Blue Creek Chinook Outmigration Monitoring

2012 Technical Memorandum

Prepared by:

Andrew Antonetti and Erika Partee
Yurok Tribe Fisheries Program
PO Box 1027 – Klamath, California 95548

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Introduction

The Lower Klamath River Sub-basin, encompassing all tributaries downstream of the Trinity River confluence, has been subjected to substantial timber harvest and related road construction over the last 60 years. Historic logging practices, occurring in a region with steep, naturally erodible terrain and high annual rainfall, have contributed to widespread streambed sedimentation and associated habitat degradation that have led to substantial declines in native fish runs throughout the sub-basin (Gale and Randolph 2000).

Blue Creek is the largest tributary to the Lower Klamath River, and correspondingly supports the largest anadromous fish populations in the sub-basin. The Yurok Tribe considers Blue Creek and other Lower Klamath tributaries to be "salmon strongholds", especially given the importance of these habitats to natal and non-natal salmonid populations, and global climate change predictions for the area. The Lower Klamath Sub-basin Restoration Plan identified Blue Creek as the highest priority watershed due to the quality and amount of habitat available to anadromous populations of chinook, coho, steelhead, and coastal cutthroat (Gale and Randolph 2000). Following its formation in 1994, the Yurok Tribal Fisheries Program (YTFP) assumed responsibility for all monitoring and assessment activities throughout the Lower Klamath Sub-basin. For Blue Creek these activities included adult spawning surveys (1994-Present), and juvenile outmigrant trapping (1995-Present) (Gale et al. 1998).

YTFP's long-term monitoring program has provided a means of assessing population trends of Blue Creek salmonids as well as enhanced knowledge of the life history patterns of Blue Creek fish populations over the past fifteen years. In addition, these monitoring efforts continue to provide information used to assess Blue Creek's contribution to the overall Klamath Basin chinook salmon run size. Continuing juvenile salmonid monitoring efforts will allow for ongoing assessment of long-term population trends and further enhance our understanding of the magnitude and importance of Blue Creek's fish runs in the Klamath Basin. This technical report summarizes long-term juvenile salmonid outmigration monitoring in Blue Creek for the year 2012.

Study Area

Blue Creek is a fourth order drainage that enters the Lower Klamath River at river mile (rm) 16.1 (Figure 1). The headwaters originate in the Chimney Rock and Elk Valley area of the Siskiyou Wilderness, at an elevation of 4,800 feet. The stream flows southwesterly 23 miles to its confluence with the Klamath River at an elevation of 40 feet. The watershed drains 81,296 acres (127 square miles) and is the largest tributary to the Klamath River downstream of the Trinity River confluence at Weitchpec (rm 43.5). The drainage is steep and mountainous with moderate to high channel confinement present throughout the basin (Gale 2009). The Blue Creek watershed has annual rainfall

averaging approximately 100 inches in the headwaters, 75% of which occurs between November and March (Helley and LaMarche 1973).

A natural barrier on the mainstem of Blue Creek is located at rm 15 approximately 0.25 miles below the confluence of the East Fork (Figure 2). This barrier, consisting of a very steep boulder jammed gorge, results in a complete blockage of upstream anadromous migration (Gale 1997). Below the barrier, four species of anadromous salmonids are present: chinook salmon, coho salmon, steelhead trout, and coastal cutthroat trout. Resident rainbow trout are the only species currently present upstream of the anadromous barrier, although brook trout (*Salvelinus fontinalis)* were stocked in the upper reaches at an undocumented point earlier in the century (Gale 1997).

Three tributaries to Blue Creek have been identified as important for anadromous salmonid spawning and rearing and comprise 41% of the watershed area: the West Fork Blue Creek, Nickowitz Creek, and Crescent City Fork Blue Creek. The Crescent City Fork is the largest and lowest gradient tributary accessible to anadromous fish, and both salmon and steelhead extensively utilize the tributary (Figure 2). Small numbers of salmon have previously been documented spawning in the lower most mile of the West Fork (Gale et al. 1998; Longenbaugh and Chan 1994), with steelhead extensively utilizing the majority of the tributary (Voight and Gale 1998). To date, only a small number of juvenile and adult salmon have been observed in Nickowitz Creek, but juvenile steelhead have been observed extensively throughout the tributary (Hayden 1998; Voight and Gale 1998). A fourth tributary, Slide Creek, has also shown importance for steelhead populations. Slide Creek has a steep gradient near its mouth, but the lower two miles have consistently supported three age classes of juvenile steelhead (YTFP unpublished survey data).

