Mattole Watershed Juvenile Coho Salmon Distribution Monitoring 2013-2014

Lone coho salmon amidst large schools of *O. mykiss* in the Mattole River near Petrolia, July 23, 2014.

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Abstract

To assess coho salmon population spatial structure in the Mattole River watershed, we used multi-pass snorkel surveys to gather information on the presence of coho and other aquatic vertebrates, and a suite of habitat parameters, during the summer baseflow period in 2013 and 2014. Possible survey reaches were pre-defined to include all likely coho rearing habitat in the watershed, based on GIS-calculated reach gradient, valley width, and mean annual discharge. We surveyed a total of 64 reaches, all reaches in the sample frame for which we were able to gain property access permission. In 2013 coho were detected in 7 of 27 reaches surveyed, and in 2014 12 of 37 reaches. Multi-scale occupancy models were used to calculate the proportion of area occupied (PAO) and the probability of species occurrence at both the reach and sample unit scale. PAO for both years was 0.13. Unit-level occupancy (within occupied reaches) was 0.43 in 2013 and 0.37 in 2014, while reach-level occupancy was 0.31 and 0.35. Chinook Salmon PAO was 0.47 in 2013 and 0.15 in 2014. Juvenile *O. mykiss* were widely distributed, present in all reaches and nearly every sample unit both years.

Patterns of coho spatial distribution appeared similar to all years in the last three decades for which data exists, with 90-95% of the coho observed concentrated in the mainstem Mattole and a few tributaries in the extreme southernmost portion of the watershed. Based on the abundance of coho juveniles, and egg-to-parr survival rates in nearby watersheds, it appears recent adult returns have been well under 100 individuals. Reaches and habitat units with coho presence had higher cover area values than those where coho were not detected, and at the unit-scale depth, cover rating. LWD count, and pool area were also greater in pools with coho.

The differences in habitat between the reaches and units with coho present and absent suggest that effective habitat restoration actions focused on enhancing habitat complexity and cover should help improve the availability of suitable coho rearing habitat. Streams and reaches with coho presence but low abundance adjacent to the core area of occupancy may be the most logical focus for continued restoration efforts. A better understanding of coho seasonal movement and winter habitat use and availability in the watershed would also help direct restoration efforts. However, the very low apparent number of returning adults suggests that recovery of the population may be primarily limited at this time by deleterious genetic effects due to low population size.

Study Area

The project took place in the 304 mi^2 Mattole River watershed, in coastal Humboldt and Mendocino counties.

Objectives

The primary project objectives were to:

- Determine distribution (spatial structure) of juvenile coho salmon in Mattole River watershed.
- Estimate abundance of juvenile coho salmon in the Mattole River watershed.

Additional objectives were to

- Assess relationship between coho occupancy and habitat variables
- Compare coho juvenile distribution to prior years

Methods

Field methods followed Garwood and Ricker (2013), and those described in detail in that document are reviewed only briefly here. Prior to each survey season, surveyors attended the protocol training conducted by CDFW in early June. Following this training, multiple days of additional training were conducted with less experienced staff, focused particularly on species identification.

Reach Selection

Survey reaches were all potential coho salmon spawning reaches in the sample frame that was developed for Mattole River adult salmonid spawner surveys by CDFW with input from the MSG (Garwood and Ricker 2008) (Figure 1). Reaches attributed as potential coho habitat in this sample frame have a maximum stream gradient of five percent or less, and a minimum estimated mean annual discharge of greater than 0.05 cubic meters per second. A handful of reaches that fall outside of these parameters were included based on past documentation of coho presence (Garwood and Ricker 2008).

Existing MSG thermograph data was used to exclude reaches judged to have little potential to contain habitat units that met the spot temperature criteria of ≤ 20° C in Garwood and Ricker (2013), in order to avoid the cost of staff time to access a reach with no qualifying units. Reaches with an absence of summer MWAT temperatures ≤ 19°C for any year of record and a lack of significant thermal heterogeneity (i.e. relatively confined reaches with low potential for off-channel features) were excluded from the sampling frame. Five reaches were excluded from the sampling frame based on thermograph data.

Reaches were surveyed in order from a spatially-balanced random draw developed for 2012-13 spawning ground surveys in the Mattole. Landowners were contacted for access

permission by both mail and phone (when phone numbers were obtainable). In 2013, reaches (or portions of reaches) were surveyed only if access permission was obtained to >50% of the reach. In 2014, based on the revised recommendation of Justin Garwood, any segment of a reach where access permission was obtained was surveyed, unless the segment required additional travel time of greater than one hour to access (was not adjacent to another surveyed reach) and was so short that it may not have contained any qualifying units.

Field work and data handling

Pools within a reach were sampled that met specific depth, width, area, and temperature criteria, in addition to descriptive morphologic criteria, as described in Garwood and Ricker (2013). In "large river" reaches, defined as mean annual discharge of >10 m^3 s^{-1}, qualifying units were defined by the presence of cover in addition to the above criteria. Every other pool in a reach meeting these criteria was snorkeled using an independent double-pass, with divers identifying and tallying all fish species present, as well as other relevant aquatic or amphibious species (in 2014, protocol was changed so only every fourth pool surveyed was surveyed with a double-pass). Every pool meeting the criteria was sampled in "large river" reaches, due to the infrequent occurrence of qualifying units.

The following physical parameters were recorded for each sampled unit: pool type, length, average width, maximum depth, cover rating, instream shelter, and woody debris. In reaches where coho were observed, surveyors were instructed to obtain photographic documentation of coho presence.

Data from paper field data sheets was entered into the *Microsoft Access* database provided by CDFW. QA/QC checks were completed based on procedures provided by CDFW staff, and the completed database was transferred to Justin Garwood and Seth Ricker of CDFW.

Data analysis – occupancy and spatial structure

Population spatial structure was assessed by using detection probabilities from the independent double-pass dives to calculate the probability of species occupancy at the sample unit and sample reach scale. These calculations were completed by Justin Garwood of CDFW, and are described below:

> "We used the single-season multi-method approach in program PRESENCE (USGS 2013) to calculate estimates of occupancy (ψ), estimates of conditional occupancy (θ), and detection probability (p) of each species and age class category. We assumed p was constant in pools between the two snorkel passes. The proportion of area occupied was determined by simply multiplying the two occupancy parameters ($\psi * \theta$). " (Garwood and Larson 2014)

Estimate of coho abundance

The use of data collected under this protocol to make watershed-level juvenile coho abundance estimates incorporating detection probabilities and within- and between-reach

variance has not yet been completed, but is under development (J. Garwood, pers com. January 2015).

With the highly skewed dataset and a majority of reaches with no coho presence, accounting for between-reach variance and developing a confidence interval would require the use of a bootstrapping technique, which is beyond the scope of this report. To develop an idea of how many juvenile coho were in the watershed in 2013 and 2014, we calculated a simple watershed-wide "abundance" estimate that does not incorporate detection probability nor provide a confidence interval.

$$\textit{Estimated abundance} = \textit{Sum of coho observed (single dive pass)} * 2 * \frac{100}{\textit{Percentage of total frame length surveyed}}$$

The total number of coho observed was multiplied by two since only every other qualifying unit was sampled.

The estimate of juvenile abundance was then used to back-calculate a potential number of spawning adults by using egg-parr survival rates and estimates of eggs/female from the Pudding Creek life-cycle monitoring station on the Mendocino Coast (Gallagher et al. 2013), the watershed nearest the Mattole for which egg-parr survival has been calculated. The average high and low bounds of the 95% confidence interval of egg-parr survival from brood years 2006-2011 were used to estimate a potential high and low count of female spawners.

Coho distribution 1980-2014

To compare the spatial extent of coho distribution to prior years, we assembled the presence/absence information compiled by Garwood (2012a, 2012b) by survey reach, and added 2013 and 2014 data both from the surveys reported in this report and detections from incidental dives and the summer steelhead census conducted by the Mattole Salmon Group. We coded presence by natal or non-natal use when sufficient information was available to make that determination. No presence/absence data prior to 2013 was collected using a random-sampling scheme, and sampling methodology included electrofishing and snorkeling. With few exceptions, surveys were less spatially extensive within reaches than those implemented in 2013-2014.

Data analysis – coho presence and habitat values

We performed some cursory analysis of habitat data to examine the following questions:

- Are there differences in habitat characteristics between reaches with and without coho presence?
- In reaches with coho, are there differences in habitat between pools with and without coho occupancy?

Data from the "large river" reaches was not used due to the differences in criteria for a qualifying unit, particularly the requirement that the unit must contain cover.

Most habitat data was non-normally distributed, commonly with a preponderance of small values (positively skewed). We used the Wilcoxon rank-sum test (also known as the Mann-Whitney test), the non-parametric equivalent of the t-test, to test the hypothesis that there was no difference between habitat values in reaches with and without coho presence.

Reach median values of unit depth, cover rating, cover area, LWD count, pool area, and the percentage of pool area with cover, and reach mean temperature values were used in this comparison. Basin area at the downstream end of the reach, and stream distance to the ocean, as well as reach-averaged intrinsic potential (Agrawal et al. 2005) were also included.

In comparing habitat between units with and without coho detections, within reaches with coho presence at the reach-level, we excluded data from the five reaches where only a single coho was detected - 310, 453, 733, 911, and 939.

In order to account for the compounding probability of Type I error with the use of multiple tests, we applied Bonferroni's adjustment to the p-value that would be considered significant at the 95% confidence level. Bonferroni's adjustment is α/p, where p is the number of variables, so for the comparison between reaches $0.05/10=0.005$, and for the comparison between unit values $0.05/6=0.008$.

Results

Reaches surveyed

One hundred sixty four landowners were contacted for stream access permission. Half of them, 82, gave permission, while 77 did not respond, or we were unable to find a valid address or phone number to reach them. Five landowners, 3% of those contacted, replied and denied access permission.

By the end of the 2014 survey season all reaches in the sample frame where access was granted had been surveyed (Figure 1). Out of a total of 94 reaches in the Mattole sample frame, 64 reaches were surveyed, 68% of the possible reaches (Table 1). In 2013 27 reaches were surveyed, and 37 in 2014. A total of 182.5 km of stream were surveyed, 72% of the total length in the frame. Private property access was not obtained to 56 km of the sample frame. Reach-by-reach lengths surveyed are noted in Appendix A.

Table 1. Summary to number of reaches and reach length surveyed by year.

Year	# of reaches surveyed	Length surveyed (km)	# of units surveyed	% of reaches in frame surveyed	% of frame surveyed by length
2013	27	83.8	588	29%	33%
2014	37	98.7	716	39%	39%

Revisions to sample frame

Following the survey season, we made several revisions to the sample frame, based in part on survey observations. On closer inspection of GIS-modeled stream slope we noticed four reaches where over half the reach had a maximum gradient >5%, exceeding the threshold in Garwood and Ricker (2008) for inclusion in a coho salmon spawning frame. Field inspection confirmed that these reaches were steep, step-pool dominated streams, with little or no potential coho habitat, and these reaches were removed from the coho salmon spawner and juvenile frames. We added the furthest-downstream reach on the mainstem Mattole, and surveyed it as an incidental reach in 2014. These changes are detailed in Appendix B. We anticipate final refinement of the juvenile survey frame in spring of 2015 following consultation with Seth Ricker of CDFW.

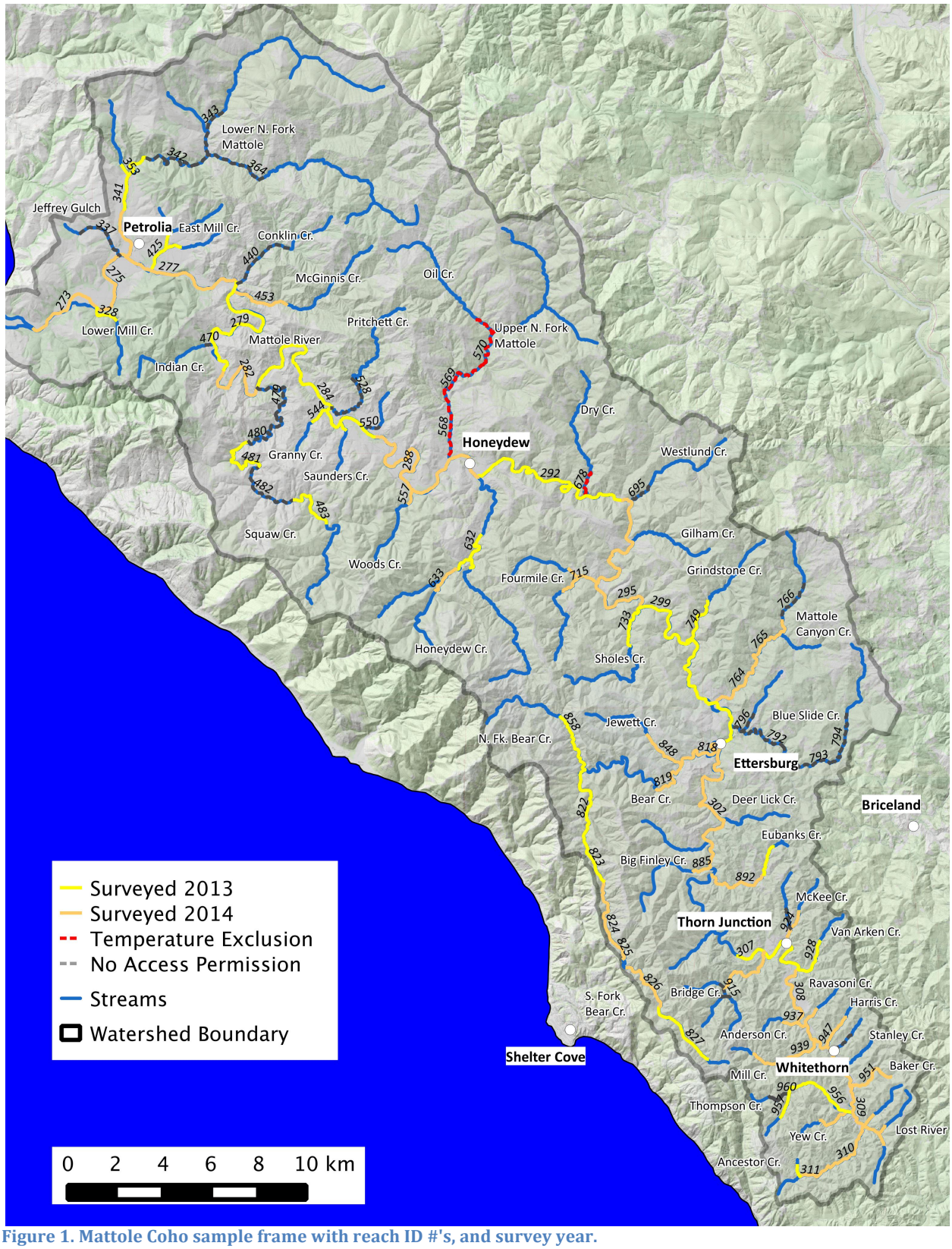

Figure 1. Mattole Coho sample frame with reach ID #'s, and survey year.

