Final Report

2011 Temperature, Water Quality and Juvenile Salmonid Presence/Absence Monitoring, Mattole River Watershed

Funding for this project has been provided through the
State Water Resources Control Board (SWRCB),
U.S. Bureau of Land Management (BLM), and
U.S. Environmental Protection Agency (EPA):
Targeted Watershed Grants Program

Submitted in partial fulfillment of:

Agreement # L08AC14502 (BCA072012) between the Mattole Salmon Group and BLM
Phase I. Task C.

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March 2012

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Mattole Salmon Group juvenile dive in Woods Creek, spring 2011. Photo courtesy of MSG Staff.

Acknowledgements

The Mattole Salmon Group acknowledges the following people as integral to 2011 Temperature, Water Quality, and Juvenile Salmonid Presence/Absence Monitoring:

- Kate Cenci and Matt Hanington, for their dedication and work as crew leaders for 2011 temperature and water quality monitoring and associated dives
- Sam Adelson, Daniel Hoshizaki, and Dave Wesolowski, the Mattole Salmon Group's AmeriCorps Watershed Stewards Project members, for their hard work as field staff
- Many landowners throughout the Mattole River Watershed, whose hospitality and partnership makes dive surveys possible in many of our monitoring locations

We also appreciate the following partner organizations for their crucial support (both financial and technical) of 2011 Temperature, Water Quality, and Juvenile Salmonid Presence/Absence Monitoring:

U.S. Bureau of Land Management
U.S. Environmental Protection Agency: Targeted Watershed Grants Program
Mattole Restoration Council
Sanctuary Forest, Inc.
State Water Resources Control Board: Mattole Integrated Coastal Watershed Management Program

Mattole Coho Salmon juvenile in the upper Mattole mainstem, confluence of Thompson Creek on July 15, 2011. Photo courtesy Kate Cenci, MSG staff.

Abstract

Past salmonid habitat and population monitoring has indicated rearing habitat is a major limiting factor to salmonid survival and abundance in the Mattole River Watershed. Water quality, particularly temperature and dissolved oxygen, limits suitable habitat during the summer months and compromises salmonid growth and survival. The decrease in quality and extent of freshwater habitat has inevitably resulted in reduced run strength, particularly for native Mattole Coho Salmon.

2011 was the third year of an extensive water quality and juvenile dive monitoring effort conducted by the Mattole Salmon Group (MSG) to assess available habitat and juvenile population trends, health, and distribution of Coho Salmon (*Oncorhynchus kisutch)* in the Mattole Watershed. Data on two additional salmonid species found in the Mattole – Chinook Salmon (*Oncorhynchus tshawytscha*) and Steelhead Trout (*Oncorhynchus mykiss*) – was also collected.
Data from direct underwater observation via mask and snorkel were used to determine the distribution and relative abundance of the three species of juvenile salmonids. 2011 dive surveys were conducted in all tributaries with Coho presence determined by MSG monitoring since 2002. Dive survey results suggest Mattole Coho are at risk of extinction, with current observed distribution limited to a small geographical area near the headwaters and abundance at critically low densities.

Water quality investigations were used to quantify habitat parameters and identify suitable habitat regimes. Investigations included deployment of hourly-recording temperature monitoring devices in selected locations and multi-parameter spot checks in all monitoring locations in both spring and fall.

Water quality monitoring results indicate favorable thermal habitat for summer rearing of juvenile Coho is restricted to the headwaters of the mainstem Mattole upstream of River Mile (RM) 56.3 and a limited number of tributaries.

Introduction

The Mattole River is home to three independent populations of threatened salmonids: Coho Salmon, Chinook Salmon and Steelhead Trout.

The Mattole Coho Salmon (*Oncorhynchus kisutch)* population is part of the Southern Oregon/Northern California Coast (SONCC) Coho Salmon Evolutionarily Significant Unit (ESU), composed of populations inhabiting coastal streams between Punta Gorda, California to Cape Blanco, Oregon (70 FR 37160).

The Chinook Salmon population of the Mattole is part of the California Coastal Chinook Salmon ESU, composed of populations inhabiting coastal streams from Redwood Creek in Humboldt County south through the Russian River (70 FR 52488).

Mattole Steelhead Trout are part of the Northern California Steelhead Distinct Population Segment (DPS), composed of populations inhabiting coastal streams from Redwood Creek in Humboldt County south through the Gualala River (70 FR 52488)

National Oceanic and Atmospheric Administration National Marine Fisheries Service (NMFS) listed the SONCC Coho Salmon ESU, CC Chinook Salmon ESU, and NC Steelhead Trout DPS as Threatened under the Federal Endangered Species Act (ESA) in 1997, 1999, and 2000, respectively (70 FR 37160, 64 FR 50394, 65 FR 36074). Coho Salmon are also listed as Endangered under the California Endangered Species Act (CESA).

NMFS has completed more recent status reviews (Good et al. 2005, 71 FR 834 862) and concluded that all 3 ESUs are likely to become Endangered in the near future. However, the most recent status review of SONCC Coho and CC Chinook (76 FR 50447), released on August 15, 2011, concluded both populations should remain listed threatened as previously determined at this time.

Excessively high summertime water temperatures in the Mattole have been identified as a primary limiting factor in the survival of native anadromous fish stocks (Downie et al. 2002, Coates et al. 2002). Temperature is one of the most important environmental influences on salmonid biology. Salmon and Steelhead, like most aquatic organisms, are poikilotherms, meaning their temperature and metabolism are determined by the ambient temperature of the water in which they reside. Temperature therefore affects growth and feeding rates, metabolism, development of embryos and alevins, timing of life history events such as upstream migration, spawning, freshwater rearing, emigration to the ocean, and the availability of food. In addition, changes in temperature can cause stress, and even death in extreme cases (Ligon et al. 1999).

Juvenile Coho Salmon and Steelhead are vulnerable to increased instream temperatures as they rear in freshwater over the summer and fall months. Of the three Mattole salmonid species, Coho Salmon are acknowledged to be the most imperiled, in part due to their extended freshwater rearing strategy and greater sensitivity to high instream temperatures. Steelhead can tolerate warmer water temperatures than Coho (Frissell 1992), however, some Steelhead remain in freshwater for up to three years, resulting in a longer duration exposed to thermal stressors.

Figure 1 lists threshold temperature criteria used by the Mattole Salmon Group in this report to evaluate suitable thermal habitat at monitoring locations throughout the watershed. Criteria used to evaluate thermal habitat suitability for salmonids must consider both lethal exposure to high temperatures as well as the effects of stress and reduced growth capacity during prolonged exposure to elevated yet sub-lethal temperatures (Armour 1991).

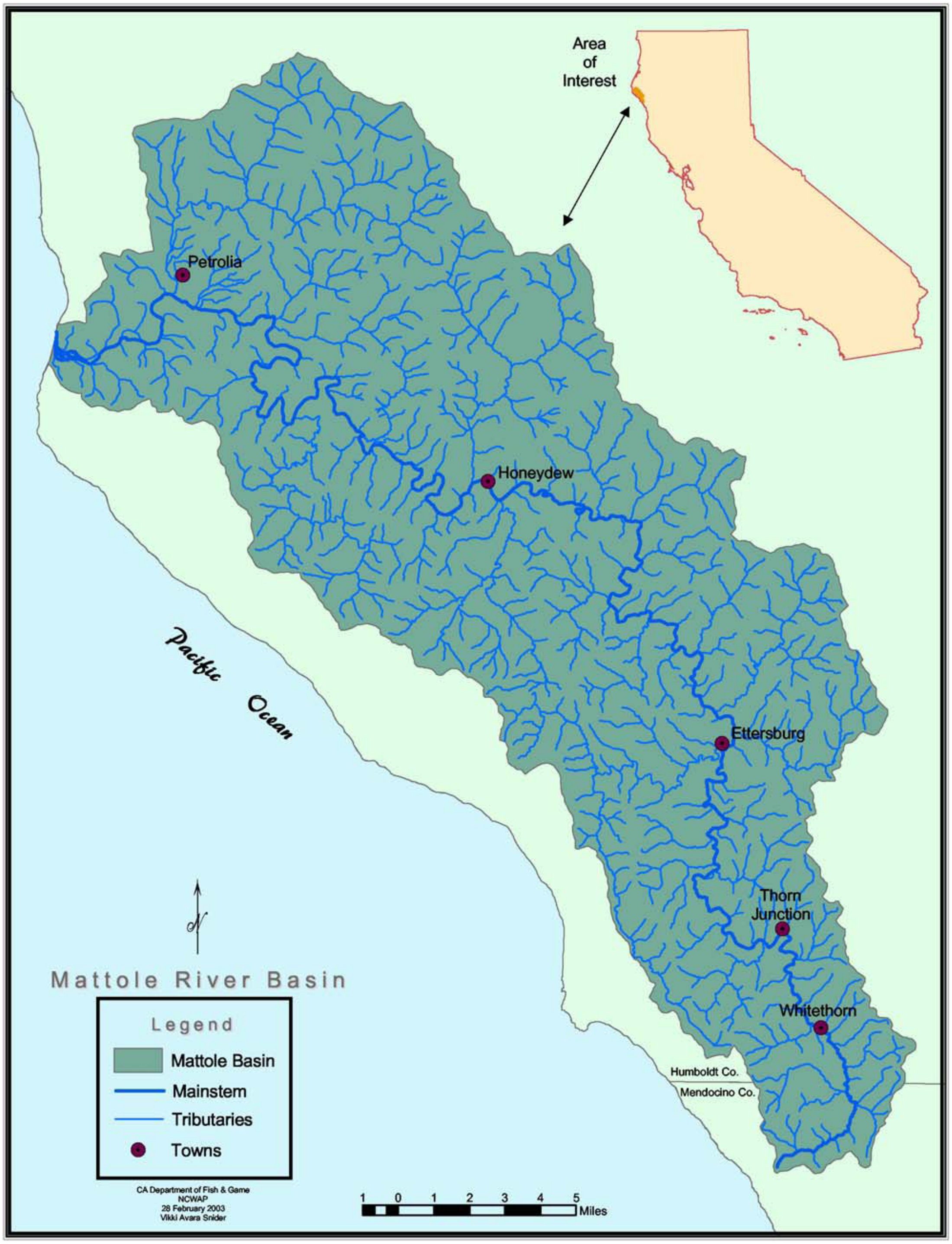
Criteria	Temperature	Reference
Prolonged Temperature Stress	Days >20°C	Brett 1952
Growth Stops	19.1°C	Armour 1991
Growth Occurs	5-17°C	Brungs and Jones 1977
Optimum Growth	12-14°C	Brett 1952
	10-15.6°C	Armour 1991
Maximum Weekly Maximum Temperature (MWMT)	>18.1°C MWMT (Coho)	Welsh et al. 2001
Maximum Weekly Average Temperature (MWAT)	>16.8°C MWAT (Coho)	Welsh et al. 2001
UILT*	26°C (Coho)	Brett 1952
Short-term Maximum Temperature (50% survival)	23.7°C (Coho) 23.9°C (Steelhead)	Brungs and Jones 1977

*upper incipient lethal temperature

Figure 1. Criteria used to evaluate thermal habitat for salmonids in the Mattole River.

The Mattole Salmon Group has conducted temperature monitoring throughout the Mattole River Watershed (Figure 2) annually since 1995 and dissolved oxygen monitoring since 2003, with concurrent dive surveys. Dive surveys have documented juvenile presence and distribution since 1991. Dive surveys have generally occurred in late spring/early summer (May-June) and early fall (September-October) using a “modified 10 pool protocol” (Preston et al. 2002).

The goal of our long-term juvenile salmonid population and habitat monitoring program is to quantify distribution and relative abundance of juvenile salmonids in relation to available suitable habitat during non-winter months. Here we analyze water quality and dive data collected in 2011 in relation to threshold values for salmonids as well as data collected over prior survey years.



Downie et al. 2003

Figure 2. Mattole River Watershed.

We use maximum weekly average temperature (MWAT) to evaluate chronic thermal stress. MWAT is the maximum value of the running 7-day average of the daily average temperatures over a defined period of time. In other words, MWAT is the single highest mean of daily average temperatures over any 7-day period during the study (Brungs and Jones 1977). Welsh et al. (2001) conducted a study of Coho distribution in relation to temperature in the Mattole and found MWAT of 16.8°C or less as a reliable indicator of Coho presence. We use this value to evaluate thermal habitat suitability for Coho.

Daily maximum temperatures are used to evaluate acute thermal stress and duration of temperature stress (days >20°C). Laboratory studies found an upper incipient lethal temperature (UILT) of 26°C for juvenile Coho and Chinook Salmon, although they showed indications of thermal stress at much lower temperatures (>20°C; Brett 1952). Brungs and Jones (1977) found survival was reduced by 50% at temperatures above 23.7-23.9°C.

Low flows in the headwaters have been determined to be the primary factor limiting oversummer survival of juvenile Coho at their current distribution (MRRP 2011). Seven of the last 11 years (through 2011) have had the lowest flows of the past 61 years on record at the USGS Petrolia gauge (Tasha McKee, personal communication, January 15, 2012). In the recent seven dry years, extreme low flows have caused the upper 9.4 miles of the mainstem Mattole as well as several tributaries to become disconnected, with some pools drying completely. Substandard water quality, mainly low dissolved oxygen, in remaining pools further limits survival and fitness of salmonids rearing in the headwaters.

Dissolved oxygen (DO) is an important requirement of water quality for salmonid habitat because it is a key factor affecting the growth and survival of aquatic organisms (Bjornn and Reiser 1991). Low DO levels cause metabolic stress for juvenile salmonids and increase their susceptibility to disease.

