Yankee Fork Drainage Fisheries Summary and Analysis

Final Report

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Introduction

Recently, there has been renewed interest from multiple agencies in recovering anadromous fish populations through habitat improvement in the Yankee Fork watershed. The first step in this process was the completion of the Yankee Fork Tributary Assessment which evaluated tributary-scale features and processes in order to identify geomorphic reaches with potential for habitat improvement (BOR 2012). This document, the Yankee Fork Drainage Fisheries Summary and Analysis, is intended as a supplement to the Yankee Fork Tributary Assessment with the objective of describing the life histories of fish species in the Yankee Fork drainage using both recent and historical data. Additionally, where possible, we have attempted to identify life stages of anadromous fishes that may be underperforming in the Yankee Fork in comparison to fish from adjacent basins. Such determinations will help us identify life stages that may benefit from habitat improvement.

The Yankee Fork of the Salmon River (Yankee Fork) is a large tributary to the upper main-stem Salmon River, located in central Idaho. The Yankee Fork watershed drains an area of approximately 122,000 acres (USFS 2006; BOR 2012). Several native fish species are present in the drainage including spring/summer Chinook salmon (*Oncorhynchus tshawytscha*), summer steelhead (*O. mykiss*), and mountain whitefish (*Prosopium williamsoni*), which primarily inhabit the main-stem Yankee Fork and major tributaries, westslope cutthroat trout (*O. clarkii lewisi*), which occupy the smaller tributaries, and bull trout (*Salvelinus confluentus*), and sculpin (*Cottus spp*.), which are found throughout the drainage (Gamett and Bartel 2008; Figure 1). No non-native salmonids were collected by USFS fisheries crews during 2006 and 2007 sampling (Gamett and Bartel 2008).

Several of these native species' populations have declined throughout or in portions of their range (BOR 2012) and multiple agencies are interested in restoring habitat in those areas. Snake River Chinook salmon, Snake River steelhead, and bull trout are listed as threatened under the Endangered Species Act (ESA) and westslope cutthroat trout are designated as a sensitive species within the Intermountain Region by the US Forest Service (USFS).

Information related to the trends of resident and fluvial fish populations within the Yankee Fork is somewhat limited in comparison to anadromous fish. Anadromous fish (Chinook and steelhead) populations have declined significantly from historic levels of abundance (Reiser and Ramey 1987). These declines are likely related to factors both inside of and outside of the Yankee Fork watershed (NMSF 1998; BOR 2012).

Anadromous fish from the Yankee Fork are exposed to substantial mortality pressures in the Columbia and Snake River migration corridors (Nemeth and Kiefer 1999) and poor conditions in the ocean (NMFS 1998). Nemeth and Kiefer (1999) outlined how the Snake River basin was once the most productive tributary of the Columbia River. Three dams completed on the lower Columbia River and one dam completed on the lower Snake River from 1938 to 1961 resulted in decreased, but still robust adult returns of spring/summer Chinook salmon to the Snake River basin. Four additional dams, completed on those rivers from 1968 to 1975, resulted in a systematic decrease in smolt-to-adult return rates (Nemeth and Kiefer 1999).

