# ASSESSMENT OF ANADROMOUS SALMONID SPAWNING IN BLUE CREEK, TRIBUTARY TO THE LOWER KLAMATH RIVER, DURING 2011 - 2012

**Prepared by:**

Andrew Antonetti and Erika Partee
Yurok Tribal Fisheries Program
Lower Klamath Division
15900 Highway 101 North
Klamath, CA 95548

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## Table of Contents

## List of Figures



## List of Tables



## Appendices

## Acknowledgments

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## 1.0 Introduction

Historically the Klamath River Basin contained bountiful anadromous fish runs, supporting indigenous peoples throughout the region. Anthropogenic activities over the last 150 years, coupled with natural events, have resulted in substantial declines in these fish populations and widespread reduction and degradation of their associated habitat. Concern over diminishing runs resulted in the 1997 listing of Klamath Basin coho salmon (*Oncorhynchus kisutch*) as threatened under the Endangered Species Act (ESA). Klamath River chinook salmon (*O. tshawytscha*), steelhead (*O. mykiss*) and coastal cutthroat trout (*O. clarki clarki*) populations were also petitioned for ESA listing, and despite the listings being determined "Not Warranted", concerns regarding their status and long-term trends continues to exist.

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 1998).

The primary objectives of this project were to: 1) continue direct observation snorkel surveys and 2) implement mark/recapture techniques using an Area Under the Curve (AUC) methodology to generate an escapement estimate and stream residence times for chinook salmon. The results will contribute to long-term population assessment efforts and provide a means of assessing population trends in Blue Creek, as well as enhance our knowledge of the life history of Blue Creek fish populations. In addition, the results of this project will allow managers to assess Blue Creek's contribution to the overall Klamath Basin chinook salmon run, which is managed for tribal subsistence, commercial, and sport fishing. Continuation of this monitoring effort will further enhance our understanding of the magnitude and importance of Blue Creek's fish runs in the Klamath Basin.

## 2.0 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.

Blue Creek was historically vegetated with moderate to dense timber stands comprised mostly of coastal redwood (*Sequoia sempervirens*), Douglas fir (*Psuedotsuga menziesii*), Port Orford cedar (*Chamaecyparis lawsoniana*), incense cedar (*Libocedrus decurrens*), tanoak (*Lithocarpus densiflorus*), and madrone (*Arbutus menziesii*). Dominant riparian species include red alder (*Alnus rubra*), willow (*Salix* spp.), California laurel (*Umbellularia californica*), and big leaf maple (*Acer macrophyllum*).

Four major rock types of the Coastal Range and Klamath Mountains provinces underlie the Blue Creek watershed. Proceeding upstream from the mouth, Blue Creek flows through (1) sandstone and shale of the Franciscan Complex, (2) ultramafic rocks (serpentinized peridotite) of the Josephine Ophiolite (3) slate, metagraywacke, and greenstone of the Galice Formation and (4) an assemblage of diverse rock types (mostly metasedimentary) of the Western Paleozoic and Triassic Belt (Wagner and Saucedo 1987, as cited in Chan and Longenbaugh 1994). The streambed substrate is typically dominated by small and large cobble with numerous bedrock and boulder control points.

The Blue Creek watershed receives rainfall averaging approximately 100 inches in the headwaters, 75% of which occurs between November and March (Helley and LaMarche 1973). Stream discharge data collected in lower Blue Creek by the U.S. Geological Survey (USGS) for the period 1965-1978 indicate large seasonal flow variations. Stream flows over this period ranged from 43 cubic feet per second (cfs) on November 1, 1965 to 33,000 cfs on March 2, 1972. The extreme flood event of December 22, 1964, although outside the period of record, was estimated at 48,000 cfs (Chan and Longenbaugh 1994). The recurrence interval of this flood event, based on geomorphic evidence as well as radiocarbon analysis and tree ring counts of material entrained in historic Blue Creek flood deposits, is estimated to be at least 100 years (Helley and LaMarche 1973).

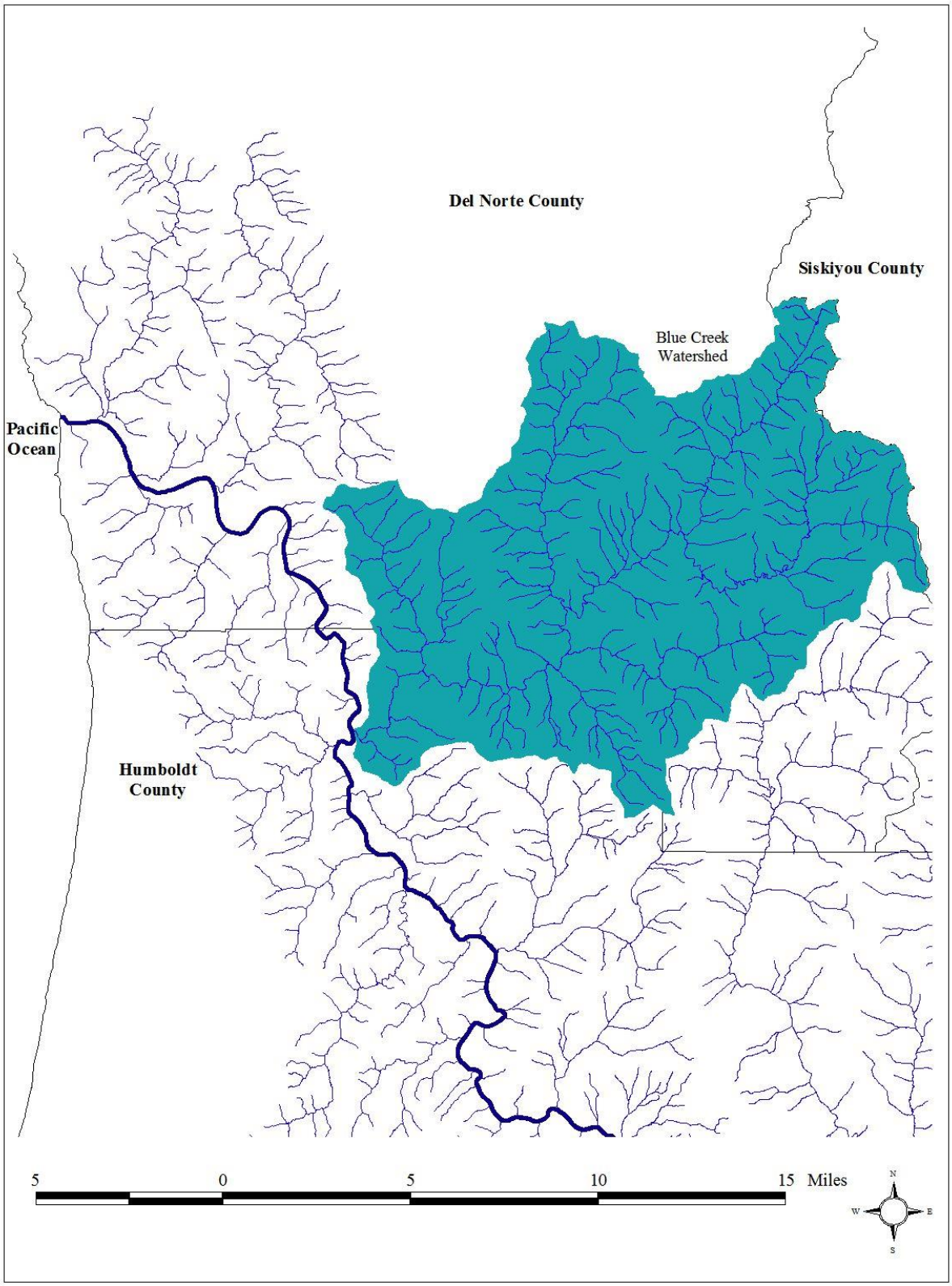


Figure 1. Location and extent of Blue Creek drainage within the Lower Klamath River Subbasin, California.

Three tributaries to Blue Creek have been identified as having importance to anadromous salmonid spawning and rearing (Figure 2). These include West Fork Blue Creek, Nickowitz Creek, and Crescent City Fork Blue Creek, which is the largest and lowest gradient tributary accessible to anadromous fish (Figure 2). These three tributaries comprise 41% of the entire watershed area, but both salmon and steelhead only extensively utilize the Crescent City Fork. Small numbers of salmon have previously been documented spawning in the lower one mile of the West Fork (Gale et al. 1998; Longenbaugh and Chan 1994), with steelhead extensively utilizing the majority of the drainage (Hayden 1998; 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 throughout the basin (Hayden 1998; Voight and Gale 1998). A fourth tributary, 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).

A natural barrier on the mainstem of Blue Creek is located approximately 0.25 miles below the confluence of the East Fork (rm 15) (Figure 2). This barrier, consisting of a very steep boulder jammed gorge, results in a complete blockage of upstream anadromous migration (Gale 1997a). 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 upper reaches at an undocumented point earlier in the century (Gale 1997a). Hereinafter, Blue Creek discussions are restricted to the lower 15 miles of stream accessible to anadromous salmonids.