Minimum daily DO levels below 6 mg/L can result in slight production impairment to rearing salmonids (US EPA 1986, SWRCB 2002). Oxygen distress causes severe production impairment at DO levels below 4 mg/L (USEPA 1986), acutely impacting growth. Bjornn and Reiser (1991) recognized 3.3 mg/L as the minimum threshold for survival for salmonids. While some salmonids have been known to survive in waters with DO below 3 mg/L (SWRCB 2002), diminished fitness reduces chances for long-term survival.

Existing information on impacts of other water quality factors upon salmonid populations in the Mattole are largely unknown. To ameliorate this, spot-checks using a multi-parameter water quality instrument were conducted during 2009-2011 monitoring. Specific conductance, pH, and DO were the parameters measured, which are known to affect salmonid life.

PH is the measure of the acidity or alkalinity of a solution, and is determined by the molar concentration of hydrogen ions. Instream pH is important for development of adult and juvenile salmonids. Low pH can affect reproductive success for adults and reduce survival during early life stages (Jordahl and Benson 1987). High pH levels can negatively impact feeding and create stress (Wagner et al. 1997), as well as lead to ammonia toxicity if conditions warrant (Piper et al. 1982). An increase in pH by one unit alone may increase the fraction of unionized ammonia (NH_3) ten-fold (Piper et al. 1982). High instream temperature can also exacerbate the effects of high pH on salmonid life (Wagner et al. 1997), and extremes in pH can cause mortality (Wagner et al. 1997). The MSG uses the pH range of 6.5 to 8.5 to evaluate acceptable salmonid habitat (Kier & Associates and NMFS 2008, Spence et al 1996, NCRWQCB 2001).

Specific conductance is a measure of electrical conductivity of an aqueous solution, corrected to the resistance of the solution at 25°C. Specific conductance is related to the concentration of dissolved solids. The breakdown of compounds results in an increased amount of unbound ions, which are positively or negatively charged when dissolved in water. Conductivity increases with increasing amount of unbound ions, so it is an indirect measure of the presence of dissolved solids such as chloride, nitrate, sulfate, phosphate, sodium, magnesium, calcium, and iron. Conductivity can be used as an indirect indicator of water pollution, as an increase in dissolved solids will elevate conductivity levels. Here we use NCRWQCB specific conductance objectives for the Mattole, which are 300 μs/cm (0.30 mS/cm) for a 90% upper limit and 170 μS/cm (0.17 mS/cm) for a 50% upper limit, for evaluation purposes (NCRWQCB 2001).

Project Goals

Each water quality monitoring site in the Mattole watershed was chosen according to its ability to meet one or more of the following goals identified by Mattole Salmon Group staff:

1. Monitor air and water temperature at reference locations to evaluate changes in thermal regime from year to year and over longer time frames.
2. Document geographic distribution of suitable thermal habitat.
3. Document temperatures prior to and/or subsequent to road improvement work and/or timber harvest in specific locations.
4. Help determine where instream restoration and revegetation projects are best directed, and assess the effects of restoration activities.
5. Monitor temperature, dissolved oxygen, and other water quality parameters at low-flow monitoring locations in the headwaters.
6. Monitor temperatures in conjunction with downstream migrant trapping in the lower Mattole River and water quality monitoring in the Mattole Estuary.
7. Monitor Coho-bearing tributaries to determine current salmonid distribution in relation to temperature and other water quality parameters.

Procedures

In 2011, the MSG monitored all tributaries in the Mattole Watershed (Figure 3) with Coho presence since 2002 to determine current distribution in relation to temperature and other water quality parameters. Determination of Coho-bearing tributaries was based on data compilation efforts completed for the *Mattole Coho Recovery Strategy* (MRRP 2011). In spring, upper and lower reaches were monitored to evaluate habitat in multiple locations within each monitored tributary, while nearly all fall surveys were limited to lower reaches due to funding constraints. Temperature, water quality, and salmonid presence were also monitored at selected mainstem locations.

Additional locations were monitored for restoration project effectiveness. These locations included two instream restoration project sites in the Mattole estuary (MSG installation in 2010) and one at the confluence of Stansberry Creek (RM 1.3; MSG installation 2009). Monitoring also occurred in conjunction with 2011 sediment reduction work conducted by the Mattole Restoration Council in the Upper North Fork (RM 25.5) drainage.

Monitoring consisted of placing a temperature monitoring device for the duration of the summer, water-quality spot-checks to measure additional parameters affecting habitat suitability, and snorkel surveys to determine salmonid presence/absence (Table 1). GPS coordinates were recorded at temperature monitoring locations and the start and end of dive reaches.

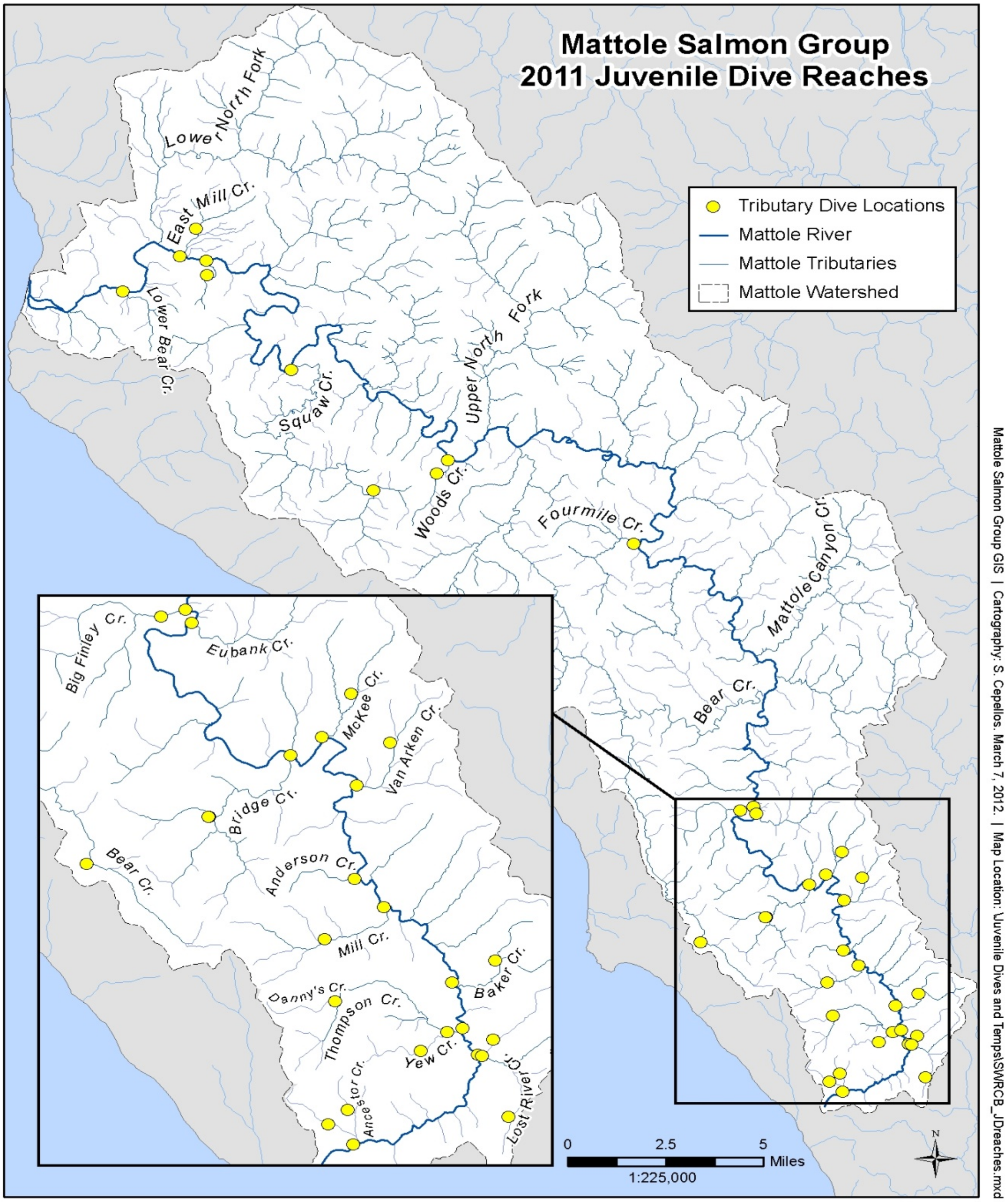
Temperature Data Collection

Temperature monitoring devices (Hobo Water Temp Pro data loggers, herein referred to as “loggers”) were deployed to provide an hourly record of temperature at monitoring locations throughout the season.

All temperature data is subject to a verification process. Prior and subsequent to placement in the field, the MSG verified the accuracy of all loggers with a two-point calibration method using a NIST-traceable thermometer. Methods follow the U.S. Fish and Wildlife Service (USFWS) Water Temperature Data Collection Methods (Zedonis and Scheiff 2009). Loggers that deviated from the acceptable range (+/- 0.2°C) during pre-calibration were not placed in the field.

The temperature loggers were launched to record hourly temperature for the duration of the field season. Surveyors placed water temperature loggers in or near the thalweg, where water turbulence and mixing was greatest, and at sufficient depth (greater than one foot if possible) to prevent exposure at low flows. Typically, suitable sites were located in runs or heads of pools. Loggers were also placed out of direct sunlight so as to avoid artificially high temperatures resulting from direct solar heating of the device. A description of general and precise placement location of logger, placement depth of logger, depth of logger upon retrieval, and maximum pool depth at placement location were recorded. Surveyors took air temperature at the beginning of the survey using a calibrated hand-held thermometer and noted current and recent weather. Using the float method, surveyors estimated instream flow at each site in spring and fall.

Following retrieval, data was downloaded from the devices and analyzed. Data that deviated from the acceptable accuracy range were discarded. Erroneous data, such as data recorded while loggers were in transit, were deleted as well. Maximum and average daily statistics were calculated from the trimmed files for data analysis.



Mattole Salmon Group GIS | Cartography: S. Cepellos, March 7, 2012. | Map Location: \Juvenile Dives and Temps\SWRCB_JDreaches.mxd

Figure 3. Tributaries & tributary reaches monitored for juvenile Coho Salmon presence/absence in the Mattole River Watershed, 2011 Mattole Salmon Group monitoring.

Water Quality Data Collection

Using a YSI Multi Parameter Instrument (556 MPS or Pro-Plus), surveyors recorded water quality at temperature monitoring locations. The multi-parameter instrument measures temperature (˚C), dissolved oxygen (mg/L), dissolved oxygen (% saturation), pH, specific conductivity (mS/cm), and barometric pressure (mmHg).

Instruments were calibrated according to the manufacturer's specification prior to the field season. Calibration occurred monthly during the monitoring season, or more often, if the probes exhibited signs of inaccuracy, such as difficulty stabilizing, or obviously inaccurate values.

Snorkel Survey Methods

A snorkel survey was conducted at each monitoring location at the time of temperature logger placement and retrieval to identify salmonid species present and determine relative abundance. Salmonid observations were recorded in the following size classes based on estimated fork length, >4" (young-of-the-year), 4"-8" (1+, greater than one year old), and >8."

Surveyors dove in teams of two people. As the flows dropped and the pool size decreased, in some cases only a single diver performed the survey. Surveyors used underwater flashlights to increase visibility below undercut banks, bedrock, and into thick aquatic vegetation.

Our snorkel surveys followed a "modified 10-pool protocol" for determining presence/absence of juvenile Coho Salmon, as employed by the California Department of Fish and Game (Preston et al. 2002).

The scope of the MSG's snorkel surveys was limited by project funding and, in some streams, by lack of access points. It was unfeasible to survey reaches in the lower, middle, and upper areas of a stream given project resources, and in some cases, stream access. In 2009, only lower reaches were surveyed in each tributary. In 2010, in an effort to more comprehensively and confidently determine actual Coho presence by tributary, surveys included upper and lower reaches. In 2011, both upper and lower reaches of selected tributaries were surveyed in the late spring, but only the lower reaches were surveyed in the fall due to funding constraints. One exception was the upper reaches of the Thompson Creek drainage, which were surveyed in both spring and fall due to the relative abundance of juvenile Coho in those locations and their importance as Coho rearing habitat. Given that in actuality fewer reaches are sampled per stream than designated in the modified 10-pool protocol cited previously (one less reach per tributary), determination of species absence in a stream is less certain.

Another way the Mattole Salmon Group's snorkel surveys differed from a standard modified 10-pool protocol is that when a Coho Salmon was sighted, the survey continued until 10 pools (or the maximum number of pools possible if less than 10) were surveyed. This allowed for a broader sampling of relative abundance.

In 2011, an evaluation of an alternative dive survey protocol was conducted. The Webster and Pollock (2005) dive survey protocol for detecting rare species was field-tested. Feasibility, logistics, and results were assessed and compared to the modified 10-pool protocol, as well as measured against availability of trained labor and funding. Low abundance of Coho in the Mattole and lack of juvenile Coho observation in most tributary reaches despite extensive survey efforts using the ten pool protocol prompted the Mattole Salmon Group to believe the Webster and Pollock protocol is better suited to detecting juvenile Coho presence at current abundance due to the greater area covered (i.e. more intensive survey effort per stream/tributary).

Both the Webster and Pollock (2005) protocol and the modified 10-pool protocol were conducted in Ancestor Creek (RM 60.8) and McKee Creek (RM 52.8) at the same time in each tributary. This was done to compare the likelihood of Coho detection using the two different methods. The two tributaries were selected based on the encompassing ranges they represent in terms habitat features, length, and likelihood of Coho presence, which characterize Mattole headwaters tributaries. Ancestor Creek was chosen due to the high percentage of the drainage within conservation land usage, few water withdrawals, dependable summer flow, good riparian cover, and consistent Coho presence over the past three years. McKee Creek was chosen due to known low-flow issues and water withdrawals, favorable intrinsic potential, and mid-range possibility for Coho presence (based on an adult observation the preceding winter and inconsistent presence since 2002).

