2016 Spring Chinook Salmon Spawning Ground Survey

Salmon-Scott Rivers Ranger District
Klamath National Forest

Prepared by
Maija Meneks
Salmon-Scott Rivers District Fish Biologist

March 31, 2017

Salmon-Scott Rivers Ranger District
Klamath National Forest
11263 N. State Hwy 3
Fort Jones, CA 96032

Table of Contents

ABSTRACT

Cooperative Spring Chinook (*Oncorhynchus tshawytscha*) spawning ground surveys between the U.S. Forest Service, Salmon River Restoration Council, California Department of Fish and Wildlife, Yurok Tribe, Karuk Tribe, and volunteers have occurred on the Klamath National Forest similar to its current format since the mid-2000s. These surveys provide information to land managers and local resource councils as to where these fish spawn. Additionally, they assist in tracking long-term trends in use under different environmental and discharge conditions, as well as provide data on mixing of spring- and fall-run Chinook stocks. Biological samples – scales and tissue – are passed to the California Department of Fish and Wildlife.

The Salmon River is surveyed on an annual basis using redd count techniques. The 2016 cooperative survey began September 19th and ended October 13th. All scheduled surveys were completed. Forest Service participation concluded prior to the week of October 10th due to commitment of resources toward Fall Chinook surveys. Although discharge was generally low through much of the survey period, surveys were forced to end earlier than normal due to the arrival of a large storm system in mid-October which pushed discharge to unsafe levels.

Approximately 406 fish returned to the Salmon River. Spring Chinook run estimates are completed during summer holding surveys of the Salmon River system. Using data collected since initiation of cooperative holding surveys in 1990, year 2016 returns appear to be below average for the Salmon River [rank 17th (of 27 survey years)].

INTRODUCTION

Since 1978, Chinook salmon spawning surveys have occurred in the Salmon River drainage. However, historical surveys often did not distinguish between spring and fall runs. In the mid-1990s, the first attempt was made to separate the two life histories, while at the same time focus of cooperative surveys began to shift timing and river location to favor the more numerous Fall Chinook. By the early-2000s, the Salmon River Restoration Council (SRRC) started to lead the effort to include a distinct Spring Chinook survey; and by 2006, survey timing and reaches visited were very similar to the contemporary endeavor.

Spawning by the spring and fall stocks are known to overlap in time and space. Recent genetic analysis suggests that spring and fall runs, across the species, are genetically unique from each other and the result of a single evolutionary event which has spread throughout the Chinook salmon range (Prince, *et al*. 2016). The regulatory and political response in regards to this new information has not yet occurred; and for the Klamath River drainage, including the Salmon River, it may be several years for a determination to be made as to if the genetics are sufficiently different for Spring Chinook to warrant specific recognition and a different level of protection than the more numerous fall run. Traditional focus of spawning surveys has been to capture the fall-run Chinook due to its larger size and basin-wide management (i.e., harvest) implications. The SRRC has been instrumental in establishing a separate effort specific for Spring Chinook. Other entities, including the Klamath National Forest (KNF), assist as personnel and funding resources allow.

Spring Chinook holding surveys are conducted in the Salmon River watershed on an annual basis during July or August. Effort has varied over the years, beginning with KNF snorkeling index reaches in 1980 to the contemporary cooperative effort which includes over 80 miles of water (Salmon River mainstem, forks, and selected tributaries) and involves participation from Federal and State agencies, tribes, watershed councils, volunteers, and more. The end result is a snapshot of Spring Chinook numbers and where they are holding in the system. The California Department of Fish and Wildlife (CDFW) uses holding survey results for tracking and management purposes. A portion of the most recent (2015) Spring Chinook "MegaTable" for the Klamath River basin is found in **Appendix A**.

Due to the summer holding surveys for Spring Chinook, spawning surveys are not necessary in order to acquire a population estimate. This is unlike Fall Chinook, which need spawning (carcass and redd) surveys to determine population in those areas, such as the Salmon River, where weirs or other counting methods for individual fish are not available. Instead, the primary objective of the Spring Chinook survey is to track where in the watershed fish spawn and provide CDFW with biological samples – scales, tissue, and otoliths. Additionally, there have been efforts to use the surveys by academic and other entities to collect samples for genetic and disease studies, as well as track the overlap in use location and run timing between fall- and spring-run Chinook.

In fall 2016, surveys were completed in the upper reaches of the Salmon River to determine Chinook spawner distribution. This report summaries redd counts conducted between September 19th and October 13th on the North Fork and South Fork Salmon Rivers, as well as the East Fork Salmon River. The SRRC prepares a separate report detailing their fisheries activities, including the Spring Chinook spawning surveys.

METHODS

In 2016, redd surveys were conducted on the Salmon River, as well as one major tributary. **Table 1** summarizes each reach for 2016, including reach number and length, number of times surveyed, and total number of redds counted over the course of the survey season.

Surveys occurred twice weekly, with South Fork biased to be visited more often than North Fork due to greater numbers of fish present at the former.

- South Fork – five reaches (~18.0 miles total) bounded by Matthews Creek and Little South Fork Salmon River
- North Fork – six reaches (~18.5 miles total) bounded by River Mile 8 and Big Creek
- Tributaries – East Fork Salmon River (Shadow Creek to confluence; ~4.5 miles)

The SRRC and USFS held a training session for volunteers on September 14th at the SRRC office in Sawyers Bar. Topics discussed at the training included redd and fish identification; scale, tissue, and otolith sampling; data collection and survey sheets; salmonid life cycles; and survey safety procedures.

Table 1. Spring Chinook spawning survey reach descriptions for Salmon River in 2016.

Stream Name	Reach Name	Reach Number	Miles	Number of Times Surveyed	Total Number of Redds Surveyed…
North Fork	Mile 12 to Mile 8	11	4.0	1	9
	Mile 16 to Mile 12	12	4.0	1	11
	Whites Gul to Mile 16	13	2.0	2	4
	Idlewild CG to White Gul	14	2.5	2	11
	Mule Bridge TH to Idlewild CG	15	3.0	2	1
	Big Ck to Mule Bridge TH	16	3.0	0	N/A
South Fork	French Ck to Matthews Ck	7	4.0	1	0
	Cecillville CC to French Ck	8	4.0	5	34
	Petersburg FS to Cecillville CC	17	4.0	5	49
	Blindhorse Ck to Petersburg FS	18	3.0	4	24
	Little SF Salmon to Blindhorse Ck	19	3.0	2	13
Tributaries	East Fork Salmon River	20A (lower)	2.0	4	1
		20B (upper)	2.5	1	0
	Little NF Salmon River	21A (lower)	2.3	0	N/A

Crews counted redds and collected biological samples as per protocol developed for the Fall Chinook spawning survey (CDFW 2016). A typical crew consisted of two people. Each crew walked two to four miles of river each survey day unless health, safety, or time concerns limited ability to survey. The number of times a reach was surveyed was related to the number of people available on the survey dates, as well as the level of spawning activity observed on the prior survey date and personnel knowledge of the system. An attempt was made to have people survey

different reaches throughout the season so as to reduce estimator bias. Starting the week of October 10th, KNF and CDFW personnel switched focus to the Fall Chinook spawning surveys and were no longer available to assist with the Spring Chinook effort. The SRRC, tribal participants, and volunteers finished out the Spring Chinook surveys. Compared to most years, surveys were concluded a week or two earlier than normal. This premature end occurred due to a large, persistent storm system – remnants of a typhoon which had crossed the Pacific Ocean – that impacted the area starting mid-October. The response of the Salmon River drainage was to increase discharge to levels unsafe for survey personnel; and, additionally, the water became too turbid to effectively see redds, live fish, or carcasses.

For the redd component, all redds were counted, flagged, and location marked on a topographic map, with total number of redds tallied at the end of each reach. Additionally, redds were characterized as to size (width/length) and habitat type in which it was observed. Throughout the season redds were GPSed. Field maps of redd locations are available at the Salmon-Scott Rivers District Office in Fort Jones, CA and the SRRC office in Sawyers Bar, CA.

RESULTS

Overall survey effort was not as good as recent prior years, with productivity affected by number of surveyors available, weather, and flows. Some degree of deficiency was likely due in part to multiple personnel-related reasons – lack of a Forest Service crew to provide to the survey effort; scheduling conflicts leading to inconsistent contribution of crews by other agencies; and lower-than-estimated volunteer turn-out. The end result were reaches (e.g., Reach 7 [South Fork], Reach 12 and 16 [North Fork]) being surveyed fewer number of times than normal; and the Little NF Salmon River tributary was not visited at all. Also of note, while river discharge was low to start – a legacy of multi-year drought – the mid-October storms created unsafe flow levels, thereby shortening the Spring Chinook survey season (**Appendix B**). This truncation also impacted overall effort whereupon new late-season redds were likely missed, as well as losing the opportunity to observe timing of entry for upmigrating Fall Chinook into the Spring Chinook spawning grounds.

Spawning for Spring Chinook in the Salmon River began in mid-September. The peak was likely achieved in late-September/early-October, with greater specificity unable to be ascertained due to the decreased survey effort. Because of the elevated discharge conditions beginning mid-October, it is likely fall-run Chinook were able to pass various low-flow barriers and ascend to the traditional Spring Chinook reaches of the upper Salmon River while the latter were still spawning. Unfortunately, those same discharge conditions prevented observation of the spatial/temporal overlap of the two runs due to concern for surveyor safety. See **Appendix C** for a table of redd numbers organized by reach and date.

Specific areas of the Salmon River display a greater preference for use by spawning Spring Chinook. Six years of mapping redds by GPS (with hardcopy map back-up) is beginning to reveal patterns (e.g. “concentrated use areas”). Because the size of the spring-run is less than the fall-run, those patterns are not as clear for the former as it is for the latter. On a year-to-year basis, discerning locations of spawning beds which exhibit regular, repeated use is difficult, especially when a low number of fish spread out over tens of miles of river equates the appearance of scattered use. It is only when multiple years of spawning are examined concurrently that some initial conclusions are possible. There is an insufficient amount of data at

this point to begin the process of teasing out spawning nuances, such as shifting in use areas in response to water discharge. It is expected that inter-annual variation found within the much more numerous fall-run is mirrored by the spring-run.

Initial focus for the Spring Chinook dataset is upon locales which exhibit a cumulative (6-year) visual concentration of redds within an approximate 100 meter linear distance. Unlike the Fall Chinook dataset, no specific minimum redd density has been assigned to the spring-run at this time due to small run size (and, hence, an overall low redd density) even in years considered "exceptional". Instead, a more qualitative approach has been taken, with spawning areas assessed as to use in at least four of the six years where spatial data is available. An attempt was made to avoid those areas which may consistently have one (or two) redds every year – while these sites are important, they also likely represent small locales of consistently good gravel. Instead, the focus for mapping concentrated use areas is on locations that denote more extensive spawning sites. Of note, the definition of "concentrated use area" will be refined as more data is acquired; and it is expected that use areas will be added, removed, and shifted in future years.

The South Fork has a sufficiently large dataset to provisionally map concentrated use areas –

- South Fork Salmon River (Little South Fork Salmon River to Matthews Creek – ~18.0 miles)
    - 25 concentrated use areas
    - Notable sites include downstream of Timber Gulch; vicinity of Crawford Creek; downstream of Cecil Creek bridge (Forest Road 38N27); adjacent to the Cecilville Community Center; ~0.5 mile to ~0.2 mile downstream of East Fork; vicinity of Black Gulch; ~0.2 mile upstream of Garden Gulch; and ~0.5 mile upstream of Boardtree Gulch.

Neither the North Fork, nor the major tributaries of East Fork or Little NF Salmon River, have recorded enough data to build a map. However, the North Fork does have enough information to make some early observations –

- North Fork Salmon River (Big Creek to Mile 8 – ~18.5 miles)
    - 8 potential concentrated use areas
    - Notable sites include upstream end of Kelly Bar; upstream of Glasgow Gulch, above the channel split; upstream of Croaks Gulch in Sawyers Bar; and downstream of North Russian confluence.
    - Of note is Reach 11B (Kelly Gulch [Mile 12] to Gallea Engine Access [Mile 10]) where sharing of spawning sites by spring-run and fall-run fish is documented. In total, there are three locales of overlap, only one of which is a prospective Spring Chinook concentrated use area on its own.