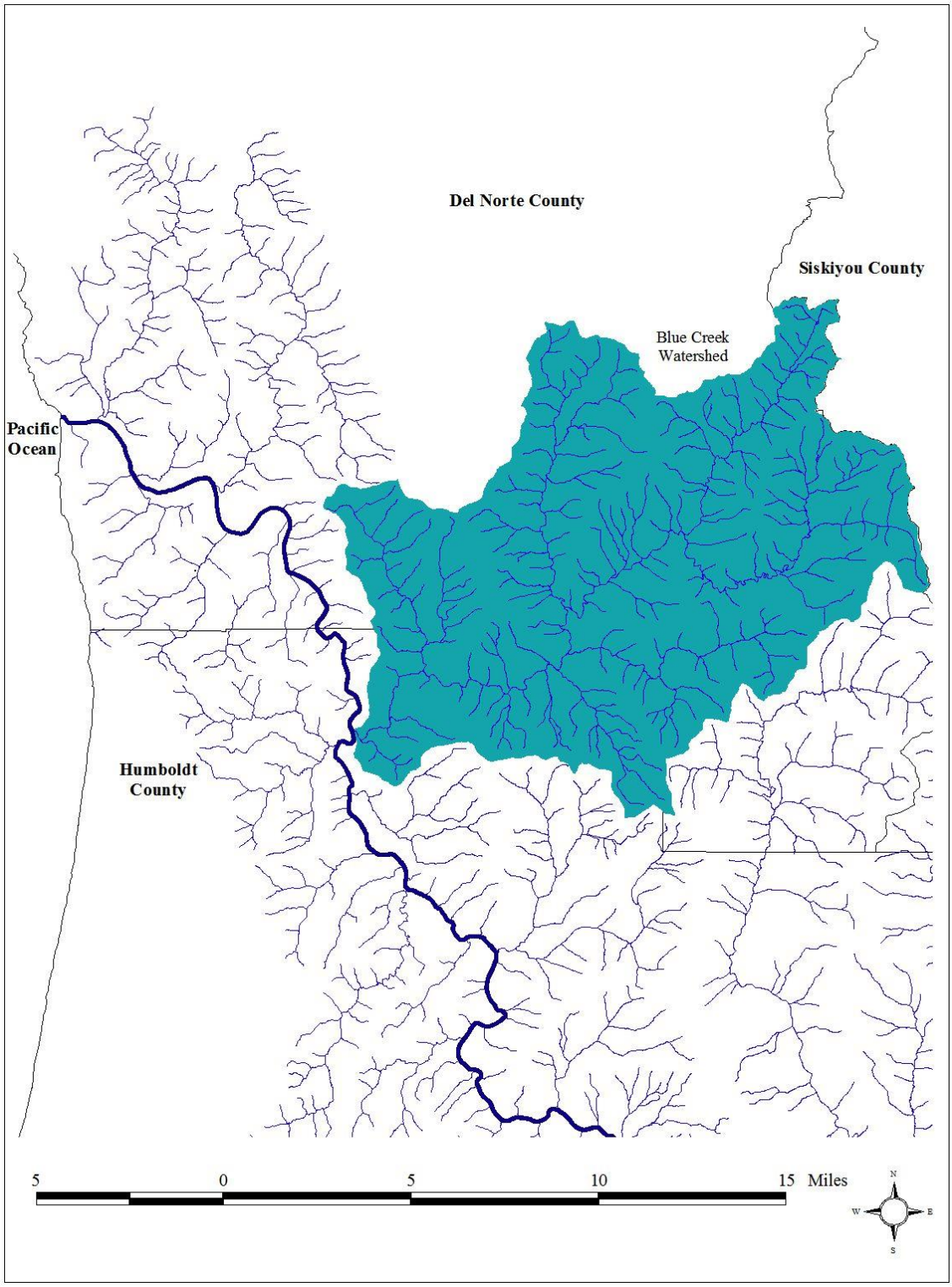

Figure 3. Map depicting the Blue Creek watershed, Lower Klamath River Sub-basin, CA.

