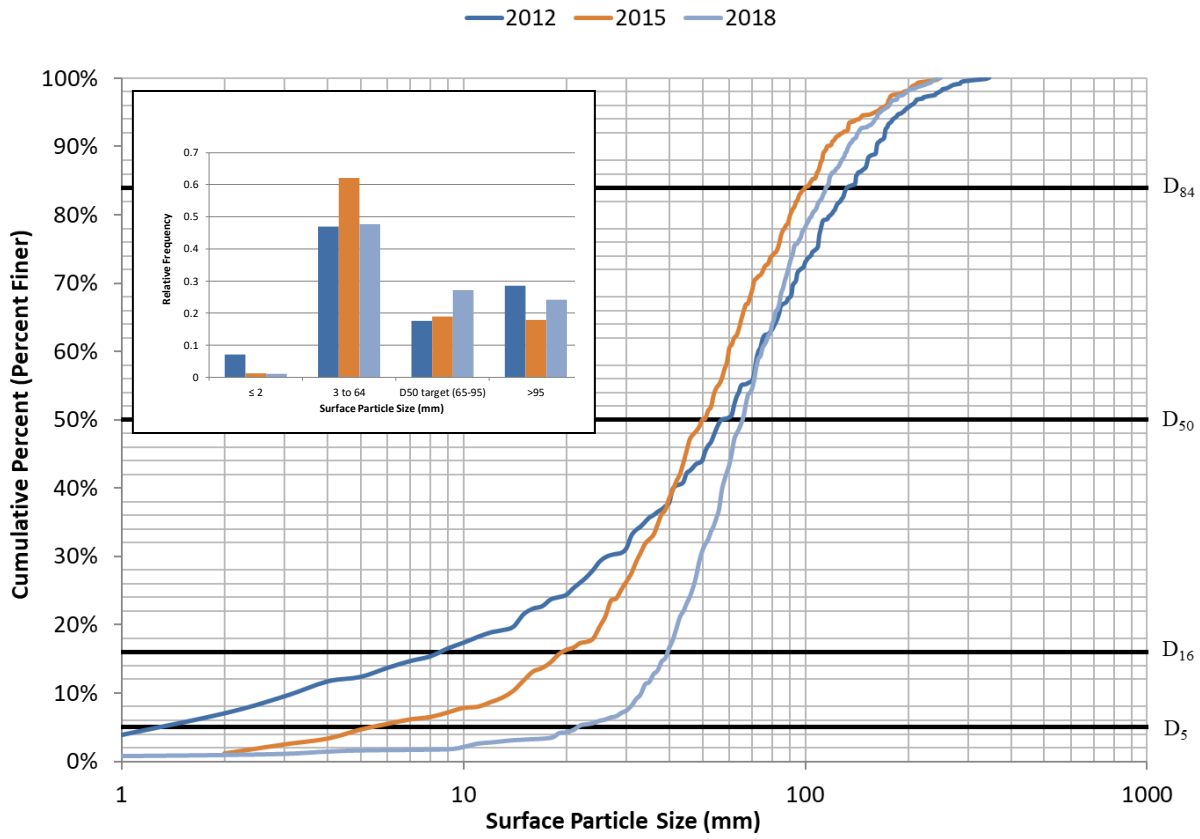

Figure 36. Cumulative frequency plot of the mean surface particle sizes of three riffles measured within the Harmonica Creek ATM 131 survey reach

ATM Site 134 – Pullen Creek [Coastal Belt: Yager Terrane (TKy)]

Data for all ATM parameters at site 134 (Figure 35) are summarized in an APFC report card (Table 22). The bed surface APFC target was met in 2018, as the data suggest a coarsening of the substrate across all particle size classes (Figure 36). Pool habitats showed a slight improvement, with half of the parameters meeting target values. LWD piece frequency did not meet the target for the fourth consecutive survey year. Over stream canopy cover in 2018 met the target value for the eighth consecutive survey year, while stream temperature met the target in 2018 for the ninth straight year.