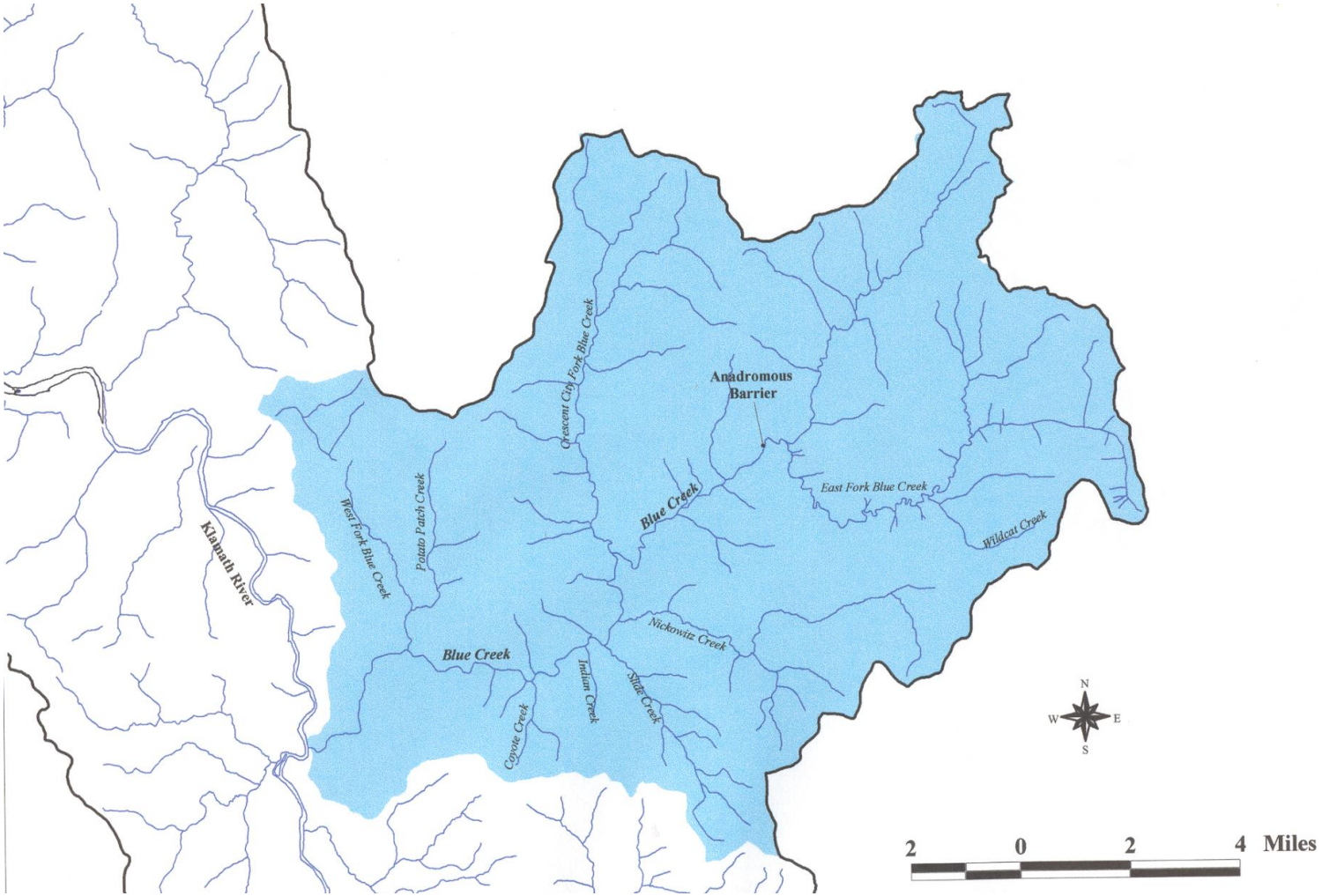


Figure 2. Blue Creek drainage, Lower Klamath River, California.

Blue Creek was historically vegetated with moderate to dense timber stands comprised mostly of coastal redwood (*Sequoia sempervirens*), Douglas fir (*Psuedotsuga menziesii*), Port Orford cedar (*Chamaecyparis lawsoniana*), incense cedar (*Libocedrus decurrens*), tanoak (*Lithocarpus densiflorus*), and madrone (*Arbutus menziesii*). Dominant riparian species include red alder (*Alnus rubra*), willow (*Salix* spp.), California laurel (*Umbellularia californica*), and big leaf maple (*Acer macrophyllum*).

As with many of the tributaries to the Lower Klamath River, widespread timber harvesting has occurred along portions of Blue Creek. Since the early 1960's, extensive road networks have been constructed and timber has been removed throughout virtually all of the West Fork drainage and the lower eight miles of the mainstem. Green Diamond Resource Company (GDRC) owns the land surrounding the lower 8.1 miles of Blue Creek, approximately 20% of the watershed, and logging continues to date in this portion of the watershed.

From the headwaters downstream to rm 8.1, the creek runs through Six Rivers National Forest (SRNF) lands. Virtually the entire Federally-owned portion of the Blue Creek basin is located in the Siskiyou Wilderness Area. The main exceptions are the portions of the Crescent City Fork, which are classified as Matrix land. The Matrix, defined as all land outside of the Reserves and "Congressionally Withdrawn Areas" (i.e. Wilderness Areas), is subject to timber harvest activities (FEMAT 1993).

Access to Blue Creek is limited in the lower reaches is limited to and regulated by GDRC, and access to the upper drainage is remote and inaccessible in some reaches during winter months. An arterial logging road maintained by GDRC parallels the southern side of Blue Creek several hundred feet above the creek from rm 2.1 to 6.0. This main road (GDRC Road #B-10) crosses Blue Creek at river mile 2.1, providing the only bridge crossing in the basin. Infrequently used roads branch off this maintained road, providing additional vehicle and/or ATV streamside access at rm 1.4, 5.6, and 8.1.Road access into the federally owned portion of the watershed (above rm 8.1) is very limited. A few old logging spur roads in the upper half of the Crescent City Fork provide vehicle access to within a half mile of the stream channel, and the USFS road #13N45 provides access (via Orleans and the "G-O" road) to within 1.5 miles of the mainstem anadromous barrier. Foot access to the stream channel from these roads is difficult due to steep terrain and dense vegetation. Use of these access points typically require survey crews to exit the channel via the GDRC road network beginning at rm 8.1 or via a foot trail to the South Red Mountain Road (USFS road #13N34).

The Yurok Tribe is currently partnering with Western Rivers Conservancy to acquire more than 47,000 acres from GDRC along the Lower Klamath River and within the Blue Creek watershed. Goals of this acquisition include establishing an ecosystem-level corridor in permanent protective stewardship, enhancing native fish and wildlife habitats, and improving water quality.

## 3.0 Methods & Materials

### 3.1 Fall Spawning Surveys

The Yurok Tribal Fisheries Program conducted snorkel surveys from October 11 through December 14 in 2011, and from October 15 through November 28 in 2012, to assess salmonid spawning activity. Diving in 2012 was limited by precipitation that resulted in unsuitable stream conditions for diving. Spawning survey data collection methods remained consistent throughout the survey periods. All surveys were conducted using direct observation (mask and snorkel) techniques until heavy fall/winter rains resulted in ineffective and/or unsafe sampling conditions.

#### 3.1.1 Equipment

All spawning surveys utilized direct observation methodology during snorkel surveys. Snorkel surveys required the use of either a full 7 mm neoprene wetsuit or snorkeling dry suit, dive hood, gloves, and mask/snorkel. Additionally, all crew members wore felt-soled stream boots for added traction on wet, slippery surfaces, and carried waistpack dry bags containing data collection kits. Data collection kits included flagging, a field notebook, markers, underwater camera, reach maps, datasheets, scale envelopes, and a small knife to collect scale samples.

#### 3.1.2 Snorkel Survey Methods

The YTFP assumed responsibility of Blue Creek spawner surveys in 1994. For consistency and logistical reasons, reaches #1-4 were based on reaches established by USFWS during their 1989-1993 snorkel surveys. Surveys between 1994 – 1996 were limited to weekly surveys of the lower four reaches. Between 1995 and 1998, in an effort to provide a more comprehensive basin-wide coverage, YTFP extended spawning survey efforts to include an additional 13.1 miles of the Blue Creek drainage, which included the upper portion of the mainstem (between reach #4 and the anadromous barrier), the Crescent City Fork, Nickowitz Creek and West Fork Blue Creek (Figure 3). Surveys were conducted weekly (weather and flows permitting) in reaches #1-4 during the fall spawning season, which is typically initiated in late September or October prior to the arrival of late-fall chinook and continued until heavy rains commence and flow conditions became unsafe and/or unsuitable for snorkel surveys. Surveys in the upper reaches were typically surveyed bi-weekly after the first fall chinook appeared in Lower Blue Creek (Gale 2009).

YTFP conducted snorkel surveys over a period of eight weeks in 2011, with surveys occurring during six weeks. In addition, reach #1 was surveyed for surveillance purposes on October 11, 2011. Weekly surveys of reaches #1-4 began on October 27, 2011. Reaches #1-4 were surveyed weekly six times between October 27 and December 16, with no surveys occurring during the weeks starting October 31, 2011 and November 21, 2011 due to high flows and low visibility. The upper mainstem Blue Creek (reach #5) and Crescent City Fork (reach #6) were each surveyed three times during the 2011 season (November 16, November 29, and December 14, 2011). The West Fork (Reach #8) was surveyed twice during the season (November 28 and December 6, 2011). The upper

Crescent City Fork (reach #7) and Nickowitz Creek were not surveyed in 2011 due to the short window of suitable weather for diving.

YTFP conducted snorkel surveys in 2012 over a period of four weeks, with surveys occurring during three weeks. In addition, reach #1 was surveyed for surveillance purposes on October 15, 2012. Weekly surveys of reaches #1-4 began November 7, 2012. Reaches #1-4 were surveyed weekly three times between October 15 and December 16, 2012, with no surveys occurring during the week starting November 19, 2012 due to high flows and low visibility. Surveys were not conducted in reaches #5-8 in 2012.

In 2012 the study period for this project was shortened due to an extremely high rainfall season (Figure 3). In past years in order to encompass the majority of the chinook salmon run YTFP has aimed to conduct surveys from early October until as late into December as weather allows, with surveys spanning an average of 10.6 weeks (1999-2009). Surveys in 2012 spanned four weeks, between October 15 and November 28, with surveys occurring during three of these weeks. Ideal conditions for snorkel surveys in Blue Creek exist when stream discharge is between 200 and 500 cfs. Above this range visibility conditions decrease rapidly due to increased turbidity and bubbles curtains, which in combination with increased swimming speed can compromise diver safety and count accuracy. Streamflow estimates during the four-week study period ranged between 91 – 350 cfs, and 24.16 inches of rain were recorded (Yurok Tribe Environmental Program, Blue Creek Gaging Station unpublished data). Conditions after the last week of surveys (November 28) did not permit further surveying, with an additional 21.39 inches of rain falling in December, and streamflow reaching 9,202 cfs.