See **Appendix D** for redd spatial distribution.

Using summer holding survey data, the Salmon River is estimated to have had a minimum of 406 spring-run Chinook salmon in 2016 (**Figure 2**; **Appendix A**). Based on long-term tracking data from summer surveys, 2016 was below average, ranking 17th for estimated run size (of a 27 year dataset).

Figure 1. Spring Chinook redds observed and survey effort on the Salmon River in 2016.

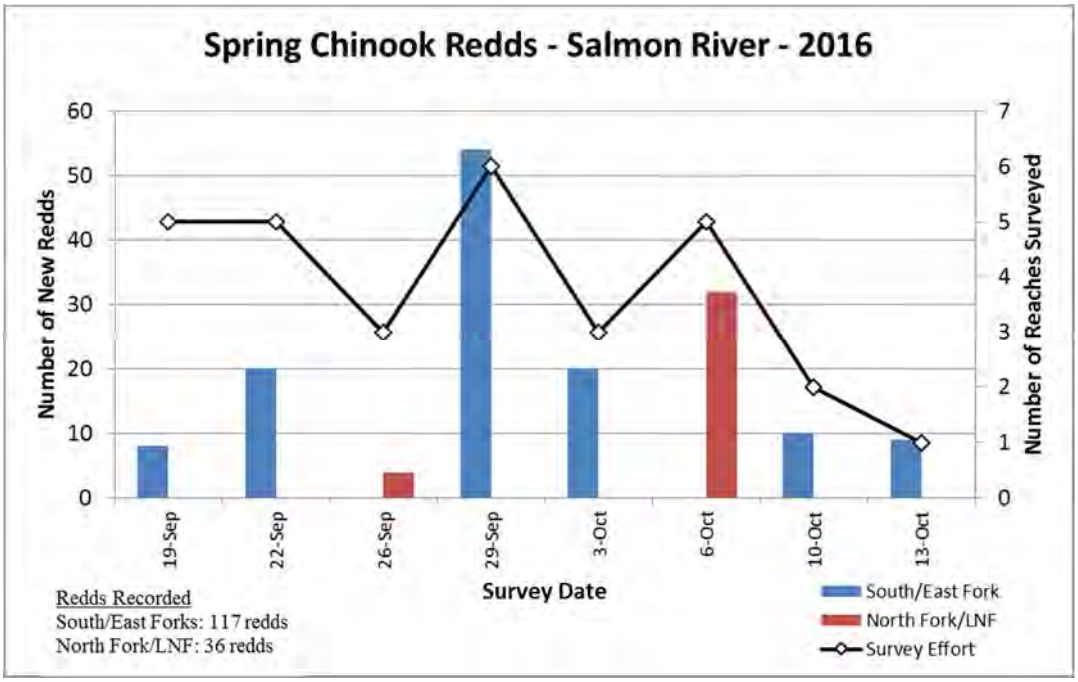
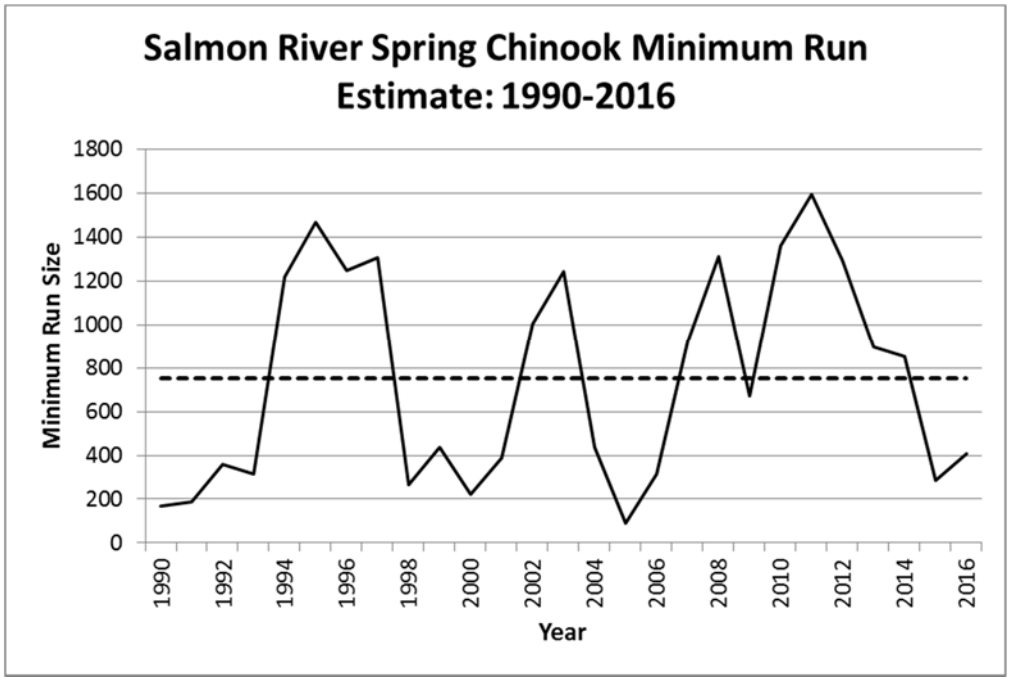


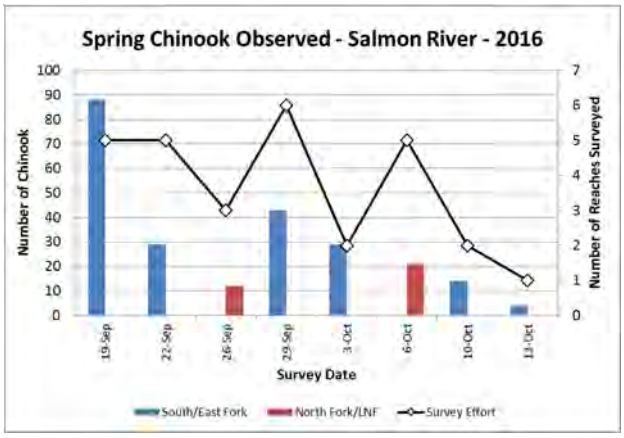
Figure 2. Salmon River spring-run minimum size for 1990 to 2016, as estimated from summer holding surveys. Dashed line is average over long-term survey period.

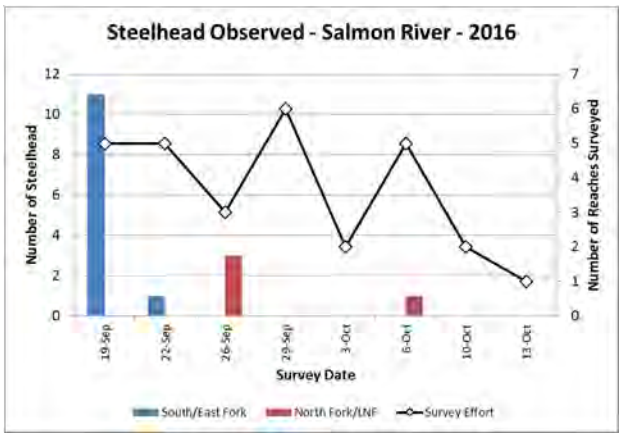


Live Chinook and steelhead were tallied during surveys (**Figure 3**). As with redds, fish observation is affected by number of surveyors, weather, discharge conditions, and surveyor experience. Peak live Chinook for the South Fork system was observed in mid-September, with subsequent numbers declining within the survey area. Too few fish were observed in the North

Fork system to draw conclusions. Steelhead numbers were generally low, with the most observed on September 19th on the South Fork. Changing flow conditions is often considered to be one of the triggers for steelhead movement with fish often observed more frequently in association with flow increase following precipitation events. Unfortunately, there was no rain during the survey period which would have prompted an increase in steelhead activity. See **Appendix C** for a table of fish numbers organized by species, reach, and date.

Figure 3. Observation of fall Chinook and steelhead during the 2016 Salmon River surveys.





Tributaries surveyed included the East Fork Salmon River. The East Fork was visited multiple times in conjunction with South Fork surveys. A single Chinook salmon redd was reported in the Taylor Creek to Confluence subreach, as was a pair of live Chinook. No live steelhead were recorded.

DISCUSSION

Overall distribution patterns are emerging for spawning by Spring Chinook in the Salmon River system within the survey area. Due to the relatively low number of Spring Chinook, compared to fall-run fish, multiple years of data have been required to reach initial, tentative interpretations. Unfortunately, information gathered to this point has been insufficient to decisively identify oft used spawning sites; and only South Fork has provisional concentrated use areas identified, which will be subject to change as more data is gathered. Annual variability in run size, discharge, and other factors make it difficult to discern specific patterns.

Fish distribution in regards to upstream spawning extent upon mainstems and tributaries is not well-defined. Specific barriers to anadromy are not well documented within the Salmon River system; and what constitutes a “barrier” will vary based upon discharge, as well as the inherent athleticism of species attempting to pass it. In many cases, suspected “hard” barriers, such as impassible waterfalls, have not been officially assessed and documented. For the most part, Spring Chinook spawning seems to “peter out” above certain points – North Fork at North Russian Creek confluence and South Fork about 0.5 mile downstream of Little Grizzly Creek. Fish will spawn upstream of these points, but it is at a much lower degree compared to below. Furthermore, use of major tributaries is variable. For example, East Fork exhibited good spawning in 2011 and 2013, but either little or nothing in 2012, 2014, 2015, and 2016.

Access to upper extent river segments and tributaries known to be used by Spring Chinook is likely controlled, in part, by discharge conditions. Summer holding habitat is not necessarily the same as spawning habitat, and fish will move in search of suitable sites as spawning time approaches. An example of relocation was seen in 2013 for the South Fork drainage. Of note, there was a series of storm in mid- and late-September, before which spawning activity was minimal. No Spring Chinook were observed on the East Fork during summer holding surveys nor the single pre-storm spawning survey, but after the storms, 17 live fish and 18 redds were recorded. The assumption of a minimum of two fish per redd means that at least 36 Spring Chinook (and likely more) moved into this tributary from the South Fork. The ability of fish to be mobile was also seen in the uppermost South Fork "Wilderness" reach of Little South Fork Salmon River to Blindhorse. Holding surveys found 59 fish present in this river segment; and a good number of fish (35) were also observed in the pre-storm spawning survey. However, after the storm, the number of fish was much less; and only 4 redds were recorded in this reach by the end of the season. Therefore, the deduction is that fish used the opportunity presented by the increase in river flows to move elsewhere (lower) in the South Fork for spawning.

Not as much data is available for the North Fork, which makes identification of potential trends and use patterns a challenge. Overall, North Fork appears to have less suitable habitat for Chinook compared to South Fork. This is seen with summer holding numbers, as well as lesser spawning use by both spring-run and fall-run fish; and past habitat surveys also support a number of differences between the two mainstem systems which together likely contribute to a lesser preference by Chinook. Therefore, discussion focus in this section is upon the South Fork.

When Spring Chinook spawning survey reaches on the South Fork above Matthews Creek are examined, evidence of fish mobility between reaches is observed, and estimated spawning numbers appear to be greater than summer holding population. Some of these observations are likely a response to inter-annual variations in discharge, timing of fall storms, and run-size.

To better characterize how Spring Chinook might move from holding habitat to spawning habitat, South Fork reach-scale data between 2013 and 2016 was examined[1]. Summer fish numbers were taken from summer holding surveys. Spawning fish numbers are more difficult to estimate. To accurately model population based upon redds requires development of an intensive multi-year study specific to the system under consideration (Murdoch, *et al*. 2010). A study which occurred in the Wenatchee River basin in Washington determined that each redd represented 1.8 to 4.5 fish, with the male:female ratio generally skewing male (Murdoch, *et al*. 2010). A similar undertaking has not been completed for the Salmon River basin. Instead, to estimate population for Salmon River Fall Chinook, if mark-recapture population estimates are unable to be acquired, it is standard practice to assume each redd represents two fish (male/female), then add the number of live fish seen on last survey day (S. Borok, CDFW). Estimated spawning population for Spring Chinook was accomplished using this latter methodology (**Table 2**, **Figure 4**).

