Final Report

Summary Report of Water Temperature and Juvenile Salmonid Presence/Absence Monitoring, May-October 2008, Mattole River Watershed

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Project Description

During spring through fall 2008 Mattole Salmon Group personnel placed and retrieved 70 continuously recording thermographs (Hobo Water Temp Pro and Hobo Tidbit data loggers, herein referred to as "loggers") in the mainstem Mattole River and selected tributaries to monitor water temperature (Figure 1). In 2008, loggers were placed in 32 tributary reaches, from Ancestor Creek (RM 60.8) to Stansberry Creek (RM 1.3) and in the mainstem Mattole River upstream of monitored tributaries. Six historical mainstem reference reaches were also monitored, including the middle Mattole Estuary (RM ~0.5), deep and shallow locations at the Wingdam pool (RM 2.9; a restoration site near the MSG Office), the Ettersburg Bridge (RM 42.3), Junction Hole (RM 52.7), and Metz Bridge (RM 56.9). Air temperature monitoring occurred at four sites, spread geographically throughout the Watershed: the Mattole estuary (RM ~0.5), the Wingdam (RM 2.8 +~1.0), the Ettersburg Bridge (RM 42.3), and at Metz Bridge (RM 56.9) near Whitethorn. In the upper Mattole River, loggers were placed in eight locations in conjunction with dissolved oxygen and low-flow monitoring near the headwaters. One logger recorded water temperatures near the Mattole headwaters (Mattole at Ancestor Creek, RM 60.8). Six water temperature loggers were deployed at different sites in the Mattole Estuary to expand knowledge of estuarine water quality. Additional temperature monitoring included possible future restoration project sites and MSG salmonid population monitoring sites, including at the downstream migrant trap (RM 3.9). See Table 1 for logger serial numbers, placement dates, locations and results.

In most cases, direct underwater observation counts of juvenile salmonids were conducted at the time of logger placement and retrieval (see Table 2 for snorkel survey results). The objective of these snorkel surveys was to determine the distribution of three species of juvenile salmonids, and to document their relative abundance. Calibrated temperature loggers were placed between March 26 and June 16, 2008. Loggers were retrieved between September 23 and November 18, 2008.

Background

The Mattole River is home to three independent populations of threatened salmonids, including Southern Oregon/Northern California Coast (SONCC) Coho salmon (*Oncorhynchus kisutch)*, California Coastal (CC) Chinook salmon (*Oncorhynchus tshawytscha*), and Northern California (NC) Steelhead (*Oncorhynchus mykiss*). The MSG Temperature Monitoring project focuses on the freshwater life stage of juvenile salmonids, as well as adult summer steelhead in the Mattole River. By conducting temperature monitoring throughout the watershed, the MSG is attempting to better understand the status and needs of the three anadromous salmonid species in the Mattole watershed.

Elevated water temperatures and excessive sediment in the Mattole River and its key tributaries has resulted in diminished or completely absent minimum threshold habitat conditions for

salmonid survival. Adult and juvenile salmonid viability partly depends on the availability of cold water, a scarce but crucial component in this degraded watershed.

Water temperature fluctuations can affect salmonids during each phase of their life history. "Most aquatic organisms, including salmon and steelhead, are poikilotherms, meaning their temperature and metabolism are determined by the ambient temperature of water. Temperature therefore influences growth and feeding rates, metabolism, development of embryos and alevins, timing of life history events such as upstream migration, spawning, freshwater rearing, and seaward migration, and the availability of food. Temperature changes can also cause stress and mortality" (Coates, et al. 2002).

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). In laboratory studies, temperatures of 68°F and greater have been documented as being stressful to juvenile coho and Chinook salmon (Brett 1952), and temperatures of 75.0-77.0° F may kill these species (Brungs and Jones 1977, Brett 1952).

Figure 1 shows the criteria used by the Mattole Salmon Group in this report to evaluate suitable thermal habitat at water temperature monitoring locations throughout the watershed. Criteria used to determine temperature suitability includes measures of chronic temperature exposure (MWAT, MWMT) as well as short-term high temperature exposure survival (maximum temperature) and length of temperature stress (days >68°F).

Figure 1. Criteria used to evaluate salmonid habitat in the Mattole River.

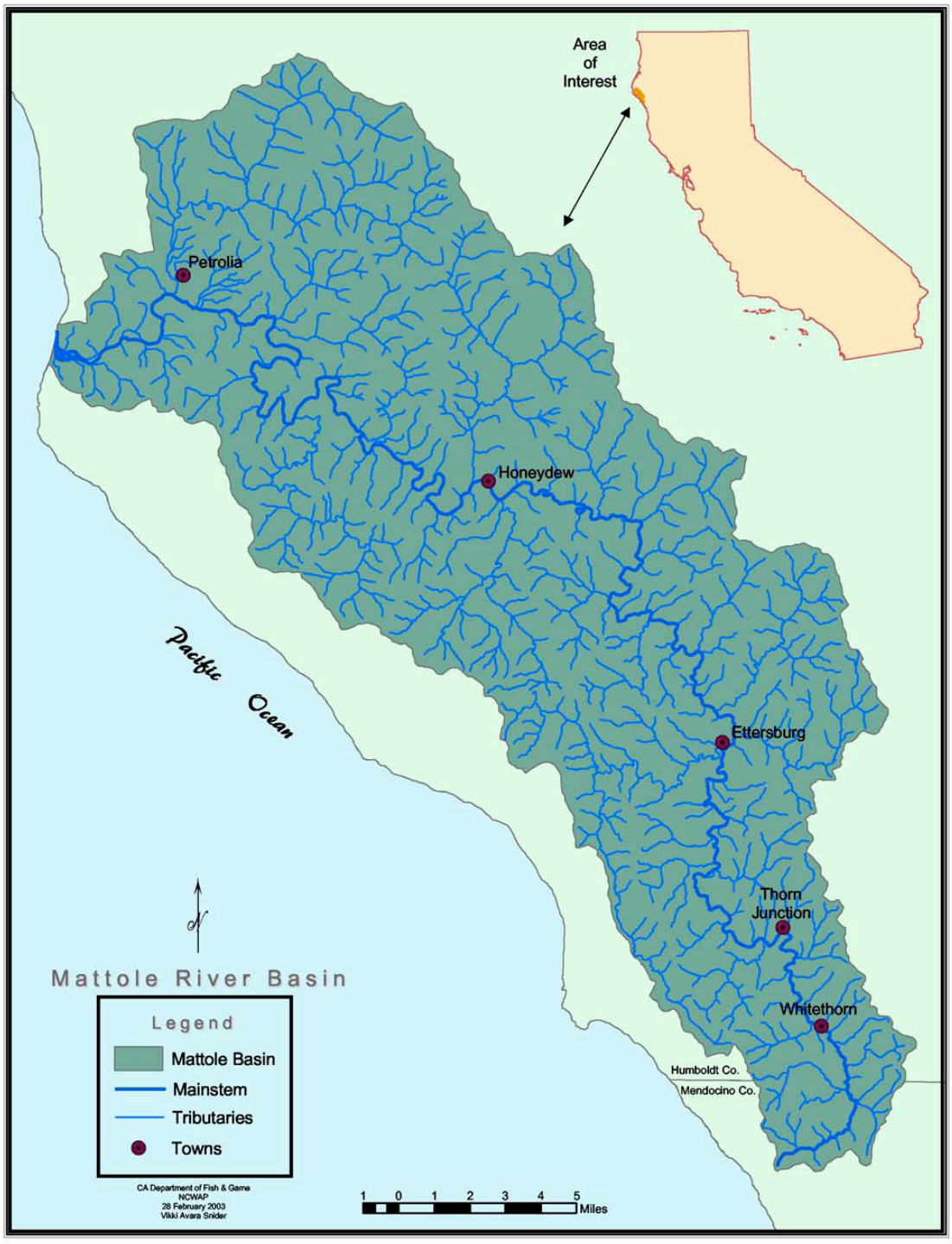
Criteria	Temperature	Reference
Prolonged Temperature Stress	Days >68 F	Brett 1952
Short-term Maximum Temperature (50% survival)	74.7°F(coho) 75.0°F(steelhead)	Brungs and Jones 1977
Maximum Weekly Average Temperature (MWAT)	>63.0°F(coho) >66.0°F(steelhead)	Coates et al. 2002
Maximum Weekly Maximum Temperature (MWMT)	>65°F MWMT (coho)	Welsh et al. 2001

MWMT and MWAT are used as quantitative measures to interpret the results of 2008 Temperature Monitoring in the Mattole. Maximum weekly average temperature (MWAT) is the highest value of the floating weekly average temperature. In other words, MWAT is the greatest mean of daily average temperatures over any 7-day period during the study (Brungs and Jones 1977). Maximum weekly maximum temperature (MWMT) is the highest average of maximum daily temperatures of any 7 days during the study period. MWMT and MWAT are used to evaluate chronic stress due to water temperature exposure, while maximum temperatures are used to evaluate acute thermal stress (50% survival) during short-term high temperature exposure.

Duration as well as severity of exposure to sub-lethal water temperatures affects long-term salmonid survival. Effects are cumulative; the longer the duration of thermal stress at sub-lethal

levels, the more negative the effects on long-term survival (Ligon et al., 1999). Duration of exposure to temperature stress in monitoring locations in the Mattole is evaluated based on the number of days maximum daily temperature exceeded >68°F.

Figure 2. Mattole Watershed



Source: Downie et al. 2003

Literature used to evaluate thermal habitat suitability for salmonids in the Mattole River and tributaries in this report includes laboratory studies of water temperature effects on salmonids and field studies of salmonid occurrence, abundance, and distribution in the field in relation to high temperature.

Brett (1952) determined biological temperature thresholds for Chinook and coho salmon based on physiological effects of water temperature in laboratory studies. Observations of salmonids in laboratory conditions indicated an upper lethal water temperature of 77°F for Chinook and coho salmon. Based on responses of fish to laboratory experiments, prolonged exposure to water temperatures greater than 68°F were determined as stressful to salmonids (Brett 1952).

Using upper lethal limit temperature and optimal temperature established in lab studies of coho and steelhead, Brungs and Jones (1977) calculated MWAT and short-term maximum temperature to quantify tolerances of salmonids to chronic and acute temperature exposure in the field during different life stages. Based on their lab results, they concluded growth was the life stage most sensitive to modified temperature due to the many physiological functions required. They determined acute short-term temperature thresholds (50% survival) were 74.7°F for coho and 75.0°F for steelhead. Salmonid distribution (in relation to temperature) observed during later field studies supported the accuracy of their predicted upper short-term thresholds. McCullough (1999) concluded that upper short-term temperatures of approximately 22-24° C (71.6-75.2°F) limit salmonid distribution. However, McCullough (1999) also noted that competitive interactions between fish species can limit salmonids at temperatures 2-4° C lower than the range of total elimination.

The Mattole Salmon Group and Redwood Sciences Laboratory completed a study comparing the distribution of juvenile coho salmon to temperature in 21 tributaries of the Mattole River in 2001 (Welsh et al.). The study found juvenile coho salmon only in tributaries with MWAT values less than 62.2º F, and MWMT values less than 64.6º F. MWAT is determined by the highest average of mean daily temperatures of any 7-day period, and MWMT is determined by the highest average of maximum daily temperatures over any 7-day period. Coho were found in 16 of the 18 streams surveyed including the mainstem Mattole.

In 2002, the State of California classified water quality in the Mattole as impaired due to sediment and temperature under the Clean Water Act, Section 303 (d). Impacts on the anadromous salmon fishery in the Mattole were identified as the primary adverse effect of elevated sediment load and temperature. All three species of salmonids in the Mattole are listed under the Endangered Species Act. The EPA established Total Maximum Daily Loads (TMDL) for Sediment and Temperature in the Mattole River in 2002. Coates et al. (2002) completed a literature review to determine temperature tolerance criteria for salmonids in the Mattole. MWAT was used as the primary statistical measure for interpretation of stream temperature conditions. Based on past lab and field studies, Coates et al. determined MWAT stream temperature values (See Figure 3) to characterize the temperature quality of surface waters in the Mattole River watershed.

Figure 3. Summary of temperature tolerances of coho salmon and steelhead (Coates et al. 2002).

Descriptor	Coho Salmon	Steelhead
Good	<15° C (<59.0° F)	<17° C (<63.0° F)
Marginal	15°-17° C (59.0°-63.0° F)	17°-19° C (63.0°-66.0° F)
Poor/Unsuitable	>17° C (63.0° F)	>19° C (>66.0° F)

Many of the Mattole's tributaries and portions of its mainstem exceed 80º F during the summer months when the flow is low and solar radiation is high. "However, discrete areas of colder water can be created by tributaries, groundwater seeps, inter-gravel flow, deep pools, and areas separated from currents by obstructions" (Nielsen et al, 1994). Salmonids are able to access these pockets of colder water, called thermal refugia, as an avoidance strategy to survive during periods of elevated temperatures. "The existence of these thermal refugia allows salmonids to persist in these reaches of otherwise poor or marginal habitat (Coates et al. 2002)."

Mattole Salmon Group temperature and dive monitoring establishes presence and distribution of salmonids in relation to water temperatures and identifies thermal refugia and cool-water tributaries throughout the watershed. The decrease in quality and extent of freshwater habitat has inevitably resulted in considerably reduced run strength, particularly for Chinook and coho native to the Mattole River.

Now completing our fourteenth year of temperature monitoring in the Mattole's tributaries and mainstem, the Mattole Salmon Group has begun to identify trends in the consistent presence and absence of juvenile salmonids at certain locations in the watershed, and how species presence correlates to summertime water temperatures.

Project Goals

Staff of the Mattole Salmon Group identified the following goals for water temperature monitoring in the Mattole watershed:

1. Establish reference points, to determine how temperatures at set locations with relatively stable conditions change from year to year.
2. Help determine where and when water temperatures are stressful or lethal to salmonids, and where refugia are located when temperatures spike.
3. Document temperatures prior to and/or subsequent to timber harvest in specific locations.
4. Help determine where instream restoration and revegetation projects are best directed.
5. Monitor and document recovering tributaries.
6. Monitor and document refugia in the lower mainstem Mattole.
7. Locate and document cold-water areas (in predominantly warm reaches of stream), such as seeps and cold stratified pools.
8. Monitor lower and middle river tributaries to establish which tributaries offer cool-water over-summering habitat where the mainstem reaches high temperatures.
9. Monitor temperature at low-flow monitoring locations in the headwaters.
10. Monitor streams to establish to establish coho presence/absence in relation to temperature and other water quality parameters.

11. Monitor streams and mainstem locations to determine Chinook over-summer distribution in relation to temperature and other water quality parameters. Develop threshold temperature standards for Chinook in the Mattole Watershed.

Each monitoring site was chosen according to its ability to meet one or more of the above goals. The overall goals in 2008 were to collect baseline data in tributary reference locations, evaluate ambient river temperatures in the mainstem, and document conditions and salmonid habitat utilization in tributaries.

Seven sites in the upper Mattole River were also chosen for temperature monitoring in conjunction with low-flow and dissolved oxygen monitoring in the headwaters. In recent years, flows in the headwaters of the Mattole have subsided to mere groundwater flows and become a series of disconnected pools. Sites were identified in the upper mainstem with suitable temperatures for juvenile salmonid over-summering and areas where temperature in the upper mainstem exceeds thresholds for juvenile survival.

Procedures

Temperature Logger Calibration

Temperature loggers operate under battery power for the duration of the field season. Loggers contain a microchip, which records electronic data generated by a sensing device. Calibration tests before field placement were done to verify that each device operated within the manufacturer's specified limits (+/- 0.5° C). Loggers that deviated from this range upon testing were not placed in the field. The same calibration process was performed with loggers after they were retrieved. Data that deviated from the acceptable accuracy range were discarded.

Loggers were calibrated using the following procedure:

1. All recording thermometers were launched to record temperature every 10 seconds.
2. All recording thermometers and a laboratory-certified calibration thermometer were placed in an ice chest filled with ice water. The ice water was stirred every two minutes.
3. The time and indicated temperature of the calibration thermometer were recorded every five minutes for 30 minutes.
4. Recording thermometers were taken out of the ice chest.
5. Data were downloaded from each temperature logger and examined to ensure proper function of each recording thermometer. Loggers that recorded temperatures that deviated more than +/- 0.5ºC from the temperatures recorded at the same time by the calibration thermometer were not used in the field.

Logger Installation

Instream temperature loggers were placed 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, riffles, or heads of pools, but not in slack water, backwater pools, at the bottom of pools (except when measuring for stratification) or in shallow riffles that may become exposed. Loggers were also placed out of direct sunlight. Using nylon cord, and in some cases rocks, temperature loggers were secured in locations where they would not be dislodged during high flows and were hidden or camouflaged from human detection.

The Optic Stowaway, Hobo Water Temp Pro, and Tidbit loggers were launched to record hourly temperature for the duration of the field season. On "Rite-in-the-Rain" field forms, the following information was recorded when each logger was placed, and when applicable, when it was retrieved: time, date, air and water temperature taken by hand-held thermometer, 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.

Data Management

Each temperature logger was launched with its serial number and placement location recorded. All data was downloaded in Boxcar Pro software and exported to Excel, and data was stored in both formats. Field location, serial number, date of placement, and date of retrieval were recorded in a separate Excel file (Table 1). Data that deviated significantly from the expected range or from previously obtained data from that site was evaluated for accuracy and adherence to placement protocols. In Excel, all data obtained prior to, and following removal from field placement (when the monitor was not in its field position) was discarded and removed from the data file. This process is also known as "trimming" the data. "Trimmed" and "raw" data were stored in separate files.

Boxcar Pro temperature data files were also uploaded into Klamath River Information System for the Mattole River (KRIS Mattole). 2008 Temperature monitoring data were appended to the 2000-2007 temperature source table. New KRIS topics were created with updated information for all 2008 Temperature Monitoring locations. Figures from the KRIS database were used to analyze and interpret results during the 2008 season and over the course of 2000-2008 temperature monitoring in the Mattole.

Snorkel Survey Methods

Our temperature-related snorkel surveys followed a modified ten-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 Mattole Salmon Group's snorkel surveys was limited by project funding and in some streams by lack of landowner permission. It was often unfeasible to survey reaches in the lower, middle and upper areas of a stream. At many monitoring sites only a short stretch of stream could be accessed, sometimes less than ten consecutive pools. In many instances, accessible survey reaches did not contain ten pools with relatively suitable coho habitat. Therefore, when a species was not observed in a sampling that was less complete than that employed in the above-mentioned modified ten-pool protocol, that species could not justifiably be declared "absent" in an entire stream.

Another way in which the Mattole Salmon Group's temperature-related snorkel surveys differed from a standard modified ten-pool protocol, is that when a coho salmon was sighted, the survey continued until ten pools, or the maximum number of pools possible, were surveyed. This allowed for a broader sampling of relative abundance.

Results and Discussion

Basinwide

Floating Weekly Maximum Temperatures in many locations were above thresholds set for coho presence by Welsh et al. (2001). Additionally, Maximum Weekly Average Temperatures in many mainstem monitoring locations, especially in the middle and lower river, indicated unsuitable thermal habitat for steelhead and coho (Coates et al. 2002).

2008 was a low water year. The low flows affected the pattern of river mouth closure, which was earlier and more erratic than usual for the Mattole. Initially, the mouth closed in mid-May. The mouth then reopened and closed for the duration of the summer from June 7th to October 4th. On October 5th, the mouth opened, but closed and opened again several times until November 1st, when it remained open for the winter. The early date of initial closure and number of open/close cycles was no doubt stressful for emigrating juveniles, delaying ocean migration for some and forcing many to remain in the lower river and estuary over-summer. By comparison, in 2007 the mouth remained open until July 3.

The MSG was able to monitor salmonids over-summering in the lower river and estuary via weekly dive surveys. Many Chinook were observed in the lower section of river downstream of the Hideaway Bridge (RM 5.2). Divers saw many more inhabiting the Mattole estuary. In the estuary, the upper section and left bank were the most utilized habitats.

Daily Average streamflow in the Mattole at Petrolia in summer 2008 was noticeably less than median streamflow based on 60 years on record for most of the summer (Data from USGS). Streamflow fell below 100 cubic feet per second in the mainstem Mattole River at Petrolia by mid-June, which was slightly earlier than last year but much earlier than the previous two years when there were late spring rains (See Figure 4). Temperatures at many temperature monitoring locations reached their maximum on July 9th or 10th. MWATs at the majority of monitoring sites were recorded for the weeks beginning the 4th - 8th of July. The warmest water temperatures in 2008 were on average a couple of weeks earlier than last year, which is likely related to the lower flows.

The lower Mattole is characterized by its aggraded river channel and lack of riparian vegetation to provide shelter from solar radiation. The basinwide maximum temperature is recorded in the lower Mattole mainstem during most years. The highest water temperature recorded in 2008 was 82.53° F, which occurred in the mainstem Mattole River upstream of Squaw Creek (RM 15) on July 10th. The maximum temperature recorded in 2007 was slightly higher; in the mainstem Mattole at Clear Creek (RM 6.1), temperature reached 83.15° F on 7/23/07. Peak 2008 temperatures were warmer than average temperatures since 2000 in locations with multiple years of record, but cooler than many maximum temperatures recorded in 2006, probably the warmest of recent years.

The lowest maximum water temperature (59.1°F) was recorded in the Mattole headwaters just downstream of Ancestor Creek (RM 60.8) on 7/10/08. The seasonal maximum temperatures at most monitoring locations were reached either between 7/9-7/10/08, 8/15/08, or on 8/28/08. The seasonal maximum water temperatures corresponded to peaks in air temperatures throughout the

Watershed (Figure 5). Air temperatures in the Mattole Estuary were usually cooler than air temperatures in Ettersburg or Whitethorn.

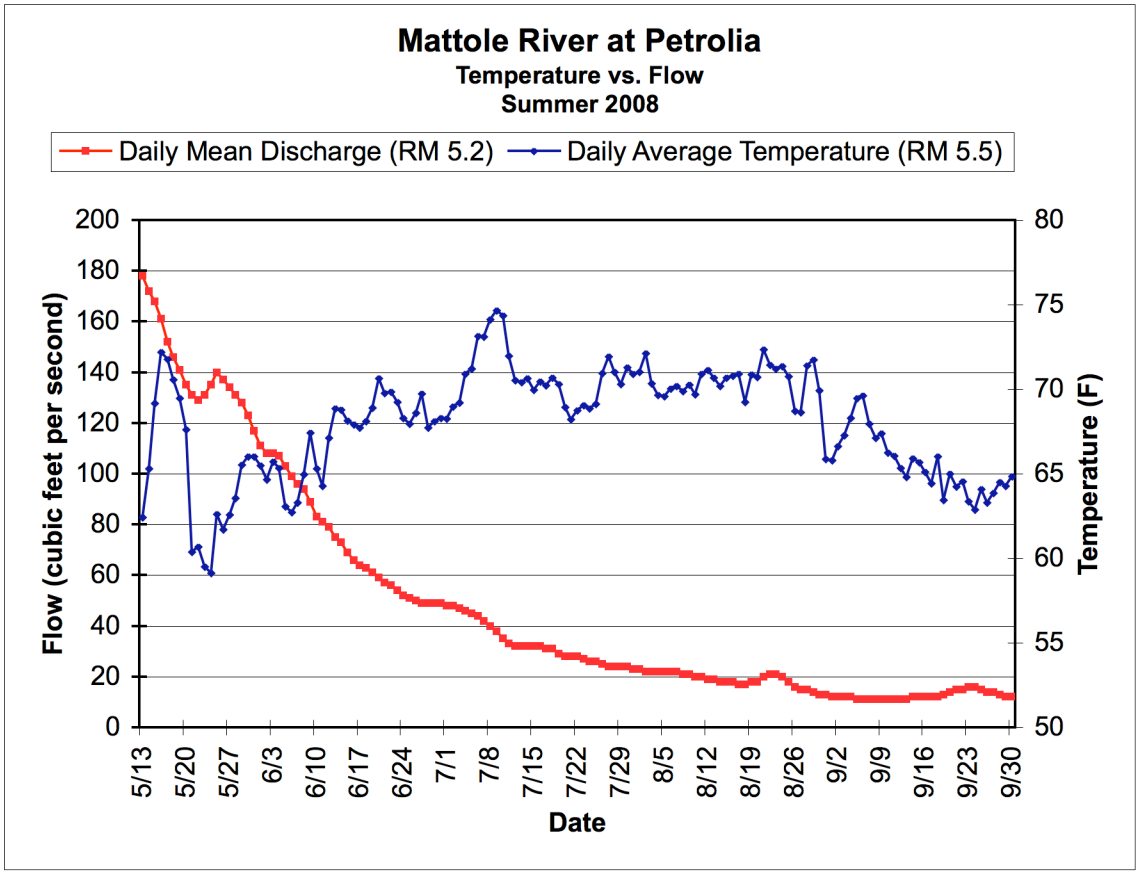


Figure 4. Daily Average Streamflow vs. Daily Average Temperature in the Mattole River at Petrolia (Summer 2008).