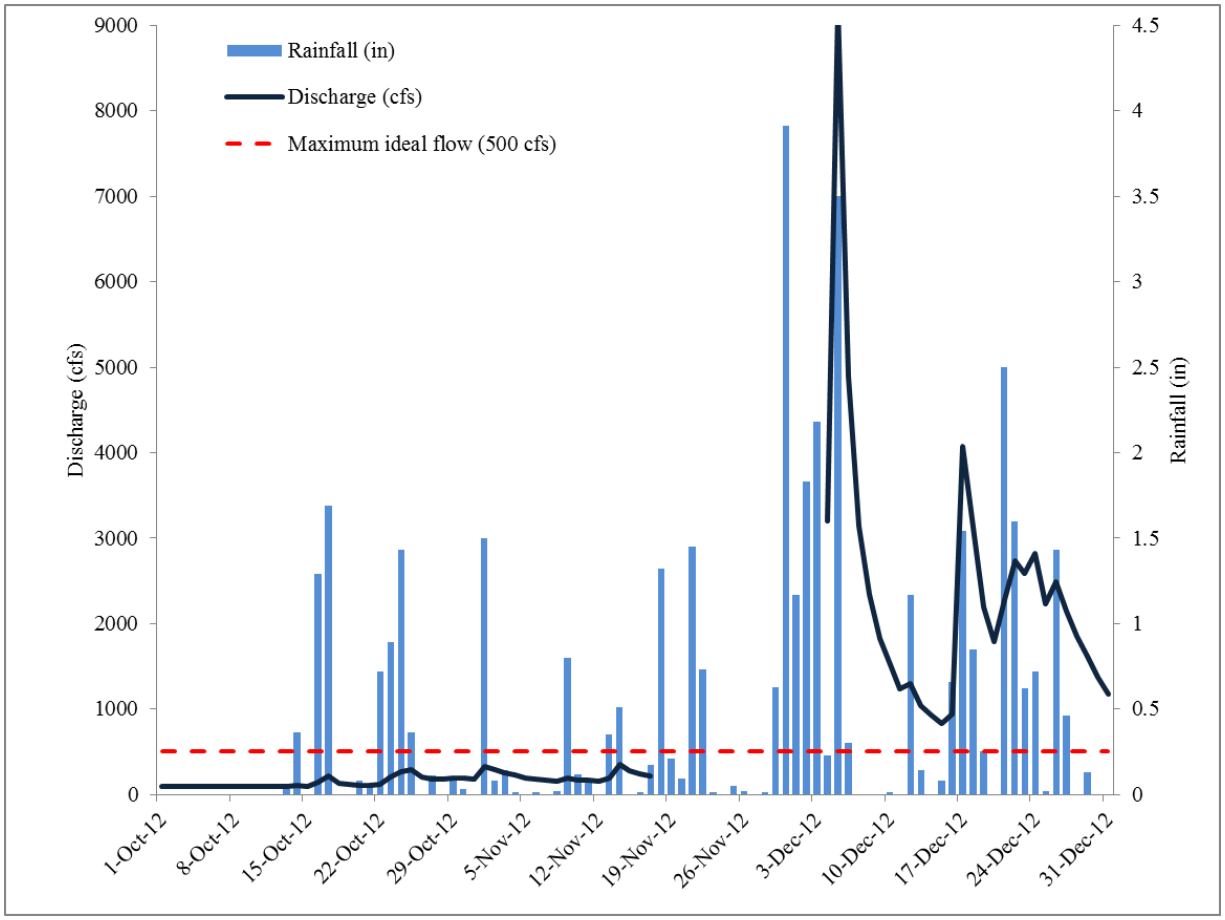


Figure 3. Discharge, precipitation, and maximum ideal flow for snorkel surveys during fall/winter 2012, Blue Creek, Klamath, California.

Snorkel survey crews, consisting of two to four divers, swam downstream in parallel lanes and collected data on redds, live fish, carcasses, and other biological observations (test redds, predators, etc.). In an attempt to provide comparable counts and maximum coverage of the stream channel, additional crewmembers surveyed at times of increased flows and/or reduced water visibility. When heavy rain resulted in unsuitable snorkeling conditions, surveys were postponed until conditions improved. In order to maximize consistency between surveys, crews followed specific data collection protocols:

1) ***Redds***. Each identified "area" of redd construction was assigned a location number ("R-#") and its geographical location was marked on a topographic map. Multiple redds in one location would be counted and described separately in the notes but grouped together under one location number on the map. Each new area of redd construction was flagged at the downstream extent of the disturbed substrate to prevent double counting between surveys. Pertinent data such as overall redd dimensions (length x width), depth of the mound (or "tail-spill") and pit, and other site-specific observations such as fish presence, habitat type, construction stage, and redd age were recorded in a field notebook.

2) ***Live Fish Sightings***. In addition to adult chinook salmon, YTFP also collected biological data on other adult salmonids observed. Each fish sighting was assigned a location number ("F-#") and corresponding site location on the survey map. For each site, the number of each species observed and the habitat type was recorded. In addition, crews recorded the estimated age class (adult vs. jack), sex, and relative condition of observed fish, as well as the presence of any clips, marks, or scars when possible. Oftentimes, factors such as fluctuating stream-flow and water visibility, large schools of fish, and/or swiftly darting fish frequently limited such detailed data collection.

3) ***Carcasses***. The location of each observed carcass was assigned a corresponding number ("C-#") on the survey map as they were encountered during a survey. In addition, the following biological data for each carcass was recorded: species, sex, fork length, estimated % "spent" or spawned out, the relative condition, and any identifying clips, marks or scars. A scale sample was collected from each carcass when possible. A piece of flagging with the date was attached to each carcass so that it would not be recounted during subsequent surveys. Heads were collected from all adipose-clipped carcasses for coded-wire tag retrieval to determine hatchery origin.

Reach delineations are as follows (Figure 4):

- **Reach #1**:

From the confluence with the Klamath River upstream to the Simpson road #B-10 bridge crossing (total length: 2.1 miles).

- **Reach #2**:

Upstream from the Blue Creek Bridge to the "B-10X" road access at river mile 5.6 (total length: 3.5 miles).

- **Reach #3:**

Between the "B-10X" road access and the Slide Creek confluence pool, 8.1 miles from the mouth (total length: 2.5 miles).

- **Reach #4**:

Between the Slide Creek confluence pool and the mouth of the Crescent City Fork (total length: 2.2 miles).

- **Reach #5**:

The upper mainstem of Blue Creek, from the Crescent City Fork (CCF) confluence to the anadromous barrier (total length: 4.25 miles).

- **Reach #6**:

The lower portion of the CCF, between the mouth and the U.S. Forest Service (USFS) Road # 13N34A trail access (total length: 3.5 miles).

- **Reach #7**:

The upper portion of the CCF, between the USFS Road # 13N34A trail access and the USFS Road #14N01C trail access (total length: 3.5 miles).

- **Reach #7b**:

Unnamed tributary to the CCF ("Doctor Rock Creek") – enters the CCF in T13N, R3E, NE ¼ Section 9 (total length: 0.75-1.0 miles).

- **Reach #8**:

The lower portion of West Fork Blue Creek, from the Potato Patch Creek confluence to the mouth (total length: 0.85 miles).

- **Reach #9**:

Lower portion of Nickowitz Creek, upstream from its confluence with Blue Creek (total length: 0.75-1.0 miles).

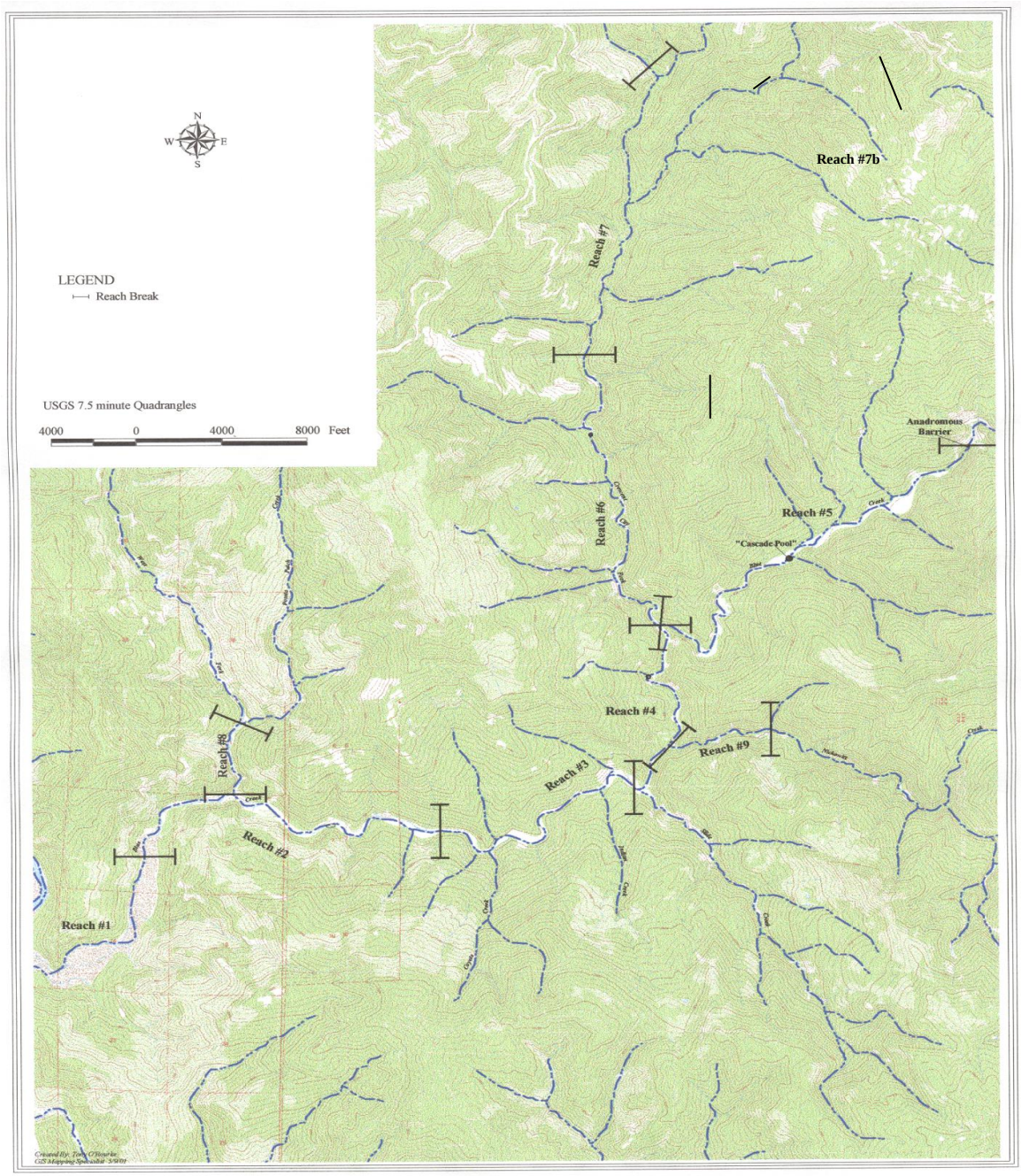


Figure 4. Location of adult spawner survey reaches in Blue Creek, Lower Klamath River, California.