Broadly speaking, gross patterns of fish movement in the upper South Fork in regards to migration between holding habitat and spawning habitat seem to be consistent. Specific observations of relocation before and after a storm were described previously for 2013, but summer holding versus estimated spawning populations on a reach-scale show a more general redistribution that appears to occur regardless of discharge conditions or run size. Reach 7 may

[1] Quality and availability of Spring Chinook spawning data required for analysis prior to 2013 is poor.

offer a greater quantity/quality of summer habitat compared to the other upper South Fork reaches (e.g., a one mile segment of deep, sheltered pools), and so tends to support a larger population of holding Spring Chinook. Later, in conjunction with the spawning season, a net population decline occurs in Reach 7 as fish move into Reach 8, 17, and 18 to utilize spawning beds. No definite pattern is seen thus far for Reach 19.

Table 2. Comparison of Spring Chinook numbers observed during summer holding surveys and estimated spawning population. Reaches are located on the South Fork Salmon River between Matthews Creek and Little South Fork Salmon River. For difference in estimated total population sizes, the larger number is bolded.

	2013		2014		2015		2016	
	Summer Holding	Corrected Spawn Pop.	Summer Holding	Corrected Spawn Pop.	Summer Holding	Corrected Spawn Pop.	Summer Holding	Corrected Spawn Pop.[1]
Reach 7	179	120	112	82	27	26	49	
Reach 8	67	138	79	120	10	50	22	77
Reach 17	49	139	104	120	21	28	35	103
Reach 18	49	72	46	130	16	24	26	52
Reach 19	59	8	35	36	1	18	8	31
Total	403	**477**	376	**488**	75	**146**	91	**263**
Difference	74		112		71		172	

[1]In 2016, due to lack of survey effort in Reach 7, a corrected spawning population cannot be calculated. Therefore, "total" and "difference" are Reach 8 through Reach 19 only.

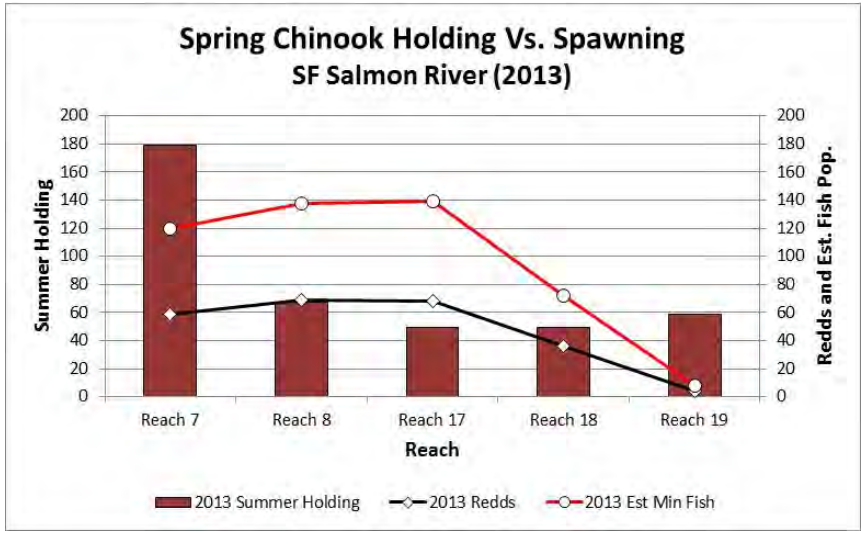
Observation of the transition of fish to spawning habitat from holding was affected by the 2016 survey effort. Specifically, Reach 7 – French Creek to Matthews Creek – was only surveyed once (e.g., September 19th). Early in the Spring Chinook spawning season, Reach 7 usually supports the most fish, often similar to the numbers observed during the summer snorkel census, and 2016 was no different. Most years, there is a subsequent shift in distribution as Reach 7 fish move to other locales, which is reflected with the corrected spawning population being less than the summer holding numbers (**Table 2**). By not revisiting Reach 7 in 2016, that shift and the degree to which it occurred was not observed.

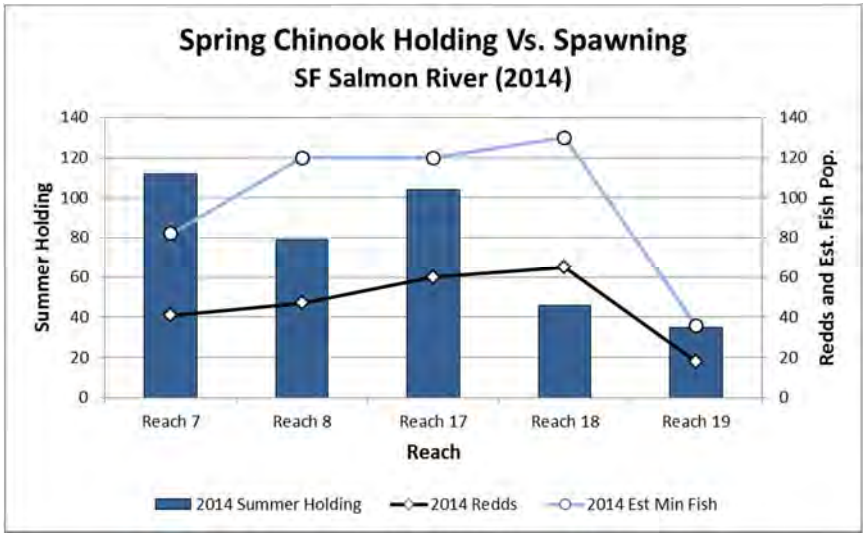
<u>All years suggest a consistently larger estimated spawning population of Chinook are present in the upper South Fork compared to summer holding survey numbers</u>. Some possible explanations, or combination thereof, include:

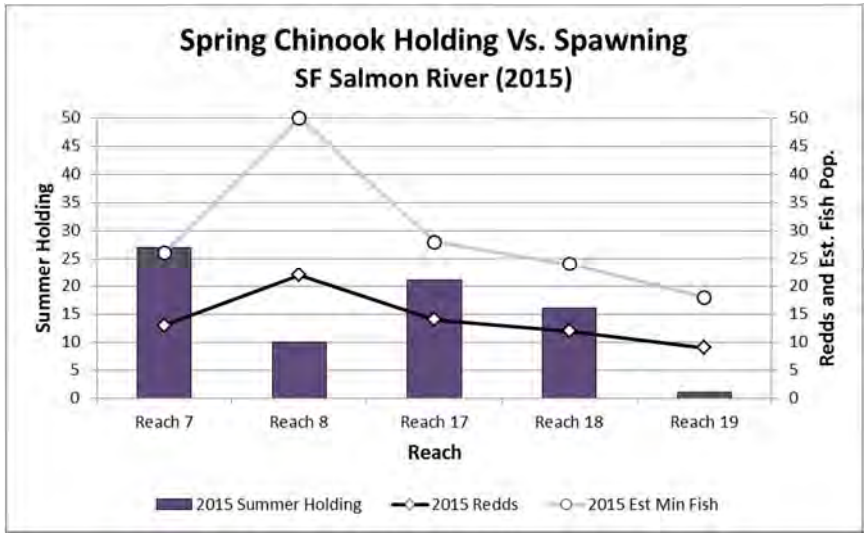
- Fish movement into the survey area
    - Redistribution of Spring Chinook from lower in the drainage
    - Influx of upmigrating Fall Chinook
- "Corrected spawning population" calculation assumption (from CDFW)
- Survey errors
    - Overcounting redds
    - Underestimation of fish during summer holding surveys

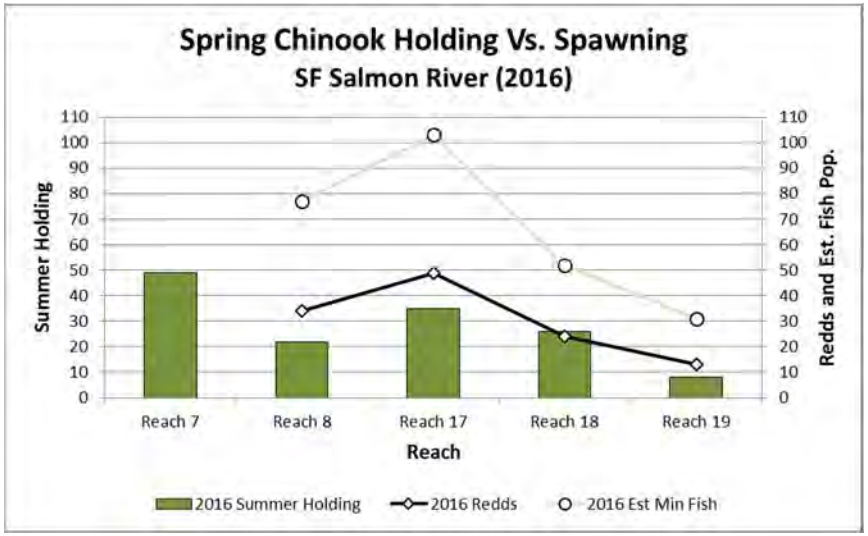
Each of these conjectures is discussed in turn below.

Table 4. Comparison of Spring Chinook observed summer holding population versus redd numbers and estimated spawning population, 2013 through 2016. Location is South Fork Salmon River for the five reaches between Little South Fork Salmon River and Matthews Creek.









Fish Movement

A potential explanation of the spawning vs. holding population discrepancy is that there is an influx of fish into the South Fork Spring Chinook spawning survey reaches. A fish influx might be accomplished in two ways. First, Spring Chinook could move upstream from reaches below Matthews Creek during the time period after the summer census but before spawning surveys commence. Second, Fall Chinook entering the drainage could be upmigrating into the survey area, thereby inflating fish numbers from the summer count "baseline". This section will examine these possibilities.

Fish movement throughout the Salmon River drainage, including the South Fork, appears to be significantly controlled by low-water barriers. At the downstream end of Reach 7, and upstream of the Matthews Creek Campground pool, is a bedrock/boulder cascade barrier which restricts fish movement during low-water conditions of late summer and early fall. While other low-water barriers are present in the South Fork above and below this point, this particular barrier is believed by local fish biologists to be a difficult obstacle for Chinook to pass. In fact, a proposal was made in 1984 to modify the barrier by blasting, but it is unknown if this action occurred (USFS 1984). Currently, this obstacle is considered the natural structure limiting spatial overlap of spring-run and fall-run Chinook in the upper South Fork Salmon River.

River discharge conditions are critical as to allowing fish passage at low-water barriers. In mid-September, at the start of the Spring Chinook spawning season, the discharge within the upper South Fork reaches was likely similar for all years surveyed. Small between-year differences, on the order to 40 to 50 cubic-feet-per-second, were recorded by the gage at the Salmon River mouth. However, these variations are expected to have been minimal once the distance between gage and the survey reaches is taken into account. "Regular base flow conditions" is probably the best description of starting survey conditions, with 2014 through 2016 perhaps slightly lower than the historical normal due to drought. In 2013 and 2014, mid- and late-September storms provided a short period of elevated discharge – much more so in 2013 than 2014 – after which baseflow conditions were enhanced. In contrast, no similar weather event occurred in 2015 or 2016, and the river remained at low flow conditions through the Spring Chinook spawning season. Of note, the mid-October storm event in 2016 would have significantly altered barrier status, but due to its timing, any effect to Spring Chinook is expected to have been minimal because it occurred at the end of the spawning season.

The increase of flows in 2013 and 2014 appear to have allowed fish to pass the barrier upstream of Matthews Creek. Observed Chinook numbers in Reach 7 and 8, and to a lesser extent Reach 17, increased following the storms. Some of these observations was undoubtedly fish already present in the upper South Fork reaches mobilizing out of difficult-to-see-in pools. However, fish were also certainly moving over the barrier. Case in point, in 2014, just after the late-September storm, more fish were counted within the upper South Fork reaches during spawning surveys than were seen during summer holding; and because accuracy of counting fish from the banks is lower than when snorkeling, spawning surveys probably underestimated actual live numbers. While some of these "new" fish were Spring Chinook migrating higher in the system in search of spawning gravels, other fish were likely fall-run Chinook taking advantage of the flows to pass the barrier. Although Fall Chinook surveys do not start in the Salmon River system until mid-October, spawning is typically well underway by then; and fish have been reported to enter the lower river as early as August. Unfortunately, the degree of spatial and temporal overlap of the spring-run and fall-run in the Salmon River, including the South Fork, is poorly understood.

