ASSESSMENT OF ANADROMOUS SALMONID SPAWNING IN BLUE CREEK, TRIBUTARY TO THE LOWER KLAMATH RIVER, DURING 2009

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Table of Contents

List of Figures

List of Figures, continued

Figure **Page**

List of Tables

Table **Page**

Acknowledgments

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Abstract

The Yurok Tribal Fisheries Program (YTFP) continued long-term monitoring of anadromous salmonid populations in Blue Creek, a fourth order lower Klamath River tributary, during 2009. This project assessed adult escapement and spawning activity during the fall months via direct observation. The resulting information provided a means of assessing escapement estimates and spawning trends of Blue Creek salmonids as well as enhancing knowledge of the life history of these unique fish populations.

Spawning surveys are used in the Blue Creek drainage to assess migration timing and relative abundance of live fish, redds, and carcasses. The Peak Count Method (PCM) is the traditional method used to provide an index of salmonid escapement (Gale 2009). Although the PCM provides valuable information on spawning salmonids, it does not generate an estimate of escapement. The primary objective of this project was to capture upstream migrant chinook salmon (*Oncorhynchus tshawytscha*), mark with highly visible streamer tags, and visually recapturing marked fish during traditional snorkel counts. By employing mark/recapture techniques, we estimated stream residence time and escapement using the Area-Under-the-Curve (AUC) method (Hetrick et. al 2003).

Three marking events were implemented during fall 2009, resulting in a total of forty five marked Chinook. Recapture events were coupled with traditional PCM snorkel surveys. The peak count occurred during week ending 13-Nov with 1,029 chinook observed. A total of 95 recaptured chinook were observed during eight weeks of snorkel surveys. Stream residence time was estimated to be 16.18 days and total escapement was estimated to be 2,334.9 (+/-140.96).

1.0 Introduction

The Klamath River Basin contained bountiful anadromous fish runs historically, supporting indigenous peoples throughout the region. Anthropogenic activities over the last 150 years, coupled with natural events, have resulted in widespread reduction and degradation of habitat causing substantial declines of anadromous salmon runs. The Lower Klamath Sub-basin, which encompasses all tributaries downstream of the Trinity River confluence, has been subjected to substantial timber harvest and related road construction over the last 60 years. These activities, occurring in a region with steep, naturally erodible terrain and high annual rainfall, have contributed to widespread streambed sedimentation and associated habitat degradation and native fish run declines throughout the Sub-basin (Gale and Randolph 2000). 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”, concern continues to exist over their status and long-term trends.

Blue Creek is the largest and most pristine tributary to the Lower Klamath and supports the largest proportion of anadromous fish populations in the Sub-basin. Monitoring of returning adult Chinook was initiated in 1988 by the United Fish and Wildlife Service (USFWS) out of concern over the proposed collection of broodstock for small-scale aquaculture activities in the Lower Klamath Sub-basin.The USFWS continued monitoring for five years to evaluate the status of Blue Creek chinook populations (Longenbaugh and Chan 1994). The Yurok Tribal Fisheries Program (YTFP) assumed responsibility of all monitoring and assessment activities throughout the lower Klamath Sub-basin in 1994.The YTFP has continued long-term monitoring of Blue Creek anadromous salmonid populations since 1995 using direct observation snorkel survey methodology initiated by USFWS to assess population trends in Blue Creek.

The primary objectives of this project were to: 1) continue direct observation snorkel surveys and 2) Implement mark/recapture techniques using Area Under the Curve (AUC) methodology to generate an escapement estimate and stream residence time. The results will provided a means of assessing population trends in Blue Creek as well as enhancing 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 size, 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 (Gale 2009). 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 has the highest level of precipitation in the Klamath Basin, with annual 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) between 1965-1978 indicate large seasonal flow variations, and records during this period ranged from 43 cubic feet per second (cfs) on November 1, 1965 to 33,000 cfs on March 2, 1972. Flows during the extreme flood event of December 22, 1964, although outside the period of record, were 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). Streamflow estimates during the study period ranged between 60 – 1574 cfs, and 11 inches of rain were recorded. Water temperatures during the survey period ranged between 4.2 – 14.5°C (Yurok Tribe Environmental Program, Blue Creek Gaging Station unpublished data).

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 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 the 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.

Three tributaries to Blue Creek have been identified as important for anadromous salmonid spawning and rearing and comprise 41% of the watershed area (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 and both salmon and steelhead extensively utilize the tributary (Figure 2). Small numbers of salmon have previously been documented spawning in the lowermost mile of the West Fork (Gale et al. 1998; Longenbaugh and Chan 1994), with steelhead extensively utilizing the majority of the tributary (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 extensively throughout the tributary (Hayden 1998; Voight and Gale 1998). A fourth tributary, Slide Creek, has also shown importance for steelhead populations. The mouth of 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).

