2015 Spring Chinook Salmon Spawning Ground Survey

Salmon-Scott Rivers Ranger District
Klamath National Forest

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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 2015 cooperative survey began September 13th and ended October 22nd. All scheduled surveys were completed. Forest Service participation concluded the week of October 12th due to commitment of resources toward Fall Chinook surveys. The Salmon River drainage exhibited low discharge as a result of a multi-year drought, and there was no substantial September or early-October freshet. Surveys also included tributary visits.

Approximately 286 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 2015 returns appear to be below average for the Salmon River [21st highest (of 26 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; and, as yet, there is no final conclusion as to the degree of genetic separation of the runs, and if it is sufficient for Spring Chinook to warrant recognition and a different (higher) level of protection than the fall. 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 involving 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 (2014) 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 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 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 2015, surveys were completed in the upper reaches of the Salmon River to determine Chinook spawner distribution. This report summaries redd counts conducted between September 17th and October 22nd on the North Fork and South Fork Salmon Rivers, as well as the East Fork Salmon River and Little North Fork Salmon River tributaries. The SRRC prepares a separate report detailing their fisheries activities, including the Spring Chinook spawning surveys.

METHODS

In 2015, redd surveys were conducted on the Salmon River, as well as two major tributaries. **Table 1** summarizes each reach for 2015, 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); Little North Fork Salmon River (Specimen Creek to confluence; ~2.3 miles)

The SRRC and USFS held a training session for volunteers on September 14th at the Forks of Salmon Community Center. 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 2015.

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	2	9
	Mile 16 to Mile 12	12	4.0	3	5
	Whites Gul to Mile 16	13	2.0	2	1
	Idlewild CG to White Gul	14	2.5	4	6
	Mule Bridge TH to Idlewild CG	15	3.0	3	0
	Big Ck to Mule Bridge TH	16	3.0	1	0
South Fork	French Ck to Matthews Ck	7	4.0	6	13
	Cecillville CC to French Ck	8	4.0	7	22
	Petersburg FS to Cecillville CC	17	4.0	7	14
	Blindhorse Ck to Petersburg FS	18	3.0	7	12
	Little SF Salmon to Blindhorse Ck	19	3.0	3	9
Tributaries	East Fork Salmon River	A (lower)	2.0	3	0
		B (upper)	2.5	2	0
	Little NF Salmon River	A (lower)	2.3	1	1

Crews counted redds and collected biological samples as per protocol developed for the Fall Chinook spawning survey (CDFW 2015). 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 12th, 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.

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 very good. Low flow conditions were present throughout the spawning season as a result of multiple drought years and poor winter snowpack/run-off (**Appendix B**). Furthermore, major tributaries which often support spawning fish – East Fork Salmon River, Little North Fork Salmon River – had either little or no evidence of fish this year. Access into these tributaries for upmigrating fish from the mainstem forks was likely restricted by the water-year conditions; and habitat for fish attempting to hold over the summer within the streams may also have been negatively impacted. Also of note, the North Fork exhibited a high amount of fines deposited downstream of the North Russian Creek confluence as a result of landslides in the Music/Highland Creeks tributary drainage triggered by a summer thunderstorm sited over an area of high burn severity from the 2014 White Fire.

Spawning for Spring Chinook in the Salmon River began in mid-September. The peak was reached in late-September/early-October, although continued activity was observed into the latter half of October. Unlike years with normal discharge conditions (baseflow and storm freshet timing), it is unlikely fall-run Chinook were able to pass the various low-flow barriers and ascend to traditional Spring Chinook reaches of the upper Salmon River while the latter were still spawning, so the spatial/temporal overlap of the two runs was probably minimal in the survey area. With the caveat of a limited dataset (3 years) and the small number of redds observed in 2015, the peak seems to have come a week or so earlier compared to the last several spawning seasons. Overall survey effort was affected by number of surveyors available, weather, and flows. 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. Five years of mapping redds by GPS (with hardcopy map back-up) is beginning to reveal patterns. Unfortunately, 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 may be difficult, when, as in 2015, 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 as a factor of water discharge or debris flow impacts. It is expected that inter-annual variation found within the much more numerous fall-run is likely mirrored by the spring-run.

Initial focus for the Spring Chinook dataset is upon locales which exhibit a cumulative (5-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".

- North Fork Salmon River (Big Creek to Mile 8 – ~18.5 miles)
    - 8 potential concentrated use areas
    - Notable sites (downstream to upstream) 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 Gallia 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 Spring Chinook concentrated use area on its own.
- South Fork Salmon River (Little South Fork Salmon River to Matthews Creek – ~18.0 miles)
    - 24 potential concentrated use areas
    - Notable sites (downstream to upstream) 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 and ~0.2 mile downstream of East Fork; vicinity of Black Gulch; ~0.2 mile upstream of Garden Gulch; and ~0.3 mile and ~0.5 mile upstream of Boardtree Gulch.

Also of interest are those stretches of river which regularly exhibit <u>little or no</u> spawning. Potential reasons for observed lack of spawning are considered in the "Discussion" section.

- North Fork Salmon River
    - Eddy Gulch to Whites Gulch – very scattered use.
    - Upstream of North Russian Creek confluence – use below this point, but very scattered above.
- South Fork Salmon River
    - About 1 mile between Smith Creek (near Cody Bar) and Matthews Creek – no spawning.
    - Petersburg tailing piles upstream of the Forest Service fire station – very scattered use.
    - About 0.5 mile downstream of Little Grizzly Creek – use below this point, but very scattered above.

A concentrated use area redd dataset is under construction. A similar product was completed for Fall Chinook in 2014. Due to lower spring-run numbers compared to fall-run, more time has been required to identify locations which exhibit regular elevated use for Spring Chinook. Unfortunately, because run size for the 2015 season was very depressed, at least one more year of data will be needed to construct the initial dataset.

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

Using summer holding survey data, the Salmon River is estimated to have had a minimum of 286 spring-run Chinook salmon in 2015 (**Figure 2**; **Appendix A**). Based on long-term tracking data from summer surveys, 2015 was below average, ranking 21st for estimated run size (of a 26 year dataset).

Figure 1. Spring Chinook redds observed and survey effort on the Salmon River in 2015.