Cross-section data suggest varying degrees of channel aggradation and scour since surveys were instituted in 2006 (see Appendix). Channel scour was observed at 3/5 cross-sections between survey years 2015 and 2018. The greatest degree of channel scour occurred at cross-section 5, where channel area increased +0.30m^2. The greatest degree of channel aggradation occurred at cross-section 2, where channel area decreased -0.17m^2.

A snorkel survey on 6/15/2018 identified trout in all 5 pools sampled. Other observed species include Foothill yellow-legged frogs.

Table 22. Individual site report card for ATM 134, Pullen Creek

Site 134 Pullen Creek	Parameter	Target Value (# no target)	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Bed Surface	D_{84} (mm)	#	185	124		129			140			131			89			118
	D_{50} (mm)	65-95	69	39		30			60			42			42			71
	D_{16} (mm)	#	21	9		2			12			8			16			35
	D_5 (mm)	#	1	1		1			4			2			6			12
Pool Characteristics	Pool Area (%)	≥25	5	14		18			34			17			13			14
	Pool Spacing (CW/pool)	≤6.0	10.1	12.9		3.9			5.0			3.6			7.7			5.1
	Residual Pool Depth (m)	≥0.91	0.39	0.34		0.42			0.43			0.32			0.41			0.40
	Pools Assoc. w/wood (%)	≥50	100	100		75			89			64			75			100
Large Woody Debris	Total Piece Frequency (#/100 ft)	≥7.5							4.3			7.3			3.3			4.2
	Total Piece Count	#							53			84			29			38
Water Temperature	MWAT (°C)	≤16.8	15.9	15.1	14.7	16.5	14.0	14.5	17.5	13.6	13.6	14.5	16.4	15.3	15.6	14.9	16.1	15.1
Riparian Overstory	Canopy Over Stream (%)	≥53	87	99	99	85			93			100			99			99
	Canopy of Rip Forest (%)	≥85	89	87		92						99						