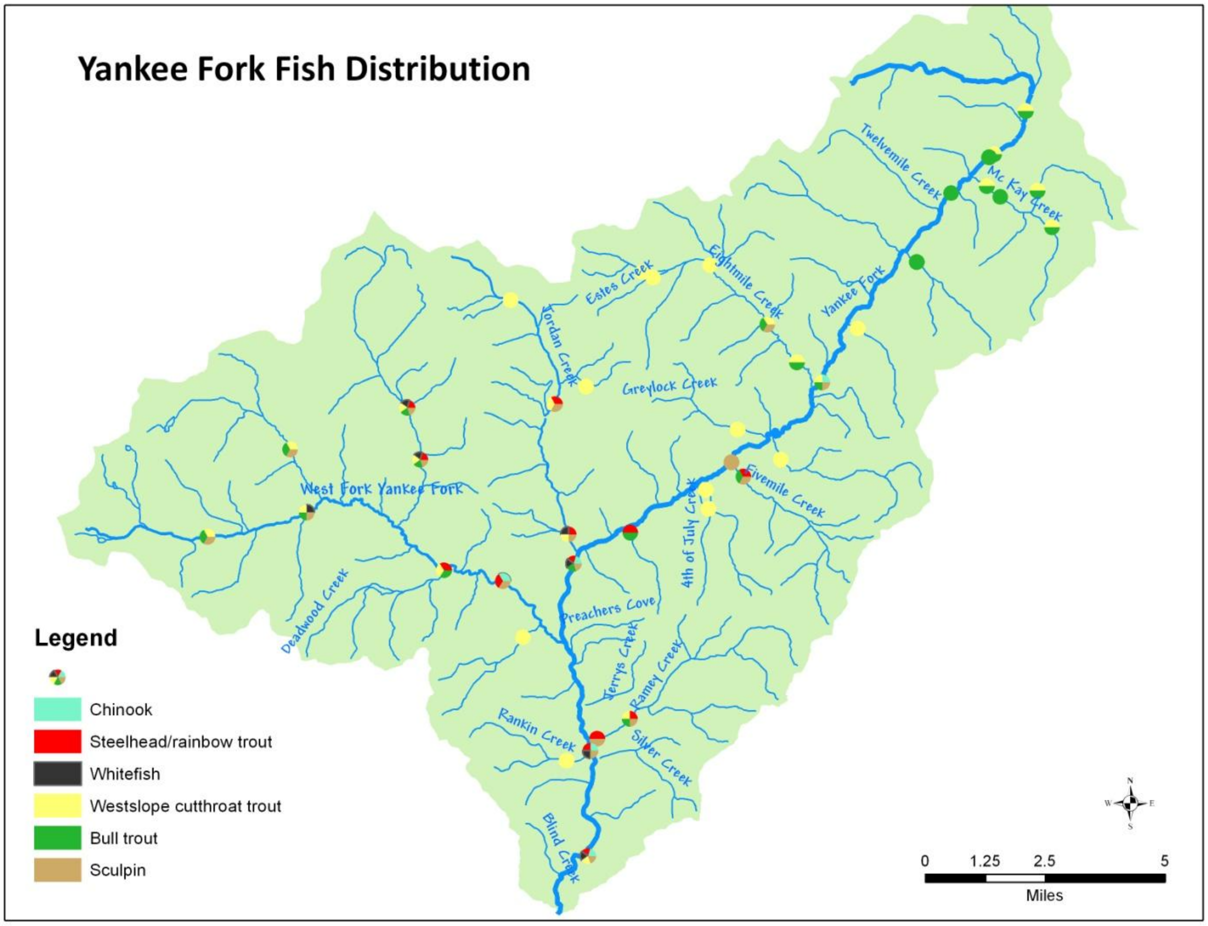

Figure 1. Fish species collected by Forest Service crews at various locations in the Yankee Fork drainage during 2006 and 2007 (Gamett and Bartel 2008).

Correlations between climate and Chinook salmon abundance over the past 20 years indicate that the marine environment has contributed to the variability and decline of Chinook salmon returning to the Columbia River (Francis and Sibley 1991; Pearcy 1992). Marine conditions are the dominant "natural" factor influencing Chinook salmon population abundance, distribution, and survival in the marine environment (NMFS 1998). Climatic conditions can change prevailing ocean currents and productivity associated with nutrient-rich cold waters varies depending on the ocean currents. These shifting ocean currents, named either "El Nino" or "La Nina," can produce widely varied cycles of productivity (Spence et al. 1996). Ocean conditions resulting from large-scale weather patterns such as El Nino affect food supplies, predator distribution and abundance, and migratory patterns for Chinook salmon. It is likely that mortality of anadromous fish in areas downstream from the Yankee Fork is largely independent of conditions within the Yankee Fork. However, conditions in the Yankee Fork can affect the fitness and, within some bounds, the number of out-migrants produced. Maximizing the quantity and general condition of Yankee Fork out-migrants requires providing quality habitat conditions for two life-stages. First, adequate quality spawning habitat must be present to provide spawning areas for the number of adult Chinook that return to the Yankee Fork. Second, juvenile rearing conditions in the Yankee Fork must be sufficient to maximize both the survival rate of juveniles and the fitness of out-migrants, giving fish the best possible chance for continued survival.

The spawning and rearing habitat that the Yankee Fork provides for anadromous fish has been noticeably impacted by natural and human caused disturbances. The most prominent human caused disturbances include mining, roads, timber harvest, and livestock grazing. Currently, these activities are closely regulated to minimize their impacts to land and water resources. Historically, however, the impacts from various land use practices drastically altered riparian and stream habitat. The most notable impacts were associated with the dredge mining of the Yankee Fork. During the 1940's and early 1950's, a floating dredge and doodle-bug dredge were used to extract valuable metals from the Yankee Fork valley from Polecamp Creek to and including Jordan Creek. The dredge mining resulted in a simplified channel configuration that confines flows within the channel and between dredge tailings, with little interaction between the channel and the floodplain (BOR 2012). This has interrupted natural physical and ecological processes that normally occur within the stream, in the riparian area, and on the floodplain which ultimately create fish habitat.

During the late 1980's, the Shoshone-Bannock Tribes attempted to mitigate the effects that the dredge mining had on fish habitat by connecting several remnant dredge ponds to the Yankee Fork in an effort to provide off-channel rearing areas for juvenile anadromous fish (BOR 2012). Since that time, substantial amounts of fisheries data has been collected from the ponds and the Yankee Fork by the Shoshone-Bannock Tribes (Tribes), the Idaho Department of Fish and Game (IDFG), the USFS, and others.

Basic Overview of Fish Habitat Conditions

The Bureau of Reclamation (2012) summarized habitat conditions in the Yankee Fork based on habitat surveys conducted in 1934 (Rodeheffer 1935), 2001 (USFS 2006), and 2010 (USFS 2010). Rodeheffer (1935) indicated that in 1934, prior to dredge mining of the Yankee Fork, the lower Yankee Fork stream substrate was almost entirely comprised of large stones and boulders and that the upper Yankee Fork, above Fivemile Creek, was comprised largely of gravel where salmon spawning was observed. Rodeheffer (1935) also indicated that good pools were almost entirely lacking and high water velocities made it difficult for salmonids in the lower Yankee Fork. However, spawning areas were rated as excellent, presumably upstream from Fivemile Creek. Rodeheffer (1935) stated that the Yankee Fork needed improvements more than any of the streams they surveyed in the upper Salmon River basin.

The Yankee Fork gold dredge worked discontinuously from 1940-1952 extracting gold from the Yankee Fork valley bottom and by doing so, up-earthed and relocated much of the Yankee Fork stream channel and floodplain (BOR 2012). Besides moving the channel, long-term dredging impacts include remnant dredge tailing mounds which confine the river channel, impact channel/floodplain interactions, and disconnect tributaries. While these actions undoubtedly reduced spawning and rearing habitat for salmonids, much of the main-stem habitat disturbed was evidently not high quality before dredging (BOR 2012). Conversely, tributary habitat such as Jerry's Creek, Silver Creek, and possibly Jordan Creek likely contained quality spawning and rearing habitat for salmonids, as noted by Rodeheffer (1935) who observed many fingerlings in the lower quarter mile section of Silver Creek.