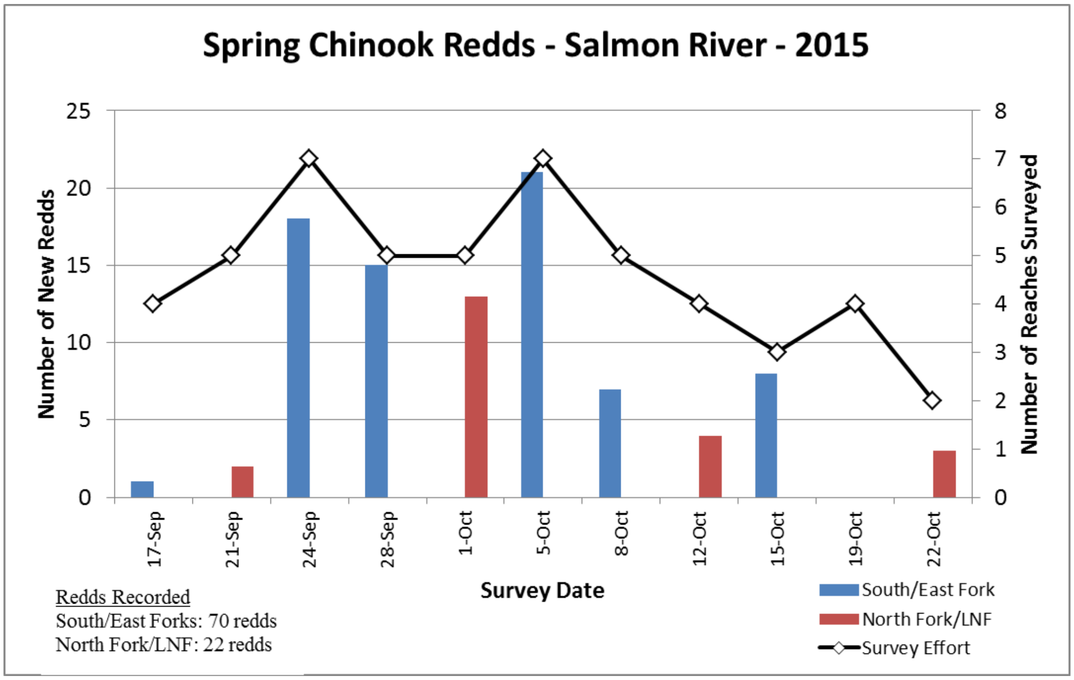
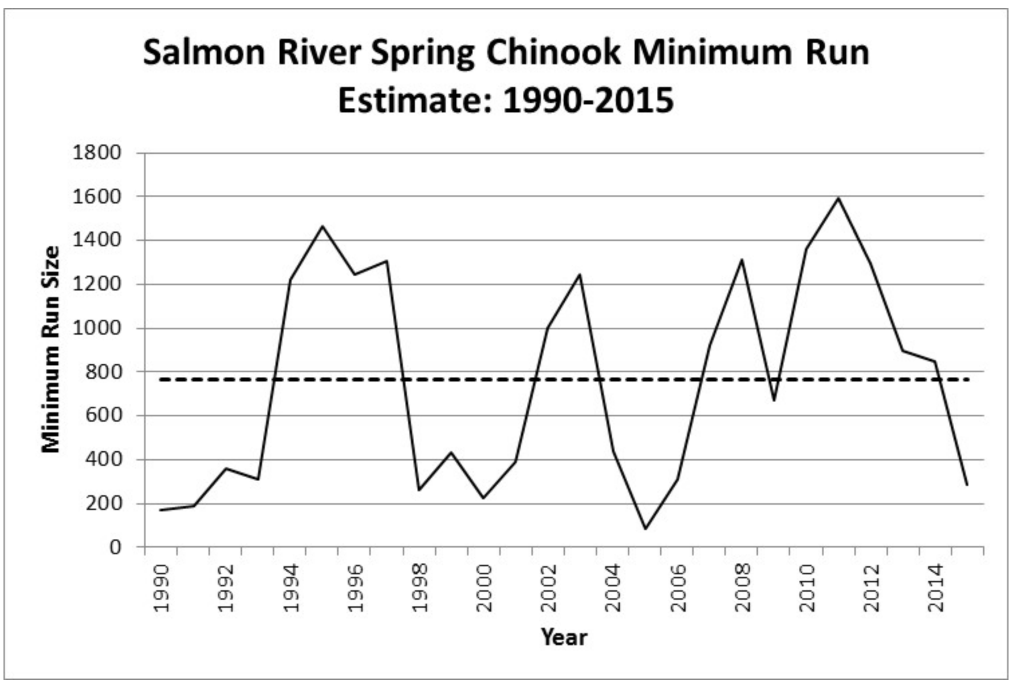
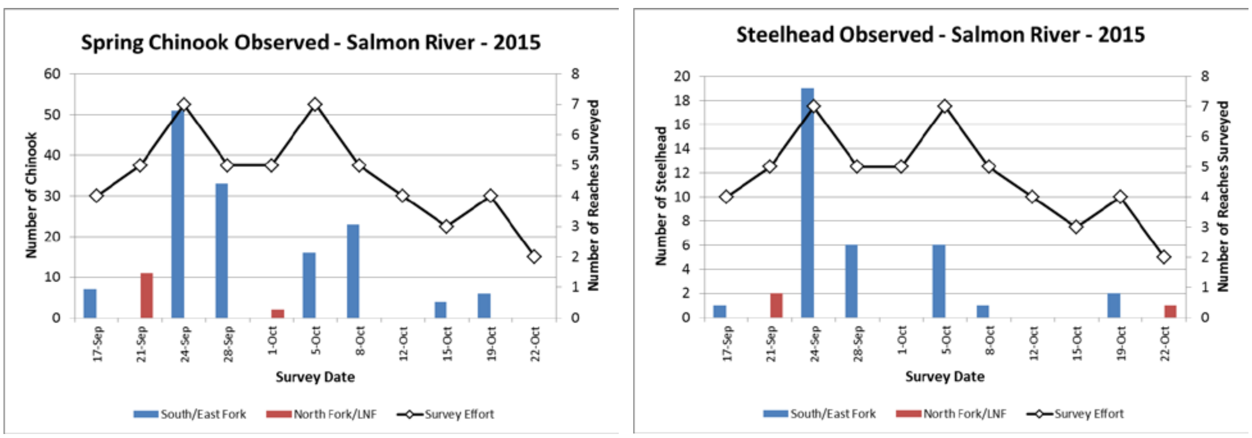


Figure 2. Salmon River spring-run minimum size for 1990 to 2015, as estimated from summer holding surveys. Dashed line is average over long-term survey period.



Live Chinook and steelhead were tallied during surveys (**Figure 3**). As with redds, survey effort is impacted by high flow; and 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 the latter half of September, with subsequent numbers declining within the survey area. Too few fish were observed in the North Fork system to draw conclusions. Steelhead were variable, with the most observed on September 24th on the South Fork. Changing flow conditions is often considered to be one of the triggers for steelhead movement. Steelhead seemed to be observed more frequently in association with flow increase following precipitation events, even the minor ones which characterized the spawning season. 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 2015 Salmon River surveys.



Tributaries surveyed included the East Fork Salmon River and Little North Fork Salmon River. The East Fork was visited multiple times in conjunction with South Fork surveys. In contrast, the Little North Fork was only visited once during the Spring Chinook spawning season. A single Chinook salmon redd was reported for Little North Fork Salmon River, and neither tributary recorded live Chinook nor steelhead.

DISCUSSION

Overall distribution patterns are beginning to emerge 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 an initial, tentative interpretation. Unfortunately, insufficient information has been gathered to this point to decisively identify oft used spawning sites – annual variability in run size, discharge, and other factors make overall patterns unclear. However, what has emerged thus far are locales within the river system where fish either do not spawn or minimally use.

Of particular note, there is a one mile segment on the South Fork between Smith Creek and Matthews Creek where spawning is rarely recorded. In fact, within the last five years, only one redd (2013) was observed. The lack of spawning appears to have a natural origin. Specifically, this portion of the river is characterized by large, deep pools and steep bedrock canyon walls. Pool-tailouts are poorly defined, and transitions between pools are typically steep gradient fast-water where the substrate is dominated by boulders. Furthermore, there are numerous potential low-water barriers, especially upstream of the Matthews Creek Campground pool. In summary, while this segment of the South Fork offers excellent summer holding opportunities, spawning habitat (i.e., gravel/cobble substrate within low to moderate gradient channel) is largely lacking.

Other areas in the Salmon River drainage which have similar deep pool habitat, such as the "canyon" on South Fork downstream of Indian Creek (in Reach 6A) also exhibit minimal or no spawning. However, none of these areas are of as great extent as the Smith Creek-Matthews Creek segment.

An area of low spawning density likely linked with historic channel manipulation is the Petersburg tailing piles. For a distance of about 0.5 mile upstream of the Petersburg Forest Service fire station, extensive tailing piles are present. Furthermore, the stream valley is broad and the channel relatively unconfined; and, when combined with an underlying instable substrate, this means that the river regularly shifts its course during times of high flow, especially at spring run-off. Upstream of this area, the South Fork flows through a confined canyon area; and downstream of Petersburg Station, while tailings are still present, the valley walls also constrict, thereby better maintaining channel integrity and year-to-year location. As a result of this shifting channel, fish which enter the tailing pile reach find a "scary" environment where they are exposed to predators – pool quality is marginal and riparian development is poor. Furthermore, redds which may be built in this area are susceptible to high-water scour, else stranding if the channel avulses to a new stream course.

On the North Fork, the reason behind the low redd number between Eddy Gulch and Whites Gulch is less certain. Likely there are elements of both natural and human-caused limitations. The reach includes aspects of deep pool, confined channel, bedrock, and marginal pool-tailout quality which restricts spawning habitat elsewhere in the Salmon River system. However, it also has experienced channel manipulation, especially dredging, as evidenced by the historic tailing piles present upon some banks.

Fish distribution in regards to upstream spawning extent and tributary use is unclear. 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. 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. 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, and 2015.

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 is 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, 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 elevation in river flows to move elsewhere (lower) in the South Fork for spawning. Unfortunately, insufficiently detailed data exists for the North Fork drainage to determine if similar broad patterns can be discerned there as well.

To better characterize how Spring Chinook might move from holding habitat to spawning habitat, South Fork reach-scale data between 2013 and 2015 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, for the Salmon River Fall Chinook season, 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 to estimate population (S. Borok, CDFW). Estimated spawning population for Spring Chinook was accomplished using this latter methodology (**Table 2**, **Figure 4**).

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	
	Summer Holding	Estimated Spawn Pop.	Summer Holding	Estimated Spawn Pop.	Summer Holding	Estimated Spawn Pop.
Reach 7	179	120	112	82	27	26
Reach 8	67	138	79	120	10	50
Reach 17	49	139	104	120	21	28
Reach 18	49	72	46	130	16	24
Reach 19	59	8	35	36	1	18
Total	403	**477**	376	**488**	75	**146**
Difference	74		112		71	

When Spring Chinook spawning survey reaches on the South Fork above Matthews Creek are examined, similarities and differences between years are seen. In all three seasons, 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.

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 offer a greater quantity/quality of summer habitat compared to the other upper South Fork

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

reaches (i.e., 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.

All years suggest a consistently larger estimated spawning population of Chinook are present in the upper South Fork compared to summer holding survey numbers. Some possible explanations include underestimation of fish during summer holding surveys, redistribution of Spring Chinook into the survey area from lower in the drainage, influx of upmigrating Fall Chinook, or some combination thereof. These conjectures are discussed next.

One potential reason for the inconsistency between Spring Chinook numbers holding versus spawning is that crews who participate in the summer surveys 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, although on the whole, the annual summer holding counts are felt to be fairly accurate. However, prospective underestimation of Spring Chinook is unlikely to be the only explanation in the holding versus spawning population discrepancy.

In mid-September, at the start of the Spring Chinook spawning season, the discharge within the upper South Fork survey reaches was likely similar for all years 2013 through 2015. 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 and 2015 perhaps slightly lower than 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, and the river remained at low flow conditions through the Spring Chinook spawning season (and depressed throughout much of Fall Chinook spawning, too).

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. So much so, it is considered the natural structure limiting spatial overlap of spring-run and fall-run Chinook in the upper South Fork Salmon River.