Methods

A rotary screw trap manufactured by E.G. Solutions, Inc (Corvallis, Oregon) equipped with a five foot diameter cone and supported by two aluminum-covered foam pontoons was used to capture fish traveling downstream in Blue Creek. The trap was located approximately two miles upstream of the mouth of Blue Creek (Figure 2) and has been in operation annually since 1995. The screw trap was placed in the main thalweg to maximize the quantity of stream flow sampled and was secured in position using 3/8" steel cable attached to anchor points on each bank. Repositioning occurred throughout the season in response to changing flow conditions in order to maximize catch.

YTFP installed the rotary screw trap in late April and began capturing fish on April 24, 2012. The trap was deployed 7 days per week and was checked at least every other day in the morning to reduce handing and heat-induced stress. Captured fish were removed from live boxes and placed in five gallon buckets with aerators. Water was replenished every fifteen minutes and fish were monitored closely for stress. All captured salmonids were anesthetized with tricane methanesulfonate (MS-222) and identified to species and class. YTFP staff randomly selected thirty to fifty fish of each salmonid species, measured them to the nearest mm (FL) and weighed them. All non-salmonid species were identified and tallied on a daily basis. All chinook were inspected for marks (fin clips) from previous captures, and a subsample of fifty to one hundred and fifty chinook were marked daily with a partial fin clip. If fewer than fifty chinook were captured, all fish were marked. A unique upper caudal or lower caudal fin clip was given each week to determine trap efficiency. The use of different fin clips enables the tracking of marked fish from discrete marking periods, thereby increasing the reliability of trap efficiency estimates. All marked fish were transported approximately ¼ mile upstream after recovering from anesthesia and released. All non-marked fish were released downstream of the trap after recovery from anesthesia.