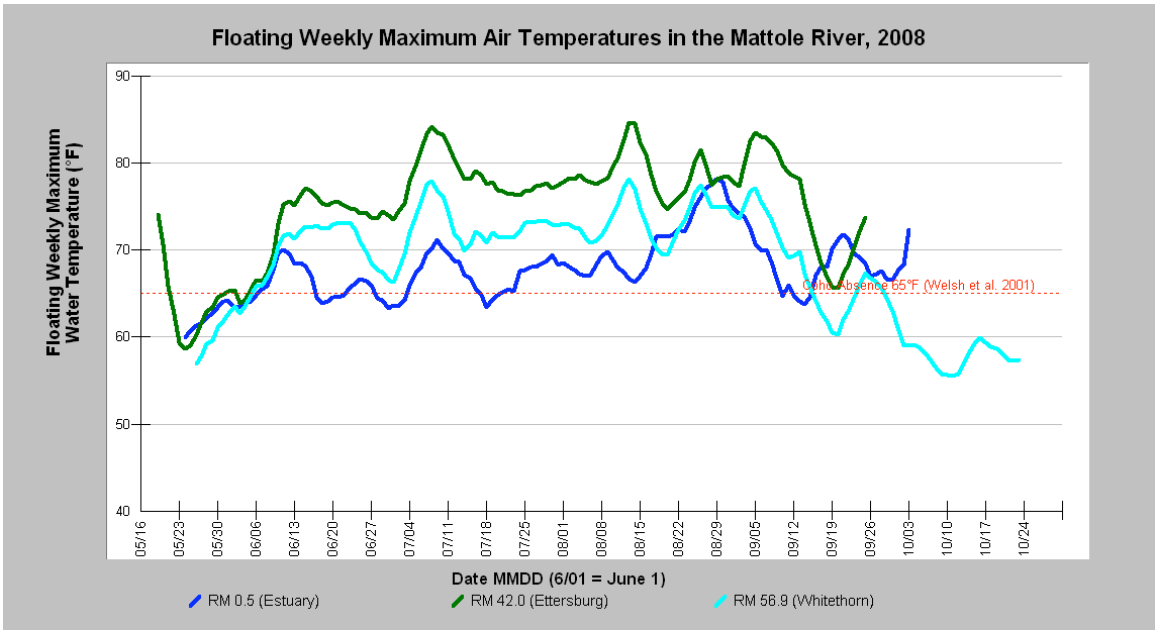


Figure 5. 2008 Floating Weekly Maximum Air Temperatures in the Mattole Watershed.

Upper Mainstem Mattole

In 2008, thirteen temperature monitoring locations were selected in the upper Mattole to determine locations with suitable temperatures for juvenile salmonid over-summering in the upper mainstem (Table 1).

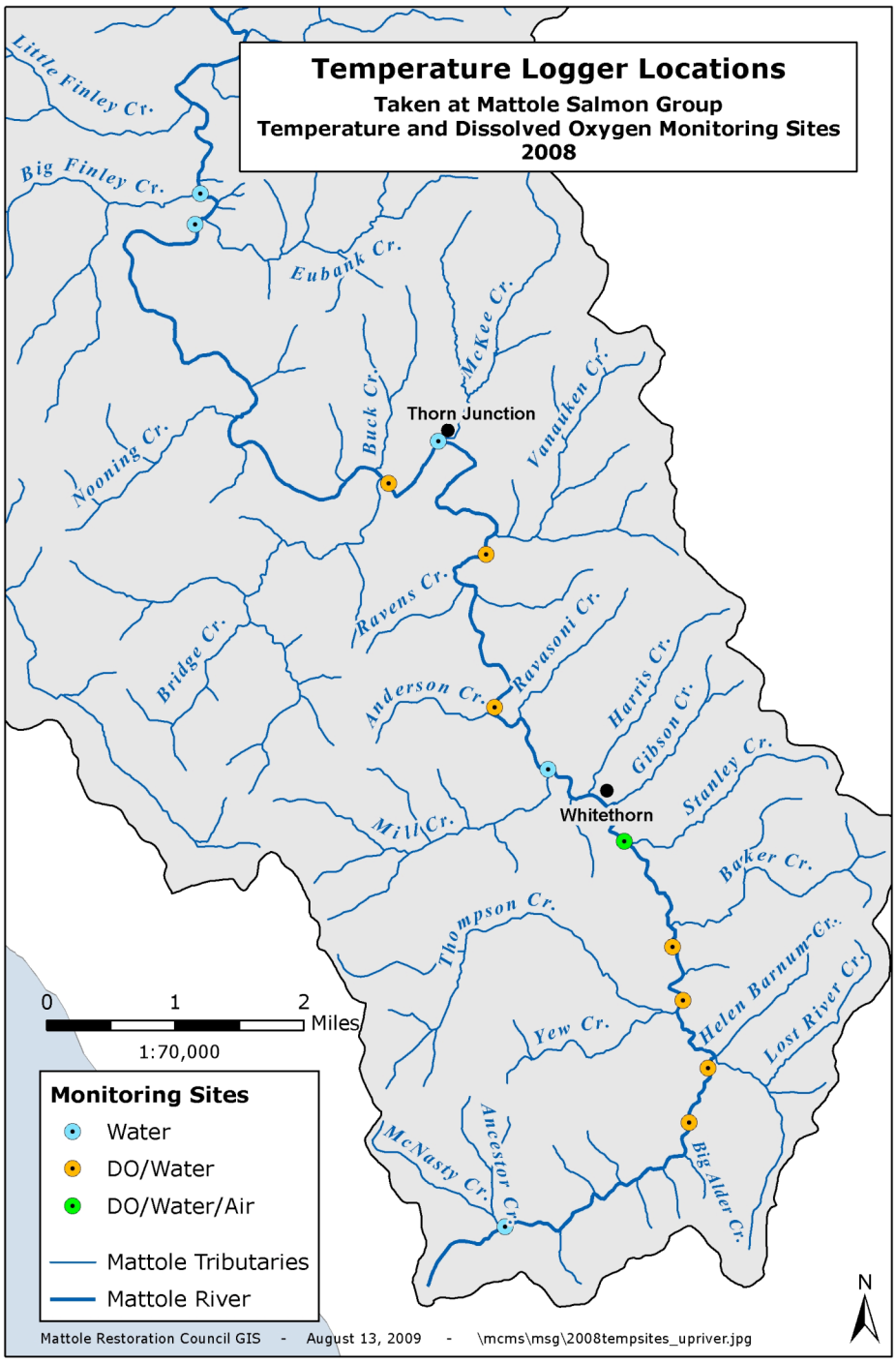


Figure 6. Upper Mattole Dissolved Oxygen and Temperature Monitoring Locations.

Eleven of thirteen upper Mattole temperature monitoring sites were in the southern subbasin (upstream of Bridge Creek, RM 52.1). Two downstream sites were the Mattole at the Big Finley Creek pool (RM 47.4) and upstream of Eubanks Creek (RM 47.8). Eight sites (MS-1 (RM 59.4), MS-2 (RM 58.8), Mattole us Thompson Creek/MS-3 (RM 58.5), Mattole us Baker Creek (RM 57.8), Mattole at Stanley Creek/MS-4 (RM 57.1), Mattole us Anderson Creek (RM 55.6), MS-5 (RM 53.0), and MS-6 (RM 52.2)) were selected in conjunction with MSG dissolved oxygen monitoring of the Mattole headwaters (Figure 6). Temperature monitoring at RM 60.8 (just downstream of the confluence of the Mattole and Ancestor Creek) provided information regarding temperatures near the Mattole headwaters (Figure 7). Mattole at Metz Bridge (RM 56.9) was chosen as the main reference location for water and air temperatures in Whitethorn due to continuous monitoring since 2002. Mattole at Junction Hole (RM 52.7) was another mainstem reference location with multiple contiguous years of past data.

2008 floating weekly maximum temperatures recorded at Metz Bridge (RM 56.9), the upper Mattole reference location, were similar to 2007, with the peak of temperature occurring approximately two weeks earlier this year. In comparison to 2002-2005 temperatures, temperatures recorded in 2007 and 2008 were moderate. 2006 temperatures were the highest on record (Figure 8).

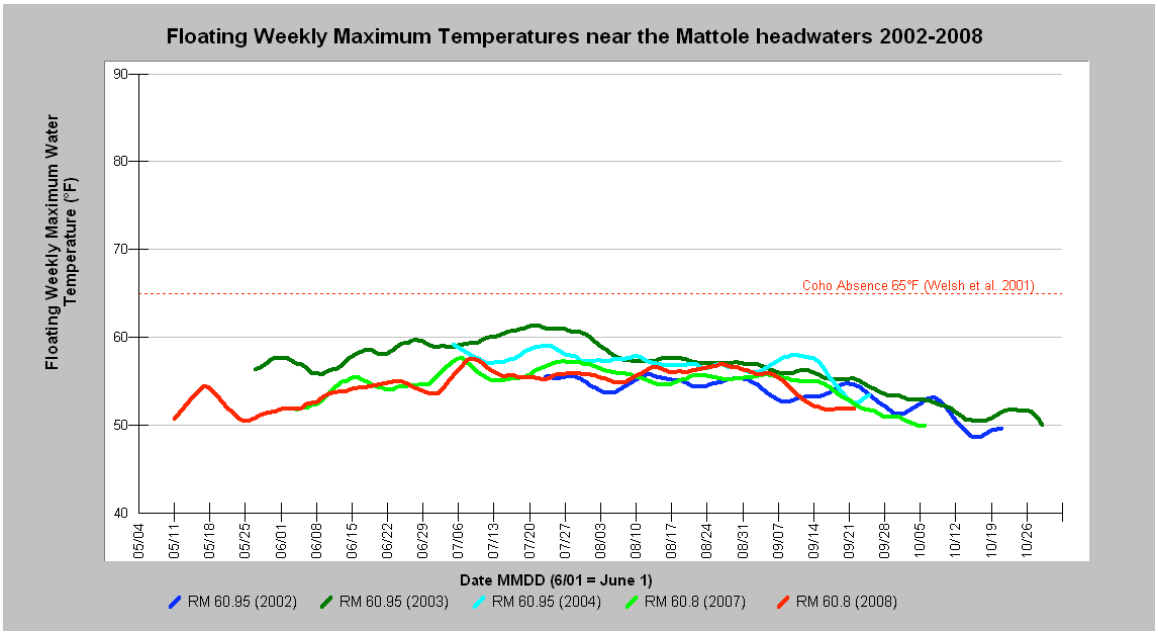


Figure 7. 2002-2008 floating weekly maximum water temperatures near the Mattole headwaters.

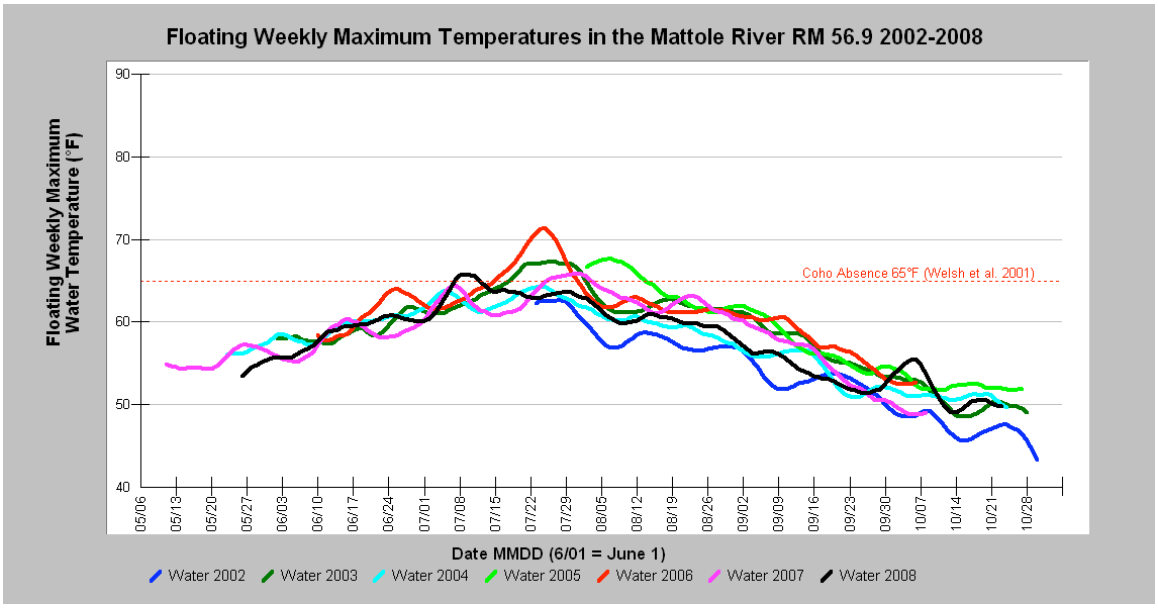


Figure 8. 2008 floating weekly maximum water temperatures in the Mattole at River Mile 56.9.

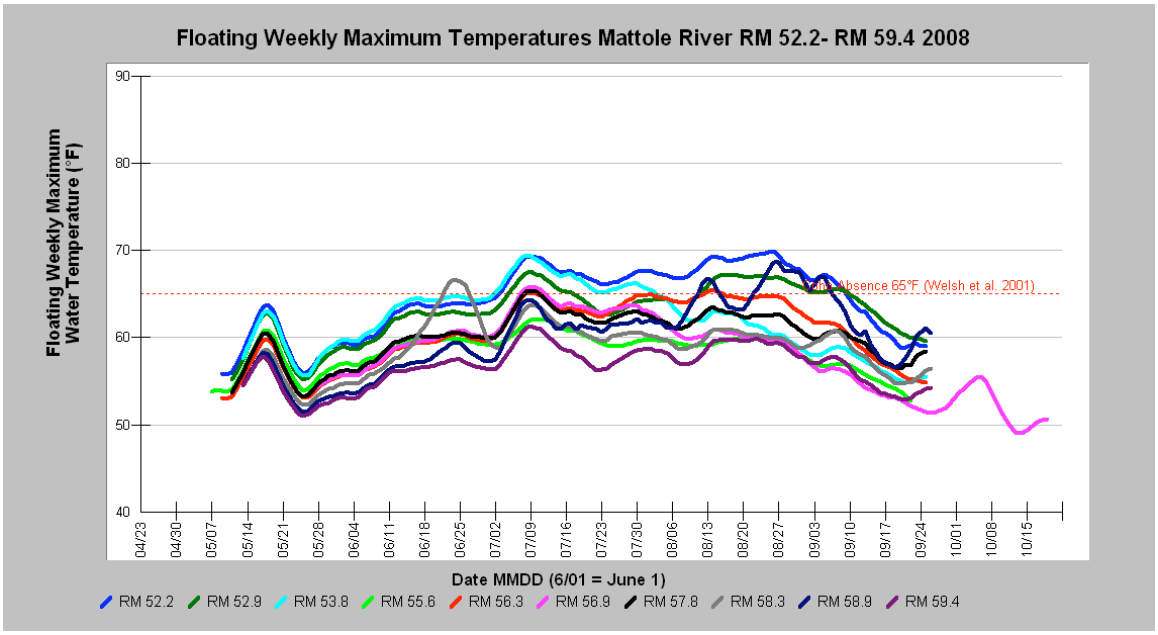


Figure 9. 2008 floating weekly maximum water temperatures at Mattole mainstem temperature monitoring locations in the southern subbasin, River Mile 59.4 to River Mile 52.2. Sites listed downstream (left) to upstream (right). See Table 1 for more information on locations.

Floating Weekly Maximum Temperatures exceeded 65°F in seven of twelve water temperature monitoring locations with available data, indicating unsuitable temperatures for coho rearing (Welsh et al. 2001) (Figures 7, 8, and 9). Temperatures warmer than the coho threshold occurred in the upper mainstem during peak temperatures in mid July until as late as September depending on location. Upper Mattole locations where temperatures surpassed 65°F MWMT included

Mattole at Baker Creek (RM 57.8), Metz Bridge (RM 56.9), Mattole upstream of Upper Mill Creek (RM 56.3), MS-5 (RM 53.8), Mattole at Junction Hole (RM 52.9), and MS-6/Mattole upstream of Bridge Creek (RM 52.2), and Mattole at Big Finley Creek (RM 47.4).

Loggers at two monitoring locations (MS-2 and MS-3) recorded temperatures above the coho threshold only while the loggers were out of water due to low flow in late June (MS-3) and after mid-August (MS-2). The two uppermost temperature monitoring locations (MS-1 at RM 59.4 and Mattole at Ancestor Creek at RM 60.8) and the deep pool upstream of Anderson Creek (RM 55.6) also remained cool enough for rearing coho for the duration of the season. Results were similar to temperatures recorded in the upper mainstem in 2007.

Downstream of the southern subbasin, Floating Weekly Maximum Temperatures recorded in the Mattole at the Big Finley Creek pool (RM 47.4) surpassed the 65°F threshold for coho rearing just slightly during peak temperatures in mid-July (Welsh et al. 2001) (Figure 10). The temperature logger upstream of Eubanks Creek (RM 47.8) was in a shallower location representative of less favorable over-summering habitat, but data was irretrievable. Last year, temperatures upstream of Eubanks Creek were warmer than ideal for coho over-summering, emphasizing the importance of deep pool over-summering habitat even in the upper river.

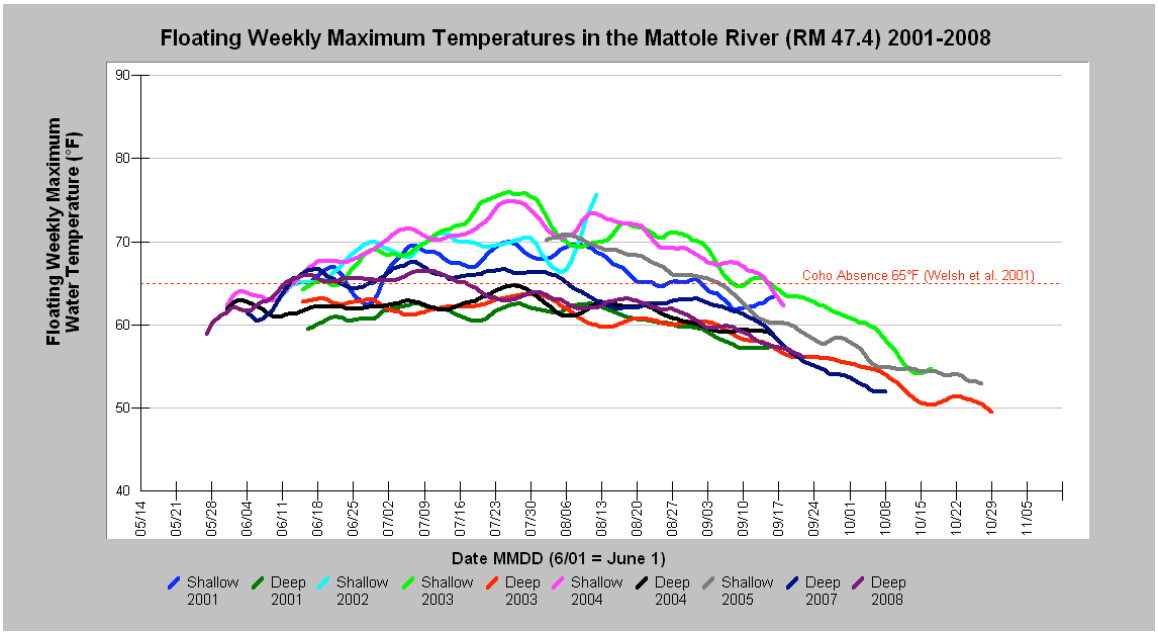


Figure 10. 2002-2008 floating weekly maximum water temperatures in the Mattole at the Big Finley Creek pool (RM 47.4).

2008 maximum weekly average temperatures also exceeded thresholds for rearing salmonids. Four of the most upstream temperature monitoring locations, the Mattole headwaters (downstream of Ancestor Creek at RM 60.8, 56.33°F), MS-1 (RM 59.4, 59.76°F), MS-2 (RM 58.8, 60.76°F), and upstream of Thompson Creek (RM 58.6, 61.58°F) had suitable over-summering temperature for both juvenile coho (<63°F) and steelhead (<66.0°F), based on temperature tolerance criteria developed by Coates et al. 2002. The deep pool at Anderson Creek (RM 55.6, 60.97°F) also remained cool enough for over-summering coho based on its

MWAT. MWATS recorded in the pool at Big Finley Creek (RM 47.4, 64.91°F), Mattole upstream of Baker Creek (RM 57.8, 63.40°F), at Metz Bridge (RM 56.9, 63.73°F), and upstream of Upper Mill Creek (RM 56.3, 63.18°F) were just slightly warmer than the coho threshold, but cool enough for steelhead. MS-5 (RM 53.8, 66.07°F), Junction Hole (RM 52.7, 66.10°F), and MS-6 (RM 52.2, 67.00°F) exceeded favorable temperatures for both coho and steelhead (>66.0°F, Coates et al. 2002).

In 2007, the same four temperature monitoring sites showed suitable MWATs for coho (Coates et al. 2002). 2006 was the warmest of recent years, and no monitoring sites had a MWAT suitable for coho. Some sites upstream of McKee Creek (RM 52.7) had MWATs as high as 69°F in 2006.

Maximum temperatures recorded at all sites upstream of RM 47.4 were below 75.0°F, the short-term lethal temperature for survival. Temperatures were cooler at sites farther upstream and in deeper pools. During the peak heat, temperatures exceeded thresholds for a short time period, but were usually favorable in most locations. Maximum temperatures greater than 68°F occurred for 23 days at MS-6 (RM 52.2), 6 days at MS-5 (RM 53.8), and 4 days at Junction Hole (RM 52.9).

Snorkel surveys in the upper headwaters in summer 2008 confirmed the presence of coho in mainstem locations from RM 60.8 to RM 52.1, indicating the possibility that coho may be able to persist in a reach if floating weekly maximum temperatures do not exceed 65°F for a lengthy time period.

The upper Mattole provides the majority of thermally suitable mainstem over-summering habitat for juvenile salmonids. Temperatures in the upper river are significantly cooler than in the lower mainstem due to a variety of reasons including aggradation, insufficient habitat, and riparian dysfunction in the lower river. Temperatures above or near juvenile salmonid MWAT and MWWT thresholds indicates over-summering salmonids in most areas of the upper mainstem experience stress due to chronic exposure to warmer than optimal rearing temperatures but are not subject to acute thermal stress. Some locations in the upper mainstem, especially upstream of RM 54.0, showed suitable temperatures for juvenile survival and growth. Only the uppermost temperature monitoring locations were suitable for coho; more areas are thermally suitable for steelhead survival due to their greater temperature tolerance.

Despite favorable temperatures in the uppermost mainstem, issues with low-flow have depleted available habitat in the coolest areas of the mainstem. In recent years, many of the coolest areas of the upper mainstem have dried to a series of disconnected pools. Further effort is underway to monitor flow in addition to dissolved oxygen and other water quality parameters to further quantify risks to salmonids in these critical rearing reaches.

In 2008, drought conditions in tributaries were exceptional compared to past years. Near the Mattole headwaters, the river was dried to a series of isolated pools. Three upper Mattole temperature monitoring locations from RM 58.9 to RM 60.8 (Mattole ds Ancestor Creek, MS-1 and MS-2) were located in the area most compromised by low flows. Surveyors noted very low water and/or poor water quality due to low flows at several more upper Mattole monitoring

locations, including Mattole us Upper Mill Creek (RM 56.3), Mattole us Anderson Creek (RM 55.6), MS-5 (RM 53.8), Mattole at Junction Hole (RM 52.9), and MS-6 (RM 52.1).

Most smaller tributaries had little to no flow by fall in 2008. Some creeks, especially in the upper Mattole, are often dry by fall. This year, however, more drainages were found dry, some for the first time on record. Surveyors in fall 2008 noted the following tributaries were completely dry at their confluence with the Mattole: Lower Bear Creek (RM 1.0), Stansberry Creek (RM 1.3)*, Lower Mill Creek (RM 2.8)*, Woods Creek (RM 24.1)*, Fourmile Creek (RM 34.6)*, Sholes Creek (RM 36.6)*, Eubanks Creek (RM 47.7), McKee Creek (RM 52.8), Anderson Creek (RM 55.6), Lost River Creek (RM 58.8), and Ancestor Creek (RM 60.8). Creeks marked with an asterisk were uncharacteristically dry.

Additional creeks with notable low flow conditions in fall 2008 included Thompson Creek (RM 58.4, 1.25gpm), Baker Creek (RM 57.6, most of snorkel reach dry), Upper Mill Creek (RM 56.2, 10gpm), Van Arken Creek (RM 54.0, most of snorkel reach dry), Bridge Creek (RM 52.1, 10gpm), Squaw Creek (RM 14.9, small pools or non-existent), and Conklin Creek (RM 7.8, just a trickle). Two loggers were found out of water due to low flow this fall, Mattole at Honeydew Creek (RM 26.5) and Stansberry Creek (RM 1.3 +~0.2), while others were left in remaining pools as the water receded.

Lower and Middle Mainstem Mattole

Fifteen sites in the Mattole were monitored to establish typical ambient water temperatures throughout the middle and lower mainstem. Sites were upstream of tributaries or in areas of interest like the downstream migrant trap. In comparison to the upper mainstem, floating weekly maximum temperatures in the middle and lower mainstem were significantly higher. All sites in the mainstem downstream of RM 47.4 exceeded 65°F MWMT for the majority of the time period monitored, indicating lack of suitable coho habitat (Figures 11-12).