The increase of flows in 2013 and 2014 appears 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 accuracy of counting fish from the banks is lower than when snorkeling, so spawning surveys probably underestimated actual 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 during the Spring Chinook spawning season. However, there is evidence that fish did move from holding to spawning habitat, perhaps to a lesser extent than previous years, and the estimated number of spawners still appeared to be larger than the summer holding population. The theory for the lattermost observation is weaker than for 2013 or 2014. 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, the numbers were likely 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.

In summary, the discrepancy in Chinook numbers for 2013 and 2014 is likely linked to an increase in flows allowing passage around the Matthews Creek barrier for both spring-run and fall-run fish. Unfortunately, the factors of the discrepancy in 2015 are unclear because low flows restricted barrier passage through the Spring Chinook spawning season and the low number of fall-run fish 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. For all years, initial underestimation of Spring Chinook numbers during summer holding surveys may also contribute.

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.

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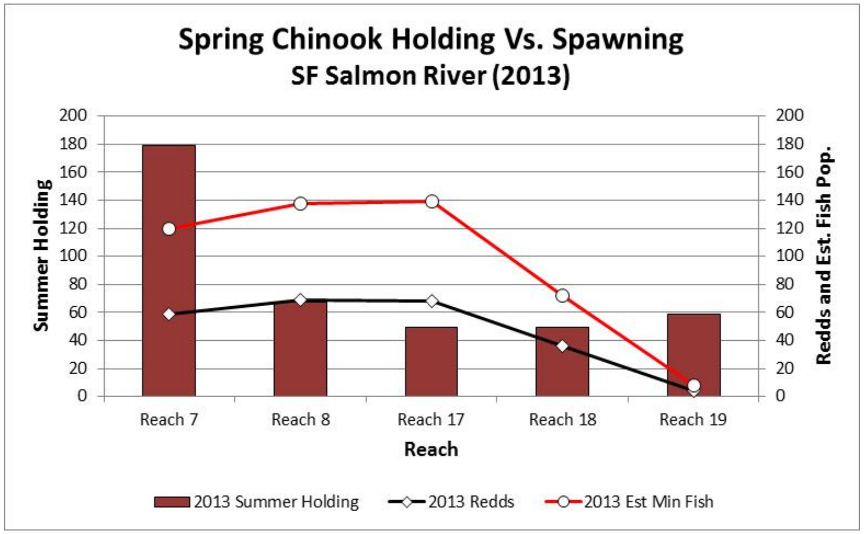
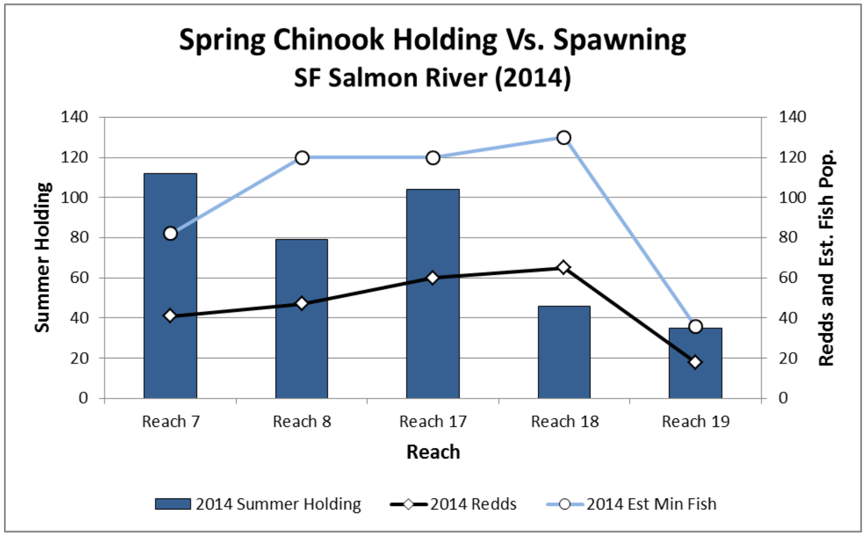
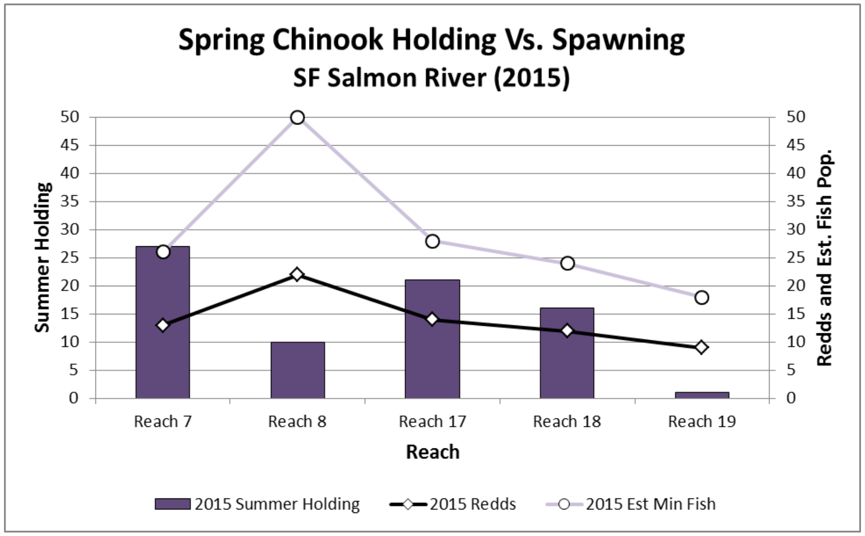
Table 4. Comparison of Spring Chinook observed summer holding population versus redd numbers and estimated spawning population, 2013 through 2015. Location is South Fork Salmon River for the five reaches between Little South Fork Salmon River and Matthews Creek.







Of note, in the summer of 2015, landslides occurred in the North Fork subwatershed of Music/Highland Creek. These debris flows were the result of an intense thunderstorm stalling over landscape impacted by moderate- and high-burn severity from a 2014 wildfire. A large amount of fine sediment from the landslides made its way to North Fork Salmon River, where it impacted over 20 miles of river (and more, if the mainstem below the North Fork/South Fork confluence is considered). Due to the inherent small number of Spring Chinook in the North Fork – and even more so this year with depressed run number – and lack of a good long-term dataset, the effect of this event on spawning fish is unknown. If any changes are seen in the more detailed fall-run data, they are likely also applicable to spring-run fish. As of the time of this document, winter storm flows had mobilized and exported the sediment deposited during the summer. It is unknown how remnant debris flow sediments will continue to mobilize out of the Music/Highland Creek drainage and into North Fork, but the impact is expected to be considerably less than 2015.

Although specifics in regards to the Salmon River drainage is unknown, it is anticipated that climate change will eventually have an effect on the region. Safeeq, *et al*. (2015) took historical winter data from the western United States to determine which regions were more sensitive to projected temperature increases and, hence, shifts in the projected proportion of precipitation falling as snow and/or rain. For the Klamath Mountains, they projected that by 2040, the <u>average</u> winter precipitation year will look more like what happens during <u>current</u> warm winters. In other words, the average snow line will be higher, there will be less snow at low elevations and less snow overall as more precipitation falls as rain. In turn, there will be hydrologic changes as a smaller, higher elevation snowpack translates to less spring run-off and less water in general through the remainder of the year. Winter temperatures will not only be affected, but temperatures throughout the year; and by the 2060s, what is now considered to be an exceptionally "hot" summer day will become much more common in California, as will be the occurrence of multiple sequential "hot" days (Pierce, *et al*. 2013). The effect of climate change upon timing and amount of precipitation is less clear. The most recent research on climate models for California suggest that average annual precipitation in the northern portion of the state will remain relatively constant (Pierce, *et al*. 2013). A slight increase in winter precipitation may be offset by less summer precipitation, but overall, precipitation patterns will likely remain within the range of historical natural variation, making it very difficult to resolve if climate change is having an effect of precipitation amount or timing (Pierce, *et al*. 2013).

Climate change will have an effect on spring-run and fall-run Chinook, although there will likely be both similarities and differences in the response of the two life histories. Current (and near future) inter-annual variability in factors such as river discharge and run-size are not necessarily attributable to climate change, but are likely instead within the variability of the natural cycle. However, observations of Chinook behavior and habitat use made during current cycles of dry, normal, and high water, as well as differences between above- and below-average run years, do provide a view of future expectations as the climate shifts. For instance, low flows in and of themselves do not appear to hamper the general ability of Spring Chinook to move between mainstem holding and spawning habitat, although some low-flow barriers may be more difficult to pass. In the spring, the timing and magnitude of the spring run-off are very important factors in how far upstream Spring Chinook can travel to reach summer holding habitat, as well as influence passage through barriers such as the one upstream of the Matthews Creek Campground on the South Fork. How future impacts to spring run-off from climate change will ultimately affect Spring Chinook distribution is a large question. During the spawning season for both spring-run and fall-run fish, the timing of early fall storms strongly influences access. For instance, many Salmon River drainage tributaries exhibit small deltas or steep cascades at their mouth which are barriers to entry at low flow. Fortunately, at this time it appears climate change will minimally affect fall precipitation events, so their occurrence will remain within the range of past variation (i.e., sometimes they occur [2013, 2014] and sometime they do not [2015]).

Outside of the consideration of spawning or access to spawning/holding areas, climate change in the form of warmer water temperatures and lower baseflow will undoubtedly impart other impacts. For example, because Spring Chinook hold in-river through the summer, this strategy makes the run much more susceptible compared to Fall Chinook to the stresses and potential pre-spawn mortality associated with elevated water temperatures. Similarly, other lifestages, such as juveniles, are also expected to be affected in some manner.