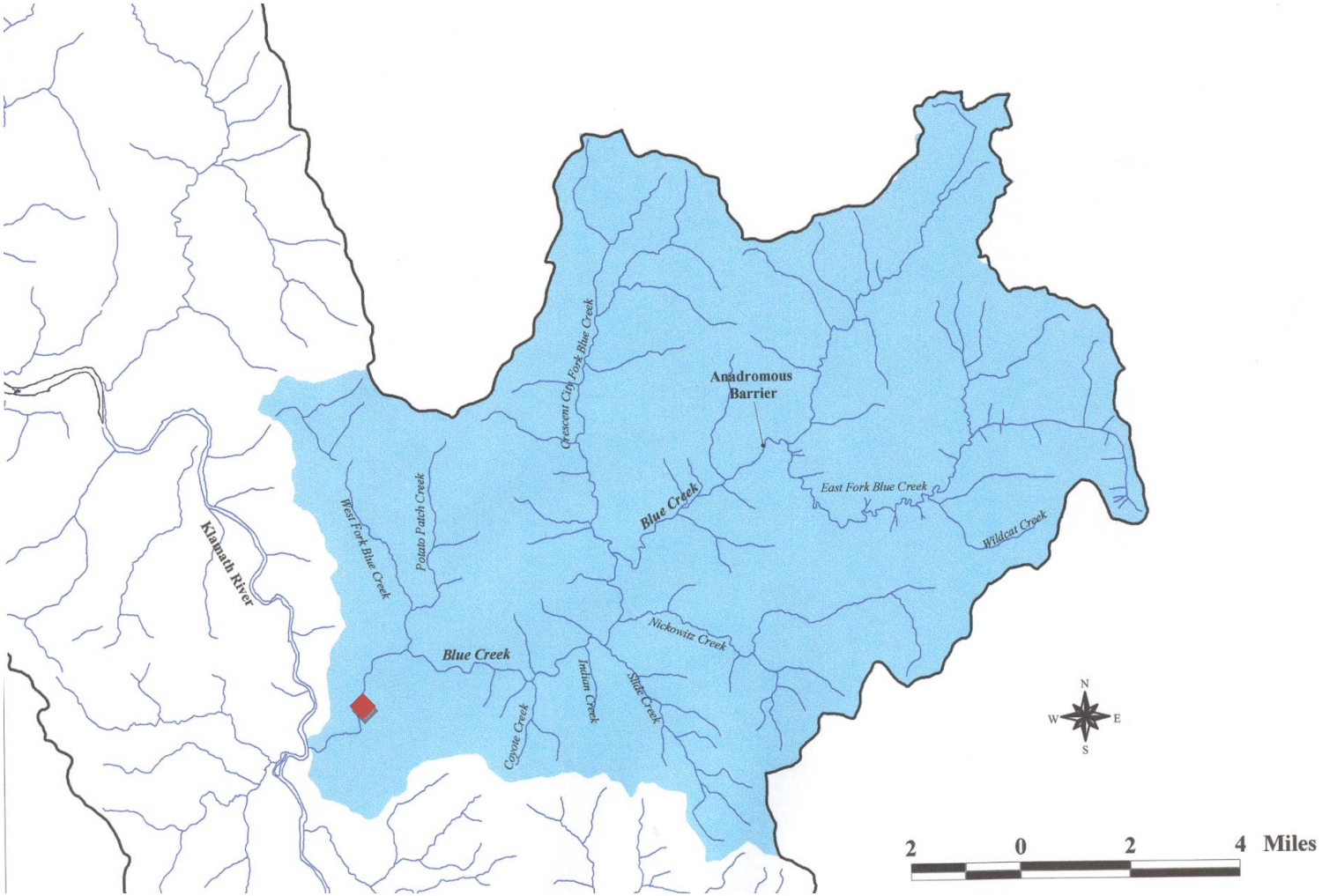

Figure 2. Map showing location of outmigrant screw trap (red diamond) in Blue Creek drainage, Lower Klamath River, California.

Summary

YTFP operated the outmigrant screw trap for a total of 160 days in 2012. During this period the screw trap captured a total of 32,045 juvenile chinook smolts. The trap also captured 1,346 steelhead young-of-the-year, 253 age 1+ and older steelhead, and three coastal cutthroat trout. In addition, 7 coho young-of-the-year (YOY) and 34 coho yearlings were captured in 2012 (Table 1).

Table 1. Total number of juvenile salmonids captured by week in the Blue Creek rotary screw trap during 2012.

	# Days		Coho		Steelhead		
Week Ending	Sampled	Chinook	YOY	Yearling	YOY	Parr/Smolt	Cutthroat
29-Apr-12	5	1,439	0	1	3	6	0
6-May-12	7	880	1	1	0	5	0
13-May-12	7	726	0	0	2	1	0
20-May-12	7	947	0	3	1	32	1
27-May-12	7	1,796	3	11	4	57	0
3-Jun-12	7	661	1	8	3	32	0
10-Jun-12	7	709	0	7	0	28	1
17-Jun-12	7	1,779	0	2	41	15	0
24-Jun-12	7	2,274	0	0	95	12	0
1-Jul-12	7	757	0	0	122	4	0
8-Jul-12	7	344	0	0	7	1	0
15-Jul-12	7	7,672	0	0	102	4	0
22-Jul-12	7	4,157	0	1	174	5	0
29-Jul-12	7	3,213	0	0	97	1	0
5-Aug-12	7	624	0	0	55	1	0
12-Aug-12	7	986	0	0	128	1	0
19-Aug-12	7	684	0	0	186	2	0
26-Aug-12	7	290	0	0	167	5	0
2-Sep-12	7	54	0	0	72	4	0
9-Sep-12	7	186	1	0	17	9	0
16-Sep-12	7	247	0	0	11	7	0
23-Sep-12	7	972	0	0	50	6	1
30-Sep-12	7	395	0	0	6	4	0
7-Oct-12	1	253	1	0	3	11	0
- Trap Pulled on October 1, 2012 Due to Low Fish Numbers -							
Season Totals:	160	32,045	7	34	1,346	253	3

Chinook

Juvenile chinook were captured immediately following trap installation on April 24, indicating that juveniles began emerging, and likely emigrating, prior to trap installation (Table 1). Peak weekly capture of 7,672 individuals occurred during the week ending July 15, and 47% of total capture occurred between this peak capture week and July 29.

Trapping efficiency for the rotary screw trap in 2012 ranged from 0.5% (29-Apr) to 51.3% (1-Oct) (Table 2). Efficiencies were lower at the start of the trapping season, remaining below 5% until the week ending 3-Jun-12, and then increased gradually to the maximum during the last week of sampling. The observed increased was attributed to decreasing stream flows and the corresponding ability to reposition the trap closer to the head of the pool, which maximized the percentage of streamflow sampled. Based on these efficiencies, an estimated 615,474 (+/- 127,262) juvenile chinook emigrated past the rotary screw trap in 2012 (Figure 3).

