Monitoring the Russian River Coho Salmon Captive Broodstock Program: Annual Report

July 2005 to June 2006

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INTRODUCTION

RUSSIAN RIVER COHO SALMON CAPTIVE BROODSTOCK PROGRAM

To aid in the effort to recover coho salmon in the state and federally endangered Central California Coast Coho Salmon ESU, CDFG, NOAA Fisheries, and the USACE initiated the Russian River Coho Salmon Captive Broodstock Program (RRCSCBP) in 2001 with the goal of reestablishing self-sustaining runs of coho salmon in tributary streams within the Russian River basin. Under this program, offspring of wild captive-reared coho are stocked as juveniles into tributaries within their historic range. These fish are released during different seasons (spring and fall after hatching) and into different historic tributaries within the Russian River drainage.

Monitoring Component of RRCSCBP

The University of California Cooperative Extension (UCCE) and California Sea Grant Program are working with agency partners to develop and implement a monitoring and evaluation component for the RRCSCBP. The overall monitoring goal is to evaluate the effectiveness of the RRCSCBP by documenting whether released program fish return to their streams of release as adults and successfully complete their life cycles. Different hatchery release protocols and stocking environments will be assessed to determine the optimal stocking strategies for successfully restoring coho to the Russian River drainage. Specific monitoring objectives for each release stream include estimating seasonal instream abundance and survival of spring and fall-released coho, estimating adult return rates and juvenile to adult survival rates, measuring coho size and condition, and documenting food availability and baseline flow and temperature regimes. All of these biotic and abiotic metrics are compared among the different program streams. With this information, agencies will have the ability to make informed decisions about the future direction of the program and adaptively manage release strategies for optimal survival. Results from monitoring efforts are routinely reported at Monitoring and Evaluation Committee (M&E Committee) meetings. The M&E Committee (representing county, state, and federal agencies, non-governmental organizations, and public and private parties), in turn, provides feedback and suggestions about how to improve the monitoring program, and the RRCSCBP in general.

2005-2006 Statement of Goals and Objectives

Our primary goal for 2005-2006 was to compare instream seasonal survival and growth rates among groups of juvenile coho stocked into Mill, Palmer, Sheephouse, Ward, and Gray Creeks during different seasons (spring and fall after hatching). We also aimed to collect temperature, flow, and macroinvertebrate abundance data that may help explain any observed variation in coho growth and survival rates.

Specific objectives include:

1) Estimate late summer abundance and oversummer apparent survival of juvenile coho stocked into Russian River tributaries during the spring of 2005.
2) Estimate the number, migration timing, size, and condition factor of coho smolts emigrating from stocked tributaries.
3) Estimate instream overwinter apparent survival of coho that were released during the spring and fall of 2005.
4) Compare instream overwinter apparent survival, size and condition factor between spring and fall-released coho.
5) Conduct snorkeling surveys in Green Valley and Dutch Bill, and other Russian River tributaries to determine presence/absence of juvenile coho.
6) Compare macroinvertebrate abundance among program streams as a measure of food availability for stocked coho.
7) Record continuous temperature and flow data on each program stream.

Report Purpose and Time Frame

The purpose of this document is to satisfy the reporting requirements outlined in NOAA Fisheries Permit 1067 issued to CDFG under the authority of Section 10 of the Endangered Species Act. Monitoring activities were carried out on the five streams that were stocked in 2005 (Mill, Palmer, Sheephouse, Ward, and Gray Creeks), and on two streams known to have remnant wild coho populations in the recent past (Green Valley and Dutch Bill Creeks) (**Figure 1**). Data collected from July 1, 2005 through June 30, 2006 are summarized in this report and cover the instream portion of the life cycle from summer after (spring) stocking through smolt migration. For stream flow and temperature data, the period covered in this report extends to October 2006.

Additionally, this report is intended to compile and compare previous years' monitoring results beginning with UCCE's initial coho monitoring activities in 2004. Accordingly, the tables and figures have been formatted to provide summary data for this reporting year and the 2004-2005 reporting year. Successive reports will continue with this compilation so that each report provides a summary of the results from the monitoring program over time.

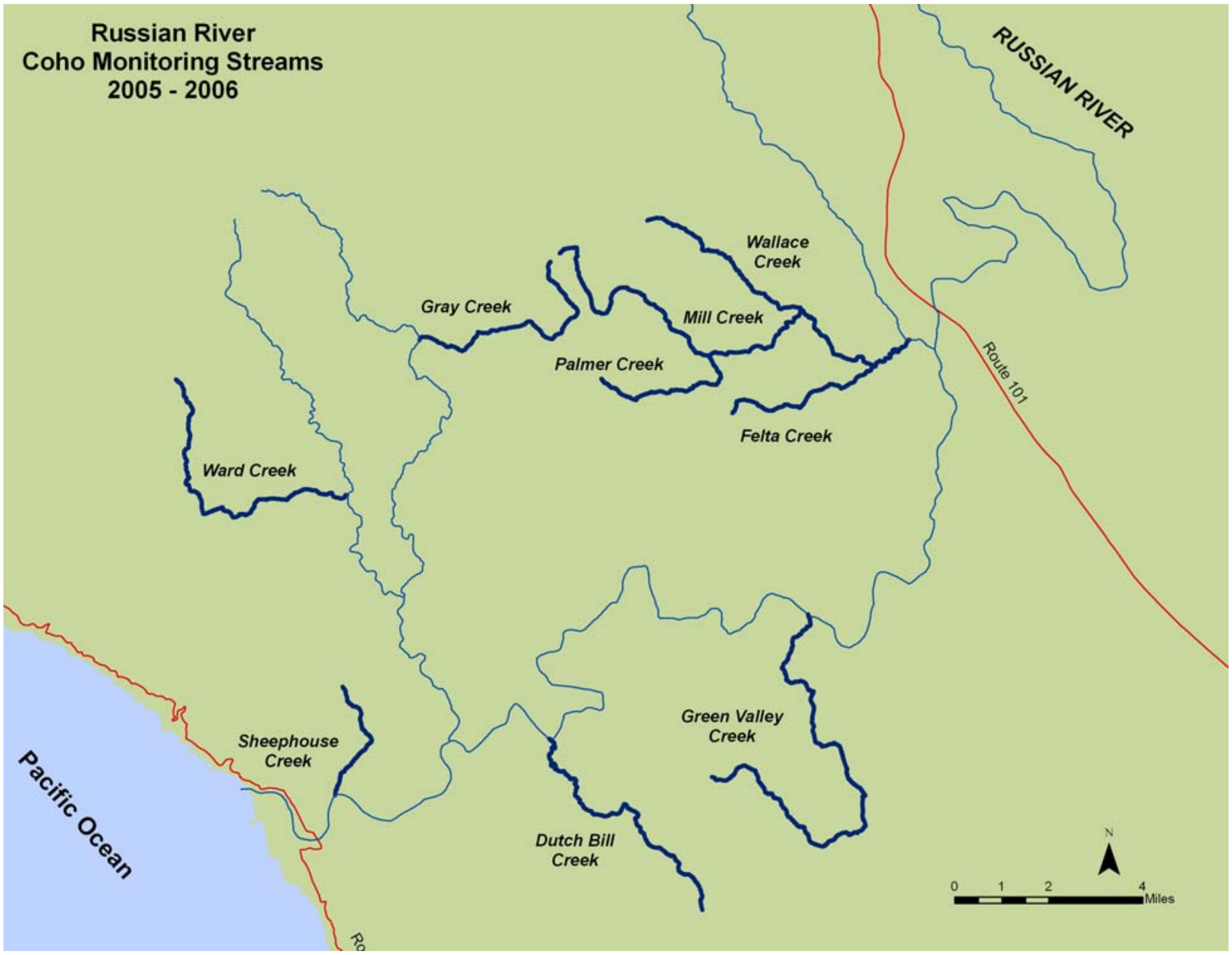


Figure 1. Map of Russian River coho program streams monitored in 2005-2006.

DATA COLLECTION AND ANALYSIS

OVERSUMMER SURVIVAL ESTIMATES

Summer field data was collected to estimate late summer abundance and oversummer apparent survival of coho released from Warm Springs Hatchery into three creeks during the spring of 2005. In addition, we collected data on fish size and condition in the three release streams.

Methods

Population estimates using the basinwide visual estimation technique (BVET) (Dolloff et. al. 1993) were conducted on Palmer, Sheephouse, and Gray Creeks to estimate population size at the end of summer (August – September) 2005. These estimates were then compared to the number of fish released into each creek during the spring to estimate oversummer survival of released coho in each creek. Following the BVET sampling design (Dolloff et. al 1993) and CDFG sampling methodology (CDFG 2003), we collected data for the population estimate in three parts:

1. Habitat surveys: Sampling reaches on each tributary extended from the mouth of the tributary upstream to a known migration barrier for juvenile coho. Surveyors walked each reach from downstream to upstream classifying habitat units as pools, glides, or riffles. Each habitat unit was measured for length, width, average depth, maximum depth, and dominant substrate types. Pools were additionally given a qualitative instream cover rating and the percentage of the pool with instream cover was visually estimated.

2. Snorkeling counts: Approximately every other pool and glide in each tributary was snorkeled (by one or two divers depending on pool size) and counts were made for coho yoy, steelhead yoy and steelhead parr ($\geq$ age 1+).

3. Electrofishing surveys: A proportion of the pools and glides that were snorkeled were also electrofished using a multiple-pass removal method (White et. al. 1982). Program MARK (White and Burnham 1999) was used to estimate the total number of coho yoy, steelhead yoy, and steelhead parr in each electrofished habitat unit. A calibration ratio between the number of fish observed diving and the number estimated based on electrofishing was calculated to adjust the dive counts. Additionally, a small proportion of the riffle habitat was electrofished but not snorkeled due to shallow water depth.

Average coho densities (fish per habitat unit) for each habitat type were calculated using the calibrated dive counts (pools and glides) or electrofishing estimates (riffles). Average densities were then multiplied by the total available habitat area (based on habitat surveys) for each habitat type, and summed over habitat type, resulting in an abundance estimate for the entire stream reach. Resulting abundance estimates were then compared to the number of fish stocked the previous spring to estimate oversummer apparent survival rates. Because we had no means of detecting fish that migrate out of the stream between the time of stocking and our BVET survey, we could only estimate "apparent" survival, or the number of stocked fish remaining in the stream at the end of the summer. We did not know the quantity nor the fate (emigration or death) of fish that were missing from the stream at the end of the summer so we could not incorporate such information into our estimates. Because the interval between spring stocking and completion of the BVET surveys differed among streams, daily survival rates were calculated and then expanded to a four month interval between June 15 and October 15, the approximate time of spring stocking until the first rain of the season and fall release. This allowed for comparison among streams, however, it assumed that the daily summer survival rate in a given stream did not vary over the four month period.

In addition to collecting data for abundance estimates, the electrofishing samples allowed us to collect data on size and condition of salmonids. In each electrofished habitat unit, subsamples of up to 15 coho and steelhead per pool were anesthetized in a bucket of water containing Alka Seltzer and measured for length (+/- 1mm) and weight (+/- 0.1 g). Each coho was checked for presence of an adipose fin to determine whether the fish was of wild (intact adipose fin) or hatchery (clipped adipose fin) origin. All other fish and non-fish species were quantified.

Results

BVET surveys

BVET surveys were completed on Palmer Creek (8/8-8/18), Sheephouse Creek (9/1-9/15) and Gray Creek (9/20-10/3). Survey reaches on each creek extended from the mouth of the stream to an upstream migration barrier above the uppermost stocking site (**Figures 2-4**). In order to confirm that coho were not able to swim over the barrier, 10 to 15 pools above the barrier were snorkeled, and no coho were observed.

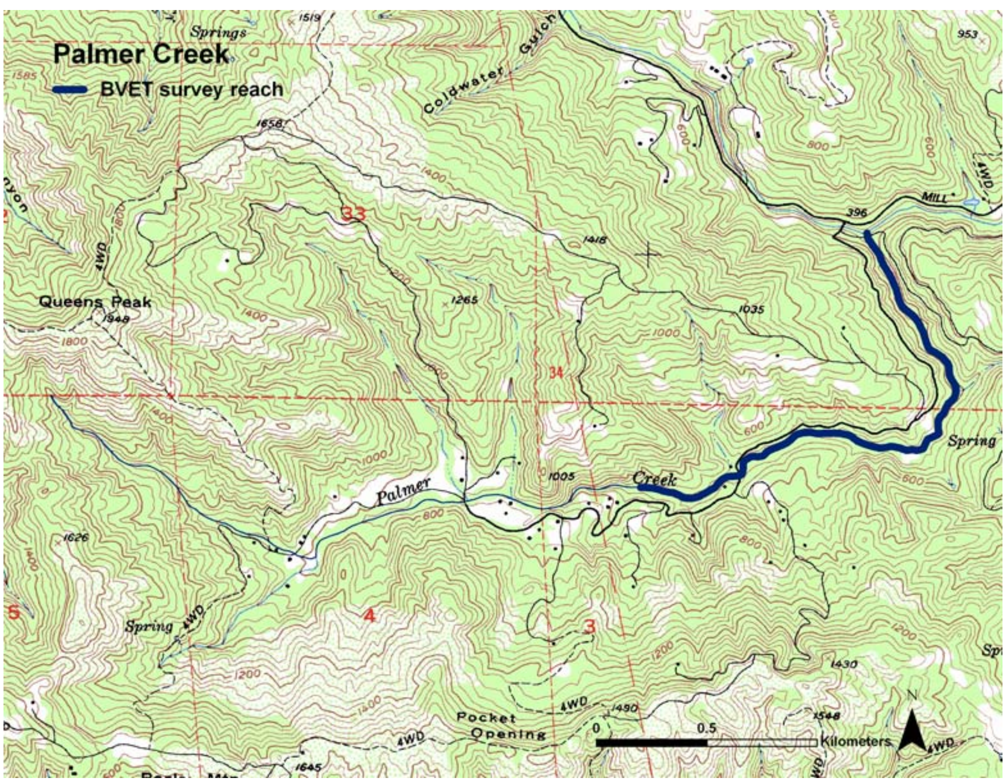


Figure 2. Map of BVET survey reach on Palmer Creek, 2005.

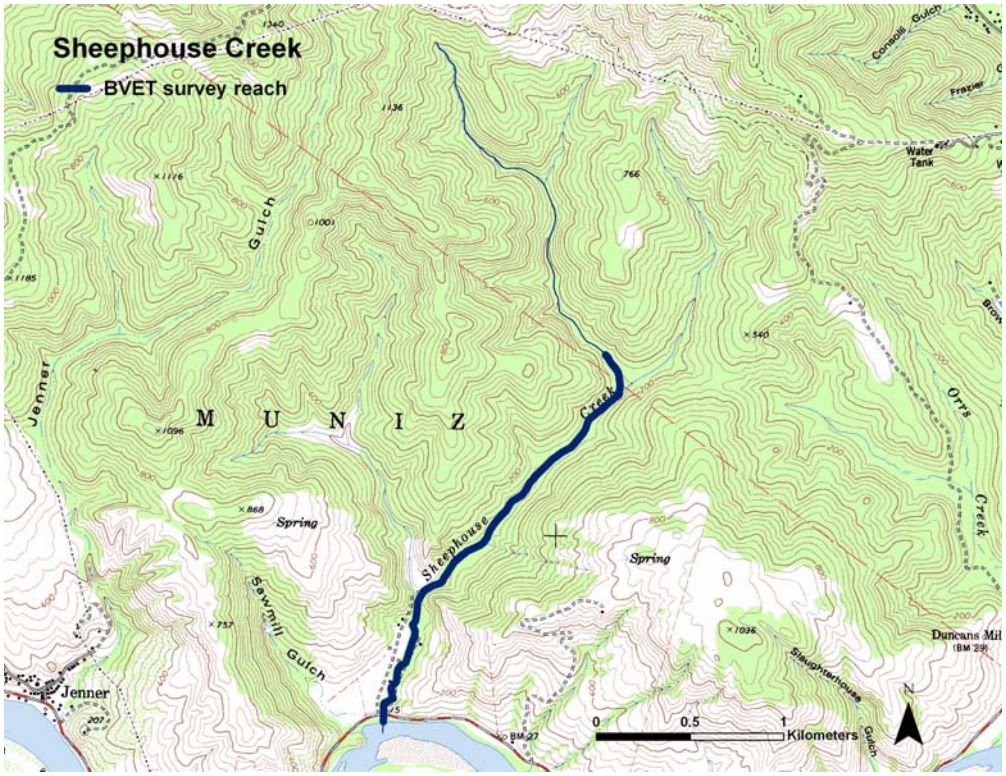


Figure 3. Map of BVET survey reach on Sheephouse Creek, 2005.