### 3.2 Area-Under-the-Curve (AUC) Escapement Estimates

*Salmon Capture and Tagging*

Adult salmon were captured to collect age, sex, and length data using either angling gear or a gill net. Pools in Reach #1 of Blue Creek were targeted due to access and the ability to sample fish prior to their arrival at their spawning grounds. Divers initially snorkeled pools to determine fish abundance, after which time a 4" gill net was deployed in pools selected by divers. Divers herded fish into the nets by swimming upstream from the pool tailout. Captured fish were immediately placed into holding tubes, and when fishing efforts were exhausted, all fish were measured, sexed, tagged, assigned an identifying number and released.

Adult salmonids were tagged with highly visible streamer tags on their dorsal fins to estimate residence times. White 'spaghetti' floy tags were applied to adult salmonids in addition to Hi-Viz Artic Flagging, which included capture/tag date and fish identification number clearly marked on it. Floy tags were inserted through the posterior end of the dorsal fin using a 6" long by 1/8" diameter hollow needle. Hi-Viz Arctic Flagging was then attached to the Floy tag using a square knot, with 4-8"of flagging trailing behind the knot. The color of the flagging was changed weekly, and all tagged fish were marked with a hole punch in the anal fin as a secondary mark.

*Residence time*

Residence time is defined as the average duration that individuals of a species spend alive in a stream (Hetrick 2003). The residence time of chinook in Blue Creek was measured in 2011 by marking two separate batches of fish during two separate marking events (weeks starting November 7 and November 14) with different colored streamer tags. In 2012 three separate marking events took place (weeks starting October 15, October 29, and November 5). Tagged fish were counted on subsequent snorkel surveys. Counts of tagged fish were plotted against time to yield a tag depletion curve, with the intercept of the y axis representing the total number of tags (100%) at the beginning of each survey. The area under the tag depletion curve was then divided by the original number of tags deployed to estimate a period specific residence time (rt) (in fish days) for that time period. Number Cruncher Statistical Software (NCSS) was used to calculate area under the tag depletion curve.

*Escapement Estimates*

Escapement was calculated for chinook by extrapolating snorkel survey counts using the area-under-the-curve method as defined by the equation:

$$E = \sum_{i=1}^{a} ([C_i / O_i]t_i) / rt$$

Where $E$ is the escapement estimate, $a$ equals the number of survey periods, $C_i$ is the count for the $i^{th}$ survey, $O_i$ is the observer efficiency for the $i^{th}$ survey, $t_i$ is the number of

days between surveys: *rt* is the residence time (in days) for the species counted (Irvine et al 1993). $O_i$ was assumed to be 1.00 for all surveys.

*Observer Efficiency*

During each snorkel survey, divers rated observer efficiency parameters: Water clarity, discharge, and weather were rated from 1 to 4, 1 being poor survey conditions and 4 being excellent survey conditions. $O_i$ needed to be tested after each marking session. Due to budget limitations Yurok Tribal Fisheries Program (YTFP) was unable to conduct tests of this variable, therefore observer efficiency was assumed to be 1.00.

## 4.0 Results & Discussion

### 4.1 Spawning Surveys

*2011*

In 2011, YTFP surveys of the lower Blue Creek mainstem (reaches #1-4) resulted in weekly observations of chinook salmon ranging from a low of 89 adults and 51 jacks during the week starting October 24 to a peak count of 1,143 adults and 418 jacks during the week starting November 7 (Table 1, Figure 5). This is the highest peak count of adult and jack chinook recorded in lower Blue Creek since surveys began 1988 (Figure 5). This peak count was followed by two additional record-breaking survey weeks for chinook adults, during week starting November 14 (1,209 adults and 309 jacks) and November 28 (1,144 adults and 153 jacks). The last two weeks of surveys (weeks starting December 5 and December 12), YTFP snorkelers observed 926 adults and 110 jacks, and 712 adults and 76 jacks, respectively.

Coho were first observed in lower Blue Creek reaches (#1-4) during the first week of surveys (five adults and one jack) (Table 1). Peak count of coho occurred during the week starting November 14, when 13 adults and 30 jacks were observed. However, peak count of coho adults occurred the week starting December 12, with 28 observed. Steelhead were observed in reaches #1-4 throughout the study period, and peak count of 28 adults and six half-pounders occurred during the week starting December 12. One cutthroat was observed during 2011 snorkel surveys, on December 16 in reach #1.

Upper reaches (#5-8) of Blue Creek were surveyed as staff availability and water quality conditions allowed in 2011. Reaches #5-6 were surveyed three times, with a combined peak count of 249 adults and 45 jacks on November 29 (Table 1). Reach #8 was surveyed twice, however chinook were only observed during the survey conducted on November 28 (five adults and one jack). A total of 21 coho adults and three coho jacks were observed in reaches #5, 6, and 8 in 2011, and one steelhead adult. Reach #7 was not surveyed in 2011.

A total of 364 new redds were observed in all seven reaches surveyed throughout the study period. One redd was observed during the first week of surveying, and peak count of 224 new redds were observed during the week starting November 28. Reach #1 had

the highest number of new redds with 137 observed, followed by reach #2 with 96 new redds, and reach #6 with 53 new redds (Table 1, Appendix 1). Biological data and scale samples were taken from 192 chinook carcasses during 2011. Most of these carcasses were retrieved from reach #1 (n=99), followed by reach #2 (n=61) and reach #3 (n=22).

*2012*

In 2012, YTFP surveys of the lower Blue Creek mainstem (reaches #1-4) resulted in weekly observations of chinook salmon ranging from a low of 361 adults and 53 jacks on November 28 (all four reaches were surveyed on this date) to a peak count of 761 adults and 406 jacks occurring during the week starting November 5 (Table 2, Figure 5). Surveys were conducted during a third week, starting November 12, when 742 adults and 209 jacks were observed.

Coho were observed throughout the survey period, with a peak count of 18 adults and no jacks occurring during the week starting November 12 (Table 2). A peak count of 8 adults and 57 half-pounders also occurred during this week, though steelhead were observed throughout the survey period. Three adult cutthroat were observed during 2012 surveys; all on November 15 in reach #2. Steelhead were also observed throughout the survey period, and peak count of 8 adults and 57 half-pounders occurred during the week

A total of 104 new redds were observed in reaches #1-4 during 2012 surveys. Redds were first observed during the first week of surveys (21 new redds), and peak count of 46 new redds occurred during the week starting November 12 (Table 2, Appendix 1). Reach #2 had the highest number of new redds with 52 observed, followed by reach #1 with 37 new redds (Appendix 1). Biological data and scale samples were taken from eight chinook carcasses during 2012.

Table 1. Summary of adult salmonids, redds, and carcasses observed by reach during snorkel surveys, Blue Creek, Lower Klamath River, California, 2011.