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. Currently, genetic analysis is ongoing to determine if Spring Chinook are sufficiently different from the more numerous Fall Chinook to warrant a higher degree of protection, as has occurred in other basins. If the runs are determined to be genetically distinct, a better and more nuanced understanding of the distinctions between the runs 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 has taken primary responsibility for basic paperwork QA/QC following each survey day.

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. As an example of a positive for the 2015 Spring Chinook survey, every date had a complete set of datasheets turned in consisting of carcass sheet, redd sheet, and map.

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.

- 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.
  - For redds, always use the header sheet. Only use the continuation sheet as the primary datasheet for redds when no header sheet is available.
  - 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** assume all redds are the same size and thereby report the same dimensions repeatedly.
  - "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.
  - 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.

The 2015 Spring Chinook survey was much closer to the desired goal for sufficient equipment be available to allow all reaches to be GPSed for redds every survey. Federal, State, and tribal agencies usually brought sufficient GPSes to cover their own crews; and both KNF and SRRC often had extra machines for use by volunteers. Only in a few cases were crews without GPSes. Furthermore, the KNF survey administrator attempted to gather GPS files from as many machines as possible once a week.

Continuing, there are several recommendations aimed specifically at KNF, as based upon survey observations made in 2015, 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.
- Update redd sheets to include an example of the redd GPS point.
- Consider the possibility of placing a map on the back side of the header redd datasheet.
- As necessary, flagging should be placed on the river and the road to demark entry/exit points to reaches, alternate exit points, and so forth.

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Personal Communications

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Appendix A – California Department Fish and Wildlife "MegaTable"

Due to large size of the Klamath River spring Chinook "MegaTable" (1980 to 2014), 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

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 o	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

MEGA-TABLE_Spring-Chinook_2014.xls

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			0
Natural Spawners									
Klamath River Basin									
Salmon River	125	770	895	63	788	851			0
Misc. Tribs.			0			0			0
Trinity River Basin									
Above JCW, excluding TRH	185	5,956	6,141	282	2,833	3,115			0
South Fork	36	295	331	8	83	91			0
Misc. Tribs.	57	167	224	27	105	132			0
Subtotals		7,188	7,591	380	3,809	4,189	0	0	0
Total Spawner Escapement	96	9,670	10,169	742	7,064	7,806	0	0	0

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
Angler	116	1,011	1,127	120	843	963			
Trinity River Basin									
Hoopa Tribal Harvest	19	1,202	1,221	85	1,733	1,818			0
Angler	0	243	243	16	210	226			0
Total River Harvest	142	6,209	6,351	237	5,931	6,168	0	0	0

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	0	0	0

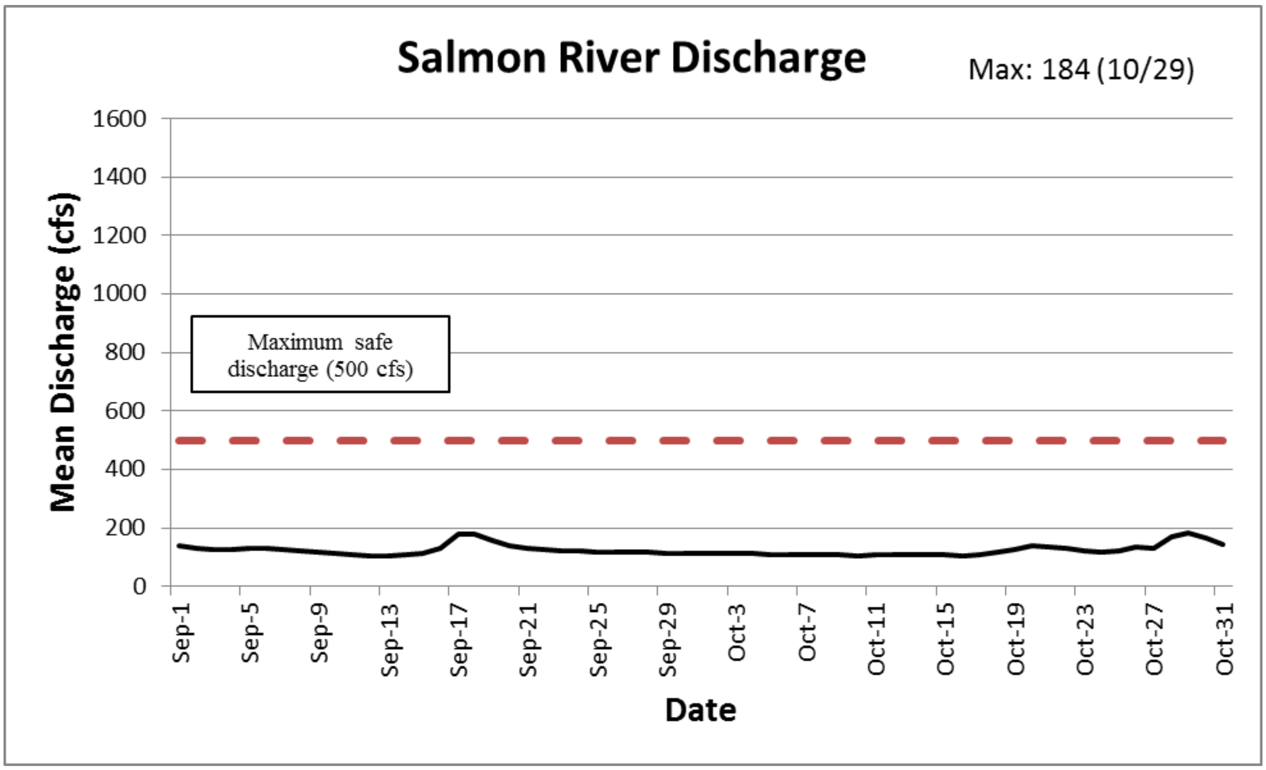
(Continued next page)

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 30th, 2015, 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 (2015)

Redds – Forks and Tributaries

Reach	**17-Sep**	**21-Sep**	**24-Sep**	**28-Sep**	**1-Oct**	**5-Oct**	**8-Oct**	**12-Oct**	**15-Oct**	**19-Oct**	**22-Oct**
South Fork Salmon River											
Reach 6 - Matthews Ck to Indian Ck											
Reach 7 - French Ck to Matthews Ck	0		1	3		9	0			0	
Reach 8 - Cecilville CC to French Ck	0		2	4		7	4		5	0	
Reach 17 - Petersburg to Cecilville CC	0		6	2		1	3		2	0	
Reach 18 - Blindhorse Ck to Petersburg	1		5	5		0	0		1	0	
Reach 19 - Little SF Salmon to Blindhorse Ck			4	1		4					
East Fork Salmon River (tributary)											
Reach 20A - Taylor Ck to Confluence			0			0	0				
Reach 20B - Shadow Ck to Taylor Ck			0			0					
North Fork Salmon River											
Reach 11 - Mile 12 to Mile 8		2			7						
Reach 12 - Mile 16 to Mile 12		0			2						3
Reach 13 - Whites Gul to Mile 16		0			1						
Reach 14 - Idlewild CG to Whites Gul		0			3			3			0
Reach 15 - Mule Bridge TH to Idlewild CG		0			0			0			
Reach 16 - Big Ck to Mile Bridge CG								0			
Little North Fork Salmon River (tributary)											
Reach 21A - Specimen Ck to Confluence								1			

Spring Chinook (Live) Observation

Reach	17-Sep	21-Sep	24-Sep	28-Sep	1-Oct	5-Oct	8-Oct	12-Oct	15-Oct	19-Oct	22-Oct
South Fork Salmon River											
Reach 6 - Matthews Ck to Indian Ck											
Reach 7 - French Ck to Matthews Ck	4		32	20		5	0			0	
Reach 8 - Cecilville CC to French Ck	0		4	6		7	20		4	6	
Reach 17 - Petersburg to Cecilville CC	3		9	5		2	2		0	0	
Reach 18 - Blindhorse Ck to Petersburg	0		5	2		2	1		0	0	
Reach 19 - Little SF Salmon to Blindhorse Ck			1	0		0					
East Fork Salmon River (tributary)											
Reach 20A - Taylor Ck to Confluence			0			0	0				
Reach 20B - Shadow Ck to Taylor Ck			0			0					
North Fork Salmon River											
Reach 11 - Mile 12 to Mile 8		3			0						
Reach 12 - Mile 16 to Mile 12		0			1						0
Reach 13 - Whites Gul to Mile 16		3			0						
Reach 14 - Idlewild CG to Whites Gul		4			1			0			0
Reach 15 - Mule Bridge TH to Idlewild CG		1			0			0			
Reach 16 - Big Ck to Mile Bridge CG								0			
Little North Fork Salmon River (tributary)											
Reach 21A - Specimen Ck to Confluence								0			

Steelhead (Live) Observation

Reach	17-Sep	21-Sep	24-Sep	28-Sep	1-Oct	5-Oct	8-Oct	12-Oct	15-Oct	19-Oct	22-Oct
South Fork Salmon River											
Reach 6 - Matthews Ck to Indian Ck											
Reach 7 - French Ck to Matthews Ck	0		9	2		6	0			0	
Reach 8 - Cecilville CC to French Ck	0		10	3		0	nd		10	2	
Reach 17 - Petersburg to Cecilville CC	nd		0	nd		nd	0		2	0	
Reach 18 - Blindhorse Ck to Petersburg	1		0	0		0	1		0	0	
Reach 19 - Little SF Salmon to Blindhorse Ck			nd	1		nd					
East Fork Salmon River (tributary)											
Reach 20A - Taylor Ck to Confluence			0			0	0				
Reach 20B - Shadow Ck to Taylor Ck			0			0					
North Fork Salmon River											
Reach 11 - Mile 12 to Mile 8		0			0						
Reach 12 - Mile 16 to Mile 12		1			0						1
Reach 13 - Whites Gul to Mile 16		nd			0						
Reach 14 - Idlewild CG to Whites Gul		0			0			0			0
Reach 15 - Mule Bridge TH to Idlewild CG		1			nd			0			
Reach 16 - Big Ck to Mile Bridge CG								0			
Little North Fork Salmon River (tributary)											
Reach 21A - Specimen Ck to Confluence								0			

*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 survey reaches and tributaries are mapped, regardless of redd presence.