Stream surveys conducted by the USFS during 2001 and 2010 show some similarities to those of Rodeheffer (1935). The 2001 USFS survey (USFS 2006) indicated a lack of pools, high width/depth ratios, and poor spawning and rearing habitat in the main-stem Yankee Fork downstream from Jordan Creek. The 2001 survey also showed that pool frequency, pool quality, Large Woody Debris (LWD) and instream cover were lacking and likely limit the growth and survival of juvenile Chinook in the Yankee Fork Drainage. The 2010 USFS survey (USFS 2010) indicated insufficient pools in the main-stem Yankee Fork and Jordan Creek and an altered width/depth ratio in much of that area. The survey further showed that LWD loading in the Yankee Fork was below Riparian Management Objectives RMO for all reaches surveyed (Figure 2).

The entire Yankee Fork drainage has been identified as a priority I stream in the Screening and Habitat Improvement Prioritization for the Upper Salmon Subbasin (USBWP 2005). Priority I streams are those streams that have the potential to realize immediate, tangible benefits to fish if recovery efforts are directed toward them. Recovery efforts identified by the National Marine Fisheries Service (NMFS) Technical Recovery Team (TRT) (NMFS 2011) for the Yankee Fork primarily included reconnecting floodplains, reconnecting tributaries (that have become disconnected through mining activities), and improving fish access to new and existing off-channel ponds. Secondary recovery efforts suggested included reducing sediment levels by reducing grazing impacts, reestablishing riparian vegetation, improving bank stability, and managing run-off from roads and mining sites (NMFS 2011). Management actions in place before 2011 (USFS 2006) had already addressed bank stability and grazing-related sediment inputs (IDEQ 2011).

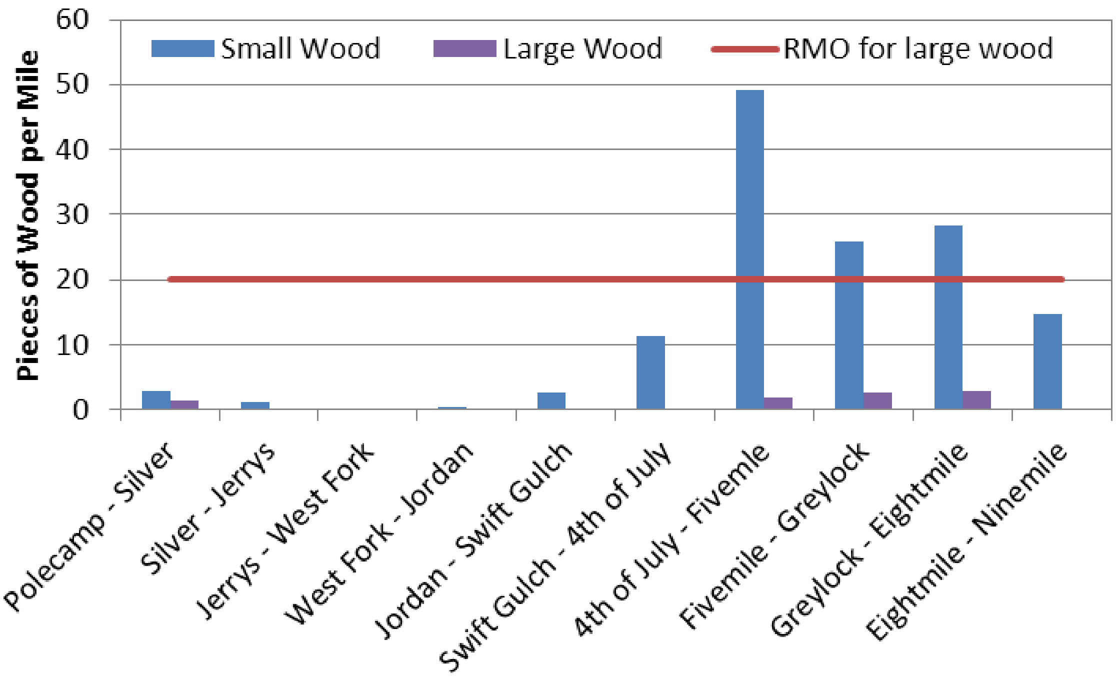

Figure 2. Pieces of small (>6 inches at 20 feet from large end) and large (>12 inches at 35 feet from large end) wood in the main-stem Yankee Fork (data from USFS 2010).

Pond Series

During the late 1980's, two basin management plans were being developed under the Northwest Power Planning Council's Columbia River Basin Fish and Wildlife Program that were expected to lead to improved fish passage at the dams and ultimately increase anadromous fish populations throughout the Snake River basin, including in the Yankee Fork. Additionally, unpublished data collected by Richards suggested that spring Chinook salmon populations within the Yankee Fork were limited by rearing habitat availability (Richards et al. 1992). Therefore, in 1987-1988, the Tribes implemented a habitat enhancement project to create off-channel habitat for juvenile Chinook. This effort resulted in four pond series with surface water connections to the river. Connecting the ponds to the river gave fish access to about 1.62 ha (4.0 ac) of pond and about 610 m (2000 ft) of channel habitat not previously available (Richards et al. 1992). Evaluation of juvenile Chinook salmon populations in the pond series showed that densities of juvenile Chinook were significantly greater in channel than in other habitats and greater in habitats with cover than in those without cover (Richards et al. 1992). When cover was present in channels, juvenile Chinook densities were "several times those in any other habitat" resulting in 32% of the fish in Pond Series 3 and 80% of the fish in Pond Series 4 occupying channel habitat, even though it accounted for less than 10% of all available habitats (Richards et al. 1992).