2008 maximum weekly average temperatures (MWAT) in mainstem Mattole temperature monitoring sites downstream of river mile 47.4 also indicated lack of favorable over-summering habitat for juvenile salmonids. MWATs in fourteen sites in the middle and lower mainstem exceeded threshold temperatures for both juvenile coho and steelhead presence (>63.0-66.0°F MWAT, Coates et al. 2002). The temperature logger in the Mattole upstream of Stansberry Creek (RM 1.3) was irretrievable, so all fifteen sites may have exceeded the MWAT threshold, but it is hard to say. This site was notably cooler than other lower mainstem locations in 2007, due to the influence of inputs of cool water from Stansberry Creek, which was not far downstream.

Maximum weekly average temperatures in the lower and middle Mattole temperature monitoring sites ranged from 71.41°F in the Wingdam, a restoration site adjacent to the MSG Office (RM 2.9), to 75.87°F (Mattole us Fourmile Creek, (RM 34.6)) in summer 2008. Notably, in 2007 the highest MWAT (75.5°F) was also recorded upstream of Fourmile Creek (RM 34.6), demonstrating the poor thermal habitat found in the middle river. Most MWATs in the middle and lower mainstem were between 71-74°F, well above suitable thresholds for salmonids. MWMTs and MWATs above threshold temperatures suggest juvenile salmonids are unlikely to

persist in the mainstem downstream of river mile 47.4 due to chronic temperature stress and indicate the importance of thermal refugia and tributaries for over-summering.

Maximum temperatures recorded in thirteen of fourteen Mattole mainstem monitoring sites downstream of Big Finley Creek (RM 47.4) to Stansberry Creek (RM 1.3) exceeded 75.0°F, indicating acute temperature stress and possible lethal effects on salmonids (50% survival, Brungs and Jones 1977) (See Figure 11 and 12). The highest maximum temperature of any location was 82.53°F upstream of Squaw Creek at RM 15. The coolest seasonal maximum temperature of any site in the lower river was 77.77°F, recorded deep in the Wingdam at RM 2.9. Daily maximum temperatures in middle to lower mainstem sites exceeded 68°F for a significant time period in summer 2008, thus salmonids were exposed to prolonged as well as acute temperature stress (Table 1).

The site upstream of Honeydew Creek (RM 26.5) was the only lower/middle mainstem site with a maximum temperature below the lethal level, and it was only lower by fractions of a degree (74.86 °F). The MWAT in this location was cooler than other lower Mattole sites (69.12°F), but the logger was out of water since July 1, so it is likely this did not represent the true peak temperature.

Ambient temperatures recorded suggest lack of suitable thermal habitat for all species of juvenile salmonids in the mainstem downstream Big Finley Creek (RM 47.4). Juvenile salmonids in the middle and lower river encounter acute as well as chronic temperature stress. Their long-term survival is threatened by exposure to lethal temperatures and/or decreased growth rates due to high metabolic demands at higher water temperatures.

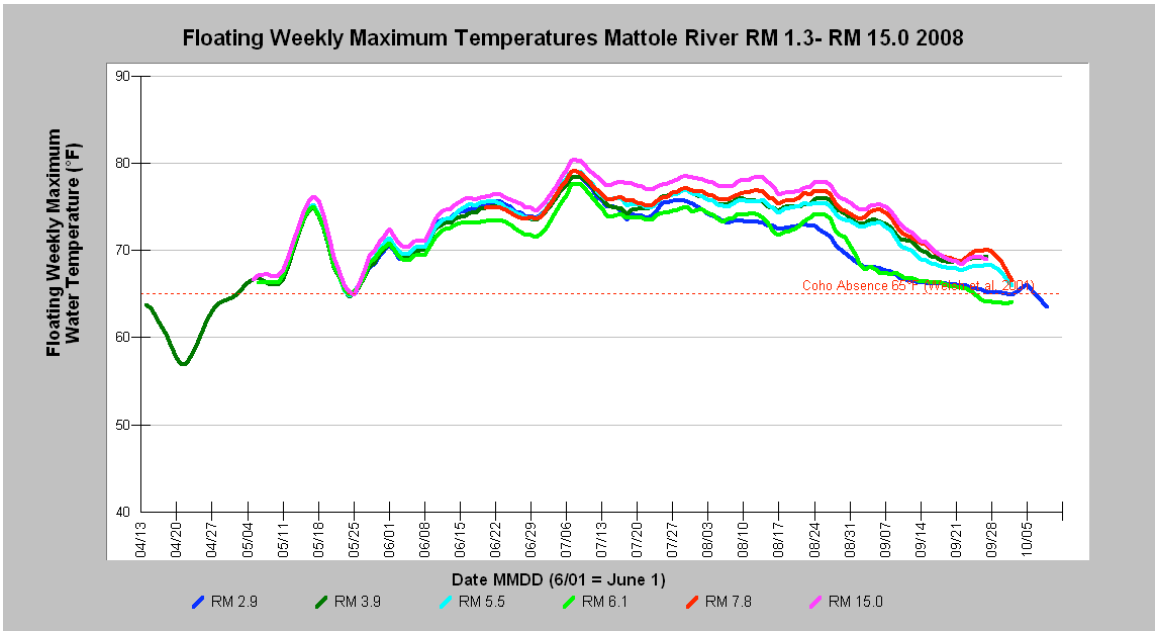


Figure 11. 2008 floating weekly maximum water temperatures at temperature monitoring locations in the Mattole mainstem, River Mile 1.3 to River Mile 15.0. Sites listed downstream (left) to upstream (right). See Table 1 for more information on locations.

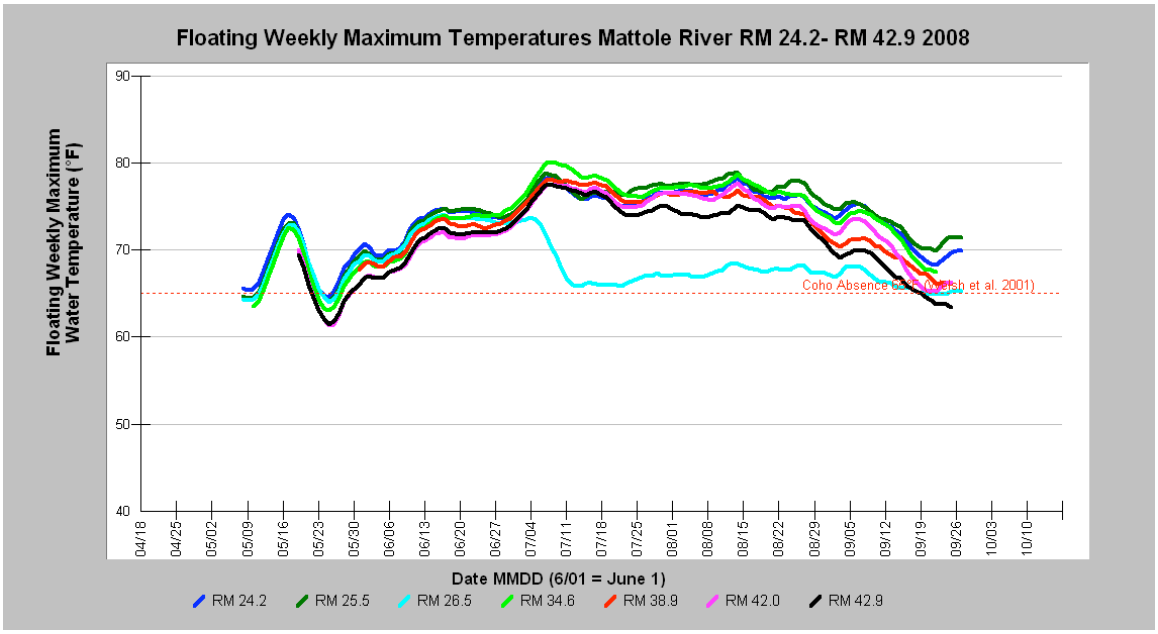


Figure 12. 2008 floating weekly maximum water temperatures at temperature monitoring locations in the Mattole mainstem, River Mile 24.2 to River Mile 42.9. Sites listed downstream (left) to upstream (right). See Table 1 for more information on locations. (As the water became extremely low this year, the logger upstream of Honeydew Creek was out of water and recording air temperatures from July 1).

2008 temperature monitoring results indicate the importance of thermal refugia such as cold pools, seeps, and cool-water tributaries for salmonids over-summering in the middle and lower mainstem. Temperatures recorded at the Wingdam, a deep pool created by a restoration project adjacent to the Mattole Salmon Group Office, demonstrate how much thermal conditions for over-summering salmonids can vary in pockets of more favorable habitat. While the maximum temperature shallow in the pool reached 80.49°F, deep in the pool the maximum temperature was nearly three degrees less (77.77°F). Thermal refugia such as stratified pools, cold seeps or cool-water tributaries are essential for salmonid survival in the lower and middle Mattole over the summer months.

The Mattole Estuary

Historically, the Mattole estuary provided deep pools and favorable over-summering habitat for juvenile salmonids. Due to channel aggradation and almost complete absence of riparian cover, pools or any sort of favorable habitat or complexity, the estuary now represents a "gauntlet" for migration to the ocean and is no longer viable over-summering habitat for Chinook salmon. The state of the Mattole Estuary has been determined a major limiting factor to recovery of salmonid populations in the basin (MRC 1995).

MSG divers observe steelhead and Chinook, and usually small numbers of coho, in the estuary in the early summer every year. By late summer, few Chinook remain. In years when the mouth is open into mid-summer, most Chinook migrate to the Ocean, but when the mouth closes earlier in the summer, habitat is poor for survival. Data from the DSMT suggest that when Chinook do

migrate to the ocean prior to mouth closure, it is at a substandard size for ocean survival (MSG 2007, Reimers 1973).

The MSG in cooperation with the USFWS initiated the first continuous multi-parameter water quality investigations using datasondes in the Mattole estuary in 2006. Concurrent dive monitoring monitored over-summer salmonid utilization at six different areas of the estuary. Because salmonids are exposed to all water quality parameters at once, effects may be cumulative. Additional factors limiting salmonid survival and growth in the estuary over-summer include food availability and predation.

Results of multi-parameter water quality monitoring in the estuary suggest water temperature is one of the most important parameters affecting the suitability of the Mattole River lagoon for rearing salmonids. Water temperature influences juvenile salmonid growth, competition among species, and vulnerability to parasites, diseases and pollutants (Armour 1991). 2008 WMT temperature data recorded throughout the estuary suggest thermal conditions were sub-optimal for the positive growth and rearing of juvenile salmonids, especially following river mouth closure (Figure 13).

MWATs also indicated both the upper and lower estuary were not suitable for positive growth of juvenile salmonids, although temperature data indicated that thermal conditions in the lower lagoon were more favorable than in the upper portions of the lagoon. The coolest locations in the Estuary were along the right bank in Collins Gulch and along the left bank (Area 4). The logger along the left bank recorded the coolest maximum temperature (75.79°F), while the coolest MWAT was found in Collins Gulch (Area 2) (69.97°F).

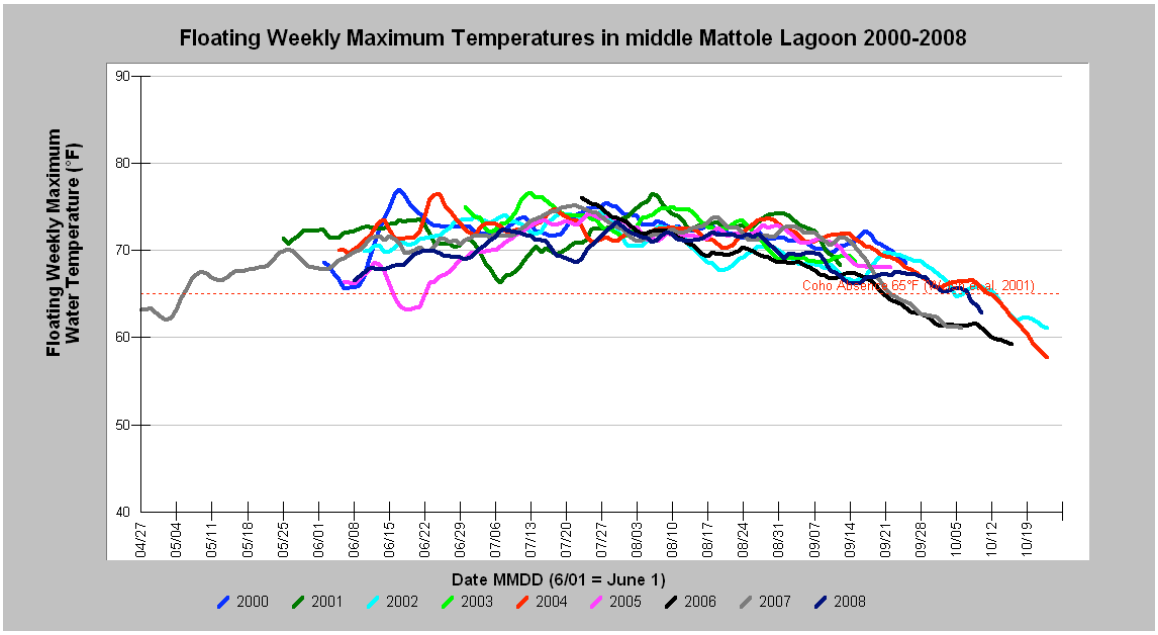


Figure 13. Floating Weekly Maximum Temperatures in the Mattole Estuary, 2000-2008.

Competition for habitat and scarce resources also plays a part in salmonid utilization of the lagoon and their over-summer survival. Despite more favorable temperatures in the lower lagoon, more

Chinook have consistently been observed in the upper lagoon. MSG divers have hypothesized the more abundant cover and food available in the upper lagoon may cause salmonids to over-summer here despite the warmer temperatures.

Weekly dive surveys have documented the complete decline of thousands of Chinook over the summers of 2007 and 2008. In 2007, an unprecedented, unseasonable rain fell throughout the watershed on July 18. On July 25, MSG divers noted an entirely unexpected phenomenon: a pulse of over 17,000 juvenile Chinook were observed in the estuary. MSG divers had been observing between 3,000 and 6,000 Chinook during prior surveys. MSG believes the Chinook exited the headwater reaches where they had been holding, perhaps mobilized by impulses that anticipated a river mouth opening. Due to poor rearing conditions in the estuary and the threat of competition for scarce resources, the MSG was immediately concerned about the possibility of a major decline in the newly enlarged juvenile Chinook population before the mouth opened, not expected until late October. Further dive surveys in 2007 confirmed a nearly a complete decline in observed Chinook. By the last dive (10/2/07) prior to mouth opening, only one Chinook was observed. MSG divers and HSU students have documented declines of salmonid populations in the estuary in past years as well, but none were so well documented by frequent dive observation as the decline in 2007.

In summer of 2008, additional habitat improvements were constructed. Salmonids were observed utilizing the structures, in addition to other habitat with cover. The distribution was similar to that observed in past years. Most salmonids were found along the left bank, in Collins Gulch, and in the upper lagoon. Few salmonids were observed in the lower lagoon.

The river mouth closed relatively early, on June 7, 2008. Salmonids in the estuary were trapped for the remainder of the summer until the mouth remained open on November 1, 2008. The greatest numbers of Chinook (16,490) were observed on July 1. Chinook counts fluctuated over the month of July depending on visibility. By the 6th of August, observations had fallen to 11,186 Chinook, and divers began to notice the condition of the surviving Chinook was deteriorating. Divers noted Chinook became increasingly emaciated as the season progressed, indicating food availability and/or energetic constraints to feeding at high water temperatures may be a key factor limiting over-summer survival of Chinook in the estuary.

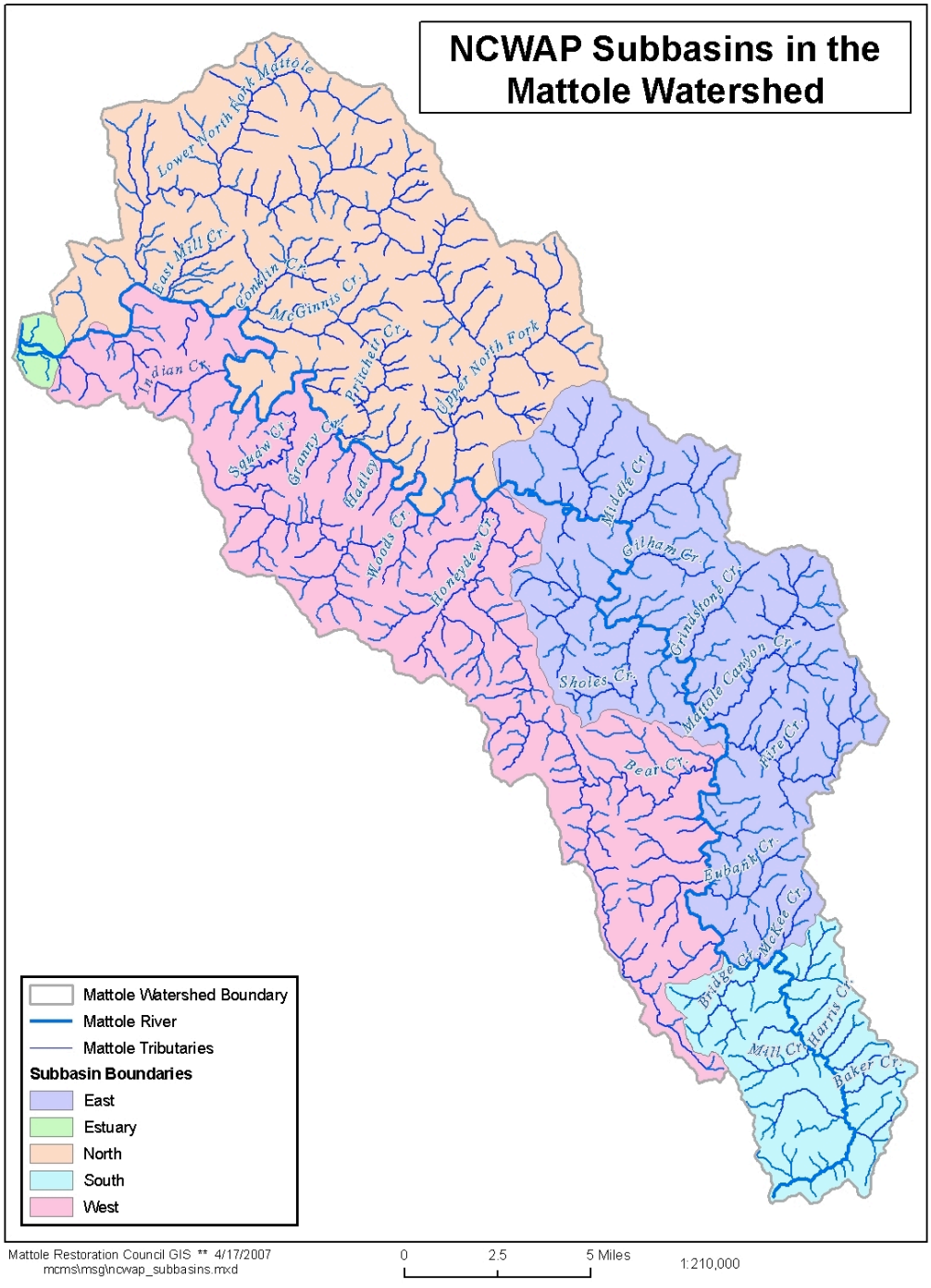
Five dive surveys in September and October 2008 yielded only 4 Chinook observations in total, occurring on September 10. The complete demise of the many Chinook over-summering in the estuary in the past two summers indicates the condition of the estuary represents a significant barrier to their survival in the Mattole. Steelhead have fared better, possibly due to their greater temperature tolerance.

Further water quality investigations will occur in 2009. The MSG is prepared to rescue fish trapped in the estuary during substandard conditions if necessary. Plans to divert Chinook facing imminent death in the estuary from the MSG downstream migrant trap to cool-water rearing ponds at the MSG Office are also an option for rescue. The MSG is currently working on legal and other aspects of enacting the Chinook Survival Enhancement Program.

Tributaries

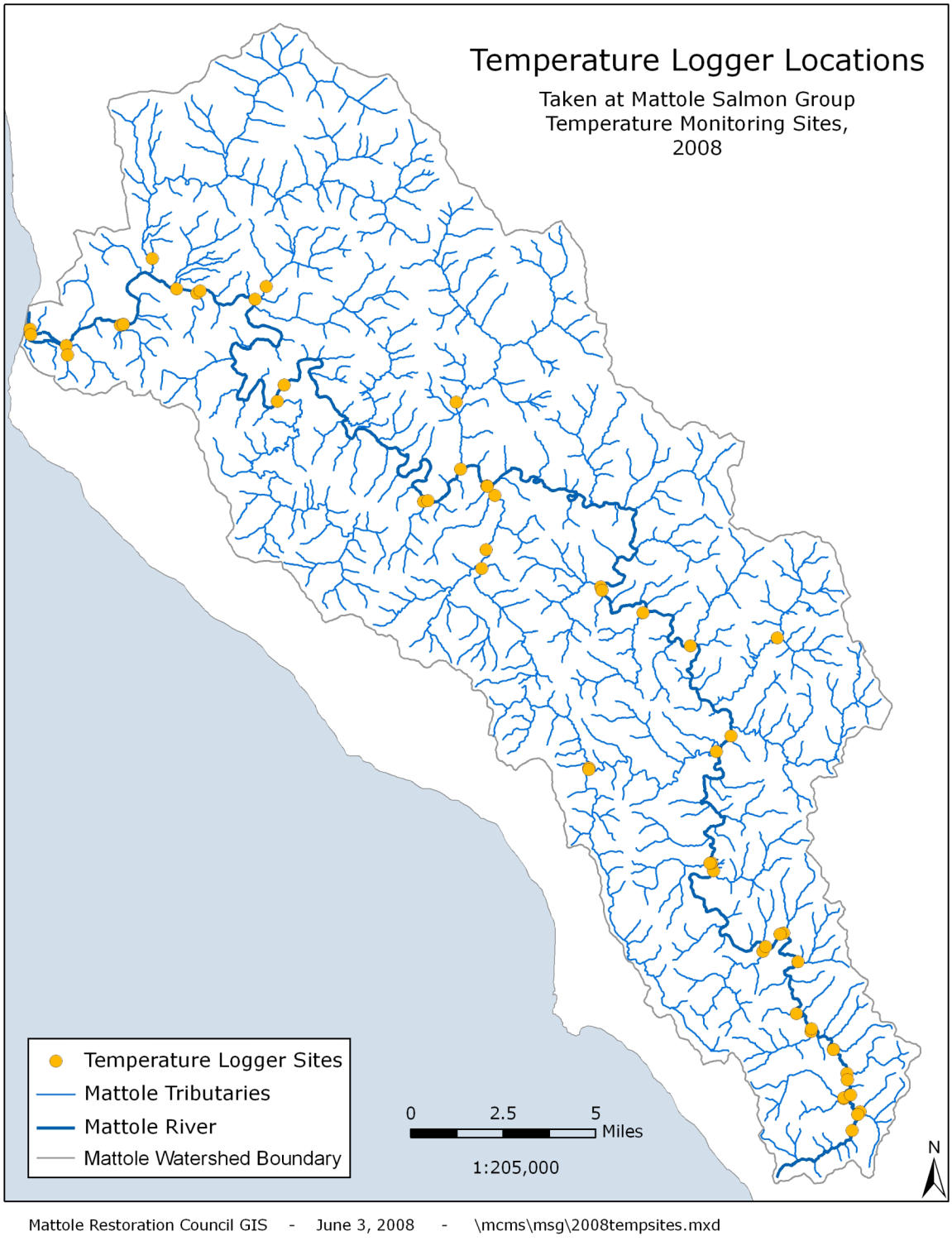
Tributaries are discussed by subbasin (Figure 14). River Mile is also listed after each tributary. Please see map for further details (Figure 15).

Figure 14. Mattole Watershed Subbasins



Map courtesy Mattole Restoration Council GIS.

Figure 15. 2008 Mattole Watershed Temperature Monitoring Sites



Map: Mattole Restoration Council GIS.

Western Sub-basin

Lower Bear Creek (RM 1.0)

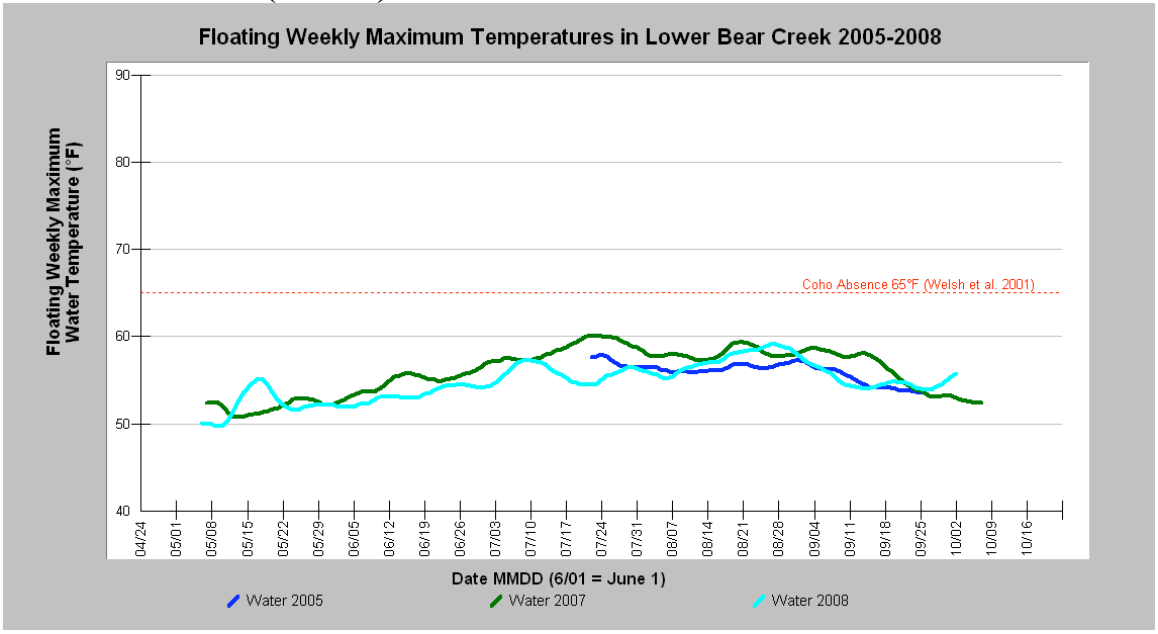


Figure 16. Floating Weekly Maximum Temperature in Lower Bear Creek, 2005-2008.