Results

Temperature

Temperature monitoring indicates thermally suitable rearing habitat is concentrated in the upper mainstem and headwaters tributaries, with a limited number of lower river tributaries also indicating favorable temperatures for juvenile salmonid rearing.

In 2011, the highest daily maximum temperature recorded at any site was 25.84°C in the mainstem Mattole at the Petrolia Bridge (RM 5.3) on 8/23/11. This was followed closely by a maximum of 25.82°C recorded in the upper Estuary (Snorkel Survey Area #6) on 10/1/11. The site with the coolest maximum daily temperature (14.05°C) of 2011 was Ancestor Creek (RM 60.8+0.15; Table 1).

The highest seasonal daily maximum temperature in 2011 was cooler than those recorded in 2009 (28.79°C in the Mattole upstream of Sholes Creek (RM 36.6)) and

2010 (26.72°C in the Mattole upstream of Squaw Creek (RM 15.0)). The lower seasonal maximum of 2011 is likely attributable to site selection. Fewer mainstem locations were monitored in 2011 in comparison with 2009 and 2010, especially in the lower and middle mainstem, where temperatures tend to be the warmest.

Temperatures recorded in 2011 were similar to those recorded in 2010; both seasonal maximum daily temperature and MWAT at sites monitored during both years were within 1°C. This general trend of cooler instream temperatures in both 2011 and 2010 in comparison with 2009 coincided with unusually late spring rains in the most recent two years.

Of 19 temperature monitoring locations/reaches in Mattole tributaries monitored in 2011, MWATs greater than the 16.8°C threshold for juvenile Coho Salmon presence occurred in only two locations: the lower reaches of Squaw Creek (RM 14.9) and the Upper North Fork (RM 25.5; Table 1). All monitored tributaries in the headwaters showed thermally suitable temperatures for Coho rearing. Outside of the headwaters, the tributaries with the coolest MWATs were Lower Mill Creek (14.14°C; RM 2.8) and Clear Creek (14.51°C; RM 6.1). These results are not surprising. In 2011, site selection was primarily based on Coho presence since 2002 (with the exception of the Upper North Fork). Given that 16.8°C is the thermal threshold for Coho presence (Welsh et al. 2001), selecting tributary monitoring locations based on Coho presence predisposes results to temperatures below that threshold. Temperature monitoring since 2002 has demonstrated relatively stable thermal habitat in Coho bearing tributaries in that time period, and 2011 results add to the data and conclusions found in these previous years that show Coho presence in the past decade is strongly correlated with suitable temperatures.

Table 1. 2011 Temperature Monitoring Summary

Serial #	Location	River Mile	GPS Point	Date In	Staff	Spring Species Present	Date Out	Staff	Fall Species Present	Max	Date	>20	Total # of Days	MWAT	Week of	Notes
1163381	Estuary, Area 2	~0.5	N40°17'42.2" W124°21'05.7"	6/29	KC, MH	SH, KS	10/10	KC, SA, DW	SH	24.39	8/25	79	102	21.26	7/21	Spring Dive 6/30/11, Fall Dive 9/29/11
1157767	Estuary, Area 3, Structure #2 (water)	~0.5	N40°17'39.4" W124°21'01.7"	6/29	KC, MH	SH, KS	10/10	KC, SA, DW	SH	24.68	8/25	80	102	21.24	7/22	"
1157773	Estuary, Area 3, Structure #2 (air)	~0.5	N40°17'39.3" W124°21'01.8"	6/29	KC, MH	"	10/10	KC, SA, DW	"	29.02	9/2	74	102	18.01	9/26	estuary air logger observed underwater during sonde calibration (fall)
9748561	Estuary, Area 4	~0.75	N40°17'31.7" W124°20'45.4"	6/29	KC, MH	SH, KS	11/15	SA, DW	SH	24.63	7/21	89	138	21.24	7/22	Spring Dive 6/30/11, Fall Dive 9/29/11
9663031	Estuary, Structure #5, deep	~0.8	N40°17'32.0" W124°20'48.4"	6/29	KC, MH	None	10/10	KC, DW	SH	23.59	7/3	42	102	20.61	9/2	Spring Dive 6/30/11, Fall Dive 9/29/11
9748562	Estuary, Structure #5, shallow	~0.8	N40°17'32.2" W124°20'48.4"	6/29	KC, MH	None	10/10	KC, DW	SH	23.91	7/5	52	102	20.42	7/3	Spring Dive 6/30/11, Fall Dive 9/29/11
9748567	Estuary, Structure #6, deep	~0.9	N40°17'31.8" W124°20'45.6"	6/29	KC, MH	SH, KS	10/10	KC, DW	SH	24.46	7/21	85	102	21.15	7/22	Spring Dive 6/30/11, Fall Dive 9/29/11
9663022	Estuary, Structure #6, shallow	~0.9	N40°17'31.8" W124°20'45.6"	6/29	KC, MH	SH, KS	10/10	KC, SA, DW	SH	24.51	7/21	88	102	21.16	7/22	Spring Dive 6/30/11, Fall Dive 9/29/11
1163386	Estuary, Section 6	~1.0	N40°17'32.4" W124°20'11.3"	6/30	KC, MH	SH, KS	10/10	KC, DH, SA	SH	25.82	10/1	83	101	21.28	7/21	Spring Dive 6/30/11, Fall Dive 9/29/11

9748570	Mattole @ Stansberry deep	1.3	N40°17'27.4" W124°19'48.6"	6/30	KC, MH	None	10/10	KC, DH, SA	N/A	17.70	8/25	0	102	14.81	8/9	
1157769	Mattole @ Stansberry shallow	1.3	N40°17'27.4" W124°19'48.6"	6/30	KC, MH	None	10/10	KC, DH, SA	N/A	19.75	9/19	0	102	15.87	9/19	
9663026	Mattole ds Stansberry Confluence LB	1.2	N40°17'26.9" W124°19'49.5"	6/30	KC, MH	None	10/10	KC, DH, SA	N/A	21.32	7/3	15	102	18.50	7/1	
9663025	Lower Mill Creek (lower)	2.8+0.1	10T 0388966 4461440	5/23	AH, SA	SH	10/14	AH, MH	SH	15.22	8/25	0	143	14.14	8/23	
1157762	Mattole @ Wingdam (deep)	2.9	N40°17'51.2" W124°18'17.4"	6/20	SA, MH	SH, KS	10/9	SA, KM	None	25.14	7/7	71	110	21.49	7/22	
9748566	Mattole @ DSMT		N40 17'55.7" W124 18' 36.1"	5/11	AP	N/A	8/2	AP	N/A	25.50	7/27	51	82	21.72	7/22	SH, KS, SS in DSMT
1163384	Mattole @ Hideaway Bridge	5.3	N40°18'48" W124°16'56"	6/20	SA, MH	None	10/9	SA, KM	KS	25.84	8/23	100	110	22.13	8/22	2 25" Chinook in pool @ left cement bridge pillar
1163388	Mattole @ Hideaway Bridge (air)	5.3	N40°18'48" W124°16'56"	6/20	SA, MH	"	10/9	SA, KM	"	37.59	9/21	92	100	19.41	9/17	data after 9/28/11 discarded
9748558	East Mill Creek (lower)	5.4+~0.2	N40°18'51.1" W124°16'46.4"	7/5	MH, DH	SH	10/14	MH	SH	17.34	8/25	0	100	15.45	8/23	
1157756	Clear Creek (lower)	6.1+0.2	N40°18'37.3" W124°16'4.3"	7/7	MH, DH	SH	10/9	SA, KM	SH	15.56	8/25	0	93	14.51	8/23	
1000293	Squaw Creek (lower)	14.9+0.1	10T 0395929 4458088	5/24	AH	SH	10/14	AH, MH	SH	20.63	7/5	9	142	18.53	8/23	
2334524	Upper North Fork	25.5 +~1.0	N40°16'18.93" W124°07'50.0"	6/27	MH, WK	SH	10/13	KM, AH	None	21.92	7/6	48	107	18.79	8/23	Fall survey after first rains
1163383	Mattole ds Ettersburg Bridge	~42.0	N40°08'24.7" W123°59'28.6"	6/17	KC	SH	10/11	KC, DW	SH	23.69	8/28	70	115	20.49	8/23	>8" SH was 12"
9748556	Mattole ds Ettersburg Bridge (air)	~42.0	N40°08'24.7" W123°59'28.6"	6/17	KC	"	10/11	KC, DW	"	31.97	6/21	96	115	20.43	8/22	

1157775	Big Finley Creek (lower)	47.4+ ~0.1	N40°05'24.0" W124°00'05.0"	5/24	MH, DH	SH, KS	10/12	MH, DW	SH, SS	15.94	7/29	0	140	14.80	7/27	
9748569	Big Finley Creek (upper)	47.4+ ~0.75	N40°05'19.4" W123°00'31.4"	5/24	MH, DH	SH	10/12	MH, DW	SH	15.56	7/29	0	140	14.63	7/27	
9663021	Mattole @ Big Finley Creek (deep)	47.4	N40°05'23.1" W124°00'02.3"	5/24	MH, DH	None	10/12	MH, DW	None	20.65	7/29	8	140	18.50	7/27	
9748563	Eubanks Creek (lower)	47.7 +0.1	N40°05'11.9" W123°59'52.0"	5/24	DH, MH	SH	10/12	MH, DW	SH	16.89	7/29	0	124	15.22	7/27	Data discarded after 9/25 - logger out of water
1157774	Bridge Creek (lower)	52.1+ ~0.2	N40°03'30.6" W123°58'26.2"	5/23	DH, MH	SH, KS, SS	10/11	SA, MH	SH, SS	17.03	8/28	0	140	15.09	8/5	
2334526	MS-6, Mattole us Bridge	52.2	N40°03'27.4" W123°58'23.3"	5/23	DH, MH	SH, UN	10/11	SA, MH	SH	19.53	8/6	0	140	17.62	8/5	
9663027	Van Arken Creek (lower)	54.0+ 0.1	N40°03'06.0" W123°57'23.7"	5/23	DH, MH	SH	10/11	MH, SA	SH	16.11	8/6	0	140	15.09	8/5	
1163389	Upper Mill Creek (lower)	56.2+ 0.1	10T 0419183 4430783	8/19	KC, NQ	SH	10/12	KC, DW		15.75	8/28	0	53	14.66	8/24	Spring dive survey on 5/26/11; logger placement in August may not represent seasonal max
1157764	Upper Mill Creek (lower) (air)	56.2+ 0.2	10T 0419159 4430670	8/19	KC, NQ	"	10/12	KC, DW	"	19.65	8/28	0	53	15.40	8/23	logger placement in August may not represent seasonal max
1157765	Mattole us Upper Mill Creek	56.3	10 T 0419180 4430824	8/19	KC, NQ		10/12	KC, DW		16.68	8/26	0	53	15.81	8/23	logger placement in August

																may not represent seasonal max
2334530	Baker Creek (lower)	57.6+ ~0.1	N40°00'32.1" W123°55'47.6"	6/17	MH, KC	SH	10/11	KC, DW	SH	16.18	8/5	0	115	14.87	8/4	
2334525	Thompson Creek (lower)	58.4+ ~0.1	N39°59'53.6" W123°55'47.0"	5/26	KC, SA	SH, SS	10/12	KC, SA	SH, SS	17.15	8/6	0	138	15.41	8/5	
1163385	Thompson Creek (upper)	58.4+ 2.3	N40°00'16.4" W123°57'39.7"	5/26	JG, KM	SH, SS	10/12	SA, KC	SH, SS	14.96	7/7	0	138	13.88	8/6	
1163387	NF Thompson (Danny's) Creek	58.4+ 2.2	N40°00'15.3" W123°57'37.7"	5/26	KM, JG	SH, SS	10/12	KC, SA	SH, SS	15.01	8/28	0	138	14.01	8/24	
1163382	Yew Creek (lower)	58.4+ 0.15+ 0.1	N39°59'52.8" W123°55'53.3"	6/16	MH, KC	SH	10/12	KC, SA	SH	16.25	8/26	0	117	14.77	8/4	
1157761	Helen Barnum Creek (lower)	58.7+ 0.01	N39°59'34.9" W123°55'24.7"	5/25	MH, DH	None	10/11	SA, MH	SH	14.05	7/7	0	138	13.65	8/6	
9748564	Lost River (lower)	58.8+ ~0.1	N39°59'33.1" W123°55'24.7"	5/25	MH, DH	SH	10/11	MH, SA	None	15.44	8/6	0	138	14.56	8/5	
1157766	MS-2/Mattole us Lost River	58.9	N39°59'34.3" W123°55'26.9"	5/26	MH, DH	SH	10/12	KC, DH, SA	SH, SS	16.25	8/28	0	138	15.15	8/24	
1157760	MS-2/Mattole us Lost River (air)	58.9	N39°59'30.4" W123°55'26.3"	5/25	KC, DH, SA	"	10/11	KC, DH, SA	"	20.37	9/9	2	138	15.17	8/23	
2334529	Ancestor Creek (lower)	60.8+ 0.15	N30°58'50.8" W123°57'24.7"	6/15	KC, MH	SH, SS	10/11	KC, DW	SH, SS	14.05	7/27	0	117	13.26	8/6	
9663024	Mattole ds Ancestor Creek	60.8	N30°58'23.7" W123°57'18.7"	6/15	KC, MH	SH, SS	10/11	KC, DW	SH, SS	14.24	8/18	0	117	13.47	8/24	

Water Quality Spot-Checks

Dissolved Oxygen

Spot-checks of dissolved oxygen (DO) in spring and fall of 2011 showed DO levels were favorable in comparison to results of DO monitoring since 2002. 2011 DO levels recorded at spot checks ranged from a maximum of 12.06 mg/L (Thompson Creek, RM 58.4 +0.15) to a minimum of 6.32 mg/L in the mainstem Mattole at Stansberry Creek (RM 1.3) in the spring (Figure 4, Table 2). Fall DO levels in 2011 varied from a maximum of 11.22 mg/L in Bridge Creek (RM 52.1 +0.1) to a minimum of 7.77 mg/L in the mainstem Mattole at Stansberry Creek (RM 1.3). For both spring and fall, all DO spot checks showed levels above the 6.0 mg/L slight impairment threshold, indicating suitable habitat for juvenile salmonids in regard to DO (Figure 3, Table 2).