In contrast to the prior two years, there was no substantial change in river discharge in 2015 or 2016 during the Spring Chinook spawning season. However, there is evidence that fish did move from holding to spawning habitat, and the estimated number of spawners, unexpectedly, still appeared to be larger than the summer holding population. Unlike the other years, there was no abrupt uptick in live fish within any reach beyond that which could be explained by movement by fish already present. Neither were any "bright" fish informally communicated to survey administrators, as in 2013 or 2014, which would further indicate an infusion of fish which had been in freshwater for a relatively short amount of time (e.g., Fall Chinook). It is possible that some fall-run fish did pass the Matthews Creek barrier, despite low flows. However, evidence from 2015 suggests that numbers were minimal given the Fall Chinook surveys in the reach directly below Matthews Creek never reported high numbers of live fish: in addition to the fall-run being depressed in 2015, fish appeared to have their own difficulty in passing low-water barriers lower in the watershed.

Fish movement cannot fully explain the spawning vs. holding population discrepancy. While influx of fish, particularly Fall Chinook undoubtedly occurs under the right conditions of discharge and run-timing (e.g., 2013, 2014), it is not the full story. A deeper look at the numbers shows that three of the last four years had a greater calculated influx of fish than were seen during the summer snorkel census for all South Fork reaches below the Spring Chinook spawning survey area. However, to attain the number of fish in the corrected spawning population, it would require all fish of the South Fork (and then some) to move into the spawning grounds upstream of Matthews Creek.

- 2014 – Discrepancy is 112 fish; and number of fish observed during the summer holding census downstream of Reach 7 is 68. This is a net increase of 44 fish.
- 2015 – Discrepancy is 71 fish; and number of fish observed during the summer holding census downstream of Reach 7 is 18. This is a net increase of 53 fish.
- 2016 – Discrepancy is 172 fish; and number of fish observed during the summer holding census downstream Reach 8 is 130 (see text and **Table 2** for explanation for alteration in considered area). This is a net increase of 42 fish.

The above numbers appear to be nonsensical. For one, the discrepancy has occurred during 2015 and 2016 when low-water barriers would have been difficult to pass during the summer, and when there was no obvious influx of Fall Chinook into the survey area. Additionally, in all years, Spring Chinook continued to be present downstream Matthews Creek as indicated by (1) informal observations of spawning seen from the County Road and (2) the first mid-October Fall Chinook surveys in the lower South Fork encountering "old"er redds that were obviously constructed earlier in the season, but not by Fall Chinook.

In summary, fish movement by Spring Chinook and/or Fall Chinook only has the potential to explain a small portion of the spawning vs. holding population discrepancy. Instead, other possible sources of error should be considered.

Corrected Spawning Population Assumption

A potential explanation of the spawning vs. holding population discrepancy is that the calculation of the corrected spawning population is incorrect; and, in fact, the estimated number of fish spawning in the South Fork survey reaches is less than that presented. As explained earlier in this document, it is assumed that each redd represents two fish (male/female). If this assumption is wrong, then any result would also be erroneous.

The assumption of one male/female pair per redd is likely conservative for Chinook. Males are not faithful to a single redd (Healey 1991); and, theoretically, each redd could represent one female and less than one male. In the literature, it is difficult to find instances where the sex composition of adult Chinook is not either equal or, more likely, male-dominated. This observation is true for live counts as fish pass weirs/dams, as well as carcass surveys. As one of the few examples of female-dominance upon the spawning grounds, Murdoch, *et al*. (2010) reported several years of male:female carcass ratios, ranging from 0.8 to 3.5 (which was similar to visual observation of live fish upmigrating through a dam). However, even if the Murdoch, *et al.* (2010) estimate of males were applied to the South Fork Salmon River data, if would not be near enough to account for the spawning vs. holding population discrepancy. Instead, if anything, literature suggests that males often outnumber females on the spawning ground. In that case, the corrected spawning population estimate as currently applied is conservative, and may underestimate the real number of fish if one assumes that each redd actually represents one female and more-than-one male.

Survey Errors

A potential explanation of the spawning vs. holding population discrepancy is that there is an underlying protocol issue with redd surveys and/or the summer holding snorkel census. If redds are over-counted and/or Spring Chinook under-counted, those results could contribute towards the observed disagreement. This section will examine the potential for survey error.

The over-counting of redds during the Spring Chinook spawning survey is a potential source of error. Dunham, *et al*. (2001) looked at the validity of annual redd counts as a tool in monitoring salmonid populations. Although the salmonid under evaluation was bull trout, the results are applicable to other species such as Chinook. The primary suggestions provided to decrease error included having experienced crew and use of multiple surveys during the season. The Spring Chinook surveys on the Salmon River already incorporate most, if not all, of the recommendations to decrease survey error. For instance, crews consist of experienced individuals, some of whom have been performing redd surveys for a decade (or more); and they are well-versed in how to discern a redd from a not-redd (e.g., “test” scrape, hydraulic feature, gravel sorting from small-scale sluicing, etc.). New surveyors are always paired with an experienced individual and/or crew, and are not allowed to survey on their own until the survey administrator is confident that redds can be properly identified. Additionally, multiple surveys are completed over the course of the spawning season. This practice not only allows the temporal tracking of spawning activity, but it permits a crew to be “conservative” in redd identification: if a crew is not sure that a feature is a redd, they can leave it for the next crew. Since crews visit different reaches each survey day, there is a decreased chance for complicity to set in because the habitat is “new” every time. Therefore, while there is the possibility that there is some error in the redd count, it is unlikely to be a significant concern.

The under-counting of fish during the annual cooperative Spring Chinook/Summer Steelhead snorkel census is a potential source of error. Crews who participate in the summer surveys may regularly underestimate the number of fish. Such a source of error is not unexpected: spooked schools of fish are difficult to count, leading to estimation; complex, deep pool habitat offers rocks, underhangs, crevices, and other difficult-to-observe hiding spots; bubble curtains and other turbulent water easily occlude fish; rapids are much more difficult to search compared to pools; and crews may not fully search an area due to reasons of personal safety and snorkeling experience. Overall, there are many ways to miss fish. Thurow (1994), in his guide to underwater

fish observation methodology, emphasizes training and experience for accurate counts. His review of studies which looked at population estimates gathered via snorkeling versus electrofishing found accuracy for the former to range from 20-95%, with most counts greater than 70%. The take-home message is that many factors – crew-related, as well as habitat complexity, water visibility, stream size, and fish behavior – can affect accuracy, but that measures can be taken to minimize error. Unfortunately, accuracy for the cooperative census has the potential to be suspect given the wide range of snorkeler experience and the habitat complexity of the Salmon River drainage; and, therefore, it is highly likely that undercounting of Spring Chinook is a factor in the spawning vs. holding population discrepancy. The degree to which fish are under-counted is unknown.

In summary, there are likely three sources of error regarding the spawning vs. holding population discrepancy for the South Fork survey reaches.

1) An increase in flows in 2013 and 2014 likely allowed passage around the Matthews Creek barrier for both spring-run and fall-run fish, leading to the augmentation of Chinook numbers. However, fish movement cannot be the only contributing factor because low flows during the Spring Chinook spawning season during 2015 and 2016 is thought to have inhibited large-scale fish redistribution; and, furthermore, the low number of fall-run Chinook in 2015 had their own issues navigating obstacles lower in the drainage and, therefore, were unlikely to have noticeably augmented spring-run size in the upper South Fork.
2) There is the potential that Spring Chinook redds have been over-counted, although the amount is thought to be minimal due to an existing protocol which addresses this source of error.
3) Most likely, Spring Chinook numbers may be underestimated during summer holding surveys due to a variety of reasons.

Of possible sources of error, the underestimation of fish during the cooperative snorkel surveys is potentially the most worrisome. These surveys are the primary source of tracking the Spring Chinook population in the Salmon River drainage and represent a very important dataset that spans decades. In turn, adult fish population is utilized on the State and Federal levels when considering stock health and management implications. Therefore, a focus for investigation would be to determine if there is an issue with the fish counts; and if so, how great. If there is no evidence of a significant departure from the census count, then the question of discrepancy and the reasons behind it should be revisited.

It is important to continue to gather information related to Spring Chinook and increase the detail of the dataset. Many of the challenges facing spring- and fall-run fish are the same, and conclusions reached for Fall Chinook will apply to Spring Chinook, but there are also fundamental differences between the two life histories. Important in the short-run is to identify those areas most critical to Spring Chinook for spawning habitat in order to ensure that they are adequately protected in the future from human-caused impact, be it logging, mining, or other action. This task has already been accomplished for Fall Chinook. In the long-term, it is essential to track how Spring Chinook respond to variation in water-flow, run size, and other factors. This information will provide a dataset for fisheries managers to know what is “normal”, and be able

to identify deviation from expected behaviors and use patterns, be it in response to events such as wildfire or debris flow, or climate change. Finally, it is crucial to determine the degree of spatial and temporal overlap between spring- and fall-run fish in the Salmon River drainage. Genetic analysis has identified fundamental differences between spring- and fall-run fish which applies across the species' range (Prince, *et al*. 2016). How this emerging information will be applied to the Klamath River basin in general, and the Salmon River drainage in particular due to the presence of non-hatchery produced spring-run fish, is unknown, but a better and more nuanced understanding of the distinctions between the runs at the local level will assist Federal, State, and other entities in their management.

Survey Observations and Recommendations

The crew comprising the Spring Chinook survey team is smaller than that employed by the Fall Chinook effort. With a smaller group, span of control for the survey manager is easier. SRRC is the lead entity for Spring Chinook surveys, and in previous years has taken primary responsibility for basic paperwork QA/QC following each survey day. In 2016, SRRC hired a new fisheries program manager whom began their employment only a few months prior to the onset of the Spring Chinook spawning season. Due to this transition, certain aspects related to paperwork and volunteers was not as consistent as it otherwise has been. However, these concerns are expected to resolve by next year as the SRRC fisheries program manager continues to learn their position.

Many of the datasheet/map issues seen for the Spring Chinook surveys are similar to those encountered during the Fall Chinook effort. This observation is not surprising because two surveys use the same datasheets, and many of the same people participate in both events. Unlike the Fall Chinook survey, the fewer number of crew means it is easier to identify problems as they occur and apply fixes faster and/or talk to individuals about datasheet specifics.

To address common annually reoccurring issues, it is on the onus of the survey manager, or their representative, to ensure crews fully understand all aspects of survey protocol. Although pre-season training introduces (or re-introduces) the protocol to crew, the information imparted may not be fully understood by a new crewmember, or yearly adjustments in protocol might not be wholly absorbed by a multi-season surveyor. Therefore, it is highly recommended that survey managers begin each survey day by reminding crew of the expected protocol. This activity should occur prior to acquisition of datasheet/map packets. This daily announcement may include proper dictation of carcass and/or redd numbers, GPS protocols, reminder to fill in summary sheets, and any other issue of concern.

Additionally, communication between SRRC and KNF is paramount to ensure that all is well should one survey manager or the other be unable to make a survey.

There are several crew-associated issues to continue to address during training and daily survey announcements. This list is a subset of topics derived from Fall Chinook surveys; and, in general, less issues are seen during Spring Chinook surveys compared to Fall Chinook. Of note, a suggestion at the end of the 2015 Fall Chinook surveys was to combine the reach map with the redd datasheet. This alteration was welcomed by Spring Chinook crewmembers because it decreased the overall amount of paper of which to keep track.

- Be sure to have all datasheets/maps before leaving for the reach.