Coho salmon occupancy and distribution

The calculated percent area occupied (PAO), the product of reach and pool-level occupancy probabilities, was the same in both 2013 and 2014, 0.13. The probability of reach-level occupancy, **Ψ,** was slightly greater in 2014 than in 2013, while **Θ**, the probability of coho detection in a given pool in a reach where coho were present, was lower in 2014 than in 2013. Coho were seen in 97 units in 2013 and 95 in 2014. Coho were present in a greater proportion of reaches in 2014 than 2013, but within those reaches presence was patchier. This was likely a contributing factor to the lower detection probability, ***p,*** in 2014 (0.68) versus 2013 **(**0.86)(Table 2).

Among the seven reaches with coho detected in 2013, detections were concentrated in the Mattole headwaters region in the extreme southern portion of the basin, specifically Thompson Creek and Ancestor Creek (Table 3, Figure 2). Incidental dives in Baker Creek reach #951 and reach #309 in the mainstem Mattole, not reported elsewhere in this report, also detected coho in numbers and distribution similar to those observed in Thompson and Ancestor Creeks. These three streams in addition to Squaw Creek appeared to be the only streams snorkeled where spawning occurred the previous winter. Coho were observed throughout mainstem reach #307, but in very low abundance (Table 3). The only other coho detections were single coho downstream of Ettersburg - one in the mainstem Mattole and one in Sholes Creek.

In 2014 coho were observed in 12 reaches - in the mainstem Mattole in all reaches surveyed from Ettersburg upstream, Bear Creek, Baker Creek in the Mattole headwaters, plus single fish in Upper Mill Creek, Bridge Creek, and McGinnis Creek (Table 4, Figure 2. All units surveyed and coho detections, 2013-14. No YOY were observed in reach #311, only 1+ fish, and there was also spatial segregation in Baker Creek of yoy and 1+ fish, with no YOY upstream of the county road culvert. While fish were distributed throughout mainstem reaches 309, 308, and 302, densities were very low and fish absent from over half the units surveyed except near the upstream end of reach 309, presumably proximal to the location of successful spawning activity (Table 4, Figure 2. All units surveyed and coho detections, 2013-14. Ninety-seven coho, nearly 15% of the total observations, were counted in a single pool in reach #309.

We documented coho parr in two reaches where they had not previously been detected, the mainstem Mattole in reach 299 just upstream of the mouth of Mattole Canyon Creek, and in McGinnis Creek approximately 2 km upstream of the stream mouth. After reaching the end of the reach and observing no other coho, divers dove the “skip” pools upstream and downstream of where the individual was seen, but did not see any additional coho. We think it is most likely that this fish immigrated upstream from the mainstem. While the maximum documented upstream movement of coho parr we were able to find in the literature was ~0.5 km (Bolton et al. 2002), in the last few years pit-tagged coho parr have been observed moving upstream >10 km in the Scott and Shasta Rivers (Chris Adams, CDFW, Yreka, CA, pers. comm., January 2015)

In contrast, we believe that the three fish in a single pool near the downstream end of Squaw Creek reach #481, 6 km upstream of the mouth of that stream, were likely natal fish, and indication of successful spawning in that stream. Squaw Creek is a much larger stream than McGinnis with some high-gradient riffles that would presumably make upstream movement more difficult. Unfortunately we were unable to dive more than two pools downstream of this detection due to a lack of private property access.

Chinook and steelhead occupancy

Juvenile *O. mykiss* were present and relatively abundant in every reach and nearly every unit surveyed in both 2013 and 2014 (Table 2). In 2014, it appeared that steelhead spawning distribution had been slightly truncated by the lack of stormflows the previous winter, as YOY steelhead were absent from the upstream portions of some of the smaller stream reaches, including Lost River, Helen Barnum Creek, and Baker Creek

Chinook were present in ten reaches in 2013, and five in 2014, with PAO of 0.10 and 0.04, respectively (Table 2). Rarely were more than a one or two Chinook observed in a unit. In 2013 they were most prevalent in South Fork Bear Creek reaches #822 and 823, and in the Mattole headwaters, especially mainstem reach #307, where counts in some pools exceeded 20 individuals (Figure 3, Table 3).

Distribution was much more restricted in 2014, due to spawning distribution limited by the lack of winter rainfall (Table 4, Figure 3). No Chinook were observed upstream of reach 302 in the mainstem Mattole and reach 819 in Bear Creek. All detections were in mainstem reaches except for these in Bear Creek.

Estimate of coho abundance

In 2013 the sum of all coho observed was 507 (Table 3) with 33% of the total reach length in the sample frame surveyed, yielding a basin wide abundance estimate of 3,072 coho parr. In 2014 655 coho juveniles were observed (Table 4), and 39% of the total reach length was surveyed, yielding a basin wide abundance estimate of 3,358 coho juveniles.

In 2014, 99 juvenile coho, 15% of all coho observed, were judged to be 1+ fish. Making separate estimates for YOY and 1+ coho in 2014 results in estimates of 2,851 and 507 fish, respectively.

Fifteen percent is a high percentage of 1+ fish. Using our "abundance" estimate from 2013 of the total number of coho parr, ~17% of these fish remained in freshwater as 1+ fish. There was clear spatial segregation between yoy and 1+ fish. No yoy were observed mainstem Mattole reaches #310 and 311, only 1+ fish, and there was also spatial segregation in Baker Creek of yoy and 1+ fish, with no YOY upstream of the county road culvert. Lack of rainfall and flows for spawning passage the previous year were responsible for the truncated upstream distribution of YOY, and some combination of factors leading to high survival but slow growth - high rearing densities, low summer and winter flows, cold winter temperatures - probably accounted for the high number of 1+ coho in 2014.

Table 2. Occupancy estimates by salmonid species, Mattole River basin, 2013-2014. Calculations completed by J. Garwood.

Species and Year	Psi	SE	95% CI	Theta	SE	95% CI	*p*	SE	95% CI	PAO	# of Reaches present	Mean pool count	Median pool count
Coho salmon 2013	0.31	0.10	0.15 - 0.52	0.43	0.03	0.36 - 0.50	0.86	0.03	0.80 - 0.91	0.13	7 of 24*	5.7	4
Coho salmon 2014	0.35	0.08	0.21 - 0.53	0.37	0.05	0.28 - 0.46	0.68	0.07	0.53 - 0.80	0.13	12 of 37	10.3	4
Chinook Salmon 2013	0.47	0.11	0.27 - 0.68	0.22	0.03	0.17 - 0.28	0.71	0.06	0.58 - 0.81	0.10	10 of 25	3.4	1
Chinook Salmon 2014	0.15	0.06	0.06 - 0.30	0.29	0.08	0.15 - 0.47	0.79	0.11	0.50 - 0.94	0.04	5 of 37	2.1	2
YOY *O. mykiss* 2013	1.00	–	–	0.95	0.01	0.93 - 0.97	0.98	<0.01	0.97- 0.99	0.95	25 of 25	27.2	15
YOY *O. mykiss* 2014	1.00	–	–	0.82	0.02	0.78 - 0.85	0.97	<0.01	0.95 - 0.98	0.82	37 of 37	44.8	23
1+ *O. mykiss* 2013	1.00	–	–	0.94	0.01	0.91-0.95	0.93	0.01	0.91 - 0.95	0.93	25 of 25	10.7	6
1+ *O. mykiss* 2014	0.92	0.04	0.78 - 0.98	0.76	0.03	0.70 - 0.81	0.79	0.03	0.73 - 0.84	0.73	34 of 37	4.8	3

Psi Ψ- The probability a species is detected in a given reach for the survey year.

Theta-**Θ** Conditional occupancy - the probability a species is detected in a given sample pool conditional to the species being present in the reach for the survey year.

p-Individual species detection probability if present in a given sample pool.

PAO-Proportion of area occupied. (PSI * Theta) Overall occupancy value; incorporates reach-level- and pool-level occupancy for the entire sample frame in a given year

*Reach #827 in South Fork Bear Creek was excluded from this calculation because coho had previously been relocated to the stream from Baker Creek, as a result of a habitat restoration project in that stream. Based on the location and number of fish observed in reach #827, we feel that all coho observed in this reach in 2013 were relocated fish

Table 3. Drainage area, length surveyed, # of units surveyed, and coho occupancy and Chinook presence by reach, 2013

Reach ID	Stream Name	Drainage area km^2	Length surveyed (m)	# of units in reach	# of units occupied by coho	Total # coho observed **	Mean coho unit count	Suspected coho rearing type	Chinook presence
279	Mattole River	616.6	8084	0	---	---	---		
284	Mattole River	522.4	10821	2	0	0	---		yes
292	Mattole River	357.1	9421	0	---	---	---		
299	Mattole River	261.9	10733	2	1	1	1	non-natal	
307	Mattole River	79.4	4867	24	8	10	1.3	non-natal	yes
341	Lower N. Fork Mattole	94.9	2152	4	0	0	---		
353	Grizzly Creek	5.4	520	4	0	0	---		
425	East Mill Creek	7.4	1238	23	0	0	---		
428	East Mill Creek, S. Branch	2.1	794	3	0	0	---		
481	Squaw Creek	37.0	2130	14	1	3	3	natal	yes
483	Squaw Creek	18.9	2417	21	0	0	---		
544	Granny Creek	2.4	914	5	0	0	---		yes
548	Saunders Creek	2.2	311	5	0	0	---		yes
632	Honeydew Creek	33.8	2539	11	0	0	---		yes
641	Honeydew Creek, Lower E. Fork	13.5	583	7	0	0	---		
733	Sholes Creek	10.5	2270	31	1	1	1	non-natal	yes
749	Grindstone Creek	9.9	2370	26	0	0	---		
822	S. Fork Bear Creek	22	2758	26	0	0	---		yes
823	S. Fork Bear Creek	15.3	2986	22	0	0	---		yes
827	S. Fork Bear Creek	4.0	3522	102	7	20	2.9	non-natal*	
858	N. Fork Bear Creek	13.4	2990	21	0	0	---		
893	Eubanks Creek	3.8	1178	14	0	0	---		
928	Van Arken Creek	5.2	1926	35	0	0	---		
956	Thompson Creek	9.5	3565	79	53	249	4.7	natal	yes
957	Thompson Creek	2.3	1120	46	8	10	1.3	natal	yes
972	Ancestor Creek	2.6	449	18	18	213	11.8	natal	
Totals				545	97	507			

**Coho observed in reach #827 were relocated there from Baker Creek due to de-watering associated with a restoration project.*

***In double-dive pass units, the maximum count was used.*

Table 4. Drainage area, length surveyed, # of units surveyed, and coho occupancy and Chinook presence by reach, 2014.