Weekly mean fork length for captured chinook ranged from 40.5 mm (week ending May 13) to 89.2 mm (week ending September 9) (Table 3, Figure 5). Fork lengths remained between 40.5 mm and 42.1 mm for the first four weeks of sampling, and then gradually increased for the remainder of the season. A shift in mean weekly fork length from fry ($\leq$ 50 mm) to fingerlings ($\geq$ 50 mm) occurred the week ending June 10.

Table 2. Mark-recapture summary for juvenile chinook captured in the rotary screw trap, Blue Creek, CA, 2012

Week Ending	Mark Period	Days Sampled	# Captured	# Marked	# Recaptured	Trap Efficiency (%)	Estimated # of Outmigrants	Standard Deviation
29-Apr-12	1	5	1439	1029	6	0.5%	275,712	124,739
6-May-12	2	7	880	684	14	1.4%*	62,480	15,046*
13-May-12	3	7	726	523	3	1.4%*	51,546	12,413*
20-May-12	4	7	947	619	22	2.9%	32,309	11,919
27-May-12	5	7	1796	1449	73	4.5%	39,791	6,503
3-Jun-12	6	7	661	573	38	6.6%	10,008	1,603
10-Jun-12	7	7	709	548	45	7.8%	9,060	1,400
17-Jun-12	8	7	1779	1429	191	13.6%	13,106	1,007
24-Jun-12	9	7	2274	1312	158	11.8%	19,243	1,539
1-Jul-12	10	7	757	735	129	15.3%	4,948	488
8-Jul-12	11	7	344	344	100	29.8%	1,154	101
15-Jul-12	12	7	7672	1460	267	18.5%	42,221	2,407
22-Jul-12	13	7	4157	1355	296	21.9%	18,982	984
29-Jul-12	14	7	3213	1050	197	18.5%	17,404	1,145
5-Aug-12	15	7	624	429	130	30.5%	2,048	149
12-Aug-12	16	7	986	674	152	22.6%	4,372	309
19-Aug-12	17	7	684	492	112	22.7%	3,008	247
26-Aug-12	18	7	290	260	66	25.4%	1,142	118
2-Sep-12	19	7	54	54	22	47.5%	114	35
9-Sep-12	20	7	186	138	69	32.6%*	570	43*
16-Sep-12	21	7	247	202	42	32.6%*	757	57*
23-Sep-12	22	7	972	450	106	22.9%	4,237	367
30-Sep-12	23	7	395	150	77	51.3%*	769	59*
1-Oct-12	24	1	253	0	0	51.3%*	493	23*
Season total:		160	32,045	15,959	2,315		615,474	127,262

*trap efficiency and standard deviation estimated for pooled marking periods

Figure 3. Estimated weekly number (+/- SD) of chinook salmon young-of-the-year emigrating past the rotary screw trap, Blue Creek, Spring – Fall 2012.