- Correctly fill out all datasheets.
    - Complete header information as appropriate – start/end time, weather, streamflow, temperature (when available), crew names, etc. Header information allows survey administrators to gage effort. For instance, it is expected that better data will have been gathered in conditions of clear water and sunny skies, compared to rain/wind with high flows.
    - Count all live fish. Record total live Chinook seen during a survey on both the carcass and redd datasheets. The redd sheet also asks for Coho and steelhead. If there are no fish, write a "0". This action confirms to the administrator that a count was undertaken.
    - Redd dimensions should be measured to the nearest 0.1 meter, or as close as possible given equipment limitations. **Do not** use feet. **Do not** use the nearest meter or half meter. **Do not** estimate.
    - "Unflagged Segments" on the redd sheet should only be filled in when and where not flagged. There are no unflagged segments for Spring Chinook surveys.
    - Always fill out the hardcopy maps! They are used for post-season QA/QC, as well as a back-up should GPS data be lost or not collected.
- Perform the GPS protocol correctly.
    - **Ensure that crew can use a GPS when it is given to them**. Have them demonstrate if there is a question as to competency.
    - Each redd is a single GPS point – do not lump multiple redds into a single point. GPS points are used to delineate location of spawning areas for management and monitoring purposes. Mapping resolution for GIS or GoogleEarth is lost when redds are grouped.
    - Input the correct redd number label.
    - When a crew is GPSing, they should capture **all flags** which have not already been mapped, not just the new ones recorded that survey day. Do not assume that a redd has already been GPSed - check flagging for knots.
    - Use information on flagging – date and redd number – to build a redd GPS point. Do not sequentially number all redds on the day that the GPS is used, regardless of original date of discovery.
- Other issues
    - At the end of the survey day, turn in all datasheets and maps, even those with negative information.
    - If a reach is ended early due to injury, weather, or other reason, mark on the map where the survey stopped. For example, Reach 7 can end prior to the canyon if crew are not geared up to swim.
    - Redd flagging should always include survey date and redd number to avoid double-counting.

Continuing, there are several recommendations aimed specifically at KNF, as based upon survey observations made in 2016, as well as prior years:

- The KNF administrator should continue to ensure that redd datasheets and maps are always available, thereby eliminating the need for crews to improvise.

Although the purpose of this document is to discuss Spring Chinook spawning surveys, questions raised surrounding the precision of the summer holding census should be addressed. The number

of fish observed during the summer informs managers involved in the subsequent spawning season how many redds (and carcasses) to generally expect. Therefore, consideration should be expended about how to address concern of the potential under-count of Spring Chinook during the cooperative summer holding surveys. The KNF should work with the appropriate CDFW office(s), as well as other interested entities, to devise a methodology to deploy during 2017 or 2018, as funding and personnel resources allow. An initial suggestion is to use an experienced crew to visit a target reaches prior to the cooperative survey event, then return to recount the locale afterwards. A comparison can then be made between the experienced crew and the "normal" event crew. Furthermore, it is suggested that this effort is expended to least two locations known to support higher numbers of fish: an "advanced" reach (e.g., French Creek to Matthews Creek [South Fork]) and an "easy" reach (e.g., Henry Bell to Forks of Salmon [South Fork]). Often, while experienced surveyors will swim the harder segments of the rivers, individuals with much less (or no) experience finding and identifying fish will be shepherded through reaches by an experienced crew leader. Therefore, if there is under-counting, it may be more exaggerated in the traditionally "easier" portions of the survey area, compared to the harder.

LITERATURE CITED

California Department of Fish and Wildlife (CDFW). 2016. Klamath Basin cooperative spawning ground survey – 2016 training manual. 61 p.

Dunham, J., Rieman, B., and K. Davis. 2001. Sources and magnitude of sampling error in redd counts for bull trout. *North American Journal of Fisheries Management* 21: 343-352.

Healey, M.C. 1991. Life history of Chinook salmon (*Oncorhynchus tshawytscha*). Pages 312-393 in Pacific Salmon Life Histories (ed. C. Groot and L. Margolis). UBC Press, University of British Columbia, Vancouver, BC.

Mudroch, A.R., Pearsons, T.N., and T.W. Maitland. 2010. Estimating the spawning escapement of hatchery- and natural-origin Spring Chinook salmon using redd and carcass data. *North American Journal of Fisheries Management* 30: 361-375.

Prince, D.J., O'Rourke, S.M., Thompson, T.Q., Ali, O.A., Archiniega, M., Lyman, H.S., Saglam, I.K., Clemento, A.J., Hotaling, T.J., Kinziger, A.P., Spidle, A.P., Garza, J.C., Perse, D.E., and M.R. Miller. 2016. The evolutionary basis of premature migration in Pacific salmon highlights the utility of genomics for informing conservation. Pre-print article. doi: http://dx.doi.org/10.1101/056853.

Thurow, R.F. 1994. Underwater methods for the study of salmonids in the Intermountain West. General Technical Report INT-GTR-307. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station. 28 p.

U.S. Forest Service (USFS). 1984. Categorical Exclusion for South For Salmon River waterfall modification. Salmon River Ranger District, Fort Jones, CA. 1 p.

Personal Communications

Sara Borok, Environmental Scientist, California Department of Fish and Wildlife - Arcata

Appendix A – California Department Fish and Wildlife "MegaTable"

Due to large size of the Klamath River spring Chinook "MegaTable" (1980 to 2015), only the most recent years and summary tables are provided in this Forest Service document. See the original California Department of Fish and Wildlife document for the full MegaTable, including footnotes and acronyms.

Klamath River Basin Spring Chinook Salmon Spawner Escapement, River Harvest and Run-size Estimates 1980-2014

Page 11

SPAWNER ESCAPEMENT

	2010			2011			2012		
Hatchery Spawners	Grilse	Adults	Totals	Grilse	Adults	Totals	Grilse	Adults	Totals
Trinity River Hatchery (TRH)	245	2,457	2,702	2,758	3,823	6,581	109	6,712	6,821
Natural Spawners									
Klamath River Basin									
Salmon River	280	1,081	1,361	351	1,242	1,593	187	1,104	1,291
Misc. Tribs.				23	82	105 e			0
Trinity River Basin									
Above JCW, excluding TRH	1,512	6,617	8,129	5,217	7,309	12,526	542	16,117	16,659
South Fork	15	108	123	195	242	437	61	773	834
Misc. Tribs.	50	183	233	199	361	560	69	358	427
Subtotals	1,857	7,989	9,846	5,985	9,236	15,221	859	18,352	19,211
Total Spawner Escapement	2,102	10,446	12,548	8,743	13,059	21,802	968	25,064	26,032

RIVER HARVEST

	2010			2011			2012		
Harvest	Grilse	Adults	Totals	Grilse	Adults	Totals	Grilse	Adults	Totals
Klamath River Basin									
Yurok Tribe	6	3,273	3,279	29	2,586	2,615	33	3,589	3,622
Angler	164	557	721 g	446	917	1,363 g	111	510	621
Trinity River Basin									
Hoopa Tribal Harvest	4	1,740	1,744	108	2,282	2,390	21	2,647	2,668
Angler[m]	0	454	454	112	0	112	163	1,976	2,139
Total River Harvest	174	6,024	6,198	695	5,785	6,480	328	8,722	9,050

RUN-SIZE ESTIMATES

	2010			2011			2012		
	Grilse	Adults	Totals	Grilse	Adults	Totals	Grilse	Adults	Totals
Total Run-size Estimates	2,276	16,470	18,746	9,438	18,844	28,282	1,296	33,786	35,082

2013 - 2015 MEGA-TABLE_Spring-Chinook

Klamath River Basin Spring Chinook Salmon Spawner Escapement, River Harvest and Run-size Estimates

SPAWNER ESCAPEMENT

	2013			2014			2015		
Hatchery Spawners	Grilse	Adults	Totals	Grilse	Adults	Totals	Grilse	Adults	Totals
Trinity River Hatchery (TRH)	96	2,482	2,578	362	3,255	3,617	240	1,748	1,988
Natural Spawners									
Klamath River Basin									
Salmon River	125	770	895	63	788	851	28	258	286
Misc. Tribs.			0			0			0
Trinity River Basin									
Above JCW, excluding TRH	185	5,956	6,141	282	2,833	3,115	253	2,055	2,308
South Fork	36	295	331	8	83	91	1	19	20
Misc. Tribs./p	57	167	224	27	105	132		26	
Subtotals		7,188	7,591	380	3,809	4,189	282	2,358	2,614
Total Spawner Escapement	96	9,670	10,169	742	7,064	7,806	522	4,106	4,602

RIVER HARVEST

	2013			2014			2015		
Harvest	Grilse	Adults	Totals	Grilse	Adults	Totals	Grilse	Adults	Totals
Klamath River Basin									
Yurok Tribe	7	3,753	3,760	16	3,145	3,161	0	2,577	2,577
Angler	116	1,011	1,127	120	843	963	65	417	482
Trinity River Basin									
Hoopa Tribal Harvest	19	1,202	1,221	85	1,733	1,818	15	1,087	1,102
Angler	0	243	243	16	210	226	0	139	139
Total River Harvest	142	6,209	6,351	237	5,931	6,168	80	4,220	4,300

RUN-SIZE ESTIMATES

	2013			2014			2015		
	Grilse	Adults	Totals	Grilse	Adults	Totals	Grilse	Adults	Totals
Total Run-size Estimates	238	15,879	16,520	979	12,995	13,974	602	8,326	8,902

(Continued next page)

n/ Above JC weir, numbers derived from tag returns only

a/ Numbers from the Spring Chinook crew performed by CDFG mid-April until the fall Chinook crew began the first weekend in August.

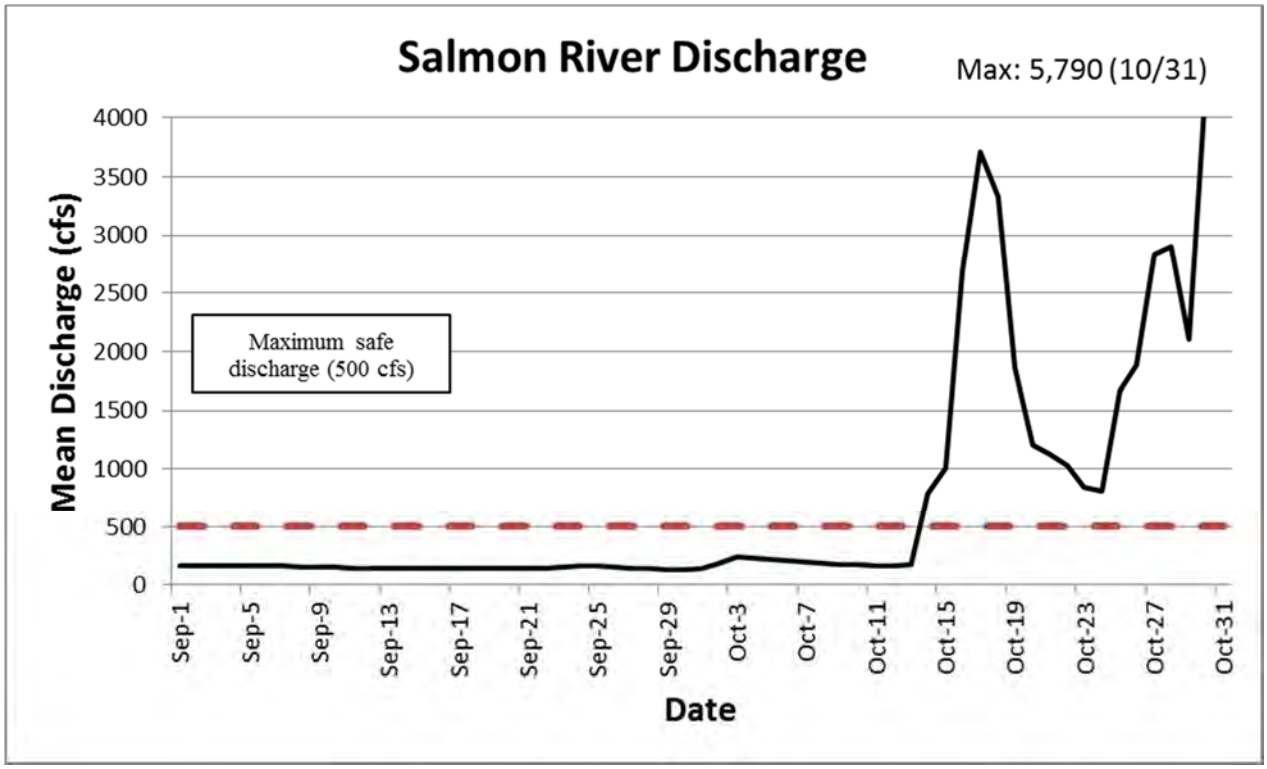
b/ No Canyon Creek or New river dives due to fires. Data from Lower Trinity Ranger district.

Appendix B – USGS Discharge Chart

Salmon River
The Salmon River gauge (11522500) is located 1.0 miles upstream from Somes Bar, CA, at the confluence with the Klamath River.