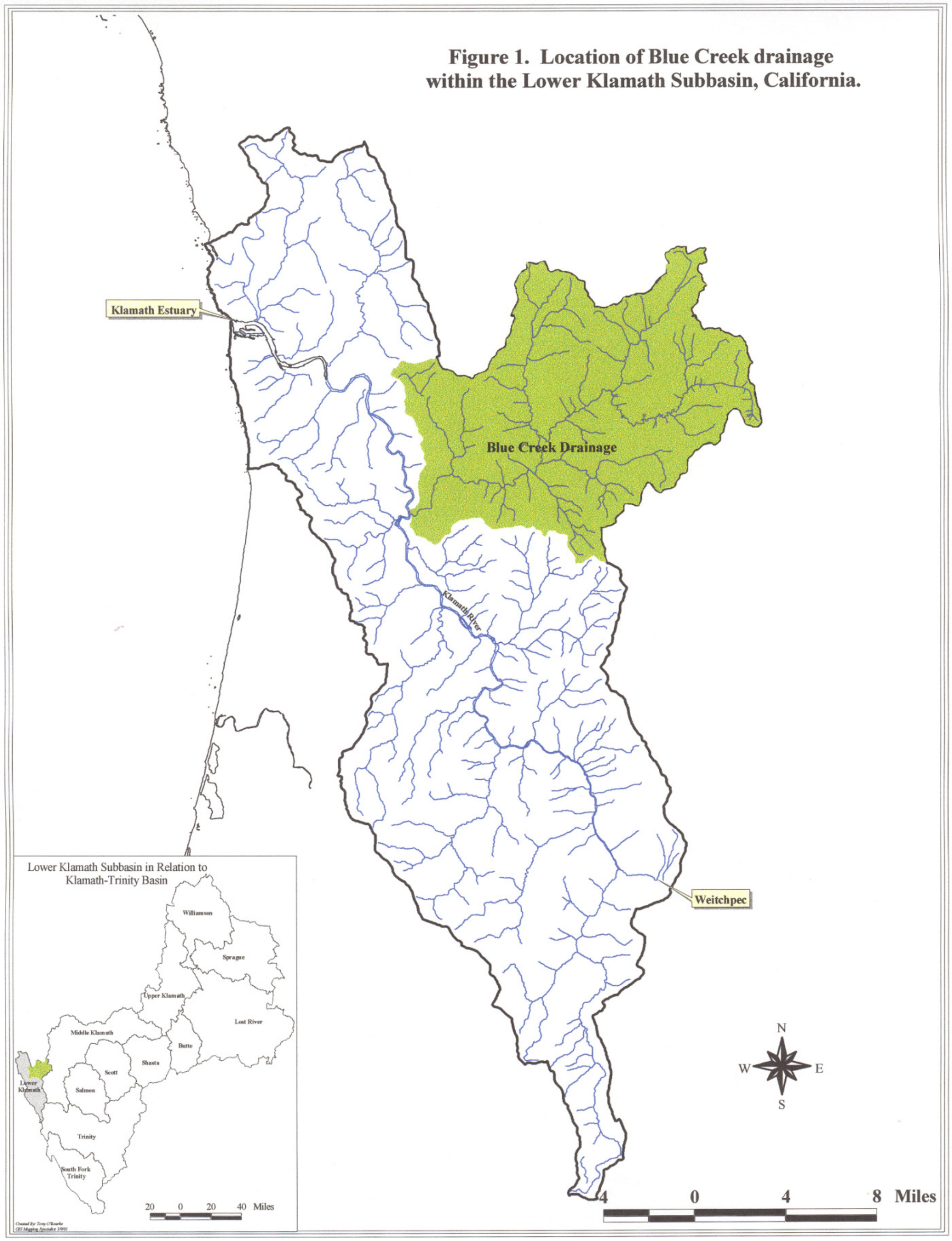

Figure 1. Location of Blue Creek drainage within the Lower Klamath Subbasin, California.

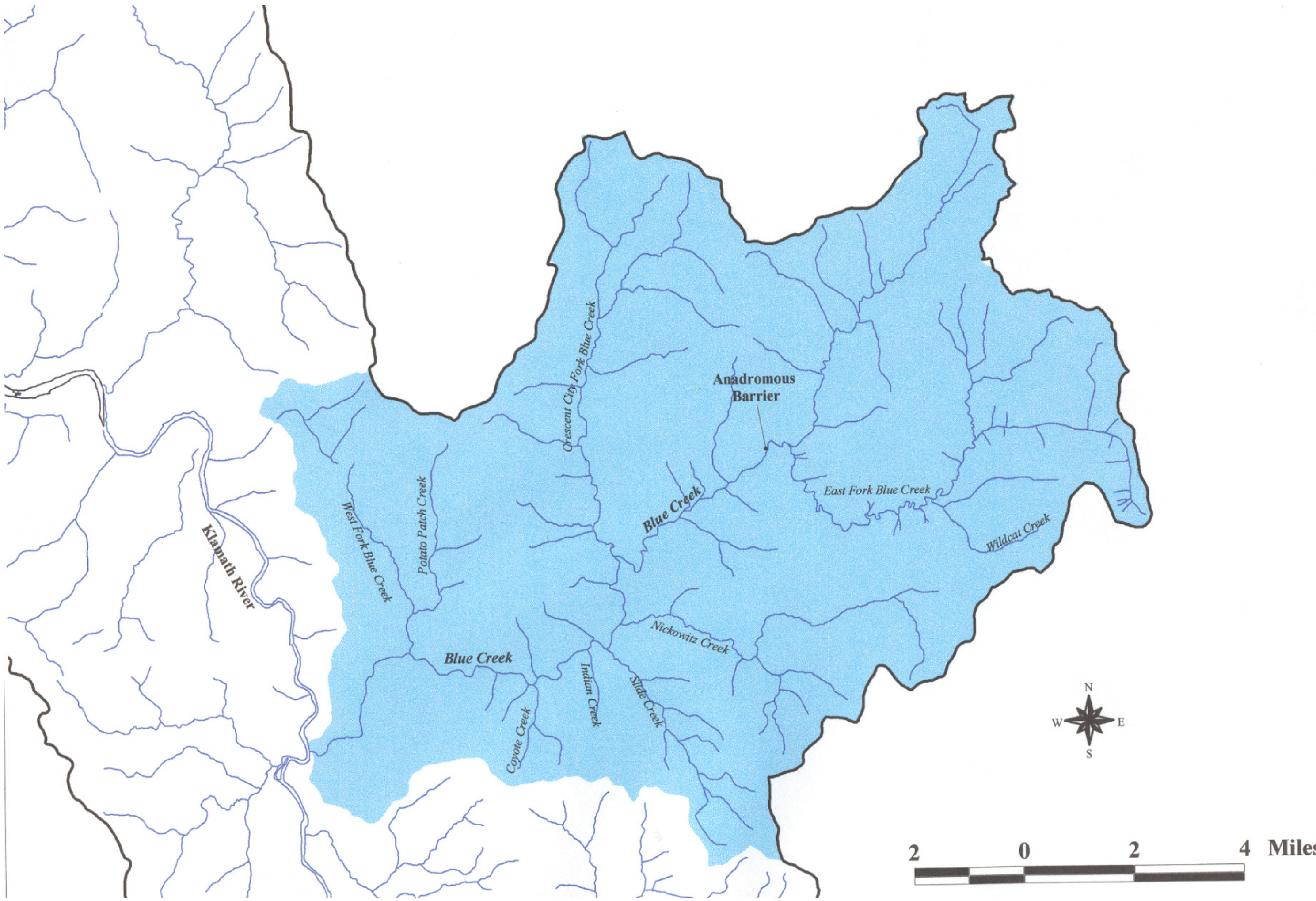

Figure 2. Blue Creek drainage, Lower Klamath River, California.

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 densiflora*), and madrone (*Arbutus menziesii*). Dominant riparian species include alder (*Alnus* sp.), willow (*Salix* sp.), 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 lower eight miles of the mainstem.

The two major landowners of the Blue Creek drainage are Green Diamond Resource Company (GDRC – formerly Simpson Timber Company) and the United States Forest Service (USFS). Green Diamond Resource Company owns the land surrounding the lower 8.1 miles of Blue Creek, and continues to manage their lands for timber production. Upstream of GDRC property, the creek runs through USFS land managed by the Six Rivers National Forest (SRNF), which is almost entirely included in the Siskiyou Wilderness Area. Portions of the Crescent City Fork are not included in the Siskiyou Wilderness and are classified as "Matrix land", which are defined as all land outside of the Reserves and "Congressionally Withdrawn Areas" (i.e. Wilderness Areas) and are 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).

3.0 Methods & Materials

3.1 Fall Spawning Surveys

The Yurok Tribal Fisheries Program conducted snorkel surveys from late October through mid-December 2009 to assess salmonid spawning activity. Spawning survey data collection methods remained consistent throughout the survey period. All surveys were conducted using direct observation (mask and snorkel) techniques until heavy fall/winter rains resulted in ineffective and/or unsafe sampling conditions (Gale et al. 1998).

3.1.1 Equipment

All spawning surveys utilized direct observation methodology during snorkel surveys. Snorkel surveys required the use of either a full 7mm neoprene wetsuit or drysuit, 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 U.S. Fish and Wildlife Service (USFWS) began performing Blue Creek spawning surveys in 1988. Initially, the USFWS performed bi-weekly "index" reach surveys that consisted of four consecutive stream reaches in the lower 10.3 miles of Blue Creek. These surveys focused on collecting consistent spawner data to monitor trend data for adult spawning escapement, habitat utilization, run composition, and the timing and duration of fall runs. The USFWS attempted to conduct consistent bi-weekly surveys during 1988, 1990, and 1992. Additionally, the USFWS conducted sporadic surveys of portions of the upper basin and significant tributaries, but comprehensive basin-wide surveys were never performed.