Salmon River Data

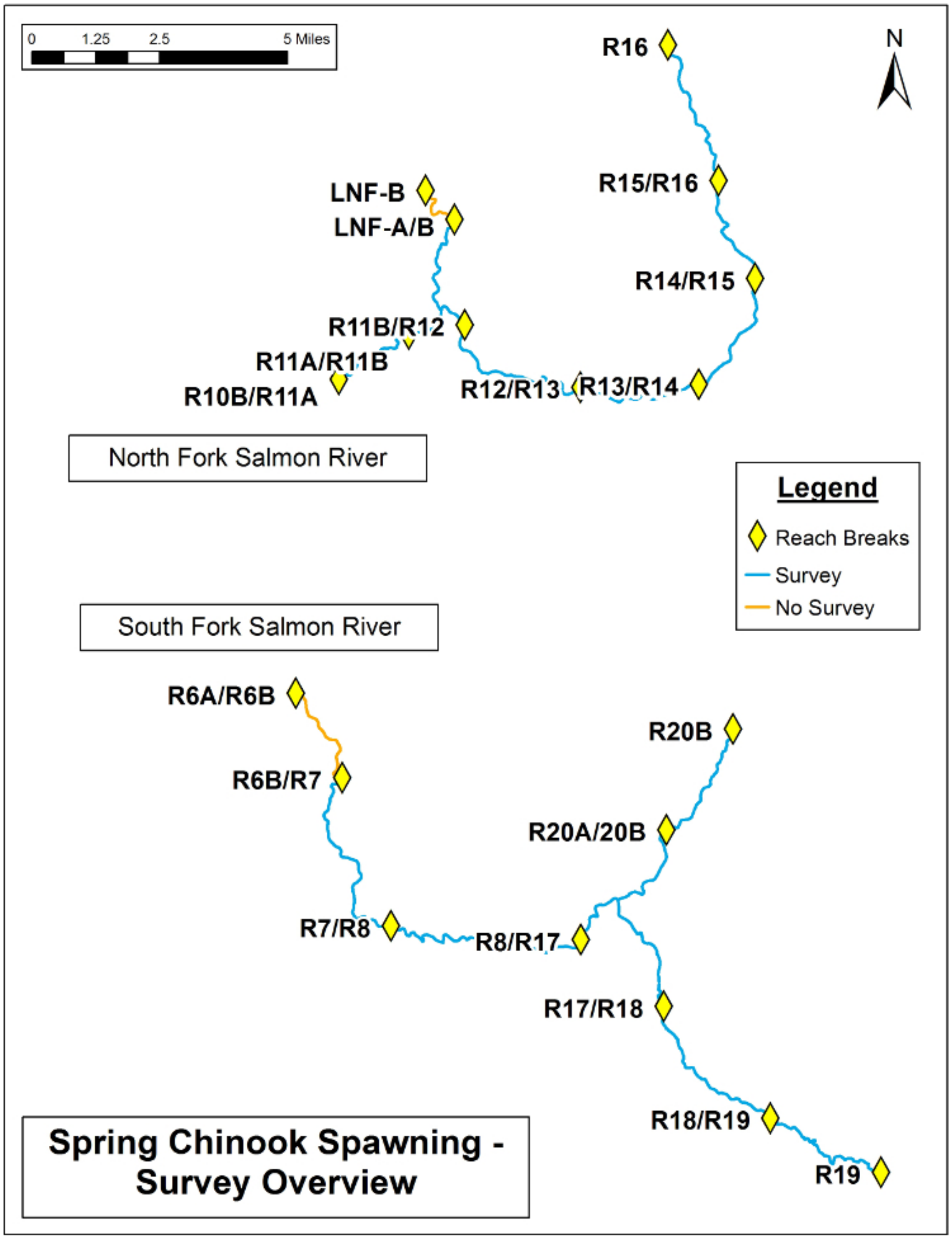


Figure D-SA1. General overview of location of reaches visited during Spring Chinook surveys upon the Salmon River. Map is of survey area only and does not include roads, hillslopes, or other landmarks.

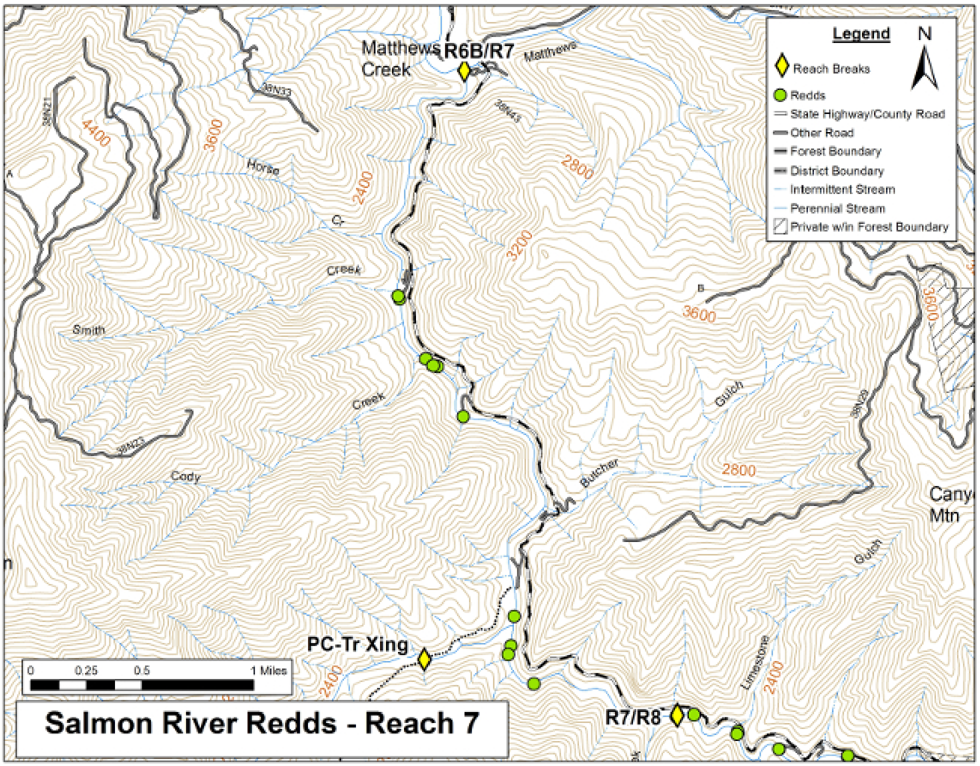


Figure D-SA2. Redd distribution for SF Salmon River, Reach 7.

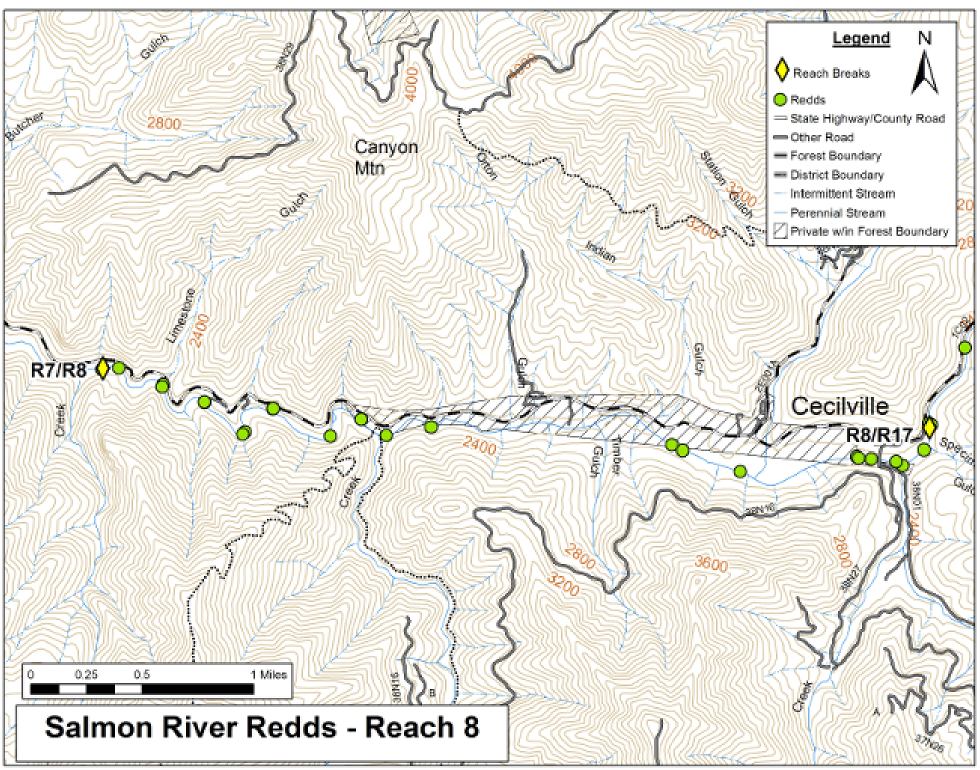


Figure D-SA3. Redd distribution for SF Salmon River, Reach 8.