- Legal location T.11N., R.6E., Sec. 3 (Humboldt Meridian); or
- Lat. 41°22'36" by Long. 123°28'33" (referenced NAD 1927)

The graph shown provides a daily mean of discharge at the gauge and includes September 1st through October 31st, 2016, which encompasses the redd/carcass survey dates and is inclusive effort by cooperators which may continue after KNF had ended the survey season. Instantaneous discharges measured at the gauge can be higher or lower than that pictured. Variability in flow during an actual survey day may provide a window of safe discharge not reflected in the figure.



Appendix C – Salmon River Redd and Fish Survey Tables (2016)

Redds – Forks and Tributaries

Reach	19-Sep	22-Sep	26-Sep	29-Sep	3-Oct	6-Oct	10-Oct	13-Oct
South Fork Salmon River								
Reach 6 - Matthews Ck to Indian Ck								
Reach 7 - French Ck to Matthews Ck	0							
Reach 8 - Cecilville CC to French Ck	0	6		19	6		3	
Reach 17 - Petersburg to Cecilville CC	0	5		23	14		7	
Reach 18 - Blindhorse Ck to Petersburg	8	2		5				9
Reach 19 - Little SF Salmon to Blindhorse Ck		7		6				
East Fork Salmon River (tributary)								
Reach 20A - Taylor Ck to Confluence	0	0		1	0			
Reach 20B - Shadow Ck to Taylor Ck				0				
North Fork Salmon River								
Reach 11 - Mile 12 to Mile 8						9		
Reach 12 - Mile 16 to Mile 12						11		
Reach 13 - Whites Gul to Mile 16			2			2		
Reach 14 - Idlewild CG to Whites Gul			1			10		
Reach 15 - Mule Bridge TH to Idlewild CG			1			0		
Reach 16 - Big Ck to Mile Bridge CG								
Little North Fork Salmon River (tributary)								
Reach 21A - Specimen Ck to Confluence								

Spring Chinook (Live) Observation

Reach	19-Sep	22-Sep	26-Sep	29-Sep	3-Oct	6-Oct	10-Oct	13-Oct
South Fork Salmon River								
Reach 6 - Matthews Ck to Indian Ck								
Reach 7 - French Ck to Matthews Ck	45							
Reach 8 - Cecilville CC to French Ck	19	11		18	13		9	
Reach 17 - Petersburg to Cecilville CC	4	2		10	16		5	
Reach 18 - Blindhorse Ck to Petersburg	18	13		10				4
Reach 19 - Little SF Salmon to Blindhorse Ck		3		5				
East Fork Salmon River (tributary)								
Reach 20A - Taylor Ck to Confluence	2	0		0				
Reach 20B - Shadow Ck to Taylor Ck				0				
North Fork Salmon River								
Reach 11 - Mile 12 to Mile 8						5		
Reach 12 - Mile 16 to Mile 12						8		
Reach 13 - Whites Gul to Mile 16			1			1		
Reach 14 - Idlewild CG to Whites Gul			11			6		
Reach 15 - Mule Bridge TH to Idlewild CG			0			1		
Reach 16 - Big Ck to Mile Bridge CG								
Little North Fork Salmon River (tributary)								
Reach 21A - Specimen Ck to Confluence								

Steelhead (Live) Observation

Reach	19-Sep	22-Sep	26-Sep	29-Sep	3-Oct	6-Oct	10-Oct	13-Oct
South Fork Salmon River								
Reach 6 - Matthews Ck to Indian Ck								
Reach 7 - French Ck to Matthews Ck	7							
Reach 8 - Cecilville CC to French Ck	0	1		0	0		nd	
Reach 17 - Petersburg to Cecilville CC	4	0		0	0		0	
Reach 18 - Blindhorse Ck to Petersburg	0	0		0				nd
Reach 19 - Little SF Salmon to Blindhorse Ck		0		nd				
East Fork Salmon River (tributary)								
Reach 20A - Taylor Ck to Confluence	0	0		0				
Reach 20B - Shadow Ck to Taylor Ck				0				
North Fork Salmon River								
Reach 11 - Mile 12 to Mile 8						0		
Reach 12 - Mile 16 to Mile 12						0		
Reach 13 - Whites Gul to Mile 16			0			0		
Reach 14 - Idlewild CG to Whites Gul			3			1		
Reach 15 - Mule Bridge TH to Idlewild CG			0			0		
Reach 16 - Big Ck to Mile Bridge CG								
Little North Fork Salmon River (tributary)								
Reach 21A - Specimen Ck to Confluence								

*nd = no data (surveys performed, but datasheets or data missing; number likely 0)

Appendix D – Redd Spatial Distribution

Redd spatial distribution on maps are displayed with one point equating one redd. All surveyed reaches and tributaries are mapped, regardless of redd presence.

Salmon River Data

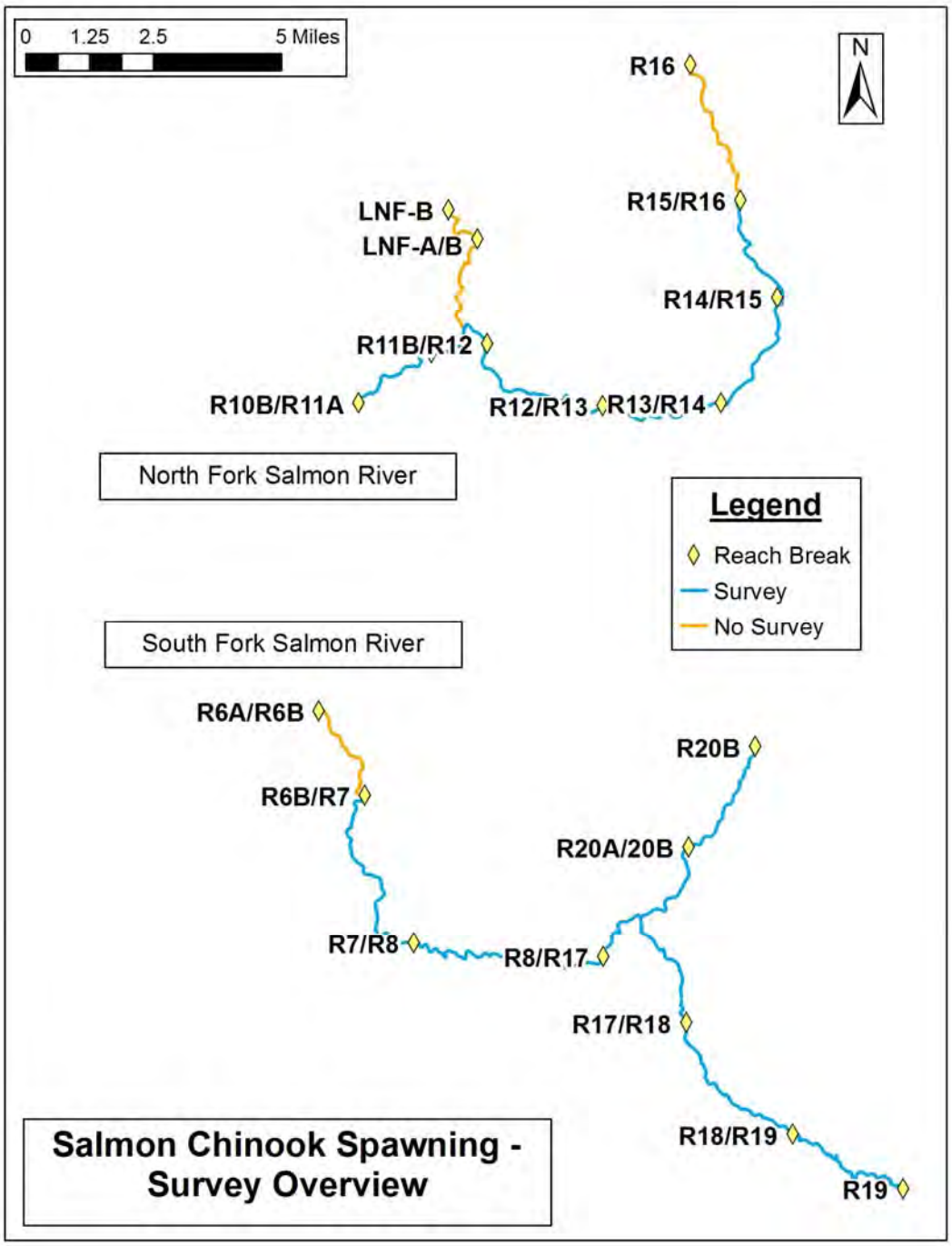


Figure D-SA1. General overview of location of reaches visited during Spring Chinook surveys upon the Salmon River. Map is of survey area only and does not include roads, hillslopes, or other landmarks.

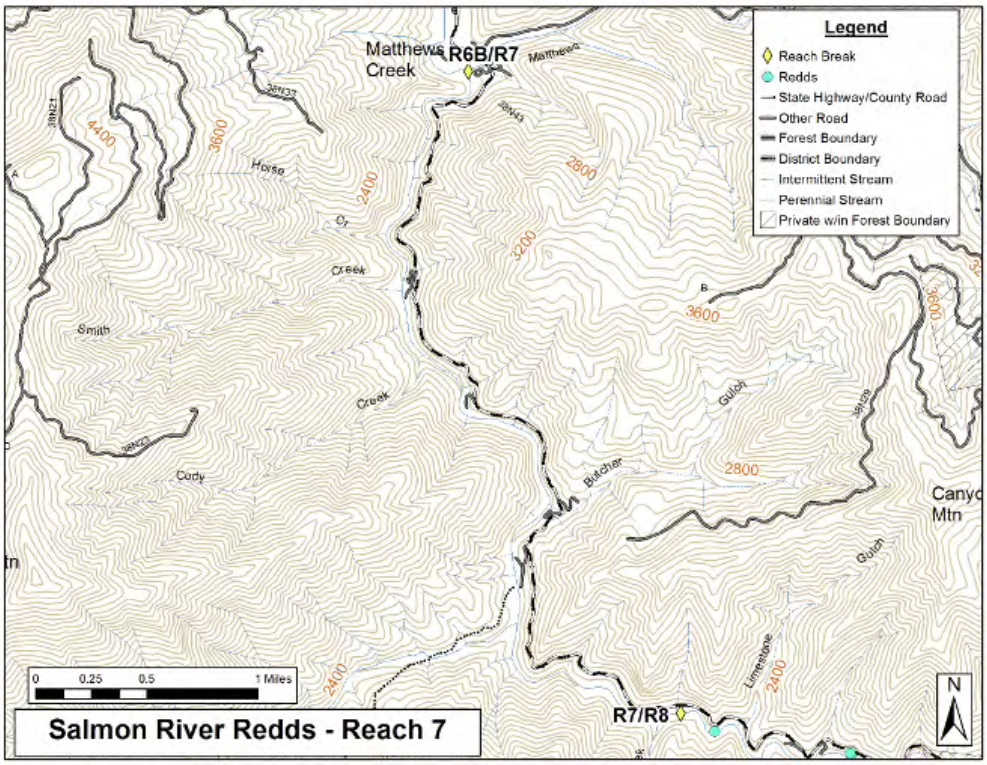


Figure D-SA2. Redd distribution for SF Salmon River, Reach 7.

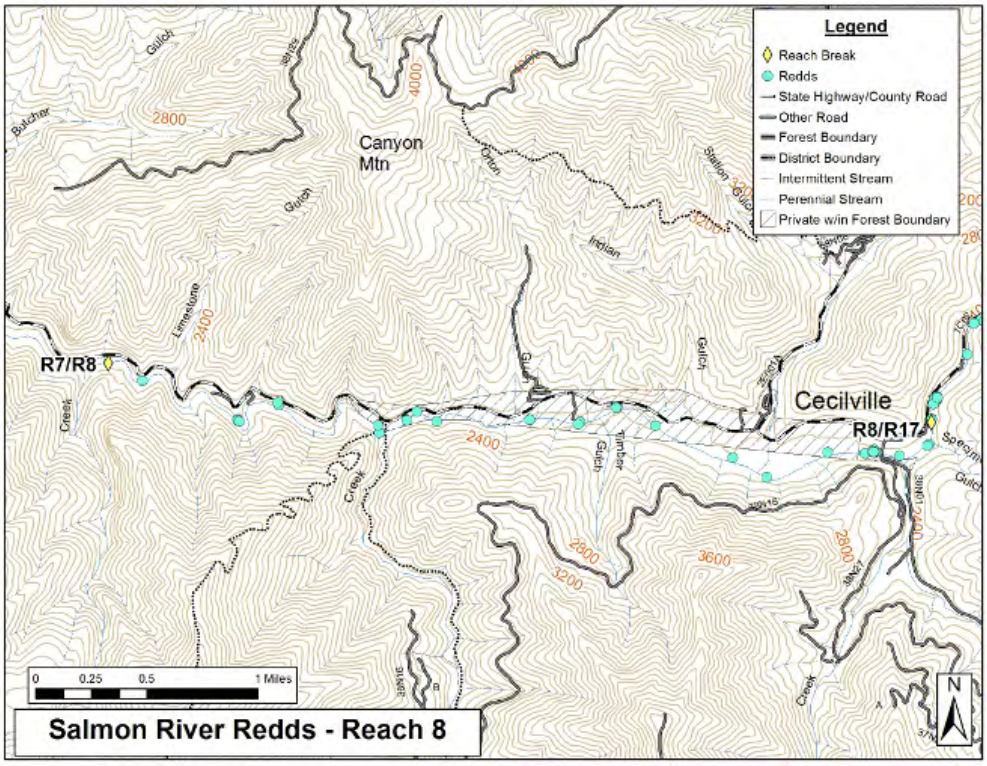


Figure D-SA3. Redd distribution for SF Salmon River, Reach 8.