Over the 25 years since their creation, the pond series adjacent to the Yankee Fork have changed based on natural processes, but continue to be utilized by juvenile Chinook. However, aggraded channel and beaver dams have substantially reduced inflow into three of the pond series, and modification is necessary to retain the usefulness and accessibility of those pond series for juvenile

Chinook. Therefore, several entities including Bureau of Reclamation, Bonneville Power Administration, the USFS, JR Simplot Company, Trout Unlimited, the Governor's Office of Species Conservation, and the Tribes are working to rebuild some of the pond series so they remain accessible to juvenile Chinook in the Yankee Fork. Additionally, given the apparent preference of juvenile Chinook for channel habitat (Richards et al. 1992) which has repeatedly been confirmed by tribal fisheries biologists (Gregory and Wood 2012), alternatives are being developed to convert these pond series into side-channel habitat.

Water Quality

In the past, several stream segments in the Yankee Fork watershed have been included on the Idaho Department of Environmental Quality's (IDEQ) 303(d) list of impaired waters. In 1994, the main-stem Yankee Fork was listed for sediment and habitat alteration from the headwaters to the mouth (IDEQ 1994). In 2001, those same sources of impairment were listed but the stream segment was shortened to include the main-stem Yankee Fork from Fourth of July Creek to the mouth (IDEQ 1998). In 2003, IDEQ did not designate a Total Maximum Daily Load (TMDL) for the listed section of the Yankee Fork as the "…source of impairment is habitat alteration" (IDEQ 2003a). The 2010 Integrated Report (IDEQ 2011) only mentions that portion of the Yankee Fork from the source to Jordan Creek but proposed to "delist physical substrate habitat alteration" in that reach (IDEQ 2011). This was done because monitoring conducted by DEQ in 2005 showed that 10.23% of the substrate was fine (<2.5 mm) material (IDEQ 2011). According to DEQ's Guide to Selection of Sediment Targets for Use in Idaho TMDLs (IDEQ 2003b), impairment is noted when percent fines are greater than 30%. During the 2005 monitoring, stream bank stability was determined to be excellent (93% of the stream rated as covered and stable) and the average Beneficial Use Reconnaissance Program (BURP) score had increased from 1.67 to 2.33, which put the stream in the category of fully supporting its beneficial uses (IDEQ 2011). IDEQ (2011) indicated that the applicable water quality standard was attained and that the "original basis for listing was incorrect." No other segments of stream in the Yankee Fork drainage were listed for impairment in that document. However, at least five major streams and nearly 130 stream miles in the Yankee Fork watershed lack sufficient data to determine whether the water bodies meet water quality standards or support beneficial uses (IDEQ 2011).

Water temperatures have occasionally exceeded IDEQ's bull trout temperature criteria (13° C 7-day average maximum) in the main-stem of the Yankee Fork upstream from Pole Flat Camp Ground, upstream from the West Fork of the Yankee Fork (West Fork), upstream from Jordan Creek, and in pond series 1 – 4 (Anderson et al. 2001, Ray et al. 2006, 2007; Salmon-Challis National Forest, unpublished data). However, water temperatures are still relatively cool, remaining below 18° C in the pond series and main-stem of the Yankee Fork most of the time (Anderson et al. 2001, Ray et al. 2006, 2007; Salmon-Challis National Forest, unpublished data).

In 2003, emergency action by Hecla Mining Company called for the diffusion of a large tailing pond from the Grouse Creek Mine into the Yankee Fork below the confluence of Jordan Creek (Ray and Bacon 2005). Ray and Bacon (2005) documented elevated levels of unionized ammonia (NH_3) downstream from the mixing zone after diffusion began in May, 2003. Ray and Bacon (2005) outlined how "[S]almonid responses to elevated levels of ammonia include; gill and kidney hyperplasia (NRC 1979, EPA 1984), reduced metabolic rate, compromised swimming performance (Shingles et al 2001), loss of equilibrium, increased breathing, decreased hatch success, decreased growth rates, and morphological deviations (EPA 1984). Currently, there is no state standard for unionized-ammonia, however, a range of values elucidate responses in salmonid fish and invertebrates. For example; at 0.0125 mg/L salmonid fry show a physiological response (Marlow and Bucks 1993) and levels of 0.002 mg/L for 6 weeks cause hyperplasia in gills (NRC 1979). The Colombia Basin Fish and Wildlife Authority (CBFWA) Interagency Hatchery Operations Team has set a water quality criteria for unionized-ammonia at <0.0125 mg/l (CBFWA 1994). Ninety-six hour acute unionized-ammonia toxicity in invertebrates occurs at 0.0355 mg/L (Williams et al. 1986). Unionized-ammonia levels below the diffuser were above these values in July and August 2003."

Heavy metals, namely mercury and selenium, present some concerns in the Yankee Fork drainage. Mercury was used in gold mining operations in the Yankee Fork drainage to help the gold to sink through the flowing water-gravel mixture and thereby increase the gold recovery rate. Selenium, on the other hand, is naturally occurring in the watershed and was not used in any mining related process. However, mining activities can lead to elevated concentrations of selenium due to the increased exposure of parent material to leaching, weathering, and other erosion processes. Recent samples of surface water in pond series 2 and 3 and the adjacent Yankee Fork showed that maximum detected concentrations of selenium (3.2 µg/L) and mercury (0.0041 µg/L) in were well below their drinking water criteria of 50 and 2.0 µg/L, respectively (CH2MHILL 2011). CH2MHill (2011) also found that selenium and mercury concentrations measured in sediments of Pond Series 2 and Pond Series 3 appeared to be generally consistent with background levels (i.e., those measured from areas of the Yankee Fork basin not impacted by historical mining activities).

Age Naming Conventions

A great deal of confusion centers around the nomenclature used to designate fish ages (Devries and Frie 1996). The American Fisheries Society (AFS) has adopted a naming convention which assumes fish begin a new year of life on 1 January and are, for example, age 1 from the January after they hatch until the end of December of that same year (AFS 2011). However, this age naming convention is not followed in the majority of the literature we reviewed for this document. Therefore, we will discuss common age naming conventions and how they will be used in this document.