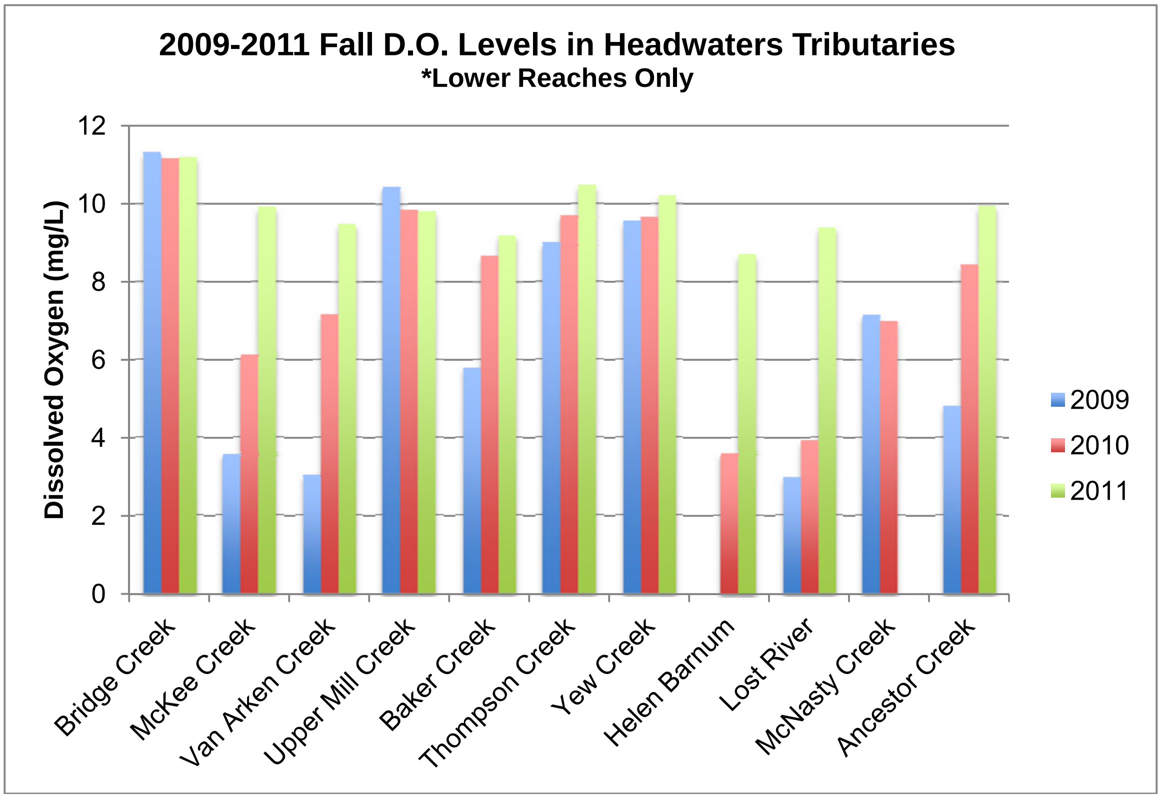


Figure 4. Dissolved oxygen levels in Mattole River tributaries recorded during 2009-2011 fall water quality spot-checks, Mattole Salmon Group**.**

Past DO monitoring in the Mattole, however, has shown lower levels of DO, especially in conjunction with low flows. The 2009 monitoring season was characterized by low flows, with some sections of the mainstem and headwaters tributaries becoming disconnected. Results of 2009 water quality spot-checks indicated fall DO levels were low enough to cause severe production impairment for salmonids in three of 10 tributaries monitored (<4 mg/L; Figure 4) in the fall. Two additional tributaries and one mainstem location also indicated slight production impairment (< 6 mg/L) in the fall (Figure 4).

The correlation of low flows with low DO levels is indirectly suggested by the results of 2011 DO monitoring: the late spring rains in spring of 2011 and relatively cool summer corresponded to higher flows. As a result, no locations with substandard DO were observed in the headwaters (Figure 4), which is in contrast to past survey years.

2010 was another year characterized by late spring rains and relatively high summer flows. While 2010 DO recordings were high relative to the extreme low flow years, they were not as favorable as those recorded in 2011. In 2010, fall DO levels below 4 mg/L occurred in 2 of 11 tributaries monitored in the headwaters, indicating severe production impairment. An additional monitoring location in one of these two tributaries indicated slight production impairment (<6 mg/L).

The difference in DO levels in 2011, 2010, and 2009 may also be a partial result of survey timing. 2010 and 2011 fall surveys were completed following the first fall rains, which came early relative to the past five years (mid-September versus mid- to late-October). Thus, DO levels recorded during fall surveys in 2010 and 2011 represent conditions following the first fall rains, and not the driest part of the low flow season, as captured by fall surveys in previous years.

pH

pH levels recorded in spring of 2011 showed wide variability, which may be the result of a faulty pH probe, despite frequent calibration. Spring pH recordings ranged from 4.01 to 13.66, with 14 instances of pH above 8.5, the upper threshold for salmonids, and 3 instances of pH below 6.5, the lower threshold for salmonids (Kier and Associates and NMFS 2008, Spence et al 1996, NCRWQCB 2001; Table 2).

In an attempt to address this issue, we obtained a new pH probe for the YSI ProPlus prior to the fall field season and used tablet-based water quality test kits to substantiate results. Fall pH readings varied from 6.68 to 10.4 in 2011. No readings below the lower threshold for salmonids (6.5) were recorded with the new probe in fall. Six instances of pH above 8.5, the upper threshold for salmonids, did occur in the fall, however: two locations in the upper mainstem Mattole (RM 47.4 and RM 58.8), and in Lower Mill Creek (RM 2.8), Squaw Creek (RM 14.9), and Big Finley Creek (RM 47.4).

Despite difficulties maintaining the pH probe over the past two survey years, the number of instances of high pH – especially following the installation of a new probe – leads to the conclusion that pH, and high pH in particular, may signify the existence of pollution affecting salmonid habitat in the Mattole.

Specific Conductivity

Specific conductance values recorded at 2011 spot-checks ranged from 0.066 to 2.53 mS/cm (Table 2).

The NCRWQCB conductivity objectives for the Mattole are 300 µs/cm (0.30 ms/cm) for a 90% upper limit and 170 µs/cm (0.170 ms/cm) for a 50% upper limit (NCRWQCB 2001). The 50% upper limit means 50% or more of the monthly means must not exceed the upper limit in a calendar year. The 90% upper limit means 90% or more of the values in a calendar year must be less than the objective. Water quality monitoring spot-checks are insufficient to determine if the objective was met throughout the year.

Specific conductance readings throughout the watershed do elucidate general trends. Estuarine readings were high relative to other sites due to the influence of salinity from the ocean. Specific conductance values recorded in all mainstem and tributary locations upstream of RM 47.4 and in South Fork Bear Creek were well below target specific conductance values, although it should be emphasized that these values are the results of spot-checks and may not be reflective of conditions over an entire season. The maximum specific conductance level of 2.53 mS/cm was recorded in the lower river at the Wingdam (RM 2.9) following the onset of fall rains. Specific conductance values recorded were higher in general in fall than in spring, showing the influence of sediment following the onset of fall rains. Higher specific conductance measurements also corresponded to monitoring locations in the lower river and lower tributaries, which is consistent with the greater impact of sediment found in the Mattole downstream of the headwaters.

Table 2. 2011 Water Quality Spot-Check Data Summary

Location	GPS Location	Spring Date	Water Temp ©	DO (mg/L)	pH	Sp. Cond.	mmHg	Instru-ment	Fall Date	Water Temp ©	DO (mg/L)	pH	Sp. Cond.	mmHg	Instru-ment
Estuary, Area 2	N 40° 17' 42.2" W124° 21' 05.7"	6/29	19.1	9.10	8.35	0.203	763.7	ProPlus	10/10	16.60	8.33	7.96	0.830	758.80	ProPlus
Estuary, Area 3, Structure #2	N 40° 17' 39.3" W124° 21' 01.8"	6/29	19.7	9.62	8.57	0.200	763.5	ProPlus	10/10	16.80	9.66	8.23	0.320	758.7	ProPlus
Estuary, Area 4	N 40° 17' 31.7" W124° 20' 45.4"	6/29	19.2	9.38	8.44	0.202	763.5	ProPlus	10/10	N/A	N/A	N/A	N/A	N/A	ProPlus
Estuary, Structure #5, deep	N 40° 17' 32.0" W124° 20' 48.4"	6/29	19.4	8.99	8.20	0.205	763.6	ProPlus	10/10	16.8	9.73	8.23	0.247	758.8	ProPlus
Estuary, Structure #5, shallow	N 40° 17' 32.2" W124° 20' 48.4"	6/29	19.4	8.99	8.20	0.205	763.6	ProPlus	10/10	16.8	9.73	8.23	0.247	758.8	ProPlus
Estuary, Structure #6, deep	N 40° 17' 31.8" W124° 20' 45.6"	6/29	19.2	9.02	8.42	0.201	763.4	ProPlus	10/10	16.7	9.46	8.17	0.249	758.6	ProPlus
Estuary, Structure #6, shallow	N 40° 17' 31.8" W124° 20' 45.6"	6/29	19.2	9.02	8.42	0.201	763.4	ProPlus	10/10	16.7	9.46	8.17	0.249	758.6	ProPlus
Estuary, Section 6	N 40° 17' 32.4" W124° 20' 11.3"	6/30	19	9.45	8.35	0.2	764.8	ProPlus	10/10	16.6	9.37	8.23	0.248	758.6	ProPlus
Mattole @ Stansberry deep	N 40° 17' 27.4" W124° 19' 48.6"	6/29	15.9	6.32	7.48	0.202	764.6	ProPlus	10/10	16.3	7.77	7.72	0.248	758.7	ProPlus
Mattole @ Stansberry shallow	N 40° 17' 27.4" W124° 19' 48.6"	6/29	15.9	6.32	7.48	0.202	764.6	ProPlus	10/10	16.3	7.77	7.72	0.248	758.7	ProPlus
Mattole @ Stansberry ds	N 40° 17' 26.9" W124° 19' 49.5"	6/29	15.90	8.59	8.03	0.201	764.6	ProPlus	10/10	16.3	7.77	7.72	0.248	758.7	ProPlus
Mattole @ Hideaway Bridge	N 40° 18' 48" W124° 16' 56"	6/20	22.42	9.71	4.01	0.179	758.6	556 MPS	10/9	16.3	9.44	8.38	0.232	767.1	556 MPS
Lower Mill Creek (lower)	N 40° 17' 46.1112" W 124° 18' 23.958"	5/23	10.65	11.14	8.49	0.133	765.4	556 MPS	10/14	12.74	9.72	9.25	0.149	757	556 MPS
Mattole @ Wingdam (deep)	N 40° 17' 51.2" W124° 18' 17.4"	6/20	22.91	8.43	4.19	0.191	758.9	556 MPS	10/9	15.89	8.80	8.08	2.53	762.3	556 MPS
Sulphur Creek (trib to LNF)	N40°20'50.2" W124°10'18.8"	No Spring Survey	N/A	N/A	N/A	N/A	N/A	N/A	10/7	10	N/A	N/A	N/A	N/A	YSI