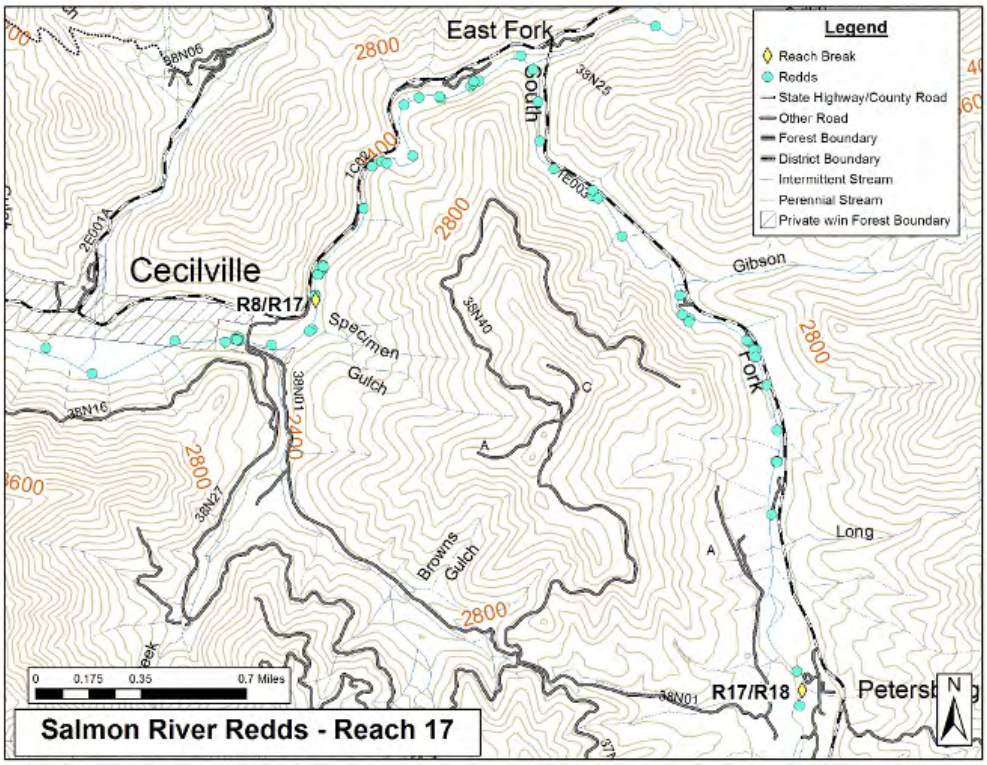


Figure D-SA4. Redd distribution for SF Salmon River, Reach 17.

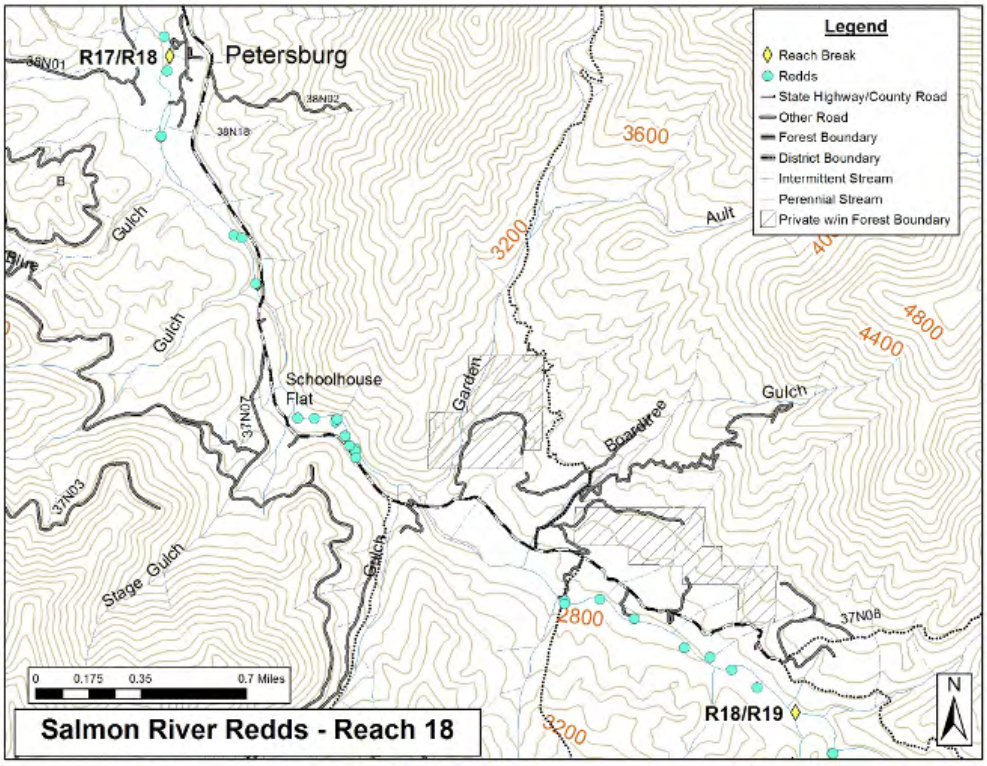


Figure D-SA5. Redd distribution for SF Salmon River, Reach 18.

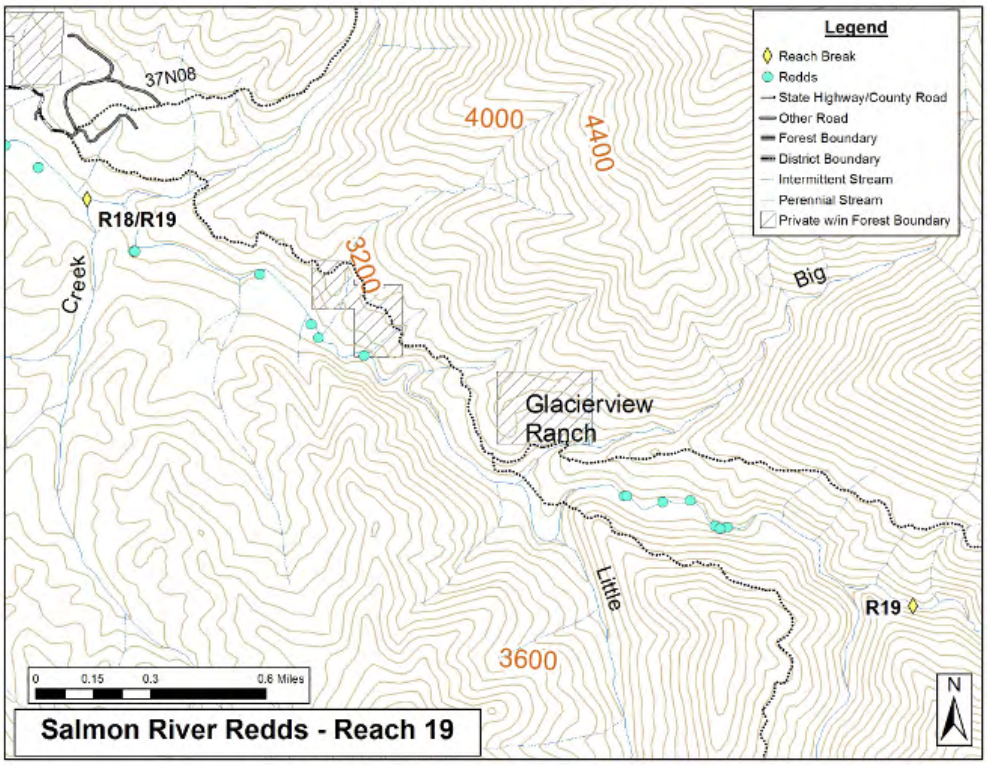


Figure D-SA6. Redd distribution for SF Salmon River, Reach 19.

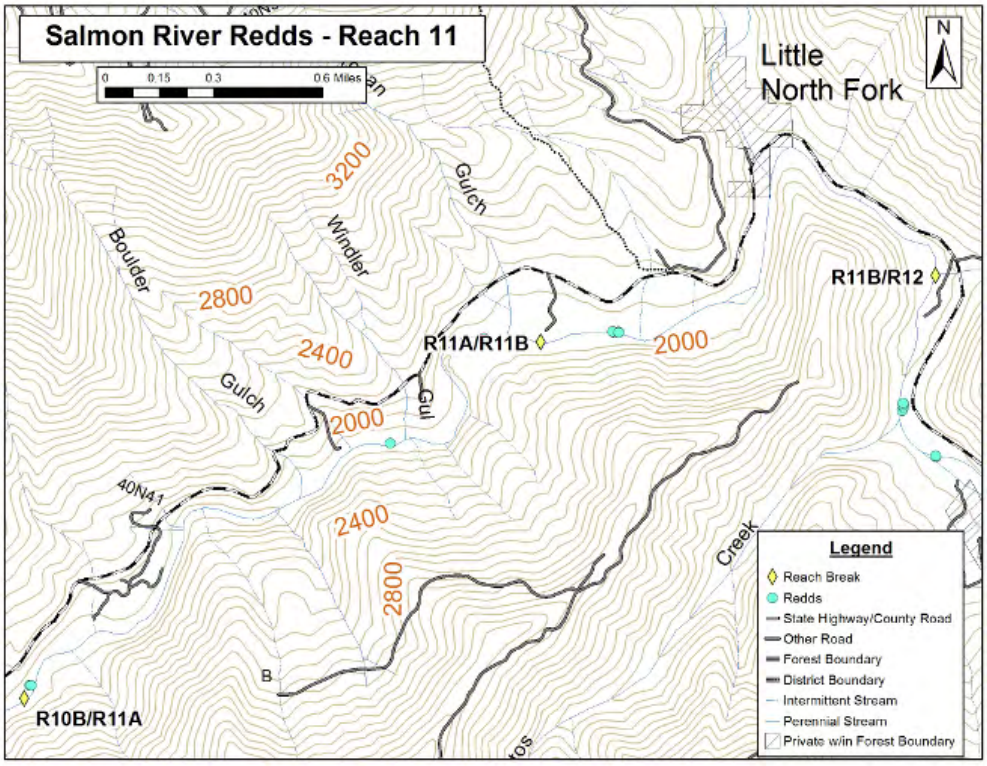


Figure D-SA7. Redd distribution for NF Salmon River, Reach 11.