Chinook salmon spawn in the fall and a cohort of fish is often referred to by the year they were spawned or 'brooded,' as in Brood Year or BY 2008. Eggs incubate through the winter, hatch in December, and the fry remain in the gravel until the yolk sac is absorbed in February or March of the following spring (Bjornn 1960). Steelhead spawn during the spring and eggs incubate and hatch during late spring or early summer. Much of the literature we reviewed refers to these fish as being age 0 from hatch until some unstated time between the following fall and the subsequent spring. Snorkelers categorized Chinook as age 0 fish when they were < 100 mm long and steelhead as age 0 fish when they were ≤ 80 mm (Anderson et al. 2001). We will refer to these fish as age 0's or juveniles. Juvenile Chinook were sometimes placed into sub-categories depending on when they were collected as migrants in screw traps: fry were collected before 1 June, parr were collected from 1 June through 31

August, and pre-smolts were collected from 1 September through the end of trapping, which usually occurred in November (Tardy 2011).

During the second calendar year after hatching, Chinook salmon that migrate from the Yankee Fork to the ocean are universally referred to as age 1's or smolts, though it is unstated when these fish change from age 0 to age 1. Snorkelers classified sub-adult Chinook as age 1 when they were > 100 mm. Steelhead were also classified into older age-groups based on size with age 1 steelhead being 81 - 160 mm and age 2 steelhead being 160 - 230 mm (Anderson et al. 2001). We will refer to steelhead as sub-adults during the time which much of the literature refers to these fish being as age 1 and 2.

Chinook salmon remain in the ocean for one to three years and leave the ocean during the spring to begin their migration back to the Yankee Fork, where they arrive during the late summer or fall. Fish that remain in the ocean only one year are typically males and are commonly referred to as jacks. These would be age 2 fish according to the AFS age naming convention. However, much of the literature we reviewed refers to these as being age 3 fish when they are captured at migration weirs in the fall. This could only be the case if the "birthday" for these fish was considered to be in the fall, presumably when they were spawned. However, using this convention, the fish technically would not be age 3 until after the spawning period. Again this is not consistent with the AFS age naming convention, so we will attempt to avoid confusion for fish that are in this age class by referring to them simply as jacks or 1-ocean fish. Likewise, fish that would be referred to as age 3 and 4 using the AFS naming convention are commonly referred to as being age 4 and 5, but will be referred to herein as 2- and 3-ocean fish, as they have spent 2 and 3 years in the ocean respectively. All fish that have been to the ocean and return to the Yankee Fork will be referred to as adults.

Chinook

Genetics

Waples et al. (1993) found that spring/summer Chinook in the main-stem Yankee Fork were highly differentiated genetically from adjacent populations, but not significantly different from 10 hatchery samples derived from Rapid River Hatchery stock. This observation likely reflected the out-planting of Rapid River hatchery stock into the main-stem Yankee Fork which occurred intermittently in years 1977 to 1991 (ICTRT 2007; Tardy and Denny 2011). Following the Waples et al. (1993) study, all hatchery Chinook out-planted in the Yankee Fork drainage were from the Sawtooth Fish Hatchery (Tardy and Denny 2011). Conversely, West Fork Yankee Fork spring/summer Chinook were found to be genetically similar to other upper Salmon River populations (NMFS 2011), even though the West Fork was reportedly supplemented with Rapid River stock Chinook salmon juveniles in 1977 (NMFS 2011; Tardy and Denny 2011).

Adult Migration and Timing

Adult Chinook salmon migrating in the Yankee Fork were enumerated at the Tribes' picket weir located adjacent to Pole Flat Campground from 2008 – 2011 (Denny and Tardy 2010; Tardy and Denny

2010, 2011; Tardy 2011). Adult Chinook passage at this weir generally occurred from early July to mid-September and had a bi-modal distribution with a peak during July and another peak in August or September. Trapping of migrating adult Chinook early in the season was often not possible due to high flows. Therefore, it is possible that adult migration into the Yankee Fork drainage starts earlier than indicated by the data. Adult Chinook passing the weir were both natural and hatchery returns and in 2008 and 2009 several adult Chinook were collected at the Sawtooth Hatchery and out-planted in the Yankee Fork to spawn naturally (Figure 3). The Tribes decision to supplement the Yankee Fork with adult Chinook salmon was based on a number of factors including: (1) an immediate need to prevent local extirpation; (2) the importance of the area as a Tribal subsistence fishery and the need to achieve the Tribal harvest objective of 500 adults; (3) the importance of recovering this population and achieving the conservation objective of 1,500 spawners annually; (4) the long history of introductions of out-of-basin stocks; (5) the proximity of a donor hatchery that could provide broodstock (i.e., Sawtooth) to support a supplementation effort; and (6) regional support for the enhancement effort (Denny and Tardy 2010).