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 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). These efforts were continued for the through 2007, with slight modifications to the survey reaches to include an unnamed tributary in upper Crescent City Fork ("Doctor Rock

Creek" – reach #7b). 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 during eight weeks in 2009, beginning the week of 19-Oct-09 through 10-Dec-09. Surveys in reaches #1-4 were conducted weekly with the exception of the week of 17-Nov-09 due to high flows and poor water visibility. The upper mainstem Blue Creek (reach #5) and Crescent City Fork (reach #6) were surveyed twice during the season (16-Nov-09 and 2-Dec-09);Table 1). The upper Crescent City Fork (reach #7) was surveyed once on 11-Dec-09. The West Fork and Nickowitz Creek were surveyed once on 10-Dec-09. 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 any 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 3):

- **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**:

- **Reach #9**:

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

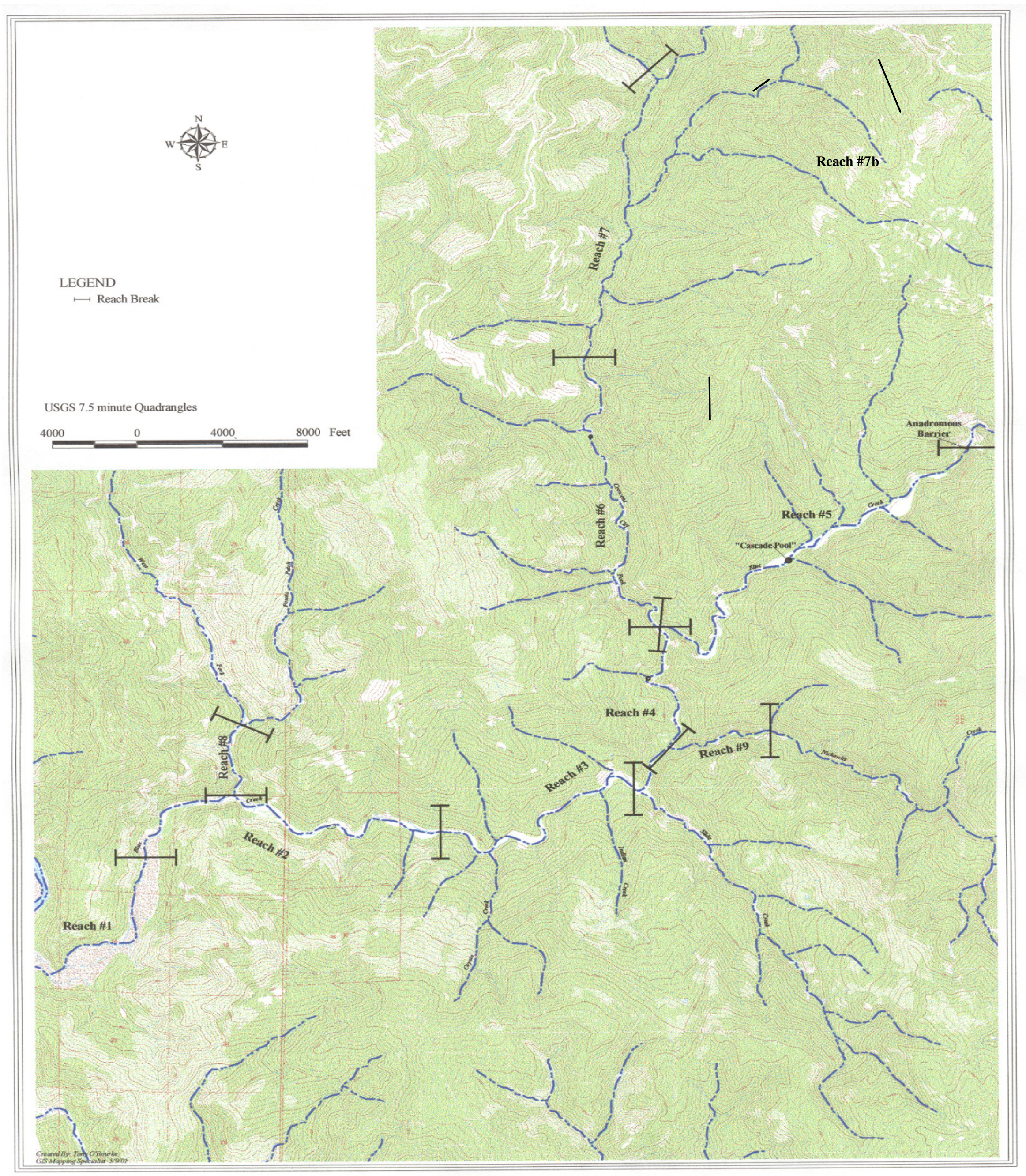

Figure 3. Location of adult spawner survey reaches in Blue Creek, Lower Klamath River, California.

3.2 Salmon Capture and Tagging

Adult salmon were captured to collect age, sex, and length data using either angling gear or a tooth tangle net. Pools in the lower reaches 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 3.5" mesh tooth tangle 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, 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 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.

3.2.1. 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 2009 by marking three separate batches of fish during three separate marking events (19-Oct, 5-Nov, and 19-Nov) with different colored streamer tags. Tagged fish were counted on subsequent snorkel surveys and 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 tagged individuals (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) for that time period. Number Cruncher Statistical Software (NCSS) was used to calculate area under the tag depletion curve.

3.2.2. Escapement Estimates

Escapement was calculated for chinook by extrapolating snorkel survey counts using the area-under-the-curve method as defined by the equation (Irvine et. al 1993):

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

where

E = the escapement estimate

a = the number of survey periods

C_i= the count for the i^{th} survey

O_i = the observer efficiency for the i^{th} survey

t_i = the number of days between surveys

rt = the residence time (in days) for the species counted

O_i was assumed to be 1.00 for all surveys

3.2.3. Observer Efficiency

During each snorkel survey, divers rated the following observer efficiency parameters: water clarity, discharge, and weather conditions. All parameters were ranked from 1 to 4, with a score of 1 representing poor survey conditions and 4 equivalent to excellent survey conditions. After each marking event, it is ideal that O_i is verified by divers, but due to limitations we were unable to conduct tests of this variable and assume that observer efficiency was 1.00.

4.0 Results & Discussion

4.1 Spawning Survey

The number of Chinook observed progressively increased each week, and the peak count of 1,029 fish occurred during week ending 13-Nov-09 (Table 1, Figure 4). A peak number of 15 adult Coho were observed during week ending 27-Nov-09. Adult steelhead and half-pounders were also observed throughout the sampling period. Two adult cutthroat trout were observed during the last week of surveys (week ending 11-Dec-09) (Table 1). The total number of Chinook observed in 2009 was the second highest abundance observed since 1990, with the most Chinook observed in 2003 (1,121; Figure 5). The number of Chinook jacks observed in 2009 was both the highest abundance (296) and proportion (40%) since YTFP began collecting such data in 1991 (Figure 5). The peak timing of returning jacks coincided with returning adults (Table 1, Figure 6).

During spawning surveys, lower reaches were the highest abundance of both redds and carcasses were during week ending 4-Dec-09, several weeks after the peak count was observed (Figure 6). The number of redds observed in reaches 1 and 2 accounted for sixty percent of all spawning activity observed (Figure 8). The number of redds observed in reaches 3 through 8 ranged between 3.9 – 11.7%, and no redds were observed in reach 9 (Figure 8) However, fewer redds may have been observed in upper reaches due to the limited number of spawners surveys conducted there.