| | | Chinook | | Coho | | Steelhead | | Adult | Unidentified | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Reach | Adult | Jack | Adult | Jack | Adult | 1/2 pounder | Cutthroat (>12") | Adult Salmonid | New Redds | Carcasses |
| 11-Oct-11 | 1 | 1 | 0 | 0 | 0 | 0 | 25 | 0 | 0 | 0 | 0 |
| | Total: | 1 | 0 | 0 | 0 | 0 | 25 | 0 | 0 | 0 | 0 |
| 28-Oct-11 | 1 | 5 | 1 | 3 | 0 | 2 | 0 | 0 | 0 | 0 | 0 |
| 28-Oct-11 | 2 | 30 | 35 | 2 | 0 | 7 | 0 | 0 | 0 | 1 | 0 |
| 27-Oct-11 | 3 | 45 | 13 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 27-Oct-11 | 4 | 9 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Total: | 89 | 51 | 5 | 1 | 9 | 0 | 0 | 0 | 1 | 0 |
| 9-Nov-11 | 1 | 155 | 52 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 10-Nov-11 | 2 | 679 | 319 | 0 | 13 | 0 | 0 | 0 | 0 | 17 | 1 |
| 10-Nov-11 | 3 | 152 | 16 | 2 | 0 | 1 | 0 | 0 | 0 | 1 | 0 |
| 10-Nov-11 | 4 | 157 | 31 | 2 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| | Total: | 1143 | 418 | 4 | 13 | 1 | 0 | 0 | 0 | 20 | 1 |
| 15-Nov-11 | 1 | 240 | 24 | 3 | 0 | 1 | 0 | 0 | 0 | 14 | 0 |
| 15-Nov-11 | 2 | 559 | 254 | 8 | 1 | 1 | 0 | 0 | 0 | 20 | 1 |
| 15-Nov-11 | 3 | 169 | 31 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 |
| 15-Nov-11 | 4 | 241 | 0 | 2 | 28 | 0 | 0 | 0 | 0 | 7 | 0 |
| 16-Nov-11 | 5 | 90 | 14 | 0 | 0 | 0 | 0 | 0 | 0 | 11 | 0 |
| 16-Nov-11 | 6 | 42 | 10 | 0 | 1 | 0 | 0 | 0 | 0 | 2 | 0 |
| | Total: | 1341 | 333 | 13 | 30 | 2 | 0 | 0 | 0 | 57 | 1 |
| 2-Dec-11 | 1 | 374 | 45 | 3 | 0 | 0 | 0 | 0 | 0 | 96 | 21 |
| 1-Dec-11 | 2 | 413 | 78 | 6 | 0 | 2 | 1 | 0 | 0 | 30 | 8 |
| 1-Dec-11 | 3 | 219 | 19 | 0 | 0 | 2 | 0 | 0 | 0 | 30 | 0 |
| 1-Dec-11 | 4 | 138 | 11 | 0 | 0 | 0 | 0 | 0 | 0 | 7 | 3 |
| 29-Nov-11 | 5 | 77 | 24 | 1 | 0 | 0 | 0 | 0 | 0 | 18 | 0 |
| 29-Nov-11 | 6 | 172 | 21 | 7 | 0 | 0 | 0 | 0 | 0 | 43 | 1 |
| 28-Nov-11 | 8 | 5 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Total: | 1398 | 199 | 17 | 0 | 4 | 1 | 0 | 0 | 224 | 33 |
| 8-Dec-11 | 1 | 270 | 42 | 4 | 0 | 7 | 0 | 0 | 0 | 26 | 38 |
| 7-Dec-11 | 2 | 398 | 40 | 6 | 0 | 2 | 0 | 0 | 0 | 22 | 21 |
| 7-Dec-11 | 3 | 119 | 10 | 2 | 0 | 0 | 0 | 0 | 0 | 7 | 13 |
| 7-Dec-11 | 4 | 139 | 18 | 3 | 0 | 0 | 0 | 0 | 0 | 1 | 3 |
| 6-Dec-11 | 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Total: | 926 | 110 | 15 | 0 | 9 | 0 | 0 | 0 | 56 | 75 |
| 16-Dec-11 | 1 | 243 | 31 | 11 | 0 | 20 | 0 | 1 | 0 | 0 | 40 |
| 15-Dec-11 | 2 | 286 | 30 | 12 | 0 | 7 | 6 | 0 | 0 | 6 | 30 |
| 15-Dec-11 | 3 | 69 | 9 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 9 |
| 16-Dec-11 | 4 | 114 | 6 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| 14-Dec-11 | 5 | 50 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 11 |
| 14-Dec-11 | 6 | 59 | 9 | 13 | 2 | 1 | 0 | 0 | 0 | 8 | 5 |
| | Total: | 712 | 76 | 28 | 0 | 28 | 6 | 1 | 0 | 6 | 82 |
| **Surveys halted after December 16, 2011 due to continuous high flows** | | | | | | | | | | | |

Reach #1: Simpson Bridge Crossing to Blue Creek Mouth (2.1 miles)
Reach #2: Simpson Road #B10X Access to Simpson Bridge Crossing (3.5 miles)
Reach #3: Slide Creek Confluence to Simpson Road #B10X Access (2.5 miles)
Reach #4: Crescent City Fork Confluence to Slide Creek Confluence (2.2 miles)
Reach #5: Mainstem reach upstream of Forks
Reach #6: Lower Crescent City Fork Blue Creek

Table 2. Summary of adult salmonids, redds, and carcasses observed by reach during snorkel surveys, Blue Creek, Lower Klamath River, California, 2012.

| | | | Chinook | | Coho | | Steelhead | | Adult | Unidentified | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Week | Reach | Adult | Jack | Adult | Jack | Adult | 1/2 pounder | Cutthroat (>12") | Adult Salmonid | New Redds | Carcasses |
| 15-Oct-12 | | 1 | 1 | 5 | 0 | 0 | 0 | 25 | 0 | 0 | 0 | 0 |
| | | Total: | | | | | | | | | | |
| 7-Nov-12 | 1 | 1 | 192 | 104 | 3 | 1 | 2 | 25 | 0 | 0 | 13 | 0 |
| 6-Nov-12 | 1 | 2 | 289 | 179 | 10 | 0 | 4 | 15 | 0 | 0 | 5 | 0 |
| 6-Nov-12 | 1 | 3 | 143 | 83 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 6-Nov-12 | 1 | 4 | 137 | 40 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 1 |
| | | Total: | 761 | 406 | 14 | 1 | 6 | 40 | 0 | 0 | 21 | 2 |
| 15-Nov-12 | 2 | 1 | 256 | 40 | 0 | 0 | 2 | 20 | 0 | 0 | 13 | 0 |
| 15-Nov-12 | 2 | 2 | 338 | 110 | 15 | 0 | 5 | 15 | 3 | 0 | 25 | 1 |
| 14-Nov-12 | 2 | 3 | 84 | 22 | 0 | 0 | 1 | 12 | 0 | 0 | 1 | 0 |
| 14-Nov-12 | 2 | 4 | 64 | 37 | 3 | 0 | 0 | 10 | 0 | 0 | 7 | 0 |
| | | Total: | 742 | 209 | 18 | 0 | 8 | 57 | 3 | 0 | 46 | 1 |
| 28-Nov-12 | 3 | 1 | 91 | 15 | 0 | 0 | 3 | 0 | 0 | 0 | 11 | 4 |
| 28-Nov-12 | 3 | 2 | 137 | 28 | 0 | 0 | 2 | 0 | 0 | 0 | 22 | 1 |
| 28-Nov-12 | 3 | 3 | 32 | 4 | 0 | 0 | 1 | 0 | 0 | 0 | 3 | |
| 28-Nov-12 | 3 | 4 | 101 | 6 | 3 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| | | Total: | 361 | 53 | 3 | 0 | 6 | 0 | 0 | 0 | 37 | 5 |
| **Surveys halted after November 28, 2012 due to continuous high flows** | | | | | | | | | | | | |

Reach #1: Simpson Bridge Crossing to Blue Creek Mouth (2.1 miles)
Reach #2: Simpson Road #B10X Access to Simpson Bridge Crossing (3.5 miles)
Reach #3: Slide Creek Confluence to Simpson Road #B10X Access (2.5 miles)
Reach #4: Crescent City Fork Confluence to Slide Creek Confluence (2.2 miles)
Reach #5: Mainstem reach upstream of Forks
Reach #6: Lower Crescent City Fork Blue Creek

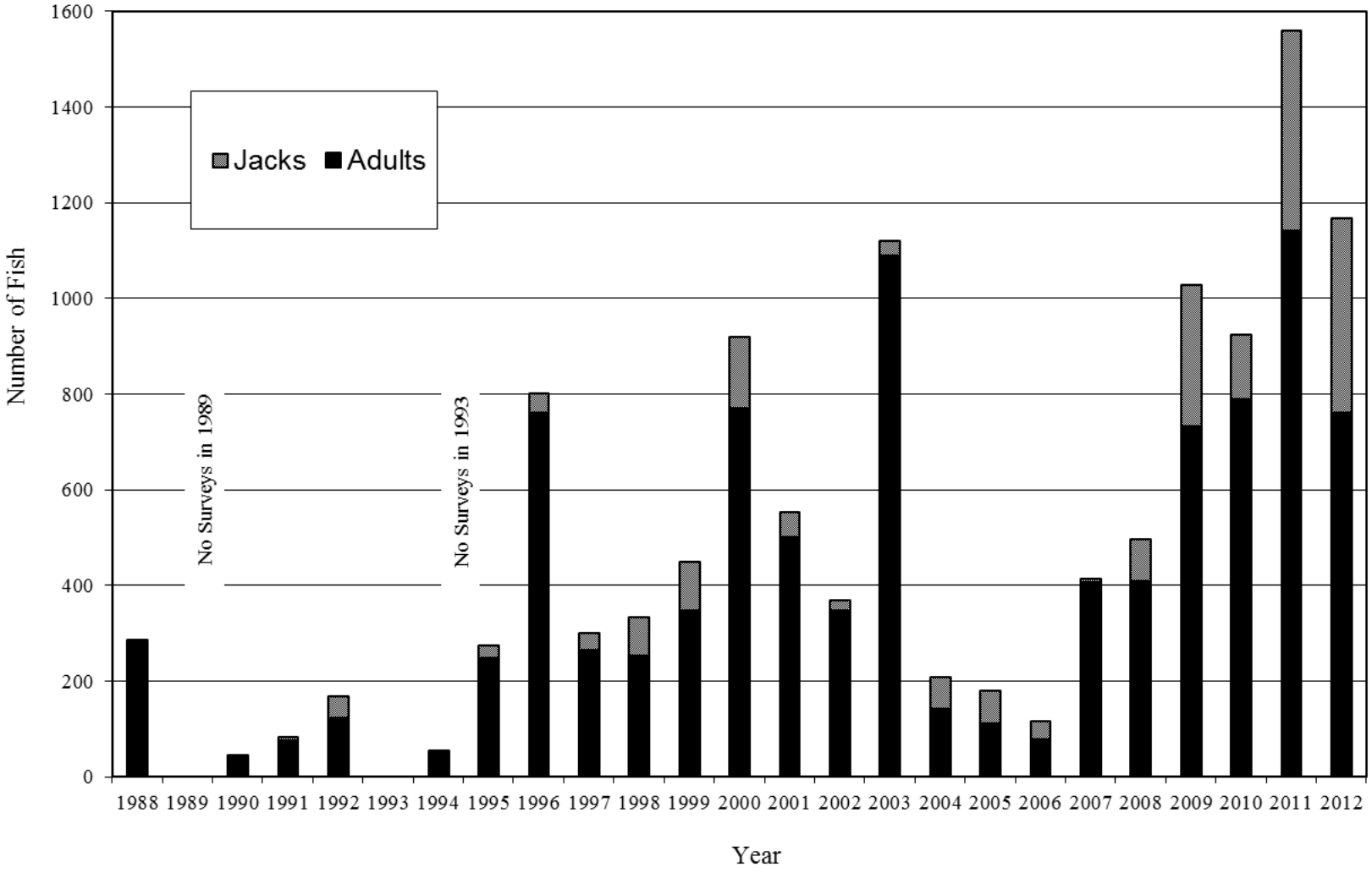


Figure 5. Annual peak counts of late-fall run Chinook salmon in reaches #1 – 4 in Blue Creek between 1989 – 2012.