Current monitoring of Lower Bear indicates temperatures remain cool throughout the summer in this tiny lower river creek. During 2005, 2007, and 2008, floating weekly maximum temperatures remained below the coho threshold (65°F MWMT, Welsh et al. 2001) (Figure 16). Lower Bear was rerouted to accommodate Lighthouse Road many years ago, and does not currently meet the river. Several seeps form deep pools and a swamp on the northern side of Lighthouse Road where Lower Bear no longer flows through its historical channel.

Access to cool-water tributaries is especially crucial in the lower Mattole where the mainstem reaches lethal temperatures. Inputs from cool-water tributaries into the mainstem are also important for salmonids over-summering in the lower river and just downstream in the estuary. The possibility of rerouting Lower Bear to its historic channel is being discussed to aid both hot temperatures in the lower river and to add more cool-water tributary habitat in this critical area. Late-summer flow in Lower Bear Creek can be low in drier years, but water flows year-round. In 2008, the snorkel reach in Lower Bear was completely dry by fall.

During dive surveys, only a very limited number of steelhead have ever been seen in Lower Bear Creek. These fish are likely residents of Lower Bear Creek as the creek is isolated from the mainstem Mattole.

Stansberry Creek (RM 1.3)

Temperature monitoring occurred in Stansberry Creek in 2006-2008. 2008 floating weekly maximum water temperatures in Stansberry Creek remained below 65°F until the logger went dry in late July, indicating temperatures were suitable for coho for most of the summer (Welsh et al. 2001) (Figure 17). 2008 was the first year on record that Stansberry Creek was noticeably dry by late summer. MSG staff observed Stansberry Creek had dried to a series of disconnected

pools near the confluence when the logger was retrieved in fall. In 2007, temperatures were suitable for coho salmon rearing excluding one occasion, and 2006 temperatures remained below the threshold.

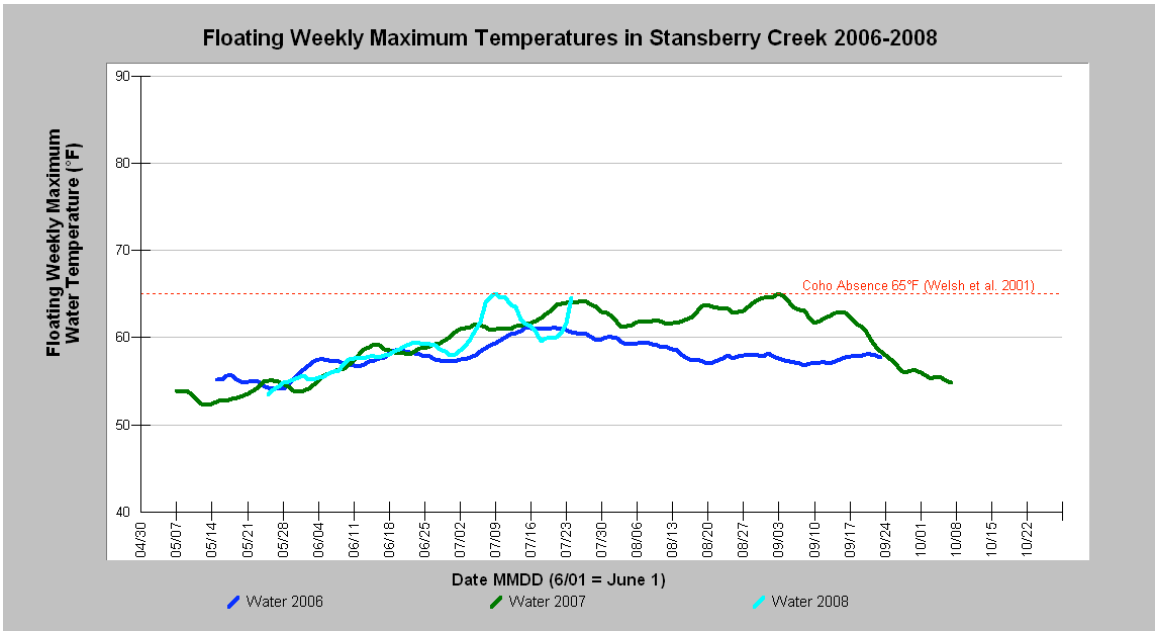


Figure 17. Floating Weekly Maximum Temperatures in Stansberry Creek, 2006-2008.

Over the past three years, the maximum weekly average temperature has ranged from 58.86°F (2006) to 60.63°F (2007). The 2008 MWAT was 59.35°F. Based on temperature tolerance criteria developed for the Mattole Watershed by Coates et al. (2002), Stansberry Creek provides good thermal habitat for steelhead (<63.0°F MWAT) and marginal thermal habitat for coho (59.0-63.0°F MWAT). The maximum temperature this year was 72.48°F, but this was the only day temperatures surpassed the threshold for prolonged thermal stress (68°F, Brett 1952). Of the lower river tributaries, Stansberry Creek provides one of the coolest habitats for salmonid over-summering.

Despite cool habitat, only steelhead have been observed during the past three years of dive surveys. Divers observed 20 (<4") steelhead and 2 (4"-8") steelhead on 5/21/08. By fall, the creek was so low that the temperature logger pool was completely dry. No salmonids were observed. Historical data also indicates only steelhead reside in Stansberry Creek.

Habitat improvements in lower Mattole tributaries with favorable summer temperatures are a restoration priority. Recently, approximately the last one hundred feet of Stansberry Creek upstream of the confluence were restored as part of a fish passage project. The streambed was re-routed and graded, a new culvert was installed, and willows and alders were planted in the riparian area.

During high flows, salmonid access to Stansberry Creek is unrestricted for all size-classes of salmonids. However, during low flows, a gap between the confluence and the new culvert presents a barrier to juveniles and is scheduled for a habitat improvement project in 2009. 2006-

2008 temperatures indicate Stansberry Creek is a cool-water source for the Mattole mainstem and thermally suitable over-summering habitat. Unrestricted access will allow juvenile salmonids usage of Stansberry Creek as a lower river refuge.

Lower Mill Creek (RM 2.8)

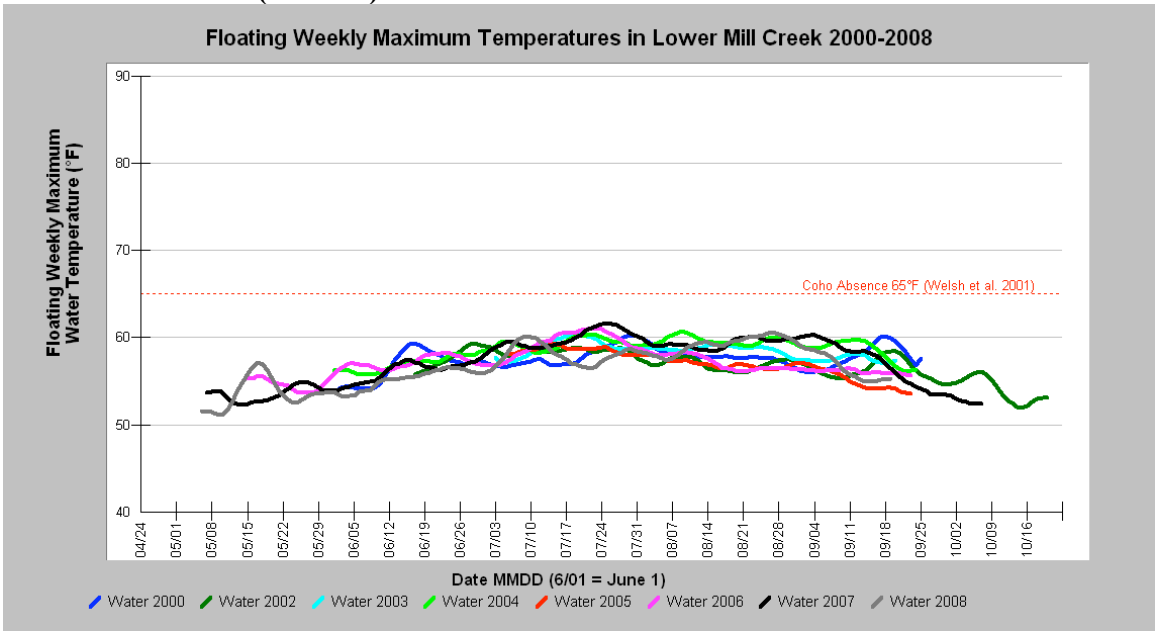


Figure 18. Floating Weekly Maximum Temperatures in Lower Mill Creek, 2000-2008.

The MSG has monitored temperature in Lower Mill Creek annually since 2000 (excluding 2001). Maximum floating weekly maximum water temperature (MWMT) remained cooler than 65°F, the coho threshold determined by Welsh et al. (2001), during all eight years monitored (Figure 18). Maximum floating weekly average temperature (MWAT), another measure of chronic temperature stress, also indicated high-quality thermal habitat for juvenile salmonids in Lower Mill Creek. The 2008 MWAT was 59.05°F, marginal for coho (<63.0°F) and good for steelhead (<66.0°F) (Coates et al. 2002).

Of the coho-bearing streams in the lower Mattole, Mill Creek is the coolest and contains arguably the best over-summering habitat for coho and steelhead. The maximum temperature recorded in lower Mill Creek in 2008 was 62.11°F, well below thresholds for prolonged stress of juvenile salmonids (68°F, Brett 1952). Fall flows in Lower Mill Creek this year were alarming. For the first time in over twenty years, Lower Mill was dry at its mouth to approximately 12' upstream.

A significant portion (222 acres, 17%) of the drainage remains old growth. The BLM owns 51% or 678 acres of the Mill Creek subshed. The Mill Creek Conservancy also acts to minimize impacts to the Mill Creek Forest and Lower Mill Creek, protecting valuable salmonid habitat and scarce old growth in the lower Mattole. Temperatures are cool enough to be suitable for coho salmon rearing, and lower Mill Creek maintains sufficient flow in the summer to provide habitat. The creek bed is also mainly cobble and gravel with little fine sediment in comparison to other lower Mattole tributaries.

A possible limiting factor to juvenile utilization of over-summering habitat in lower Mill Creek is an old sediment screen about a half mile up the creek. The structure was constructed in the 1980s to recruit spawning gravel for adult salmon in the lower reach of the creek. Prior to 2005, many redds were observed in the recruited gravels behind the lowest weir but the creek had down cut enough to leave two of the structures with passage issues. Boulder step pools were installed in summer of 2005 to mitigate this problem, allowing passage upstream for adult spawners.

While upstream-migrating adults are now able to access upper reaches of Lower Mill Creek at higher flows, the structure confines over-summering juveniles to the reach below the screens. Once juvenile salmonids have migrated downstream of the screen, they are no longer able to access the upper sections of the creek. Removal of the screen would provide unimpeded access to juvenile salmonids, allowing utilization of many more feet of cool-water coho habitat for over-summering juveniles seeking refuge from high summer temperatures in the lower mainstem.

Juvenile coho have been observed in Lower Mill Creek consistently during MSG dive surveys. In 2008, MSG divers observed eleven juvenile coho during the spring dive on 5/2. The MSG has also observed coho in lower Mill Creek during dive surveys in 2002-2004, 2006, and 2007. One adult coho was also observed in the creek during a spawner survey. Steelhead have been observed in Lower Mill Creek during every dive survey on record.

Clear Creek (RM 6.1)

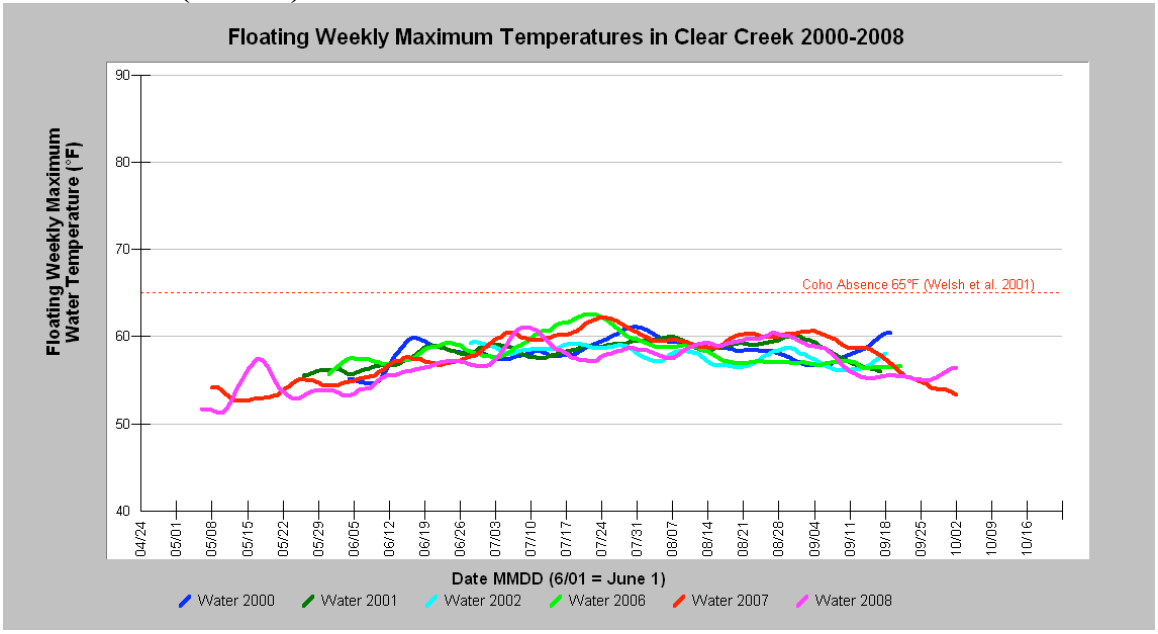


Figure 19. Floating Weekly Maximum Temperatures in Clear Creek, 2000-2008.

Clear Creek has been monitored for six years, from 2000-2002, and 2006-2008. All years indicated thermally suitable habitat for coho (<65°F MWMT, Welsh et al, 2001) (Figure 19). Based on 2008 Maximum Weekly Average Temperature (59.58°F), thermal habitat in Clear Creek is good for steelhead (<63.0°F MWAT) and marginal for coho salmon (59.0-63.0°F

MWAT) according to temperature tolerance criteria developed by Coates et al. (2002). In the lower Mattole, Clear Creek is among the coolest tributaries for salmonid over-summering. The maximum temperature recorded in 2008 was 63.01°F on 7/10/08.

In 2006, divers have confirmed the presence of small numbers of coho in Clear Creek during spring dives. During the 2007 spring dive, divers saw two salmonids that were possible coho, but were not able to make a positive id. Dive surveys in 2001-2002 and 2008 did not verify the presence of coho, although temperature monitoring indicated Clear Creek was thermally suitable for coho. Steelhead were observed in both spring and fall dives during all years surveyed. Archival MSG survey data also confirms coho and steelhead presence.

Clear Creek is a small creek, but it maintains enough flow to support salmonid habitation throughout the summer. Although no old-growth remains, only 4% of the drainage is grassland. Most of the subshed is mature forest, and Clear Creek is relatively shaded. Numerous larger rocks and large wood provide habitat and cover to over-summering salmonids. While temperature criteria characterize Clear Creek as marginal for coho, it provides more favorable coho habitat than most other creeks in the lower Mattole, especially when habitat characteristics in addition to temperature are considered.

Squaw Creek (RM 14.9)

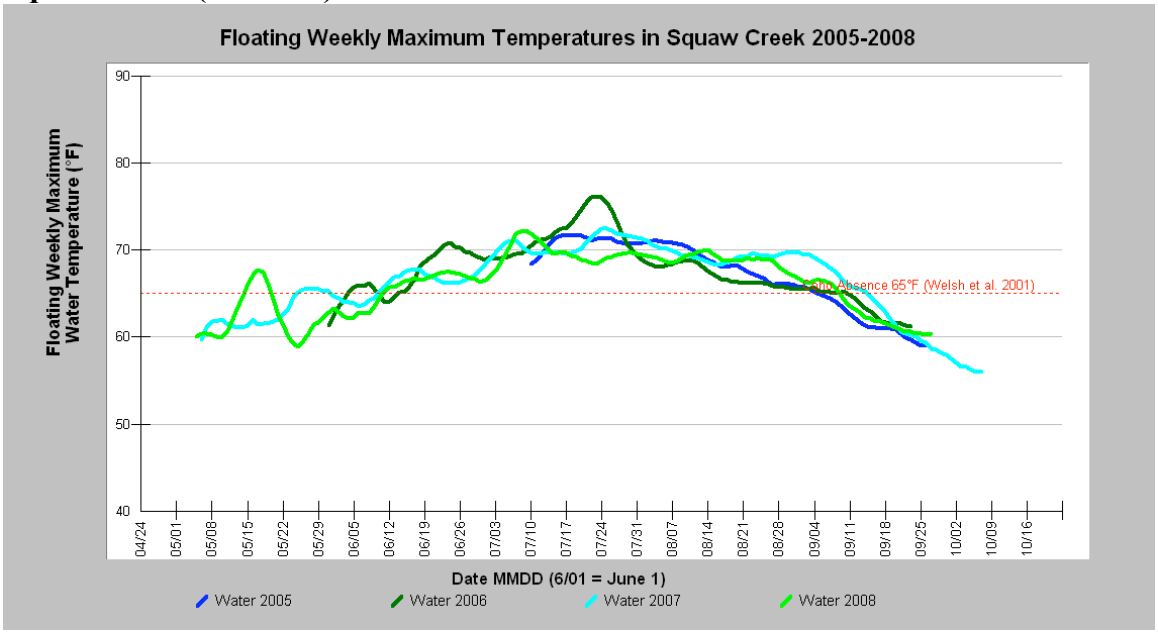


Figure 20. Floating Weekly Maximum Temperatures in Squaw Creek, 2005-2008.

Squaw Creek temperatures exceeded thresholds for juvenile salmonid over-summering in 2005-2008. Maximum floating weekly maximum water temperature (MWMT) exceeded 65°F during all four years, indicating temperatures were higher than suitable for coho salmon rearing (Welsh et al. 2001) (Figure 20). Maximum weekly average temperatures also indicated temperatures were warmer than ideal for both coho and steelhead (>63.0 and >66.0°F MWAT, Coates et al. 2002). MWATs recorded in Squaw Creek were 66.92°F, 72.61°F, and 68.94°F in 2005, 2006, and 2007, respectively. In 2008, the MWAT was slightly cooler (68.66°F), but still above

thresholds for all Mattole salmonids. Fall 2008 flow was unusually low in Squaw Creek. Divers found pools much smaller or nearly non-existent in fall in comparison with spring.

The maximum temperature recorded in 2008 was 74.64°F, just below the short-term maximum temperature threshold for salmonid survival (75.0°F, Brungs and Jones 1977). However, maximum temperature exceeded 68°F on 60 of 152 days monitored in 2008, indicating prolonged temperature stress for over-summering salmonids (Brett 1952).

Squaw Creek is one of the larger lower river tributaries, and it has some favorable salmonid habitat attributes, including bedrock pools and riparian shading. Much of the drainage is forested with 11% remaining old growth; only 13% is grasslands. A sizeable amount (39%) of the subshed is owned by the BLM.

Despite temperatures above the coho threshold during the four years on record, coho and Chinook have been observed in Squaw Creek. During the 2006 spring dive, both Chinook salmon (3) and coho (1) were observed. In 2007, there was no spring dive, and only steelhead were observed in the fall. Both spring and fall dives in 2008 yielded only steelhead observations. MSG Pipe trap data from 2006 and prior years as well as past dive survey data have also confirmed the presence of coho, Chinook and steelhead in Squaw Creek.

During the late summer of 2006, a habitat improvement project occurred in the first 200 feet above the confluence. Four structures consisting of large wood and boulder were constructed and anchored. The difference in steelhead utilization of Squaw Creek in spring before the structures were built and in fall after they were completed was substantial. While only 44 (<4") steelhead and 8 (4"-8") steelhead were observed in the spring, over a thousand <4" steelhead (1022), 5 (4"-8") steelhead, and 2 (>8") steelhead were observed on 9/27/06.

Woods Creek (RM 24.1)

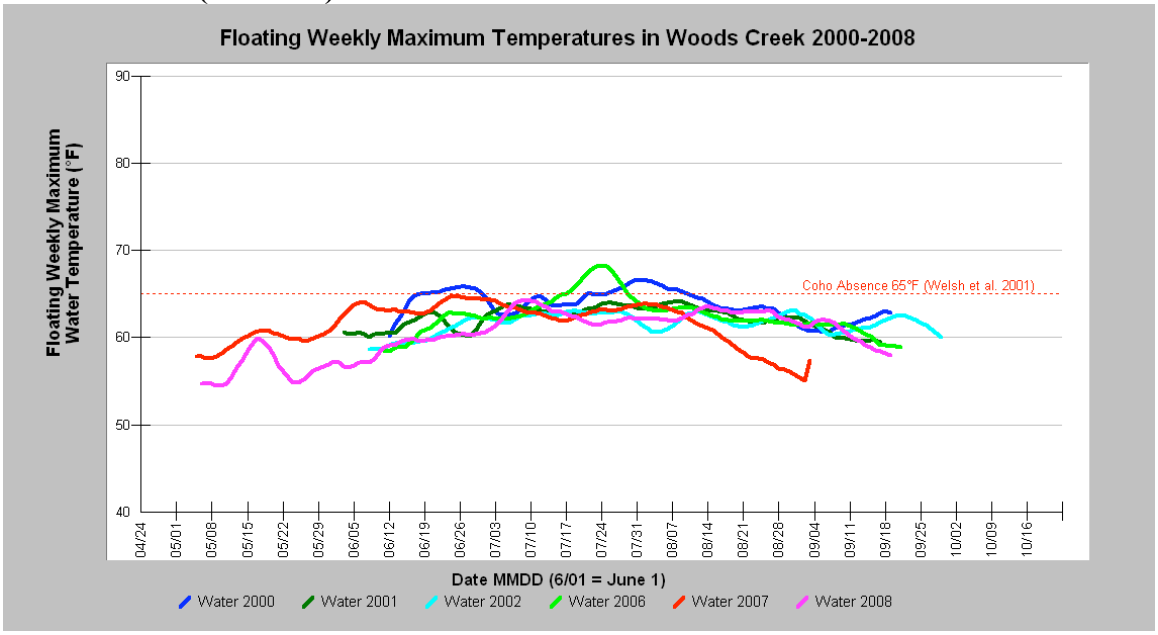


Figure 21. Floating Weekly Maximum Temperatures in Woods Creek, 2000-2008.

Temperature monitoring in Woods Creek occurred in 2000-2002 and in 2006-2008. In 2001, 2002, 2007, and 2008, maximum floating weekly maximum temperatures (MWMT) remained below the coho threshold (Figure 21). MWMT exceeded 65°F in 2000 and 2006. Results indicate temperatures are higher than suitable for coho salmon rearing during warmer years (Welsh et al. 2001). Woods Creek may provide suitable coho over-summering habitat during cooler years and outside of the period of peak summer temperature. 2000 and 2006 temperatures exceeded the coho threshold for only a short period during peak temperatures in mid-July. 2008 MWAT (61.22°F) indicated thermal habitat in Woods Creek was marginal for coho (59.0-63.0°F) but suitable for steelhead (>66.0°F) (Coates et al. 2002). The maximum temperature reached in Woods Creek in 2008 was 65.92°F, well below the short-term lethal temperature for salmonids (75.0°F, Brungs and Jones 1977). Maximum temperatures in Woods Creek did not exceed 68°F, indicating salmonids were not exposed to prolonged thermal stress (Brett 1952).

In addition to relatively cool summer temperatures, the lower reach of Woods Creek appears to have other attributes of favorable salmonid habitat, including cobble and gravel with lack of significant amounts of fine sediment as well as riparian shading and large wood for cover. Woods Creek is a smaller drainage, and can be susceptible to drying in drought years, limiting salmonid habitat. In 2008, the first 300' of Woods Creek were dry in the fall, isolating the creek from the mainstem Mattole. The subshed is mainly forested, with 0% grassland and 3% old growth. 76% of the drainage is owned by the BLM.