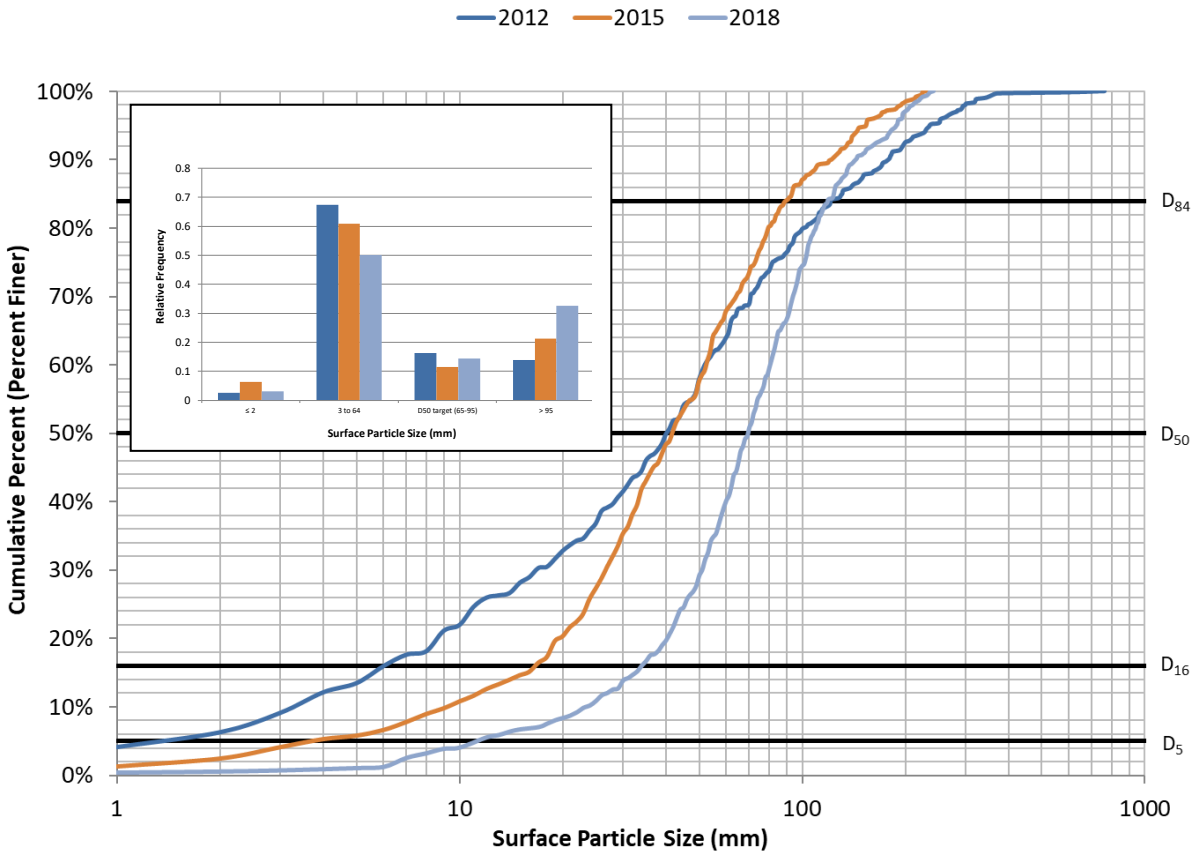

Figure 37. Cumulative frequency plot of the mean surface particle sizes of three riffles measured within the Pullen Creek ATM 134 survey reach

ATM Site 197 – Upper Bear River [Coastal Belt: Coastal Terrane (TKfs)]

Data for all ATM parameters at site 197 (Figure 35) are summarized in an APFC report card (Table 23). The bed surface APFC target was met in 2018, as the data suggest a coarsening of the substrate across all particle size classes (Figure 37). Pool habitats remained static, with 3/4 parameters meeting the target values. LWD piece frequency did not meet the target for the second straight year. Over stream canopy cover in 2018 met the target value for the third straight survey year, as stream temperature met the target for the sixth consecutive survey year.

Cross-section data suggest varying degrees of channel aggradation and scour since surveys were instituted in 2006 (see Appendix). Channel scour was observed at 4/5 cross-sections between survey years 2015 and 2018. The greatest degree of channel scour occurred at cross-section 2, where channel area increased +2.05m^2. The only location of channel aggradation occurred at cross-section 5, where channel area decreased -0.32m^2.

A snorkel survey on 6/15/2019 identified trout in all 5 of the 5 pools sampled. No other fish or amphibian species were observed.

Table 23. Individual site report card for ATM 197, Upper Bear River

Site 197 Bear River	Parameter	Target Value (# no target)	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Bed Surface	D_{84} (mm)	#							90			101			94			116
	D_{50} (mm)	65-95							44			44			44			68
	D_{16} (mm)	#							16			12			18			37
	D_5 (mm)	#							7			3			3			25
Pool Characteristics	Pool Area (%)	≥25							35			18			37			45
	Pool Spacing (CW/pool)	≤6.0							3.9			4.1			5.0			3.2
	Residual Pool Depth (m)	≥0.91							0.49			0.56			0.54			0.45
	Pools Assoc. w/wood (%)	≥50							89			75			57			70
Large Woody Debris	Total Piece Frequency (#/100 ft)	≥6.3							7.7			8.1			3.8			5.9
	Total Piece Count	#							86			90			39			50
Water Temperature	MWAT (°C)	≤16.8										14.9		14.9	16.1	15.1	16.3	15.8
Riparian Overstory	Canopy Over Stream (%)	≥92	80	89		82			85			98			98			94
	Canopy of Rip Forest (%)	≥85	86	79		99						98						