East Mill Creek (lower)	N 30° 58' 23.7" W 123° 57' 18.7"	7/5	15.4	9.75	7.94	0.212	757.6	ProPlus	10/9	12.77	9.80	7.54	0.193	761.7	556 MPS
East Mill Creek (upper)	N 40° 19' 27.4" W 124° 96' 21.7"	7/11	14.1	8.97	7.81	0.203	757.6	ProPlus	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Clear Creek (lower)	N 40° 18' 40.3" W 124° 96' 03.2"	7/7	14	9.46	8.02	0.162	759.9	ProPlus	10/9	11.89	10.33	7.08	0.17	760.9	556 MPS
Clear Creek (upper)	N/A	5/25	10.8	11.42	N/A	0.138	757.2	556 MPS	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Squaw Creek (lower)	10T 0395929 4458088	5/24	12.82	11.14	10.69	0.192	761.?	556 MPS	10/14	12.23	10.16	9.44	0.243	754.4	556 MPS
Squaw Creek (upper)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Woods Creek (lower)	N40°13'50.6" W124°08'58.2"	6/1	10.6	10.84	8.02	0.0151	756.4	ProPlus	10/18	13.3	9.91	7.81	0.19	753.9	ProPlus
Woods Creek (upper)	N 40°13'30.8" W124°09'16."	6/1	11.0	10.77	8.08	0.147	754.0	ProPlus	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Upper North Fork	N40°6.0'07" W124°7'50.0"	6/27	17.2	9.31	8.34	0.222	746.2	ProPlus	10/13	13	9.59	8.26	0.142	750.1	ProPlus
Rattlesnake Creek (trib to UNF)	N40°17'30.7" W124°06'32.3"	No Spring Survey	N/A	N/A	N/A	N/A	N/A	N/A	10/7	9.8	N/A	N/A	N/A	N/A	N/A
S.F Bear - Hidden Valley	N 40° 02' 02.5" W124° 01' 28.5"	6/17	12.4	10.38	10.93	0.098	713.8	ProPlus	10/18	11.2	9.64	7.56	0.089	719.4	ProPlus
Mattole @ Ettersburg Bridge	N40°08'24.7" W123°59'28.6"	6/17	16.1	9.67	11.15	0.118	743.8	ProPlus	10/11	13.3	10.51	8.05	0.095	749.3	ProPlus
Big Finley Creek (lower)	N40°05'24.0" W124°00'05.0"	5/24	10.2	10.89	7.9	0.111	745.0	ProPlus	10/12	11.81	9.46	9.36	0.131	746.8	556 MPS
Big Finley Creek (upper)	N40°05'19.4" W124°00'31.4"	5/24	10.5	10.72	7.97	0.11	742.9	ProPlus	10/12	11.9	10.29	10.36	104-140	733.4	556 MPS
Mattole @ Big Finley Creek	N 40°05'23.1" W124°00'02.3"	5/24	10.7	9.91	7.7	0.08	745.4	ProPlus	10/12	12.34	9.98	10.25	0.084	747.8	556 MPS
Eubanks Creek (lower)	N40°05'11.9" W123°59'52.0"	5/24	11	8.39	7.72	0.087	744.5	ProPlus	10/12	12.3	10.58	8.33	0.098	744.6	556 MPS
Bridge Creek (lower)	N40°03'30.6" W123°58'26.2"	5/23	10.1	10.31	7.81	0.085	740.0	ProPlus	10/11	12.4	11.22	7.81	0.091	741.1	556 MPS
Bridge Creek (upper)	N40°02'40.7" W123°59'36.1"	5/23	10.1	10.73	7.66	0.087	737.3	ProPlus	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Bridge Creek (WF)	N40°02'40.5" W123°59'36.4"	5/23	9.8	10.73	7.62	0.088	737.1	ProPlus	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Mattole us Bridge Creek (MS-6)	N40°03'27.4" W123°58'23.3"	5/23	10.4	10.68	7.9	0.064	740.6	ProPlus	10/11	12.8	9.21	8.33	0.08	741.4	556 MPS
McKee Creek	N40°03'44.6" W123°57'52.9"	6/16	13.90	11.17	11.81	0.120	734.2	ProPlus	10/18	11.5	9.92	7.46	0.08	737.9	ProPlus
McKee Creek (upper)	N 40° 04' 21.5" W123° 57' 24.7"	6/16	12.0	10.71	12.25	0.105	732.8	ProPlus	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Van Arken Creek	N40°03'06.0" W123°57'23.7"	5/23	9.9	10.56	7.42	0.073	739.5	N/A	10/11	12.22	9.51	6.68	0.075	740.4	556 MPS
Van Arken Creek (upper)	N 40°03'40.6" W 123°56'48.3"	5/23	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Upper Mill Creek (lower)	10T 0419183 4430783	8/19	13.4	9.8	12.34	0.074	733.4	ProPlus	10/12	11.5	9.83	7.82	0.074	737.5	Pro-Plus
Upper Mill Creek (upper)	N 40°01'05.0" W123°57'48.2"	6/17	11.6	10.32	11.3	0.093	730.1	ProPlus	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Mattole us Upper Mill Creek	10 T 0419180 4430824	8/19	14.4	7.18	13.66	0.070	733.5	ProPlus	10/12	12.0	9.98	7.40	0.072	737.6	Pro-Plus
Mattole us Upper Mill Creek us	10 T 0419431 4430686	8/19	14.6	8.23	13.03	0.070	733.3	ProPlus	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Anderson Creek (lower)	N/A	5/24	10.0	10.63	7.41	0.058	737.9	ProPlus	N/A	N/A	N/A	N/A	N/A	N/A	N/A
East Anderson Creek (lower)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Baker Creek (lower)	N40°00'32.1" W123°55'47.6"	6/17	11.4	10.48	11.67	0.099	731.7	ProPlus	10/11	12.7	9.21	7.54	0.086	736.9	ProPlus
Baker Creek (upper)	N 40° 00' 49.9" W123° 55' 10.3"	6/17	11	10.19	11.18	0.107	729.6	ProPlus	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Thompson Creek (lower)	N39°59'53.6" W123°55'47.0"	5/26	9.44	12.06	5.37	0.06	739.5	556 MPS	10/12	11.4	10.47	7.52	0.068	737.1	ProPlus
Thompson Creek (upper)	N 40°00'15.3" W123°57'37.7"	5/26	9.4	8.5	7.04	0.064	735.6	ProPlus	10/12	11.0	9.43	7.07	0.069	735.2	ProPlus
NF Thompson (Danny's) Creek	N 40°00'16.4" W123°57'39.7"	5/26	9.3	9.82	7.46	0.072	735.4	ProPlus	10/12	11.0	10.38	7.24	0.075	735.1	ProPlus
Yew Creek (lower)	N39°59'52.8" W123°55'53.3"	6/16	11.4	10.49	11.99	0.083	731.2	ProPlus	10/12	11.7	10.21	7.49	0.066	736.1	ProPlus
Yew Creek (upper)	N/A	5/26	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Helen Barnum Creek (lower)	N39°59'34.9" W123°55'24.7"	5/25	9.40	9.21	7.02	0.064	732.6	ProPlus	10/11	12.4	8.70	8.15	0.079	737.3	556 MPS

Helen Barnum Creek (upper)	N/A	5/25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Lost River (lower)	N39°59'33.1" W123°55'24.7"	5/25	9.5	10.44	7.36	0.057	733.2	ProPlus	10/11	12.56	9.40	8.24	0.058-0.072	737.3	556 MPS
Lost River (upper)	N/A	6/15	11.0	8.87	7.16	0.064	730.1	ProPlus	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Lost River (West Fork)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
MS-2	N 39°59'34.3" W123°55'26.9"	5/25	9.5	8.62	7.37	0.065	733.6	ProPlus	10/11	12.79	9.41	8.88	0.7	737.2	ProPlus
McNasty Creek	N 39°58'39.2" W123°57'42.1"	6/16	11.7	9.09	9.88	0.079	725.2	ProPlus	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Ancestor Creek (lower)	N 39°58'25.3" W123°57'18.6"	6/15	11.7	9.49	7.16	0.071	728.8	ProPlus	10/11	12.3	9.96	7.31	0.075	733.2	ProPlus
Mattole ds Ancestor Creek	N 30° 58' 23.7" W123° 57' 18.7"	6/15	11.9	9.47	7.22	0.073	728.7	ProPlus	10/12	12.3	9.92	7.1	0.067	733.4	ProPlus

Dive Survey Observations

Coho Salmon

In 2011, 188 observations of juvenile Coho Salmon were recorded in conjunction with the spring and fall survey efforts of Temperature, Water Quality, and Juvenile Salmonid Presence/Absence Monitoring. 2011 Coho observations were restricted to the headwaters and headwaters tributaries, which has been the trend for the past three years; with one exception, juvenile Coho observations have occurred solely upstream of RM 47.4 during 2009-2011 survey years. In 2011, mainstem Coho observations were limited to the uppermost two monitoring locations, MS-2 (RM 58.9) and downstream of Ancestor Creek (RM 60.8; Table 3).

One hundred Coho were observed in spring and 88 were observed in fall (Table 3). Since some of these observations occurred in the same monitoring reaches, it is entirely possible that some fish seen in the spring were also seen in the fall.
The difference in observations between seasons could be due to the fact that fewer surveys were conducted in the fall than in the spring. In total for 2011 (both spring and fall), 41 tributary *reaches* were surveyed. Spring surveys encompassed 20 tributary drainages (39 reaches), while the fall surveys were done in 19 tributary drainages (24 reaches). There were also a handful of reaches that were surveyed in either the spring or fall, but not both. Anderson Creek, East Anderson Creek, and West Fork of Lost River were surveyed in the spring, but not the fall, and Sulphur Creek and Rattlesnake Creek (a tributary to the Upper North Fork) were surveyed in the fall, but not the spring. Mainstem spot-checks occurred at the same (13) locations in both spring and fall.

Coho were observed in 3 tributary subsheds (7 reaches total) and 1 mainstem Mattole site in the spring. In the fall, Coho were observed in 4 tributary subsheds (6 reaches total) and 2 mainstem Mattole sites, although one of these tributaries was different from the spring (Table 3, Figure 5).

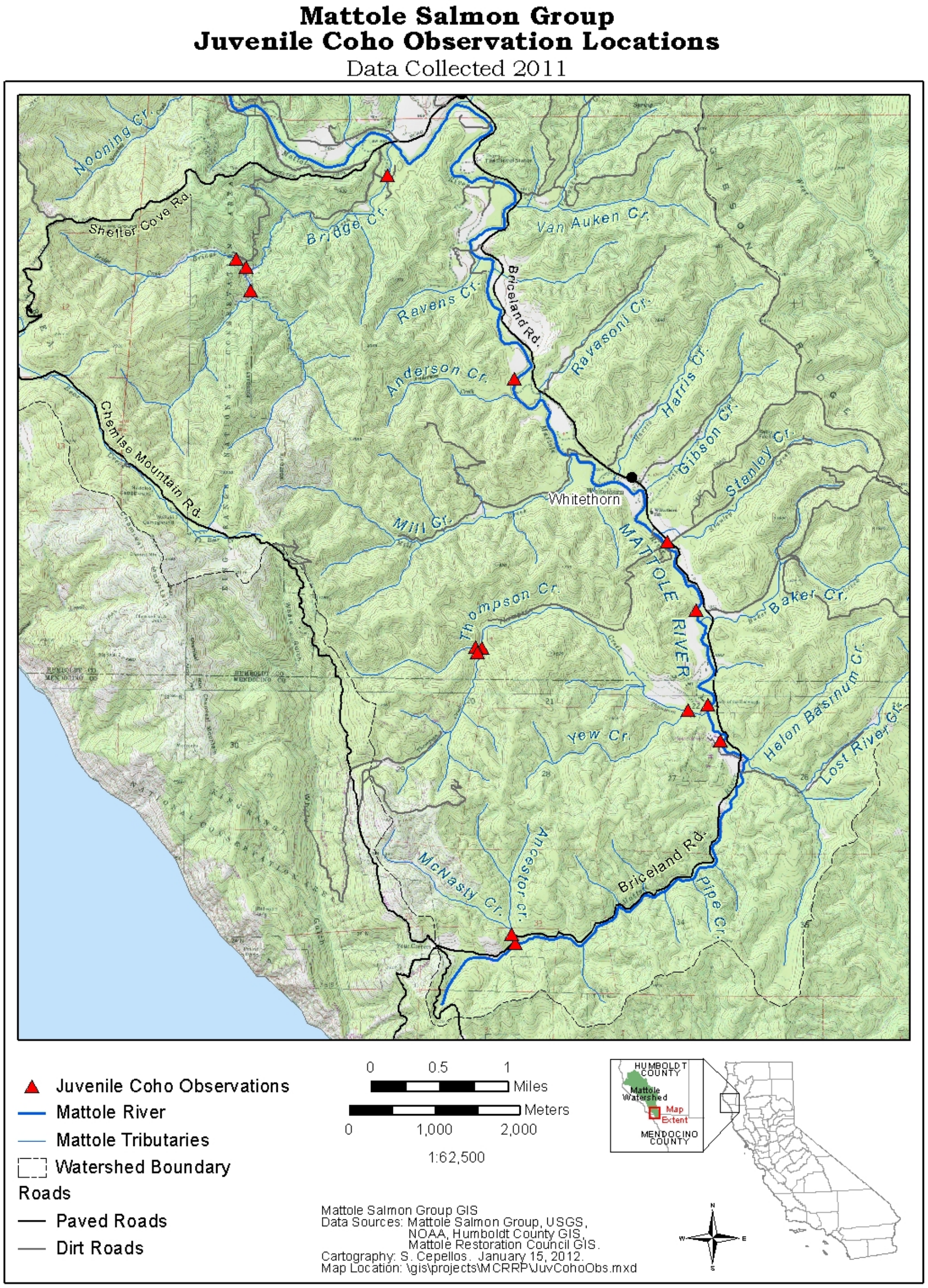


Figure 5. Mattole Salmon Group 2011 juvenile Coho Salmon observations, encompassing both juvenile Spring and Fall dives and the Summer Steelhead Dive.