While no coho were observed in 2008, past MSG dive surveys confirm coho presence in Woods Creek. In 2007, MSG divers found coho in Woods Creek during both the spring (3) and fall (2) dives. Small numbers of coho young-of-the-year were also observed during the spring dive in 2006 (8) and the fall dive 2001 (2). It is unknown if coho found in Woods Creek came from coho spawning in the creek or if juvenile coho seeking refuge from the warm temperatures prevalent in the lower mainstem Mattole over-summer in Woods Creek.

Dive surveys also indicate Chinook and steelhead presence in Woods Creek. Chinook are rarely seen. 2008 was the first confirmed Chinook observation (1) since 1996. MSG divers have identified steelhead during all dive surveys. The greatest number of steelhead observed in Woods Creek was in 2006.

Honeydew Creek (RM 26.5)

Honeydew Creek has been monitored for the past three years. In 2007 and 2008, temperature loggers were deployed at three monitoring locations in the Honeydew Creek subshed. Upper and lower reaches and the east fork of Honeydew Creek were selected for temperature and dive monitoring.

Maximum floating weekly maximum water temperature (MWMT) exceeded 65°F in all three locations, indicating temperatures in Honeydew Creek were higher than suitable for coho salmon rearing (Welsh et al. 2001) (Figures 22 and 23). MWATs at all three monitoring locations surpassed the threshold for coho (<63.0°F, Coates et al. 2002). MWATs in east fork Honeydew Creek (63.77°F) and upper Honeydew Creek (63.55°F) were cool enough for steelhead (<66.0°F), while MWAT in lower Honeydew Creek (66.27°F) was warmer than ideal for both

species. The 2007-2008 upper Honeydew Creek monitoring location was ~2.5 miles upstream of the 2006 upper Honeydew Creek location. Temperatures recorded in upper Honeydew Creek were several degrees lower in the past two years than those in 2006 at the location, reflecting this difference.

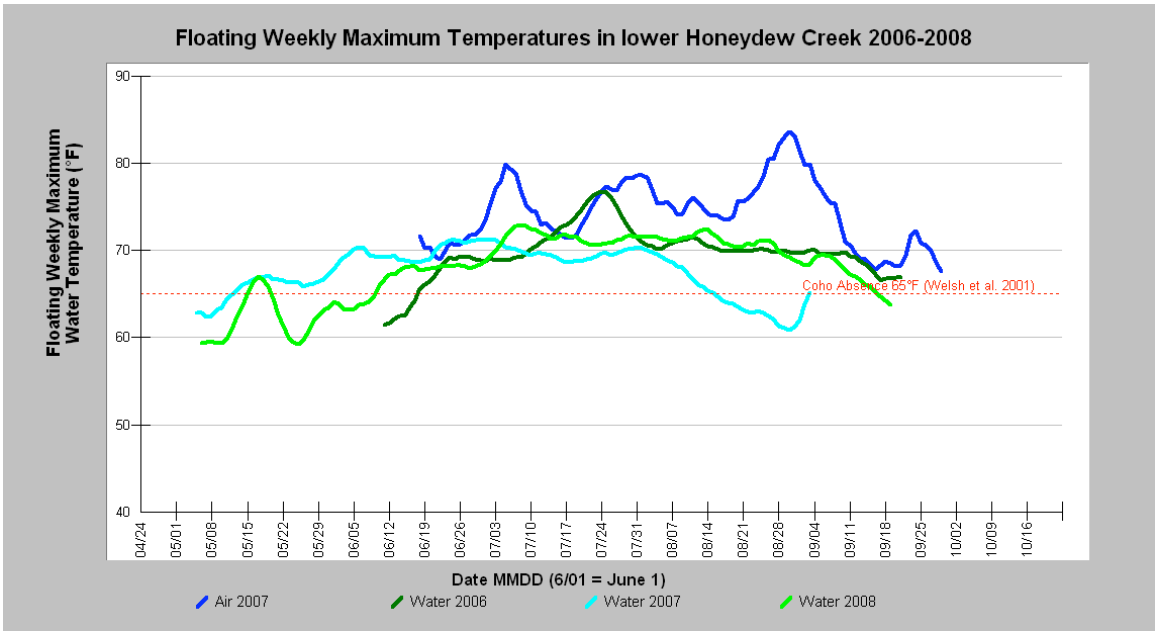


Figure 22. Floating Weekly Maximum Temperatures in Honeydew Creek 2006-2008.

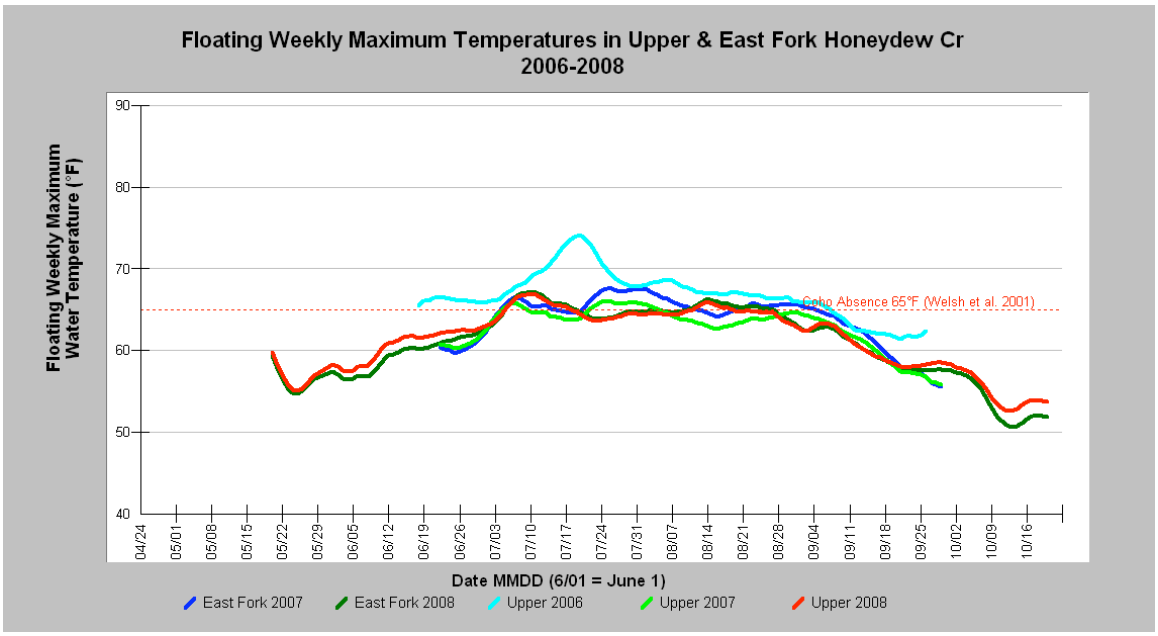


Figure 23. Floating Weekly Maximum Temperatures in Upper Honeydew Creek and East Fork Honeydew Creek 2006-2008.

Temperatures in Honeydew Creek remained below the acute lethal level of 75°F, although the maximum temperature in lower Honeydew was close (74.77°F). Maximum temperature in east

fork Honeydew Creek (68.83°F) and upper Honeydew Creek (69.43°F) were several degrees cooler. Temperatures in upper Honeydew Creek and the east fork surpassed 68°F on 2 of 166 days; in comparison, temperatures at the lower monitoring location were higher than 68°F on 78 of 143 days. Of the three sites, the upper Honeydew Creek location had the most favorable thermal habitat. The two upstream locations were notably cooler than the lower Honeydew site.

Salmonid counts in Honeydew Creek also differed significantly between lower Honeydew and the two upper reaches. In spring, hundreds of steelhead were observed in upper Honeydew (207 (<4") steelhead, 3 (4"-8") steelhead, 1 (>8") steelhead) and East Fork Honeydew (278 (<4") steelhead, 6 (4"-8") steelhead), while no fish were observed in lower Honeydew. In the fall, only 30 steelhead young-of-the-year were seen in upper Honeydew and 3 in the east fork. In lower Honeydew, steelhead were much more numerous in the fall (329 (<4"), 43 (4"-8"), 9 (>8")). The difference may be due to migration patterns; steelhead over-summering in the upper reaches may have emigrated downstream by the fall.

Historical survey data indicates steelhead, Chinook, and coho utilize Honeydew Creek. In 2008, surveyors found 24 Chinook in East Fork Honeydew Creek (RM 26.5+~2.5+0.1), which was the first Chinook observation in the past three years. Coho have not been found during recent dive surveys. Only steelhead were identified in the upper and lower mainstem of Honeydew Creek this year. Honeydew Creek is impacted by slides and sedimentation, but deep pools and refuges do exist. It is also notable that 22% (448 acres) of the Honeydew Creek drainage remains old growth and 71% (7,786 acres) of the subshed is owned by the BLM. Due the large proportion of its watershed in the King Range National Conservation Area, Honeydew Creek is one of the least impacted of Mattole tributaries by human land practices.

Fourmile Creek (RM 34.6)

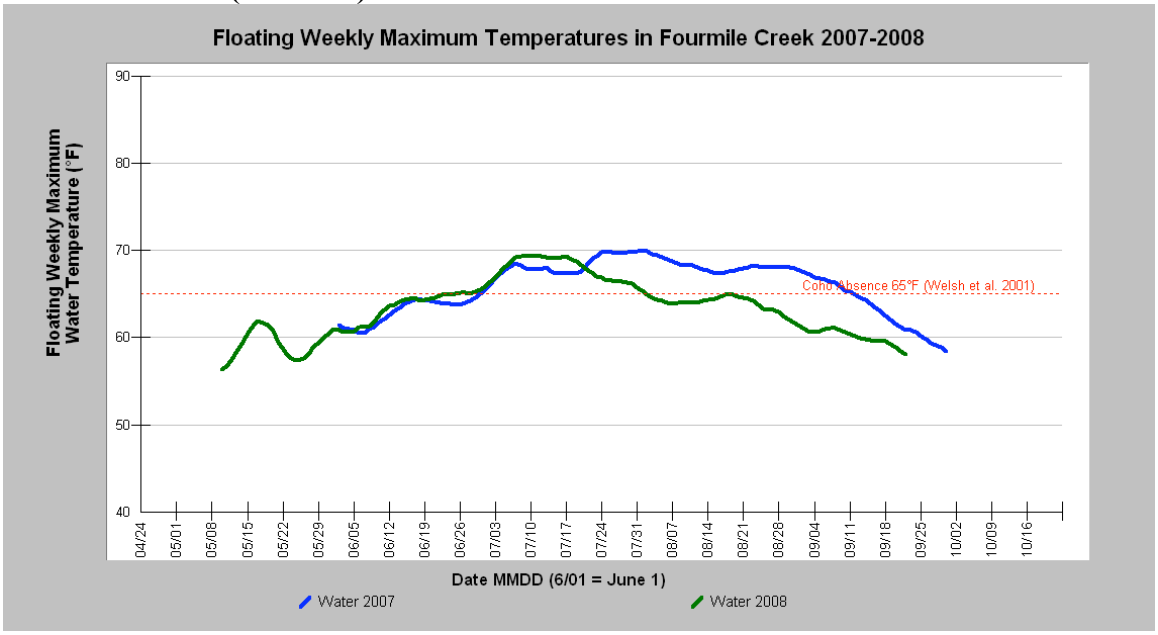


Figure 24. Floating Weekly Maximum Temperatures in Fourmile Creek, 2007-2008.

The MSG monitored Fourmile Creek for temperature and juvenile salmonid presence in 2007 and 2008. Floating Weekly Maximum Temperatures surpassed 65°F, showing thermal habitat was warmer than ideal for coho inhabitation (Welsh et al. 2001) (Figure 24). The 2008 MWAT in Fourmile Creek was 64.46°F. According to Coates et al. 2002, this MWAT indicates unsuitable thermal habitat for coho (>63°F) and marginal habitat for steelhead (59-63°F).

Maximum temperatures recorded in Fourmile Creek in 2008 verified salmonids here were exposed to chronic temperature stress (Brett 1952). Temperatures above 68°F were recorded on 15 of 142 days of monitoring. Temperatures in Fourmile Creek reached a maximum of 70.67°F, below the short-term maximum temperature (75°F) indicating acute thermal stress (Brungs and Jones 1977).

In 2008, surveyors observed low flow conditions in Fourmile Creek for the first time in the three years monitored. The first 15' of the creek upstream of its confluence with the Mattole were dry at logger retrieval.

Historically coho and steelhead have been found in Fourmile Creek. Three coho were observed in the fall of 2007 but not in the spring. Only steelhead were observed during 2008 dive surveys. Many more steelhead were observed in the fall (920 yoy and 12 (4"-8") steelhead) than in the spring (147 yoy and 7 (4"-8") steelhead). 2007 divers found greater numbers of steelhead in the fall as well.

Sholes Creek (RM 36.6)

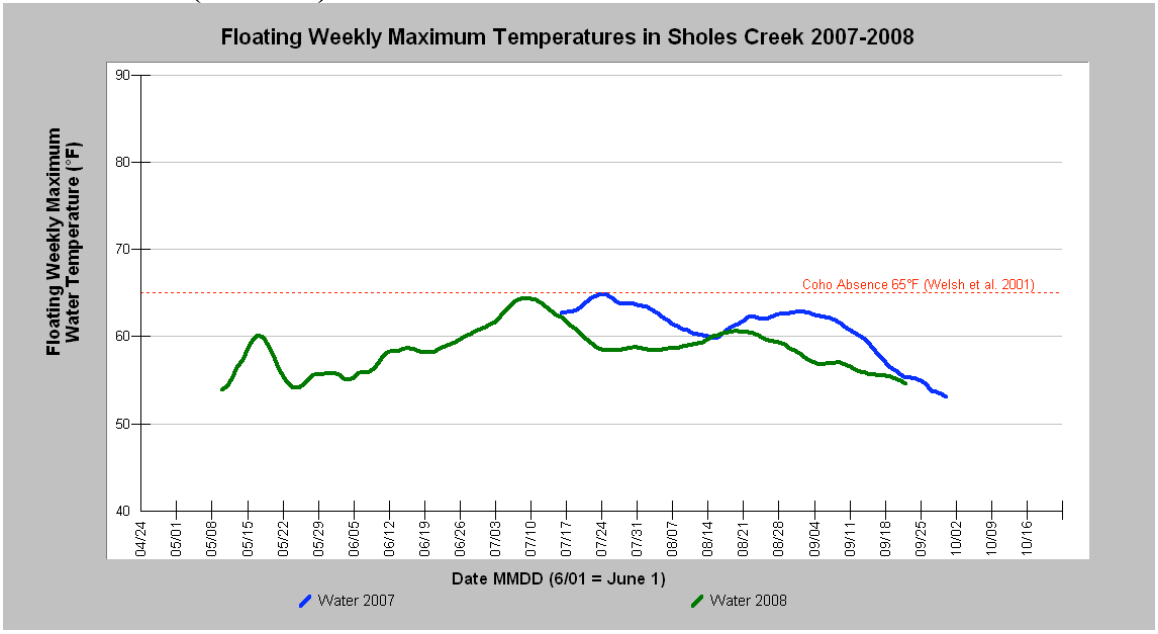


Figure 25. Floating Weekly Maximum Temperatures in Sholes Creek 2007-2008.

MSG temperature and juvenile salmonid monitoring occurred in Sholes Creek in 2007 and 2008. Floating Weekly Maximum Temperatures recorded in Sholes Creek showed suitable thermal habitat for coho (below 65°F MWMT, Welsh et al. 2001) (Figure 25). The maximum weekly average temperature in Sholes Creek was 61.77°F, indicating good habitat for steelhead (<63°F)

and marginal habitat for coho (59-63°F, Coates et al. 2002). Maximum temperatures did not suggest prolonged or acute thermal stress for juvenile salmonids. This fall, surveyors noted the first 35' upstream of the mouth of Sholes Creek was dry at logger retrieval.

Both 2007 and 2008 dive surveys in Sholes Creek identified only steelhead. Nineteen steelhead young-of-the-year and 1 (4"-8") steelhead were found in the spring, and 149 steelhead young-of-the-year and 1 (4"-8") steelhead were observed in the fall this year. Historical salmonid species presence included coho salmon and steelhead.

The Sholes Creek drainage is mainly forested, with about 3% grasslands and 5% remaining old growth. The subshed is characterized by relatively large property ownerships; some land (12%) is under the management of the BLM. Sholes Creek enters the middle Mattole where mainstem temperatures are often warm enough to be lethal to all species of salmonids. There are deep pools and some cover present in this remote area. As a cool-water tributary in the middle Mattole, Sholes Creek is important for salmonid habitat, both as a refuge and as a source of cooler water inputs for the mainstem.

Bear Creek (RM 42.8)

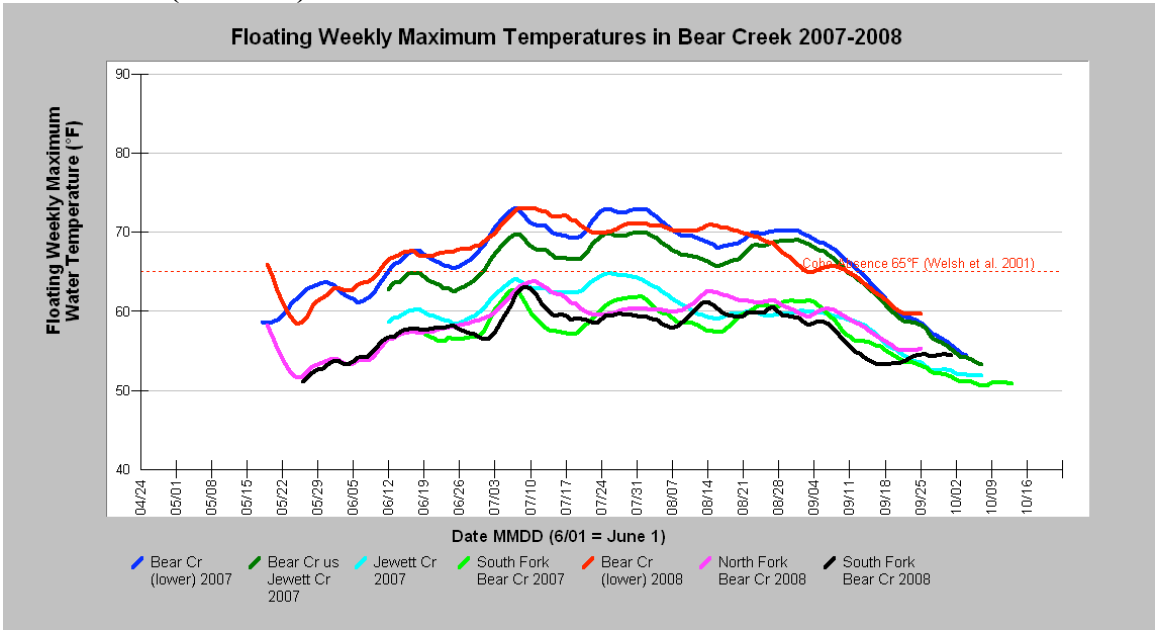


Figure 26. Floating Weekly Maximum Temperatures in Bear Creek, North Fork Bear Creek, South Fork Bear Creek, and Jewett Creek in 2007-2008.

In 2008, there were three temperature monitoring locations in the Bear Creek subshed. The warmest water temperatures were recorded in the lower reach of Bear Creek near its confluence with the Mattole River (RM 42.8 + ~0.2). Temperatures in lower Bear Creek exceeded the threshold for coho (65°F MWMT, Welsh et al. 2001) from late May until early September. Temperatures in both the North Fork (42.8 + 5.0 + 1.0) and the South Fork (RM 42.8 + 5.0 + 2.0) of Bear Creek were noticeably cooler and remained suitable for coho throughout the summer of 2008 (Figure 27).

Historical dive and downstream migrant trapping data indicate coho, Chinook, and steelhead reside in Bear Creek. In 2008, the MSG conducted dive surveys in the North and South Forks of Bear Creek, as well as the mainstem of Bear Creek. Chinook were observed only in the mainstem of Bear Creek during the spring dive. Divers saw steelhead in all three locations in both the spring and fall. No coho were observed in the Bear Creek subshed in 2008. Lower Bear Creek had the greatest observed salmonid presence. One hundred and forty-six Chinook, 353 steelhead young of the year, 28 (4"-8") steelhead, and 2 (>8) steelhead were observed in the spring. In the fall, surveyors found 459 steelhead young-of-the-year, 96 (4"-8") steelhead, and 8 (>8) steelhead. More steelhead were observed in South Fork Bear Creek in the spring, while North Fork Bear Creek has greater observed steelhead presence in the fall dive.

Bear Creek is the largest tributary in the Mattole aside from the Upper and Lower North Forks. A large proportion of this subshed exists as part of the King Range Conservation Area. In tributaries and the upper section of the tributary, there is little human impact and nearly pristine habitat features. Increased temperature and dive monitoring of the upper Bear Creek subshed would expand our knowledge of salmonid distribution in this favorable habitat area of the Mattole.

Big Finley Creek (RM 47.4)

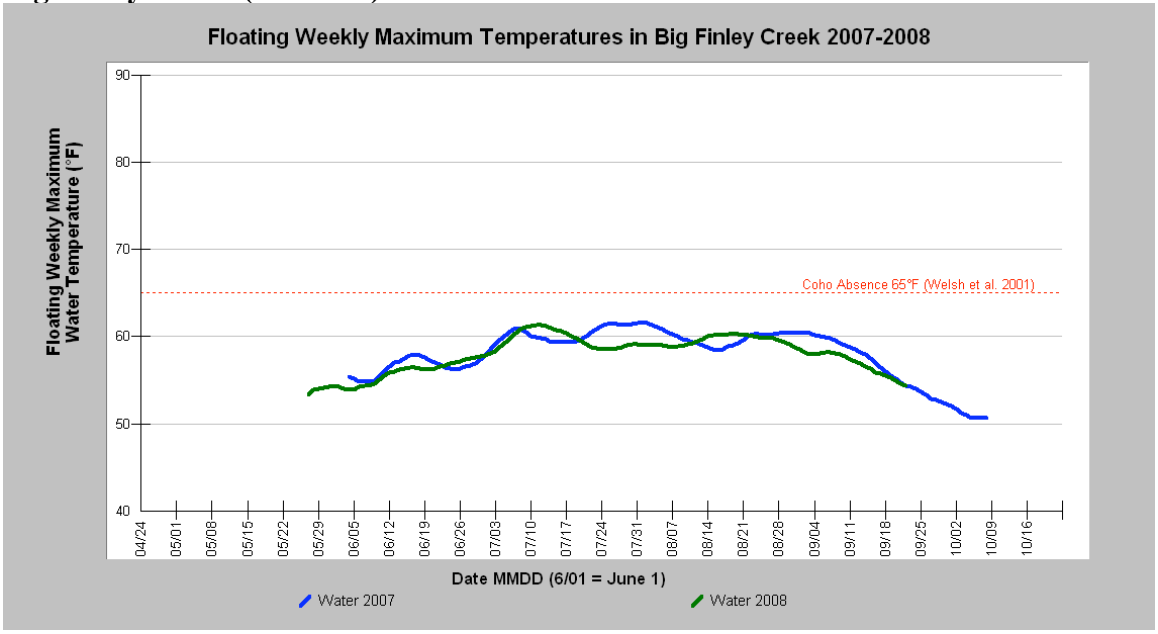


Figure 27. Floating Weekly Maximum Temperatures in Big Finley Creek in 2007-2008.

The MSG conducted temperature monitoring in Big Finley Creek for the first time in 2007. Maximum floating weekly maximum water temperature (MWMT) showed suitable thermal habitat for coho rearing in both 2007 and 2008 (<65°F, Welsh et al. 2001) (Figure 27). MWATs in 2007 (59.8°F) and 2008 (60.04°F) also indicated Big Finley Creek was favorable for coho (<63°F) as well as steelhead (<66°F, Coates et al. 2002). The maximum temperature recorded in 2008 was a cool 62.19°F, demonstrating lack of thermal stress to salmonids rearing here.

Big Finley Creek comes into the Mattole in a very remote area and provides excellent salmonid over-summering habitat. Much of the subshed (84%) is managed by the BLM. It is a larger drainage in comparison with other tributaries in the upper/middle Mattole. In contrast to other streams in the upper Mattole, there are few roads and little water diversion for human use, contributing to little fine sediment, deep pools, and significant summer flows. Additionally, much of the subshed is forested, and 19% remains old growth.

Historically, coho and steelhead were known to utilize Big Finley Creek. In 2008, MSG divers observed coho and steelhead, but no Chinook. Chinook (7) were observed in the spring of 2007. Coho were observed in both spring (13) and fall (1) of 2008, but not in 2007. Larger size class steelhead were observed in both years. Steelhead counts were slightly higher in the spring (66 young-of-the-year, 23 (4"-8"), 1 (>8")) than in the fall (46 young-of-the-year, 13 (4"-8"), 1 (>8")).