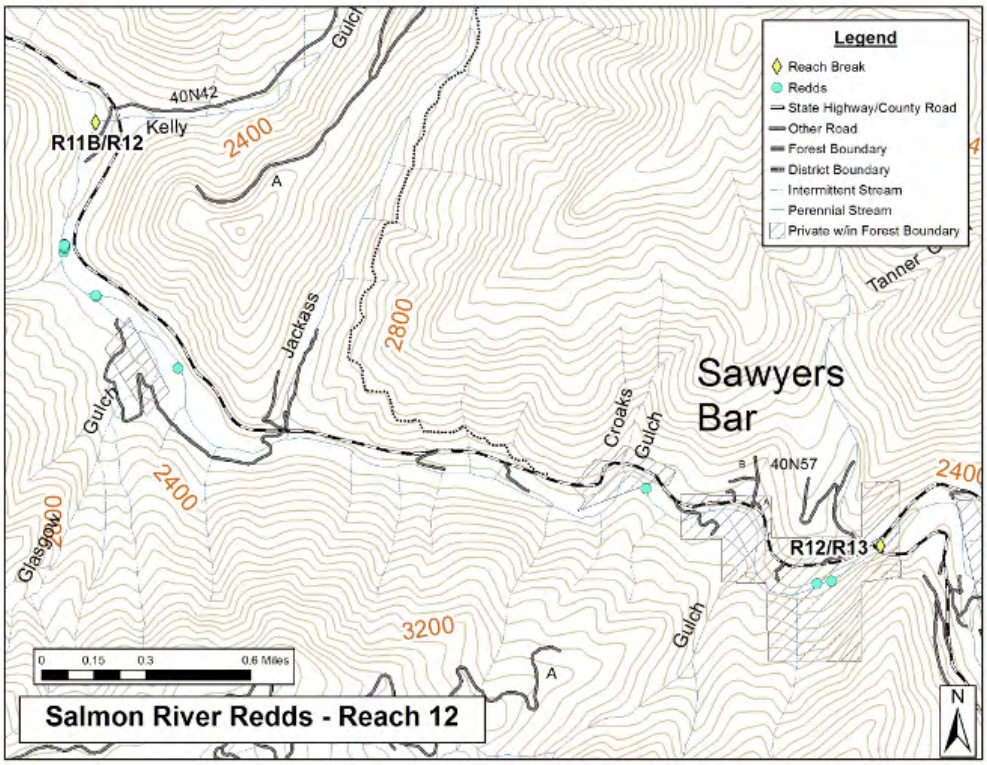


Figure D-SA8. Redd distribution for NF Salmon River, Reach 12.

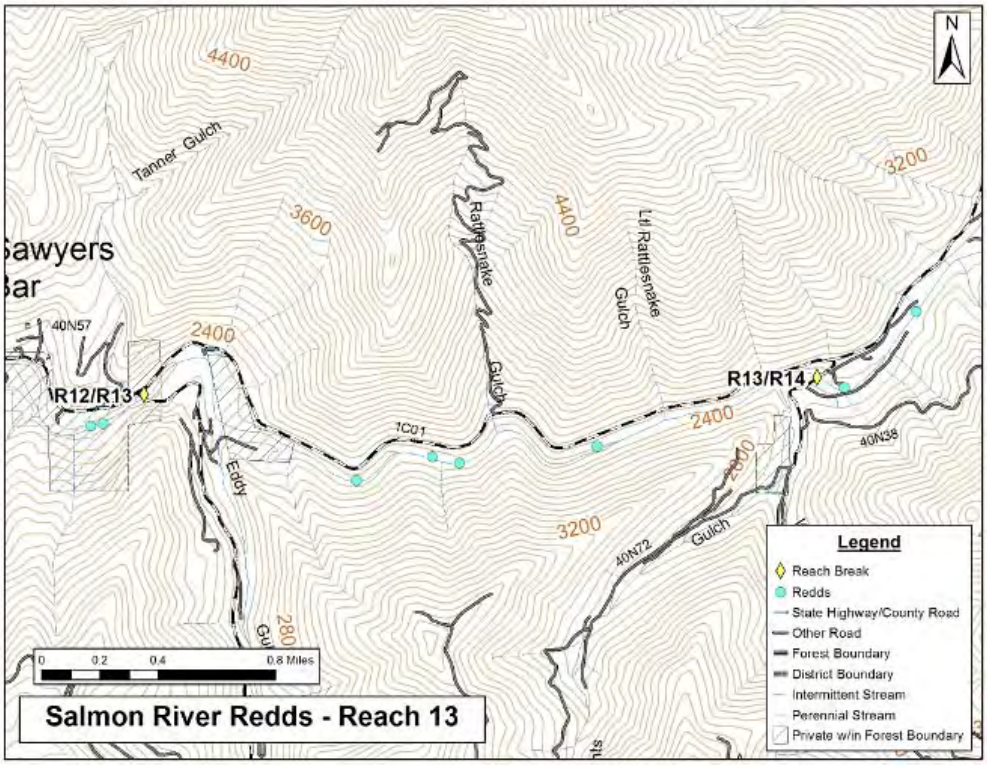


Figure D-SA9. Redd distribution for NF Salmon River, Reach 13.

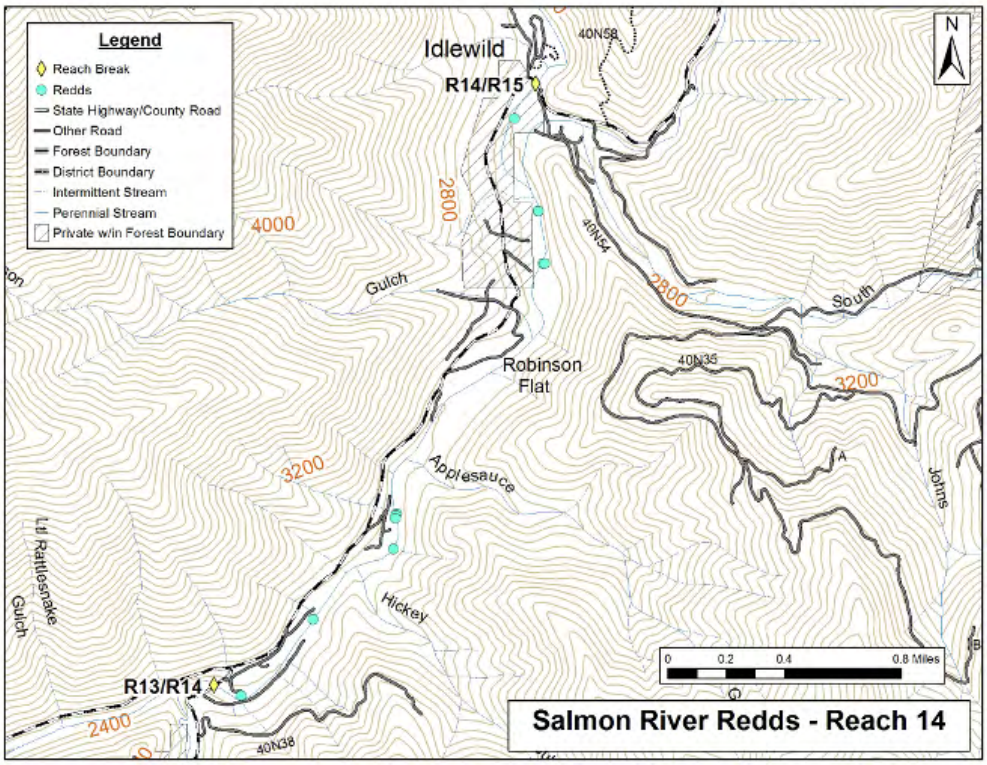


Figure D-SA10. Redd distribution for NF Salmon River, Reach 14.

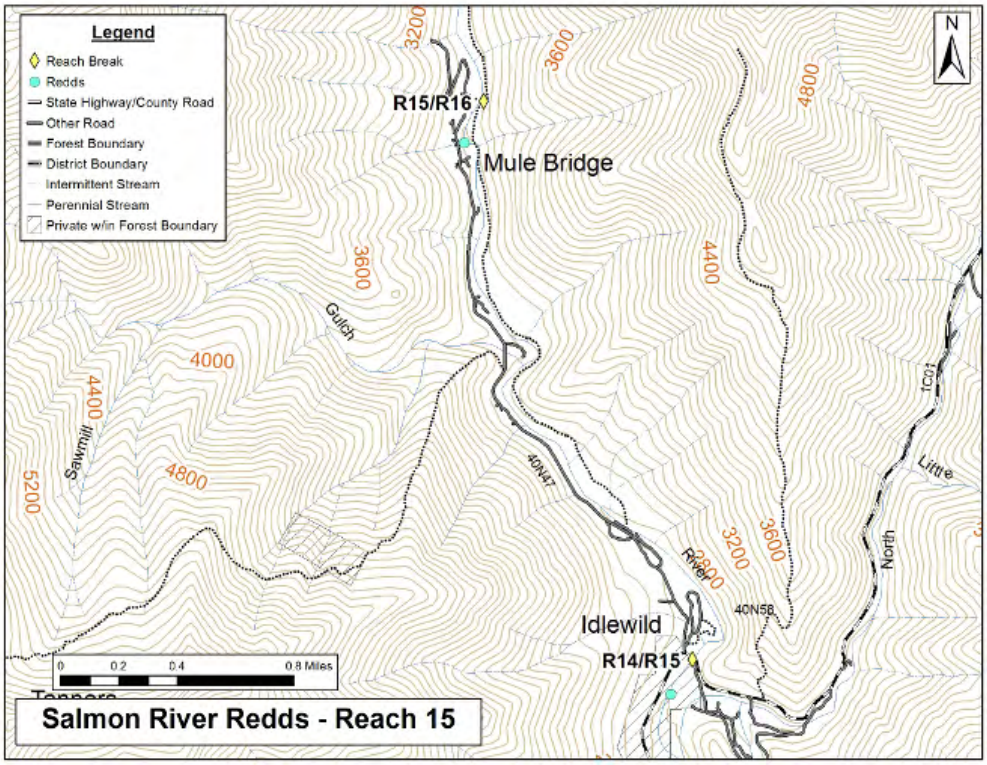


Figure D-SA11. Redd distribution for NF Salmon River, Reach 15.

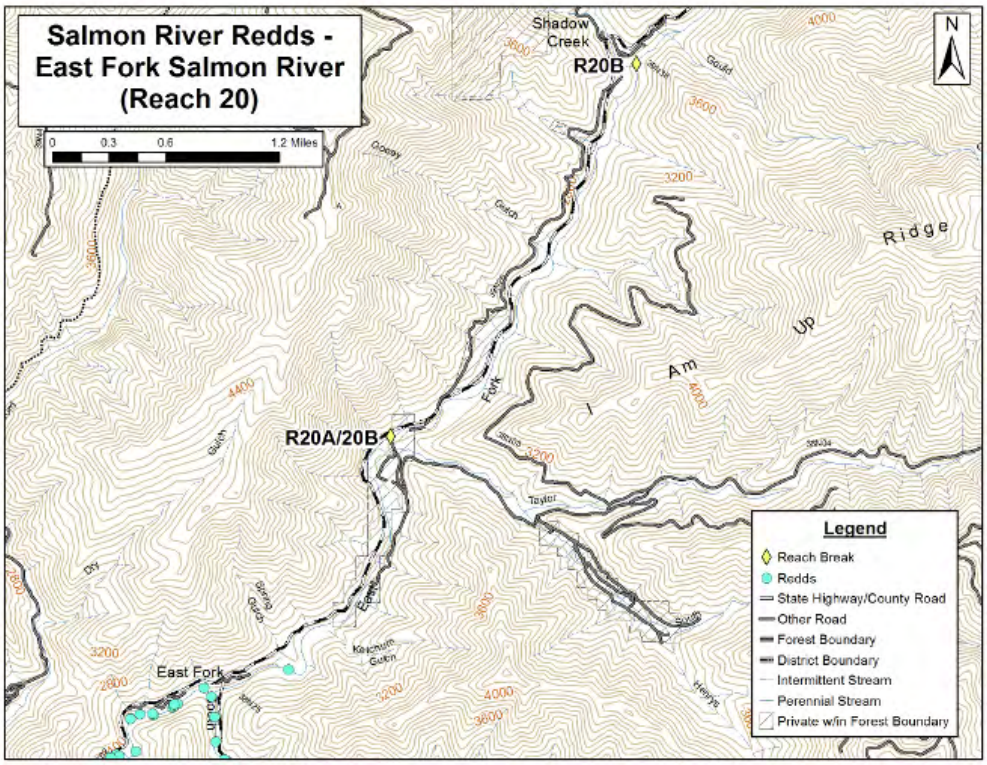


Figure D-SA12. Redd distribution for EF Salmon River, Reach 20 (A, B)

Appendix E – List of Cooperators

Federal
U.S. Forest Service – Klamath National Forest

State
California Department of Fish and Wildlife
-Arcata Office
-Yreka Office

Tribal
Karuk Tribe
Yurok Tribe

Other
Salmon River Restoration Council
Local volunteers