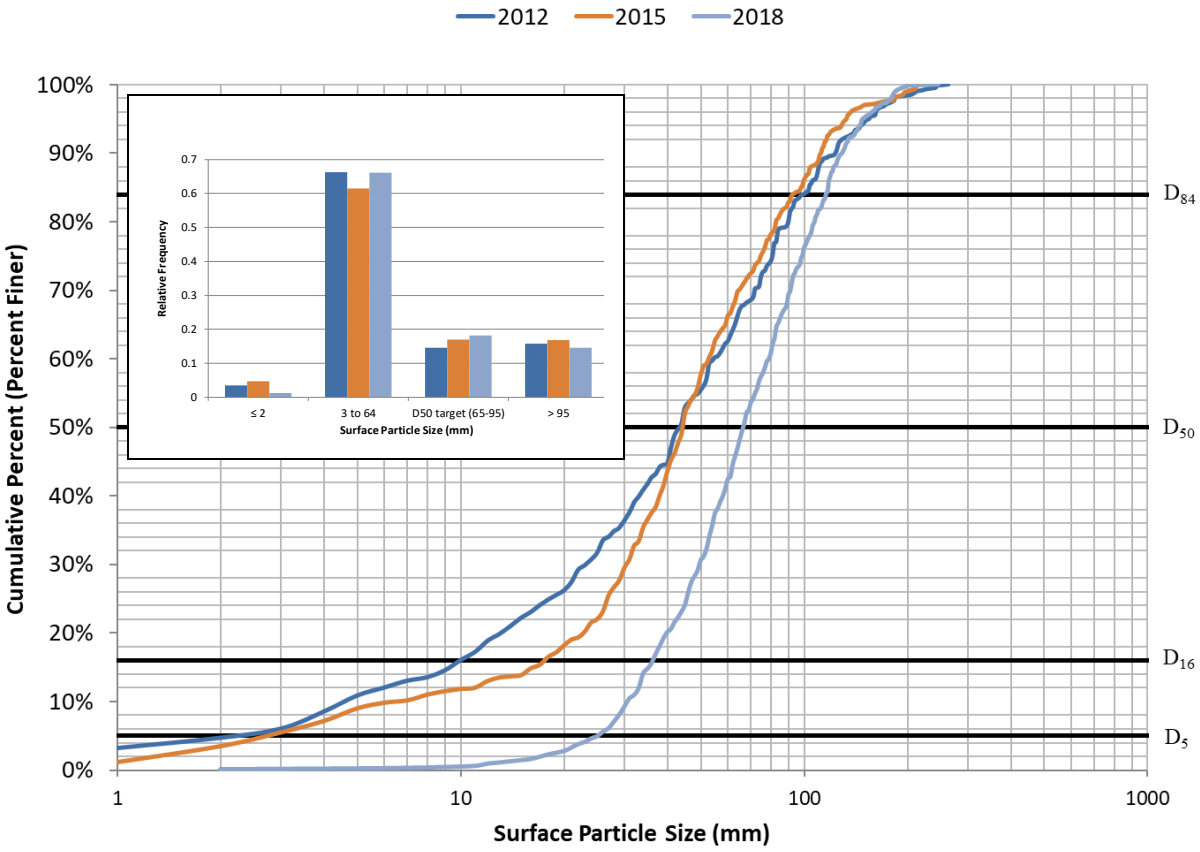

Figure 38. Cumulative frequency plot of the mean surface particle sizes of three riffles measured within the Bear River ATM 197 survey reach

ATM Site 001 – Lower Bear River [Coastal Belt: Coastal Terrane (TKfs)]

Data for all ATM parameters at site 001 (Figure 35) are summarized in an APFC report card (Table 24). The bed surface APFC target was met in 2018, as the data suggest a coarsening of the substrate across all particle size classes (Figure 39). Pool habitats showed improvement, with half of the parameters meeting the target values. LWD piece frequency did not meet the target for the seventh consecutive year. Over stream canopy cover in 2018 met the target value for the second straight year, while stream temperature did not meet the target in 2018 for the sixth straight year.

Cross-section data suggest varying degrees of channel aggradation and scour since surveys were instituted in 2006 (see Appendix). Channel aggradation was observed at 3/4 cross-sections between survey years 2015 and 2018. The greatest degree of channel aggradation occurred at cross-section 2, where channel area decreased -8.06m^2. The only location of channel scour occurred at cross-section 1, where channel area increased +2.04m^2.