### 4.2 Salmon Capture and Tagging

2011

YTFP staff captured and tagged a total of 21 adult chinook salmon during four days of tagging in 2011 (Appendix 2). Seven males and 14 females with fork lengths ranging from 23 to 41 inches were tagged at three sites within reach #1. Scales were collected from 20 individuals.

2012

YTFP staff captured, tagged, and collected scale samples from a total of 19 adult chinook salmon during four days of tagging in 2012. Nine males, eight females, and two chinook of unknown sex with fork lengths ranging from 21.5 to 42.5 inches were tagged at two sites within reach #1.

### 4.3 Residence Times

Mean residence time for the study period was estimated to be 11.38 fish days, with residence time decreasing for each subsequently tagged group. Residence time for fish tagged during marking event #1 was 17.01 days and 5.74 days for marking event #2.

No residence time was generated during the 2012 seasons due to the high flows that halted surveys.

### 4.4 Escapement Estimates

Two escapement estimates were generated in 2011. The first was based on residence time estimates determined in 2011 alone, and the second is from average residence times from all surveyed seasons combined. Using the first method, run escapement for Blue Creek from the beginning of the run to the final survey on 16-Dec-11 was estimated to be 6106.5 (+/-876.7) chinook, with a mean residence time of 11.38 days. Using residence times (rt) from 2004 (rt =11.66), 2009 (rt=16.18) and 2011(rt=11.38) resulted in an escapement estimate of 5314.5 (+/-763.0).

No escapement estimate was generated during 2012.

### 4.5 Length, Age, and Sex Composition

In 2011, 21 live chinook were measured and sampled for scales during tagging and marking activities. During snorkel surveys an additional 124 chinook carcasses were measured sampled for scales. Scale analysis determined 14 chinook to be jacks and 120 to be adults. Mean fork length was 54 (+/-5.28) cm for jack chinook (n=14), 89 (+/-10.34) cm for three year old chinook (N=16), 94 (+/-6.19) cm for four year old chinook (N=97) and 99 (+/-3.35) cm for five year old chinook (N=7). Scales were not successfully analyzed for ten adult chinook sampled.

## 5.0 Conclusion

Estimating salmon escapement in Blue Creek can be a challenging task. During high water years like 2012 it can be difficult to physically capture and visually recapture marked fish due turbid water and the inability to conduct surveys because of high flow conditions. Between October 1 and December 31, 41 inches of rain fell on the Blue Creek watershed, resulting in flows up to 9,202 cfs and preventing surveys after late November. As a result YTFP could not adequately mark and recapture enough individual chinook to determine residence times and no AUC escapement estimate was made for this year.

The YTFP has conducted direct observation snorkel surveys in Blue Creek over the past decade using the Peak Count Method. By successfully applying the AUC method with the snorkel surveys, we are often able to generate an escapement estimate for fall chinook in Blue Creek. In order to accurately estimate adult escapement in Blue Creek in future years, we recommend continuing to study stream residence time as long into the salmon run as weather allows for safe capture and recapture techniques. By collecting multiple years of residence time data, we may be able to calculate a mean residence time for fall-run Chinook in Blue Creek and use those metrics to back-calculate escapement estimates for prior survey years.

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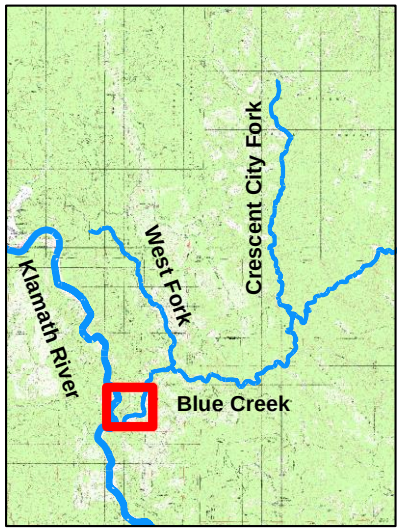
# APPENDIX I:

## Blue Creek Spawner Surveys 2011-2012

## Reach #1-6 Redd Location Maps

# Blue Creek Spawner Surveys 2011-2012
## Reach #1 Redd Locations



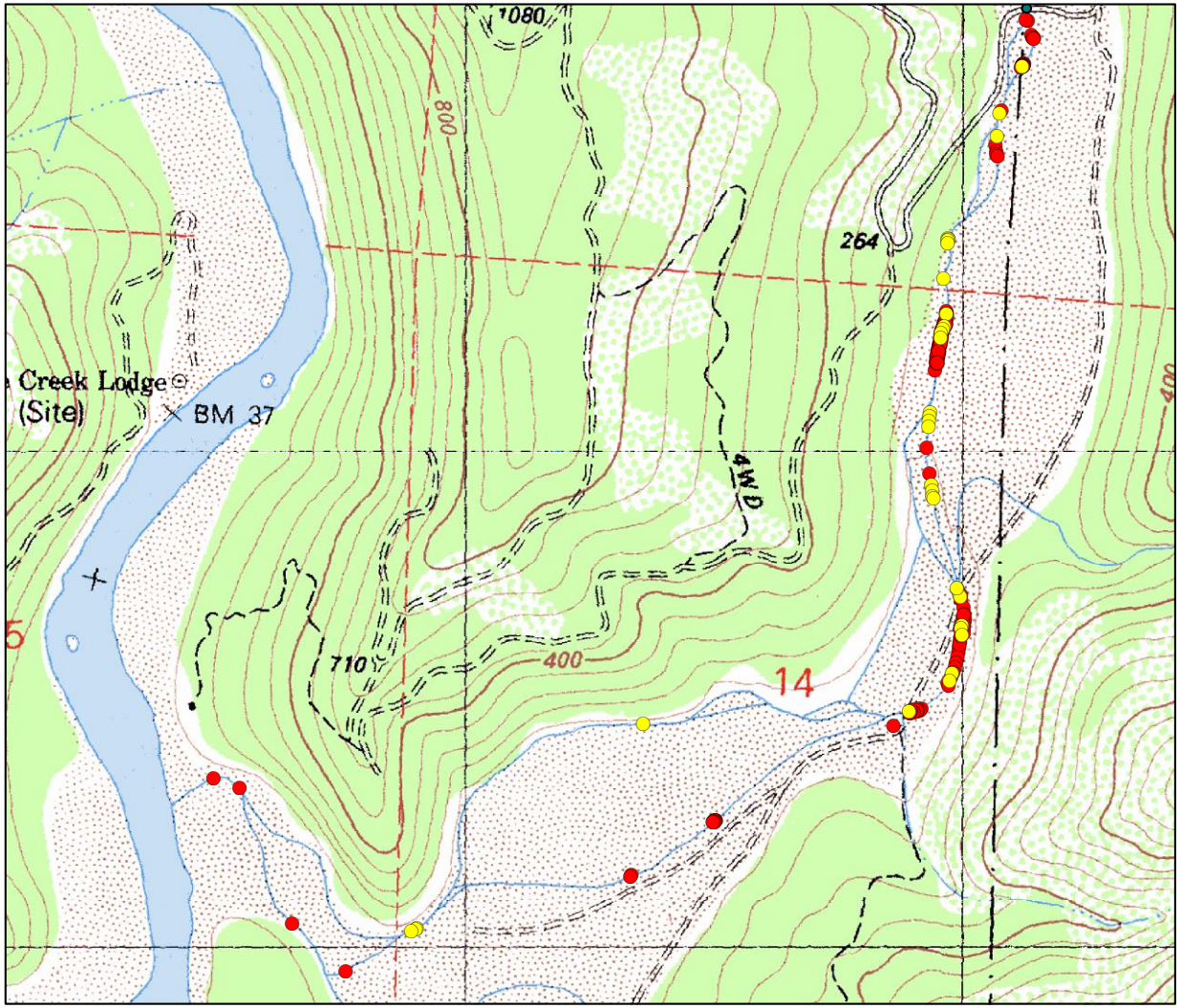

**Legend**

- 2012 Redds
- 2011 Redds

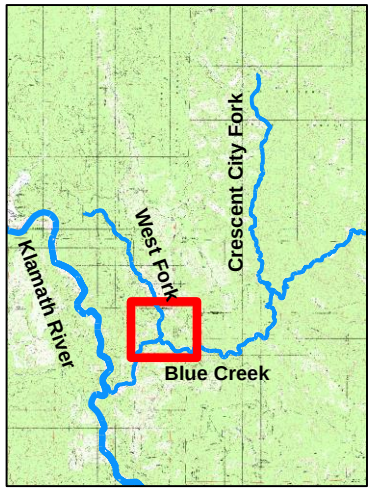
N

0 0.1 0.2 0.4 Miles

Map created by Yurok Tribal Fisheries Progam 8/22/2013 using locations recorded by YTFP staff overlaid onto USGS DRG Topographic Quadrangles Courtesy of Yurok Tribe GIS Department.
(NOTE: Redd locations are visual estimates and do not represent points collected with GPS equipment)