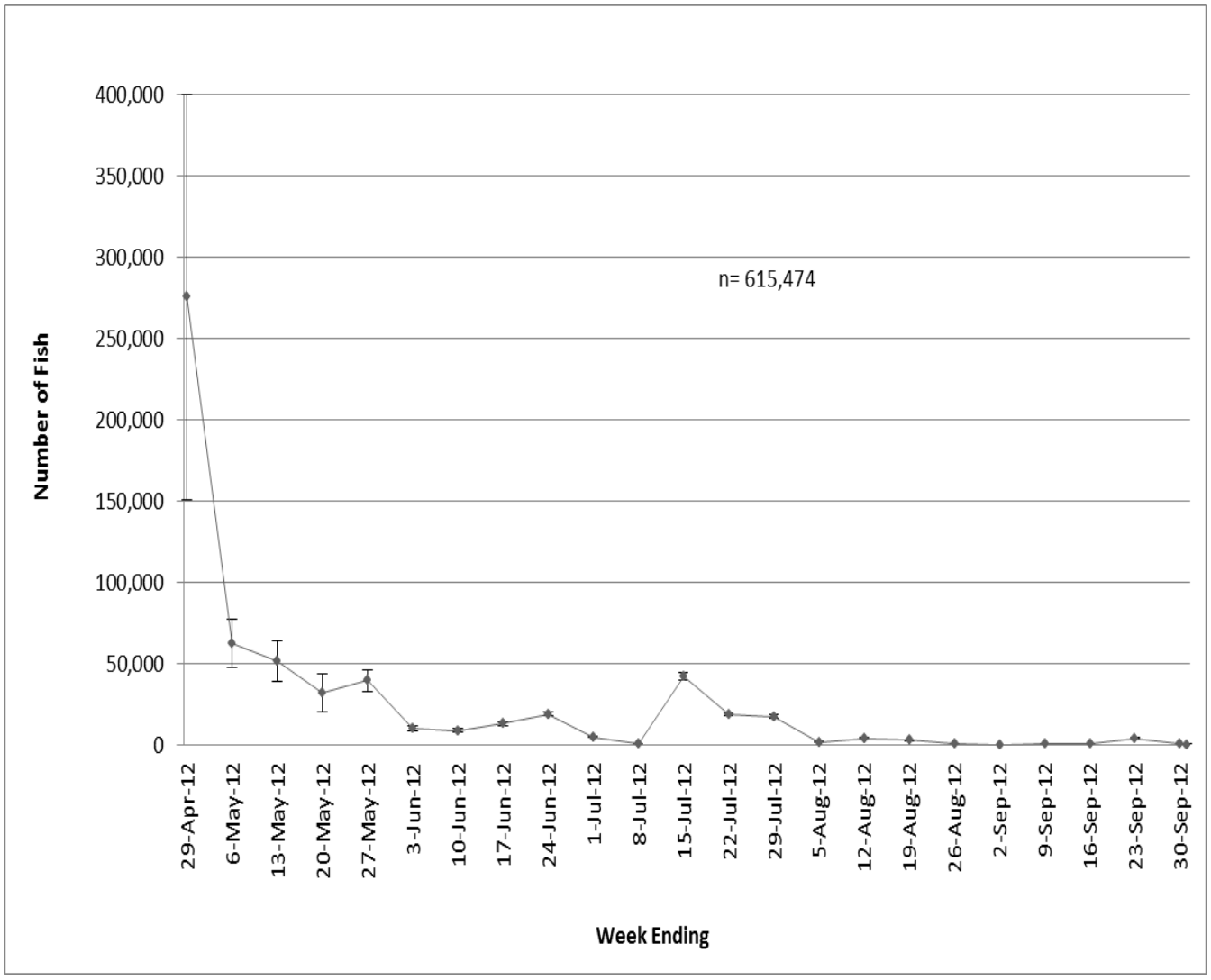

Table 3. Weekly mean fork length, fork length range, +/- 95% confidence interval, and sample size of chinook salmon captured in the rotary screw trap, Blue Creek, lower Klamath River, California, 2012.

Week #	Week Ending	Mean FL (mm)	Range FL (mm)	+/- 95% CI	# Sampled
1	29-Apr-12	41.1	31 - 53	0.3	283
2	6-May-12	41.1	33 - 62	0.3	340
3	13-May-12	40.5	36 - 60	0.3	305
4	20-May-12	42.1	36 - 60	0.5	284
5	27-May-12	45.5	34 - 75	0.6	388
6	3-Jun-12	49.5	34 - 80	0.9	271
7	10-Jun-12	52.5	38 - 87	0.8	290
8	17-Jun-12	56.3	40 - 88	1.1	330
9	24-Jun-12	58.2	40 - 84	1.1	316
10	1-Jul-12	62.5	40 - 88	1.3	295
11	8-Jul-12	74.9	46 - 98	1.6	163
12	15-Jul-12	72.2	48 - 96	1.1	301
13	22-Jul-12	72.4	47 - 96	1.0	297
14	29-Jul-12	74.0	46 - 92	1.0	281
15	5-Aug-12	78.2	50 - 103	1.1	217
16	12-Aug-12	78.9	60 - 95	0.9	230
17	19-Aug-12	80.1	56 - 98	1.0	200
18	26-Aug-12	81.0	57 - 96	0.9	200
19	2-Sep-12	82.8	66 - 97	1.7	54
20	9-Sep-12	89.2	66 - 101	1.1	98
21	16-Sep-12	88.6	75 - 102	1.1	120
22	23-Sep-12	88.2	70 - 104	1.3	120
23	30-Sep-12	87.1	68 - 106	1.4	117
24	7-Oct-12	83.9	72 - 96	2.1	37