Figure 4. Counts of Chinook salmon observed during snorkel surveys conducted on Blue Creek, Lower Klamath River California, 2009.

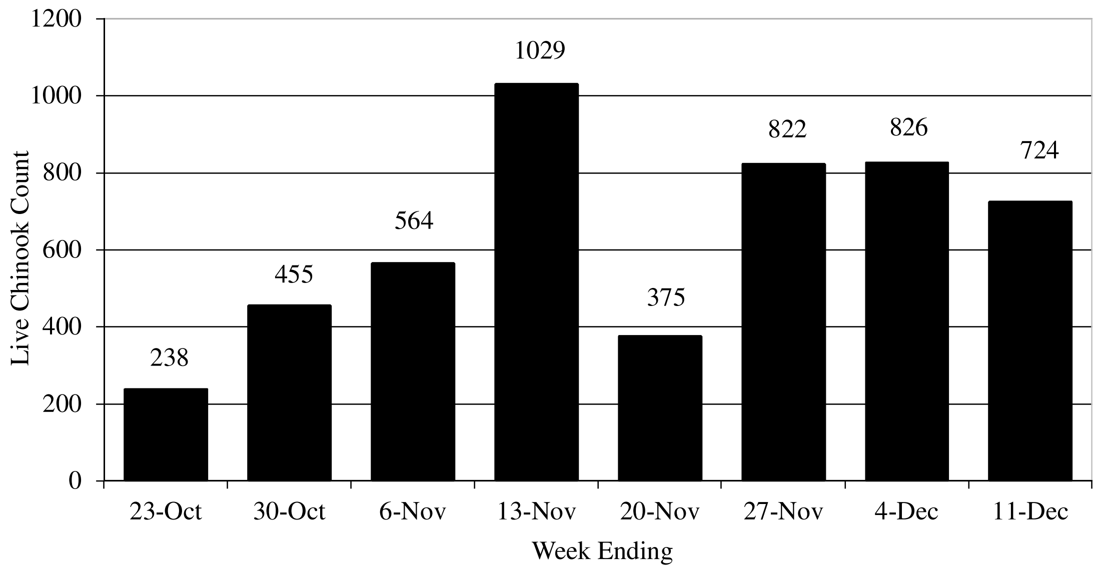

Table 1. Summary of adult salmonids, redds, and carcasses observed by reach during snorkel surveys, Blue Creek, Lower Klamath River, California, 2009.

		Chinook		Coho		Steelhead		Adult	Unidentified	New	
Date	Reach	Adult	Jack	Adult	Jack	Adult	1/2 pounder	Cutthroat (>12")	Adult Salmonid	Redds	Carcasses
21-Oct-09	1	135	103	1	1	4	96	6	0	0	0
29-Oct-09	1	118	133	2	0	2	75	6	0	0	0
28-Oct-09	2	155	40	2	0	3	41	9	0	2	0
27-Oct-09	3	30	4	0	0	0	0	6	0	0	0
27-Oct-09	4	25	10	0	0	2	0	0	0	0	0
	Total	328	187	4	0	7	116	21	0	2	0
4-Nov-09	1	135	120	1	0	1	30	0	0	0	0
4-Nov-09	2	164	80	1	0	2	29	10	0	1	0
3-Nov-09	3	22	18	0	0	0	1	6	0	0	0
3-Nov-09	4	18	7	0	0	0	0	0	0	2	0
	Total	339	225	2	0	3	60	16	0	3	0
13-Nov-09	1	356	135	2	0	7	0	0	0	3	0
13-Nov-09	2	254	126	7	2	0	31	4	0	9	1
12-Nov-09	3	45	12	0	0	0	0	0	0	0	0
12-Nov-09	4	78	23	1	0	2	3	2	0	2	0
	Total	733	296	10	2	9	34	6	0	14	1
17-Nov-09	1	305	70	6	0	3	0	0	0	13	0
17-Nov-09	2	- Survey Cancelled Due to High Flows/Poor Water Visibility -									
17-Nov-09	3	- Survey Cancelled Due to High Flows/Poor Water Visibility -									
17-Nov-09	4	- Survey Cancelled Due to High Flows/Poor Water Visibility -									
16-Nov-09	5	58	38	0	0	0	0	0	0	6	1
16-Nov-09	6	30	8	0	1	0	0	0	0	7	0
	Total	393	116	6	1	3	0	0	0	26	1
25-Nov-09	1	254	48	1	0	1	0	0	0	19	0
25-Nov-09	2	291	67	7	0	0	0	0	0	20	3
24-Nov-09	3	58	9	0	0	1	0	0	0	0	0
24-Nov-09	4	76	19	7	0	1	0	0	0	9	1
	Total	679	143	15	0	3	0	0	0	48	4
1-Dec-09	1	285	79	4	0	2	0	0	0	23	3
1-Dec-09	2	267	52	4	0	1	6	0	0	8	7
30-Nov-09	3	41	13	1	0	0	0	0	0	4	4
30-Nov-09	4	76	13	0	0	0	0	0	0	3	4
2-Dec-09	5	69	13	0	1	1	0	0	0	15	3
2-Dec-09	6	104	10	2	0	1	0	0	0	10	0
	Total	842	180	11	1	5	6	0	0	63	21
9-Dec-09	1	282	54	6	0	6	0	0	0	5	6
9-Dec-09	2	231	27	9	0	6	16	2	0	5	3
8-Dec-09	3	43	8	2	0	0	0	0	0	3	3
8-Dec-09	4	65	14	2	0	3	0	0	0	0	6
11-Dec-09	7	8	1	0	0	0	0	0	0	9	0
10-Dec-09	8	4	0	0	0	0	0	0	0	2	0
10-Dec-09	9	0	0	0	0	0	0	0	0	0	0
	Total	633	104	19	0	15	16	2	0	24	18
	Surveys discontinued after 10-Dec-09 due to continuous high flows										