Northern Sub-basin

Conklin Creek (RM 7.8)

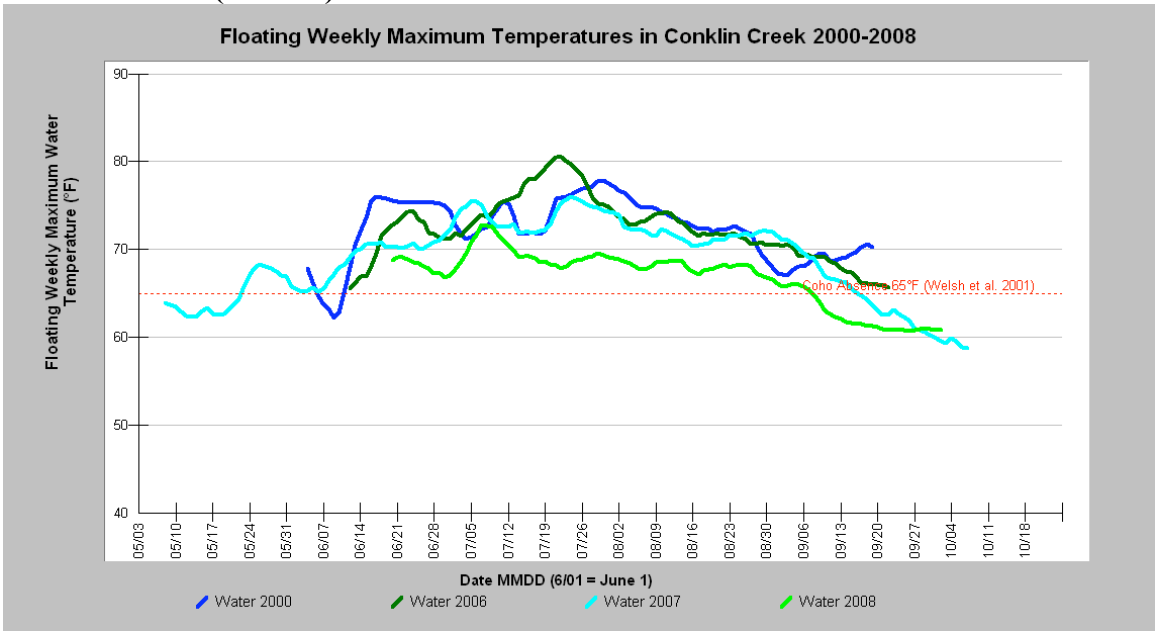


Figure 28. Floating Weekly Maximum Temperatures in Conklin Creek, 2000-2008.

Maximum floating weekly maximum water temperature (MWMT) exceeded 65°F in 2000 and 2006-2008, indicating temperatures were not suitable for coho salmon rearing (Welsh et al. 2001) (Figure 28). In 2008, the MWAT recorded in Conklin Creek was 65.12°F. According to Coates et al. 2002, this MWAT exceeded threshold temperatures for coho (<63.0°F) but remained cool enough for steelhead (<66.0°F). The maximum temperature recorded in Conklin Creek was 74.25°F, slightly less than the short-term maximum lethal temperature (>75.0°F) for juvenile salmonids (Brungs and Jones 1977). Although temperatures did not quite reach acute thermal stress levels, rearing salmonids in Conklin Creek experienced warmer than ideal over-summering habitat and were exposed to prolonged temperature stress. Maximum temperatures were warmer than 68°F during 51 of 111 days monitored.

Divers from the Mattole Salmon Group have not observed either coho or Chinook salmon in Conklin Creek despite multiple years of juvenile dive surveys. However, juvenile steelhead presence has been documented by MSG divers and historical accounts by longtime residents. Two large slides occurred in the Conklin Creek subshed during the storms of winter 2005, creating massive sediment accumulation in Conklin Creek. This disturbance has drastically degraded fish habitat in the creek, filling in pool habitat and causing most of Conklin Creek's flow to go subsurface. For the past three years, Conklin Creek has been dry at its confluence with the Mattole by fall. In 2008, MSG divers saw steelhead during both spring and fall dives. Sixty-nine steelhead young-of-the-year and 2 (4"-8") steelhead were observed in ten pools upstream of Conklin Creek's confluence with the Mattole in the spring, and 33 steelhead young-of-the-year were found in fall.

Upper North Fork (RM 25.5)

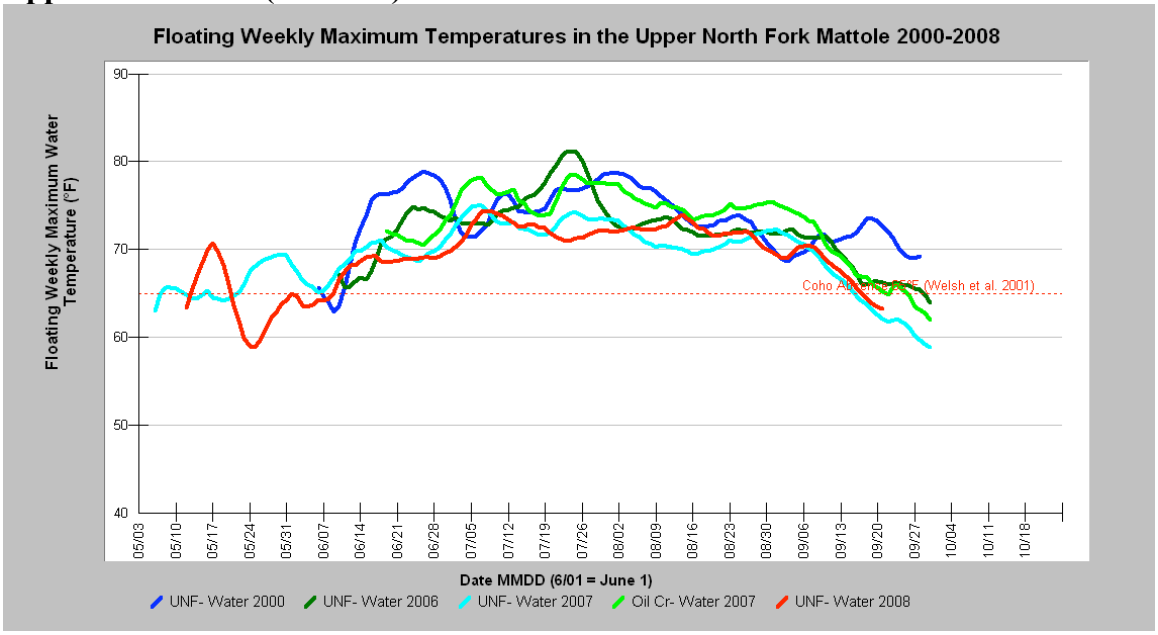


Figure 29. Floating Weekly Maximum Temperatures in the Upper North Fork Mattole and Oil Creek, 2000-2008.

Maximum floating weekly maximum water temperature (MWMT) exceeded 65°F in 2000 and 2006-2008, indicating temperatures were not suitable for coho salmon rearing (Welsh et al. 2001) (Figure 29). 2008 MWAT in the Upper North Fork was 69.43°F, also suggesting temperatures were unsuitable for coho (>63.0°F) as well as steelhead (>66.0°F). Temperatures in the Upper North Fork exceeded 68°F on 91 of 139 days monitored, subjecting salmonids to prolonged temperature stress most of the summer. The maximum temperature in the Upper North Fork was 76.42°F, well above short-term lethal temperature for juvenile salmonids (75.0°F, Brungs and Jones 1977) and comparable to mainstem maximum temperatures in many locations.

The Upper North Fork Mattole is a large subshed relative to other tributaries to the Mattole (16,696 acres). Much of the Upper North Fork Mattole is very remote and there are few road

access points. Most of the subshed was previously logged; now 2% old growth remains and 20% of the drainage is grassland. A small percentage (1%) of the drainage is owned by the BLM. Numerous slides in tributaries to the Upper North Fork and the Upper North Fork itself contribute sediment, and a layer of fine sediment is noticeable in some pools and near its confluence with the mainstem Mattole. The channel is highly aggraded in most areas, but steep bedrock canyon walls and mature forest shade some locales.

Past survey data from the Upper North Fork indicates Chinook and steelhead presence. Longtime residents report observations of salmon spawning in the Upper North in the early 1980s. 2008 snorkel surveys found many more steelhead in comparison to the past two years. Divers observed 48 steelhead young-of-the-year and 1 4"-8" steelhead during the spring dive. In the fall, salmonids were even more numerous (883 steelhead young-of-the-year, 78 4"-8" steelhead, and 4 steelhead greater than 8").

In 2007, the MSG also monitored temperature in Oil Creek, a tributary to the Upper North Fork. Temperatures recorded in Oil Creek were even warmer than in the Upper North Fork. Both Floating Weekly Maximum Temperatures and MWAT indicated unfavorable thermal habitat for over-summering salmonids (Welsh et al. 2001, Coates et al. 2002). Despite this, 2007 surveyors located greater numbers of steelhead in Oil Creek than in the Upper North Fork.

Eastern Sub-basin

Lower North Fork Mattole (RM 4.7)

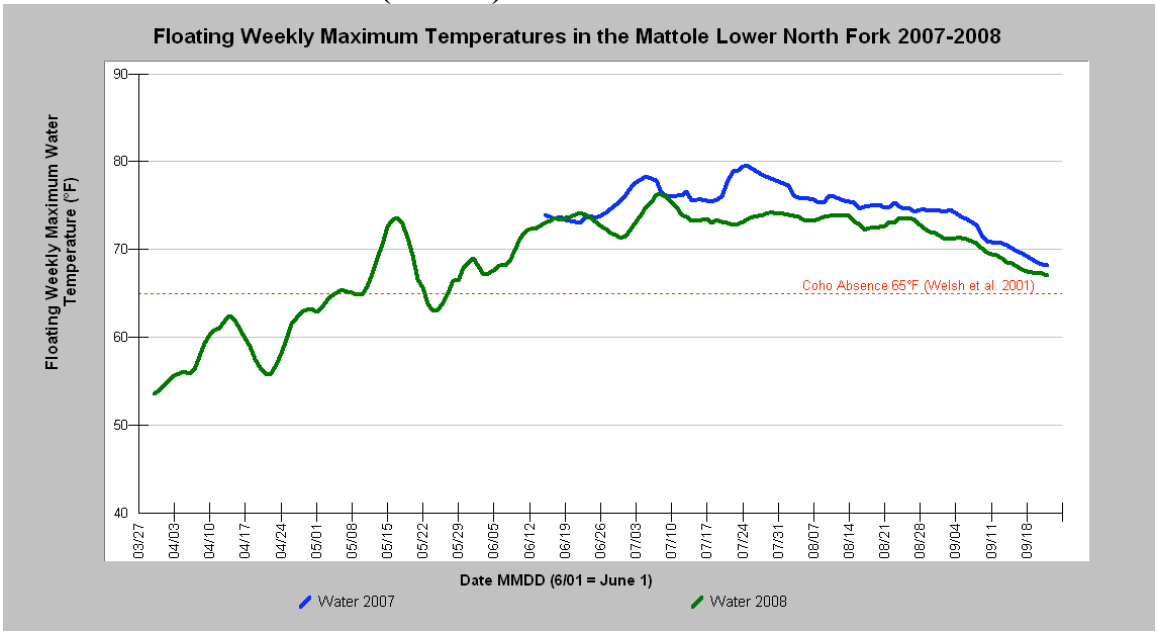


Figure 30. Floating Weekly Maximum Temperatures in the Lower North Fork Mattole 2007-2008.

Two years of temperature data exist for a lower reach of the Lower North Fork Mattole (LNF), the largest of the Mattole river tributaries. Temperatures recorded in the Lower North Fork Mattole indicate habitat is much to warm for coho rearing and thermally unsuitable for other species of salmonids for most of the summer. Beginning in mid-May, floating weekly maximum

temperatures exceeded 65°F MWMT, indicating temperatures were too warm for juvenile coho (Welsh et al. 2001) (Figure 30).

The astounding lack of hard data or even basic information on fisheries and aquatic resources in the LNF drainage is well articulated by Downie et al. 2002. 2008 was the first year of downstream migrant trapping (DSMT) in the Lower North Fork Mattole River. The MSG installed a fyke net trap was on the LNF, 1.25 miles upstream from the confluence with the main-stem Mattole River. Trapping occurred from March 26 to May 30, 2008. This opportunity provided much-needed quantitative data on present smolt production from the basin.

For the 2008 season, a total of 286 Chinook salmon were captured. This is the first documented occurrence of Chinook salmon in the Lower North Fork Mattole River. Based on trap efficiency determined by mark-recapture methods, an estimate of 628 Chinook salmon juveniles emigrated from the LNF during the period of trapping operations.

The 2008 temperature logger was installed at the MSG downstream migrant trap site. There appears to be no strong correlations between rising water temperatures and Chinook salmon emigration. The majority of the Chinook salmon run emigrated while temperatures were well below stressful levels.

Steelhead captures in the LNF downstream migrant trap were much more numerous than Chinook. 26,254 steelhead young-of-the year, 386 parr, and 6 smolts were captured in 2008. No coho salmon were captured in the LNF this year. No historical data confirming coho presence is known to exist. See the MSG North Fork Mattole River DSMT Report (2008) for further information.

Dive surveys of the LNF yielded observations of only steelhead. Dives occurred slightly upstream of the DSMT location and in Sulphur Creek, an upper tributary to the Lower North Fork. 811 steelhead young-of-the year, 257 (4”-8”) steelhead, and 13 steelhead >8” were observed in ten pools surrounding the DSMT site on 10/1/08. In Sulphur Creek, divers found 102 steelhead young-of-the year and 20 steelhead >4” in the ten pools sampled on June 20. October dives in Sulphur Creek yielded similar observations (141 young-of-the year and 4 steelhead >4” in the same ten pool reach sampled).

Continuation of downstream migrant trapping in addition to water quality and dive monitoring will provide a means for evaluating the status and trends of LNF salmonid populations more comprehensively in the future.

Mattole Canyon Creek (RM 41.1)

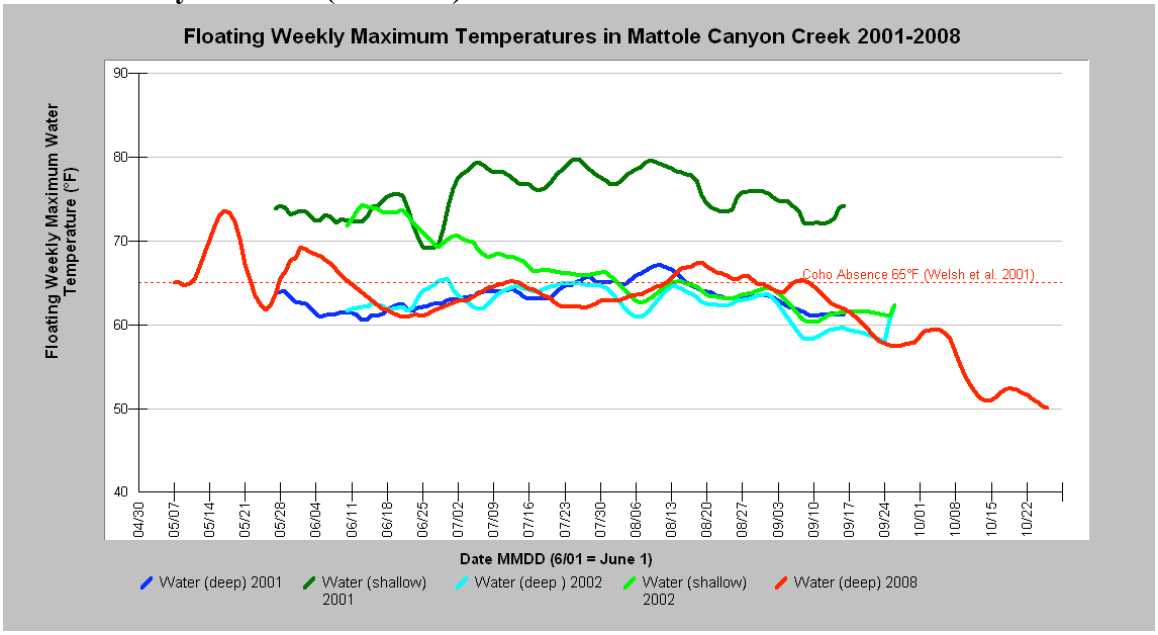


Figure 31. Floating Weekly Maximum Temperatures in Mattole Canyon Creek 2001-2008.

The MSG conducted temperature monitoring in Mattole Canyon Creek in 2001, 2002, and 2008. In 2001 and 2002, shallow and deep locations in the same pool were monitored. Floating weekly maximum temperatures exceeded 65°F during all three years, indicating the creek does not provide suitable habitat for coho rearing (Welsh et al. 2001) (Figure 31). Results indicate the 8' deep "Blue Lagoon" pool was notably cooler in the deep location, demonstrating temperature stratification. While temperatures deep in the pool exceeded 65°F, they were several degrees cooler than at the surface and the duration of temperatures above the threshold was notably less. Temperatures recorded at the deep location in 2008 were similar to those recorded in 2001-2002.

The 2008 MWAT was 66.41°F, also demonstrating temperatures were warmer than suitable for coho (>63.0°F) as well as steelhead (>66°F). Temperatures recorded in Mattole Canyon Creek did reach the short-term lethal temperature limit for salmonids (>75°F, Brett 1952), topping out at 76.46°F. For the most part, the period of extremely warm water temperatures was restricted to a couple of weeks during the peak summer heat, but it lasted long enough to present a serious threat to rearing salmonids. Maximum temperatures surpassed 68°F on 17 of 179 days.

Although historically all three salmonid species are known to inhabit the creek, dive surveys in 2001-2002 and in 2008 have found only steelhead. In 2008, divers saw 47 steelhead young-of-the-year and 8 (4"-8") steelhead in the ten-pools sampled in spring. Surveyors observed 156 steelhead young-of-the-year and 30 (4"-8") steelhead in the same ten pool reach on October 30.

The channel of Mattole Canyon Creek is highly aggraded and even the deep pool where monitoring occurred is largely filled with fine sediment. Roadwork by the Mattole Restoration Council is scheduled to remedy this problem so recovery of the drainage may begin.

Eubanks Creek (RM 47.7)

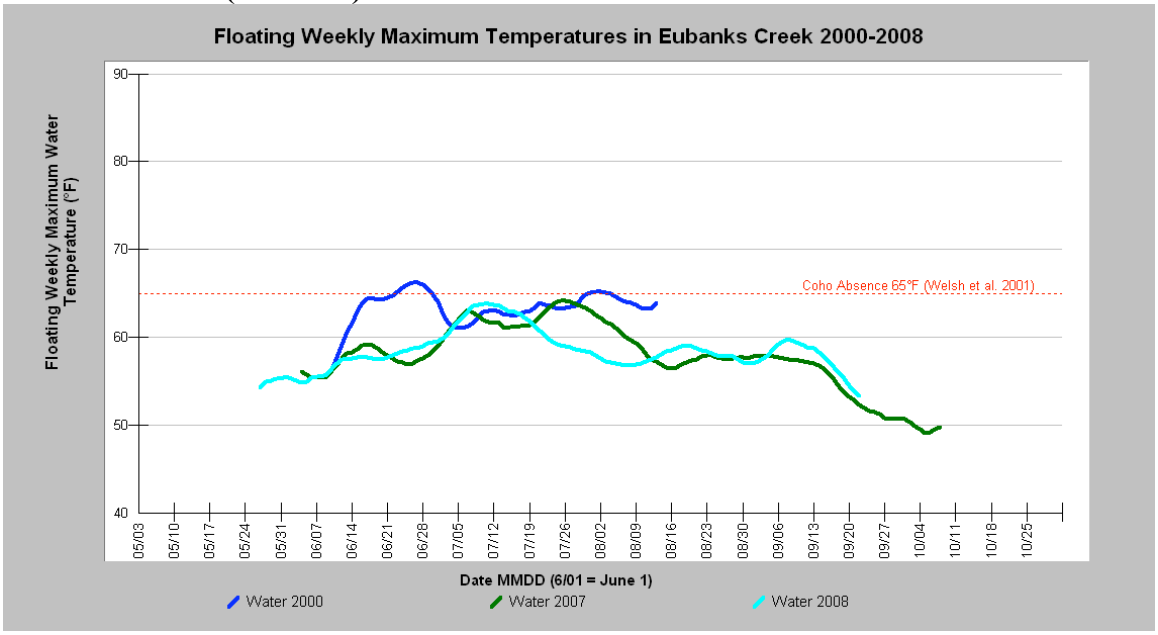


Figure 32. Floating Weekly Maximum Temperatures in Eubanks Creek 2000-2008.

The MSG monitored temperatures in Eubanks Creek in 2000, 2007, and 2008. Floating weekly maximum water temperatures exceeded 65°F in 2000 but not in 2007 or 2008, indicating temperatures are suitable for coho salmon rearing in some years (Welsh et al. 2001) (Figure 32). Data after August 16th, 2000 was not included because the logger pool went dry. In 2008, MWAT (61.14 °F) indicated thermal habitat in Eubanks Creek was marginal for coho but good for steelhead. 2008 temperatures in Eubanks Creek reached a maximum of 64.87°F, cool enough to spare rearing salmonids from prolonged or acute thermal stress. Low flow limits salmonid habitat in Eubanks Creek in some years.

Historically, steelhead, Chinook, and coho have been found in Eubanks Creek. Divers have seen only steelhead during the three years monitored since 2000. More steelhead young-of-the-year were observed this spring (85) than in the fall (12). Surveyors also found 2 (4"-8") steelhead in the spring and one in the fall.

McKee Creek (RM 52.8)

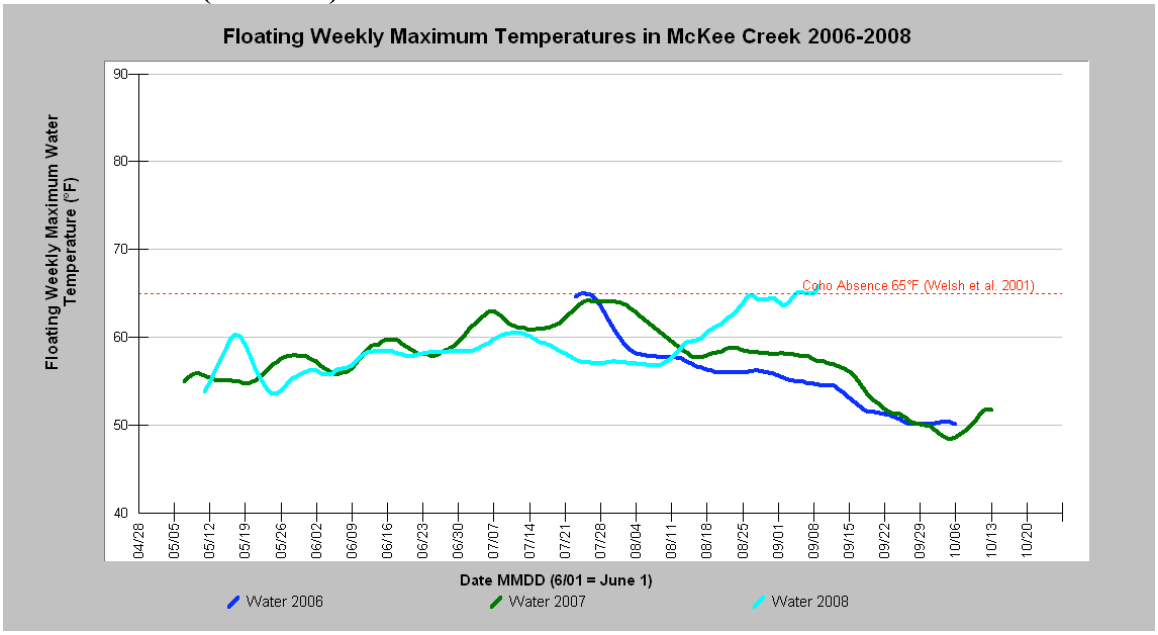


Figure 33. Floating Weekly Maximum Temperatures in McKee Creek 2006-2008.

MSG monitored temperature in McKee Creek for the past three summers. Floating weekly maximum water temperatures remained cool enough for coho rearing during all three years (<65°F MWMT, Welsh et al. 2001) (Figure 33). In 2008, the logger pool went dry by late August. According to thresholds determined by Coates et al. (2002), the 2008 MWAT (60.03°F) signifies favorable thermal habitat for steelhead (<63.0°F) and marginal thermal habitat for coho (59.0-63.0°F). The maximum temperature recorded in McKee Creek in 2008 was 68.83°F, below the acute stress threshold rearing salmonids. Prolonged thermal stress indicated by maximum temperatures greater than 68°F occurred on only two occasions during the monitoring period.

Despite favorable temperatures, McKee Creek provides limited habitat for juvenile salmonids from late summer until fall rains. While McKee had considerable flow in July, by October the entire lower stretch of McKee Creek was dry. 2008 dissolved oxygen monitoring in McKee Creek indicates low flow with resulting poor water quality threatens salmonids over-summering here.

This spring, MSG divers identified Chinook (1) and steelhead (48 young-of-the-year, 11 (4”-8”)) in McKee Creek. By fall, only one pool of the ten surveyed in the spring remained, and no fish were observed. During spring of 2007, MSG divers identified all three salmonid species in McKee Creek. By the fall, only steelhead were found in the disconnected pools remaining in the snorkel reach. Past survey data also indicates Chinook, coho, and Chinook utilize McKee Creek.