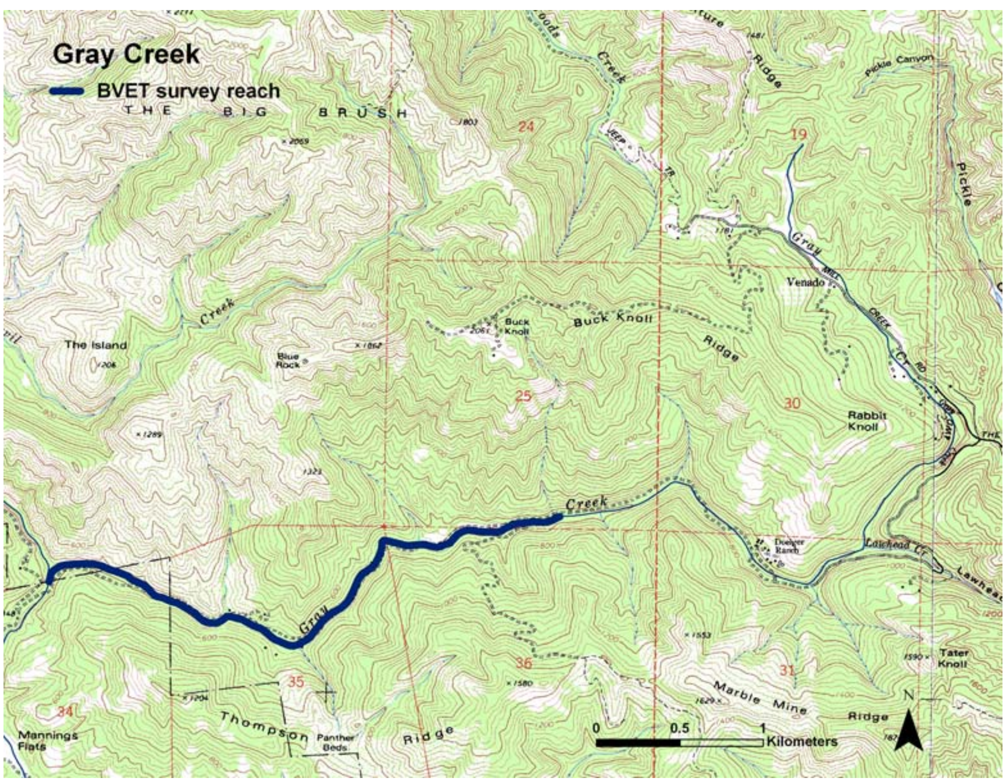


Figure 4. Map of BVET survey reach on Gray Creek, 2005.

Survey reaches ranged from 2.8 to 4.0 km. The reach on Gray Creek had the greatest wetted area available to stocked coho (**Table 1**). Pool to riffle ratios were close to 1:1 on Palmer and Gray, whereas Sheephouse had a much higher proportion of pools than riffles (**Table 1**). We suspect the low proportion of riffles in Sheephouse was the result of lower flows than in the other two creeks, with many nearly-dry riffles and more intermittent pools. In all stream reaches, 49-50% of the pools and 22-32% of the glides were snorkeled (**Table 2**). In addition to snorkeling, 16-18% of pool units, 16-32% of glide units, and 7-8% of riffle units were electrofished (**Table 2**). Riffles were too shallow to effectively snorkel so we relied entirely on electrofishing estimates to determine average coho densities in riffle habitat. Calibration ratios (electrofishing estimate/dive count) used to adjust the dive counts varied by stream and habitat type, ranging from 1.13 to 1.36 in pools and 1.32 to 1.81 in glides (**Table 3**).

Table 1. Habitat characteristics of stream reaches sampled for BVET estimates, 2005.

Tributary	Survey dates	Reach length (km)	Wetted area (m^2)				Percent of total		
			Pools	Glides	Riffles	Total	Pools	Glides	Riffles
Sheephouse	9/1 - 9/7	3.1	4,898	1,620	1,760	8,278	59	20	21
Palmer	8/8 - 8/10	2.8	3,963	1,339	4,057	9,359	42	14	43
Gray	9/20 - 9/22	4.0	5,895	2,062	4,628	12,585	47	16	37

Table 2. Percentage and number (n) of pools, glides and riffles sampled using snorkeling (SN) or electrofishing (EF) for 2005 BVET surveys. Riffles were not snorkeled due to shallow depths.

Tributary	Pools			Glides			Riffles		
	Total units	%SN (n)	%EF (n)	Total units	%SN (n)	%EF (n)	Total units	%SN (n)	%EF (n)
Sheephouse	109	50 (55)	18 (20)	45	22 (10)	22 (10)	76	0	7 (5)
Palmer	72	50 (36)	18 (13)	31	32 (10)	32 (10)	75	0	7 (5)
Gray	95	49 (47)	16 (15)	50	32 (16)	16 (8)	105	0	8 (8)

Table 3. Calibration ratios (electrofishing estimates/snorkeling counts) of pool (P) and glide (G) units sampled during BVET surveys, 2005.

Tributary	# Calibration units		Calibration ratio (R^2)	
	P	G	P	G
Palmer	13	10	1.13 (0.91)	1.81 (0.99)
Sheephouse	20	10	1.36 (0.82)	1.32 (0.81)
Gray	15	8	1.30 (0.85)	1.72 (0.97)

Coho abundance and oversummer apparent survival

The results of our BVET surveys show that Sheephouse Creek had significantly higher late summer abundance than Palmer and Gray. This is not surprising, however, given that Sheephouse was stocked with the greatest number of fish in the spring (**Table 4**, **Figure 5**). Oversummer apparent survival rates between June 15 and October 15 were similar among the three streams, ranging from 0.48 to 0.66 (**Table 4**, **Figure 6**). These oversummer apparent survival estimates are only slightly lower than estimates in pristine streams with wild coho populations in Northern California (Brakensiek 2002) and Oregon (Kruzic et. al. 2001). Because we calculated estimates of apparent survival (and not true survival), these estimates can be considered minimum estimates of true survival. It is not likely that all of the fish absent from the stocking streams at the end of the summer perished, but rather a portion of them likely left the stream and survived elsewhere. Observations of program fish in other streams from snorkeling surveys and downstream migrant trap capture provide evidence that some level of movement is occurring. However, we had no means of quantifying this at the time.

Table 4. Estimated abundance and oversummer apparent survival of spring released juvenile coho stocked into Russian River tributaries, 2005.

Tributary	Number stocked	Stocking date	Electrofishing sample dates	Abundance (95%CI)	Apparent survival[1] (95% CI)
Sheephouse	7,024	5/31	9/8 - 9/15	4,193 (3,537- 4,850)	0.54 (0.45 - 0.65)
Palmer	2,466	6/9	8/16 - 8/18	1,620 (1,322 -1,917)	0.48 (0.33 - 0.64)
Gray	2,584	6/21	9/28 - 10/3	1,839 (1,415 - 2,263)	0.66 (0.48 - 0.85)

[1] To account for different time intervals between stocking and summer sampling among streams, apparent survival estimates were adjusted to represent a four month period (June 15 - October 15).

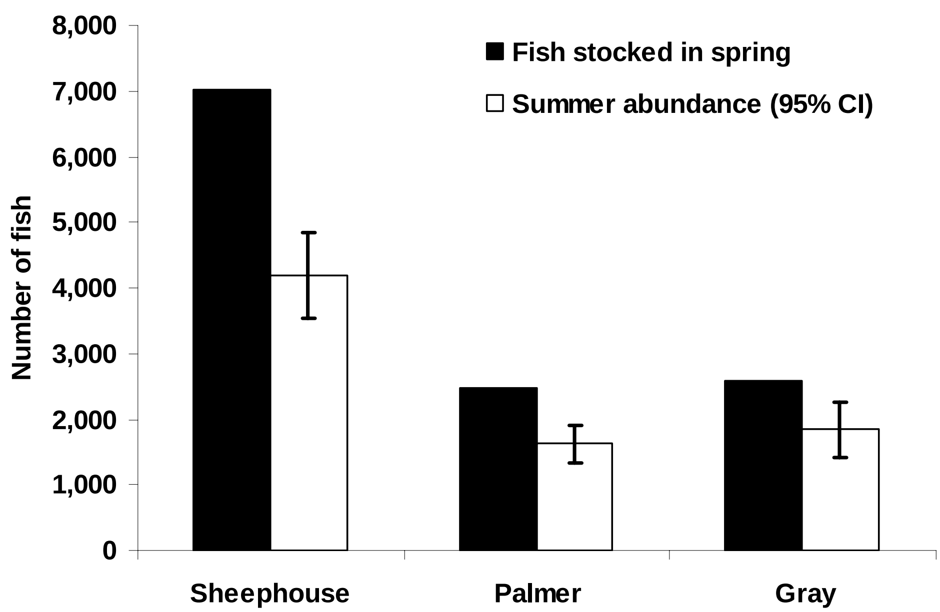


Figure 5. Number of spring released coho and late summer abundance estimates for Russian River tributaries stocked in 2005.

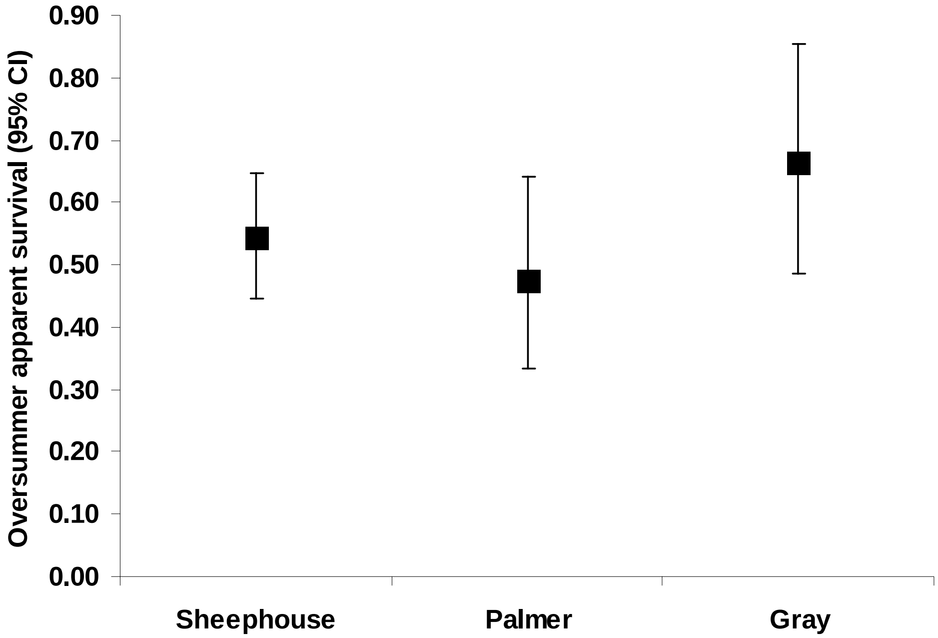


Figure 6. Oversummer apparent survival (June 15 - October 15) of spring released juvenile coho stocked into Russian River tributaries, 2005.

Coho densities

In each stream, densities of stocked coho were higher in pool habitat (0.31 – 0.76 fish/m^2) compared with glide (0.10 – 0.45 fish/m^2) and riffle (0.01 – 0.06 fish/m^2) habitat (**Table 5**). Sheephouse supported the highest densities of coho in all habitat types, but it must be repeated that Sheephouse was stocked at a higher density than the other two creeks.

Table 5. Average summer coho densities in pool, riffle, and glide habitat in Russian River tributaries stocked in spring 2005.

Year	Tributary	BVET sample date range	Fish/m^2 pools (95%CI)	Fish/m^2 glides (95%CI)	Fish/m^2 riffles (95%CI)
2005	Sheephouse	9/1 - 9/15	0.76 (0.63 - 0.88)	0.45 (0.31 - 0.60)	0.06 (0.01 - 0.11)
2005	Palmer	8/8 - 8/18	0.37 (0.24 - 0.50)	0.17 (0.00 - 0.34)	0.01 (0.00 - 0.03)
2005	Gray	9/20 - 10/3	0.31 (0.16 - 0.46)	0.10 (0.03 - 0.18)	0.02 (0.00 - 0.03)

Other species

In addition to program coho yoy, other fish and non-fish species were captured during the electrofishing portion of the BVET surveys (**Table 6**). The largest number of steelhead were captured in Gray Creek. Sculpin spp. were observed in Palmer and Sheephouse Creeks but not Gray, and roach were only found in Gray Creek.

Table 6. Fish and non-fish species counts of individuals captured electrofishing in 2005.

Tributary	# Habitat units electrofished	Electrofished area (m^2)	Coho yoy	Steelhead (age-0+)	Steelhead (> age-0+)	Sculpin Spp.	Roach	CA giant salamander	Rough skinned newt
Palmer	28	1,389	269	170	63	55	0	5	0
Sheephouse	35	1,213	741	76	39	315	0	0	0
Gray	31	1,710	247	1,211	107	0	298	43	11

Coho and steelhead distribution

Distribution of stocked coho varied by stream and stocking method (**Figure 7**). In Sheephouse Creek, where fish were dispersed throughout the stream during stocking, densities were relatively consistent throughout the stream. Densities decreased downstream of our trap site (pool 17) suggesting that most of the downstream dispersal occurred prior to our trap removal on 6/20. In Palmer and Gray Creeks, densities remained higher closer to the stocking reaches. Very few coho settled in the lower third of the Gray Creek reach. One possible explanation is that fewer fish dispersed downstream of the stocking reach, and another is that the fish migrated down but did not settle in the lower third, migrating out of Gray Creek all together. In all streams, coho dispersed upstream until they reached a summer flow juvenile migration barrier. Presumably they would have migrated further had they been able to pass over the barriers. Overall, Gray Creek had the highest densities of steelhead yoy, with concentrations remaining fairly consistent throughout the entire reach. In contrast, Sheephouse Creek had very few steelhead yoy which were concentrated in the lower half of the reach. Steelhead yoy in Palmer Creek were concentrated in the upper two thirds of the reach.

Size and growth

Assuming no size dependent emigration or mortality from the release streams, stocked coho increased in average fork length and weight over the summer in all three streams (**Table 7**). In contrast, average condition factor (K) was lower during the BVET samples than in the sample taken immediately prior to release (**Table 7**). Length, weight and condition factor data are difficult to compare among streams because the BVET sample dates were in some cases a month apart (**Figure 8**). By comparing specific growth rate ($g = (\ln W_2 - \ln W_1)/t_2 - t_1$, where W = weight or length and t=median sample date) we can account for the difference in sampling intervals and better compare growth among streams. However, because we do not have individual data, we are making the assumption of no size dependent processes and that growth rates are consistent throughout the summer. Furthermore, we cannot calculate confidence intervals. If we accept this assumption, specific growth rates for length and weight were similar among streams, with Palmer Creek fish having slightly higher specific growth rates for both length and weight (**Table 8**). For each stream, daily specific growth rates were used to predict the size of spring released fish on October 15 (approximate time of fall release) (**Table 8**). This allowed for size comparisons between spring and fall released fish at the time of fall stocking.

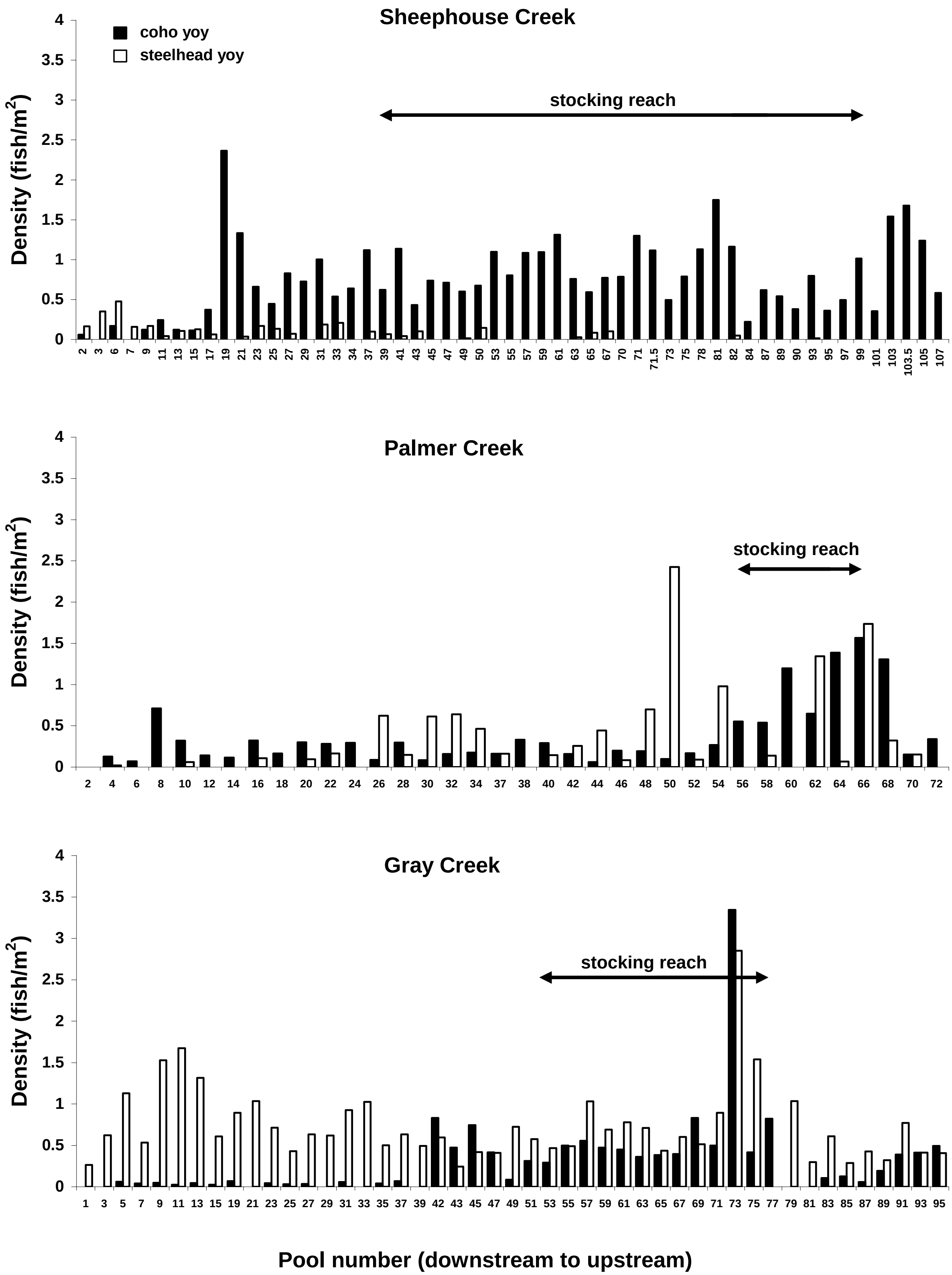


Figure 7. Summer distributions of coho and steelhead in relation to coho stocking reaches in Russian River tributaries, 2005.