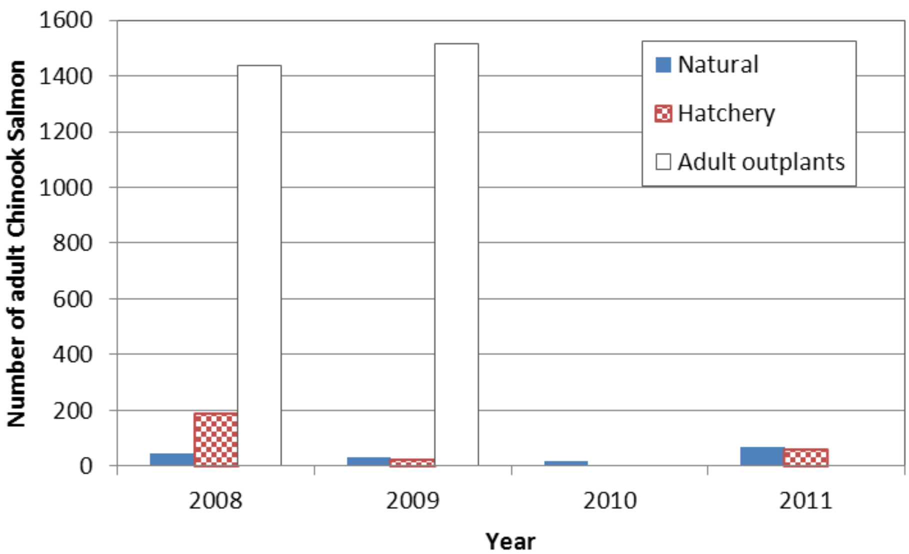

Figure 3. Number of adult Chinook salmon trapped at the Pole Flat Weir and those trapped at Sawtooth Hatchery that were out-planted in the Yankee Fork from the years 2008 – 2011 (Data from Tardy 2011).

Redd Numbers

Chinook salmon redd counts have been conducted in the Yankee Fork drainage from 1952 to 2011 using various ground and aerial counts, sometimes during the same year. Richards and Cernara (1987) indicated that "[t]he total number of redds counted by helicopter on 31 August 1986 was three, [g]round surveys indicated far more redds were present…" Because variable total redd counts were common, the Tribes fisheries personnel compiled all available redd count data and extracted the presumed most accurate counts by assuming that the largest number of redds counted most closely represented the actual number of redds constructed. This data shows that redd counts were low during the 1950's, rebounded during the 1960's and then exhibited a downward trend and remained low from the 1980's through the 2000's (Figure 4).

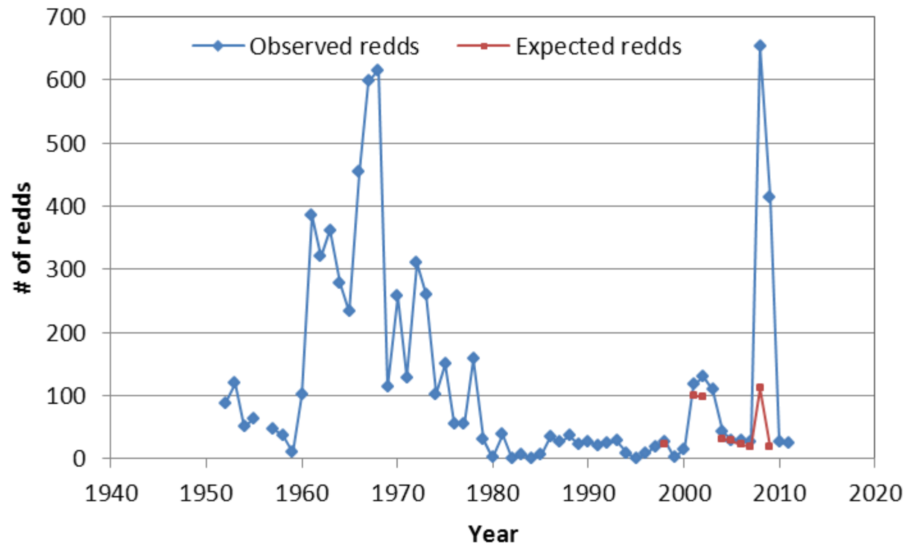

Figure 4. Yankee Fork redd counts from 1952 to 2010 including the number of redds that would have been expected without Captive Rearing Program adult out-plants and without adult out-plants from Sawtooth Hatchery being moved to the Yankee Fork.

In 2008 and 2009, redd counts were among the highest observed as a result of 1,438 and 1,517 Sawtooth Fish Hatchery adults being out-planted in the Yankee Fork, respectively. Aside from these out-planted fish, 185 hatchery fish and 43 natural fish were counted at the Pole Flat Weir in 2008 and 29 natural and 20 hatchery fish were counted at the Pole Flat Weir in 2009. We calculated an expected number of redds that would have been present in the Yankee Fork, had the fish not been moved from Sawtooth Fish Hatchery. This was done by dividing the number of redds observed in the basin upstream from the Pole Flat Weir by the number of fish that passed the Pole Flat Weir plus the additional number of fish out-planted in the Yankee Fork from Sawtooth Fish Hatchery. This number was then multiplied by the number of fish that passed the Pole Flat Weir and the result was added to the number of redds counted downstream from the Pole Flat Weir. This method assumes equal redd production by fish from each group, and shows that the expected number of redds, had additional hatchery fish not been out-planted in the Yankee Fork, would have been 125 instead of 653 in 2008 and 47 instead of 414 in 2009 (Figure 4).

Redd counts were artificially high in 1998 and 2001 – 2009 as a result of the Captive Rearing Program for Salmon River Chinook Salmon which was conducted in the West Fork of the Yankee Fork. The Captive Rearing Program was an experimental program to determine whether captive fish could increase natural-origin fish abundance in the West Fork. It was operated by the Idaho Department of Fish and Game (IDFG), through the Lower Snake River Compensation Plan (LSRCP) and Idaho Power Company hatcheries, and was initiated to compensate for lost recruitment and productivity caused by the construction and operation of private and federal hydroelectric facilities (Stark et al. 2008). This experimental conservation program began in 1995 and was started with BY 1994 juvenile Chinook parr collected from the West Fork (Hassemer et al. 1999). Juvenile fish were reared to smolts at an IDFG fish hatchery and then transferred to the National Marine Fisheries Service (NMFS) Manchester Marine

Laboratory in Port Orchard, Washington for seawater rearing. Adults nearing sexual maturity were then transported back to the IDFG fish hatchery for final maturation after which they were transferred to the West Fork and released to spawn naturally (Hassemer et al. 1999). The program was plagued with pre-spawn mortality (Table 1) and concluded operations in 2009. Redds produced by adults from the Captive Rearing program were included in annual redd counts (Ray et al. 2004-2007; Tsosie et al. 2009). We calculated an expected number of redds which would have been present in the Yankee Fork, had the captive broodstock not been released, by subtracting the number of redds captive adults constructed (Table 1) from the number of redds observed (Figure 4).