Southern Sub-basin

Bridge Creek (RM 52.8)

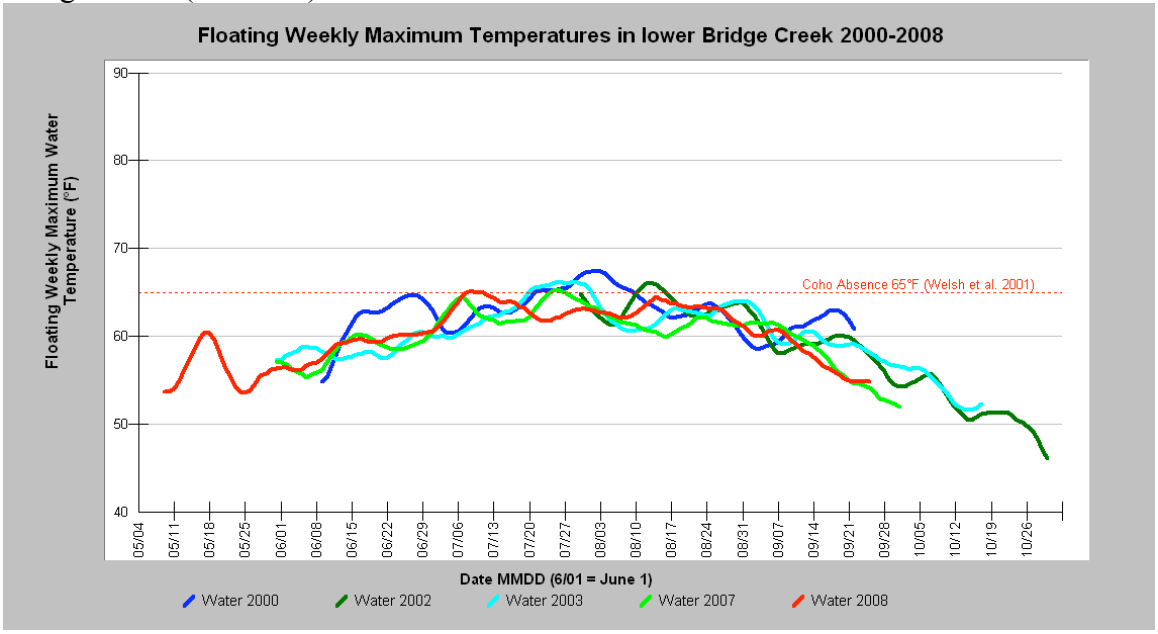


Figure 34. Floating Weekly Maximum Temperatures in Bridge Creek 2003-2008.

The MSG monitored temperature in Bridge Creek just upstream from its confluence with the Mattole in 2000, 2002-2004, and 2007-2008. Air temperature data was also collected in 2003-2004. Floating weekly maximum water temperature (MWMT) exceeded 65°F during all years monitored (2000, 2002, 2003, 2007, and 2008), indicating temperatures were not suitable for coho salmon rearing (Welsh et al. 2001) (Figure 34). In 2004, the temperature logger in the creek was damaged and data was not retrievable. Temperatures recorded in 2007 and 2008 were slightly cooler than other years on record, surpassing 65°F MWMT only slightly. The MWAT in 2008 (60.03°F) showed temperatures provided marginal habitat for coho (59.0-63.0°F) and good habitat for steelhead (<63.0°F) (Coates et al. 2002). Salmonids were not subject to acute or prolonged stress due to high temperatures (Brett 1952, Brungs and Jones 1977).

Historical salmonid presence in Bridge Creek includes steelhead, Chinook, and coho. This spring, MSG divers confirmed presence of all three salmonid species. By fall, only steelhead were observed. One Chinook was observed this spring. Divers also observed Chinook in 2003 and 2004. Coho have been observed more frequently, in 2002, 2003, and 2004. In spring 2008, MSG divers observed 2 coho. In 2000 and 2007, divers saw steelhead, but no salmon were observed.

Van Arken Creek (RM 54.0)

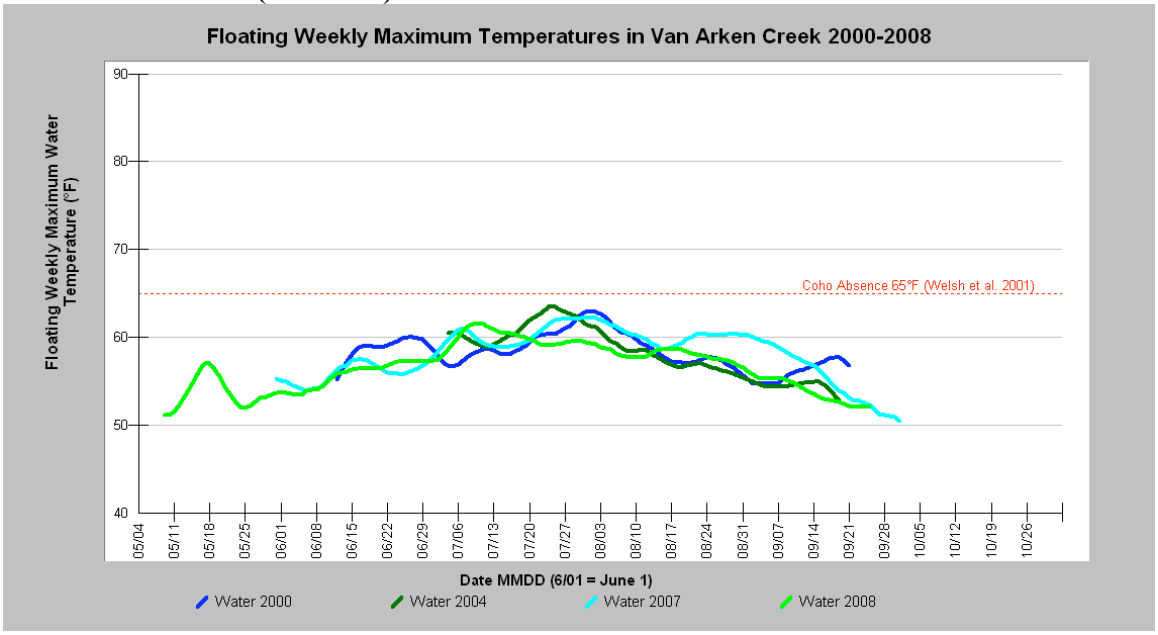


Figure 35. Floating Weekly Maximum Temperatures in Van Arken Creek 2000-2008.

MSG temperature monitoring occurred in Van Arken Creek during the summers of 2000, 2004, 2007, and 2008. During all years of monitoring, floating weekly maximum water temperatures remained below 65°F, indicating temperatures were suitable for coho salmon rearing (Welsh et al. 2001) (Figure 35). 2008 MWAT (60.14°F) showed thermal habitat was marginal for coho (59.0-63.0°F) and good for steelhead (<63.0°F) (Coates et al. 2002).

The Van Arken Creek subshed is mainly second growth forest with no old growth remaining. Most of the drainage is managed for timber. Sediment accumulation is noticeable in the creek bed especially in pools. However, water temperatures remain cool and there is riparian cover and habitat complexity provided by large wood. Salmonids are consistently observed here. In fall of 2008, the creek was dry and limited to disconnected pools near the confluence.

Historically, both coho and steelhead have been found in Van Arken Creek. This year, divers saw only steelhead. Four steelhead young-of-the-year and one (4”-8”) steelhead were found in the spring, and 3 steelhead young-of-the-year and one (4”-8”) steelhead were identified in the fall. MSG divers observed both coho and steelhead in 2007 – a single coho was observed last spring. Only steelhead were found in 2000.

Anderson Creek (RM 55.6)

The MSG monitored temperatures in Anderson Creek during the summers of 2002-2004 and 2008. The monitoring location in Anderson Creek was just upstream of its confluence with the Mattole. Floating weekly maximum temperatures recorded were less than 65°F during all years of monitoring, indicating acceptable thermal habitat for coho (Welsh et al. 2001) (Figure 36). The 2008 MWAT in Anderson Creek (56.53°F) demonstrated good thermal habitat for coho (<59°F) as well as steelhead (<63°F) (Coates et al. 2002).

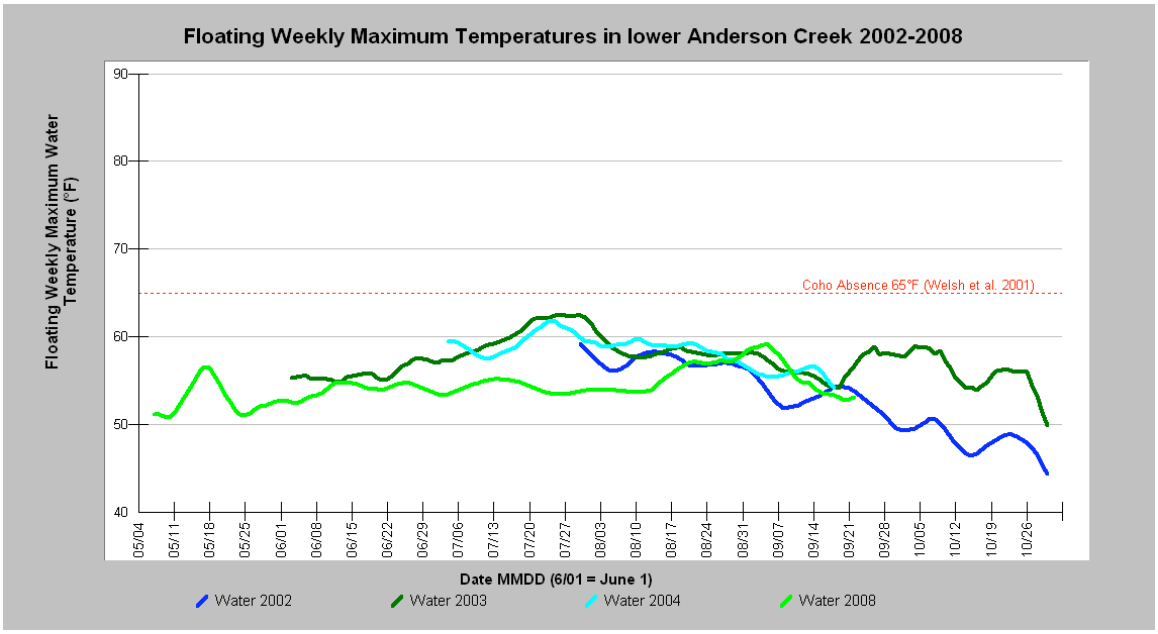


Figure 36. Floating Weekly Maximum Temperatures in Anderson Creek 2002-2008.

Temperatures in Anderson Creek remain cool over-summer, but salmonid habitat in Anderson Creek is limited by low flow in dry years. In 2008, the creek was dry from September 15 until the fall rains ensued in October. Past MSG monitoring has found only steelhead in Anderson Creek. 2008 was no exception - dive surveys found steelhead in spring. The entire snorkel reach was dry by fall, and divers were unable to locate any surviving fish. Future restoration efforts here should focus on flow monitoring and water conservation, as over-summer salmonid habitat is limited at best. Spot-checks for fish as flow conditions deteriorate are recommended.

Upper Mill Creek (RM 56.2)

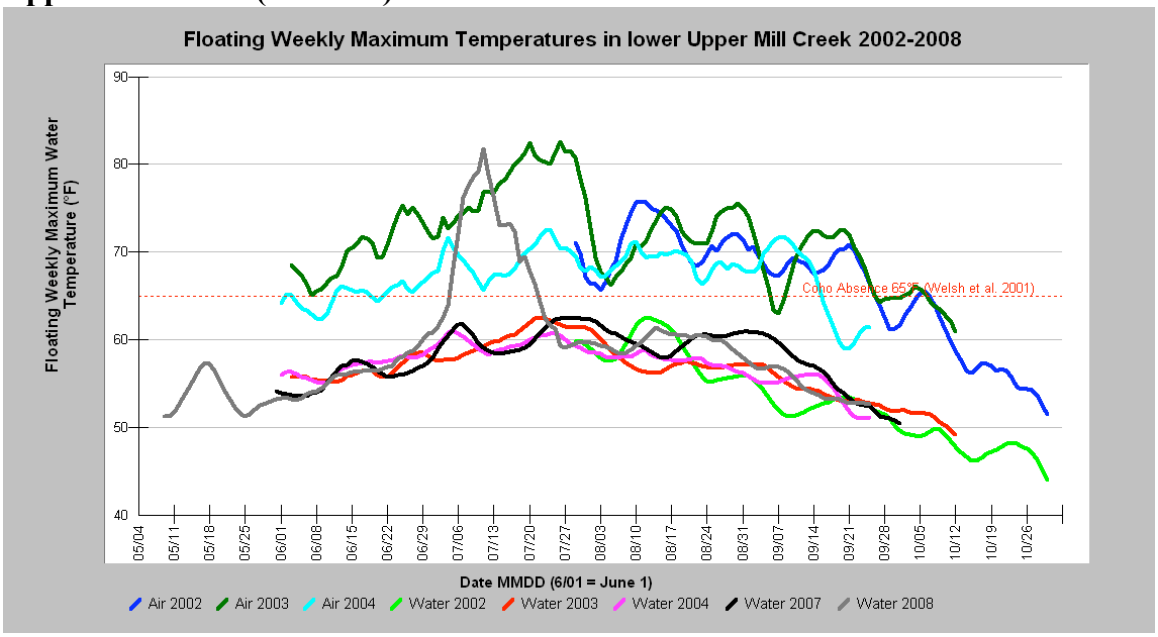


Figure 37. Floating Weekly Maximum Temperatures in Upper Mill Creek 2002-2008.

The lower section of Upper Mill Creek was monitored in 2002-2004 and in 2007-2008. Air temperatures were also recorded in 2002-2004. Floating weekly maximum water temperatures remained below 65°F during all years on record (2002-2004 and 2007-2008), indicating temperatures were suitable for coho salmon rearing (Welsh et al. 2001) (Figure 37). The peak of temperature on the graph indicates the period from 7/1/08 to 7/22/08, when the logger became dislodged and was out of water. It is likely the actual seasonal maximum occurred during this time period, but the maximum water temperature recorded by the logger was 62.49°F on 6/27/08. Although the logger was out of water during the seasonal peak, temperatures recorded in Upper Mill Creek were cool enough to ascertain lack of acute or prolonged thermal stress for salmonids. The maximum average temperature of any seven day period (MWAT) in 2008 was 59.68°F, which is considered marginal thermal habitat for coho (59-63°F) and more favorable for steelhead (<63°F) (Coates et al. 2002).

In 2002-2004, temperature and monitoring also occurred in the upper reach of Upper Mill Creek. Temperatures here were even cooler than in the lower reach; floating weekly maximum temperatures were usually below 60°F.

Coho, Chinook, and steelhead have been observed in Upper Mill Creek in the past. 2008 divers identified all three species in the fall; 85 steelhead, 2 Chinook, and 17 coho were observed on 9/29. Steelhead were the only salmonid species observed in spring 2008. Chinook were also observed in 2007. Spring 2007 was the first time juvenile Chinook were observed in Upper Mill Creek since before 2000. Chinook have been observed only in the lower reach. 2007 divers also found steelhead but no coho. Five dive surveys were conducted in Upper Mill Creek during the 2002-2004 monitoring seasons. Coho were observed in both upper and lower reaches during all 2002-2004 surveys. The maximum number of coho observed in the lower reach was 36 on 7/25/02. Coho were even more numerous in the upper reach of Upper Mill; 58 were identified on 5/30/03.

Baker Creek (RM 57.6)

Temperature monitoring in Baker Creek occurred in 2002-2004 and in 2007-2008. Floating weekly maximum water temperature did not exceed 65°F during any monitoring year, indicating temperatures were suitable for coho salmon rearing (Welsh et al. 2001) (Figure 38). 2008 MWAT (60.25°F) suggested marginal thermal habitat for coho (59.0-63.0°F) and good thermal habitat for steelhead (<63.0°F). The maximum temperature recorded in Baker Creek in 2008 was 62.15°F, indicating over-summering salmonids did not encounter acute or prolonged thermal stress.

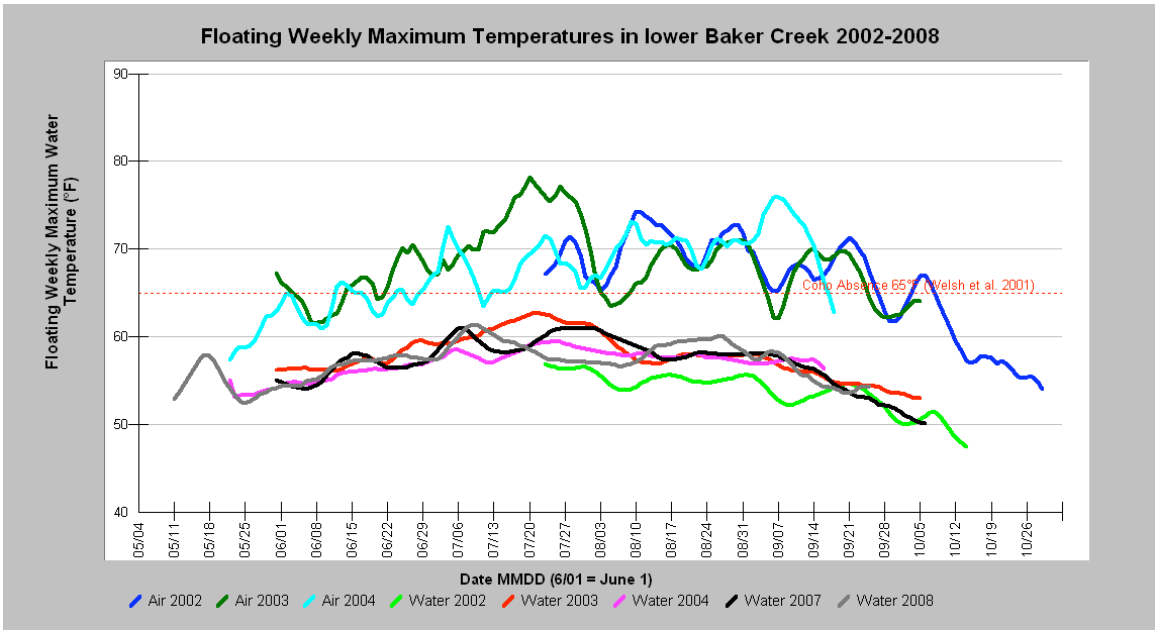


Figure 38. Floating Weekly Maximum Temperatures in Baker Creek 2002-2008.

Historical salmonid presence observed in Baker Creek includes steelhead, Chinook, and coho. MSG divers observed 35 steelhead and 127 coho in spring 2008. By fall, the snorkel reach was nearly dry except for two pools, in which only a single steelhead was observed. The Baker Creek has not been susceptible to drying in past years. As Baker Creek provides essential coho rearing habitat, monitoring over-summer flow conditions in order to enact emergency fish rescue is recommended. In 2007, MSG divers identified significant numbers of coho in the spring (71) in addition to steelhead. The 2007 fall dive followed a 3“ rain, and only 2 steelhead young-of-the-year were observed. Six dive surveys were conducted in lower Baker Creek in spring and fall 2002-2004, with 10 pools snorkeled in each survey. Coho and steelhead were observed in five out of six surveys. Five juvenile Chinook salmon were observed during surveys in the spring of 2004.

Thompson Creek (RM 58.4)

Water temperature monitoring in Thompson Creek occurred in 2000, 2002-2004, and 2007-2008. Air temperatures were also monitored in 2002-2004. Floating weekly maximum water temperatures exceeded 65°F in 2000 and 2003, indicating temperatures were not suitable for coho salmon rearing during those years. Temperatures remained cool enough to be suitable for coho in 2002, 2004, 2007 and 2008 (Welsh et al. 2001) (Figure 39). In 2008, the MWAT was 60.67°F, marginal thermal habitat for coho (59-63°F) and good thermal habitat for steelhead (<63°F) (Coates et al. 2002). The maximum temperature recorded in 2008 was a cool 62.83°F, further showing thermal habitat in Thompson Creek is favorable relative to many Mattole tributaries. Unlike many cool upper Mattole tributaries, Thompson Creek maintains significant flow throughout the summer and is one of the largest tributaries near the headwaters.

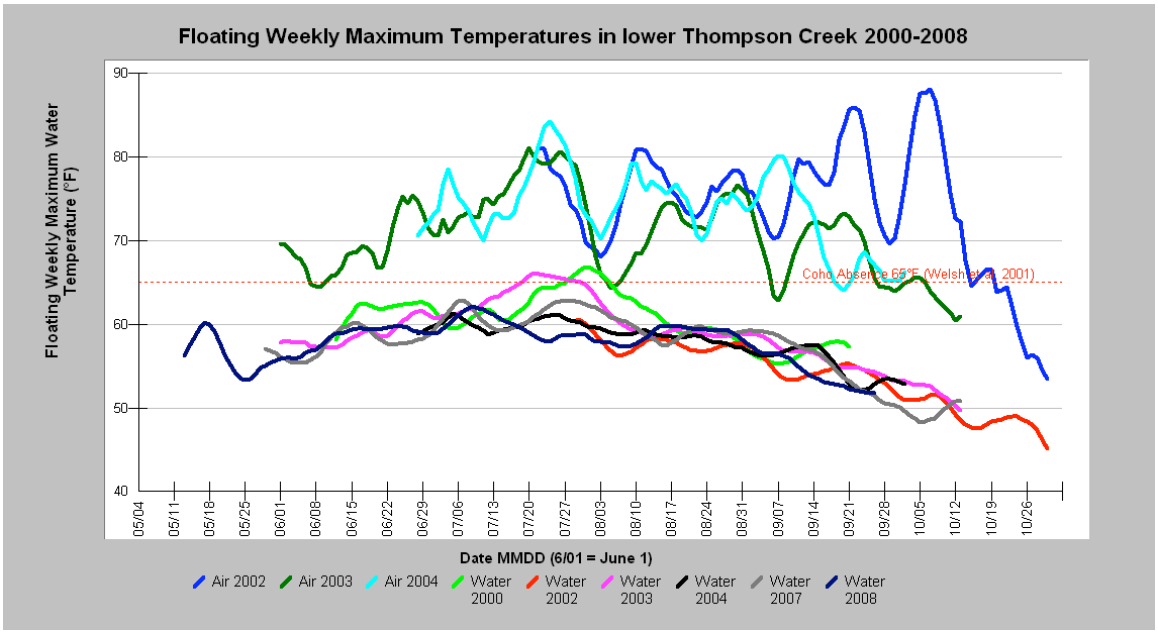


Figure 39. Floating Weekly Maximum Temperatures in Thompson Creek 2002-2008.

In addition to cool habitat and consistent summertime flow, Thompson Creek provides other positive salmonid habitat attributes. Good riparian cover and habitat complexity, including deep pools and abundant small and large woody debris, are characteristic of the drainages. Thompson and Yew Creeks are under the stewardship of Redwoods Monastery, which has contributed to their good condition and bodes well for their future. Of the upper Mattole tributaries, Thompson and its tributary, Yew Creek (see below), have the most consistent numbers of coho and often numerous Chinook as well. 11% old growth remains in the drainage, and the rest of the creek is relatively shaded. Thompson Creek is also home to numerous MSG wood structures, completed as part of old habitat restoration projects.

Historically, steelhead, Chinook, and coho have been found in Thompson Creek. In recent years, MSG divers have observed the most consistent juvenile coho abundance in Thompson Creek and its tributary, Yew Creek. In 2008, only coho and steelhead were observed. Both salmon species appear to experience excellent over-summer survival and growth in Thompson Creek. Coho and steelhead were more abundant in fall 2008 than in the spring. In spring, divers located 8 steelhead and 2 coho young-of-the-year. The fall survey found 233 steelhead and 104 coho, 98 of which were of the 4”-8” size class. Dive surveys in 2007 found all three salmonid species in both spring and fall. Twenty-three coho and 17 Chinook young-of-the-year were observed in spring 2007. Eleven Chinook were observed in the fall, and had graduated to the 4”-8” size class. Divers found 6 coho less than 4” and 24 (4”-8”) coho in fall 2007. Chinook were also observed in 2004. Coho and steelhead have been observed during all past dive surveys in Thompson Creek (2000, 2002, 2003, and 2004).

Yew Creek (RM 58.4 + 0.15)

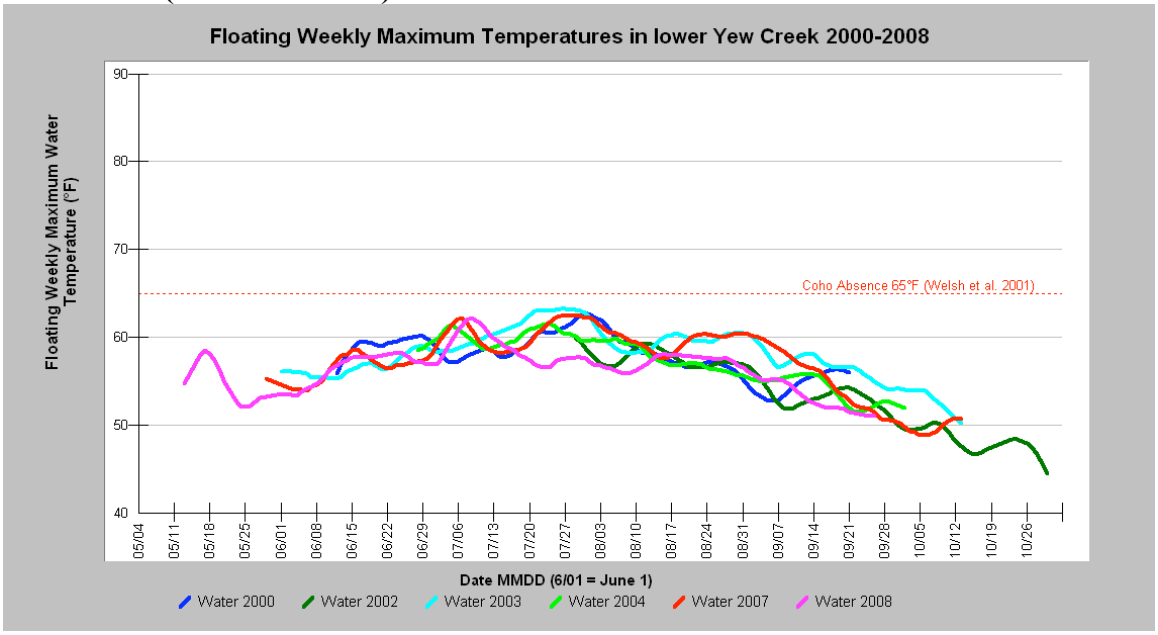


Figure 40. Floating Weekly Maximum Temperatures in Yew Creek 2000-2008.