Reach ID	Stream Name	Drainage area km^2	Length surveyed (m)	# of units in reach	# of units occupied by coho	Total # coho observed**	Mean coho unit count	Suspected coho rearing type	Chinook presence
273	Mattole River	762.5	3990	11	0	0			yes
275	Mattole River	748.0	4701	10	0	0			yes
277	Mattole River	633.8	4609	5	0	0			yes
282	Mattole River	572.4	4192	2	0	0			yes
288	Mattole River	490.4	10534	13	0	0			
302	Mattole River	126.1	8549	10	4	24	6.0	natal?	yes
308	Mattole River	52.3	6351	41	12	32	2.7	non-natal	
309	Mattole River	30.3	3828	34	26	290	11.2	natal	
310	Mattole River	9.3	2430	43	1	1	1.0	*natal	
311	Mattole River	5.8	2013	27	9	14	1.6	*natal	
328	Lower Mill Creek	5.4	1152	36	0	0			
340	Lower N. Fork Mattole	97.6	1900	5	0	0			
453	McGinnis Creek	15.6	2516	18	1	1	1.0	non-natal	
557	Woods Creek	5.1	180	1	0	0			
633	Honeydew Creek	17.9	1528	12	0	0			
715	Fourmile Creek	14.1	2067	13	0	0			
718	Fourmile Creek, N. Fork	4.6	614	8	0	0			
764	Mattole Canyon Creek	26.8	490	4	0	0			
765	Mattole Canyon Creek	24.2	2868	31	0	0			
818	Bear Creek	55.4	3392	10	5	46	9.2	natal	
819	Bear Creek	45.3	2154	9	4	7	1.8	natal	yes
824	Bear Creek, S. Fork	11.9	2795	27	0	0			
825	Bear Creek, S. Fork	9.1	1323	17	0	0			
826	Bear Creek, S. Fork	6.7	2717	32	0	0			
848	Jewett Creek	6.1	2135	17	0	0			
885	Big Finley Creek	8.2	638	5	0	0			
892	Eubanks Creek	8.9	1500	30	0	0			
911	Bridge Creek	11.1	2400	18	1	1	1.0	non-natal	
924	McKee Creek	5.4	970	15	0	0			
925	McKee Creek	2.4	217	8	0	0			
937	Anderson Creek	1.8	732	20	0	0			
938	Ravishoni (E. Anderson)	1.8	290	4	0	0			
939	Upper Mill Creek	6	1598	30	1	1	1.0	non-natal	
947	Harris Creek	2.5	480	13	0	0			
951	Baker Creek	4	2359	73	27	228	8.4	natal	
958	Yew Creek	2.4	1565	35	4	10	2.5	natal	
963	Lost River	5.1	1300	28	0	0			
964	Helen Barnum Creek	1.6	557	17	0	0			
965	Lost River, S. Fork	1.8	502	17	0	0			
Totals				749	95	655			

**Coho observed in reach #'s 310 and 311 were exclusively 1+ fish, as were 84 of the coho observed in reach #951.*
***In double-dive pass units, the maximum count was used*

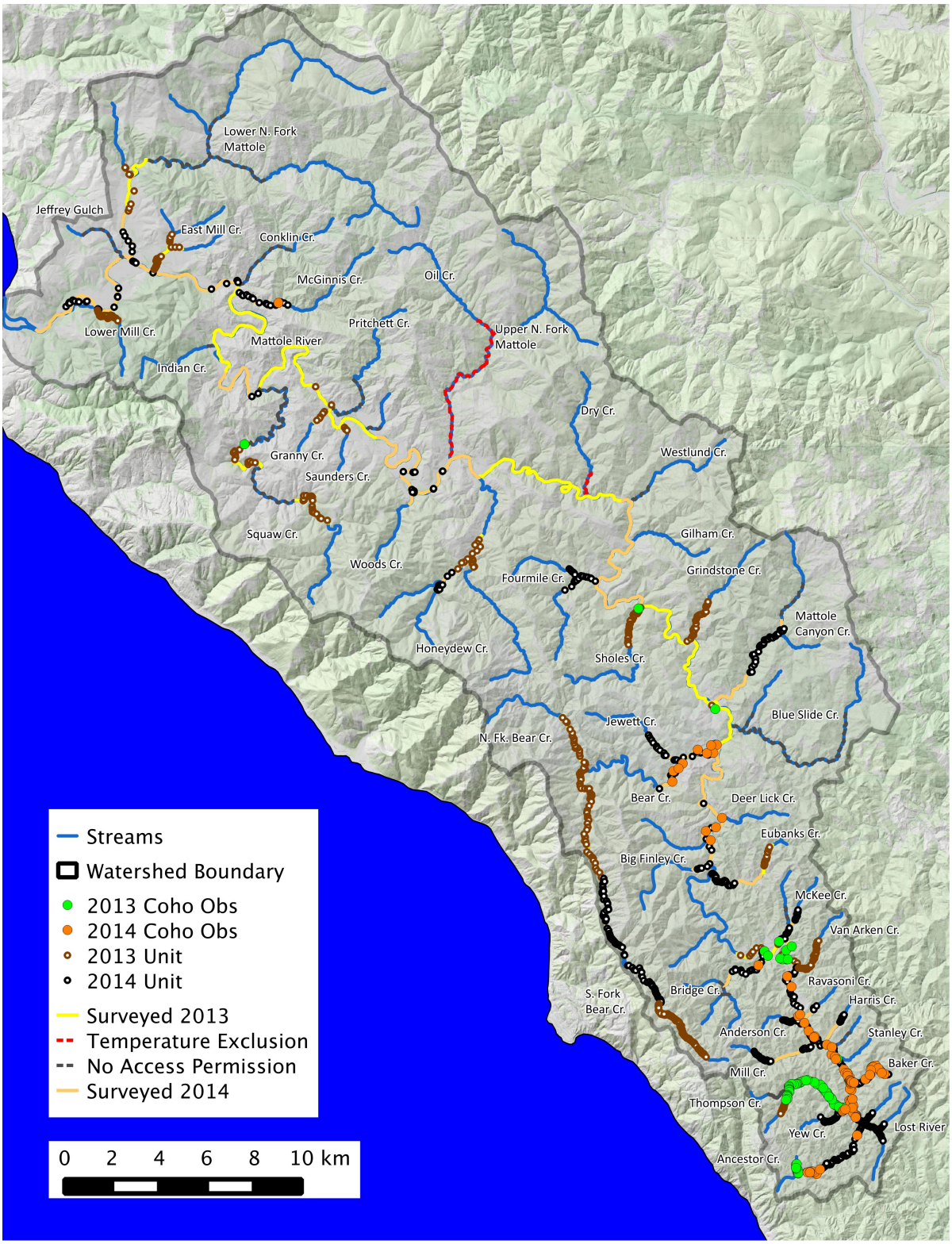

Figure 2. All units surveyed and coho detections, 2013-14.

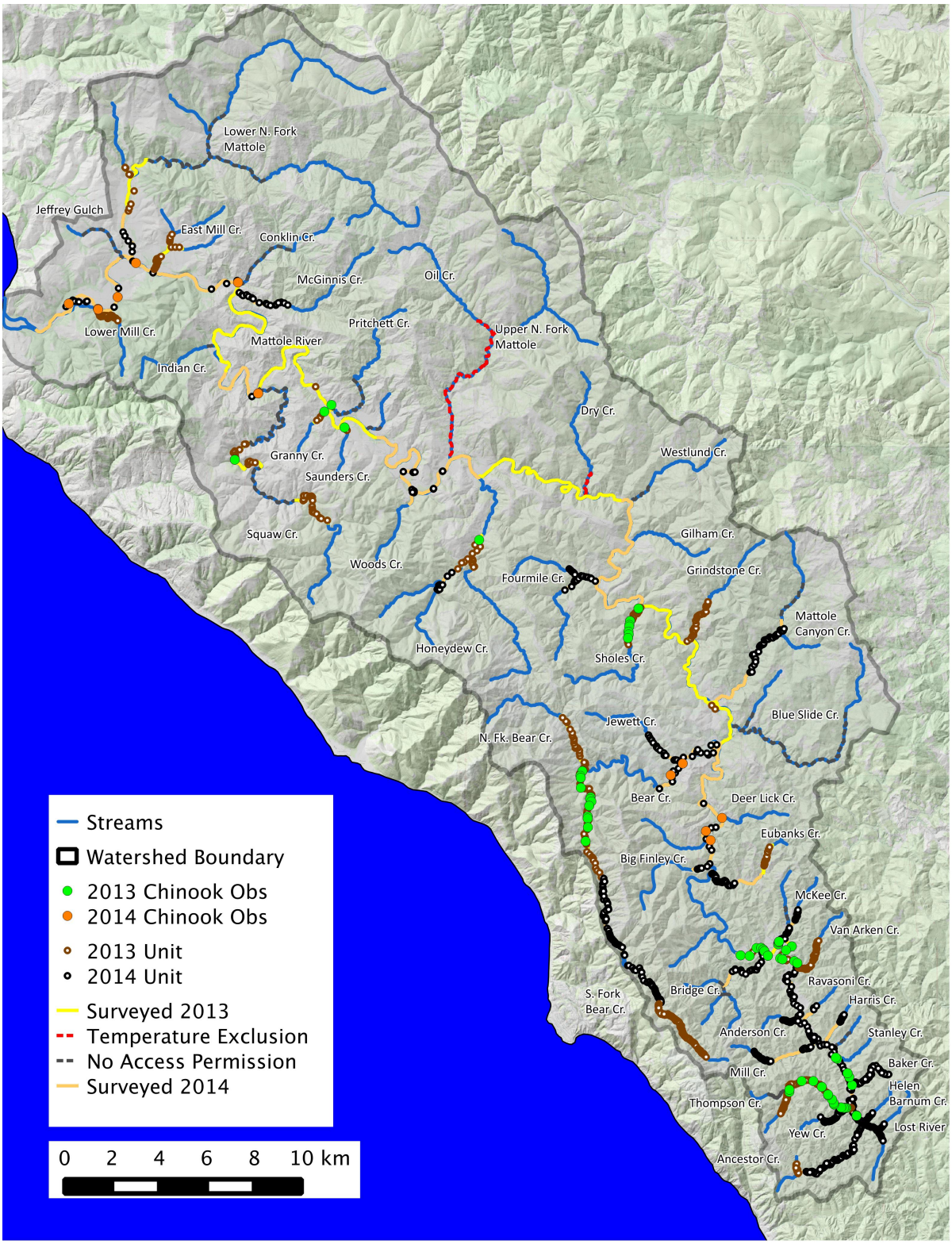

Figure 3. All units surveyed and Chinook detections 2013-14.

Back-calculation of spawner abundance, and estimated adult returns.

Applying the egg-parr survival values (0.053-0.285) and estimated mean number of eggs/female (2621) from the Pudding Creek LCM station (Gallagher et al. 2013) to the above juvenile abundance estimates results in an estimate of 4.5-24 spawning females in 2012-2013, and 3.8-20.4 in brood year 2013.

Mean coho redd abundance in the Mattole for 2012-13 estimated from redd surveys was 39 (95% conf. interval 6-72) (Ricker et al. 2014a).

Applying over-winter survival and smolt-to-adult return rates from Freshwater Creek (Ricker et al. 2014b) and the Mendocino Coast (Gallagher et al. 2013) to the juvenile abundance estimate results in an estimated return of 3 to 98 adults (using Freshwater Ck survival rates) or 3 to 479 adults (using Mendocino Coast survival estimates).

Coho distribution 1980-2014

Over the past 25 years survey effort for coho presence/absence has varied substantially, with annual spatial coverage ranging from 0-45 reaches (Table 5). The proportion of reaches with coho presence in 2013 and 2014, 0.38 in both years, was below the mean for all 25 years but within the range (mean=0.52, range 0.25-1.00). In many of the years with a very high percentage of reaches with presence very few reaches were surveyed.

Reaches 308, 309, and 310 on the upper mainstem Mattole and reach 956 in Thompson Creek (which joins the mainstem in reach 309) are notable for having coho presence every year surveyed, and having been surveyed more than half the years in the dataset. Coho presence, as well as survey effort, has been less consistent downstream of Bridge Creek, and most coho detections in this portion of the watershed appear to have been non-natal fish (Table 5). Given the differences in reach selection and sampling methodology among years it seems difficult to draw any further conclusions about trends or changes in distribution over the time period.

Other biological observations of note

In 2013 a single red-legged frog *(Rana aurora)* was observed by surveyors in reach #353,, Grizzly Creek. Species identification was confirmed by Hartwell Welsh of the USFS Redwood Sciences Lab, from photographs taken by the surveyors. This was the first confirmed sighting of *R. aurora* in the Mattole in decades.

In 2014 multiple Pacific lamprey redds were observed in reaches in Mattole Canyon Creek and Bear Creek, and reaches 302, 308, and 309 in the mainstem Mattole. Lamprey carcasses and live lamprey were also observed in reach #308.

Table 5. Presence of coho salmon juveniles by survey reach, 1980-2014. Data from 1980-2011 from Garwood (2012a and 2012b).