A snorkel survey on 7/9/2018 identified trout in all 5 of the 5 pools sampled. A single adult summer-run steelhead was also positively identified in the deepest of the 5 pools.

Table 24. Individual site report card for ATM 001, Lower Bear River

Site 001 Bear River	Parameter	Target Value (# no target)	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Bed surface	D_{84} (mm)	#	222	176		183			187			152			110			136
	D_{50} (mm)	65-95	65	43		40			85			39			44			73
	D_{16} (mm)	#	11	9		4			21			5			21			30
	D_5 (mm)	#	1	2		1			6			2			6			12
Pool Characteristics	Pool Area (%)	≥25	21	26		33			32			22			13			26
	Pool Spacing (CW/pool)	≤6.0	6.8	5.3		4.7			2.7			4.5			6.5			3.3
	Residual Pool Depth (m)	≥0.91	1.05	0.82		0.64			0.75			0.85			0.86			0.52
	Pools Assoc. w/wood (%)	≥50	50	40		25			17			0			14			33
Large Woody Debris	Total Piece Frequency (#/100 ft)	≥3.1	1.9	1.6		1.6			1.1			1.7			1.2			1.3
	Total Piece Count	#							11			19			20			25
Water Temperature	MWAT (°C)	≤16.8		19.1		19.5	17.2	16.8	17.5	15.8	15.9	16.5	17.3	17.7	17.9	17.3	17.9	17.3
Riparian Overstory	Canopy Over Stream (%)	≥61	40	34		35			35			47			78			81
	Canopy of Rip Forest (%)	≥85	86	91		100						98						