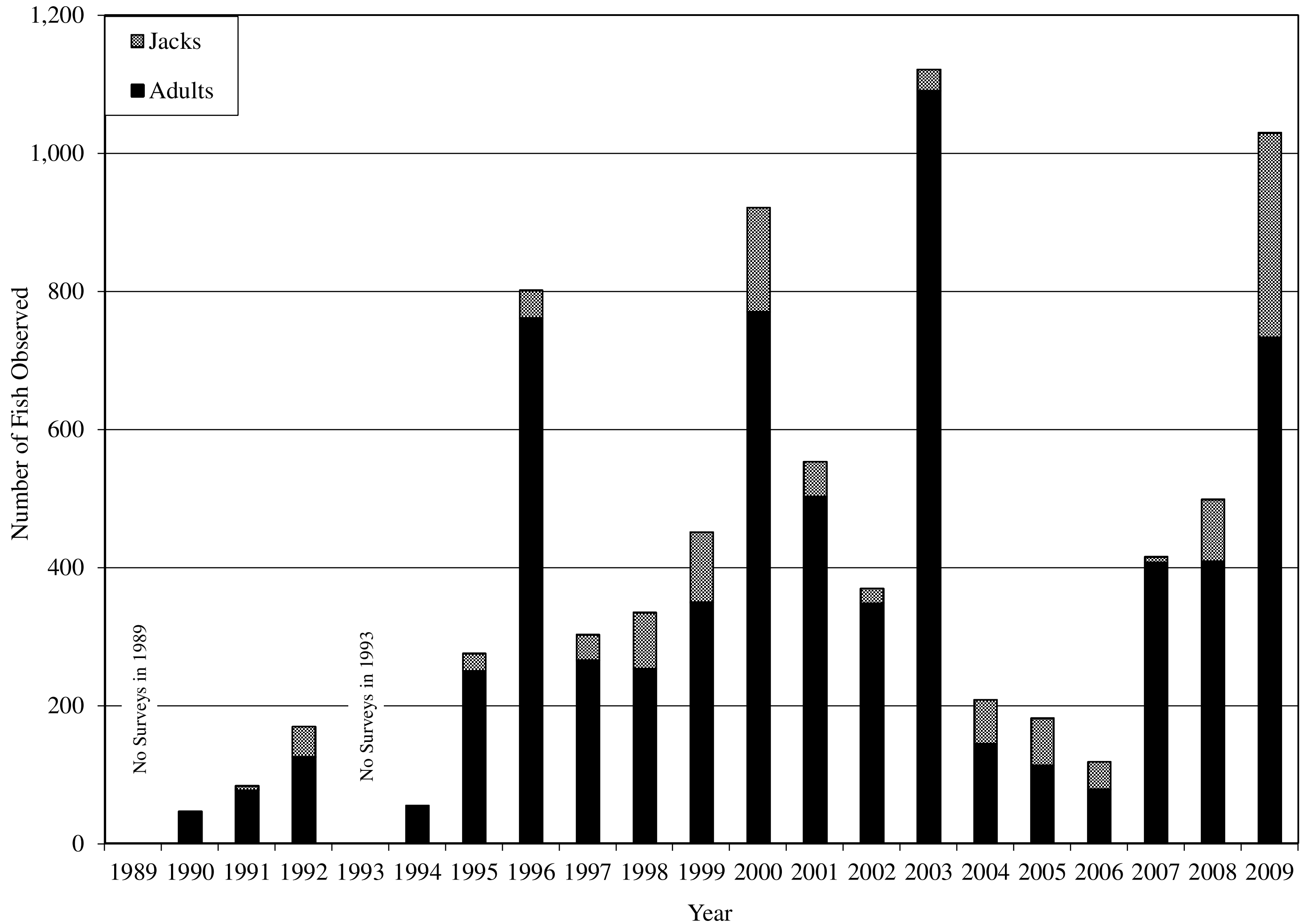

Figure 5. Annual peak counts of late-fall run Chinook salmon in reaches #1 – 4 in Blue Creek between 1989 – 2009.

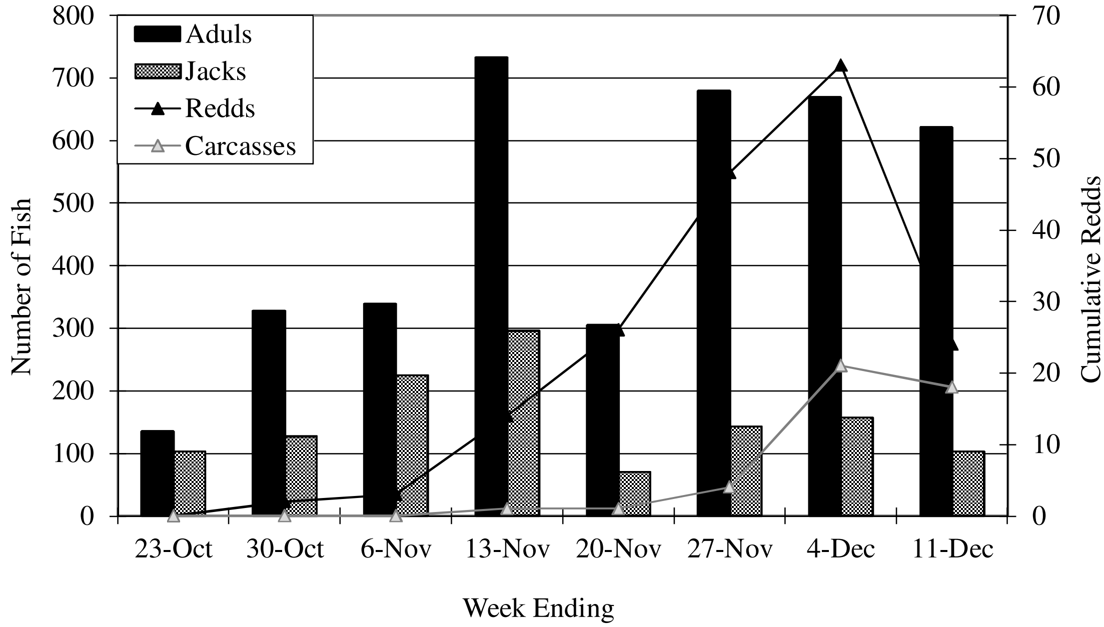

Figure 6. Total number of chinook salmon observed weekly and cumulative number of observed redds and carcass in reaches #1 - 4, Blue Creek, Lower Klamath River California, 2009.

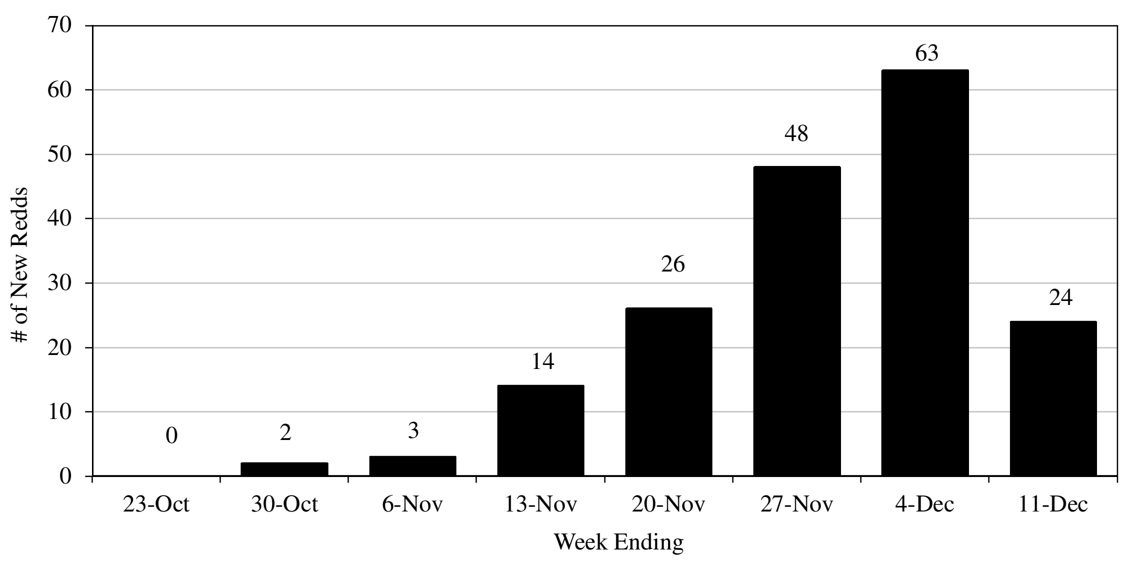

Figure 7. Number of new salmon redds observed in reaches #1 - 4 by week, Blue Creek, Lower Klamath River, California, 2009.