Reach ID #	Stream	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	# yrs surveyed	# yrs present	% yrs present
273*	Mattole River																																			0			-
275*	Mattole River																									1			2	2						3			-
277*	Mattole River																																			0			-
279*	Mattole River																																						-
282*	Mattole River																																			0			-
284*	Mattole River																									1									0				-
288*	Mattole River																																			0			-
292*	Mattole River																																						-
295*	Mattole River																																						-
299*	Mattole River																																		3				-
302	Mattole River																								1		1		0	0	0	1			3	3	8	5	63%
307	Mattole River																				0	1	1	1	1		3	0	1	1	0	0	0	1	3		14	9	64%
308	Mattole River																					2	1		2	1	2	1	1	1	1	3	3	1	2	3	14	14	100%
309	Mattole River																				1	1	1	2	2	2	2	2	1	1	1	3	1	1	2	2	16	16	100%
310	Mattole River																				1	1	2	2	2	2	2	2	1	2	2	1	1	1	1	1	16	16	100%
311	Mattole River																				1	2	1	2		1				1	0	1	2	2		1	11	10	91%
328	Lower Mill Creek					1	1		1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	1			3	3	3	0		0		0	0	26	19	73%
337	Jeffry Gulch																																				0	0	-
340	North Fork Mattole											0	0	0	0	0	0	0	0	0	0		0	0	0			0	0	0	0					0	18	0	0%
341	North Fork Mattole																																		0		1	0	0%
342	North Fork Mattole																																				0	0	-
343	North Fork Mattole																																				0	0	-

Reach ID #	Stream	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	# yrs surveyed	# yrs present	% yrs present
353	Grizzly Creek																																		0		1	0	0%
364	East Branch North Fork Mattole River																			0																	1	0	0%
425	East Mill Creek			0												0				0		0	1	0	1	3		3	0	0	0		0		0		14	4	29%
428	South Branch, East Mill Creek																																		0		1	0	0%
440	Conklin Creek						0							0				0	0		0	0		0	0			0	0								10	0	0%
453	McGinnis Creek																						0	0	0			0	0	0						3	7	1	14%
470	Indian Creek		0	1																			0	0													4	1	25%
479	Squaw Creek		1	1			0					0	0	0	0	0	0	0	0	0	0	0	0	0	1			2	0	0	0	0	0		0		24	4	17%
480	Squaw Creek																																				0	0	-
481	Squaw Creek																																		2		1	1	100%
482	Squaw Creek																																				0	0	-
483	Squaw Creek																															0			0		2	0	0%
528	Pritchard Creek																							0	0												2	0	0%
544	Granny Creek																						0	0	0										0		4	0	0%
548	Saunders Creek																						0	0	0			0							0		5	0	0%
550	Lindley Creek																																				0	0	-
557	Woods Creek																				0		1	0	0			3	0	1	0	0				0	10	3	30%
568	Upper North Fork Mattole River												0	0	0	0		0	0	0	0	0															9	0	0%
569	Upper North Fork Mattole River																											0	0	0	0		0				5	0	0%
570	Upper North Fork																																				0	0	-

Reach ID #	Stream	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	# yrs surveyed	# yrs present	% yrs present
	Mattole River																																						
593	Oil Creek												0	0	0	0	0			0			0	0	0				0								10	0	0%
632	Honeydew Creek		0	0													0	0	0	0	0	0	1	0	0			0	0	0	0			0		16	1	6%
633	Honeydew Creek																																			0	1	0	0%
641	East Fork Honeydew Creek		0																	0	0								0	0	0				0		7	0	0%
678	Dry Creek																					0	0	0													3	0	0%
695	Westlund Creek																			0	1	0	0	0	0												6	1	17%
715	Fourmile Creek																			0			1	0	0				1	0	0	0				0	9	2	22%
718	N. Fork Fourmile																			0																0	2	0	0%
733	Sholes Creek																						1	0	0				0	0	0				1		7	2	29%
749	Grindstone Creek			0																0		0	1	0	0				0		0				0		9	1	11%
764	Mattole Canyon			0											0			0	0	0	0		0	0	0											0	10	0	0%
765	Mattole Canyon																													0	0					0	3	0	0%
766	Mattole Canyon																																				0	0	-
792	Blue Slide Creek																	0	0	0	0	0	0	1	1				0								9	2	22%
793	Blue Slide Creek																																				0	0	-
794	Blue Slide Creek																																				0	0	-
796	Crooked Prairie																																				0	0	-
818	Bear Creek			0								0					0	1	1	1	0	1	0	1	0				0	0	0	0				2	16	6	38%
819	Bear Creek																																			2	1	1	100%
822	South Fork Bear Creek																																		0		1	0	0%
823	South Fork Bear Creek																												0	0	0				0		4	0	0%
824	South Fork Bear Creek																																			0	1	0	0%
825	South Fork Bear Creek																																			0	1	0	0%

Reach ID #	Stream	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	# yrs surveyed	# yrs present	% yrs present
826	South Fork Bear Creek																																			0	1	0	0%
827	South Fork Bear Creek								0	1	1	0	1	0	0		0	0	1	1	1	1	0	0	1							0			0		18	8	44%
848	Jewett Creek		0															0											0						0	4	0	0%
858	North Fork Bear Creek									1	1	1						0	0		0	0								0	0				0		10	3	30%
877	Deer Lick																												0								1	0	0%
885	Big Finley Creek			0												1	1			1	1			0	0				1	0	0	0	1			0	13	6	46%
892	Eubank Creek			1												1	1	0	0	0	1	0		1	0				0	0	0	0				0	15	5	33%
893	Eubank Creek																																		0		1	0	0%
911	Bridge Creek	0	0	0							0	0	0		0			1	0	1	1	0	1	2	2	1			0	1	0	0	1			3	22	10	45%
912	W. Fork Bridge Creek																		0		0	0	1	2	2							0	1				8	4	50%
915	Bridge Creek																							2	2	1						0	2				5	4	80%
916	Bridge Creek																																				0	0	-
924	McKee Creek		1	1													0	0			0	1	0	1	1				1	0	0	0				0	14	6	43%
925	McKee Creek																																			0	1	0	0%
926	Painter Creek		0																																		1	0	0%
928	Vanauken Creek			0						1	0					0	0	0	0	0	0	3	0	1	1				1	0	0	0	0		0		19	5	26%
937	Anderson Creek															0		1						0	0					0						0	6	1	17%
938	E. Anderson																						1	1												0	3	2	67%
939	Mill Creek			1											0			0			0	0	1	2	2	2			0	1	1	0	0			3	15	8	53%
947	Harris Creek		0	0																																0	3	0	0%
948	Gibson Creek																						0														1	0	0%
	Stanley Creek			1																	0																2	1	50%
951	Baker Creek			1					1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	2	2	2			2	2	2	0	0		2	2	26	23	88%
956	Thompson Creek		1					1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	2	2	2			2	2	2	2	2	2	2	2	28	28	100%

Reach ID #	Stream	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	# yrs surveyed	# yrs present	% yrs present
957	Thompson Creek																							2	2	2						2	2		3		6	6	100%
958	Yew Creek			0				1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	2	2	2			2	2	2	0	0		0	2	27	23	85%
960	Danny's Creek																		0	1	0	1	0	2	2	2						1	2				10	7	70%
963	Lost River														0				1	1	1			2	2	2			1	1	0		0			0	12	8	67%
964	Helen Barnum							0							0			0						1	1	1			0				0			0	9	3	33%
965	S Fork Lost																							2	0											0	3	1	33%
972	Ancestor Creek						1	1								0	0		0					2	2	2			2	2	2	2	1		2	2	15	12	80%
	# Reaches Surveyed	1	10	17	0	1	4	4	5	7	8	10	10	10	14	14	15	22	21	26	31	28	36	45	43	16	5	14	36	33	32	26	23	6	32	40			
	# Reaches Coho Present	0	3	7	0	1	2	3	4	7	6	5	5	4	4	6	6	7	7	10	13	12	18	23	24	16	5	7	14	14	8	9	12	6	12	15			
	Proportion reach occupancy	0.00	0.30	0.41		1.00	0.50	0.75	0.80	1.00	0.75	0.50	0.50	0.40	0.29	0.43	0.40	0.32	0.33	0.38	0.42	0.43	0.50	0.51	0.56	1.00	1.00	0.50	0.39	0.42	0.25	0.35	0.52	1.00	0.38	0.38			**Mean= 0.52**

0=coho not detected, 1=coho present, unclear if natal or non-natal; 2=present, suspected natal; 3=present, suspected non-natal

*Did not display non-detections prior to 2013, due to differing methodology. Most pre-2013 surveys of these large mainstem reaches have targeted other species, such as summer steelhead, and divers were not necessarily seeking out likely coho habitat.

Habitat measurements and coho presence

Median values of unit depth, cover rating, cover area, LWD counts, and pool area were all higher in reaches where coho were detected (Table 6). Reaches with coho presence were in larger drainages, with higher intrinsic potential, and further from the ocean in stream network distance. Temperatures between reaches with and without coho were very similar, as were values of cover area as a percentage of pool area. While the difference in cover area was the only one significant at 95% confidence (p=***0.0014***), examination of the distribution of values seems to suggest that there are other real differences, especially in the upper 50th percentile of unit depth, pool area, and basin area (Figure 4).

Comparing units with and without coho within reaches with coho presence, values of unit depth, cover rating and area, LWD counts, and pool area were also all higher in pools with coho (Table 7). There was again no apparent difference in cover area as a percentage of pool area. The largest relative difference between units with and without coho was in unit depth (Figure 5). Habitat measurement values for all reaches are listed in Appendix C and D at the end of this report.

Table 6. Medians of reach median habitat values, grouped by reaches with and without coho detections, and p-values from Wilcoxon rank-sum test.

	Unit Depth (cm)	Cover Rating	Cover Area (m^2)	LWD Count (pieces/ pool)	Pool Area (m^2)	Cover area as % of pool area	Basin Area (km^2)	Intrinsic Potential	Mean °C	Stream KM to ocean
Coho present *(n=18)*	59.5	2.18	2.605	0.54	52.44	0.036	10.8	0.655	15.25	101.5
Coho not detected *(n=36)*	49.46	2.065	1.39	0.3	24.105	0.0495	6.4	0.565	15.3	87.75
p-value	*0.0188*	*0.1469*	***0.0014***	*0.0765*	*0.0150*	*0.5631*	*0.0435*	*0.0484*	*0.6928*	*0.0563*

(bold p-values significant at 0.95 confidence with Bonferroni adjustment)

Table 7. Median habitat values from units with and without coho detections, within reaches where coho were present, and p-values from Wilcoxon rank-sum test.

	Unit Depth (cm)	Cover Rating	Cover Area (m^2)	LWD Count (pieces/ pool)	Pool Area (m^2)	Cover area as % of pool area
Coho present *(n=187)*	73	2.42	5.25	1.26	52.14	0.07
Coho not detected *(n=241)*	56	2.28	3.375	0.76	33.52000041	0.072
p-value	***0.0002***	*0.0415*	***0.0010***	***0.0010***	***0.0073***	*0.7007*

(bold p-values significant at 0.95 confidence with Bonferroni adjustment)

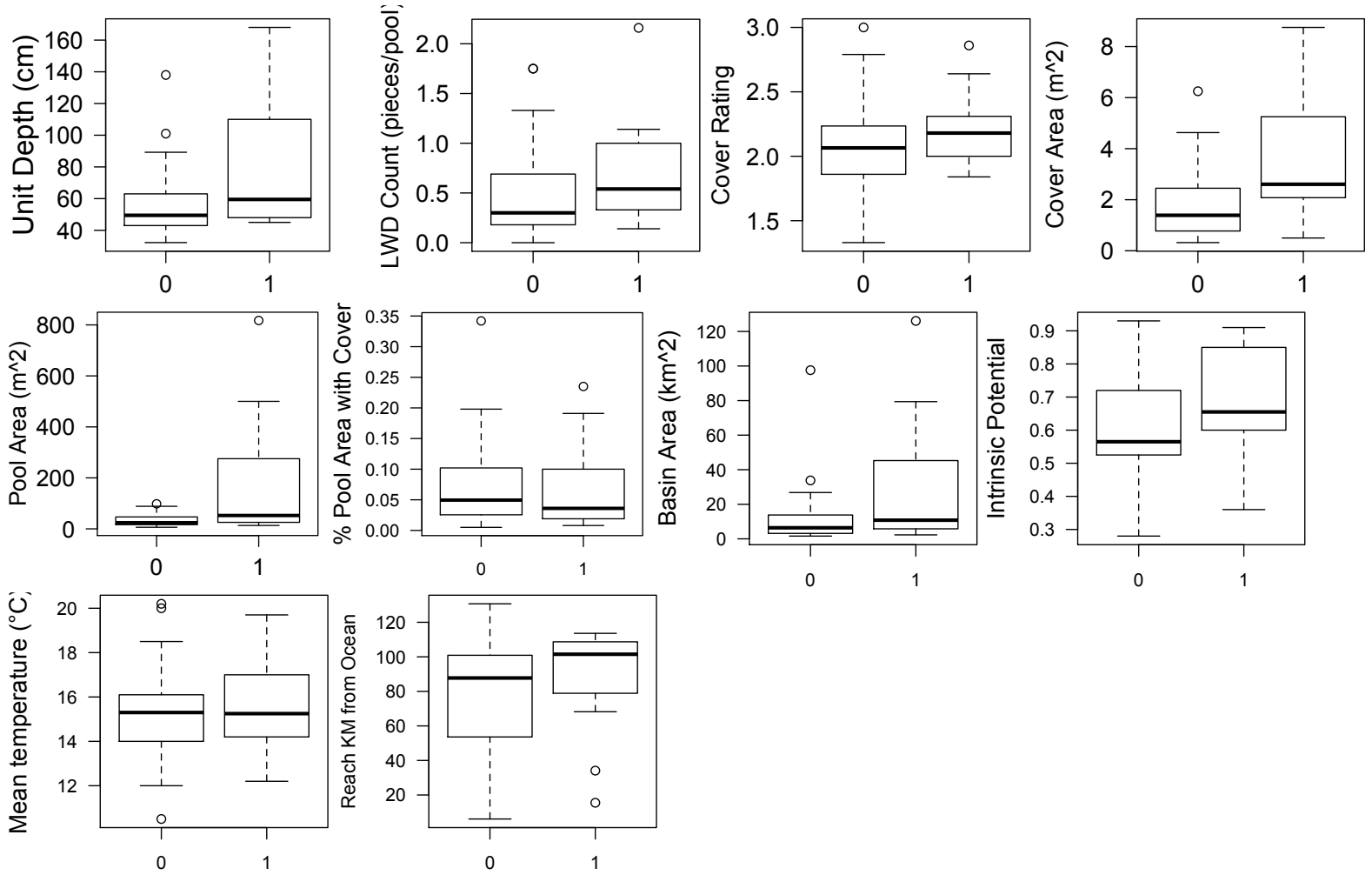

Figure 4. Boxplots comparing habitat values from the 18 stream reaches where coho were observed (1) and 36 reaches where no coho were detected (0) .