- Trap Pulled October 1, 2012 Due to Low Fish Numbers -

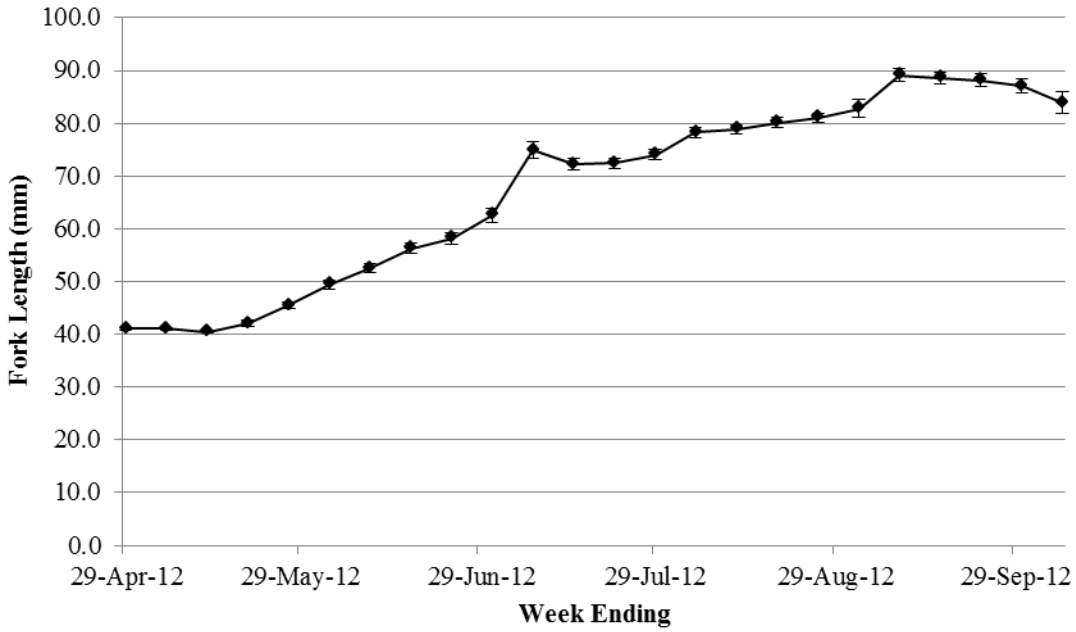

Figure 5. Mean weekly fork length (+/- 95% CI) of chinook salmon captured in the rotary screw trap, Blue Creek, lower Klamath River, CA, 2012.

Coho

Seven coho YOY were captured between the weeks ending May 6 and October 7, and peak capture of three YOY occurred during the week ending May 27. Coho yearlings were first captured during the week ending April 29, and continued to be captured in small numbers through June 17, with three additional captures occurring during the weeks ending July 22, September 9, and October 7. Peak weekly capture of 11 coho yearlings occurred during the week ending May 27. Trap efficiency and population estimates were not made for coho young-of-the-year or yearlings in 2012.

During 2012 outmigrant trapping two coho YOY and 34 coho yearlings were tagged with full duplex (FDX) Passive Integrated Transponder (PIT) tags. Fork length ranged from 87 mm to 139 mm for all coho tagged. The purpose for PIT tag marking is to assess how juvenile coho utilize the range of habitats that exist within the mainstem Klamath River corridor prior to seaward smolt migration.

Steelhead

A total of 1,346 steelhead YOY and 253 age 1+ and older steelhead were captured in the 2012 trapping season. Steelhead YOY were first captured during the week ending April 29 (first week of trapping), and continued to be captured almost weekly through the end of the trapping season. Peak weekly capture of 186 steelhead YOY occurred during the week ending August 19.

Age 1+ and older steelhead were first captured in the rotary screw trap immediately following trap installation, and continued to be captured in small numbers throughout the study period, with the exception of the week ending September 16. Peak weekly capture of age 1+ and older steelhead occurred during the week ending May 27 with 57 individuals, and 61% of total capture occurred between May 20 and June 10 (four weeks). Trap efficiency and population estimates were not made for age 1+ and older steelhead in 2012.

Mean weekly fork lengths for steelhead YOY captured in the rotary screw trap ranged from 28.5 mm (week ending May 13) to 73 mm (week ending October 7) (Table 4). Weekly mean fork lengths fluctuated between 28.3 and 40.0 mm for the first six weeks of trapping, a wider range than in previous years. Mean weekly fork length then generally increased until the end of the trapping season. Mean weekly fork length for age 1+ and older steelhead ranged from 99.0 mm (weeks ending May 13 and July 8) to 182.0 mm (week ending August 5).

Table 4. Weekly mean fork length, fork length range, +/- 95% confidence interval, and sample size of steelhead YOY and steelhead age 1+ and older captured in the rotary screw trap, Blue Creek, lower Klamath River, California, 2012.