Table 7. Average fork length (FL), weight (WT) and condition factor (K) of juvenile coho prior to stocking and during summer BVET surveys, 2005.

Tributary	Prestocking averages (95% CI)					BVET averages (95% CI)				
	Sample date	n	FL	WT	K	Median sample date	n	FL	WT	K
Sheephouse	5/18	100	57.0 (+/- 1.4)	2.53 (+/- 0.21)	1.29 (+/- 0.04)	9/11	644	69.1 (+/- 0.6)	3.86 (+/- 0.11)	1.12 (+/- 0.01)
Palmer	6/7	50	59.2 (+/- 1.5)	2.80 (+/- 0.24)	1.31 (+/- 0.04)	8/17	264	67.3 (+/- 0.8)	3.53 (+/- 0.14)	1.13 (+/- 0.01)
Gray	6/20	50	61.6 (+/- 2.1)	2.89 (+/-0.31)	1.18 (+/- 0.03)	9/30	235	70.9 (+/- 1.0)	4.10 (+/- 0.16)	1.12 (+/- 0.01)

Table 8. Daily specific growth rates and predicted sizes for fork length (FL) and weight (WT) of juvenile coho stocked into Russian River tributaries, spring 2005.

Tributary	Interval dates for g	Daily specific growth rate (g)[1]		Predicted average size Oct 15 [2]	
		FL	WT	FL (mm)	WT (g)
Sheephouse	5/18 - 9/11	0.0017	0.0092	73.1	5.26
Palmer	6/7 - 8/17	0.0018	0.0129	74.8	7.57
Gray	6/20 - 9/30	0.0014	0.0109	72.3	4.81

[1]Specific growth rate was calculated as $g = (\ln(W_2)-\ln(W_1))/t_2-t_1$ where W=average weight or length and t=median date of sample.

[2]Predicted size was calculated as Wp = W1 + exp(g(t2-t1) where W=average weight or length, g=specific growth rate, and t=date of sample or prediction.

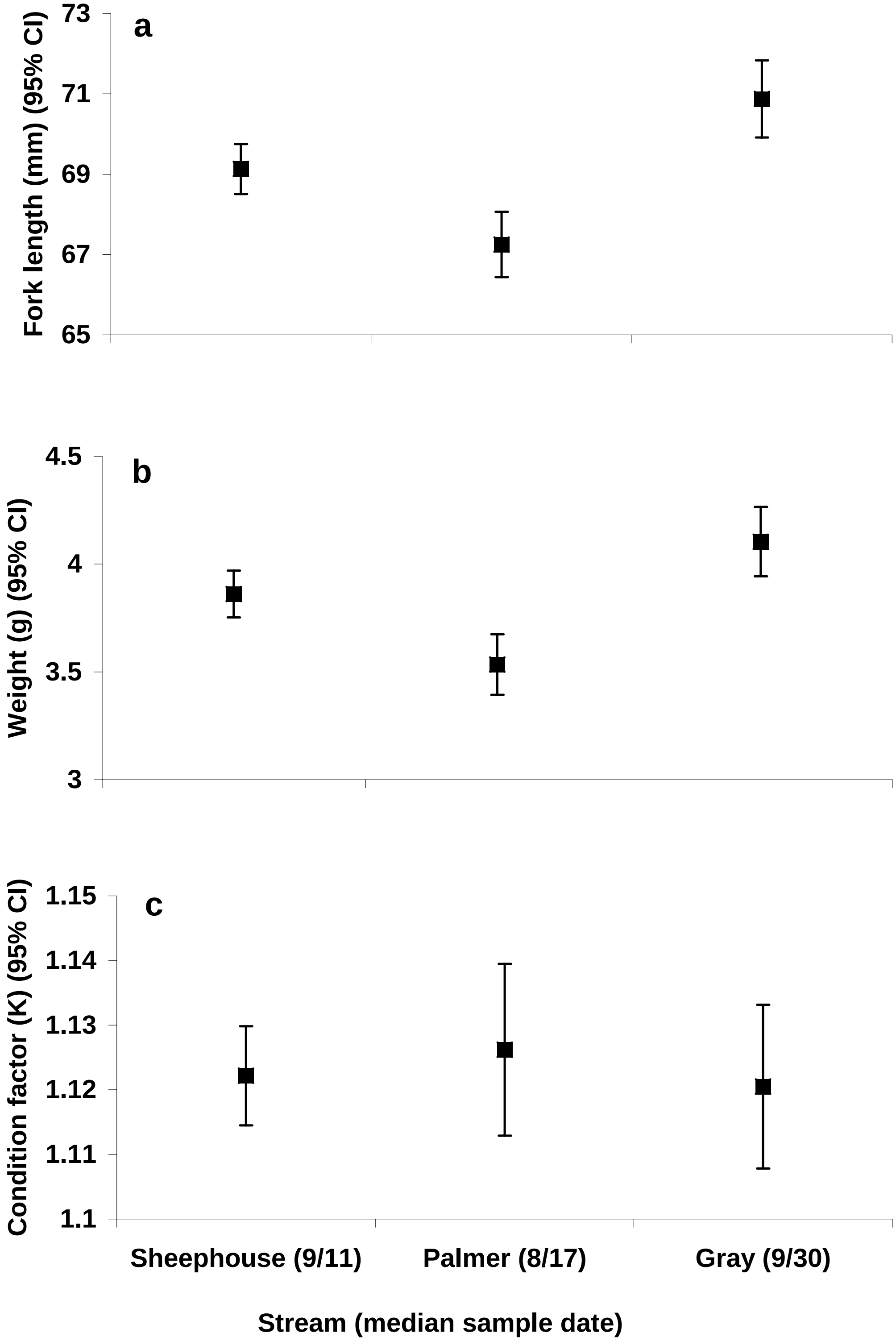


Figure 8. Mean fork length (a), weight (b) and condition factor (c) of coho captured in spring release streams during summer BVET surveys.

Mortality

Few electrofishing injuries or mortalities occurred during the BVET samples (**Table 9**). Flows were relatively high and continuous throughout the summer (almost no intermittent pools), allowing for particularly good conditions for electrofishing with little harm to fish.

Table 9. Percentage and number of coho and steelhead electrofishing sample injuries and mortalities during 2005 BVET surveys.

	Coho		**Steelhead**	
Tributary	**Injury**	**Mortality**	**Injury**	**Mortality**
Sheephouse	0.1% (1/741)	0% (0/741)	0% (0/115)	0% (0/115)
Palmer	0.4% (1/269)	0% (0/269)	0% (0/233)	0% (0/233)
Gray	0% (0/247)	0% (0/247)	0.1% (1/1,318)	0.2% (2/1,318)

Note : Injury estimates may be slightly higher; a protocol for documenting injury was not developed until part-way through the season.

JUVENILE PRESENCE/ABSENCE SURVEYS

Presence/absence snorkeling surveys for wild coho salmon yoy were conducted on seven streams during the spring and summer of 2005. These surveys were completed opportunistically to assist Warm Springs Hatchery Staff in locating potential wild broodstock, to ensure that hatchery coho would not be stocked where wild fish were already present, and to document a suspected decline of wild coho populations in Green Valley and Dutch Bill Creeks.

Methods

Streams were typically snorkeled by two person crews, diving as many pools as possible looking for the presence or absence of wild coho salmon. In each pool that was snorkeled, the number of coho salmon and steelhead was recorded in addition to notes about general habitat condition. All coho were checked for the presence/absence of an adipose fin to determine whether the fish was wild (intact adipose fin), or part of the hatchery program (clipped adipose fin).

Results

The total number of coho observed during snorkel surveys is summarized by stream (**Table 10**). Individual descriptions of diving activities and results are described in the text for each stream.

Table 10. Number of wild coho yoy observed during presence/absence snorkel surveys conducted on Russian River tributaries in 2005.

Tributary	Survey dates	Wild coho yoy	Hatchery coho yoy[3]	# of pools snorkeled (# of reaches)
Palmer Creek[1]	5/16	0	0	10 (1)
Felta Creek	5/18, 7/18, 7/28	33	2	25 (2)
Dutch Bill Creek	8/3	118	0	41 (2)
Mill Creek	8/4	7 [2]	2	40 (2)
Grape Creek	8/22	0	0	20 (1)
Green Valley Creek	8/24, 8/26	0	0	35 (1)
Ward Creek[1]	8/30, 8/31	2	5	80 (4)

[1] These surveys were conducted prior to hatchery coho releases.

[2] These fish are thought to have originated from Felta Creek (see text).

[3] These fish strayed from the stream in which they were stocked.

<u>Palmer Creek (5/16)</u>

A partial survey of lower Palmer Creek (tributary to Mill Creek) was conducted on 5/16. Ten pools were snorkeled and seven steelhead yoy, one parr and zero coho salmon were observed. Fish densities appeared sparse, possibly due to cold water temperatures. Habitat throughout this lower section contained root wads, overhanging branches and large woody debris, appearing suitable for juveniles coho. The ten pools that were surveyed were approximately the same pools surveyed by CDFG/PSMFC in 2003 per flagging.

Felta Creek (April, 5/15, 7/18, 7/28)
Following capture of approximately 25 wild (adipose fins present) coho yoy (BY 2004) in the Mill Creek downstream migrant trap in 2005, we initiated a series of coho presence/absence dive surveys in Felta Creek, to help determine the source of the wild coho. Felta Creek enters Mill Creek immediately upstream of the downstream migrant trap. In April 2005, we conducted informal dive surveys in Felta Creek and observed a few wild coho salmon yoy (~ 35-40 mm. FL) residing in a few small pools. At the time of this survey we believed these fish originated in Felta Creek because of their small size. On 5/15 we snorkeled approximately 25 pools, upstream approximately one quarter of a mile from the confluence of Mill Creek. We observed a total of four wild coho salmon yoy which were approximately 55-65 mm. long (FL).

On 7/18, Felta Creek was snorkel surveyed more extensively for the purpose of quantifying wild coho yoy for the possibility of broodstock collection by Warm Springs Hatchery staff. We surveyed from the mouth upstream to approximately 600 feet above the Felta Road bridge at the backside of Westside Union School. The mouth of Felta Creek was effectively dry with only minimal flow into Mill Creek from water resurfacing in this lowest part of Felta. Additionally, the lower portion of Felta Creek was dry in the area of the 5/15 survey where we had previously observed four wild coho yoy. The upstream extent of this survey was at a large pool below a concrete summer dam (with flashboards that are taken out during winter). Flow above the concrete dam drops approximately four feet into a large holding pool making it effectively a juvenile upstream migration barrier during low flow conditions. In this reach, we found 26 wild coho yoy and two hatchery coho yoy (adipose clipped), in addition to hundreds of steelhead of all age classes, and a small number of Centrarchids. The hatchery coho yoy were most likely fish that had been released into Palmer Creek on 6/21 of the same year. One of the hatchery coho was found at the upper boundary of the survey. All of the coho were found in pools that were not in immediate danger of drying up, including some with depths of up to four feet. The pools where the coho were found would be somewhat difficult to seine for collecting purposes. Most of the coho were approximately 70-75 mm long.

On 7/28 we snorkeled above the 7/18 survey reach in Felta Creek and found 3 more wild coho salmon yoy, suggesting that adult coho salmon migrated and spawned above the concrete summer dam since it is unlikely that juveniles could have negotiated this barrier and migrated upstream during the spring and summer. Results of these surveys provide evidence of at least one successful spawning event in Felta Creek during the winter of 2004-2005.

Dutch Bill Creek (8/3)
Dutch Bill Creek was surveyed on 8/3, in two different reaches. Reach 1 began just downstream of the Tyrone Bridge, continuing approximately 3,300 feet upstream. In this reach, we surveyed a total of 21 pools and observed 31 wild coho salmon yoy, along with numerous juvenile steelhead and a few Centrarchids. The highest number of coho salmon yoy observed in any one pool was six fish. The temperature at the beginning of the reach was 15.5°C. Reach 2 began at Alliance Redwood Retreat Center and continued upstream for approximately 2,000 feet. We snorkeled a total of 20 pools and observed 87 wild coho yoy, in addition to numerous juvenile steelhead. The highest number of coho salmon yoy observed in any one pool was 16 fish. The temperature in the first pool of Reach 2 was 15.5°C. Pool size was generally larger in the

downstream reach. There was a greater concentration of coho yoy in the upstream reach. Dutch Bill Creek has one documented year-class of coho salmon of which this year (BY 2004) coincides.

Mill Creek (8/4)

Mill Creek was surveyed on 8/4, in two different reaches. Reach 1 began approximately 300 feet above the West Side Road Bridge and continued upstream approximately 1,500 feet to a large plunge pool with a six foot high waterfall. In Reach 1 we snorkeled approximately 20 pools, and observed seven wild coho salmon yoy in the vicinity of the mouth of Felta Creek (five below the confluence of Felta Creek and two above) along with numerous steelhead juveniles. Reach 2 began above the six foot waterfall (a juvenile upstream migration barrier) and ended just downstream of an area of extended high gradient, downstream of Echols Bridge (private landowner bridge). We surveyed approximately 20 pools and observed two hatchery coho salmon yoy (2005 spring released hatchery coho yoy stocked into Palmer Creek), no wild coho salmon yoy, and numerous steelhead juveniles. This served as additional evidence that the wild coho salmon yoy in this system originated in Felta Creek.

Grape Creek (8/22)

Our 8/22 snorkel survey began at the mouth of Grape Creek at its confluence with Dry Creek, continuing upstream approximately 1,600 feet ending at the bridge on West Dry Creek Road. Approximately 20 pools were snorkeled and no coho salmon juveniles were observed. Steelhead, bluegill, suckers, roach and sculpin were found with steelhead being the most numerous species.

Green Valley Creek (8/24, 8/26)

On 8/24 and 8/26 we snorkeled approximately 35 pools in Green Valley Creek, located from the mouth of Purrington Creek, 1.32 miles upstream to Bones Rd. Bridge. This reach is likely the prime coho habitat in Green Valley, as juveniles have been observed, trapped or collected there almost every year for the last 15 years (Cook and Manning 2002; Fawcett et al. 2003; Conrad 2005, CDFG 2006). No wild coho salmon yoy were observed within this reach. Over one thousand steelhead juveniles were observed in addition to bluegill, green sunfish and roach.

Other monitoring efforts that had the potential of capturing fish from this year class included operation of a downstream migrant trap during the spring of 2005 (potential to capture newly hatched yoy) and seining efforts by Warm Springs Hatchery staff during summer of 2005. Neither of those efforts identified wild coho. The results of our snorkeling surveys and other monitoring efforts suggest that the BY 2004 year class in Green Valley has disappeared.

Ward Creek (8/30-31)

Because a wild coho salmon yoy was observed in the downstream migrant trap in Ward Creek during the spring of 2005, Ward Creek was snorkeled on 8/30-31 to investigate the possibility of a wild coho salmon year-class residing upstream. Snorkel surveys were completed in four different reaches. In each of three upper reaches, we snorkeled approximately 20 pools. Steelhead juveniles were the only salmonids present in those reaches. The lower reach was located at the mouth continuing upstream approximately ¼ mile to an area of high gradient dominated by very large boulders. In this lower reach, we snorkeled 20 pools and observed a total of seven coho salmon yoy. Five of the seven coho salmon yoy had adipose fin clips and two coho salmon yoy had completely intact adipose fins. Gray Creek is the most likely origin of the five adipose clipped coho salmon yoy. Hatchery (adipose-clipped) coho salmon yoy were stocked into Gray Creek on 6/20/05. These fish possibly traveled out of the mouth of Gray Creek and 7.7 river miles downstream through East Austin Creek, and then traveled upstream 3.5 river miles through mainstem Austin Creek into Ward Creek. The other two unclipped coho salmon we believe to be of wild origin.

OVERWINTER SURVIVAL ESTIMATES

During the spring season (March-June), downstream migrant traps were operated on Mill, Ward and Sheephouse Creeks (**Figure 9**). The primary objectives for data collection were (1) to estimate the number and migration timing of program coho smolts leaving each system, (2) evaluate overwinter survival and growth of coho smolts stocked the previous spring and/or fall, and (3) compare overwinter survival and fish size/condition between spring and fall stocked fish in Palmer (tributary of Mill) and Sheephouse Creeks. Secondary project objectives were to quantify the number of steelhead smolts emigrating from each creek, collect genetic samples from coho and steelhead, and count all other fish species captured in the traps.