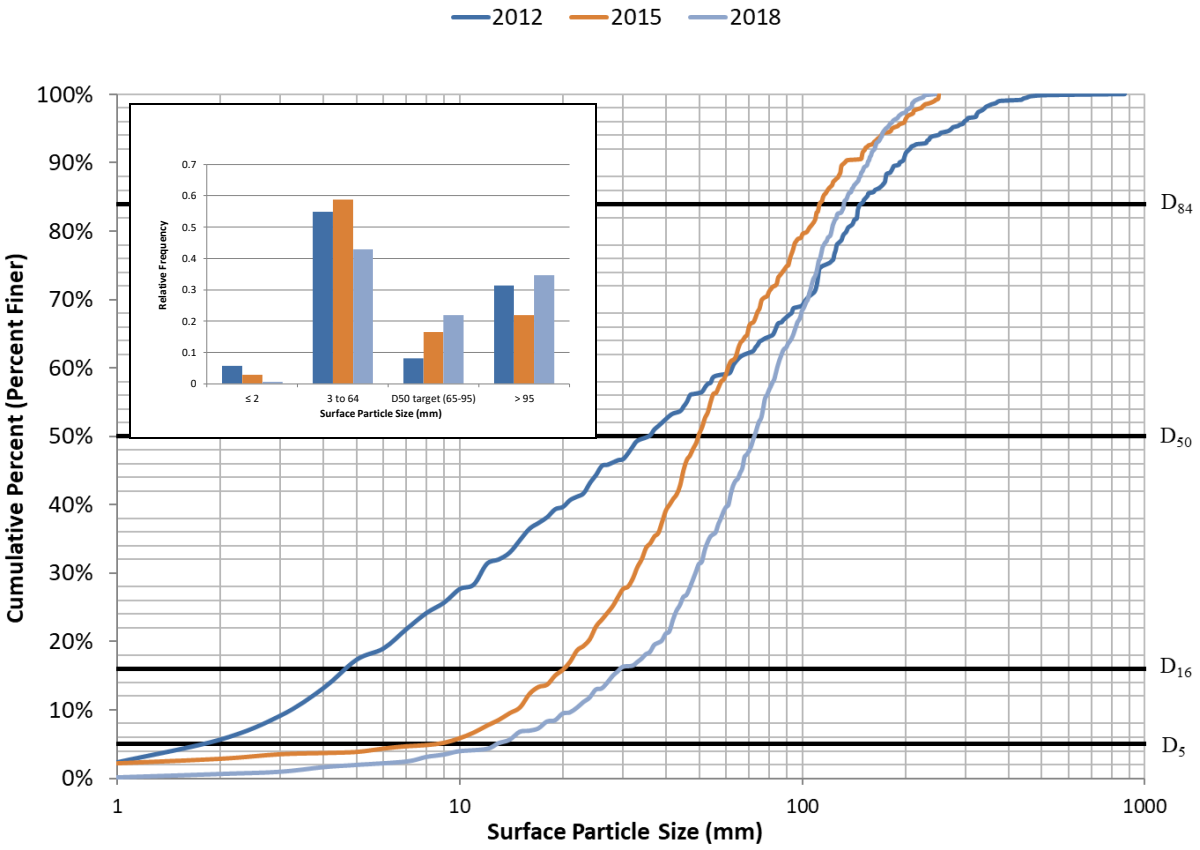

Figure 39. Cumulative frequency plot of the mean surface particle sizes of three riffles measured within the Bear River ATM 001 survey reach

Summary of ATM Trends in the Bear River WAU

A summary of the Bear River habitat characteristics from 2018 is provided in an APFC report card (Table 25). Results of habitat composite scores from 2015 and 2018 are compared to baseline (2003) data (Figure 40). Overall, the greatest improvements in habitat composite scores were observed in bed surface, pools, and stream temperature.

The bed surface composite score for 2018 (1.00) rebounded to the baseline score (1.00) after scoring 0.00 in 2015. The 2018 composite score for pools increased (+32%) from 2015, also increasing (+56%) from the baseline record. The 2018 LWD composite score remained at 0.00, the same as both the 2015 and the baseline score. The 2018 canopy cover composite score decreased (-67%) from 2015, but still scored higher (+20%) than the baseline record. The 2018 stream temperature composite score was higher (+50%) than 2015 but lower (-33%) than the baseline record.

Table 25. The most recent habitat measures for the Bear River WAU

Current Status	Parameter	Target Value (# no target)	131 Harmonica Creek	134 Pullen Creek	197 Bear River	001 Bear River
Bed Surface	D_{84} (mm)	#	112	118	116	136
	D_{50} (mm)	65-95	67	71	68	73
	D_{16} (mm)	#	40	35	37	30
	D_{5} (mm)	#	22	12	25	12
Pool Characteristics	Pool Area (%)	≥25	13	14	45	26
	Pool Spacing (CW/pool)	≤6.0	11.2	5.1	3.2	3.3
	Residual Pool Depth (m)	≥0.91	0.54	0.40	0.45	0.52
	Pools Assoc. w/wood (%)	≥50	67	100	70	33
Large Woody Debris	Total Piece Frequency (#/100 ft)	f(CW)	5.0	4.2	5.9	1.3
	Total Piece Count	#	44	38	50	25
Water Temperature	MWAT (°C)	≤16.8	15.3	15.1	15.8	17.3
Riparian Overstory	Canopy Over Stream (%)	f(CW)	77	99	94	81
	Canopy of Rip Forest (%)	≥85	82			
Watershed Area	Upstream Acreage	#	2,624	1,673	1,935	15,103
Reach Gradient	Reach Gradient (%)	#	1.6	2.0	1.4	0.8