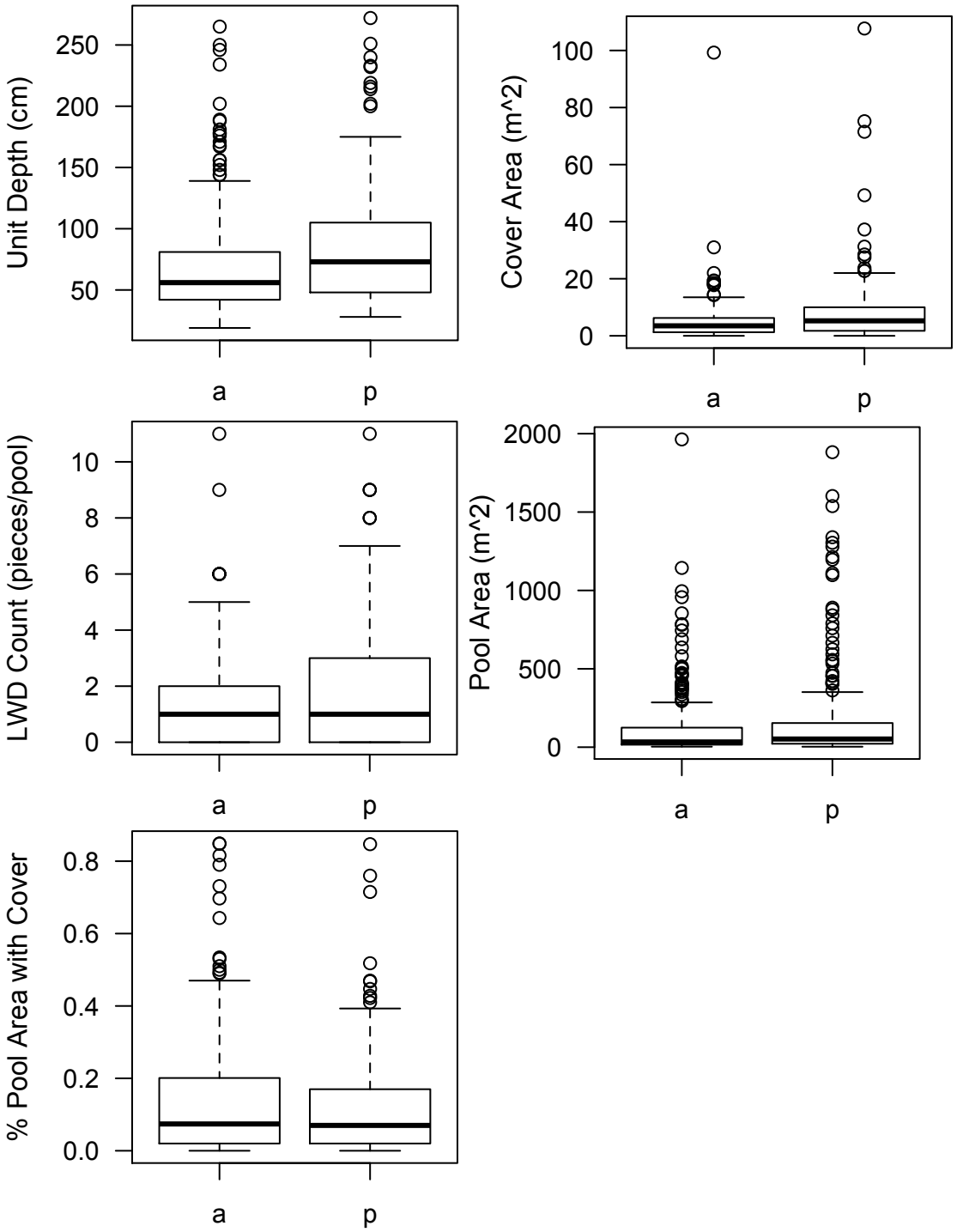

Figure 5. Boxplots comparing habitat values from the units where coho were present (*n=187)* or not detected *(n=241)* from within the 13 reaches where more than one coho was observed.

Occurrence of large river units and fish use

In "large river" reaches, with a mean annual discharge >10 CMS, surveyors found 45 units meeting the depth, temperature, and cover requirements in the 73 km of river from Bear Creek at Ettersburg downstream to tidewater (Figure 6). Three-spine stickleback was the most common species encountered in these units. Juvenile *O. mykiss* were also abundant. Only a single juvenile coho was seen (Figure 6), and Chinook were detected in eight units (Figure 3).

Both Chinook, and qualifying units, were more common in the downstream-most reaches near Petrolia. Coastally moderated air temperatures and the wider river-valley with a more connected floodplain were probably responsible for the increased incidence of qualifying units.

Most units that met the temperature criteria for inclusion (≤21°C) had little or no surface water connection with the mainstem river. Some units appeared to have been disconnected from the main channel for months, and the annual hydrological window for fish to move in and out was likely very short.

Units that were connected to the main channel, were typically the backwater portions of pools or runs that had little mixing with main channel flow, and were cooled by hyporheic inflow coming through the upstream bar. Most units were associated with hyporheic inflow, not discrete springs from an adjacent hillslope or tributary inflow.

In general, it appears that there are more thermally suitable large river units in the Mattole than there are coho juveniles to use them in the summer. Better understanding of the degree to which units are hydrologically connected to the main channel would help our understanding of the potential for fish use of these features, in both summer and winter. We recommend collecting additional data on unit character using a classification scheme such as suggested in Lestelle (2007) or Martens and Connolly (2014).

Streamflows and dry reaches

Surveyors observed multiple dry riffles in the following reaches: Granny Creek 544, Saunders Creek 548, Fourmile Creek 715, North Fork Fourmile 718, Mattole Canyon Creek 764, Van Arken Creek 928, and Baker Creek 951. Coho were present in only one of these streams, Baker Creek. Saunders and Granny Creek are extremely small drainages, and it is unsurprising they would have dry riffles in mid-summer in a low-gradient stretch. Of these seven streams, four– 715, 718, 928, and 951 – have little or no known human water withdrawals in their basins, illustrating the complexity and multiple causes of low flows and stream drying.

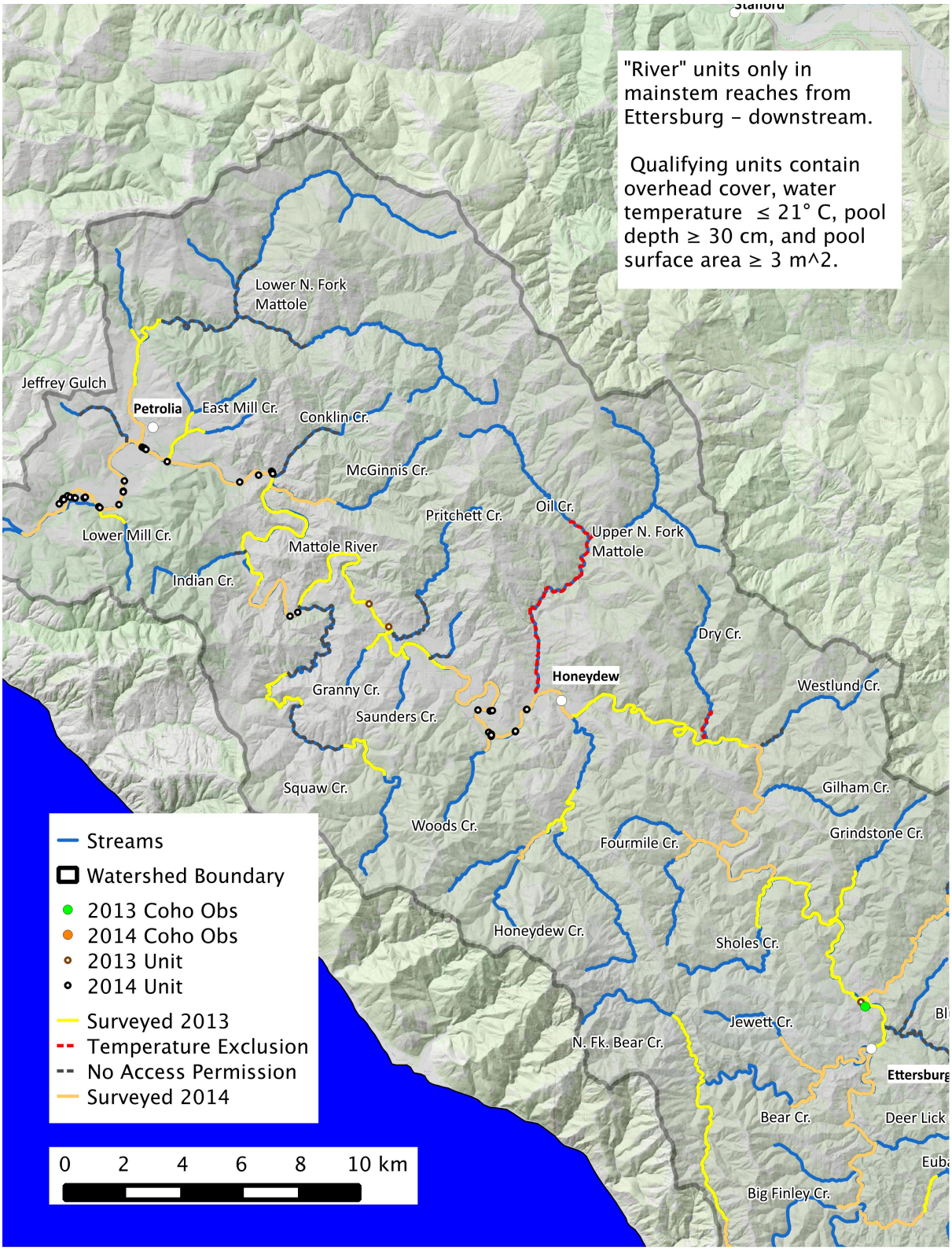

Figure 6. Qualifying units in "large river" survey reaches, 2013 and 2014.

Discussion

Patterns in coho distribution and habitat condition

Coho salmon are not abundant in the Mattole watershed, with a percent area occupied (PAO) of just 0.13 in theoretically suitable habitat, in both 2013 and 2014. Back- and forward-calculation of estimated adult coho abundance from the number of juvenile coho observed in 2013 and 2014 supports the notion that adult returns in recent years are likely well under 100 fish.

Coho juvenile distribution was broadly similar to that documented over the past two decades, with rearing (and spawning) concentrated in the Mattole mainstem and tributaries near the town of Whitethorn in the southern portion of the watershed, and only isolated detections of juveniles elsewhere (Figure 2) (Mattole River and Range Partnership 2011).

We did find differences in the habitat parameters we measured between both streams and reaches with coho presence. Differences in cover area were particularly pronounced between reaches and units with coho presence and those without. There were also differences in unit depth, LWD count, and pool area, especially at the unit-level within reaches with coho presence.

The presence of overhead cover has been found to correlate with juvenile coho presence and density in other studies, in both winter (Tschaplinski and Hartman 1983) and summer ((Fransen et al. 1993), Kiffney et al. 2011). Others have come to the opposite conclusion, and documented a lack of affinity for cover (Spalding et al. 1995). Differing conclusions about the relationship of coho habitat use and cover presence probably have to do with cover affinity being mediated by other factors such as prey availability, and the scale at which the relationship was investigated (Giannico 2000). Cover area as we measured it may in part be an indicator of the availability of suitable winter rearing habitat (velocity refuge) in a reach.

The lack of relationship between lower stream temperatures and coho presence was notable in our results. We observed coho in pools where spot temps were 21°C, similar to observations reported from the Klamath River (Sutton and Soto 2010). In most cases, these fish did appear to be using small-scale thermal refugia within the pool.

Coho were present in a number of reaches where previously recorded MWATs and MWMTs (Mattole Salmon Group data) exceed commonly accepted temperature thresholds for coho presence, such as those in Welsh et al. (2001), a study conducted in the Mattole watershed. The lack of random reach selection and reaches in the Mattole mainstem in the Welsh et al. (2001) study may have contributed to this discrepancy. In 2014 truncated spawning distribution due to low flows probably also resulted in juvenile distribution being shifted downstream into warmer stream reaches.