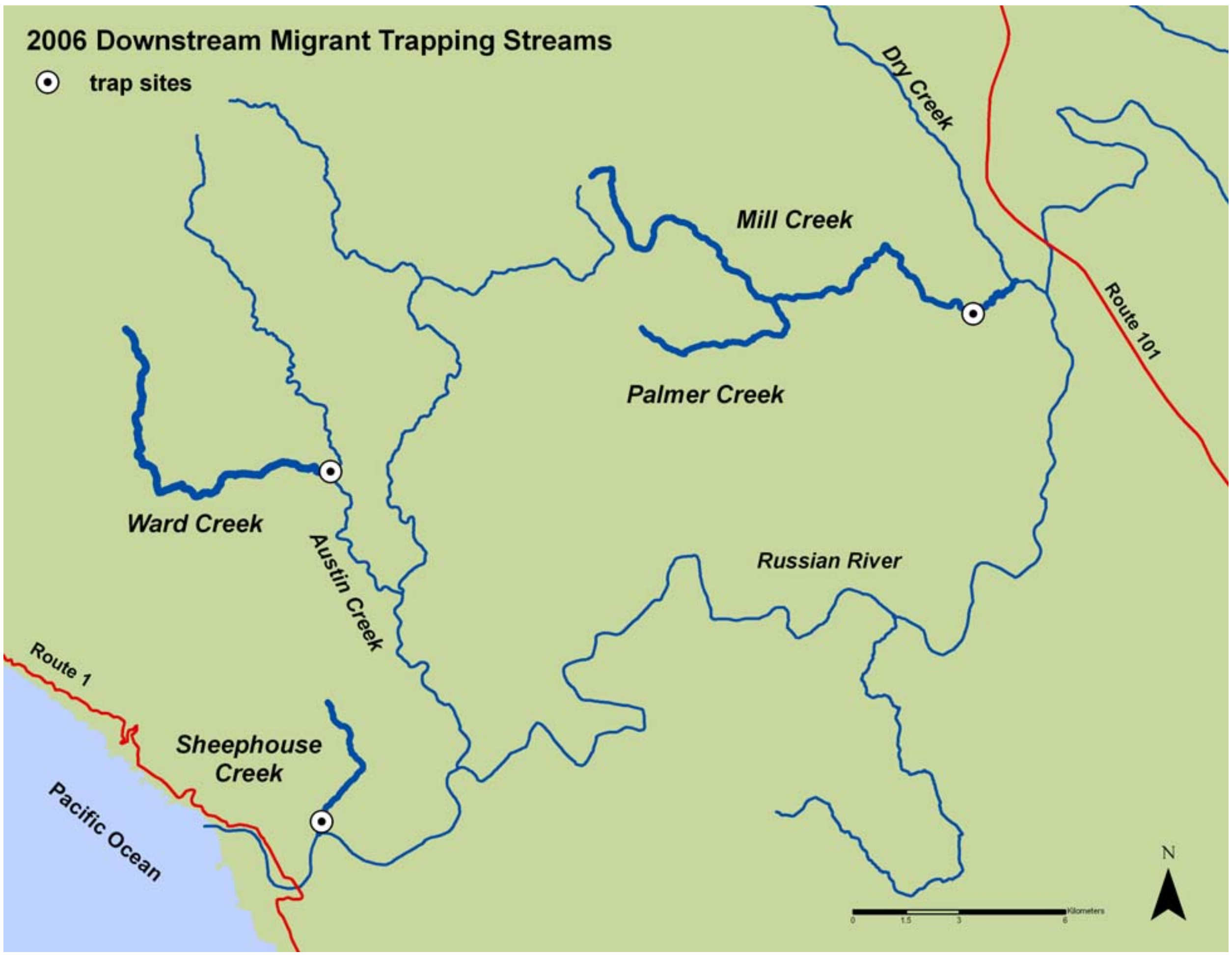


Figure 9. Spring 2006 downstream migrant trap locations on streams stocked with coho in 2005.

Methods

Funnel traps were used on Mill and Ward Creeks and a pipe trap was used on Sheephouse Creek (**Figures 10a and 10b**). The funnel traps included removable weir panels constructed of wooden framing with vexar screening. Each weir led into an 18’ funnel-shaped net which was connected to a 3’ section of 6” PVC pipe at the cod end and led into a 3’x 4’ wooden-framed holding box. Vshaped flow deflectors were placed inside the holding boxes to provide fish with relief from the current during high flows. Because of the high debris load on Mill Creek, an additional 8' x 4' weir panel was installed approximately 10 m upstream of the trap opening to collect debris and deflect it towards the bank. Trap sites were located near the mouths of the creeks to sample as much habitat as possible. The mouth of each trap was placed at the downstream end of a riffle and the cod end of the net and holding box were placed in calmer water. On Sheephouse Creek, the pipe trap design consisted of a vexar weir placed at the tailout of a pool which channeled water into a 40' section of 6" PVC pipe leading into a holding box.

To estimate the abundance of downstream migrating coho smolts, a capture-mark-recapture (CMR) study was conducted on each creek. On each stream, up to 15 coho were marked daily with a fin clip and released at a minimum of two pool/riffle sequences upstream of the trap. A different fin clip was applied each week based on an eight week rotation. This required the assumption that marked fish would survive and reemigrate within eight weeks of their upstream release. The proportions of marked and unmarked fish captured in the traps were used to estimate weekly trap efficiencies and seasonal smolt abundance using Program DARR (Bjorkstedt 2000, Bjorkstedt 2005, CDFG 2003). The Mill Creek trap was used to capture and estimate abundance of program coho outmigrating from both Mill and Palmer Creeks, as Palmer Creek is a tributary of Mill Creek.

Traps were checked a minimum of one time per day while in operation. Each day upon arrival, fish were netted into aerated buckets or bins for sampling. Juvenile coho and steelhead were anesthetized in a bucket containing water and Alka Seltzer, measured for length and weight, and scanned with a coded-wire detection wand to determine presence and location of a coded-wire tag (CWT). CWT location was later used to determine the stream and season that the fish was stocked. Every new fish was checked for the presence of an adipose fin clip to determine whether it was a hatchery-released program fish (clipped adipose fin) or a wild fish (intact adipose fin). For the CMR study, a maximum of 15 newly captured fish received a fin clip each day. Tissue from the fin clip was preserved for genetic analysis. For recaptured coho, fin clip locations were recorded and the fish were immediately released downstream to minimize processing time. Coho, Chinook and steelhead yoy and parr were measured for length and weight (up to 20 individuals per species per day). All other fish (and other aquatic species) were tallied. After processing, fish were placed in aerated buckets for recovery and then released downstream of the trap. Before leaving the trap site, debris was removed from the weir, net and box, and the trap was inspected for holes or other potential problems. The Mill Creek trap and weir was cleaned a second time each day in the late afternoon to remove excessive debris.

a.

b.

Figure 10. Trap designs used on Ward Creek (a) and Sheephouse Creek (b) in 2006. The funnel trap used on Ward Creek was similar to trap design used on Mill Creek while the pipe trap design was used only on Sheephouse Creek.

Results

Installation and operation of downstream migrant traps

Due to extremely high flows and flood conditions during the winter of 2005 to 2006, flow levels did not recede enough for trap installation until late March (Sheephouse) or late April (Mill and Ward). Because of the delayed installation of the traps, we suspect that we missed three to five weeks of the smolt migration. The Sheephouse trap was operated from 3/22/06 until 6/9/06 with the exception of two high flow events when the trap was removed (3/28-4/5 and 4/12-4/17), for a total of 66 days fished. The Ward and Mill Creek traps were installed on 4/21/06 (Ward) and 4/22/06 (Mill) and were operated continuously until 6/9/06, for totals of 50 and 49 days fished, respectively. Traps were checked seven days a week by UCCE staff with the help of partnering agency volunteers. During the 2006 trapping period, average weekly trap efficiencies were estimated at 0.53 on Mill Creek (range 0.35 to 0.99), 0.59 on Ward Creek (range 0.55 to 0.68), and 0.49 on Sheephouse Creek (range 0.37 to 0.63).

Trap counts and run-timing

In 2006, a total of 910 program coho smolts were captured in Mill, Sheephouse and Ward Creeks combined (**Table 11**). One wild coho presmolt was captured in Mill Creek, thought to have originated from adults that spawned in Felta Creek during the winter of 2004-2005. Another possible wild coho smolt, an age-2+ fish of unknown origin (possible adipose clip, no CWT) was caught at Sheephouse Creek. A total of 895 coho smolts were scanned with a CWT detection wand. Of these, 877 were classified to stream of stocking and release season (**Table 12**). Five smolts had CWT locations indicative that they were stocked in a stream other than the one in which they were captured. In Sheephouse Creek, three of the coho captured and scanned had a CWT location common to both Gray and Palmer Creeks (snout and peduncle), and we could not determine from which stream they had strayed. We assumed that the two fish captured in Ward Creek with a CWT location common to both Gray and Palmer had strayed from Gray Creek because of Gray Creek's closer proximity to Ward Creek. CWTs were not detected in fifteen scanned coho that had adipose fin clips. These data indicate that CWT detection rates for stocked fish ranged from 97 – 100%, with an overall detection rate of 98% (**Table 12**). The fact that coho stocked in Ward Creek (fall release only) had a 100% retention rate suggests that tag loss likely occurred in the spring release groups in which fish were tagged at smaller sizes.

In addition to coho smolts, a total of 91 steelhead smolts, 881 steelhead yoy/parr, 7 steelhead adults (4 of hatchery origin), 128 chinook yoy, and three wild coho yoy (later determined to be of Felta Creek origin) were captured in the traps in 2006 (**Table 11**). Adipose clips were observed on one of the steelhead smolts (Mill) and four of the steelhead adults (Mill) indicative of their hatchery origin. A number of other native and non-native fish and other species were also captured in the traps (**Tables 13-15**).

In each stream, coho smolts were present in the trap the day after the trap was installed, indicating that the smolt migration likely began prior to installation of the traps (**Figure 11**). In Mill and Sheephouse Creeks the run continued through the middle of June, whereas in Ward Creek the run ended mid-late May. Unlike 2005 run timing distributions, clear peaks in run timing were not apparent in 2006. Despite significant increases in the number of fish stocked into each stream in 2005, we did not see increases in trap catch in spring 2006 (**Figure 11**).

Table 11. Number, species, and life stage of wild (W) and hatchery (H) salmonids captured in downstream migrant traps, spring 2005 and 2006.

		Chinook	Coho				Steelhead				
		yoy	yoy		smolt		yoy/parr	smolt		adult	
Year	Tributary	W	W	H[1]	W	H	W	W	H	W	H
2005	Green Valley	925	0	0	9	6 [3]	1,723	49	0	0	1
2005	Mill	70	24	0	2	632	1,904	96	7	5	4
2005	Sheephouse	2	0	3,348	0	294	123	14	1	0	0
2005	Ward	0	1	0	0	87	668	5	0	1	0
2006	Mill	128	3	311	1	645	438	48	1	1	4
2006	Sheephouse	0	0	0	1 [2]	140	80	17	0	0	0
2006	Ward	0	0	26	0	125	363	25	0	2	0

[1] Hatchery coho yoy are program fish that were stocked in the spring of each year prior to downstream migrant trap removal.

[2] This was an age-2+ fish of unknown origin; no CWT but possible adipose fin clip (fin looked deformed).

[3] These fish strayed from another program stream; Green Valley Creek was not stocked with coho in 2004.

Table 12. Number of program coho smolts (read for CWT) captured in downstream migrant traps, spring 2006. Number of spring (S) and fall (F) released coho are designated for streams that were stocked with both release groups.

Trap site	Stocking stream	Coho smolts read for CWT
Mill	Mill	371
Mill	Palmer	251 (S=65, F=186)
Mill	Unknown[1]	11
Sheephouse	Sheephouse	131 (S=13, F=118)
Sheephouse	Gray or Palmer	3
Sheephouse	Unknown[1]	4
Ward	Ward	122
Ward	Gray	2
Ward	Unknown[1]	0
Total coho smolts CWT wanded		895
Overall CWT detection rate		98%

[1]Coho smolts classified as unknown were CWT scanned and no tag was detected.

Table 13. Non-salmonid fish species captured in downstream migrant traps in 2005 and 2006.

Year	Tributary	Native fish species												Non-native fish species							
		hardhead	hitch	Lamprey spp.[1]	Pacific lamprey[2]	roach	Sacramento blackfish	Sacramento pikeminnow	Sacramento sucker	Sculpin spp.	three-spined stickleback	tule perch	Western brook lamprey	black bullhead	black crappie	bluegill	fathead minnow	green sunfish	largemouth bass	smallmouth bass	white crappie
2005	Green Valley	147	2	32	0	211	3	62	53	371	1,699	3	5	3	2	627	15	40	1	0	11
2005	Mill	45	0	48	8	110	0	29	100	895	0	0	3	0	0	54	22	35	6	2	2
2005	Sheephouse	18	0	0	0	36	0	44	98	1,635	1	0	0	0	0	0	0	0	0	0	0
2005	Ward	6	0	0	1	59	0	0	4	866	4	0	0	0	0	0	0	0	0	0	0
2006	Mill	13	0	61	10	65	0	27	38	4,066	0	0	3	0	0	11	13	5	0	0	0
2006	Sheephouse	9	0	0	0	23	0	119	34	2,046	0	0	0	0	0	0	2	0	0	0	0
2006	Ward	1	0	0	0	33	0	0	0	3,034	0	0	0	0	0	0	0	0	0	0	0

[1]Lamprey spp. refers to uneyed ammocoetes that we could not identify to species.

[2]Pacific lamprey refer to adults. All adults were silver in color with the exception of Mill 2006, of which 7 out of the 10 observed were brown in color and presumed spawned out.

Table 14. Amphibian species captured in downstream migrant traps in 2005 and 2006.

Year	Tributary	Native									Non-native	
		CA giant salamander	Foothill yellow-legged frog	Oregon ensatina[1]	Pacific tree frog	rough-skinned newt	Speckled black salamander[1]	unknown frog	unknown tadpoles	Western toad	bullfrog	bullfrog tadpoles
2005	Green Valley	0	0	0	3	19	0	14	34	51	5	5
2005	Mill	0	0	0	0	0	0	33	111	8	13	653
2005	Sheephouse	0	0	0	0	0	0	2	0	0	0	0
2005	Ward	0	126	0	0	0	0	10	0	0	0	0
2006	Mill	4	5	0	0	0	1	0	0	5	10	10
2006	Sheephouse	0	0	0	0	0	0	0	0	0	0	0
2006	Ward	2	168	1	0	0	0	0	0	1	7	0

[1]Non-aquatic species

Table 15. Non-fish and non-amphibian species captured in downstream migrant traps in 2005 and 2006.

Year	Tributary	CA freshwater shrimp	Common merganser	mallard	Red-eared slider turtle	unknown turtle sp.	unknown crayfish	Western pond turtle
2005	Green Valley	8	0	3	1	1	60	2
2005	Mill	0	4	11	0	1	1	0
2005	Sheephouse	0	0	0	0	0	0	0
2005	Ward	0	0	0	0	0	22	0
2006	Mill	0	5	7	0	0	36	0
2006	Sheephouse	0	0	0	0	0	4	0
2006	Ward	0	11	0	0	0	50	0