Table 1. Number of hatchery adult Chinook out-planted in the West Fork Yankee Fork as part of the Captive Rearing Program for Salmon River Chinook Salmon. The number of redds these fish produced is included in the redd counts in Figure 4.

Year	# of captive adults out-planted	# of redds captive adults constructed	Captive adult/redd	Citation
1998	49	4	12.3	Ray et al. 2004
2001	89	18	4.9	Ray et aTable 4l. 2004
2002	215	33	6.5	Ray et al. 2004
2003	88	0	N/A	Venditti et al. 2005a
2004	70	12[a]	5.8	Baker et al. 2006a
2005	116	2	58.0	Baker et al. 2006b
2006	179	8	22.4	Baker et al. 2007
2007	253	7	36.1	Stark et al. 2008
2008	185	13[b]	14.2	Stark et al. 2009
2009	103	28[c]	3.7	Stark and Gable 2010

[a] 1 of the redds was located in the main-stem Yankee Fork.
[b] Tsosie et al. 2009 and Venditti et al. 2011 reported that 17 redds were constructed by Captive Rearing Program adults during 2008 (see Table 4)
[c] 12 of the redds were located in the main-stem Yankee Fork.

Redd Locations

Chinook salmon spawning takes place in the main-stem Yankee Fork and major tributaries. Spawning locations have been reported based on strata designations (Figure 5) that were developed in 1985 by Konopacky et al. (1986) based on stream size, valley width, gradient, overland vegetative community type, and land use associated with the stream (Konopacky et al. 1986). An eighth stratum, Eightmile Creek, was added in 2009 (Tardy and Denny 2010).

Spawning of natural fish is volitional throughout the drainage, but beginning in 2008, hatchery fish spawning has been limited to the areas downstream from the Pole Flat Weir and upstream from the Stratum 4 weir (this weir has been located at various places within stratum 4). Hatchery fish have been excluded from the area between the weirs, including the West Fork, to allow for Idaho Supplementation Studies (ISS). This practice does not prevent genetic mixing, as offspring of naturally spawned hatchery fish are considered natural fish and therefore would be allowed to spawn in the area between the weirs. Spawning segregation has been accomplished by capturing hatchery fish at the Pole Flat Weir and transporting them upstream past the Stratum 4 weir, where that structure prevents them from moving back downstream. Natural fish are also captured at the Pole Flat Weir and Stratum 4 weir but are passed above each weir and allowed to continue upstream to spawn (Denny and Tardy 2010; Tardy and Denny 2010). Consequently, the only hatchery-origin fish that spawn between the two weirs in the

Yankee Fork or its tributaries (i.e. West Fork or Jordan Creek) are fish that escape past weirs undetected, or access the area before weirs are installed. One or both such situations occurred in 2008 (Denny and Tardy 2010) and 2010 (Tardy and Denny 2011).

During 2011, Chinook salmon redd distribution (Figure 5) was typical of Chinook spawning locations in previous years except that more redds were usually present throughout Strata 6 (West Fork) and Strata 4 (Table 2). Additionally, in 2008 and 2009, when Sawtooth Fish Hatchery adult Chinook were outplanted in the Yankee Fork upstream of the Strata 4 weir, many more redds were present in strata 4, 5, and 8 (Table 2). In recent years, most redds observed in the Yankee Fork downstream of the Pole Flat Weir have been located just below the weir in what Tardy and Denny (2010) described as excellent spawning habitat created by a recent landslide, which resulted from the Rankin Fire that occurred during 2000. Spawning also occurs upstream of the Strata 4 weir in the Yankee Fork, but selection of this area is highly influenced by the out-planting of hatchery-origin fish upstream of the weir. Within the volitional spawning area between Pole Flat and Strata 4 weir, spawning occurs primarily immediately upstream from the Pole Flat Weir, in the main-stem upstream of the mouth of Jordan Creek, and throughout the West Fork. While fish do occasionally spawn within the dredged area of the Yankee Fork, it is clearly under-selected in comparison to other areas (Table 2).   Chinook redds are often not counted in Jordan Creek (Table 2), but Chinook do occasionally spawn in Jordan Creek, as one redd was observed there in 2002 (Ray et al. 2004). Additionally, Rowe et al. (1989) stated that, "… late summer flow (0.05 m3/s) in 1988 was extremely low in Jordan Creek, passage by adult salmon to suitable upstream habitat was probably not possible. This may account for the complete absence of this species in Jordan Creek during the last two years." This statement seems to suggest that there had been Chinook redds in Jordan Creek prior to 1988.