	YOY				Age 1+ and older			
Week Ending	Mean FL (mm)	Range FL (mm)	+/- 95% CI	# Sampled	Mean FL (mm)	Range FL (mm)	+/- 95% CI	# Sampled
29-Apr-12	39.7	33 - 43	6.5	3	113.3	66 - 244	53.2	6
6-May-12	-	-	-	0	106.2	83 - 123	15.7	5
13-May-12	28.5	27 - 30	2.9	2	99.0	-	-	1
20-May-12	40.0	-	-	1	104.6	77 - 170	6.7	32
27-May-12	35.8	28 - 49	9.5	4	115.8	73 - 711	21.7	57
3-Jun-12	28.3	27 - 30	1.7	3	105.4	81 - 180	7.6	32
10-Jun-12	-	-	-	0	108.3	11 - 197	11.8	28
17-Jun-12	30.9	27 - 39	1.2	30	117.3	88 - 173	12.5	15
24-Jun-12	29.9	24 - 38	1.0	37	108.3	84 - 135	7.9	12
1-Jul-12	30.8	27 - 42	0.6	88	104.8	93 - 115	9.9	4
8-Jul-12	36.7	29 - 41	2.8	7	99.0	-	-	1
15-Jul-12	46.9	30 - 74	2.1	46	119.8	98 - 142	18.9	4
22-Jul-12	48.0	33 - 63	1.6	51	116.8	91 - 133	14.1	5
29-Jul-12	48.6	31 - 64	1.7	69	123.0	-	-	1
5-Aug-12	54.3	38 - 79	2.4	38	182.0	-	-	1
12-Aug-12	51.3	36 - 69	1.5	89	151.0	-	-	1
19-Aug-12	49.8	39 - 64	1.8	56	128.5	127 - 130	2.9	2
26-Aug-12	49.7	35 - 67	1.3	98	125.6	83 - 182	36.9	5
2-Sep-12	50.7	36 - 65	2.0	45	151.5	113 - 168	25.3	4
9-Sep-12	58.1	46 - 75	3.9	17	178.7	133 - 220	19.1	9
16-Sep-12	56.8	48 - 65	3.0	11	131.6	78 - 225	52.5	5
23-Sep-12	59.1	44 - 85	3.3	41	114.7	78 - 185	38.7	6
30-Sep-12	61.5	46 - 75	10.1	6	118.5	85 - 156	35.5	4
7-Oct-12	73.0	64 - 78	8.8	3	105.3	83 - 167	17.7	11

- Trap Pulled October 1, 2012 Due to Low Fish Numbers -

Literature Cited

Chan, J.R., and M. Longenbaugh. 1994. Progress report for investigations on Blue Creek, FY 1992. U.S. Fish and Wildlife Service, Coastal California Fishery Resource Office, Arcata, California.

Gale, D.B. 1997. Stream channel survey and fish presence & distribution inventory in upper Blue Creek, lower Klamath River, California. Yurok Tribal Fisheries Program, 6Habitat Assessment and Biological Monitoring Division Technical Report No. 1, Klamath, California.

Gale, D.B., T.R. Hayden, L.S. Harris, and H.N. Voight. 1998. Assessment of anadromous fish stocks in Blue Creek, lower Klamath River, California, 1994-1996. Yurok Tribal Fisheries Program, Habitat Assessment and Biological Monitoring Division Technical Report No. 4, Klamath, California.

Gale, D.B.. 2009. Assessment of anadromous salmonid spawning in Blue Creek, lower Klamath River, California, 1999-2008. Yurok Tribal Fisheries Program, Habitat Assessment and Biological Monitoring Division Technical Report No. 13, Klamath, California.

Gilroy, I.B., M. Longenbaugh, and J.C. Polos. 1992. Progress report for investigations on Blue Creek, FY 1990-1991. U.S. Fish and Wildlife Service, Coastal California Fishery Resource Office, Arcata, California.

Helley, E.J., and V.C. LaMarche, Jr. 1973. Historic flood information for Northern California streams from geological and botanical evidence. U.S. Geological Survey Professional Paper 485-E.

Longenbaugh, M. and J.R. Chan. 1994. Progress report for investigations on Blue Creek, FY 1993. U.S. Fish and Wildlife Service, Coastal California Fishery Resource Office, Arcata, California.