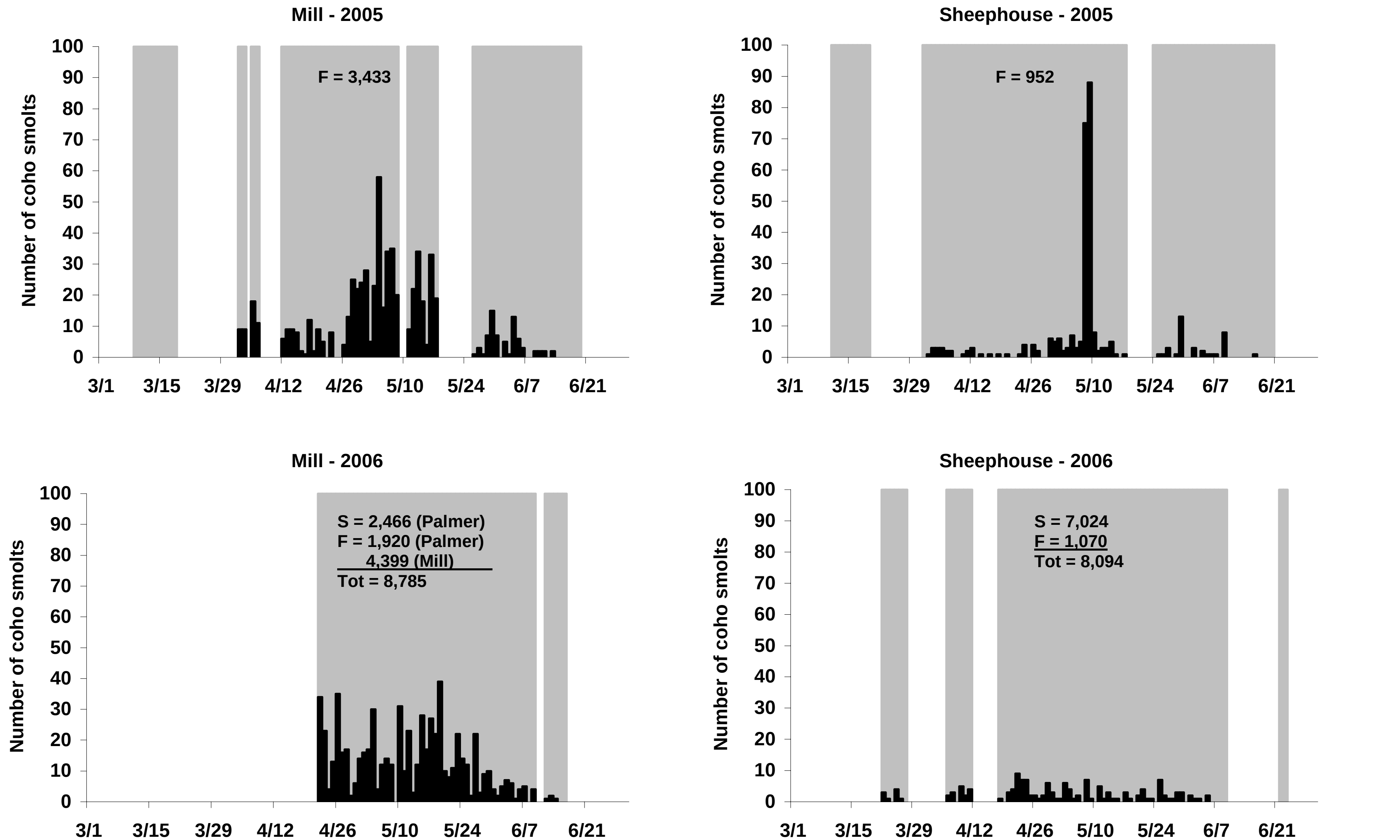
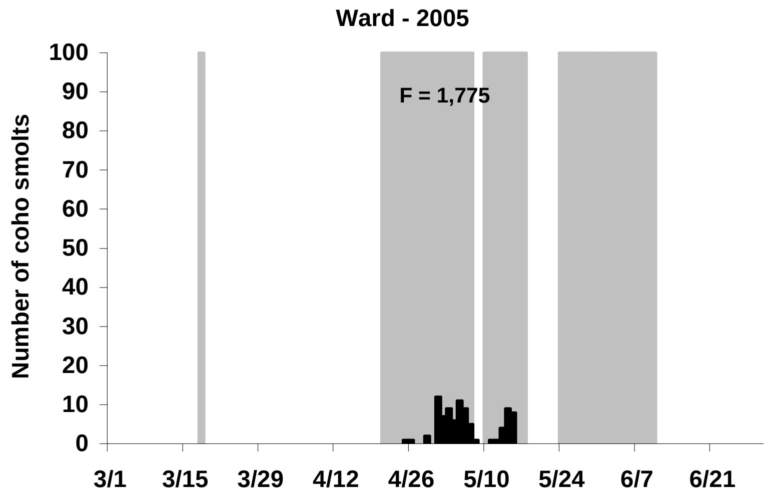
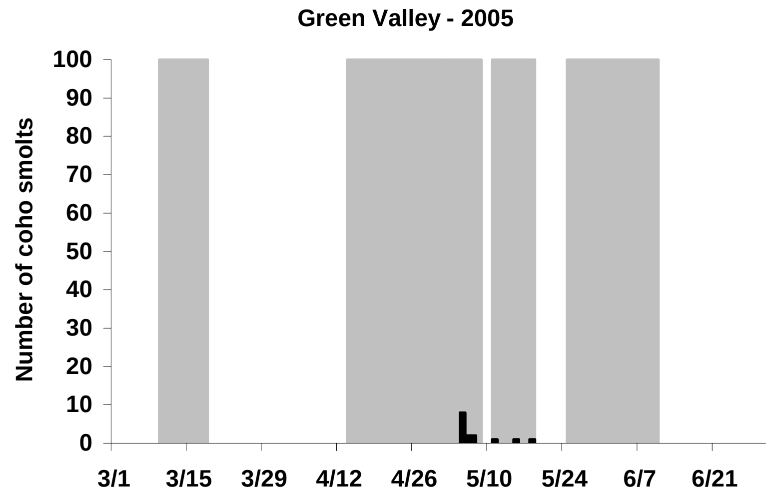
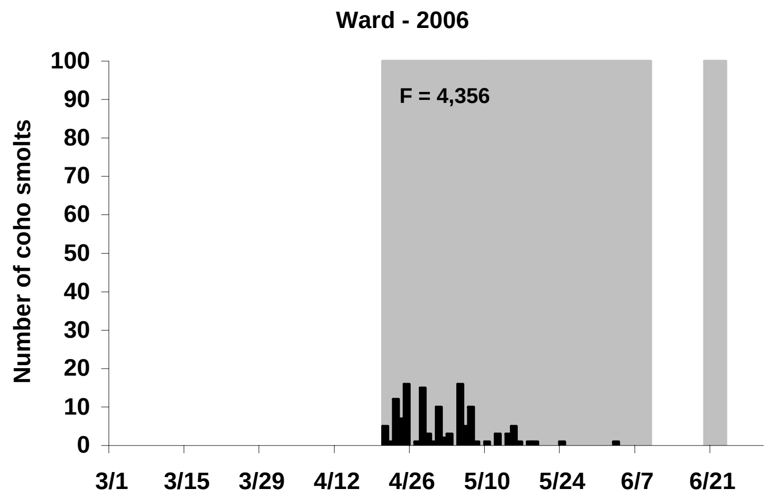


Figure 11. Number of smolts captured daily in downstream migrant traps during spring 2005 and 2006 in tributaries of the Russian River. Shaded background indicates days that the traps were fishing. Number of spring (S) and fall (F) stocked fish released the previous year are indicated on each graph. Green Valley Creek was not stocked in 2004 or 2005.







no trap operated on Green Valley in 2006

Figure 11 (cont). Number of smolts captured daily in downstream migrant traps during spring 2005 and 2006 in tributaries of the Russian River. Shaded background indicates days that the traps were fishing. Number of spring (S) and fall (F) stocked fish released the previous year are indicated on each graph. Green Valley Creek was not stocked in 2004 or 2005.

Coho smolt abundance and instream overwinter survival estimates

The 2006 estimate of smolt abundance was highest in the Mill Creek system and lower for Sheephouse and Ward Creeks (**Table 16**). These estimates do not reflect the relative number of fish present in each stream immediately after the fall release; Mill, Sheephouse, and Ward had similar numbers of fish present in the fall, and Palmer had the lowest number of fish present (**Table 16**). During the winter of 2005-2006, apparent survival estimates (± 95% CI) were 18% ± 4% (Mill and Palmer), 7% ± 2% (Sheephouse), and 5% ± 1% (Ward) (**Figure 12**, **Table 16**). In all streams (excluding Palmer which was not stocked in 2004), overwinter apparent survival estimates were lower for the winter of 2005-2006 than in 2004-2005 (**Figure 12**, **Table 16**). This may be a result of lower survival related to the extreme winter flow conditions during the winter of 2005-2006. It may also be an artifact of later trap installation in 2006; we likely missed three to five weeks of the smolt migration, which would result in artificially low abundance estimates and, in turn, artificially low overwinter survival estimates. In both years, we observed the same pattern in apparent survival among streams; Mill/Palmer system had the highest survival, Sheephouse was intermediate, and Ward was the lowest (**Figure 12**).

Comparison of spring v. fall release groups

In 2005, Palmer, Sheephouse, and Gray Creeks were stocked in both the spring and fall seasons. In each creek, the estimated number of spring stocked fish that survived until the time of the fall release was compared with the number of fall stocked fish, resulting in a spring to fall proportion of 0.54 in Palmer, and 3.06 in Sheephouse, and 0.75 in Gray (**Table 17**). The following spring, the proportion of spring to fall stocked fish captured in the downstream migrant traps was 0.35 in Palmer, 0.11 in Sheephouse, and 0.34 in Gray (**Table 17**). In all streams, the proportion of spring to fall fish during the smolt migration was lower than the values in the stream at the time of fall stocking, suggesting that overwinter survival was lower for spring released fish. In Palmer and Sheephouse Creeks where mark-recapture data was collected at the downstream migrant traps, overwinter apparent survival rates were higher for fall vs. spring-released fish (**Table 18**). In Sheephouse Creek the difference was much more extreme than in Palmer Creek. Timing of downstream migration between spring and fall release groups was similar on Palmer Creek for the window that the trap was in operation (**Figure 13**). On Sheephouse, fall-released fish were captured between 3/22/06 (day of trap installation) until mid-June, whereas the first spring released fish was not captured until 4/20/06 (**Figure 13**).

Table 16. Smolt abundance and overwinter apparent survival estimates for coho juveniles released in 2004 and 2005.

Trap year	Tributary	Number spring stocked	Number fall stocked	Spring stocked remaining at fall release (95% CI)	Total number at time of fall release[1]	Trap Count	Smolt abundance[2] (95% CI)	Overwinter apparent survival[3] (95% CI)
2005	Mill	0	3,433	0	3,433	634	1,906 (1,567 - 2,246)	0.56 (0.46 - 0.65)
2005	Sheephouse	0	952	0	952	292	415 (375 - 456)	0.44 (0.39 - 0.48)
2005	Ward	0	1,775	0	1,775	87	190 (145 - 234)	0.11 (0.08 - 0.13)
2006	Mill	0	4,399	0	4,399	371	777 (577-977)	0.18 (0.13-0.22)
2006	Palmer	2,466	1,920	1,045 (690-1,474)	2,965	251	525 (390-660)	0.18 (0.13-0.22)
2006	Sheephouse	7,024	1,070	3,277 (2,548-4,063)	4,347	131	288 (219-357)	0.07 (0.05-0.08)
2006	Ward	0	4,356	0	4,356	122	214 (181-247)	0.05 (0.04-0.06)

[1] Sum of spring stocked fish that survived until time of fall release and number of fall stocked fish.

[2] In 2006 high spring stream flows did not allow for trap installation until late March (Sheephouse) or late April (Mill and Ward), therefore abundance estimates reflect only the number emigrating during the time of trap operation.

[3] Survival estimates are likely biased in 2006 because we could not account for fish that left the streams prior to trap installation.

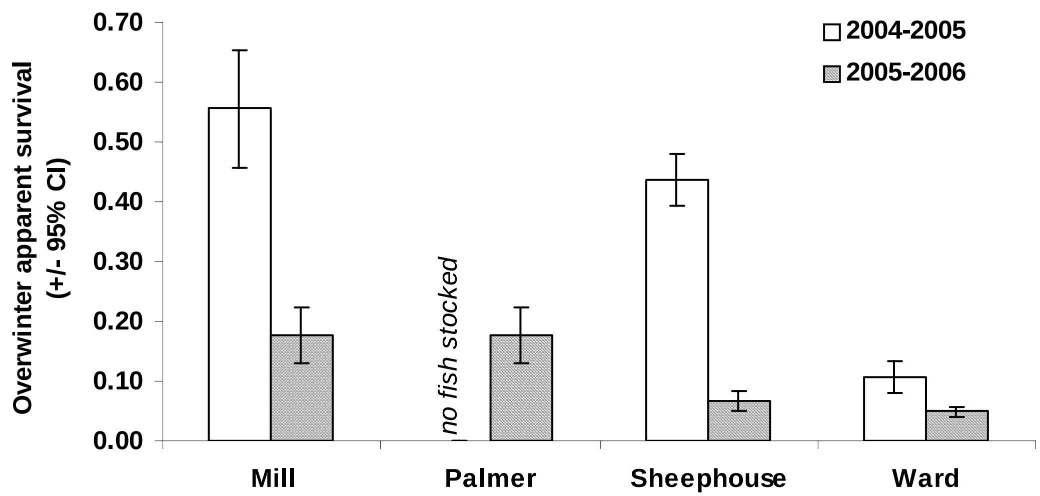


Figure 12. Overwinter apparent survival estimates of stocked juvenile coho winters 2004-2005 and 2005-2006. Palmer Creek was not stocked in 2004.

Table 17. Estimated number and proportions of spring and fall stocked coho in the fall prior to smolt migration (2005) and during smolt migration (spring 2006).

Tributary	Spring and fall abundance and proportions in fall prior to smolt migration			Spring and fall counts and proportions captured in smolt traps [1]			
	# spring (95% CI)	*# fall*	*s:f*	*# spring*	*# unk* [2]	*# fall*	*s:f* ([3])
Sheephouse	3,277 (2,548-4,063)	1,070	3.06 (2.38-3.80)	13	4	118	0.11 (0.14)
Palmer	1,045 (690-1,474)	1,920	0.54 (0.36-0.77)	65	11	186	0.35 (0.41)
Gray	1,683 (1,209-2,187)	2,240	0.75 (0.54-0.98)	13	1	38	0.34 (0.37)

[1]Spring trap capture data for Gray Creek was collected by the Austin Creek Project (Katz et. al. 2006).

[2]Fish with no detectable CWT tag (unk) were likely spring released fish because they were tagged at a smaller size.

[3]S:f proportion with "unk" fish included in the spring release group.

Table 18. Estimated smolt abundance and overwinter apparent survival of spring and fall stocked coho, spring 2006.

Tributary	Smolt abundance (95% CI)		Overwinter apparent survival (95% CI)	
	spring	*fall*	*spring*	*fall*
Sheephouse	29 (22-35)	259 (197-322)	0.01 (0.01-0.01)	0.24 (0.18-0.30)
Palmer	136 (102-171)	391 (291-490)	0.13 (0.10-0.16)	0.20 (0.15-0.26)

Growth and condition

In Palmer and Sheephouse Creeks, average fork lengths and weights were higher for fall-released fish than spring-released fish, and conversely, condition factors were higher for spring released fish (**Figure 14**). These size differences were also apparent during the fall prior to smolt outmigration, when mean fork length and weight for the fall-release group was higher than the predicted fall size for the spring-release group (**Table 19**). With the ability to predict growth in the streams and fall size of spring-released fish, in future years the program will be able to better match the size of spring and fall release groups.

In 2005 and 2006, average fork lengths and weights for Sheephouse, Mill, and Palmer (Palmer 2006 only) fall-stocked fish were similar and higher than for Ward Creek fish (**Figure 14a, b, Table 19**). Condition factor was lowest for fall stocked fish in Sheephouse and similar for fall stocked fish in the other three creeks (**Figure 14c**). In 2006, mean smolt size for the spring-release group was comparable to sizes observed for wild fish in Olema, Redwood, Pine Gulch, and Upper Lagunitas Creeks, and mean smolt size for the fall-release group was comparable to values observed in San Geronimo and Lower Lagunitas Creeks (Reichmuth, et. al. 2006).

Genetics samples

Genetics samples were collected on 735 program coho smolts (including one 2+ coho smolt of unknown origin), 2 wild Felta Creek coho yoy and 84 wild steelhead (82 smolts and 2 yoy/parr). These samples will be delivered to Carlos Garza at the Southwest Fisheries Science Center, NOAA Fisheries, Santa Cruz, CA where they will be processed and analyzed.

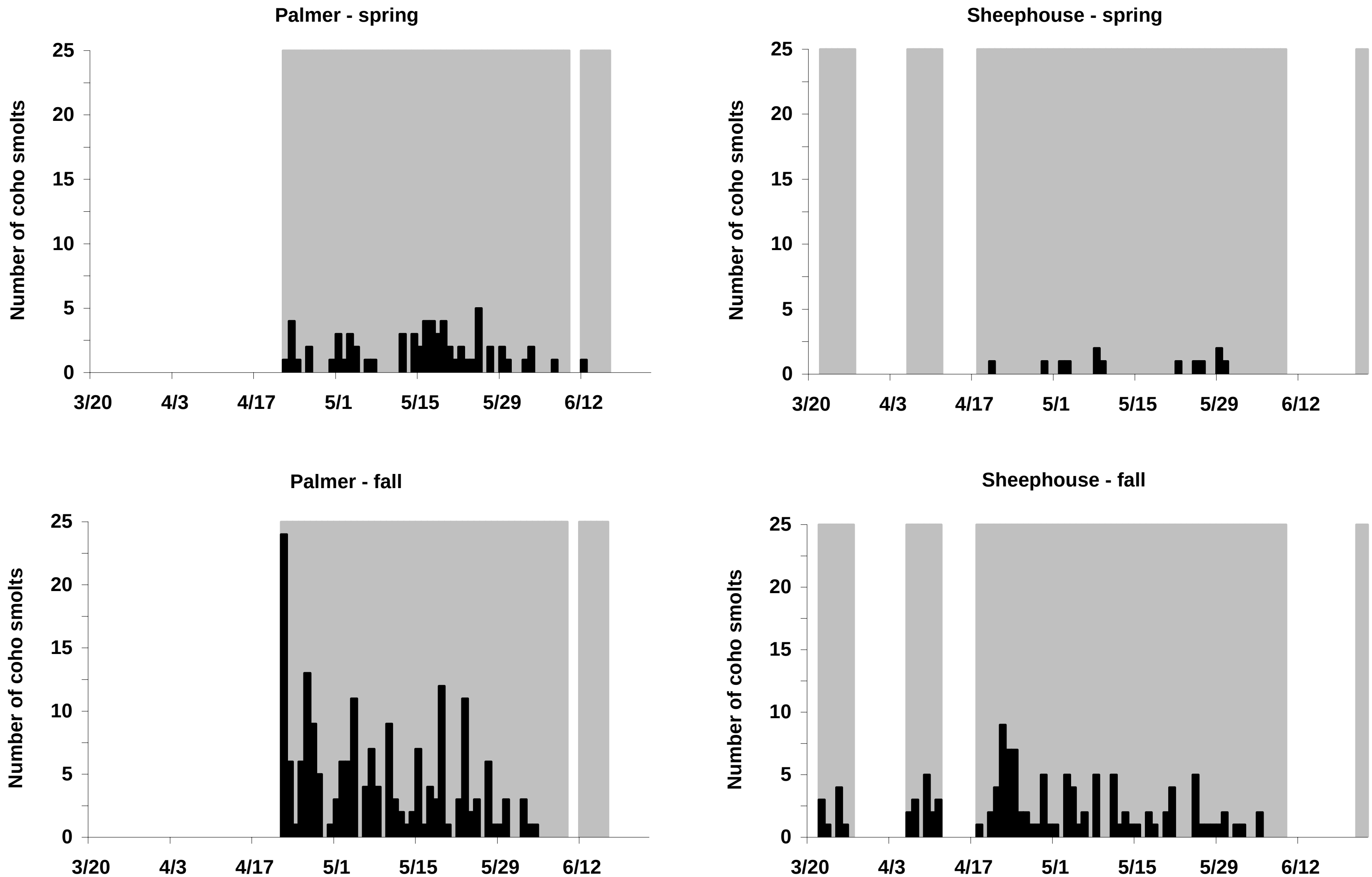


Figure 13. Number of spring and fall released coho stocked in 2005 into tributaries of the Russian River and captured in downstream migrant traps each day during spring 2006. Shaded background indicates days that the traps were in operation.