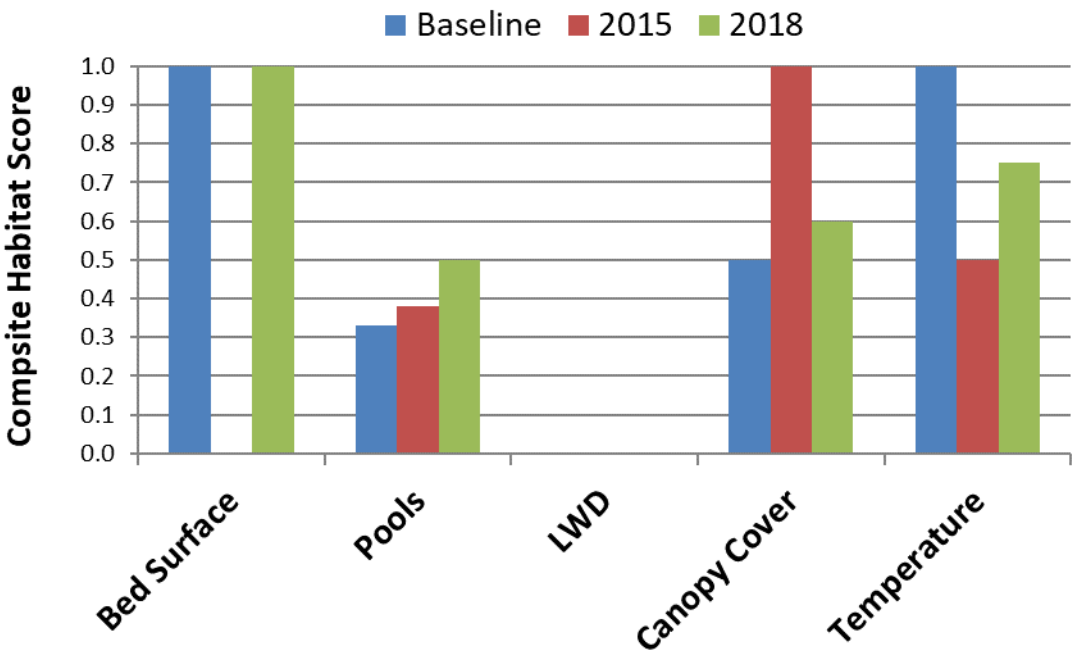

Figure 40. The composite scores for habitat characteristics in the Bear River WAU in 2015 and 2018 relative to baseline (2003) data

QUALITY ASSURANCE / QUALITY CONTROL

Three of the sixteen (3/16) ATM sites measured in 2018 were re-measured to assess the quality and reproducibility of ATM data collection. Data collection at 14/16 sites, including QA/QC, was conducted by the same two-person field crew in 2018. 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 2018 QA/QC are shown in Table 26.

Initial vs. QA/QC surface sediment measurements were highly consistent at ATM stations 40, 134, and 107 (standard deviation of the mean (+/-) 5mm, 4mm, 1.5mm, 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 2018 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 26. QA/QC data collection measures for three (3) ATM stations in 2018

2018 QA/QC	Parameter	Target Value (# no target)	040 Shaw Creek	040.1 Shaw Creek	134 Pullen Creek	134.1 Pullen Creek	107 Bear Creek	107.1 Bear Creek
Bed Surface	D_{84} (mm)	#	83	97	118	110	127	125
	D_{50} (mm)	65-95	39	49	71	63	73	76
	D_{16} (mm)	#	16	20	35	28	37	43
	D_5 (mm)	#	6	10	12	14	20	23
Pool Characteristics	Pool Area (%)	≥25	58	56	14	19	28	37
	Pool Spacing (CW/pool)	≤6.0	3.6	4.0	5.1	3.8	3.0	2.3
	Residual Pool Depth (m)	≥0.91	0.61	0.61	0.40	0.41	0.61	0.57
	Pools Assoc. w/wood (%)	≥50	100	100	100	100	100	100
Large Woody Debris	Total Piece Frequency (#/100 ft)	f(CW)	6.6	4.6	4.2	7.0	7.5	8.8
	Total Piece Count	#	53	36	38	61	106	123
Water Temperature	MWAT (°C)	≤16.8	15.1		15.1		16.1	
Riparian Overstory	Canopy Over Stream (%)	f(CW)	100	97	99	99	65	74
	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. This change was made to the monitoring program and is discussed in the ATM methods revised section of this document.

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 at ATM locations have been formally added to standard ATM protocol in consultation with HCP signatory agencies (2014).

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)