Temperature monitoring occurred in Yew Creek in 2000, 2002-2004, 2007, and 2008. Floating weekly maximum water temperature remained below 65°F during all years on record, indicating suitable temperatures for coho salmon rearing (Welsh et al. 2001) (Figure 40). According to criteria determined by Coates et al. (2002), the 2008 MWAT in Yew Creek (59.81°F) showed marginal thermal habitat for coho (59.0-63.0°F) but good habitat for steelhead. 2008 temperatures in Yew Creek peaked at 63.47°F, well below thresholds for acute and prolonged thermal stress for salmonids.

Yew Creek is a tributary to Thompson Creek, sharing the same favorable attributes for salmonid rearing, including both acceptable temperature and consistent summer flow. Abundant large wood and cover contribute to high-quality habitat. Over-summer survival and growth is also a key observation of dive surveys, further indicating excellent rearing habitat.

Dives in recent years as well as historically have found coho and steelhead in relative abundance in Yew Creek. In 2008, divers saw 14 coho (<4”) in the spring, and 19 (4 (<4”) plus 15 (4”-8”)) in the fall. Over-summer growth was noticeable. Steelhead were also observed in greater numbers this fall. 2007 fish counts in Yew Creek were also numerous compared to other upper Mattole tributaries. The only documented Chinook observations in Yew Creek were last year. MSG staff observed 10 Chinook and 87 coho young-of-the-year last spring. By the fall of 2007, some of the coho and Chinook had grown enough to be classified in the larger (4”-8”) size class. Divers observed 2 (<4”) and 3 (4”-8”) Chinook last fall. Fall 2007 coho counts were even more numerous (21 (<4”) and 24 (4”-8”)). Coho and steelhead have been observed during all dive surveys (2000, 2002, 2003, and 2004).

Lost River Creek (RM 58.8)

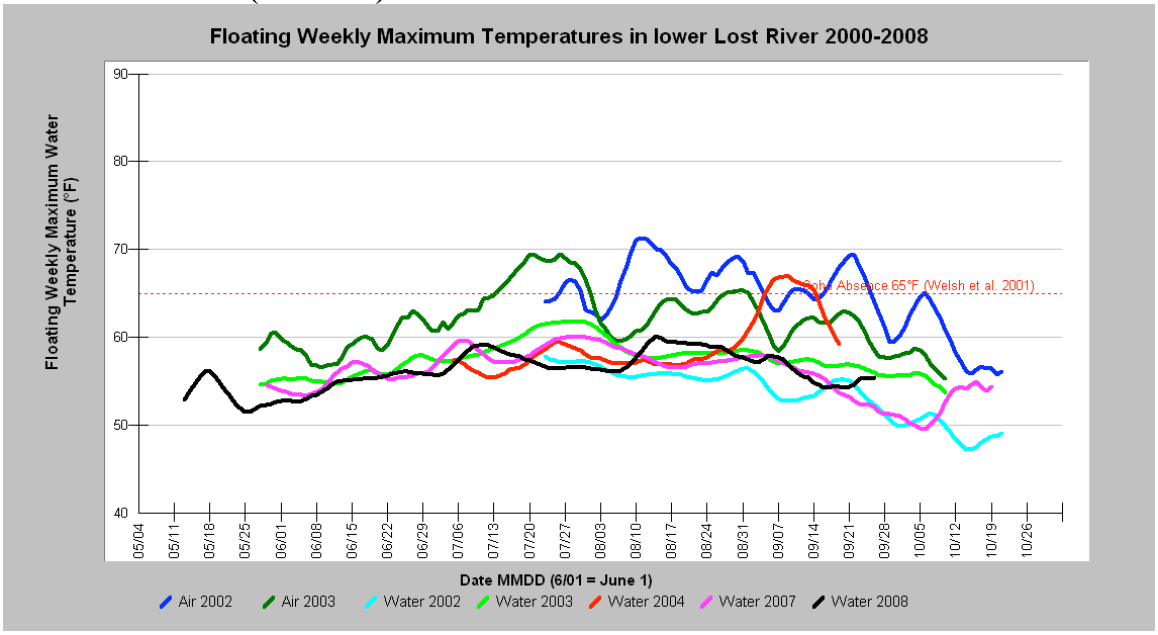


Figure 41. Floating Weekly Maximum Temperatures in Lost River Creek 2002-2008.

The MSG monitored water temperature in Lost River Creek in 2002-2004 and 2007-2008. Air temperatures were recorded in 2002-2003. Floating weekly maximum water temperatures exceeded 65°F only during 2004, indicating temperatures are suitable for coho salmon rearing during most years (Welsh et al. 2001) (Figure 41). In 2008, the MWAT in Lost River was 58.69°F, suggesting good thermal habitat for coho and steelhead (>59°F, Coates et al. 2002). Maximum temperatures in Lost River Creek remained cool throughout the summer. The peak temperature recorded was 60.99°F, well below thresholds for prolonged or acute thermal stress.

The lower reach of Lost River dries up by the fall during some years, becoming a series of disconnected pools. Despite cool temperatures, low flow problems consistently contribute to salmonid mortality as water quality becomes poor in the remaining pools. The entire survey reach was dry by fall this year (and in 2004), and therefore unsuitable for any salmonid rearing. In 2007, the confluence to 100 feet upstream was dry, and the rest of the reach was a series of disconnected pools with questionable water quality.

Based on past MSG data, historical salmonid presence in Lost River includes coho salmon and steelhead. Coho have been observed in Lost River during all spring surveys (2002-2004) but not in the fall. This year, 12 steelhead and 13 coho were observed in the spring. No salmonids were observed this fall, as the snorkel reach was dry. In 2007, MSG divers found 50 steelhead and 6 coho during the spring survey. By fall 2007, only 16 steelhead young-of-the-year were observed.

Ancestor Creek (RM 60.8)

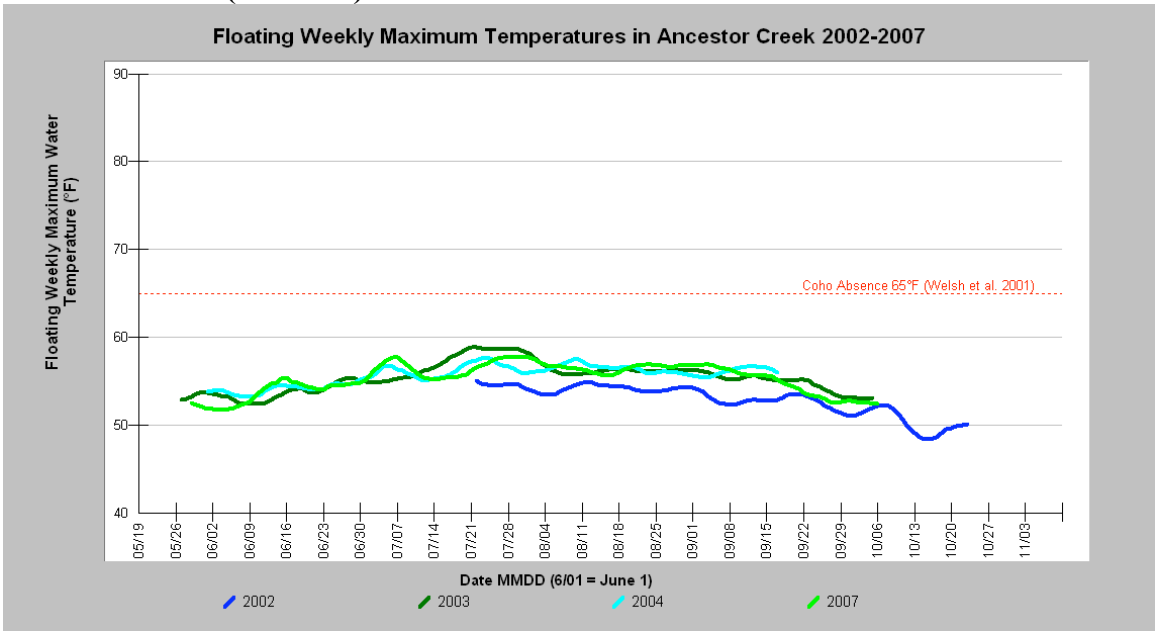


Figure 42. Floating Weekly Maximum Temperatures in Ancestor Creek 2002-2007.

Temperature monitoring in Ancestor Creek occurred in 2002-2004 and 2007-2008. Floating weekly maximum water temperatures remained below 65°F during all years on record, demonstrating suitable thermal habitat for coho salmon rearing (Figure 42). The 2008 temperature logger malfunctioned, thus data from this year is unavailable. Past temperature data indicates temperatures in Ancestor Creek provide excellent thermal habitat. The 2007 maximum weekly average temperature (MWAT) was 56.8°F, favorable for both juvenile coho salmon (<59.0°F) and steelhead (<63.0°F) (Coates et al. 2002). Temperatures near the Mattole headwaters and in the uppermost tributaries like Ancestor Creek remain cool throughout the summer, representing the best thermal habitat in the watershed. This area is invaluable for salmonid over-summering, especially for coho, the Mattole species most vulnerable to high temperatures (Welsh et al. 2001, Coates et al. 2002). The maximum temperature recorded in Ancestor Creek in 2007 was 59.19°F.

MSG surveyors have located juvenile coho salmon in Ancestor Creek on all eleven dive surveys conducted since 2002. This year, divers saw one coho and one Chinook in the spring; both were less than 4 inches in length. In the fall, surveyors found more coho (14 (<4") and 14 (4"-8")) and 2 Chinook (>4"). Over-summer growth was apparent for both species. 2007 was the first time MSG divers documented juvenile Chinook in Ancestor Creek. In 2007, juvenile coho salmon were also observed in both the spring (38) and fall (1), while Chinook (4) were observed only in the spring. Steelhead have been observed during all past dive surveys. Much of the Ancestor Creek drainage is state park property, and past surveys have found habitat is favorable for juvenile coho salmon, due to both low temperatures and habitat complexity, including large woody debris. In 2007 and 2008, surveyors noted Ancestor Creek had greater flow than the Mattole at its confluence.

Conclusion

Past MSG temperature monitoring, NCWAP and SWRCB, among others, have determined temperature is a major limiting factor to salmonid distribution, abundance and survival in the Mattole Watershed. 2008 temperature monitoring further indicated temperature is negatively impacting the recovery of Mattole salmonids. Stream temperatures in the Mattole basin have increased during the last four decades as a result of channel aggradation, widening, and the removal of riparian cover. Lack of over-summering habitat and energetic constraints to feeding and growth due to high water temperatures have contributed to reduced run strength for Mattole Chinook and coho salmon.

The life stage of salmonids most vulnerable to increased temperature is the growth phase (Brungs and Jones 1977). Juvenile salmonids in the Mattole during summer 2008 were exposed to high water temperatures, low flows and lack of riparian shading. Maximum temperature exceeded lethal temperatures for juvenile salmonids (>75°F, Brett 1952) in all temperature-monitoring sites in the mainstem Mattole River downstream of river mile 47.4 for the majority of summer 2008. Further downstream, seasonal peak water temperatures were above 80°F in most locations, demonstrating the lack of suitable over-summering habitat for salmonids in the lower and middle mainstem. MWATs in all temperature-monitoring locations in the middle and lower river also showed unsuitable thermal habitat for all salmonid species.

Temperatures recorded at the Mattole Estuary show over-summering salmonids encounter acute and prolonged thermal stress in this critical habitat. Estuarine habitat does not support growth of rearing Chinook, and long-term survival of trapped salmonids once the mouth of the river is closed is questionable at best. In years where the mouth closes early, significant numbers of rearing Mattole Chinook perish in this bottleneck to survival. Dive counts confirmed the nearly complete decline of Chinook populations in the estuary over summer 2008.

Tributaries monitored in 2008 where temperatures reached short-term lethal maximum temperature for salmonid survival (>75°F, Brungs and Jones 1977) included the Lower North Fork Mattole (RM 4.7), the Upper North Fork Mattole (RM 25.5), Mattole Canyon Creek (RM 41.1), and Bear Creek (RM 42.8) (lower reach only). Characteristics common to these streams include a high occurrence of channel aggradation, a high percentage of grasslands and road density and/or slides in the subbasins. All of these are larger Mattole tributaries, with significant summer flow. Many of the smaller tributaries maintain more favorable thermal habitat. However, the drought conditions in 2008 show that many smaller tributaries are susceptible to drying, representing an alternate threat to the survival of over-summering salmonids.

Juvenile coho have the lowest tolerance to high temperature of any anadromous species in the Mattole Watershed (Coates et al. 2002). Four hundred and thirty two coho salmon were observed during dive surveys in the Mattole and selected tributaries in 2008. In comparison, 360 coho were observed last year. This year, more coho were observed in the fall (235) than in the spring (197), which is unusual. Divers observed noticeable over-summer growth. In the spring, all coho observed were less than four inches in length, while by fall 177 coho (75%) were greater than four inches. Coho were observed in nine tributaries in 2008, including Ancestor Creek (RM

60.8), Lost River (RM 58.8), Thompson Creek (RM 58.4), Yew Creek (RM 58.4+0.15), Baker Creek (RM 57.8), Upper Mill Creek (RM 56.2), Bridge Creek (RM 52.1), Big Finley Creek (RM 47.4), and Lower Mill Creek (RM 2.8). In the spring, divers found coho in seven Mattole tributaries. By fall, observations of coho occurred in only five tributaries.

The criteria developed by Welsh et al. (2001) correctly identified coho presence in 15 of 29 tributary reaches where juvenile dive surveys and temperature monitoring were conducted in the Mattole in 2008. Temperature data for two tributaries (East Mill Creek (RM 5.4) and Ancestor Creek (RM 60.8)) was irretrievable, however past temperature data indicates both of these creeks have been consistently cool. Coho were observed in Ancestor Creek, but not East Mill Creek. Bridge Creek (RM 52.1) was the only tributary with MWMT above 65.0°F where coho were observed. In thirteen monitoring locations, floating weekly maximum temperatures remained below the coho threshold, but coho were not observed. These tributaries included: Anderson Creek (RM 55.6), Van Arken Creek (RM 54.0), McKee Creek (RM 52.8), Eubanks Creek (RM 47.7), South Fork Bear Creek (RM 42.8+~6.0), North Fork Bear Creek (RM 42.8+5.0+~2.0), Sholes Creek (RM 36.6), East Fork Honeydew Creek (RM 26.5+2.5+0.1), Upper Honeydew Creek (RM 26.5+2.5), Woods Creek (RM 24.1), Clear Creek (RM 6.1), Stansberry Creek (RM 1.3), and Lower Bear Creek (RM 1.0).

Of these, seven tributaries (Van Arken Creek (RM 54.0), McKee Creek (RM 52.8), Eubanks Creek (RM 47.7), Sholes Creek (RM 36.6), Upper Honeydew Creek (RM 26.5+2.5), Woods Creek (RM 24.1), and Clear Creek (RM 6.1) have historically had coho presence, but none were observed in 2008. Coho presence in North Fork Bear Creek has not been determined previously, although coho are known to reside in the Bear Creek subshed. Coho are also known to inhabit in the Honeydew Creek subshed, but despite suitable thermal habitat in the East Fork, they were not found in the two years monitored. In the remaining four tributaries, Anderson Creek (RM 55.6), South Fork Bear Creek (RM 42.8+~6.0), Stansberry Creek (RM 1.3) and Lower Bear Creek (RM 1.0+~0.3), past and present temperature monitoring has indicated cool thermal habitat, but coho have not been observed. Lower Bear Creek is discontinuous with the mainstem Mattole and thus impassable to salmonids.

This year was unusual in that coho were observed in only one tributary downstream of RM 47.4 (Lower Mill Creek at RM 2.8). In most years, coho are located in several middle and lower Mattole tributaries. Lower Mill Creek bears the distinction of being the lower Mattole tributary with the best salmonid habitat and the most consistent coho sightings. Lower Mill Creek is located in the Mattole's western subbasin, where coho are consistently observed. MSG divers did not find coho in any tributaries in the northern or eastern subbasins this year or last. All tributaries excluding Lower Mill Creek where coho were observed in 2008 were in the southern subbasin (upper Mattole), nearest the headwaters.

In the mainstem, coho were observed exclusively in the upper Mattole (southern subbasin, upstream of Bridge Creek at RM 52.1) during 2008 dive surveys. A small number of coho were also found in the MSG's downstream migrant trap at RM 3.9.

Floating Weekly Maximum Temperatures in seven of twelve upper Mattole mainstem temperature monitoring sites exceeded suitable temperatures for coho rearing (Welsh et al.

2001). Temperatures remained below the coho threshold at five upper mainstem locations, including the uppermost four (Mattole upstream of Ancestor Creek (RM 60.8), MS-1 (RM 59.4), MS-2 (RM 58.9), and MS-3/Mattole upstream of Thompson Creek (RM 58.5). This emphasizes the importance of the very upper Mattole mainstem and tributaries as the best rearing habitat in the Watershed for juvenile coho.

Stream temperatures are most favorable for coho and rearing habitat most abundant near the Mattole headwaters and in upper Mattole tributaries. However, low-flow issues in the upper Mattole present a dire threat to over-summer juvenile salmonid survival. In recent dry years, sections of the upper Mattole coho-rearing habitat have completely dried, resulting in death of estimated thousands of salmonids. Even when the river does not dry completely, the channel often become a series of disconnected pools. Low-flow results in water quality issues, namely low dissolved oxygen levels. Salmonids rearing here are at risk of poor feeding and reduced growth due to substandard water quality when the flows are low enough. Because the areas most affected by low-flow are some of the most important and favorable coho rearing habitat in the Mattole, addressing this problem is essential to survival of the species. Dissolved oxygen, water quality, and low-flow monitoring with concurrent salmonid dive counts are underway to monitor at-risk salmonids in the upper Mattole.

Temperature is important in determining the distribution and habitat utilization by juvenile coho in the Mattole Watershed, but other factors also play an important role. In addition to cool temperatures, tributaries where coho were observed in 2008 have other favorable salmonid habitat attributes in common, including the presence of riparian cover, pools, and habitat complexity provided by boulders and large and small woody debris. Lack of significant fine sediment and stream aggradation is also a common characteristic of streams where coho were observed in 2008.

Juvenile Chinook were observed in seven tributaries during 2008 dive surveys. These included Woods Creek (RM 24.1), East Fork Honeydew Creek (26.5 +2.5+0.1), Bear Creek (RM 42.8), Bridge Creek (RM 52.1), McKee Creek (RM 52.8), Upper Mill Creek (RM 56.2), and Ancestor Creek (RM 60.8). MSG staff also observed Chinook in the mainstem at seven D.O. monitoring locations in the upper Mattole (RM 59.4 – RM 52.1), upstream of Grindstone Creek (RM 38.9), in the downstream migrant trap (RM 3.9), at the Wingdam (RM 2.9), upstream of Stansberry Creek (RM 1.3) and in the Mattole Estuary. Current efforts to expand dive monitoring in the Mattole estuary, headwaters, and tributaries throughout the watershed aim to gain more understanding of the effects of elevated temperature and low streamflow on juvenile Chinook over-summer survival and distribution.

In order to ensure the survival of the three Mattole salmonid ESUs, both long-term planning for limiting factor remediation as well as protection and restoration of known mainstem and tributary habitat in the short-term are needed. Because of the seasonal and annual variability of mouth closure of the Mattole, it is essential for juvenile coho and Chinook survival that the coolest and best of the middle and lower Mattole tributaries are protected with reference to their favorable characteristics for salmonid over-summering. Water conservation and water storage in critical upper river and tributary over-summering habitat is crucial to preserve the viability of the best Mattole coho rearing habitat.

Instream habitat enhancement projects can provide nearly immediate benefits by deepening pools, providing complex cover and adding organic debris to the river channel. More habitat enhancement structures in the middle and lower river and estuary are essential to improve over-summering habitat where salmonids face the greatest risk from high temperatures. Recent habitat improvements implemented by the MSG include large wood structures constructed in Squaw Creek and the Mattole Estuary, both good examples of projects which have provided immediate benefit to rearing salmonids in the lower Mattole. A high priority should also be placed on habitat improvement projects in areas with suitable thermal habitat for salmonid rearing as well.

Yearly salmonid population monitoring with concurrent multi-parameter water quality monitoring is recommended in order to effectively assess risks to the population from year-to-year and enact effective rescue in the Mattole Estuary.

Conducting a basinwide salmonid habitat assessment using viability criteria developed by McElhany et al. (2000, 2003) is recommended in the MSG Salmonid Population Monitoring Plan. Central to this approach is probabilistic spatially balanced sampling as described by Stevens and Olsen 2004. This limiting factor analysis will provide crucial information and allow for detailed planning of the steps necessary to guide Mattole salmonids on the steps to recovery. The MSG is transitioning temperature and dive monitoring to become compatible with this model while keeping data collection consistent with past monitoring for comparison purposes. We hope to conduct a basinwide evaluation of salmonid habitat beginning with 2009 monitoring. With over twenty years of experience, the MSG is uniquely familiar with salmonid habitat in the Mattole Watershed and well prepared to implement long-term salmonid monitoring and enact effective restoration.

Recommendations

- Integrate Salmonid Population Monitoring Plan (MSG 2009) elements concerning Temperature and Dive Monitoring.
    - Collect temperature and dive data compatible with McElhany et al. (2000, 2003) in order to assess viability of the Mattole River salmon populations, and determine future actions needed for recovery.
        - Monitoring of temperature and other water quality factors will address limiting factor analysis of water quality conditions
        - Dive Monitoring will address evaluation of within population spatial structure, within-population diversity, and juvenile outmigrant growth rate.
    - Probabilistic spatially balanced sampling (Stevens and Olsen 2004) of tributaries throughout the watershed will allow a scientifically sound watershed-scale assessment of salmonid habitat.
    - Integrate rapid stream survey assessment as outlined in the Salmonid Population Monitoring Plan (MSG 2009).
        - Rapid steam surveys will allow basinwide habitat assessment, and document spatial distribution of good and poor habitat conditions. These

surveys will then guide future monitoring efforts and allow additional monitoring to be focused in those areas deemed to be limiting.
        - Conduct spot checks of flow and temperature during rapid stream surveys.
- Establish Life-Cycle Monitoring Stations in strategic tributaries to assess limiting factors at all stages of the salmonid life cycle for the three Mattole salmonid species.
    - Determining at which life stage and where in the watershed limiting factors are most detrimental to salmonids will allow development of the most effective restoration strategy and provide information for evaluation of the population status of the respective salmonid ESUs.
- Continue to deploy long term year round temperature monitoring devices in juvenile salmonid survey reaches and/or as low in the tributary as possible. Monitoring juvenile salmonids in the same locations as habitat monitoring will facilitate evaluation of habitat in relation to actual population numbers.
- Conduct spot-checks of other water quality parameters using a multi-parameter water quality monitoring device at all temperature monitoring locations during placement and retrieval.
    - Conducting more detailed water quality investigations at established monitoring sites will allow the MSG to evaluate other water quality factors affecting salmonid habitat utilization in relation to historical temperature and salmonid salmonid population data.
- Continue dive surveys to monitor Chinook and coho presence in creeks and mainstem locations throughout the Mattole Watershed over multiple study years to establish a baseline of salmonid habitat distribution in comparison to temperature trends.
- Install temperature monitoring devices at the USGS gauging stations near Petrolia and Ettersburg.
- Continue temperature monitoring at Mattole mainstem and tributary reference locations.
- Conduct dissolved oxygen and temperature monitoring in critical reaches of upper mainstem rearing habitat subject to summertime low-flows.
- Monitor coho, Chinook, and steelhead presence in the Mattole Estuary via dive surveys to determine survival, distribution, and abundance over the summer months.
- Enhance pool habitat in the mainstem to expand over-summering habitat for juvenile salmonids.
- Utilize temperature data to determine areas where restoration activities can be conducted to enhance habitat in areas that support water temperatures favorable for salmonid over-summering.
    - Evaluate cooler sites for restoration potential to address over-summer temperatures as a major limiting factor to salmonids.
- Implement pre- and post-project monitoring of restoration sites.
- Continue to study specific cold areas (pools and seeps), observing the dynamics of the channel morphology/temperature relationship through time.
- Integrate Multi-year Analysis into Project Reports when possible.

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