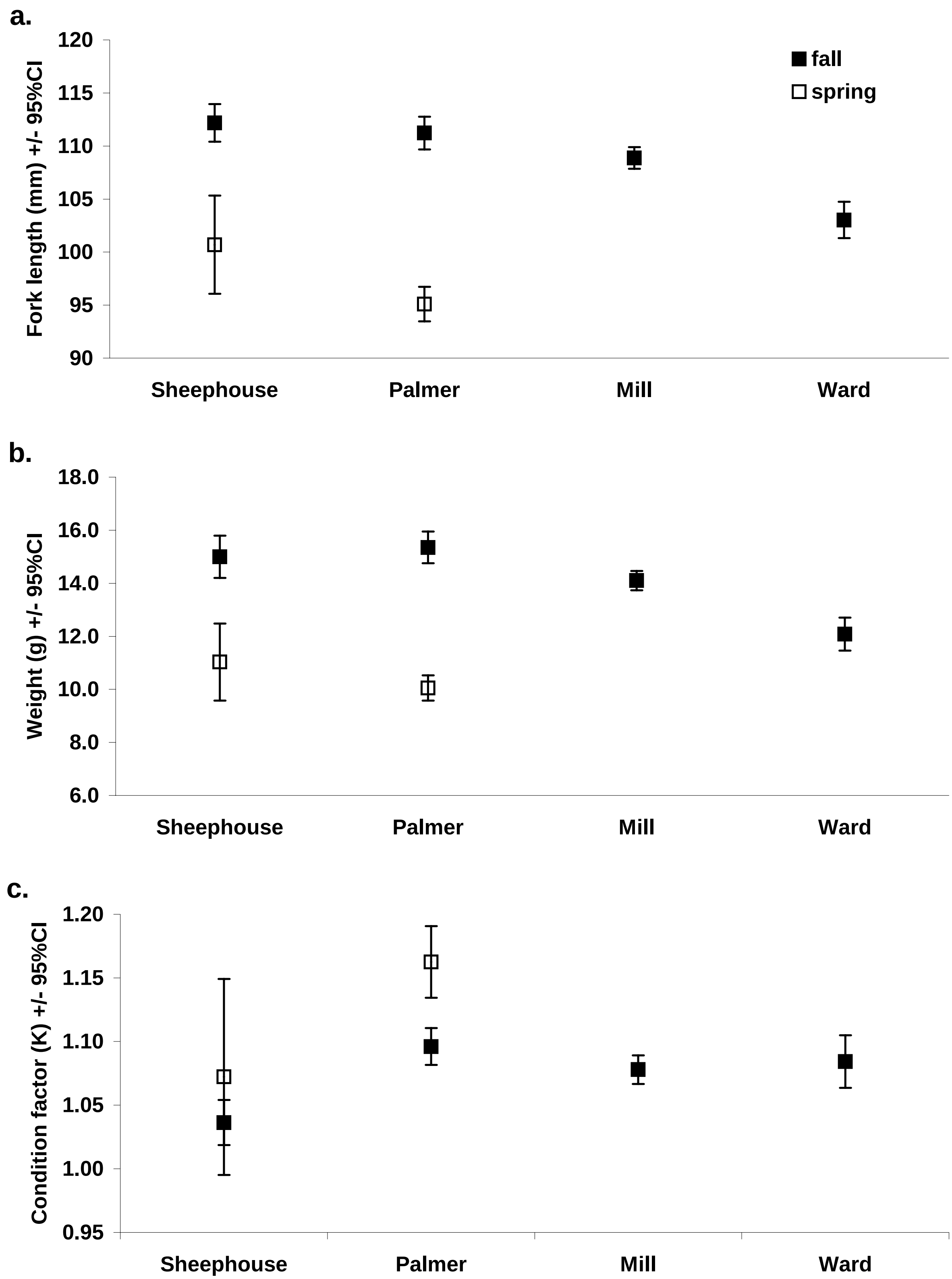


Figure 14. Mean fork length (a), weight (b), and condition factor (c) of coho smolts released in spring or fall 2005 and captured in downstream migrant traps, spring 2006.

Table 19. Mean fork length (FL) and weight (WT) of spring and fall coho release groups in the fall prior to outmigration and during smolt outmigration.

Trap year	Tributary	Size in fall (95% CI)						Size in spring (95%CI)					
		spring group [1]			*fall group* [2]			*spring group*			*fall group*		
		n	FL (mm)	WT (g)	n	FL (mm)	WT (g)	n	FL (mm)	WT (g)	n	FL (mm)	WT (g)
2005	Mill	0	*NA*	*NA*	125	100.1 (+/-2.9)	13.5 (+/-1.2)	0	*NA*	*NA*	576	118.0 (+/-0.9)	16.8 (+/-0.4)
2005	Ward	0	*NA*	*NA*	100	100.7 (+/-3.2)	14.2 (+/-1.4)	0	*NA*	*NA*	87	111.1 (+/-2.1)	13.7 (+/-0.8)
2005	Sheephouse	0	*NA*	*NA*	100	110.4 (+/-4.0)	18.8 (+/-2.1)	0	*NA*	*NA*	255	118.6 (+/-1.3)	16.8 (+/-0.5)
2006	Mill	0	*NA*	*NA*	99	85.9 (+/-2.3)	8.3 (+/-0.7)	0	*NA*	*NA*	354	108.9 (+/-1.0)	14.1 (+/-0.4)
2006	Ward	0	*NA*	*NA*	100	85.9 (+/-2.6)	8.4 (+/-0.7)	0	*NA*	*NA*	120	103.0 (+/-1.7)	12.1 (+/-0.6)
2006	Sheephouse	-	73.1	5.26	50	97.4 (+/-3.9)	12.2 (+/-1.4)	13	100.7 (+/-4.6)	11.0 (+/-1.5)	117	112.2 (+/-1.8)	15.0 (+/-0.8)
2006	Palmer	-	74.8	7.57	50	87.7 (+/-3.3)	9.0 (+/-1.1)	64	95.1 (+/-1.6)	10.1 (+/-0.5)	180	111.2 (+/-1.5)	15.3 (+/-0.6)
2006	Gray	-	72.3	4.81	50	87.9 (+/-2.7)	8.2 (+/-0.7)	13	101.0 (+/-3.4)[3]	-	38	107.5 (+/-2.1)[3]	-

[1]Sizes for spring-released fish in fall are predicted based on estimated oversummer growth rates.

[2] Size data was collected by Warm Springs Hatchery staff 3 to 27 days (Oct-Nov) prior to fall stocking.

[3] Data collected by Austin Creek trapping effort (Katz et. al. 2006).

Mortalities

Measures were taken to minimize mortality of salmonids captured in the downstream migrant traps including frequent (at least once daily) checking of traps and removal of debris, installation of flow deflectors inside of the box to provide relief from the current and removal of the traps during high-flow events. Despite these efforts, mortality of salmonids at various life stages occurred (**Table 20**). Mill Creek, which was checked twice daily because of occasional high debris loads, had the majority of coho smolt mortalities. Early in the season this was due primarily to high flows coupled with high debris loads. We also observed that on a couple of occasions where mortalities occurred in the Mill trap, there were few/no physical injuries to the fish, and there were large quantities of bay leaves in the trap box. It is possible that the bay leaves had a toxic effect on the fish. Later in the season mortality seemed to be due to a small proportion of the coho smolts exhibiting symptoms including low body weight, fungus, frayed fins and scale loss, and generally appearing "less healthy." Some of these symptoms may have been due to increasing temperature, predation or interrupted migration from the downstream migrant trapping. In Ward Creek, twelve newly emerged steelhead yoy were found dead upon arrival one morning due to a soccer ball clogging the cod end of the net.

Table 20. Percentage and number of salmonid mortalities related to operation of downstream migrant trapping, spring 2006.

	Coho		Steelhead			Chinook
Tributary	**yoy**	**smolt**	**yoy**	**smolt**	**adult**	**yoy**
Mill	33.3% (1/3)	3.6% (23/646)	0.5% (2/438)	2.0% (1/49)	0% (0/5)	0.8% (1/128)
Sheephouse	NA[1]	0% (0/141)	0% (0/80)	0% (0/17)	NA[1]	NA[1]
Ward	NA[1]	2.4% (3/125)	3.3% (12/363)	0% (0/25)	0% (0/2)	NA[1]
Total	33% (1/3)	2.9% (26/912)	0.11% (3/881)	1.1% (1/91)	0% (0/7)	0.8% (1/128)

[1]NA=no fish captured

POST-STOCKING MOVEMENTS OF SPRING RELEASED FISH

During the spring of 2006, program coho yoy were released into five streams: Mill-5,297, Sheephouse-2,911, Ward-5,690, Palmer-2,102, and Gray-3,201. These creeks were monitored to assess immediate mortality and downstream movement of recently released coho salmon yoy.

Methods

The immediate downstream movement of spring-released coho salmon yoy was monitored in Mill, Sheephouse and Ward Creeks by continuing operation of the downstream migrant traps installed to capture outmigrating smolts. If 50 or more hatchery coho salmon yoy were captured in the downstream migrant trap, the fish were placed in an aerated cooler and transported upstream and re-released into the stocking reaches. If fewer than 50 fish were captured, they were released downstream of the trap. Downstream movement of spring-released coho salmon yoy in Palmer and Gray Creeks was monitored by installing a block seine net near the creek mouths.

Results

Following the spring release of program coho on Mill Creek on 6/13-14/06, a total of 321 coho yoy were caught in the downstream migrant trap between 6/14-16/06. On 6/14, three fish entered the box and were released downstream. On 6/15 and 6/16, 163 and 145 coho yoy, respectively, were captured in the trap box and transported back upstream to Mill Creek near the mouth of Palmer Creek. The Mill Creek trap was removed after being checked on 6/16. Ward Creek was stocked on 6/19 and 6/20. A total of 26 coho yoy were captured in the Ward Creek trap and released downstream between 6/19 and 6/21. The Ward Creek trap was removed on 6/21. Sheephouse Creek was stocked on 6/21 and no coho yoy were captured in the downstream pipe trap for two days following release, 6/22-23.

The block seine at Palmer Creek was monitored daily between 6/12 and 6/16. Crews also snorkeled the area on 6/14 to get a more accurate count under the woody debris in the pool directly upstream of the net. Approximately 200-250 coho yoy were observed holding upstream of the net. The net on Gray Creek was monitored daily between 6/15 and 6/19 and approximately 15-20 coho yoy were visually observed in two pools above the net.

TEMPERATURE COMPARISONS

Temperature data was collected on coho program streams in order to document and compare patterns in temperature among stocking streams, and between stocking streams and comparison streams that sustain wild coho populations.

Methods

Onset Hobo Temp or Optic StowAway loggers were deployed at various sites in Mill, Palmer, Felta, Wallace, Ward, Sheephouse, Dutch Bill, and Green Valley Creeks (**Figures 15-20**). During the summer, temperature loggers were deployed in multiple reaches on each stream (between two and five loggers per stream) with the exception of Wallace and Felta which had one logger per stream. Temperature was recorded hourly at each station. This distribution of loggers enabled within-stream temperature comparisons during the summer survival period. Temperature loggers were deployed in the spring (April-June) and removed in the fall (October-November). Stream audits were performed three times over the summer season to download data and check that the instrumentation was functioning properly. At the downstream temperature (and flow) recording stations on Mill, Sheephouse, Ward, Dutch Bill, and Green Valley, temperature loggers were left in the streams year-round to record hourly temperature during all seasons.

Results

Stream temperatures were consistently warmer across all monitored streams in 2006 than in 2005 (**Table 21**). For example, within Dutch Bill Creek at site RR-DUT-10.55 the overall mean and maximum temperatures were 13.37 and 17.10°C in 2005, respectively. This is compared to 13.99 and 18.71°C in 2006, respectively. In addition to this annual variability, stream temperatures are generally warming in the downstream direction. Comparing Green Valley Creek sites RR-GRE-13.88, furthest upstream, and RR-GRE-2.14, furthest downstream demonstrates this dynamic. In 2005 the upstream maximum weekly average temperature (MWAT) was 17.67°C compared with 19.29°C downstream. And similarly, in 2006 the MWAT was 20.31°C upstream and 22.06°C downstream.

Keeping these annual and within stream differences in mind, there are also important similarities and differences in stream temperature between program streams. Temperature in all monitored streams rises and falls according to an annual cycle. In the winter months temperatures are cool, approximately 10°C or cooler and warm in the summer to temperatures above 14°C (**Figure 21**). Winter temperatures, across the studies streams, are generally similar. In contrast, there can be a wide range in summer stream temperatures between streams. Sheephouse Creek, for example, has consistently cooler running weekly average temperatures and running weekly maximum temperatures than other program streams throughout the summer months (**Figure 21**). This difference can be as great as 10°C for single temperature measurements. Documenting these differences in stream temperatures between streams and the duration of potential exposure of stocked coho to stress-related temperatures will increase the program's understanding of the variation in survival rates of spring stocked coho into these streams.

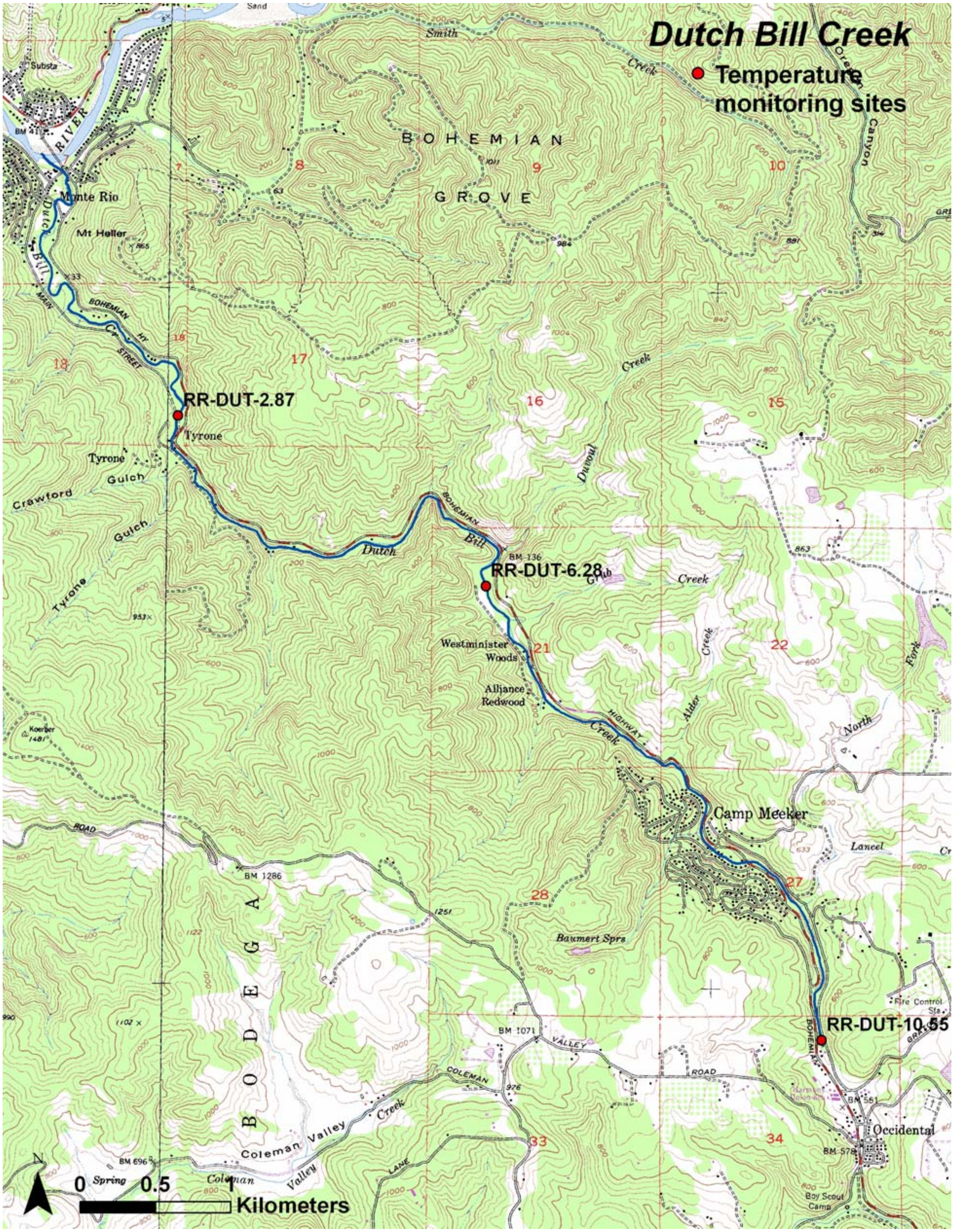


Figure 15. Temperature monitoring sites on Dutch Bill Creek, 2005-2006.