Table 3. 2011 Dive Survey Summary

Spring Dives

Location	Date	person-nel	SH <4"	SH 4"- 8"	SH >8"	KS <4"	KS 4"- 8"	SS <4"	SS 4"- 8"	ND <4"	ND 4"- 8"	# Pools	Comments
Estuary, Area 2	6/30	KC, MH	145	45	2	275	0	0	0	0	0	See 6/30/11 Estuary Dive Datasheet	
Estuary, Area 3, Structure #2	6/30	KC, MH	125	15	0	75	0	0	0	0	0	Counts for Structure #2 only, see 6/30/11 Estuary Dive Datasheet	
Estuary, Area 4	6/30	KC, MH	201	297	0	405	0	0	0	0	0	Entire Area 4	
Estuary, Structure #5	6/30	KC, MH	0	0	0	0	0	0	0	0	0	See 6/30/11 Estuary Dive Datasheet	
Estuary, Structure #6	6/30	KC, MH	50	30	0	50	0	0	0	0	0	See 6/30/11 Estuary Dive Datasheet	
Estuary, Area 6	6/30	KC, MH	11	124	0	290	0	0	0	0	0	Entire Area 6	
Mattole @ Stansberry Creek	6/29	KC, MH	0	0	0	0	0	0	0	0	0	1 pool @ structure	
Lower Mill Creek (lower)	5/23	AH, SA	50	2	0	0	0	0	0	0	0	10	
Mattole @ Wingdam (deep)	6/20	SA, MH	3	5	0	5	0	0	0	0	0	1	
Mattole @ Hideaway Bridge	6/20	SA, MH	0	0	0	0	0	0	0	0	0	1	
East Mill Creek (lower)	7/5	MH, DH	90	10	1	0	0	0	0	0	0	10	
East Mill Creek (upper)	7/11	MH, DH	93	6	0	0	0	0	0	0	0	10	
Clear Creek (lower)	7/7	MH, DH	9	2	0	0	0	0	0	0	0	10	Yellow legged frog and sculpin in pool 9
Clear Creek (upper)	5/25	AH, KC	15	3	0	0	0	0	0	0	0	10	newts

Squaw Creek (lower)	**5/24**	**AH**	**8**	**2**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**10**	**frogs, sticklebacks, rough-skinned newts**
Squaw Creek (upper)		**KC**	**Present**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**10**	
Woods Creek (lower)	**6/1**	**KC, SA**	**143**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**10**	
Woods Creek (upper)	**6/1**	**KC, SA**	**193**	**13**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**10**	
Upper North Fork	**6/27**	**MH, WK**	**57**	**51**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**10**	
Mattole ds Ettersburg Bridge	**6/17**	**KC**	**8**	**7**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**>8" SH was 12", 1 crayfish**
S.F Bear (lower)	**6/17**	**KC, MH**	**9**	**29**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**10**	
Big Finley Creek (lower)	**5/24**	**MH, DH**	**34**	**7**	**3**	**5**	**0**	**0**	**0**	**0**	**0**	**10**	**crayfish**
Big Finley Creek (upper)	**5/24**	**MH, DH**	**9**	**22**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**10**	**Active slide not currently in creek, only active at higher flow**
Mattole at Big Finley Creek	**5/24**	**MH, DH**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	
Eubanks Creek (lower)	**5/24**	**MH, DH**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**10**	**crayfish**
Bridge Creek (lower)	**5/23**	**MH, DH**	**42**	**2**	**0**	**1**	**0**	**1**	**0**	**0**	**0**	**10**	
Bridge Creek (upper)	**6/17**	**KC, MH**	**70**	**18**	**1**	**0**	**0**	**47**	**0**	**0**	**0**	**10**	
Bridge Creek (WF)	**6/17**	**KC, MH**	**23**	**0**	**0**	**7**	**0**	**1**	**0**	**0**	**0**	**10**	
MS-6, Mattole us Bridge	**5/23**	**DH, MH**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**1**	**Freshwater mussel, newt, SH yoy in side channels to pool**
McKee Creek (lower)	**6/16**	**KC, MH**	**104**	**7**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**10**	**newt, snakes, many caddisflies**
McKee Creek (upper)	**6/16**	**MH, KC**	**21**	**7**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**10**	**SH w/scoliosis on p.6**

Van Arken Creek (lower)	**5/23**	**MH, DH**	**28**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**10**	
Van Arken Creek (upper)	**5/23**	**MH, DH**	**9**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**10**	
Anderson Creek (lower)	**5/24**	**MH, DH**	**5**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**10**	
E. Anderson/Ravasoni Creek (lower)	**7/28**	**KC, CP**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**10**	
Upper Mill Creek (lower)	**5/26**	**KC, SA**	**17**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**10**	
Upper Mill Creek (upper)	**6/17**	**KC, MH**	**31**	**25**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**10**	
Baker Creek (lower)	**6/17**	**MH, KC**	**89**	**4**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**10**	**salamander**
Baker Creek (upper)	**6/17**	**KC, MH**	**2**	**7**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**10**	**some fines in a few pools**
Thompson Creek (lower)	**6/16**	**KC, MH**	**45**	**2**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**10**	**5/26/11 Dive found only 1 SH <4"**
Thompson Creek (upper)	**5/26**	**JG, KM**	**6**	**1**	**0**	**0**	**0**	**3**	**0**	**0**	**0**	**10**	**saw very new yoy (~1" long), very high sediment load (fines)**
North Fork Thompson (Danny's) Creek	**5/26**	**JG, KM**	**30**	**3**	**0**	**0**	**0**	**30**	**0**	**0**	**0**	**10**	**lots of algae covering rocks + instream sediment**
Yew Creek (lower)	**6/16**	**KC, MH**	**22**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**10**	
Yew Creek (upper)	**5/26**	**JG, KM**	**0**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**10**	
Helen Barnum (lower)	**5/25**	**MH, DH**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**10**	**Wall still present, not much life in lower Helen Barnum**
Helen Barnum (upper)	**5/25**	**MH, DH**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**10**	**beetles, worms, caddis fly, not much life; lots of fines**

Lost River (lower)	**5/25**	**MH, DH**	**35**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**10**	
Lost River (upper)	**6/15**	**KC, MH**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**10**	**Fish passage barrier b/t pools 5 and 6 (earthen dam), many fines, newts**
Lost River (West Fork)	**6/15**	**KC, MH**	**1**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**10**	
MS-2/Mattole us Lost River	**5/25**	**MH, DH**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	
McNasty Creek	**6/16**	**KC, MH**	**7**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**10**	**Pacific Giant Salamander (pool 7), water shallow and turbid**
Ancestor Creek (lower)	**6/15**	**KC, MH**	**8**	**5**	**0**	**0**	**0**	**16**	**0**	**0**	**0**	**10**	**brown algae makes water very turbid, especially for 2nd diver**
Mattole ds Ancestor Creek	**6/15**	**KC, MH**	**1**	**2**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**1**	**Lots of brown algae**
Spring Totals			**1849**	**757**	**18**	**1113**	**0**	**100**	**0**	**1**	**0**		
Fall Dives													
Location	**Date**	**person-nel**	**SH <4"**	**SH 4"- 8"**	**SH >8"**	**KS <4"**	**KS 4"- 8"**	**SS <4"**	**SS 4"- 8"**	**ND <4"**	**ND 4"- 8"**	**# Pools**	**Comments**
Estuary, Area 2	**9/29**	**FB, NQ**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**All of Section 2**	**Dive from 9/29/11 Estuary Survey, logger retrieved 10/10/11**
Estuary, Area 3	**9/29**	**FB, NQ**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**All of Section 3**	**Dive from 9/29/11 Estuary Survey, logger retrieved 10/10/11**
Estuary, Area 4	**9/29**	**KC, MH**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**All of Section 4**	**Dive from 9/29/11 Estuary Survey, logger retrieved 10/10/11**

Estuary, Structure # 5	9/29	KC, MH	0	0	0	0	0	0	0	0	0	All of Section 5	Dive from 9/29/11 Estuary Survey, logger retrieved 10/10/11
Estuary, Area 6	9/29	KC, MH	100	2900	200	0	0	0	0	0	0	All of Section 6	Dive from 9/29/11 Estuary Survey, logger retrieved 10/10/11
Lower Mill Creek (lower)	10/14	MH, AH	42	20	0	0	0	0	0	0	0	10	
Mattole @ Wingdam (deep)	10/9	SA, KM	0	0	0	0	0	0	0	0	0	1	
Sulphur Creek (trib to LNF)	10/7	KC, Aaron (HRC)	229	14	1	0	0	0	0	0	0	10	
Mattole @ Hideaway Bridge	10/9	SA, KM	0	0	0	0	0	0	0	0	0	1	2 25" Chinook in pool @ left cement bridge pillar
East Mill Creek (lower)	10/19	SA, DW	61	21	0	0	0	0	0	0	0	10	10/9/11 Km, Sa dive found 35 SH <4"
Clear Creek (lower)	10/9	SA, KM	13	0	0	0	0	0	0	0	0	10	sculpin in pool #2
Squaw Creek (lower)	10/14	MH, AH	1	1	0	0	0	0	0	0	0	10	stickleback
Woods Creek (lower)	10/18	SA, DW	99	22	1	0	0	0	0	0	0	10	lots of stickleback, resident trout on pool #5
Upper North Fork	10/13	KM, AH	0	0	0	0	0	0	0	0	0	10	stickleback
Rattlesnake Creek (trib to UNF)	10/7	KC, Aaron (HRC)	94	18	3	0	0	0	0	0	0	10	old lamprey redd in pool #2
Mattole ds Ettersburg Bridge	10/11	KC, DW	1	4	0	0	0	0	0	0	0	10	
S.F Bear (lower) - Hidden Valley	10/18	SA, DW	35	33	4	0	0	0	0	0	0	10	

Big Finley Creek (lower)	10/12	MH, DW	67	6	0	0	0	1	0	0	0	11	Coho observed in pool 11, crayfish abundant and big (~6")
Big Finley Creek (upper)	10/12	MH, DW	56	13	4	0	0	0	0	0	0	10	
Mattole at Big Finley Creek	10/12	MH, DW	0	0	0	0	0	0	0	0	0	10	crayfish
Eubanks Creek (lower)	10/12	MH, DW	38	2	0	0	0	0	0	0	0	10	lots of crayfish
Bridge Creek (lower)	10/11	SA, MH	125	32	0	0	0	0	1	0	0	10	MH observed 2 Coho
MS-6, Mattole us Bridge	10/11	SA, MH	10	2	0	0	0	0	0	0	0	1	
McKee Creek (lower)	10/18	SA, DW	100	6	0	0	0	0	0	0	0	10	lots of leaf litter, hard to see fish hiding in some pools
Van Arken Creek (lower)	10/11	MH, SA	59	5	1	0	0	0	0	0	0	10	
Upper Mill Creek (lower)	10/12	KC, SA	84	10	0	0	0	0	0	0	0	10	8/19/11 Dive found 104 SH <4"
Mattole us Upper Mill Creek	10/12	KC, SA	28	10	0	0	0	0	0	0	0	1	
Baker Creek (lower)	10/11	KC, DW	61	3	2	0	0	0	0	0	0	10	stickleback
Thompson Creek (lower)	10/12	KC, SA	105	11	0	0	0	13	0	0	0	10	
Thompson Creek (upper)	10/12	KC, SA	30	15	0	0	0	13	0	0	0	10	
NF Thompson (Danny's) Creek	10/12	KC, SA	19	3	0	0	0	19	0	0	0	10	
Yew Creek (lower)	10/12	KC, SA	35	7	1	0	0	0	0	0	0	10	
Helen Barnum (lower)	10/11	SA, MH	5	2	0	0	0	0	0	0	0	10	

Lost River (lower)	**10/11**	**MH, SA**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**10**	
MS-2/Mattole us Lost River	**10/11**	**SA, MH**	**8**	**1**	**0**	**0**	**0**	**7**	**1**	**0**	**0**	**1**	**Phosphorus test kit high, b/t 4 and 6**
Ancestor Creek (lower)	**10/11**	**KC, DW**	**20**	**2**	**1**	**0**	**0**	**20**	**10**				**Most Coho were 4"-8"**
Mattole ds Ancestor Creek	**10/11**	**KC, DW**	**1**	**0**	**0**	**0**	**0**	**0**	**3**	**0**	**0**	**1**	
Fall Totals			**1522**	**3161**	**218**	**0**	**0**	**73**	**15**	**0**	**0**		
2011 Totals			**3371**	**3918**	**236**	**1113**	**0**	**173**	**15**	**1**	**0**		

As was the case in 2009 and 2010, Thompson Creek (RM 58.4) accounted for the majority of Coho observations. The three reaches surveyed in Thompson Creek (lower, upper, and North Fork/Danny's) accounted for 34% of Coho observations in spring (34) and 51% of Coho observations in fall (45). Of all 2011 Coho observations, ~42% (79) occurred in the Thompson Creek subshed (Table 4).

Table 4. Juvenile Coho Salmon Observations by Number and Percent for Select Tributaries in the Mattole River Watershed, Mattole Salmon Group Surveys, 2011.

COHO OBSERVATIONS	ANCESTOR CREEK	THOMPSON CREEK	BRIDGE CREEK	BIG FINLEY CREEK	MAINSTEM MATTOLE
Spring #	16	34	49	0	1
Spring %	16%	34%	49%	0%	1%
Fall #	30	45	1	1	11
Fall %	34%	51%	1%	1%	13%
Total #	**46**	**79**	**50**	**1**	**12**
Total %	**24%**	**42%**	**27%**	**1%**	**6%**

In addition to Thompson Creek, Ancestor Creek (RM 60.8) has had consistent Coho observations over the 2009-2011 survey years. In 2011, 16% of spring Coho observations (16) and ~34% of fall Coho observations (30) occurred in Ancestor Creek, accounting for ~24% of all Coho observations in 2011 (Table 4). The past two years of juvenile dives show that this drainage is accounting for an increasing percentage of total annual juvenile Coho observations.

Coho were also observed in Bridge Creek (RM 52.1) in both spring and fall of 2011. Additionally, even though not detected in the spring, a single Coho was observed in Big Finley Creek (RM 47.4) in the fall (Table 4). Prior to this year, the most recent observations of juvenile Coho in both Bridge Creek and Big Finley Creek were in 2008, notable since that year was the last run of this same Cohort.

In Bridge Creek (RM 52.1), Coho were observed in the lower reach, upper reach, and the West Fork. In 2011 the greatest number (49) of Coho observed in any one reach were found in the upper reach of Bridge Creek. It is notable that Bridge Creek had many more juvenile Coho this year than in comparison to past survey years. This, in conjunction with the majority of individuals being located in the upper and West Fork reaches shows evidence of spawning activity there. The Bridge Creek drainage accounted for 49% of observations in spring of 2011 (Table 4). Fall surveys were not conducted in the upper and West Fork reaches of Bridge Creek, although fall Coho presence in this subshed was confirmed both by the lower reach fall survey and seining in the upper reaches during the summer.

In regard to observed (yet unmeasured) growth, spring observations were solely of young-of-the-year (<4"), while fall observations captured growth over the summer in some locations: 73 Coho <4" and 15 Coho >4" were recorded. Observations of larger size class Coho (4"-8") in the fall occurred in Ancestor Creek (RM 60.8), Bridge Creek (RM 52.1), and the two upper mainstem locations. It should be noted, however, that not all surveyors consistently delineate size class of Coho, as they all are young-of-the-year during the course of the monitoring season, unless otherwise noted as a "smolt" during early spring dives.