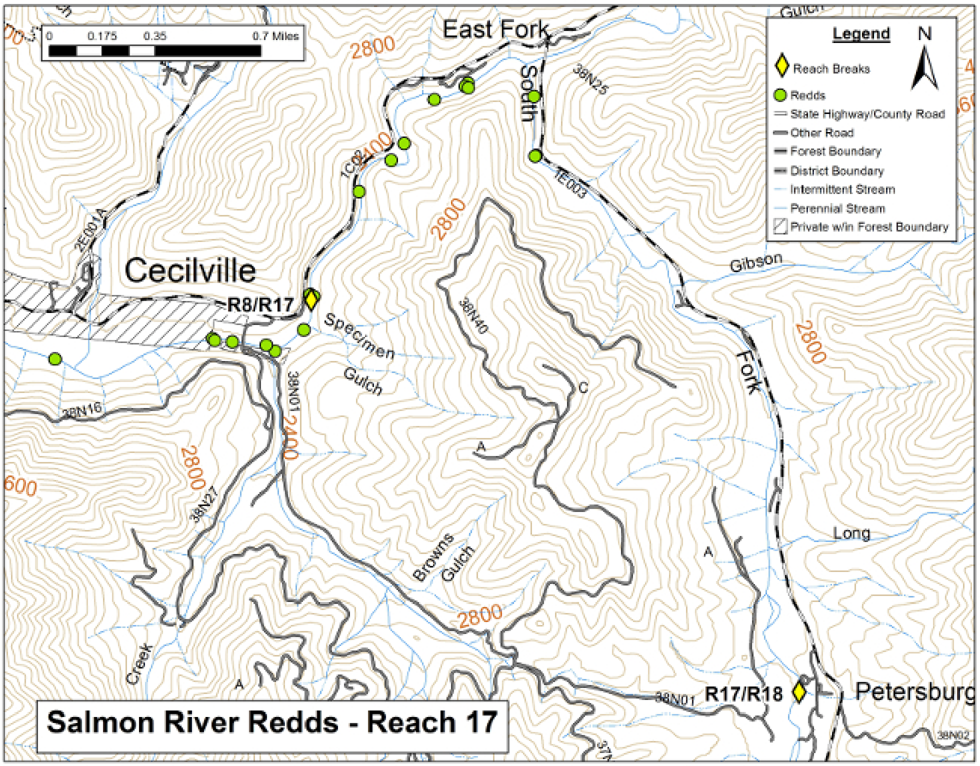


Figure D-SA4. Redd distribution for SF Salmon River, Reach 17.

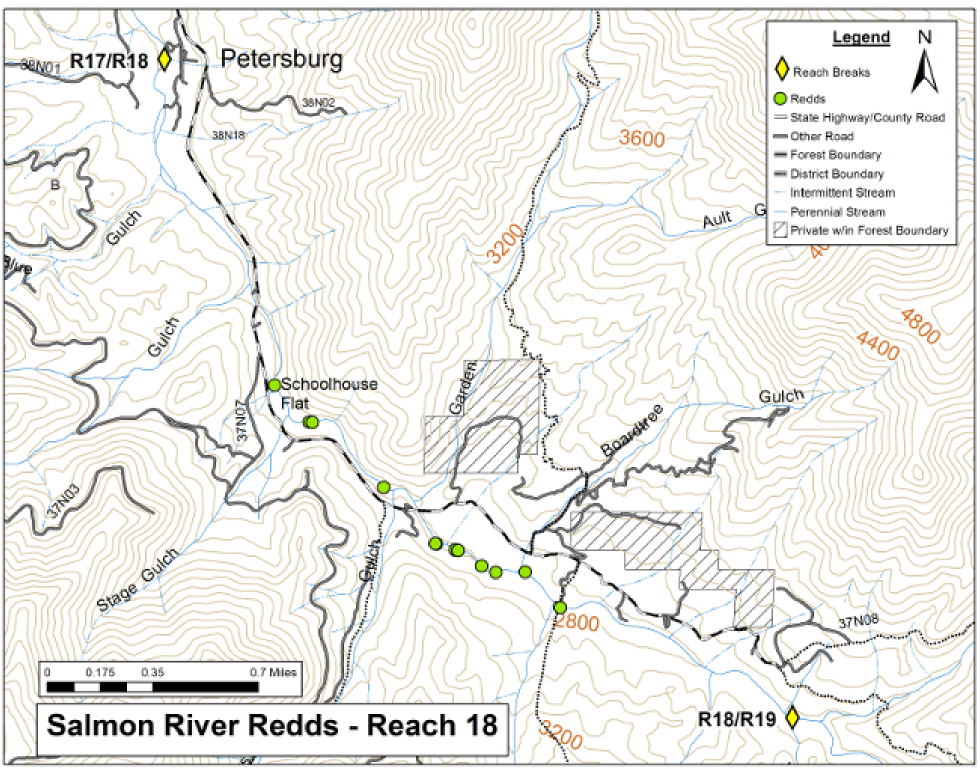


Figure D-SA5. Redd distribution for SF Salmon River, Reach 18.

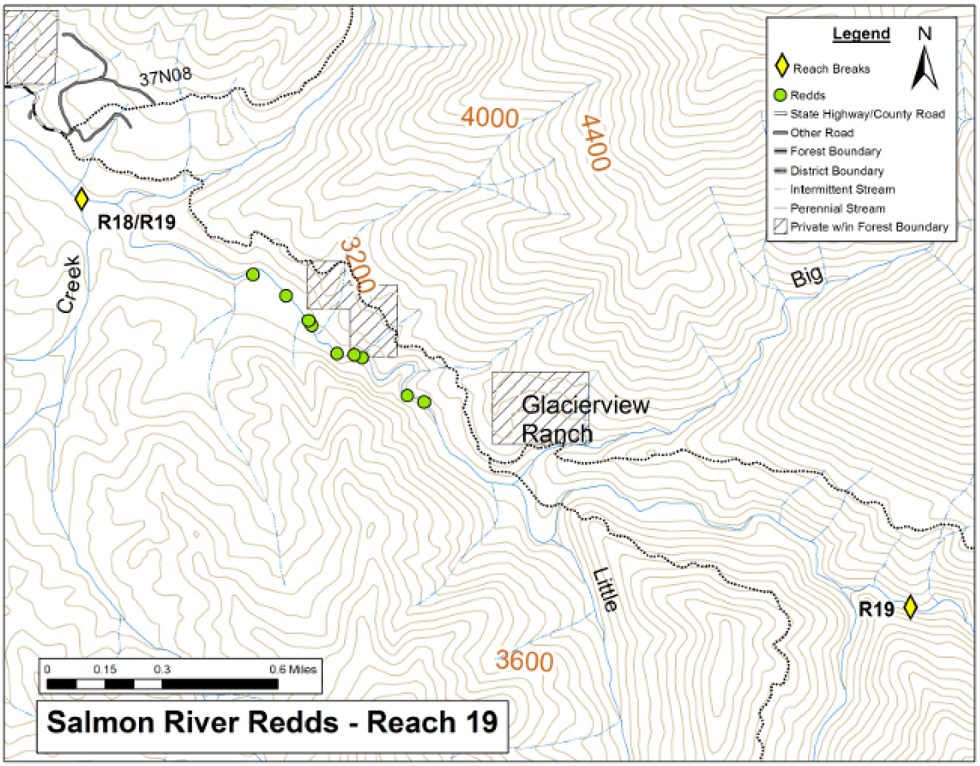


Figure D-SA6. Redd distribution for SF Salmon River, Reach 19.

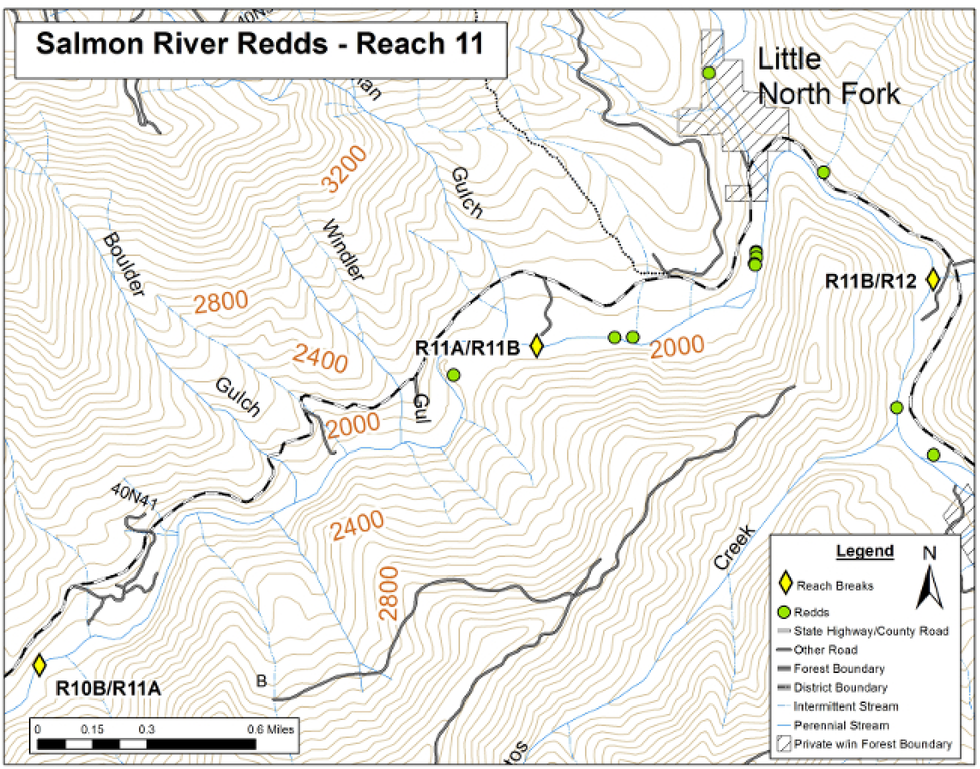


Figure D-SA7. Redd distribution for NF Salmon River, Reach 11.