Figure 16. Temperature monitoring sites on Green Valley Creek, 2005-2006.

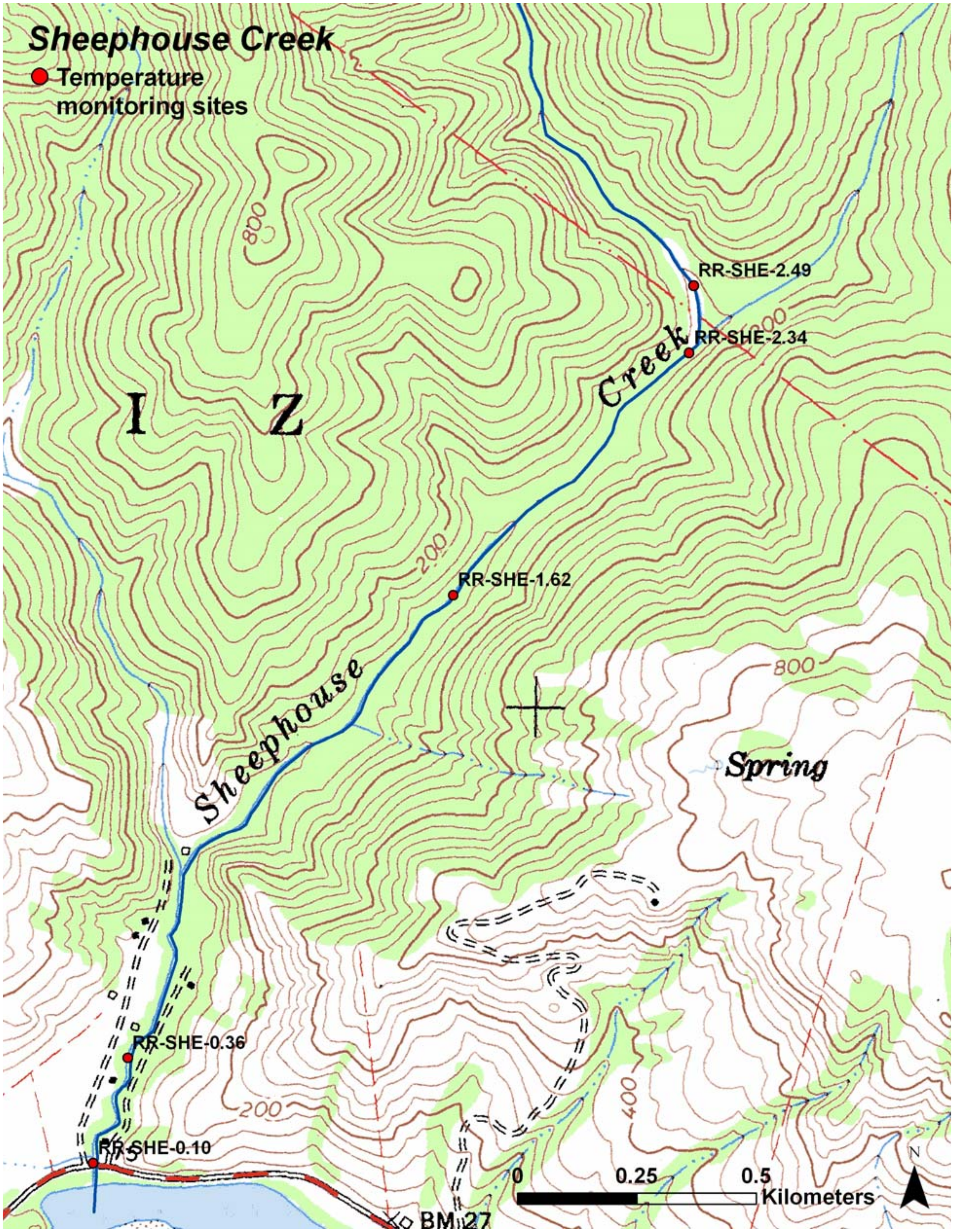


Figure 17. Temperature monitoring sites on Sheephouse Creek, 2005-2006.

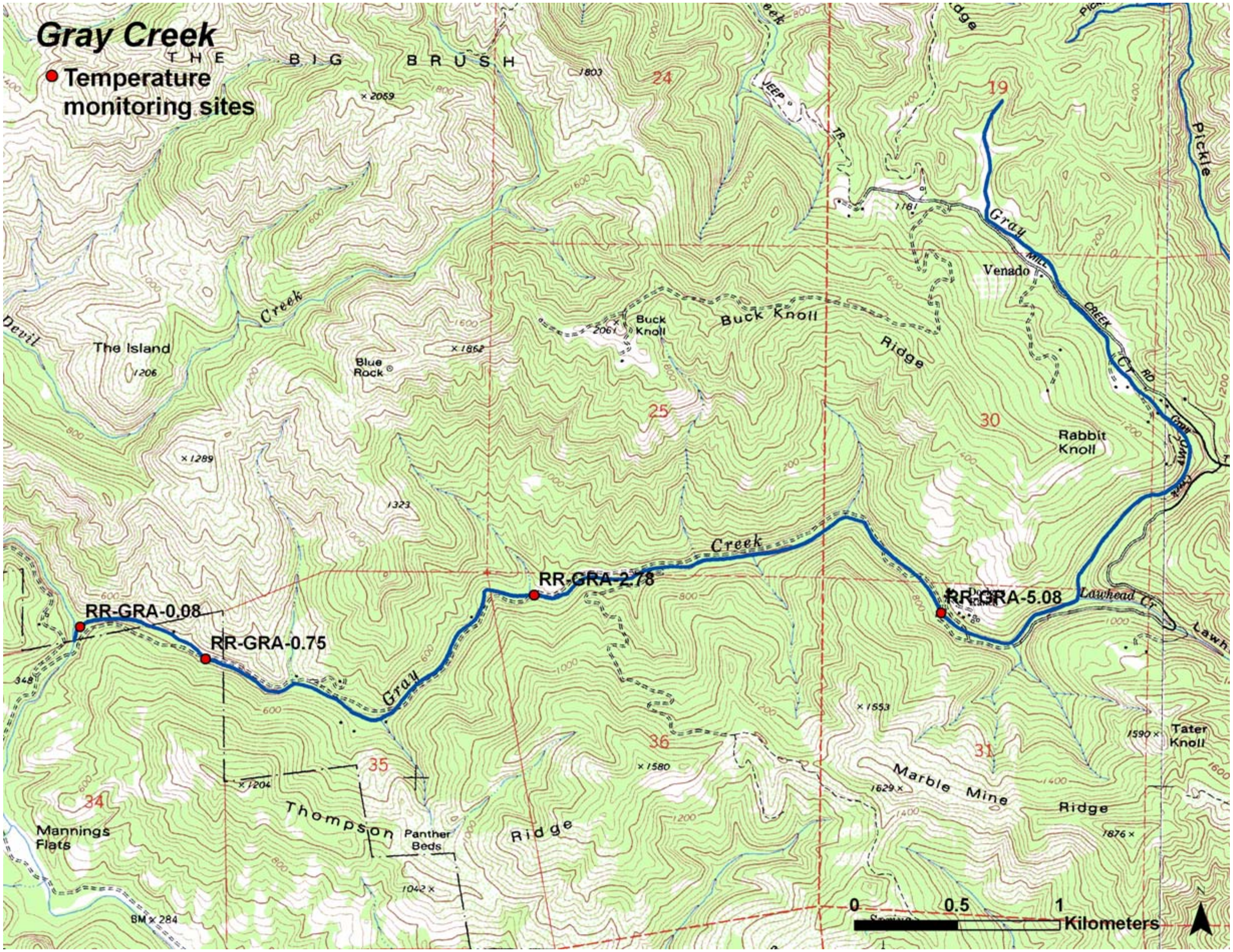


Figure 18. Temperature monitoring sites on Gray Creek, 2005-2006.

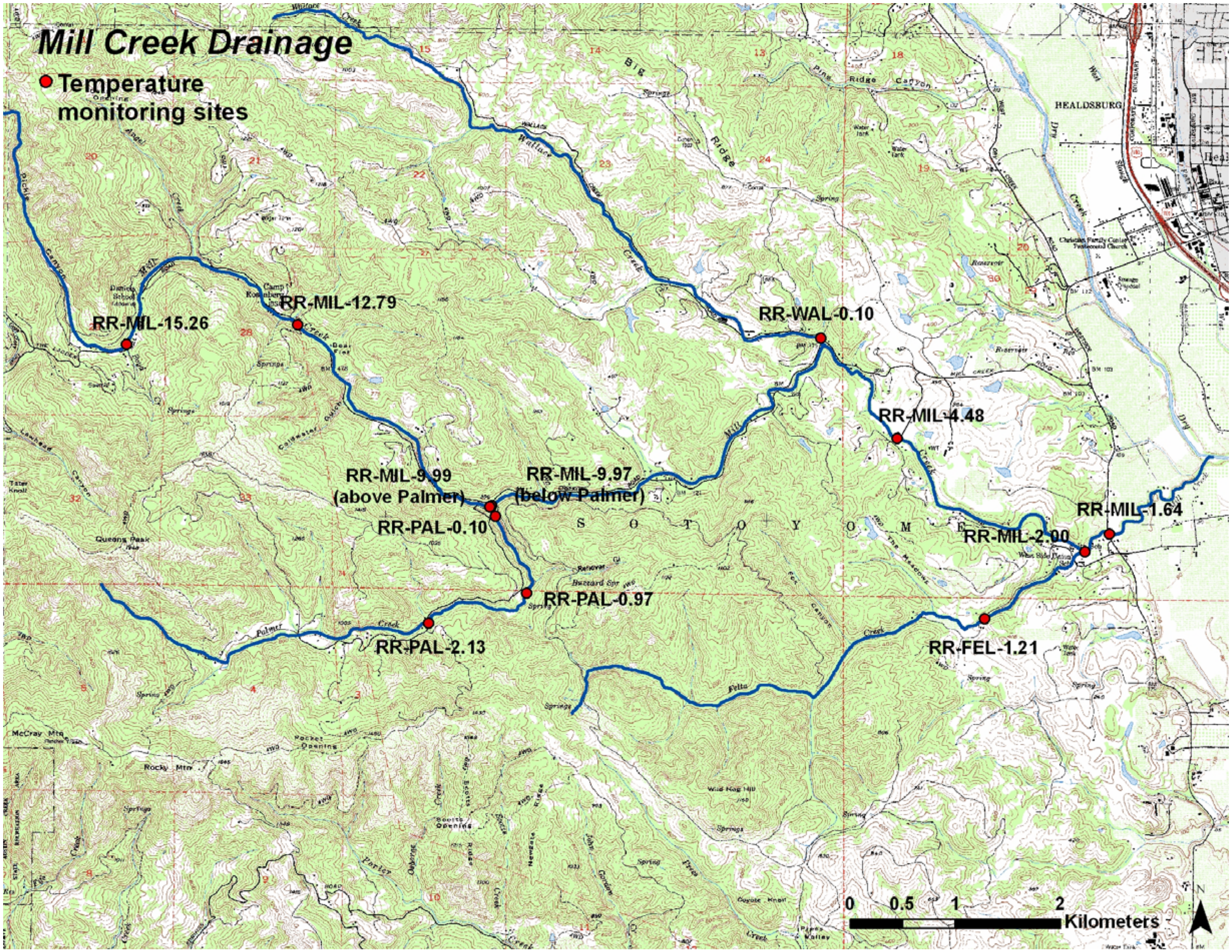


Figure 19. Temperature monitoring sites on Mill, Felta, Wallace, and Palmer Creeks, 2005-2006.

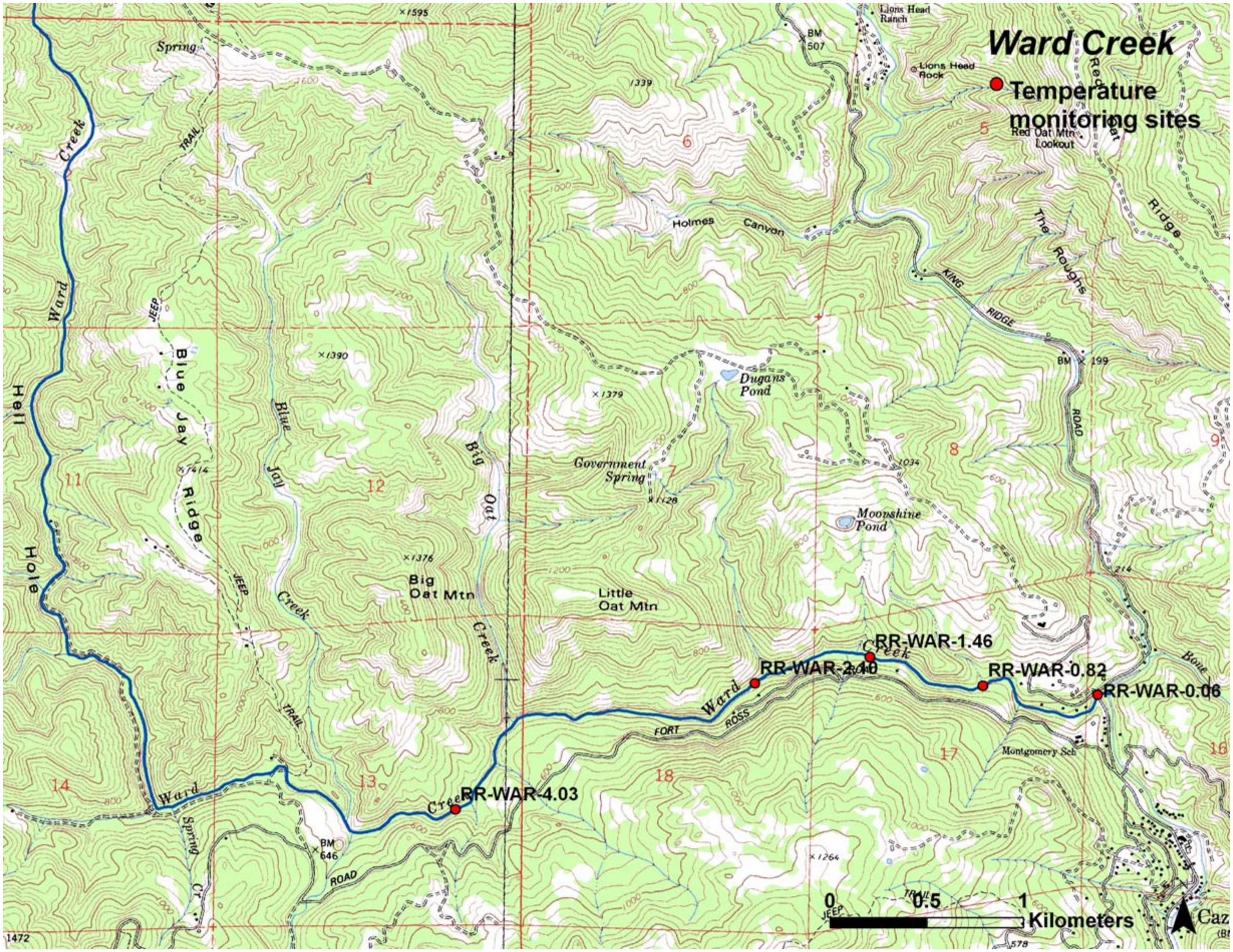


Figure 20. Temperature monitoring sites on Ward Creek, 2005-2006.

Table 21. Summary of temperature data collected between June 15 and October 15 at various sites on Russian River tributaries, 2005-2006. MWAT was calculated as the maximum running weekly average temperature between the start and end dates. MWMT was calculated as the maximum running weekly maximum temperature between the start and end dates.