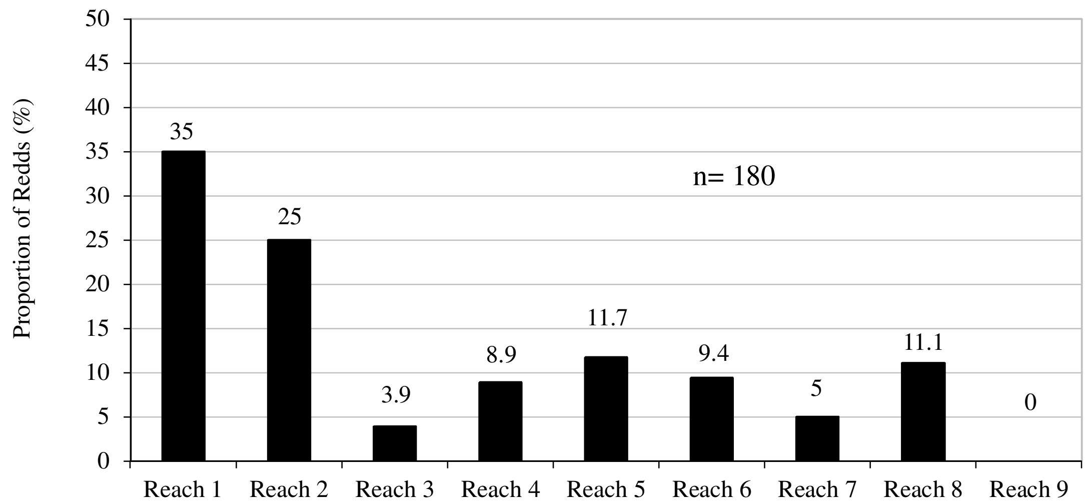

Figure 8. Percent occurrence by reach of observed salmon redds, Blue Creek, Lower Klamath River, California, 2009.

4.2 Salmon Capture and Tagging

A total of forty-five adult Chinook were marked during three sampling events. Marking efforts began 19-Oct-09 (marking event #1) resulting in 19 tagged chinook. The second marking event took place on 2-Nov-09 (marking event #2) with 20 marked chinook, and 6 chinook were marked and released on 19-Nov-09 (marking event #3) (Table 2). During eight weeks of snorkel surveys, YTFP visually recaptured 95 chinook marked with Hi-Viz Artic Flagging ranging from Lower Blue Creek to reach 6 in the Crescent City Fork. The majority of the marked fish remained in the lower reaches 1 and 2 (Figures 9 and 10). Divers did not observe any marked Chinook in reaches 5, 7, 8, or 9. Six marked chinook were observed on spawning redds.

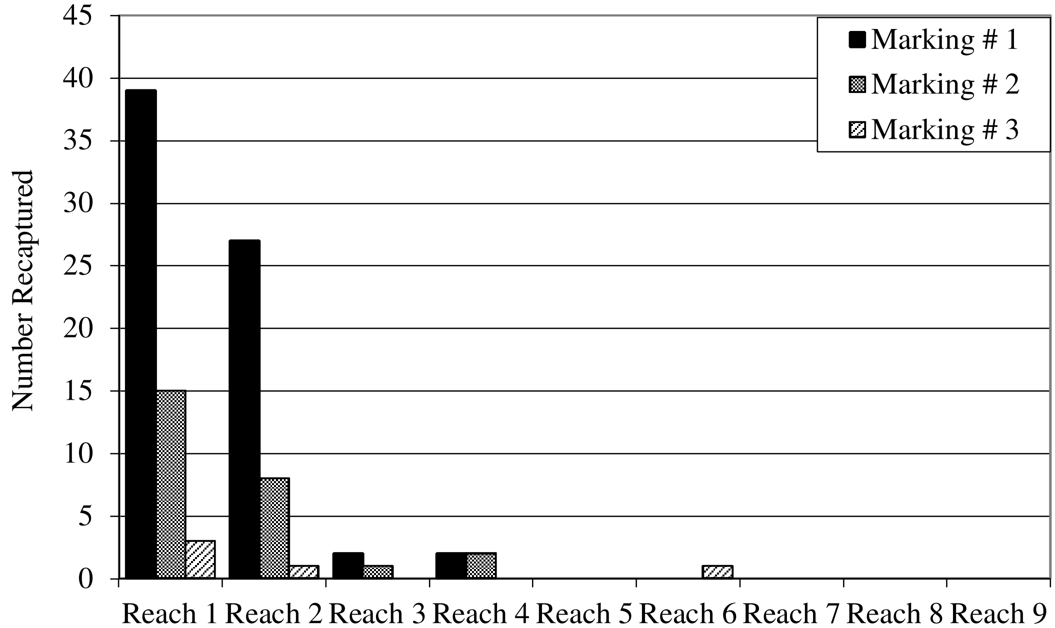

Figure 9. Total number of recapture chinook observed by reach in Blue Creek, Lower Klamath River California, 2009.

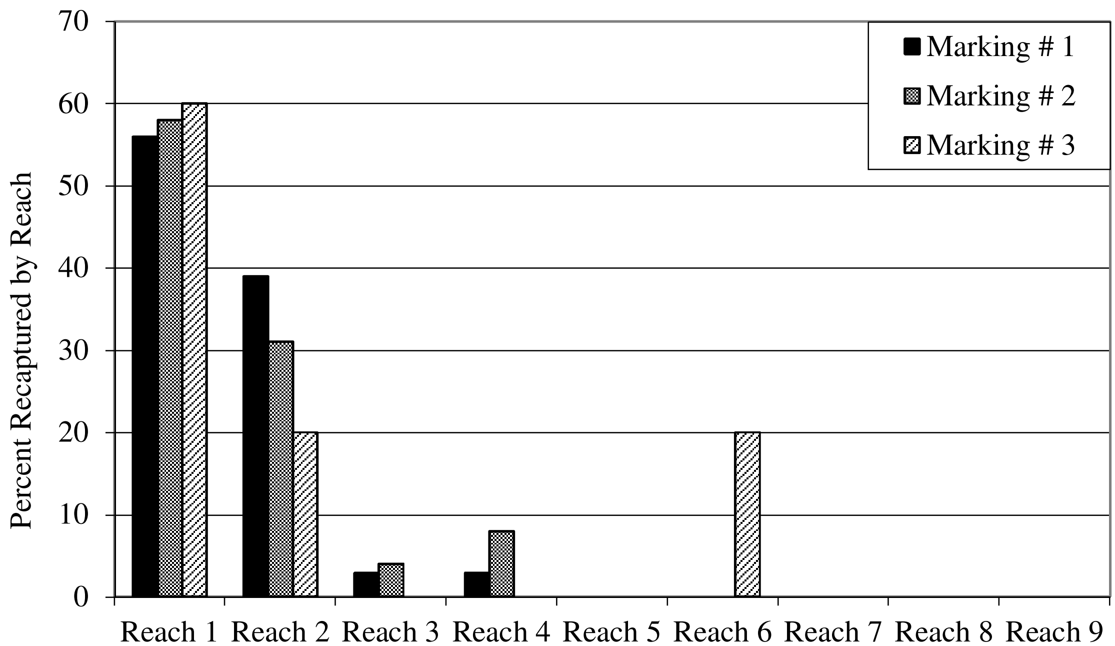

Figure 10. Percent occurrence by reach for recaptured chinook in Blue Creek, Lower Klamath River California, 2009.