# Blue Creek Spawner Surveys 2011-2012
## Reach #2 Redd Locations



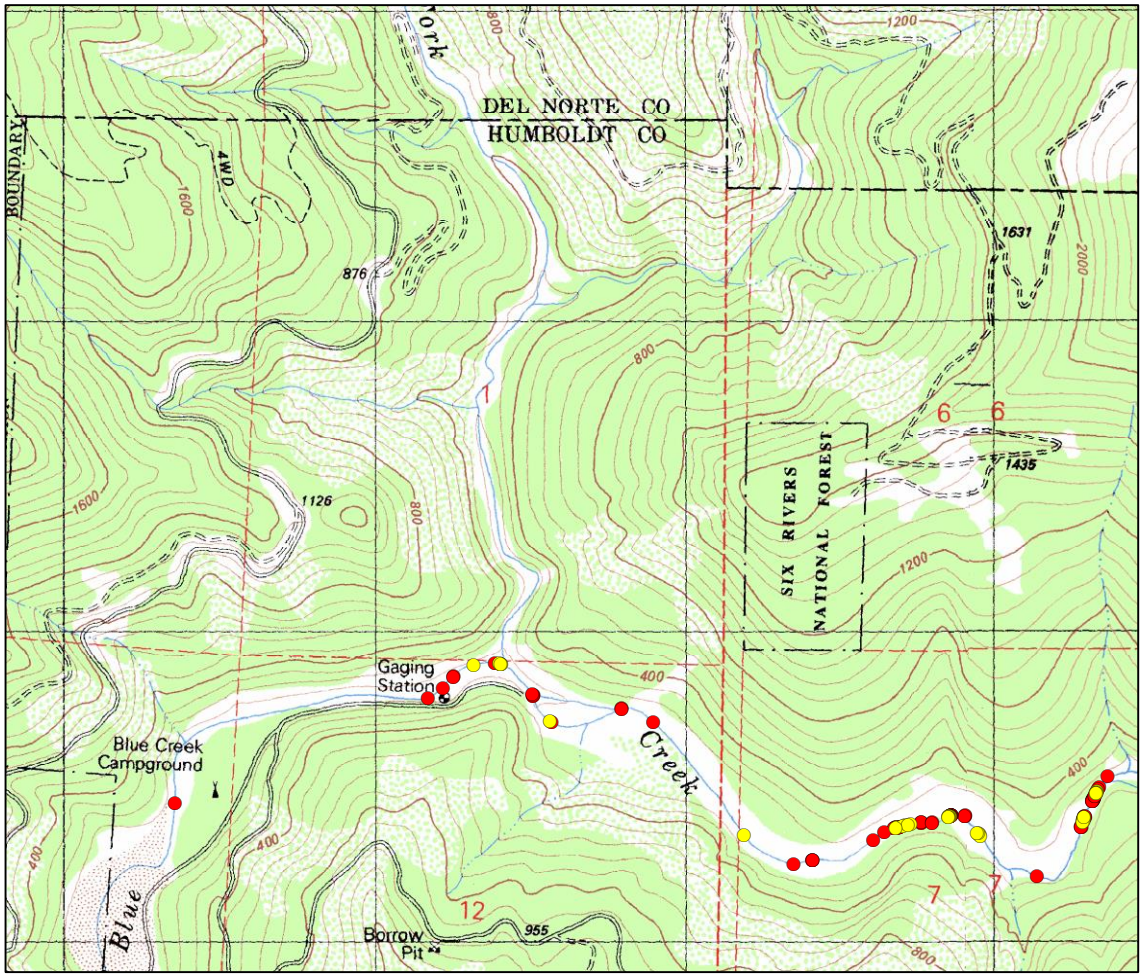

**Legend**

- 2012 Redds
- 2011 Redds

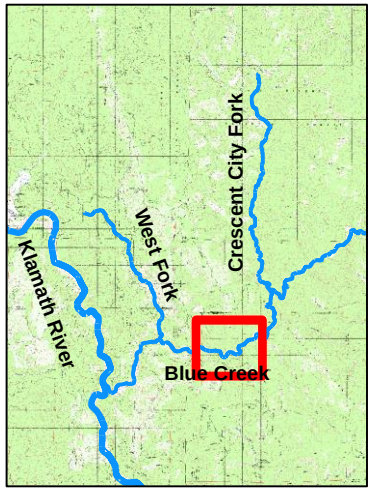
N

0 0.15 0.3 0.6 Miles

Map created by Yurok Tribal Fisheries Progam 8/22/2013 using locations recorded by YTFP staff overlaid onto USGS DRG Topographic Quadrangles Courtesy of Yurok Tribe GIS Department.
(NOTE: Redd locations are visual estimates and do not represent points collected with GPS equipment)



# Blue Creek Spawner Surveys 2011-2012
# Reach #3 Redd Locations



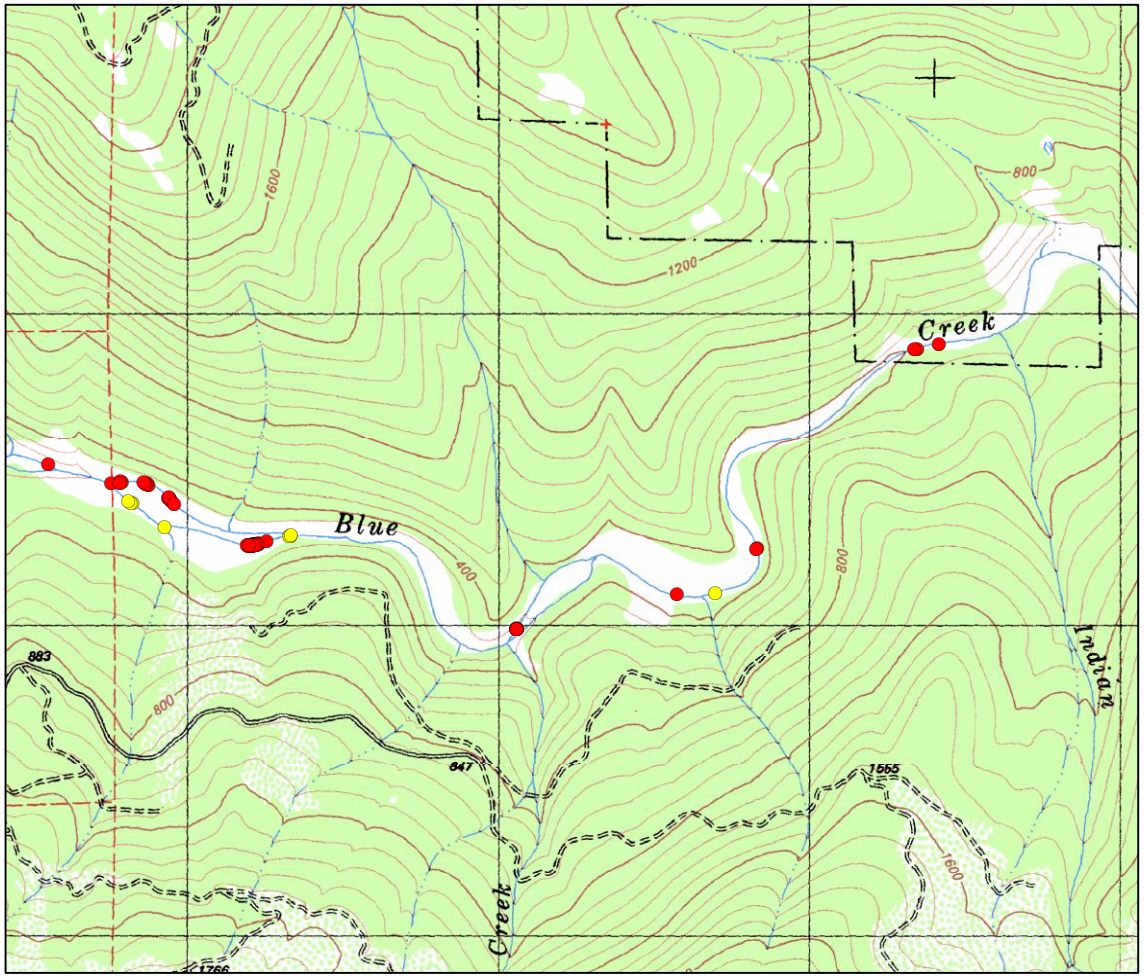

**Legend**

- 2012 Redds
- 2011 Redds

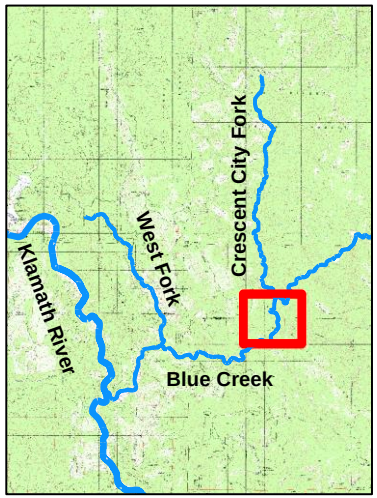
N

0 0.15 0.3 0.6 Miles

Map created by Yurok Tribal Fisheries Progam 8/22/2013 using locations recorded by YTFP staff overlaid onto USGS DRG Topographic Quadrangles Courtesy of Yurok Tribe GIS Department.
(NOTE: Redd locations are visual estimates and do not represent points collected with GPS equipment)