						Temperature (°C)				
Year	Tributary	Site	Start Date	End Date	Comments	Mean	Min	Max	MWAT	MWMT
2005	Dutch Bill	RR-DUT-10.55	6/22/05	10/15/05		13.37	10.20	17.10	15.32	16.47
2005	Gray	RR-GRA-2.78	6/28/05	10/15/05	No data 9/6 - 9/26	15.19	10.90	19.40	17.45	19.29
2005	Gray	RR-GRA-5.08	6/28/05	10/15/05		14.98	10.99	19.42	17.51	19.04
2005	GreenValley	RR-GRE-2.14	6/22/05	10/15/05		16.42	11.70	20.50	19.29	20.20
2005	GreenValley	RR-GRE-12.49	6/22/05	10/15/05		15.00	10.11	19.80	17.76	19.40
2005	GreenValley	RR-GRE-13.69	6/22/05	8/25/05		16.41	13.22	19.58	18.10	19.13
2005	GreenValley	RR-GRE-13.88	6/22/05	10/15/05		15.22	11.70	19.40	17.67	18.94
2005	Mill	RR-MIL-9.99	6/22/05	10/15/05		14.88	10.20	20.50	17.85	20.11
2005	Mill	RR-MIL-12.79	6/22/05	10/15/05		14.84	10.70	19.37	17.42	19.05
2005	Mill	RR-MIL-15.26	6/22/05	8/5/05		15.98	12.10	18.60	17.27	18.43
2005	Palmer	RR-PAL-0.10	6/22/05	10/15/05		14.75	10.18	19.32	17.74	18.94
2005	Palmer	RR-PAL-0.97	6/22/05	10/15/05		14.79	10.14	19.30	17.71	18.90
2005	Palmer	RR-PAL-2.13	6/22/05	10/15/05		14.57	10.41	18.73	17.17	18.38
2005	Sheephouse	RR-SHE-0.10	6/22/05	10/15/05		13.54	11.18	16.94	14.52	15.91
2005	Sheephouse	RR-SHE-1.62	6/22/05	10/15/05		12.50	9.31	14.89	13.92	14.38
2005	Sheephouse	RR-SHE-2.49	6/22/05	10/15/05		12.28	9.42	15.23	13.76	14.47
2005	Ward	RR-WAR-0.06	6/22/05	10/8/05		17.19	11.82	21.94	20.23	21.75
2005	Ward	RR-WAR-4.03	6/22/05	10/15/05		14.93	10.07	19.34	17.52	19.04
2006	Dutch Bill	RR-DUT-2.87	6/22/06	10/10/06		15.86	6.37	22.67	18.38	22.00
2006	Dutch Bill	RR-DUT-6.28	6/22/06	10/10/06		15.60	10.55	22.16	19.66	21.05
2006	Dutch Bill	RR-DUT-10.55	6/22/06	10/10/06		13.99	10.71	18.71	16.67	17.55
2006	Felta	RR-FEL-1.21	6/22/06	10/15/06		15.97	11.78	22.64	20.23	21.48
2006	Gray	RR-GRA-0.08	6/22/06	10/15/06		16.32	10.54	24.20	20.94	23.32
2006	Gray	RR-GRA-0.75	6/22/06	10/15/06		15.53	9.82	22.48	20.13	21.66
2006	Gray	RR-GRA-2.78	6/22/06	10/15/06		16.00	11.17	22.66	20.17	21.85
2006	Gray	RR-GRA-5.08	6/22/06	10/15/06		15.50	11.33	22.16	20.00	21.40

Table 21 (cont). Summary of temperature data collected between June 15 and October 15 at various sites on Russian River tributaries, 2005-2006. MWAT was calculated as the maximum running weekly average temperature between the start and end dates. MWMT was calculated as the maximum running weekly maximum temperature between the start and end dates.

						Temperature (°C)				
Year	Tributary	Site	Start Date	End Date	Comments	Mean	Min	Max	MWAT	MWMT
2006	GreenValley	RR-GRE-2.14	6/22/06	10/12/06		17.52	5.75	25.93	22.06	24.64
2006	GreenValley	RR-GRE-12.49	6/22/06	10/12/06		16.31	11.49	22.65	20.27	21.87
2006	GreenValley	RR-GRE-13.88	6/22/06	10/12/06		16.39	12.41	22.82	20.31	21.71
2006	Mill	RR-MIL-1.64	6/15/06	10/6/06		16.39	6.26	22.88	19.35	22.18
2006	Mill	RR-MIL-2.00	6/15/06	10/15/06		16.09	6.38	23.66	20.22	22.53
2006	Mill	RR-MIL-4.48	6/15/06	10/15/06		17.03	11.65	25.08	21.71	23.70
2006	Mill	RR-MIL-9.97	6/15/06	10/15/06		15.66	10.24	23.18	20.38	22.39
2006	Mill	RR-MIL-12.79	6/15/06	10/15/06		15.21	10.53	21.47	19.25	20.88
2006	Palmer	RR-PAL-0.10	6/22/06	10/15/06		15.42	10.34	22.10	20.10	21.37
2006	Palmer	RR-PAL-2.13	6/22/06	10/15/06		15.08	10.28	21.52	19.49	20.80
2006	Sheephouse	RR-SHE-0.36	6/22/06	10/9/06		13.10	10.60	15.32	14.63	15.12
2006	Sheephouse	RR-SHE-2.34	6/22/06	10/15/06		12.73	9.80	16.04	14.91	15.52
2006	Wallace	RR-WAL-0.10	6/22/06	10/15/06		15.30	11.32	20.17	18.27	19.11
2006	Ward	RR-WAR-0.06	6/22/06	10/15/06		16.97	10.57	25.76	21.92	24.44
2006	Ward	RR-WAR-0.82	6/22/06	10/15/06		16.82	11.16	24.16	21.78	23.09
2006	Ward	RR-WAR-1.46	6/22/06	10/15/06		16.76	10.39	25.71	21.83	24.77
2006	Ward	RR-WAR-2.10	6/22/06	10/15/06		16.21	9.92	25.42	21.38	24.26
2006	Ward	RR-WAR-4.03	6/22/06	10/15/06		15.51	10.09	22.65	20.04	21.65

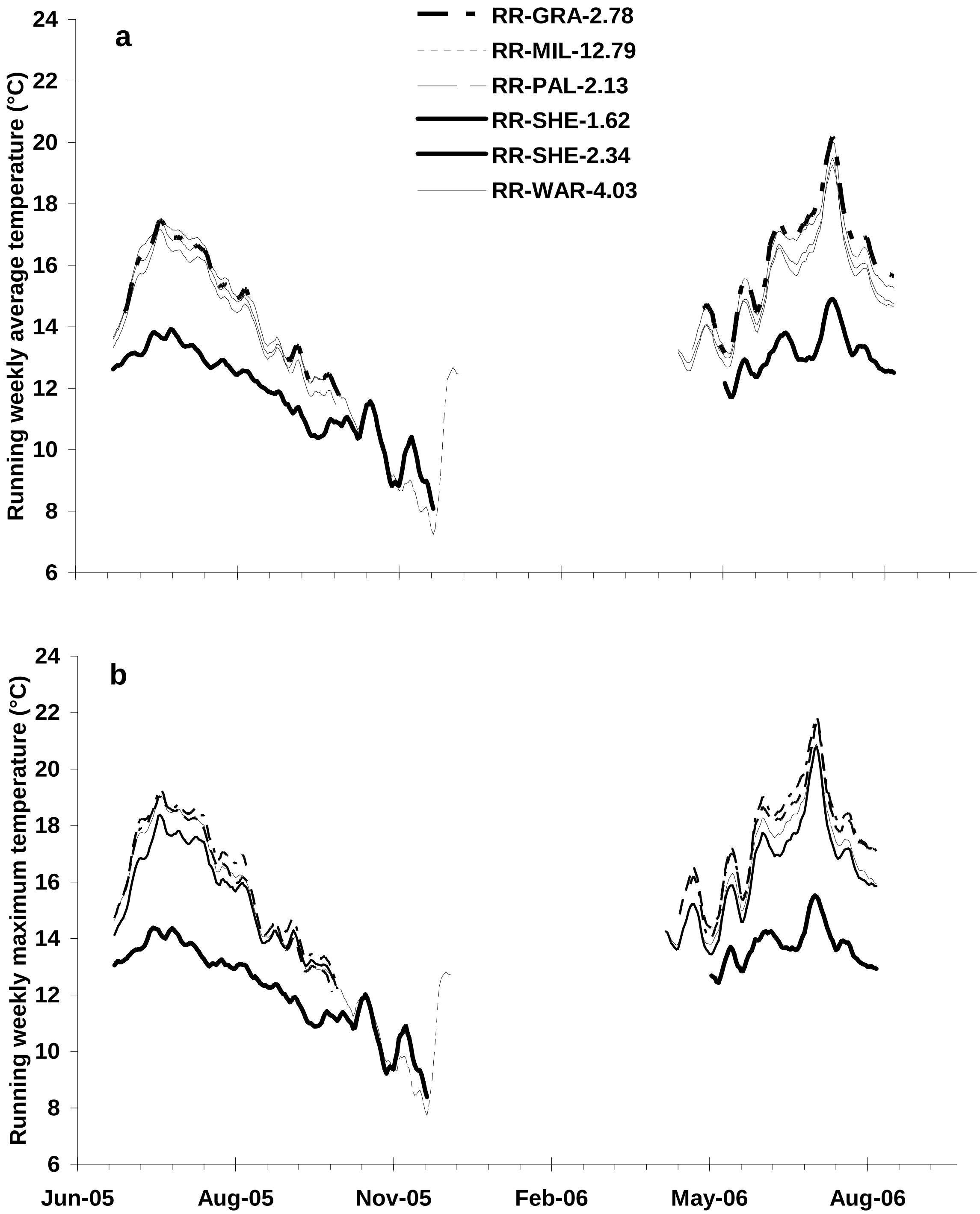


Figure 21. Running weekly average temperature (a) and running weekly maximum temperature (b) in 2005 and 2006 for selected monitoring sites on spring stocked program streams.

FLOW COMPARISONS

Flow data was collected on several coho program streams in order to document and compare patterns in flow among stocking streams, and between stocking streams and comparison streams that sustain wild coho populations.

Methods

Global Water water level loggers were installed at or near the mouths of Mill, Ward, Sheephouse, and Dutch Bill Creeks during the spring of 2005. Installation of instrumentation in Green Valley was delayed until fall of 2005 because of a delay in permitting/landowner permission. These meters record stage height on an hourly basis year-round. Discharge at various stage heights was estimated by multiplying the average stream velocity (measured with a Global Water flow probe) by the area of a cross section of the stream channel (calculated by multiplying stream width by average stream depth) (Mosley and McKerchar 1993). Regression was used to develop a relationship between stage height and discharge to estimate hourly discharge from stage height recordings.

Results

The 2005-2006 water year contained extreme discharge events including basin wide flood conditions from December 30, 2005 to January 2, 2006 (**Figure 22**). In Mill Creek, this was evidenced by the peak discharge of 2,076 cfs on December 31 at 6:00 am and 1,131 cfs on January 1 at 4:00 pm. However, unlike the previous year, discharge in the Russian River and program streams decreases to baseflow conditions by late April of 2006.

Streamflow in each of the program streams demonstrated this response to the large storm events and annual variability (**Table 22**). For all five streams monitored, maximum daily mean discharge, annual mean discharge, and total annual discharge were greater in the 2005-2006 than in the 2004-2005 water year. This was primarily the result of the large rain and flooding that occurred over New Year's and successive days of precipitation in March and April 2006 that generate significant discharge.

Mill and Ward creeks generated the greatest streamflow of all the streams primarily due to their relatively larger drainage areas (**Table 22**). In the case of Ward Creek it may also be that coastal proximity and greater slopes within that drainage contributed to greater precipitation amounts and thus streamflow. By comparison, streamflow in Sheephouse was consistently lower during extreme events and into the summer, as a result of its relatively smaller drainage area. As one of the habitat characteristics that will contribute to understanding the program's success, it will be important to make comparisons between years and respective seasons to understand how extreme events and changes in summer and winter streamflow may influence program coho survival.

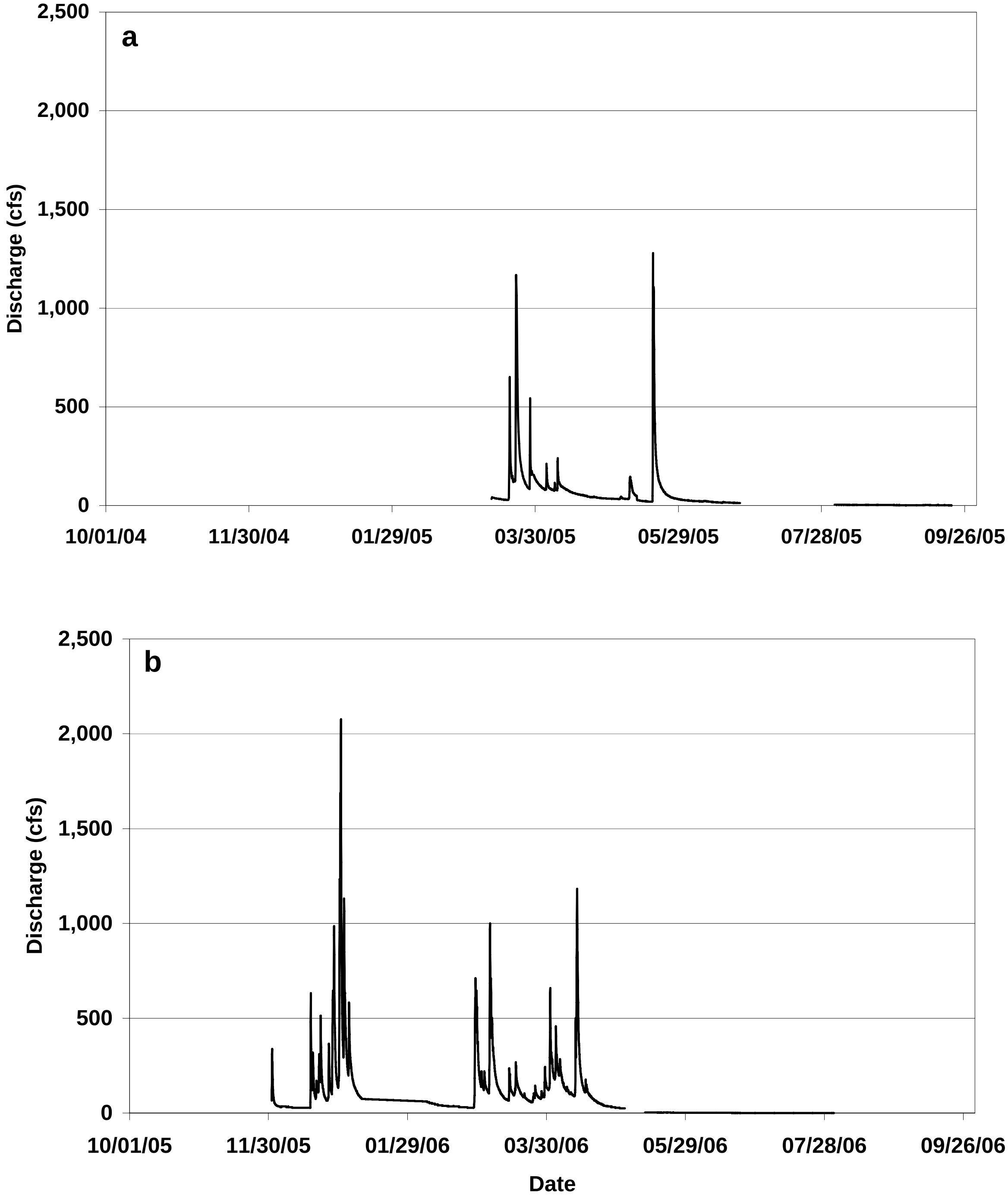


Figure 22. Hourly discharge hydrograph for Mill Creek during the 2004-2005 (a) and 2005-2006 (b) water years.

Table 22. Summary of discharge data collected during the 2004-2005 (2005) and 2005-2006 water years in program streams.

Year	Tributary	Sampling Days	Discharge Statistics[1] Min Daily Mean Discharge (cfs)	Max Daily Mean Discharge (cfs)	Annual Mean Discharge (cfs)	Total Annual Discharge (acre-feet)
2005	Dutch Bill	186	0.7	1,464.3	16.7	10,020
2005	Green Valley	31	-	-	-	-
2005	Mill	155	0.5	1,278.9	51.2	11,545
2005	Sheephouse	221	1.3	276.6	6.7	4,567
2005	Ward	205	2.2	1,232.6	35.7	19,724
2006	Dutch Bill	192	0.3	2,611.6	88.0	16,195
2006	Green Valley	297	0.7	3,113.0	28.9	17,004
2006	Mill	235	0.8	2,076.6	82.3	38,202
2006	Sheephouse	365	0.2	395.3	36.6	27,153
2006	Ward	313	0.1	3,537.0	92.4	26,124

[1]Summary discharge statistics are based on the sampling days for each respective stream site.

BENTHIC MACROINVERTEBRATE SAMPLING

During the spring and summer of 2006, we compared macroinvertebrate abundance among program streams as a measure of food availability for stocked coho. This is the first step in environmental data collection for comparisons with coho population data which will eventually provide insights into the successes or failures on a stream-by-stream basis relative to ecological condition of the streams and food availability for supplemented fish.

Methods

In order to compare food abundance for juvenile coho in program streams, benthic macroinvertebrate sampling was conducted on Mill, Palmer, Sheephouse, Ward, Gray, Green Valley, and Dutch Bill Creeks during the spring of 2006. Samples were collected monthly between May and July in lower, middle and upper reaches on each stream. On each sampling occasion, three benthic samples (at three randomly selected transects within a 100m stream section) were collected in each reach for a total of 27 samples per stream over a three month period.

Benthic samples were collected in each reach using a Hess sampler (500 µm mesh). At each randomly selected transect, three samples were collected (at right bank, at left bank, and at mid-channel) and then combined to form one composite sample. All samples were stored in 70% ethanol for later analysis. After sample collection, debris was separated from the invertebrates with the aid of a dissecting microscope. Cleaned and sorted samples were then shipped to EcoAnalysts for dry weight determination.

Results

At the time of reporting, samples were still being processed in the laboratory. The results will be presented in the 2006-2007 annual report.

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