In comparison to 2010, 2011 Coho observations were both more numerous and more widely distributed. Observations of Coho outside of the Ancestor and Thompson Creek drainages in 2011 are an encouraging sign. In 2010, Coho observations occurred solely in these two drainages (Figure 6).

In addition, despite greater survey coverage in 2010, more Coho were observed in 2011. A total of 77 Coho were observed in 2010, while 188 Coho were observed in 2011 as part of the Temperature, Water Quality, and Juvenile Salmonid Presence/Absence Monitoring (Figure 6). 2010 survey coverage included both upper and lower reaches in spring and fall, while 2011 surveys included upper and lower reaches in spring, and lower reaches only (with the exception of the upper reaches of Thompson Creek) in fall.

While the results of this monitoring project reflect only those Coho observations in the spring and fall, it should also be noted that an additional snorkel survey in the Mattole mainstem and select tributaries, took place as part of the annual Summer Steelhead Dive (Figure 5). In 2011, the dive of the upper Mattole was conducted on July 15. A total of 516 Coho were observed, 35 of which were in the lower reach of Thompson Creek. Since this survey effort took place on a single day, 516 observations can be translated into 516 individual fish. As the Summer Steelhead Dive did not survey Ancestor or Bridge Creeks, or any other headwaters tributaries besides the lower reach of Thompson Creek, this number can be interpreted as a minimum census count of the number of juvenile Coho Salmon present in the Mattole Watershed in 2011. In comparison to 2011, the 2010 Summer Steelhead Dive produced a much lower census count – 127 Coho observed – echoing results of 2010 juvenile dive monitoring.

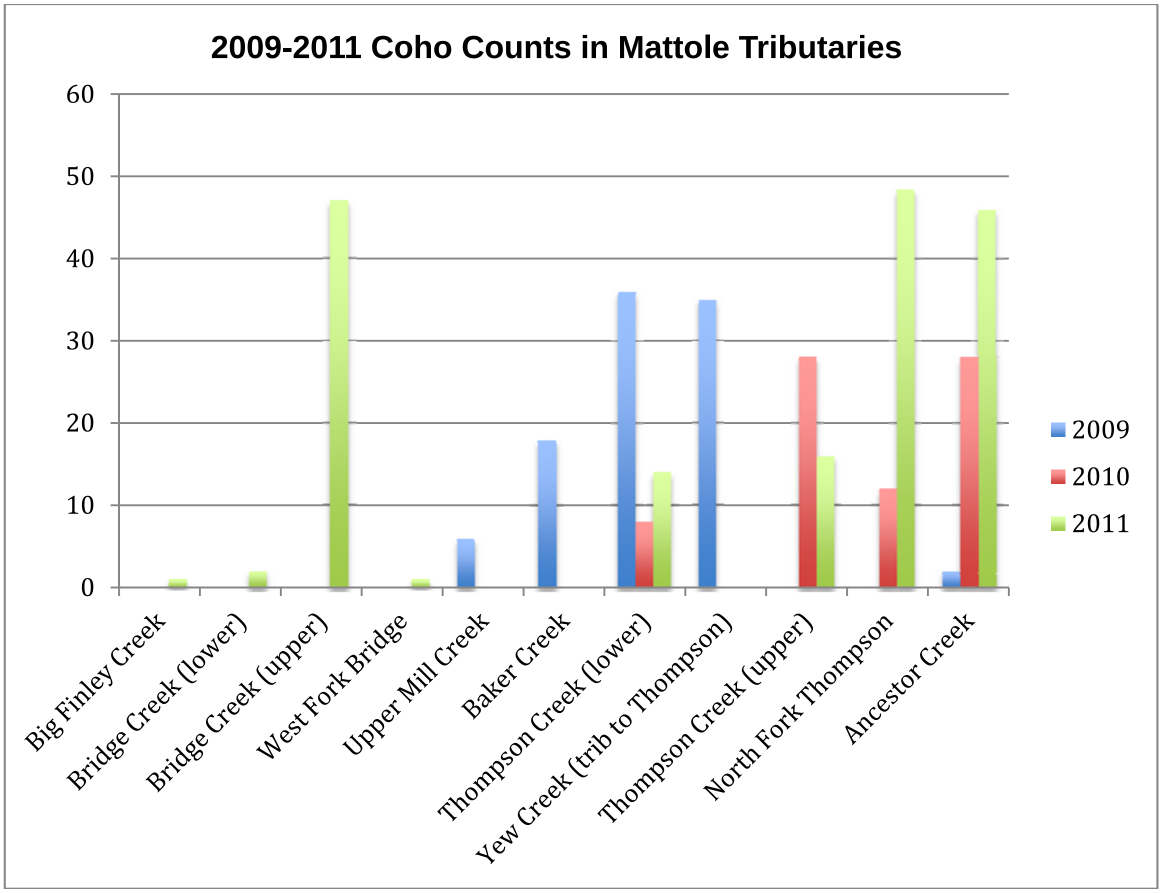


Figure 6. Juvenile Coho Salmon observations in Mattole River tributaries, Mattole Salmon Group Temperature, Water Quality, and Juvenile Salmonid Presence/Absence Monitoring, 20109-2011.

Both the Webster and Pollock (2005) protocol and the California Department of Fish and Game modified 10-pool protocol yielded the same results in the two tributaries where both protocols were conducted, as far as determination of presence/absence is concerned. Coho were observed in the lower 10-pool reach of Ancestor Creek, and the Webster and Pollock protocol was completed in the first pool, when Coho were observed. The greater survey effort in McKee Creek (91 units sampled) did not result in a Coho observation, nor were they observed in the two 10 pool reaches surveyed (upper and lower).

Chinook Salmon

Survey timing does not allow for accurate determination of juvenile Chinook Salmon distribution and abundance, although there were some incidental Chinook observations in 2011. Early spring flows make dive surveys infeasible due to safety concerns, and rain can compromise visibility. Additionally, identifying and enumerating salmonids prior to May in the Mattole is difficult due to their small size and tendency to hide in refuges at higher flow during spring rain events.

100% of Chinook observations during 2011 juvenile presence-absence dive monitoring occurred in the spring. Of the 1,113 Chinook observed in 2011, 1,095 (98%) were found in the Mattole Estuary. Five Chinook were also identified at one additional lower mainstem Mattole River location (the Wingdam, adjacent to the MSG Office at RM 2.9).

Tributary locations with Chinook presence in 2011 included the lower reach of Bridge Creek (RM 52.1), West Fork Bridge Creek (RM 52.1+2.15) and Big Finley Creek (RM 47.4). Both Bridge Creek and Big Finley Creek are relatively large tributaries with cool temperatures and favorable salmonid habitat, where Chinook have been observed in past survey years.

Steelhead Trout

Steelhead were observed throughout the Mattole River Watershed during 2011 juvenile dive surveys. As in past years, they were more abundant and more widely distributed than either Coho or Chinook. In 2011, divers enumerated 3,371 steelhead young-of-the-year (<4"), 3,918 1+ (4"-8") steelhead, and 236 steelhead with a fork length >8". In comparison, 2009 yielded 6,316 Steelhead young-of-the-year, 2,273 1+ Steelhead, and 100 Steelhead >8". In 2010, 4,562 Steelhead young-of-the-year, 765 1+ Steelhead, and 30 Steelhead >8" were observed. Variations in survey effort and timing – especially those in the Mattole estuary – may be responsible for the difference in numbers of steelhead observations.

Discussion

2009-2011 dive survey observations indicate current Coho distribution in the Mattole River Watershed is restricted to a limited area of favorable headwaters habitat (both mainstem and headwaters tributaries). Only a single Coho was observed outside of the headwaters during the past three survey years (2009 in the mainstem Mattole upstream of Stansberry Creek confluence. This is just the most recent step in a downward trend of abundance and distribution. Over all years surveyed, numbers throughout the watershed have declined significantly at all locations. The lowest was in 2010 when only 77 total observations of juvenile Coho were recorded.

Despite more observations in 2011 (188) than in the previous two years, 2011 data indicate a 56% decline in relative abundance among this Cohort when compared to 2008 observations (432). This is indirectly substantiated by the fact that the 2011 survey effort was broader and more Coho-centric – focusing on all creeks with documented recent historical Coho presence. 2008 surveys included 32 reaches (lower reaches only) in comparison with 41 reaches surveyed in 2011 (upper and lower reaches). Surveys of the 2010 Cohort indicate an even steeper decline of 79%, when compared to 2007 observations (368). It should be noted that this analysis is limited to spring and fall juvenile dives associated with temperature and water quality monitoring. Coho abundance during the Summer Steelhead Dive has been enumerated only since 2010 – prior to that, only presence was noted in most cases.

In addition to decline in relative abundance, surveys show diminishing distribution throughout the Mattole River Watershed. In recent years, Coho have been observed in fewer and fewer tributaries as a percentage of tributaries and tributary reaches surveyed (Figure 7). Since MSG dive surveys began in 1994, Coho Salmon have been observed in 26 tributaries, accounting for 60% of the 43 tributaries surveyed. When considering only dives since 2000, Coho have been observed in 16 tributaries, representing 41% of the 39 tributaries surveyed. The widespread dive monitoring effort during the 2009-2011 survey years found Coho in only 6 tributaries over the 3-year period, or 21% of the 28 tributaries monitored.

The past three years show an even more marked decline in distribution when considering results from year to year. In 2009, Coho were observed in 16% (4 of 25) of tributaries monitored. In 2010, juvenile Coho were found in 10% (2 of 20) of tributaries surveyed – this observed distribution was the most restricted on record. In 2011, Coho were observed in 19% (4 of 21) of tributaries surveyed (Figure 7).

Observations of Coho in the mainstem have also shown a trend towards becoming more and more restricted to the upper headwaters. In 2011, the only Coho observations in the mainstem occurred at the uppermost two monitoring locations (RM 60.8 and RM 58.9).

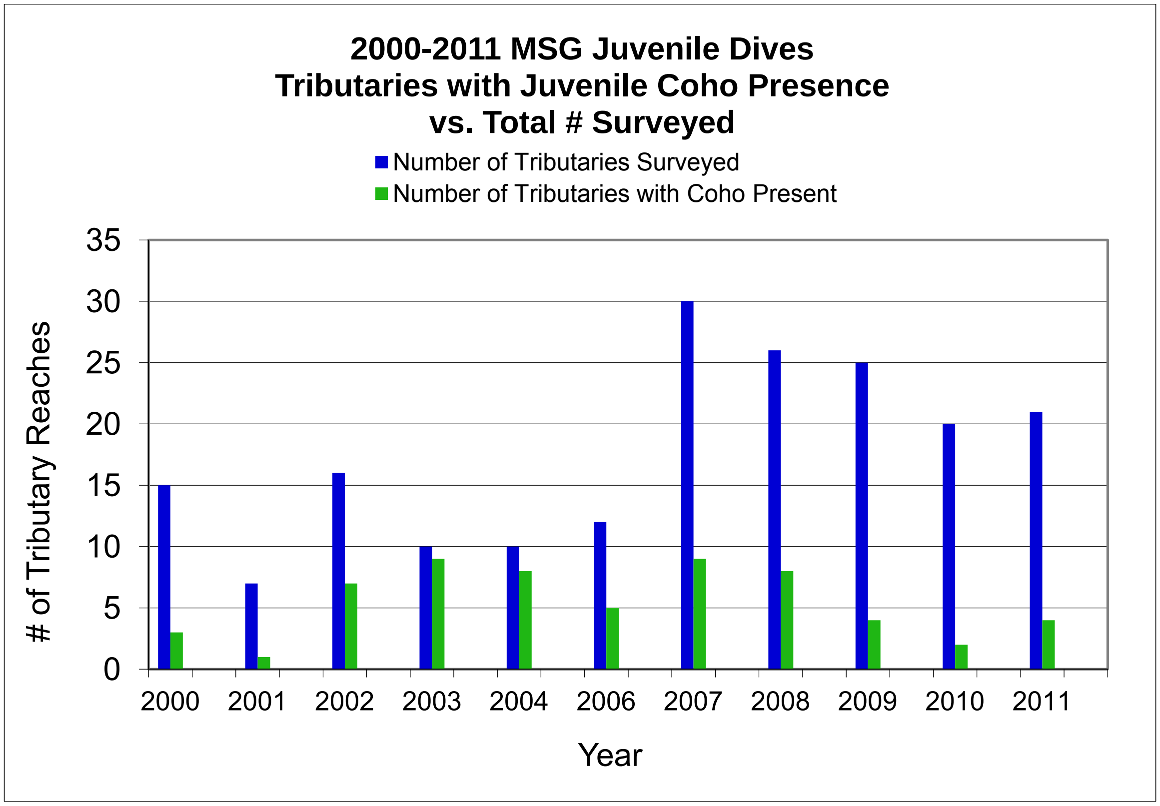


Figure 7. Tributaries with juvenile Coho Salmon presence vs. total number of tributaries surveyed in the Mattole River Watershed, based on MSG snorkel surveys using the "modified 10-pool" protocol, 2000-2011.

Recent surveys not only document the trend of fewer and fewer tributaries with Coho presence, but also show geographical distribution throughout the watershed is shrinking over the past 18 years. Surveys since 1994 have documented Coho in 17 tributaries downstream of RM 52.1 (the Bridge Creek confluence). When examining the data since 2000, that number has declined to only 7 tributaries. Despite expanded survey effort, more recent surveys have elucidated further decline in downriver distribution. When looking at data since 2007, Coho were found in only 4 tributaries downstream of RM 52.1. No Coho were observed downstream of RM 52.1 in either 2011 or 2010, while 2009 surveys documented a single Coho observation downstream of RM 52.1 in the mainstem. Additionally, for nearly all years where Coho have been observed in downriver locations, they have been less abundant than Coho observations in the headwaters; with less than 15 individuals observed in all downriver locations since 2007.