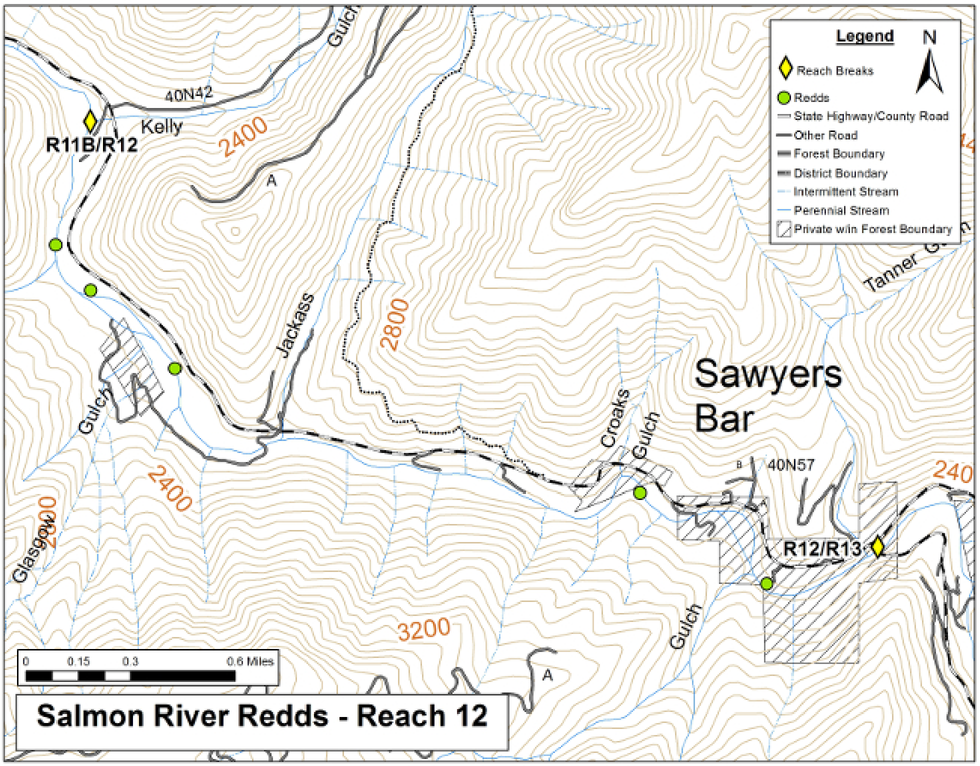


Figure D-SA8. Redd distribution for NF Salmon River, Reach 12.

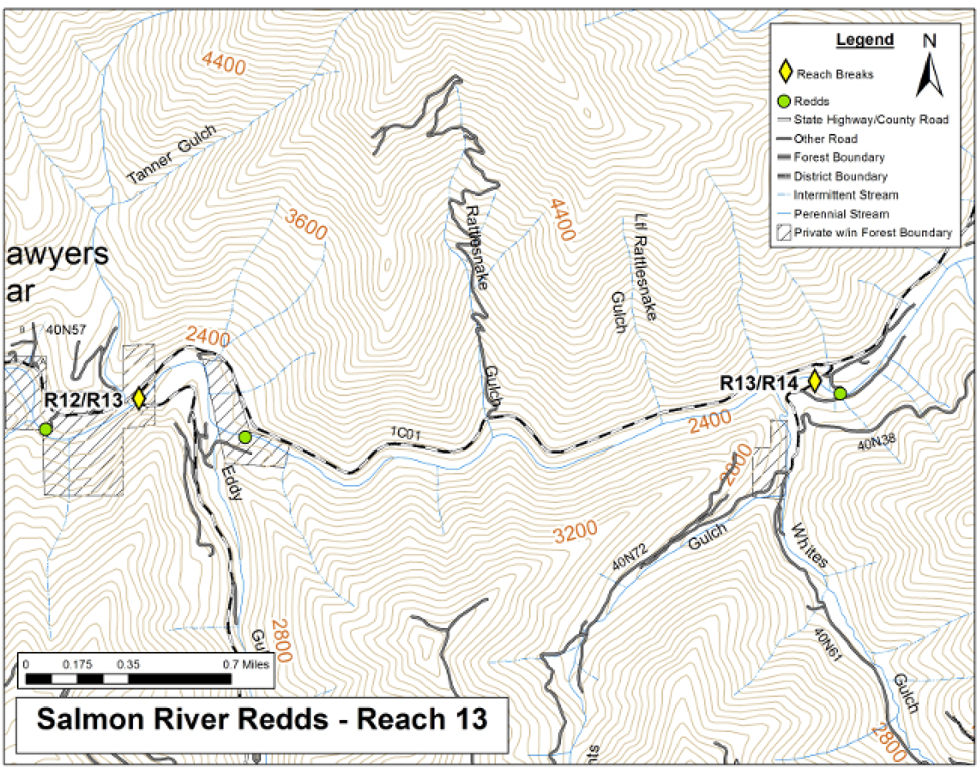


Figure D-SA9. Redd distribution for NF Salmon River, Reach 13.

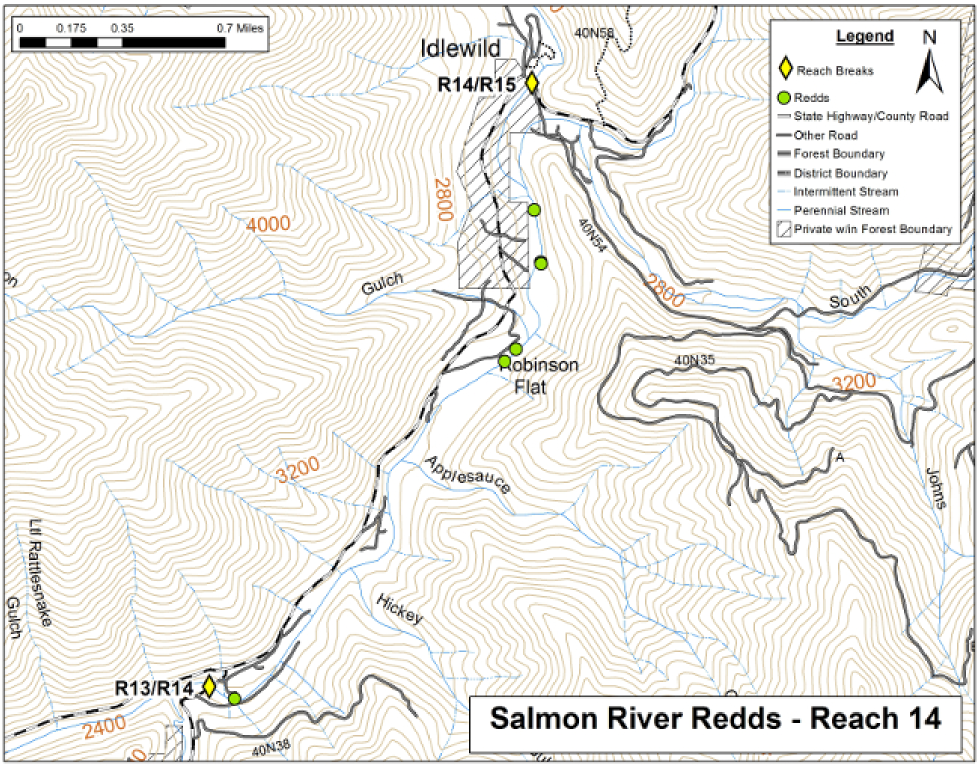


Figure D-SA10. Redd distribution for NF Salmon River, Reach 14.