Coho in these "warm" reaches, such as 302 in the mainstem Mattole and 818 in Bear Creek appeared to be in good condition and were among the largest parr we observed in the summer of 2014. They may have not fared so well in summer with less mild temperatures, but their presence seems to suggest that coho thermal tolerance may not be as narrow as sometimes thought, and/or that changes in watershed conditions since the Welsh et al. (2001) study and thermograph placement may have contributed to greater availability of thermally suitable niches.

Our comparison of habitat variables and coho presence had several shortcomings, including spatial auto-correlation, not quantifying the interaction between reach and unit variables, a time span of only two years including one with restricted spawning distribution, and a focus on fish presence and habitat quality during only the summer base-flow period. These are common issues with analyses of fish-habitat relationships (Sharma and Hilborn 2001). We also failed to account for the natural correlation between larger streams and greater cover and pool area.

Nonetheless, it seems clear that coho juveniles are choosing habitat with specific attributes for summer rearing. The differences in habitat between the reaches and units with coho present and absent suggest that effective restoration actions that increase cover should provide more suitable coho rearing habitat.

Recovery planning for Mattole coho has concluded that a lack of summer and winter rearing habitat are primary impediments to the population's survival, with a history of timber harvest and stream cleaning resulting in a lack of instream cover and winter flow refuge (Mattole River and Range Partnership 2011, National Marine Fisheries Service 2014). Considerable restoration work has been done to address these issues. In Thompson Creek reach 956, we noted the number of wood pieces placed as habitat structures, and determined that 56 out of the 224 pieces of qualifying LWD in surveyed units were restoration pieces. Additionally, 23 pieces of qualifying LWD were racked on these structures, so at least 35% of the qualifying LWD in Thompson Creek was attributable to restoration activites. Reach 956 had the highest incidence of LWD among all reaches surveyed.

While we found coho present throughout the watershed (Figure 2), over 90% of juveniles and the highest counts per pool were in the very southern portion of the basin in the mainstem Mattole, and Thompson, Ancestor, and Baker Creeks (Figure 7). The presence of non-natal coho the length of the watershed provides evidence of spatial diversity that contributes to population resiliency, but the extremely low numbers of non-natal fish, especially within thermally suitable habitat in the Mattole mainstem from Ettersburg downstream, seem to suggest that restoration work focused on this habitat are unlikely to lead to near-term increases in rearing success and population size.

However, the availability of suitable non-natal habitat in seasons other than summer baseflow may be an important factor inhibiting population recovery. A lack of understanding of coho juvenile winter habitat use or the distribution of suitable winter

rearing habitat inhibit our ability to identify the areas of the watershed or life-stages which are currently limiting coho survival.

Stream reaches proximal to the portion of the watershed with higher counts of coho seem like an important area of focus for continued restoration work (Figure 7). The mainstem Mattole downstream of Stanley Creek through the Whitethorn valley may be particularly important. Distribution in 2013 and 2014, with very low coho densities, but fish spread throughout this ~10 km reach, seems to be consistent with prior years (Mattole Salmon Group unpublished data). Better understanding distribution in this reach relative to juvenile density and distribution in upstream reaches, and spring/summer streamflows would improve our understanding of the factors limiting coho salmon and productivity in the watershed.

In addition to continued habitat improvement work, the very low apparent population of adult coho suggests that genetic supplementation should be seriously considered as a recovery strategy, if suitable habitat exists to support an expanded population.

Summary of restoration and monitoring recommendations

- Continue to implement habitat restoration work that increases instream cover and complexity
- Prioritize this work in areas proximal to reaches with the highest coho densities and consistent coho presence
- Build relationships with landowners in Squaw Creek, possibly the only tributary in the lower watershed with a spawning sub-population of coho
- Inventory winter rearing habitat availability and distribution, and seek to understand seasonal movements and habitat use of coho juveniles
- Further investigate annual patterns in coho juvenile distribution in the Mattole mainstem in the Whitethorn valley.
- Gather additional information on qualifying “large river” units to better understand period of connectivity to main channel
- Seek to better understand importance of genetic vs. habitat suitability bottlenecks to population recovery

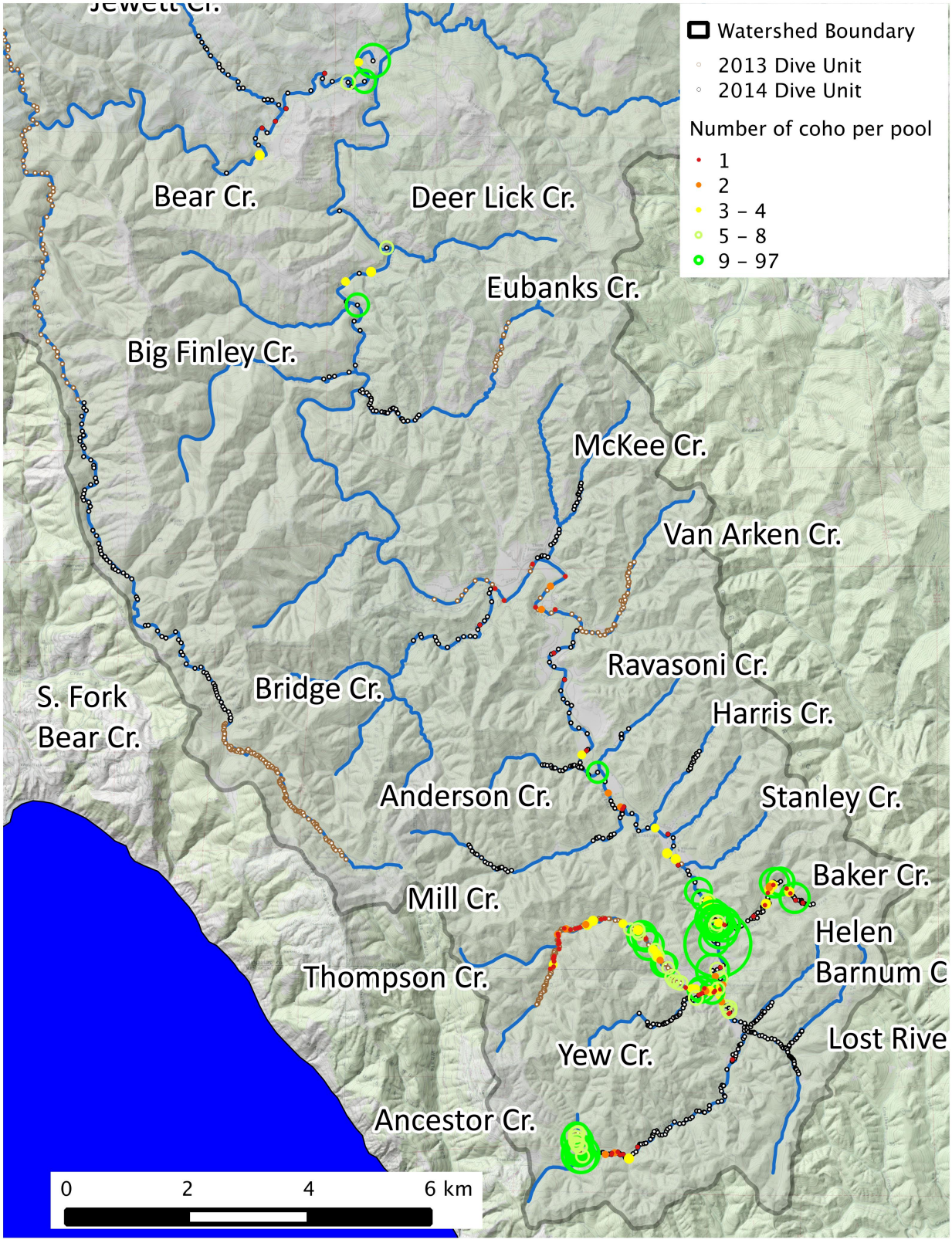

Figure 7. Coho presence upstream of Ettersburg. Circle size is scaled based on number of coho in unit. Gap in distribution in mainstem between Lost River and Ancestor Creek is atypical, a result of low winter flows preventing adults access in the winter of 2013-14.

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Table 8. Reaches where access was obtained to 100% of reach, by year surveyed and reach length.

Stream Name	Reach ID#	Year	Length Surveyed (km)
Mattole River	279	2013	8.1
Mattole River	284	2013	10.8
Mattole River	292	2013	9.4
Mattole River	299	2013	10.7
Mattole River	307	2013	4.9
Lower Mill Creek	328	2013	1.2
Grizzly Creek	353	2013	0.5
Squaw Creek	483	2013	2.4
Granny Creek	544	2013	0.9
Honeydew Creek	632	2013	2.5
East Fork Honeydew Creek	641	2013	0.6
Sholes Creek	733	2013	2.3
Grindstone Creek	749	2013	2.4
South Fork Bear Creek	822	2013	2.8
South Fork Bear Creek	823	2013	3.0
South Fork Bear Creek	827	2013	3.5
North Fork Bear Creek	858	2013	3.0
Vanauken Creek	928	2013	1.9
Thompson Creek	956	2013	3.6
Thompson Creek	957	2013	1.1
Ancestor Creek	972	2013	0.2
Ancestor Creek	973	2013	0.3
Mattole River	275	2014	4.7
Mattole River	277	2014	4.6
Mattole River	282	2014	4.2
Mattole River	288	2014	10.5
Mattole River	295	2014	9.7
Mattole River	302	2014	8.5
Mattole River	308	2014	6.4
Mattole River	309	2014	3.8
McGinnis Creek	453	2014	2.5
Honeydew Creek	633	2014	1.5
Fourmile Creek	715	2014	2.1
N. Fork Fourmile	718	2014	0.6
Bear Creek	818	2014	3.4
Bear Creek	819	2014	2.2
South Fork Bear Creek	824	2014	2.8
South Fork Bear Creek	825	2014	1.3
South Fork Bear Creek	826	2014	2.7
Jewett Creek	848	2014	2.1
McKee Creek	925	2014	0.2
Anderson Creek	937	2014	0.7
Baker Creek	951	2014	2.4
Yew Creek	958	2014	1.6
Lost	963	2014	1.3
Helen Barnum	964	2014	0.6
S Fork Lost	965	2014	0.5

Table 9. Partial reaches surveyed due to landowner access denial in portion of reach.

Stream Name	Reach ID#	Year	Length not surveyed (km)	Length Surveyed (km)	% of reach surveyed
North Fork Mattole River	341	2013	0.8	2.2	73%
East Mill Creek	425	2013	0.7	1.2	63%
South Branch, East Mill Creek	428	2013	0.2	0.8	77%
Squaw Creek	481	2013	1.2	2.1	65%
Saunders Creek	548	2013	0.1	0.3	82%
Eubanks Creek	893	2013	0.1	1.2	89%
Mattole River	310	2014	0.2	2.4	92%
Mattole River	311	2014	0.3	2.0	88%
North Fork Mattole River	340	2014	0.6	1.9	77%
Woods Creek	557	2014	0.5	0.2	28%
Mattole Canyon	764	2014	2.7	0.5	15%
Mattole Canyon	765	2014	0.5	2.9	86%
Big Finley Creek	885	2014	0.2	0.6	78%
Eubank Creek	892	2014	1.6	1.5	48%
Bridge Creek	911	2014	0.8	2.4	75%
McKee Creek	924	2014	0.5	1.0	65%
E. Anderson	938	2014	0.6	0.3	34%
Mill Creek	939	2014	1.8	1.6	48%
Harris Creek	947	2014	1.1	0.5	31%

Table 10. Reaches not surveyed and reason for no survey.

Stream Name	Reach ID#	Year	Reach Length (km)	Reason for no survey
East Branch North Fork Mattole River	364	2013	3.0	Landowner access denied
Conklin Creek	440	2013	3.1	Landowner access <50% of reach
Indian Creek	470	2013	0.4	Landowner access denied
Squaw Creek	479	2013	2.9	Landowner access <50% of reach
Lindley Creek	550	2013	0.7	Landowner access denied
Oil Creek	593	2013	1.0	Temperature exclusion
Dry Creek	678	2013	1.5	Temperature exclusion
Mattole Canyon	766	2013	2.0	Landowner access <50% of reach
Blue Slide Creek	793	2013	3.0	Landowner access <50% of reach
Blue Slide Creek	794	2013	2.7	Landowner access <50% of reach
Danny's Creek	960	2013	1.5	Landowner access denied
Jeffry Gulch	337	2014	2.5	Landowner access denied
North Fork Mattole River	342	2014	3.0	Landowner access denied
North Fork Mattole River	343	2014	2.9	Landowner access denied
Squaw Creek	480	2014	3.6	Landowner access denied
Squaw Creek	482	2014	3.4	Landowner access denied
Pritchard Creek	528	2014	3.1	Landowner access denied
Upper North Fork Mattole River	568	2014	3.2	Temperature Exclusion
Upper North Fork Mattole River	569	2014	2.5	Temperature Exclusion
Upper North Fork Mattole River	570	2014	1.9	Temperature Exclusion
Westlund Creek	695	2014	1.1	Landowner access denied
Blue Slide Creek	792	2014	3.2	Landowner access denied
Crooked Prairie	796	2014	0.8	Landowner access denied
Deer Lick	877	2014	0.2	Landowner access denied
W. Fork Bridge Creek	912	2014	0.2	Landowner access denied
Bridge Creek	915	2014	0.6	Landowner access denied
Bridge Creek	916	2014	0.2	Landowner access denied
Painter Creek	926	2014	0.9	Landowner access denied
Gibson Creek	948	2014	1.0	Landowner access denied

Appendix B – Changes to sample frame following 2013-14 survey effort

Changes to juvenile coho sample frame made as a result of 2013-14 survey effort.