In the headwaters, Coho have become increasingly dependent on a small area of the Mattole mainstem and a few upper tributaries with both suitable temperatures and DO levels. Thompson Creek and its tributaries (North Fork Thompson/ Danny's and Yew Creeks) have accounted for an increasing percentage of total annual juvenile Coho observations since 2007. Thompson Creek and the North Fork of Thompson

Creek accounted for 42% (79 of 188) of all observations in 2011 yet only 32% in 2008. In 2010, observations of Coho in the Thompson drainage accounted for 62% (39 of 77) of all observations, compared to only 50% in 2007. In 2009, the drainage accounted for 58% of all 2009 observations (2006 data not available). It has become apparent from this trend that juvenile Coho are becoming increasingly dependent on the Thompson Creek drainage to provide summertime rearing habitat. Despite this overall trend for the subshed, Yew Creek – a major tributary to Thompson – has suspiciously provided no Coho observations in 2010 or 2011, which is in contrast to previous years.

Aside from the Thompson Creek subshed, the drainage with the most consistent Coho observations in spring and fall is Ancestor Creek. 2011 observations of juvenile Coho in Ancestor Creek were the highest of the past five years, and Ancestor Creek was the only tributary in addition to Thompson Creek and the North Fork of Thompson Creek where Coho were observed in 2010.

Other tributaries where Coho have been observed during 2009-2011 juvenile dives include Big Finley Creek (RM 47.4), Bridge Creek (RM 52.1), Upper Mill Creek (RM 56.2), and Baker Creek (RM 57.8). With the exception of Bridge Creek in 2011, all observations were only in a single season (spring or fall).

We believe at current densities of juvenile Coho Salmon in the Mattole River Watershed, the modified 10-pool protocol is inadequate to confidently determine actual distribution. Because so few juvenile Coho are present and probability of detection in itself is low, the modified 10-pool protocol becomes increasingly limited in its confidence to determine presence/absence the rarer the species becomes (Webster et al. 2005).

Due to the positive relationship of species density and confidence of detection in survey design, in 2011 we began to suspect that the dramatic declines in relative abundance and distribution sine 2000 may not solely be a reflection of population trends, but also perhaps exaggerated – or at the very least skewed – by the survey limitations of the modified 10 pool protocol and our application of it. As one example of the inadequacy of the modified 10-pool protocol, the Coho observed in Big Finley Creek in 2011 occurred when surveyors by chance sampled the 11th pool due to its appearance as ideal habitat.

The long-term usage of the modified 10-pool protocol has allowed some evaluation of relative abundance from year to year, however, so we suggest continuing to monitor established ten pool reaches in Thompson and Ancestor Creeks to provide an index of abundance from year to year. We tested the Webster et al. (2005) protocol in spring of 2011, and, at this time, this is the protocol we recommend pending further research. Although results in the two creeks sampled with both protocols did not differ, we believe the greater survey effort utilized in the Webster et al. (2005) protocol will allow us to better evaluate current distribution. While neither protocol can guarantee 100% detection, at current low species' density and low probability of detection, the modified 10 pool protocol has at best a 6% chance of detecting the fish if they are in fact there, while the Webster et al. (2005) protocol has at best a 52% chance. This is a significant improvement.

To give us better answers in a shorter time, it may be practical given limited resources to prioritize sampling to the Mattole headwaters, where the great majority of both juvenile Coho observations and Coho spawning activity have been found in the past five years. We are pursuing using a spatially-balanced random sampling system to determine which tributary drainages to sample, and sampling a minimum of 20% of the sample set per year, to ensure that all reaches are sampled in every five year period (MSG 2009). Sampling a greater percentage (33%) would allow sampling of all tributaries every three years, which may make better sense given Coho's 3-year life history strategy. Funding and state and Federal agency consultation in future years will guide whether efforts will only be focused in the headwaters, or Coho-bearing tributaries only, or all tributaries within the sample frame.

Temperature monitoring results indicate summer rearing habitat in the *mainstem* is severely restricted, with optimal temperatures for Coho rearing occurring only in monitoring locations in the upper extent of the headwaters. In 2011, mainstem temperatures suitable for oversummering Coho occurred from RM 56.3-RM 60.8. Coho rearing in the mainstem downstream of RM 56.3 are subject to thermal stress, which has a detrimental effect on growth and fitness, ultimately affecting survival.

Coho observations in the mainstem most frequently occur in this area of thermally favorable habitat, indicating temperature is an important factor limiting habitat selection. In 2011, Coho were observed in only the uppermost two temperature monitoring locations (RM 58.9 and RM 60.8), where temperatures remained below the MWAT threshold for Coho presence (Welsh et al. 2001).

Consistent favorable thermal habitat for Coho rearing in t*ributaries* is also heavily concentrated in the headwaters area, although 2009-2011 temperature monitoring indicates that other areas of the watershed can provide suitable thermal habitat. Of all the tributaries monitored these years, most remained within threshold temperatures for Coho rearing. However, site selection based on past Coho observation favored monitoring of the coolest tributaries in the watershed, the greatest concentration of which are in the headwaters.

Of the 19 temperature monitoring locations located in tributaries in 2011, 11 (58%) were located in the headwaters (Southern Sub-basin, upstream of RM 52.1). Of 8 monitoring locations outside of the headwaters, 6 had temperatures within the threshold for Coho presence, but no Coho were found. This indicates that other factors in addition to the availability of thermally suitable summertime rearing habitat are limiting overall Coho survival in the Mattole.

With selection of monitoring sites based on Coho presence since 2002 (with the exception of the Upper North Fork), we sought to cover the greatest range of tributaries known to have provided suitable Coho habitat in recent history, thereby assessing to what extend this entire known range of habitat was occupied. This would provide the most up-to-date picture of current juvenile Coho distribution in the Mattole. However, it is likely even this recent record of Coho presence (since 1991) shows a more limited distribution than what was historically observed prior to landscape disturbance. We therefore are looking at a “prolonged-exposure snapshot” in the history of juvenile Mattole Coho distribution.

Our long-term monitoring results indicate that temperature plays a key role in determining juvenile Coho distribution in the Mattole over the long-term. Since 2002, the presence of Coho (and some consistent annual presence) in tributaries with consistently cool-water supports this conclusion. It is also supported by the consistent *absence* of Coho in tributaries downstream of RM 52.1 that appear to offer habitat complexity and cover, but are limited by temperature. For example, Sholes Creek (RM 36.6) appears to offer ideal habitat, but, despite being one of the coolest salmonid-bearing tributaries in the middle river, it shows temperatures above the 16.8°C threshold for Coho presence, and no Coho have been observed in Sholes despite three years of recent surveys.

It seems temperature, however, is not the only factor determining Coho distribution or limiting the population in the Mattole. In 2011, 6 of 7 locations in bearing-bearing tributaries downstream of RM 52.1 indicated suitable temperature for Coho rearing, although no Coho were found. This indicates temperature, while an important factor on a watershed scale, is not currently the most influential limit to juvenile Coho habitat utilization at their current distribution. It should be also noted that these 7 tributaries are a representation of the best remaining habitat downstream of the headwaters, but by no means are representative of the majority of the lower and middle river tributaries in the Mattole. With one exception, in these thermally suitable best-available habitats no Coho were found. This indicates that other factors besides the availability of thermally suitable summertime rearing habitat may be limiting overall Coho survival and distribution in the Mattole.

The best-functioning habitat remaining in the Mattole – where favorable temperatures, greater habitat complexity, cover, and low sediment loads exist – is concentrated in the headwaters. Unfortunately, much of this favorable habitat is the same area most impacted by low summertime flows, another important factor that can directly limit salmonid survival and abundance. Not only may dry stream reaches cause direct mortality, but results of water quality monitoring also indicate harmfully low DO is directly related to low instream flows. This means that already sparse suitable rearing habitat (based on temperature) is further depleted in abundance because of low DO levels due to low flows. Even outside of drought years, water quality is still an issue: flows in 2009-2011 were high relative to recent years and stream reaches did not become dry, however DO levels in three headwaters tributaries in 2009 and two in 2010 were below severe impairment levels by the time of fall spot-checks. Spring DO levels during these two years were well above impairment levels for salmonids, suggesting DO dramatically declined over the season as a result of the decline in flow. Low flows also impair the ability of juveniles to move to better habitat, which in turn can increase competition for space, food, and predation, and increase the stress already associated with poor water quality conditions.

While DO levels in 2011 were suitable for juvenile salmonid rearing, another water quality factor – pH – remains suspect. High pH can affect salmonid fitness and survival, and can significantly exacerbate the negative effects of other water quality characteristics, such as temperature and ammonia toxicity. High pH can occur in conjunction with many different factors, among which are possible pollutants and high nutrient loads, which could be related to agricultural activities and small-scale cultivation. Pursuing water quality spot-checks is recommended, along with replacing the pH probe annually, improved equipment storage (to safe-guard probe from freezing temperatures), substantiating YSI results with in-field test kits, and/or sending in water samples for analysis when spot-checks are suspect.

Given the influence of flow on quantity and quality of summer rearing habitat, we believe that instream flows are currently the primary limiting factor to juvenile Coho *oversummer* survival in the Mattole River Watershed. However, the overall depressed state of the Mattole Coho population – both in terms of survival and distribution – is most likely due to the combined effects of temperatures, low flows, *and* other factors. These factors include habitat limitations in other seasons (winter, early spring) outside of the current juvenile monitoring window (summer, fall), the difficulty of spawners finding a mate, and spawning only occurring in those tributaries with the highest persistent concentration of Coho.

Scarcity of winter rearing habitat, such as off-channel habitat and refuges from high flow, has been found an important factor limiting Coho survival and abundance elsewhere in Pacific Northwest streams. Due to the limited amount of such habitat existing in the Mattole, we hypothesize lack of winter rearing refuge is limiting *overall* juvenile Coho survival.

Lack of mating opportunities at the low population density observed in the Mattole is another factor likely limiting the Mattole Coho population (MRRP 2011). The adult Mattole Coho population is well below population numbers know to lead to depensation (Barrowman et al. 2003). Consistent spawning has only been observed in a few select tributaries (such as Thompson Creek) – the same tributaries where consistent juvenile presence is documented. This supports the theory that there are too few fish, both adult and juveniles, to occupy the entire available suitable habitat.

With the severely depressed status of Coho in the Mattole in combination with extremely limited summertime habitat with both favorable temperatures and adequate flow, and limited wintertime habitat with adequate flow refuge, we conclude human intervention and direct stock enhancement are necessary to ensure species survival.

In regard to Chinook Salmon, the great majority of 2011 juvenile observations likely reflected outmigrating fish, based on most observations occurring in the estuary and all observations occurring in the spring. With a relatively late river mouth closure date of September 13, it is likely that these fish emigrated to the ocean prior to mouth closure.

It should be noted, however, that some Chinook juveniles were seen in headwaters tributaries in the spring. We were unable to document a stationary presence in those creeks throughout the season in 2011 (i.e. no Chinook observed in the fall), which may signify that these fish were late spring migrants. Equally probable is that these fish oversummered in these creeks and simply emigrated prior to our survey in the fall which followed the first fall rain. Although we may not be able to conclude one or the other for 2011, in other years we have documented both spring and fall presence in headwaters tributaries and the mainstem. We believe such observations capture an expression of a stream-type life-history strategy: rearing in freshwater in the headwaters over the summer (and possibly through the winter) prior to outmigration. These data provide evidence of multiple life-history strategies employed by Chinook in the Mattole watershed. Given the limitations in juvenile Chinook migrating and oversummering habitat lower in the system – including the middle river and estuary – it seems upriver rearing is an important life history variant to preserve, and may contribute significantly to the genetic robustness and resiliency of the Mattole population. As headwaters habitats are susceptible to becoming compromised from low flows and the resulting poor water quality in the summer, it is important that this sub-population of Chinook is considered in addition to Coho in regards to management and restoration decisions.

Recommendations

- Conduct annual snorkel surveys in randomly selected Coho-bearing tributaries to determine Coho distribution and ascertain whether distribution is remaining consistent, shrinking, or expanding
- Revise survey protocol to better assess distribution. The 10-pool survey method is not effective at detecting rare species, such as at the current observed density of Mattole Coho Salmon juveniles.
- We tested the Webster and Pollock (2005) protocol in spring of 2011. At this time, this is the protocol we recommend pending further research.
- Continue 10-pool surveys in the two tributaries where Coho have been consistently observed in 2009-2011 (Thompson and Ancestor Creeks) to evaluate relative abundance trends of juvenile Coho.
- Complete a complete census count juvenile Coho and Chinook during the Summer Steelhead Dive to determine distribution and trends in abundance throughout the mainstem.
- Continue other salmonid population monitoring efforts, such as downstream migrant trapping and spawner surveys, to assess abundance of Coho and Chinook populations
- Continue temperature monitoring at a few geographically distributed reference locations throughout the Mattole Watershed to determine trends in temperature over a longer time frame, monitor climate change, and determine how any changes in thermally suitable habitat corresponds to current salmonid distribution.
- Initiate a more comprehensive water quality monitoring program throughout the watershed that assesses DO, pH, and other nutrients and toxins that may be associated with agriculture and small-scale cultivation.
- Assess overwinter Coho survival in the Mattole and the extent to which winter rearing habitat limits salmonid survival relative to other factors.
- Future restoration should include efforts to increase winter flow refuges.
- Initiate Mattole Recovery Rearing Program in cooperation with State and Federal Agencies.
- Consider upriver Chinook survival in current recovery and restoration plans.

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