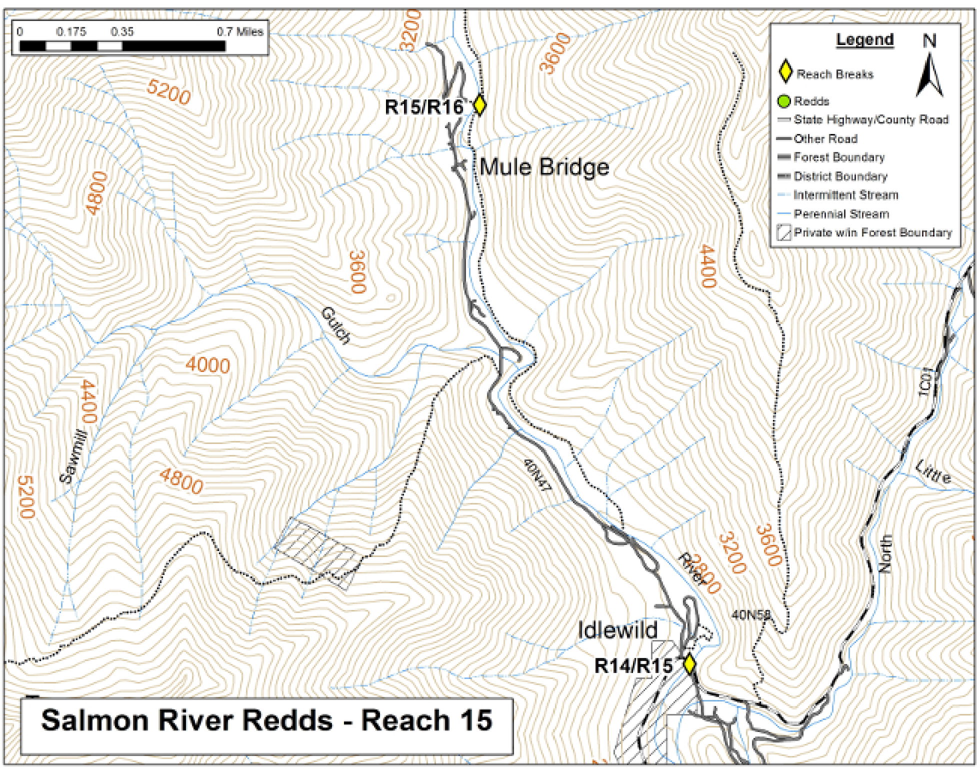


Figure D-SA11. Redd distribution for NF Salmon River, Reach 15.

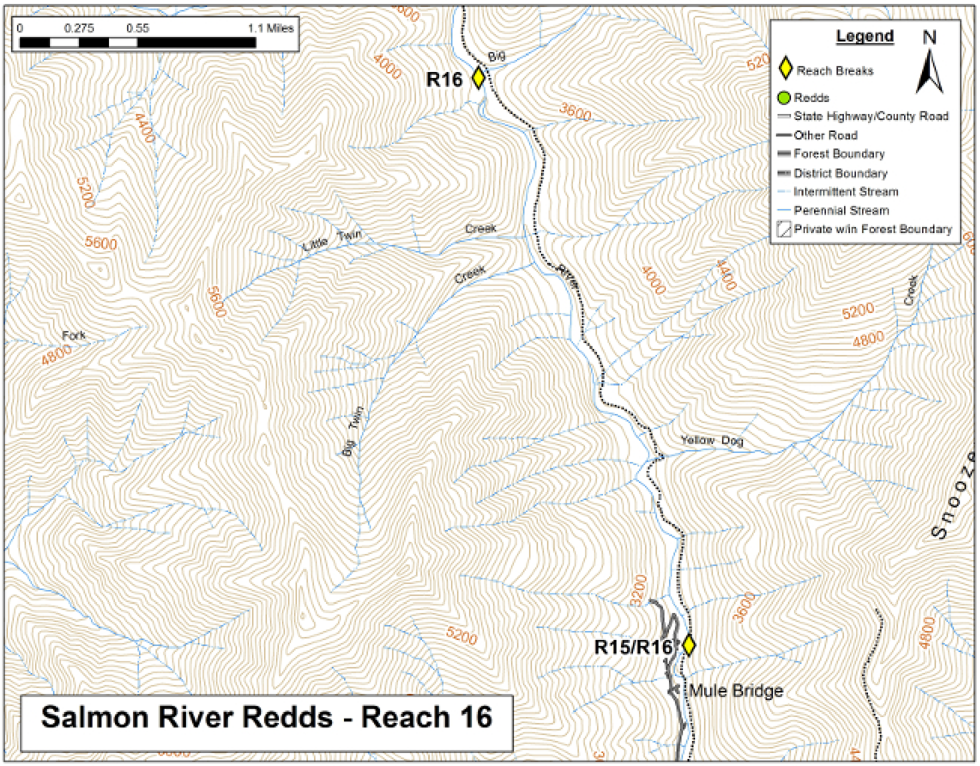


Figure D-SA12. Redd distribution for NF Salmon River, Reach 16.

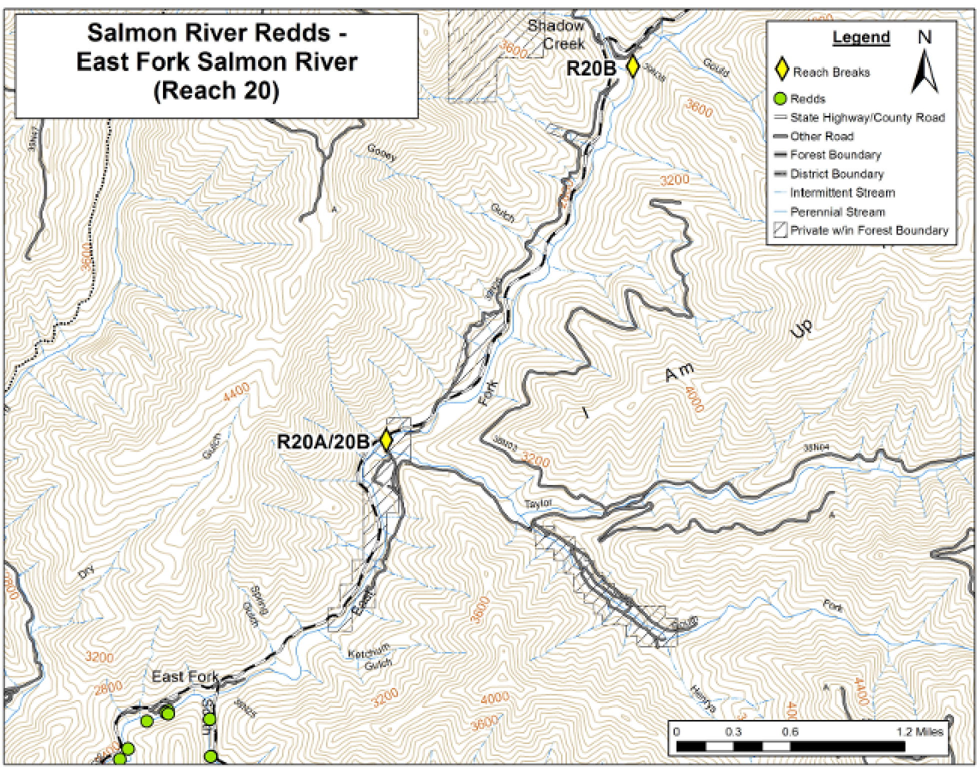


Figure D-SA13. Redd distribution for EF Salmon River, Reach 20 (A, B)

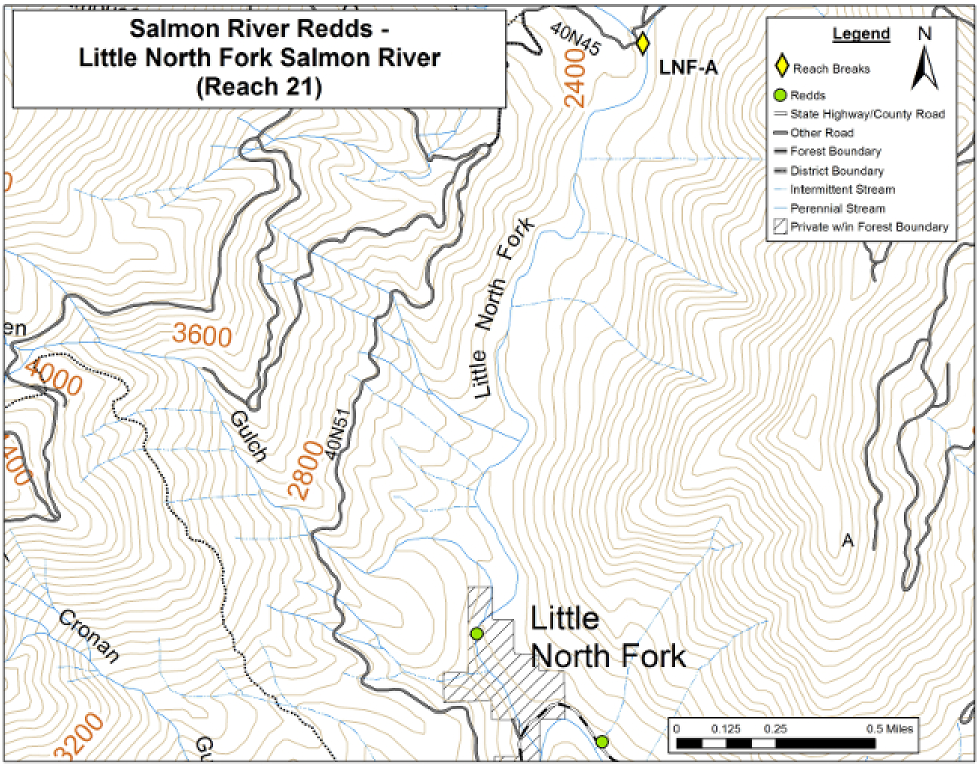


Figure D-SA14. Redd distribution for Little NF Salmon River, Reach 21A

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