4.3 Residence Time

Mean residence time for the entire season was estimated to be 16.18 fish days, with residence time decreasing for each subsequently tagged group. Residence time for fish tagged during marking event #1 was 22.85 days (Figure 11), 15.66 days for marking event #2 (Figure 12), and 10.04 days for marking event #3 (Figure 13). Figure 14 depicts the decrease in residence as the season progressed.

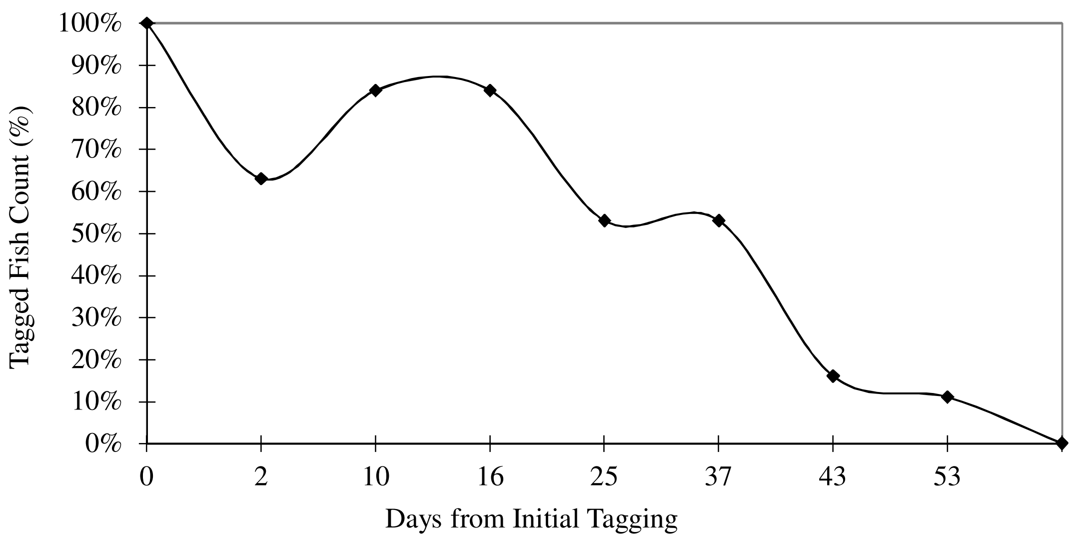

Figure 11. Proportion of Chinook salmon tagged on 20-Oct-09 that were observed during subsequent snorkel surveys, Blue Creek, Lower Klamath River, California, 2009.

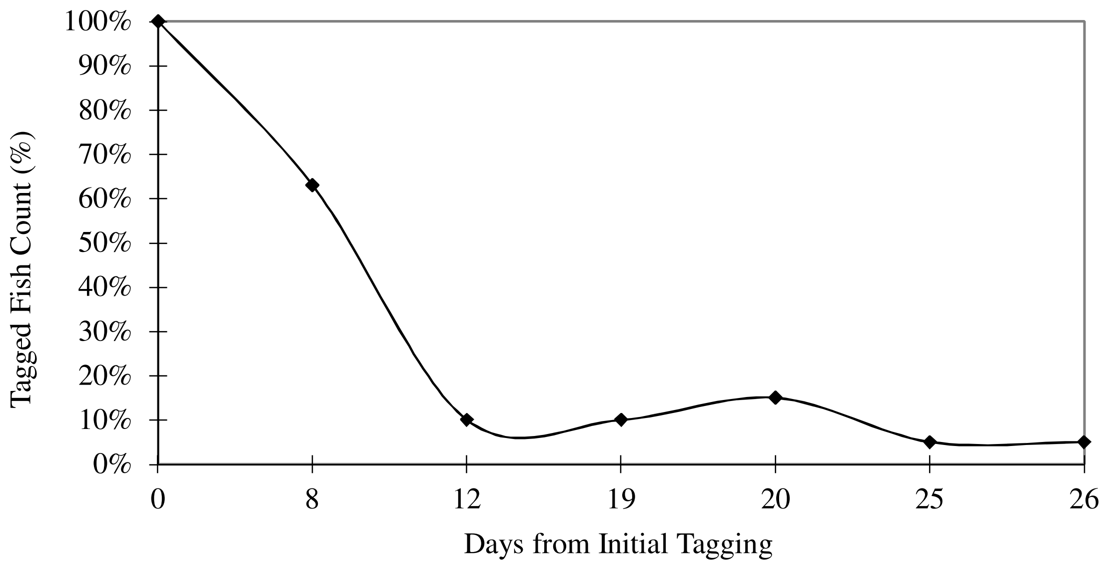

Figure 12. Proportion of Chinook salmon tagged on 05-Nov-09 that were observed during subsequent snorkel surveys, Blue Creek, Lower Klamath River, California, 2009.

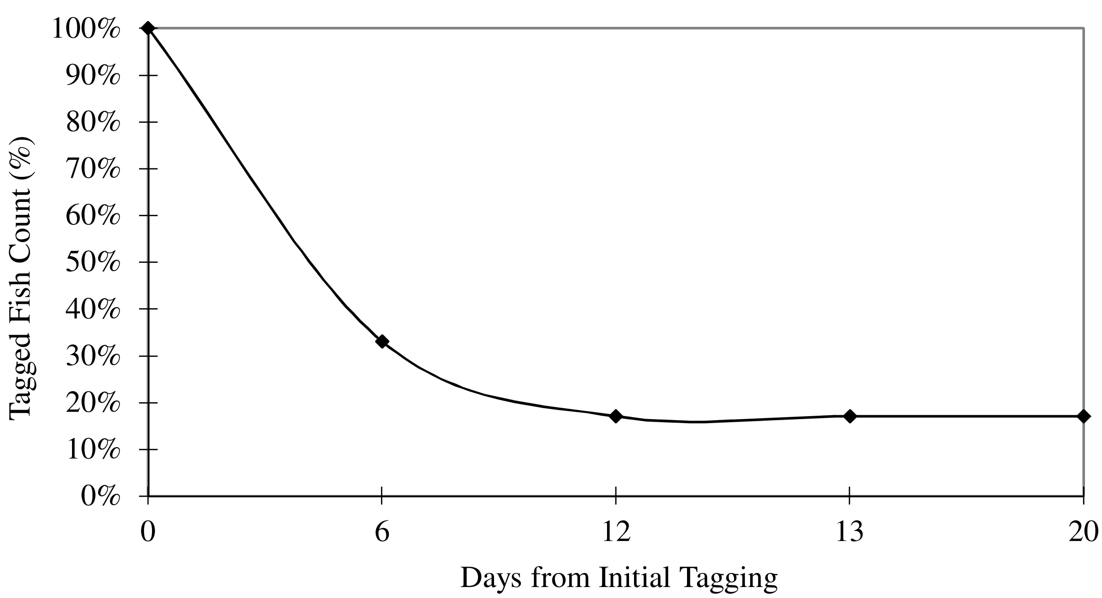

Figure 13. Proportion of Chinook salmon tagged on -Nov-09 that were observed on subsequent snorkel surveys, Blue Creek, lower Klamath River, California, 2009.