Stream Name	Reach ID#	Change	Reason for Change
Beartrap Ck	636	Removed	GIS max gradient >5%, field inspection confirmed reach steep and offers little to no coho habitat
Gilham Ck	704	Removed	GIS max gradient >5%, field inspection confirmed reach steep and offers little to no coho habitat
Grindstone Ck	749	Removed	GIS max gradient >5%, field inspection confirmed reach steep and offers little to no coho habitat
South Fork Bear Crk	822	Removed	GIS max gradient >5%, field inspection confirmed reach steep and offers little to no coho habitat
Mainstem Mattole, Lower Mill Creek to Estuary	273	Added	Presence of multiple qualifying units

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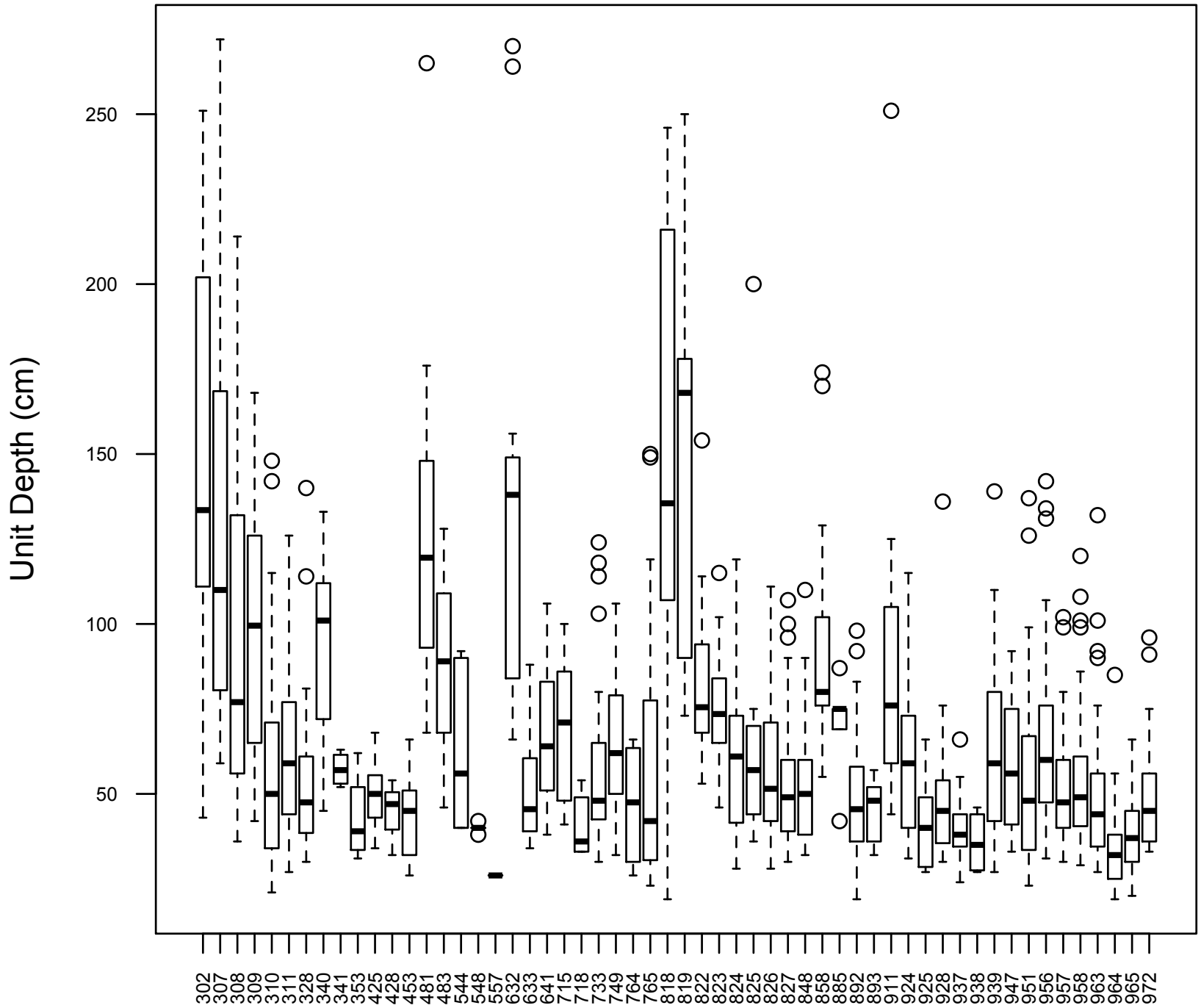
Reach ID #	Coho Presence	Median Unit depth (cm)	Median Cover Rating	Median Cover Area (m^2)	Median LWD Count	Median Pool Area (m^2)	Basin Area, downstream end of reach (km^2)	Reach – averaged Intrinsic Potential	Mean Temperature °C	#of Units
273	0	57	3.00	14.50	0.0	35.3	762.5	0.66	18.1	11
275	0	64	3.00	8.50	0.0	58.7	748.0	0.76	16.5	10
277	0	63	2.50	15.62	0.0	124.8	633.8	0.60	17.5	5
282	0	130	2.50	6.25	0.0	118.7	572.4	0.61	18.0	2
284	0	131	3.00	16.00	1.5	21.1	522.4	0.60	20.0	2
288	0	65	2.00	1.00	0.0	53.8	490.4	0.61	17.8	13
299	1	97	3.00	86.00	0.5	165.7	261.9	0.62	18.5	2
302	1	134	2.06	8.75	0.5	817.4	126.1	0.60	19.7	10
307	1	110	1.92	2.38	0.6	307.3	79.4	0.61	18.3	24
308	1	77	2.22	6.50	1.1	275.2	52.3	0.63	15.3	41
309	1	100	2.25	5.38	1.1	149.2	30.3	0.91	13.2	42
310	1	50	2.07	2.08	0.3	68.4	9.3	0.85	15.1	43
311	1	59	2.46	2.58	1.1	33.4	5.8	0.85	14.7	27
328	0	48	2.15	0.83	0.2	10.1	5.4	0.28	12.8	36
340	0	101	2.33	6.25	1.8	98.3	97.6	0.93	18.5	5
353	0	39	1.50	0.63	0.0	20.1	5.4	0.54	12.0	4
425	0	50	2.20	1.88	0.3	17.9	7.4	0.84	15.3	23
428	0	47	2.75	0.50	0.3	6.3	2.1	0.64	16.0	3
453	1	45	2.00	1.10	0.2	25.6	15.6	0.58	17.0	18
481	1	120	1.95	1.50	0.4	118.3	37	0.36	15.7	14
483	0	89	2.07	1.83	0.5	66.8	18.9	0.53	14.3	21
544	0	56	1.33	0.50	0.0	14.0	2.4	0.62	18.2	5
548	0	40	1.88	0.50	0.3	8.9	2.2	0.76	14.0	5
557	0	26	2.00	1.25	0.0	73.0	5.1	0.56		1
632	0	138	1.86	1.25	0.1	88.5	33.8	0.55	15.9	11
633	0	46	2.06	2.40	0.5	54.5	17.9	0.46	16.0	12
641	0	64	1.67	0.50	0.1	50.7	13.5	0.39	14.7	7
715	0	71	2.43	3.25	1.1	38.2	14.1	0.62	16.6	13
718	0	36	2.50	1.88	0.3	17.9	4.6	0.53	16.0	8
733	1	48	1.84	0.50	0.2	36.5	10.5	0.50	16.1	31
749	0	62	1.81	0.50	0.3	27.7	9.9	0.32	16.3	26
764	0	48	2.00	1.00	0.0	37.7	26.8	0.65	20.0	4
765	0	42	1.95	2.00	0.2	38.7	24.2	0.54	20.2	31
818	1	136	2.06	4.63	0.5	487.1	55.4	0.67	18.9	10
819	1	168	2.25	8.25	0.1	500.1	45.3	0.62	18.0	9
822	0	76	2.08	1.00	0.2	51.9	22	0.44	14.8	26
823	0	74	2.07	1.33	1.0	75.6	15.3	0.56	15.0	22
824	0	61	2.55	2.50	1.1	77.0	11.9	0.55	17.0	27
825	0	57	2.27	2.50	0.8	42.9	9.1	0.47	16.5	17
826	0	52	2.33	3.88	0.9	41.1	6.7	0.72	14.0	32

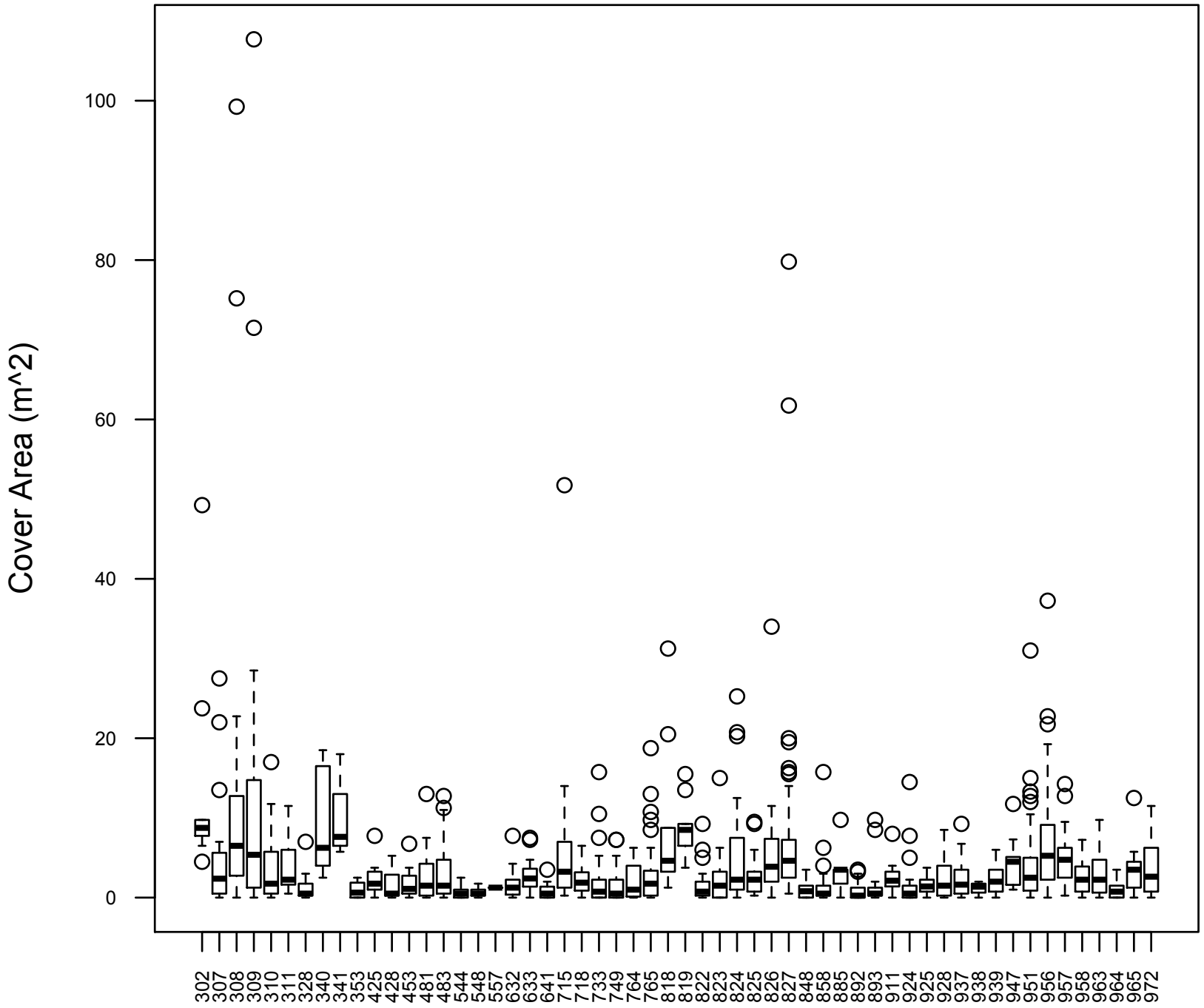
Appendix C – Summary of Habitat Values by reach