Blue Creek Spawner Surveys 2011-2012
Reach #4 Redd Locations



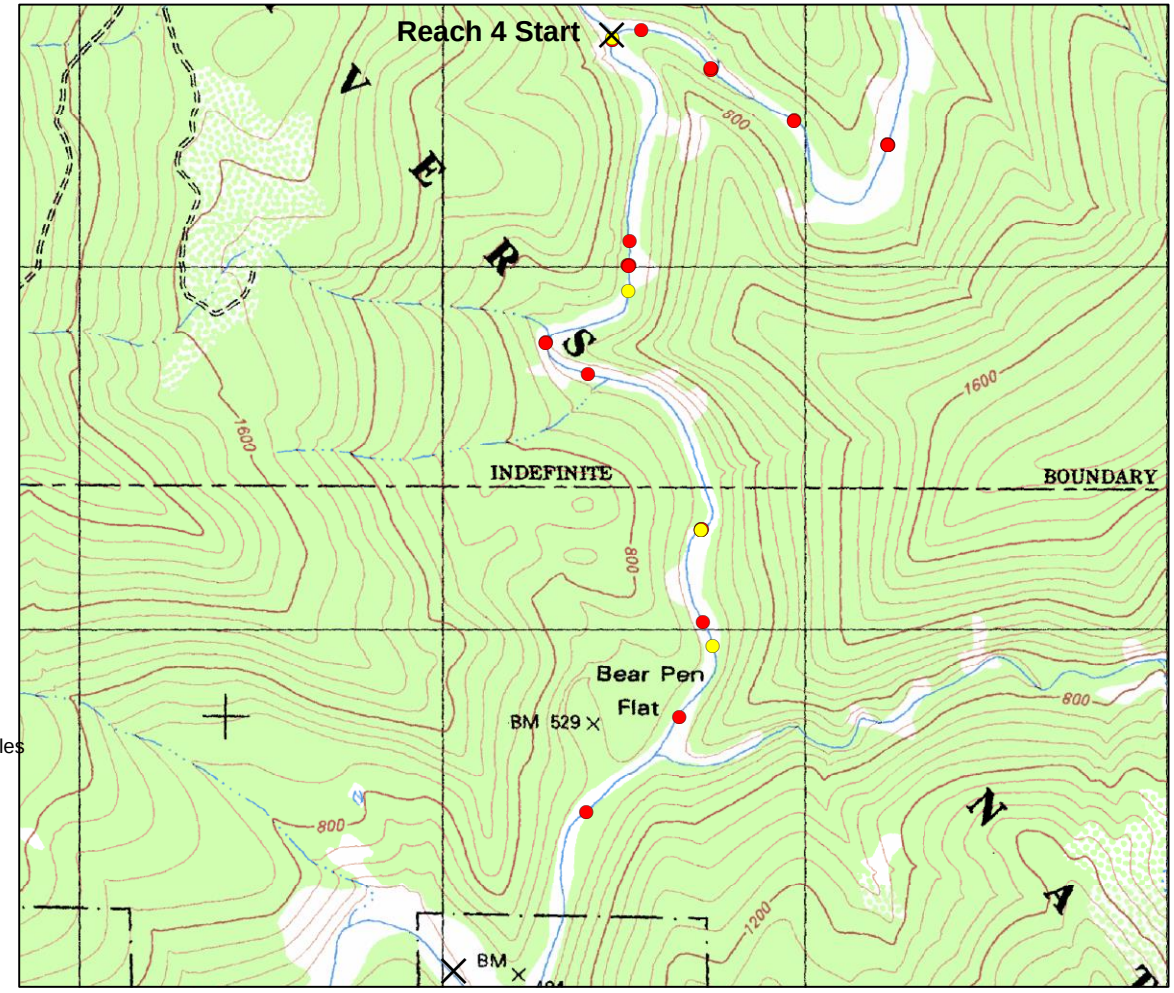

**Legend**

- 2012 Redds
- 2011 Redds

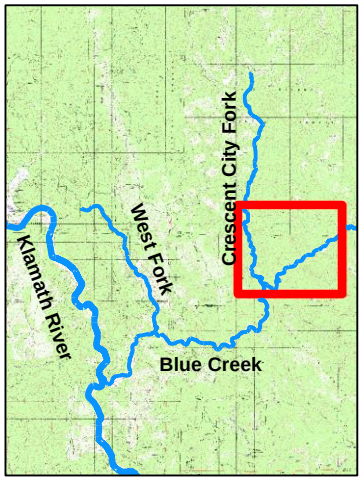
N

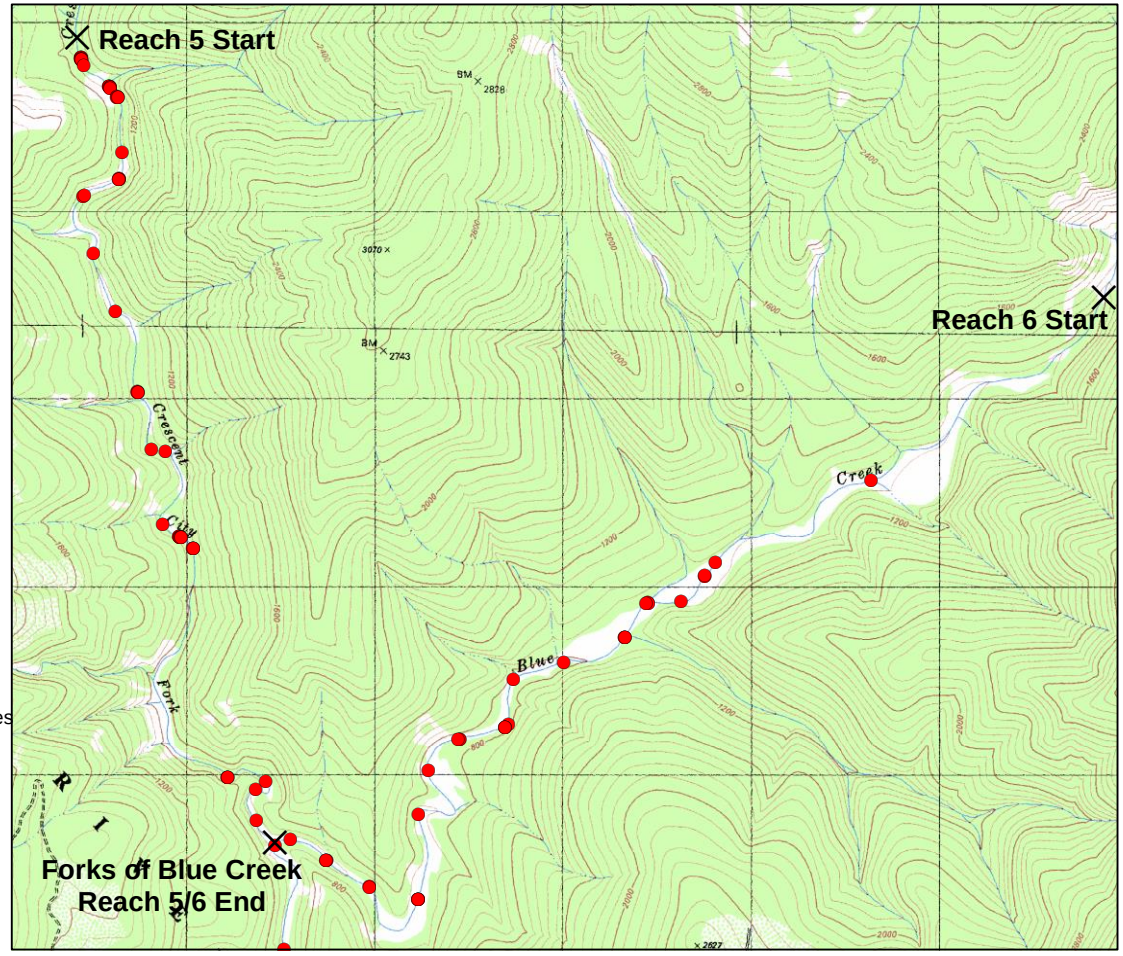
0 0.15 0.3 0.6 Miles

Map created by Yurok Tribal Fisheries Progam 8/22/2013 using locations recorded by YTFP staff overlaid onto USGS DRG Topographic Quadrangles Courtesy of Yurok Tribe GIS Department.
(NOTE: Redd locations are visual estimates and do not represent points collected with GPS equipment)



Blue Creek Spawner Surveys 2011
Reaches #5 & 6 Redd Locations




**Legend**

- 2011 Redds

N

0 0.275 0.55 1.1 Miles

Map created by Yurok Tribal Fisheries Progam 8/22/2013 using locations recorded by YTFP staff overlaid onto USGS DRG Topographic Quadrangles Courtesy of Yurok Tribe GIS Department. (NOTE: Redd locations are visual estimates and do not represent points collected with GPS equipment)

# APPENDIX 2. Salmon Capture and Tagging Summary, 2011

| Date | Weather | Locale | Species | Mid-Eye Length (in.) | Fork Length (in.) | Condition | Sex |
|---|---|---|---|---|---|---|---|
| 11/8/2011 | OVERCAST | TRAP POOL | CNK | 19.5 | 23 | 3 | M |
| 11/8/2011 | OVERCAST | BRIDGE | CNK | 36 | 39 | 3 | M |
| 11/8/2011 | OVERCAST | BRIDGE | CNK | 33 | 36 | 3 | F |
| 11/8/2011 | OVERCAST | BRIDGE | CNK | 26.5 | 28.5 | 3 | F |
| 11/8/2011 | OVERCAST | BRIDGE | CNK | 34 | 37 | 3 | F |
| 11/8/2011 | OVERCAST | BRIDGE | CNK | 30.5 | 33.5 | 3 | F |
| 11/8/2011 | OVERCAST | BRIDGE | CNK | 29.5 | 33.5 | 3 | M |
| 11/8/2011 | OVERCAST | BRIDGE | CNK | 27 | 30 | 3 | F |
| 11/9/2011 | SUNNY | GAUGE POOL | CNK | 35 | 40 | 3 | F |
| 11/9/2011 | SUNNY | GAUGE POOL | CNK | 33 | 36 | 3 | M |
| 11/9/2011 | SUNNY | GAUGE POOL | CNK | 34.5 | 39.5 | 3 | M |
| 11/9/2011 | SUNNY | GAUGE POOL | CNK | 36 | 41 | 3 | M |
| 11/9/2011 | SUNNY | GAUGE POOL | CNK | 36 | 39.5 | 3 | F |
| 11/9/2011 | SUNNY | GAUGE POOL | CNK | 33 | 36.5 | 3 | F |
| 11/18/2011 | RAINY | GAUGE POOL | CNK | 33 | 37 | 2 | F |
| 11/18/2011 | RAINY | GAUGE POOL | CNK | 33 | 37 | 3 | F |
| 11/18/2011 | RAINY | GAUGE POOL | CNK | 34 | 39 | 3 | F |
| 11/21/2011 | RAINY | GAUGE POOL | CNK | 34.5 | 38 | 2 | F |
| 11/21/2011 | RAINY | GAUGE POOL | CNK | 31 | 34 | 4 | F |
| 11/21/2011 | RAINY | GAUGE POOL | CNK | 33.5 | 38 | 3 | M |
| 11/21/2011 | RAINY | GAUGE POOL | CNK | 35.5 | 39 | 3 | F |