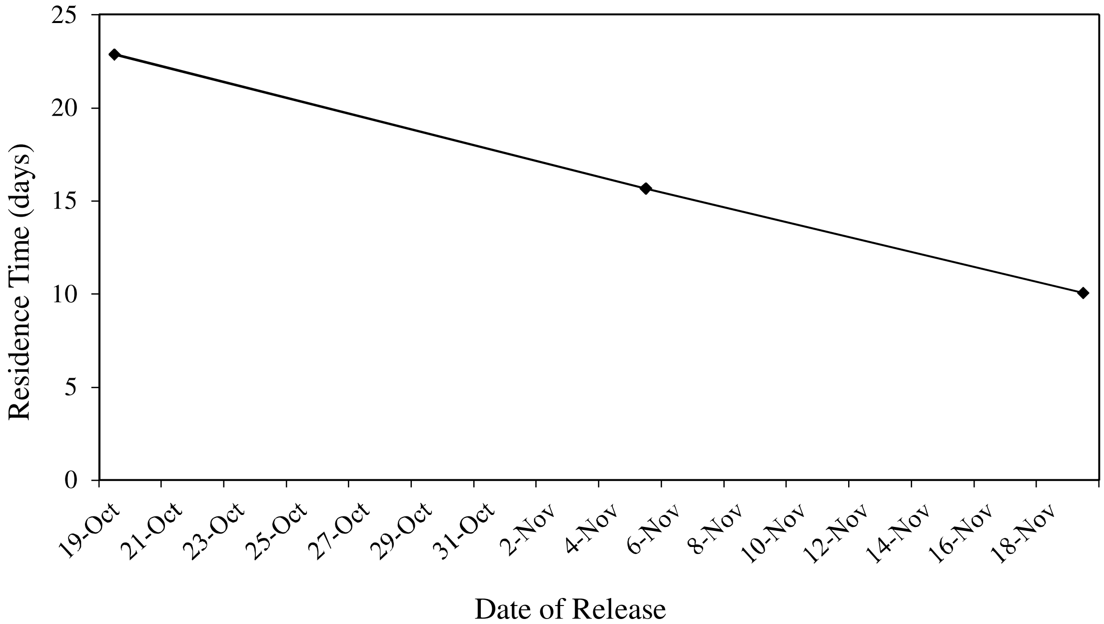

Figure 14. Chinook residence time throughout the season, Blue Creek, Lower Klamath River, California, 2009.

4.4 Escapement Estimate

Three escapement estimates were generated based on residence time estimate from 2004 and 2009 seasons. The two residence time were averaged to generate the third estimate. Run escapement from the beginning of the run until the final survey on 11-Dec-09 was estimated to be 2434.9 (+/-140.96) chinook with mean residence time of 16.18 days. Using 2004 residence time (rt =11.66) resulted in escapement estimate of 3378.7 (+/-195.60). The mean residence time for 2004 and 2009 (rt= 13.92) resulted in escapement estimate of 2830.2 (+/-163.84).

4.5 Length, Age, and Sex Composition

Forty five Chinook were measured and scales were collected during tagging and marking activities. Scale analysis determined seventeen chinook to be jacks and twenty eight to be adults. Mean fork length was 53.6 (+/-3.32) cm for jack chinook (n=17), and 80.8 (+/-2.85) cm for adult chinook (N=28).

Age composition results from scale analysis indicate that the majority of fish were three years old (N = 26, 57%), seventeen were two year olds (“jacks”), one was four years old, and one was five years old.

Sex was determined based on morphological features of fish during examination. All jacks examined were assumed to be males. Results indicate that the ratio of male to female Chinook returning to Blue Creek was 2:1, with fifteen fish determined to be female and thirty determined to be males.

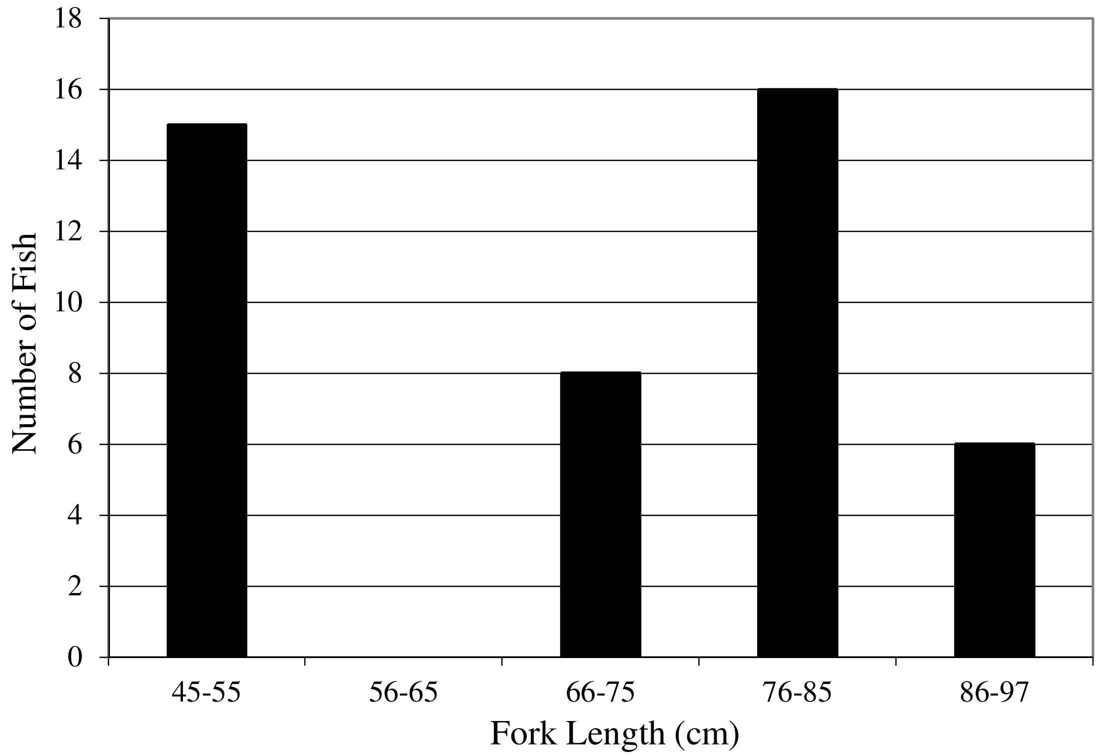

Figure 15. Fork length distribution of Chinook captured and tagged (N = 45), Lower Blue Creek, 2009.

5.0 Conclusion

Estimating salmon escapement in Blue Creek could be a challenging task. This season was relatively successful because of the low water year, which enhanced the ability of divers to enumerate marked fish and obtain accurate counts of fish. During high water years it can be difficult to visually recapture marked fish due to high flows, turbid water, and the inability to conduct surveys due to flow conditions. Due to the large number of returning Chinook, YTFP was able to obtain and successfully mark forty five Chinook. During years with fewer returning fish, the ability to mark a large enough sample size to generate stream residence time could be compromised and make estimating populations difficult and have a higher error associated with estimates. Another problem with creating population estimates based on visual recaptures is tag retention. During surveys in 2009, several recaptured fish were identified only by the knot or a small piece of streamer tag, and some of the tags were frayed.

The YTFP has conducted direct observation snorkel surveys in Blue Creek over the past decade Peak Count Method (Figure 15). By applying the AUC method with the snorkel surveys, we were 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 the continuation of studying stream residence time. 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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