Reach ID #	Coho Presence	Median Unit depth (cm)	Median Cover Rating	Median Cover Area (m^2)	Median LWD Count	Median Pool Area (m^2)	Basin Area, downstream end of reach (km^2)	Reach – averaged Intrinsic Potential	Mean Temperature °C	#of Units
827	0	49	2.79	4.63	0.4	23.2	4	0.86	12.8	102
848	0	50	1.82	0.80	0.4	22.4	6.1	0.53	16.0	17
858	0	80	1.89	0.83	0.2	75.7	13.4	0.45	16.2	21
885	0	75	2.13	3.25	0.1	29.5	8.2	0.47	16.0	5
892	0	46	1.77	0.32	0.2	21.7	8.9	0.52	16.0	30
893	0	48	2.05	0.75	0.2	17.1	3.8	0.57	15.3	13
911	1	76	2.00	2.13	0.3	74.1	11.1	0.56	16.0	18
924	0	59	1.86	0.50	0.2	28.4	5.4	0.66	15.8	15
925	0	40	2.00	1.40	0.3	15.2	2.4	0.72	15.0	8
928	0	45	2.18	1.75	0.6	16.3	5.2	0.72	13.9	35
937	0	38	2.12	1.63	0.4	12.9	1.8	0.56	14.5	20
938	0	35	1.83	1.38	1.0	16.5	1.8	0.72	14.0	4
939	1	59	2.14	2.00	0.4	28.0	6	0.73	15.2	30
947	0	56	3.00	4.25	1.3	22.0	2.5	0.81	14.5	13
951	1	48	2.26	2.67	0.9	20.1	4	0.85	13.6	73
956	1	60	2.86	5.25	2.2	36.5	9.5	0.87	13.1	79
957	1	48	2.64	5.00	0.6	18.2	2.3	0.84	14.2	46
958	1	49	2.31	2.25	0.6	15.0	2.4	0.64	15.0	35
963	0	44	2.00	2.25	0.2	25.1	5.1	0.85	12.3	28
964	0	32	1.82	1.00	0.6	11.1	1.6	0.78	13.0	17
965	0	37	2.18	3.50	1.8	13.8	1.8	0.83	10.5	17
972	1	45	2.39	2.63	1.0	13.3	2.6	0.81	12.2	18

Appendix D – Boxplots of Habitat Values by reach



Appendix D – Boxplots of Habitat Values by reach



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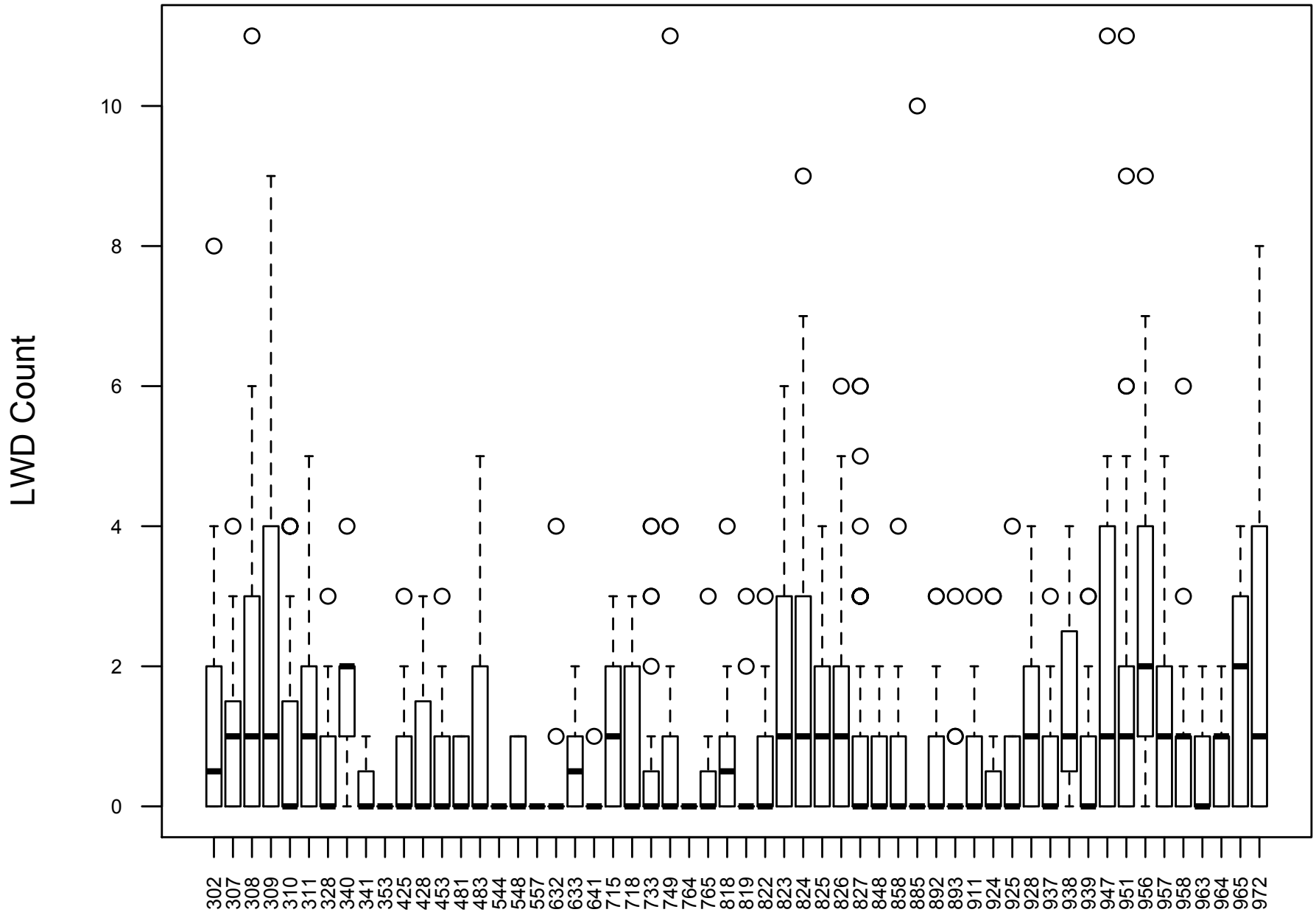
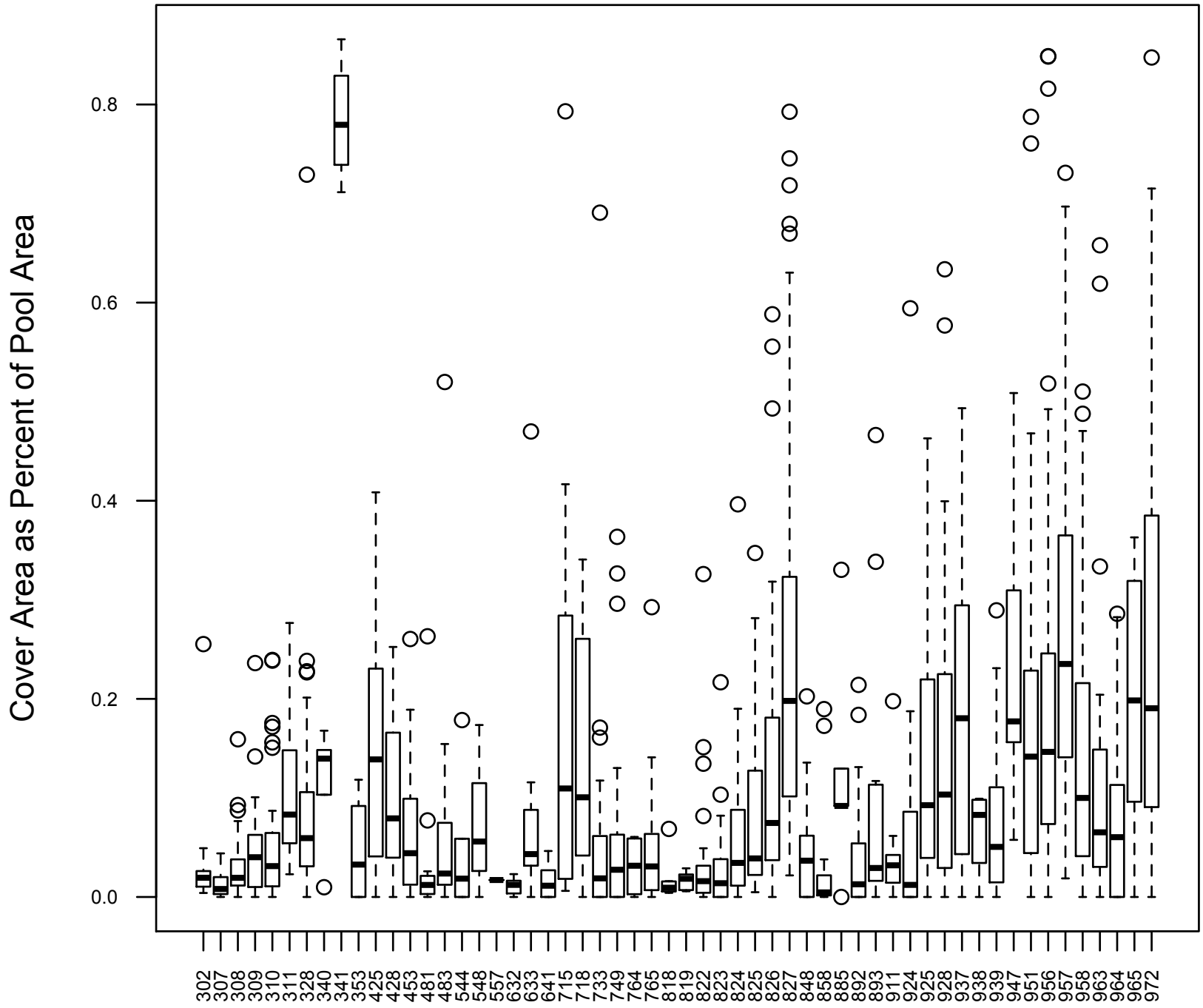


Appendix D – Boxplots of Habitat Values by reach



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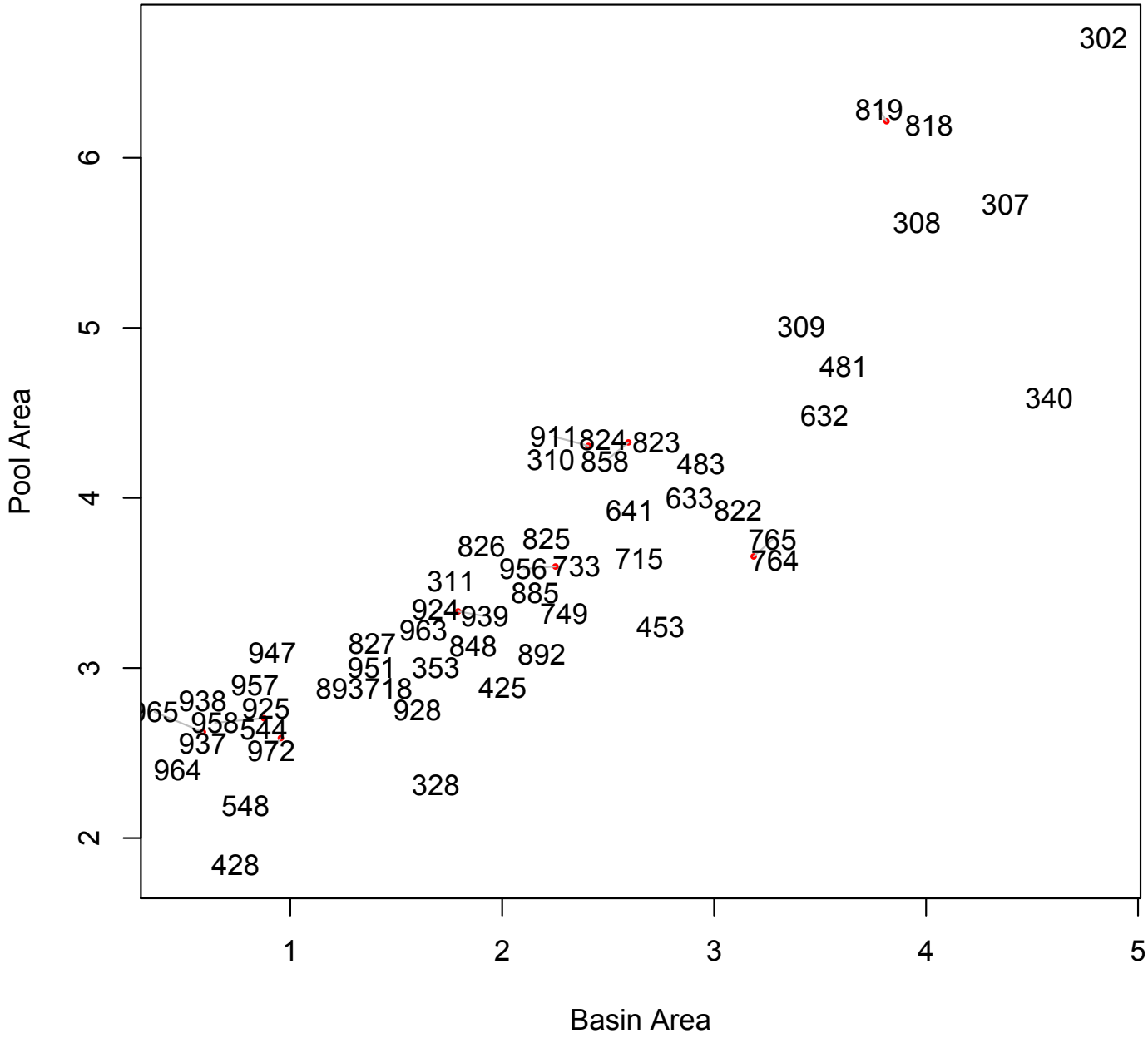

Log-log plot of reach median pool area and max basin area, by reach.