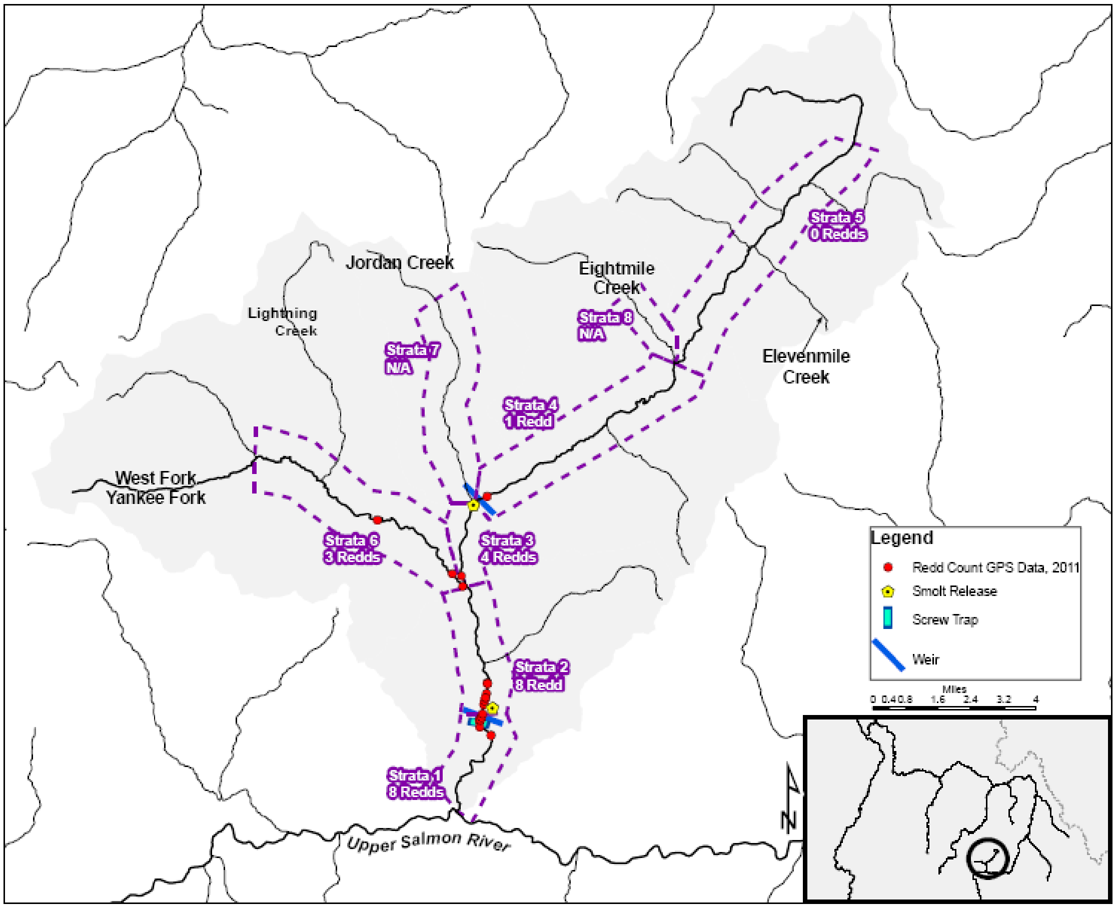

Figure 5. Yankee Fork Strata designations and Chinook redd locations observed during 2011 (Figure from Tardy 2011).

Table 2. Chinook salmon redd abundance and locations in the Yankee Fork drainage from 2008 – 2011 (Denny and Tardy 2010; Tardy and Denny 2010, 2011; Tardy 2011).

Year	Reach extent	2008	2009	2010	2011
Strata 1	YF Mouth - Polecamp Cr.	41	35	5	8
Strata 2	Polecamp Cr. - West Fork	5	4	1	8
Strata 3	West Fork - Jordan Cr.	2	6	2	4
Strata 4	Jordan Cr - Eightmile Cr.	332	256	12	1
Strata 5	Eightmile Cr. - above McKay Cr.	266	95	1	0
Strata 6	West Fork Yankee Fork	24[a]	19[a]	6	3
Strata 7	Jordan Creek	NS	NS	NS	NS
Strata 8	Eightmile Creek	NS	15	NS	NS
	Total	653	414	27	24

[a] = Number includes redds constructed by Captive Rearing Program adults outplants (Stark and Gable 2010; Venditti et al. 2011)

NS = Not sampled

Available Spawning Habitat

In 2008, the Tribes used a spawning habitat model developed by Reiser and Ramey (1987) to estimate the number of Chinook salmon redds that could be present in the Yankee Fork drainage (Denny and Tardy 2010). Derivation of this estimate was based on a habitat model that incorporated usable spawning habitat (length of stream and width), area of an average Chinook salmon redd, and 2.5 fish per redd" (Denny and Tardy 2010). They calculated that the drainage was able to support 4,746 Chinook salmon redds and an average redd density of 69 redds/km over the portion of the basin that was assumed to be usable by adult Chinook salmon. The highest redd density was predicted to be 225 redds/km in the area from Fivemile Creek to Ninemile Creek (Table 3).

Table 3. Amount of spawning habitat available in the Yankee Fork and the number of redds and spawning adult Chinook salmon that could be supported in that habitat (Denny and Tardy 2010).

Drainage Stream	Length (km)	Habitat Model Used [a]	Estimated Total Spawning Area (m^2)	Estimated Usable Area (m^2) [b]	Estimated # of Redds [c]	Estimated # of adults [d]	Redds per km
Yankee Fork							
Mouth to Polecamp Creek	4.5	YF-2	2,259	226	61	91	14
Polecamp Creek to West Fork	6.4	YF-4	10,385	1,038	279	419	43
West Fork to Jordan Creek	3.7	YF-3	8,613	861	232	347	63
Jordan Creek to Fivemile Creek	6.4	YF-2	4,042	404	109	163	17
Fivemile Creek to Ninemile Creek	8.5	YF-1	14,252	7,126	1917	2875	225
Ninemile Creek to McKay Creek	7.2	YF-2 (adjusted)	2,593	259	70	105	10
Sub-total	36.9		42,144	9,915	2,668	4,000	
West Fork							
Mouth to Cabin Creek	12.9	WF-1	27,811	6,953	1,870	2,805	145
Cabin Creek to Divide	6.4	WF-1 (adjusted)	7,742	774	208	312	32
Sub-total	19.3		35,552	7,727	2,078	3,117	
Total	108.8		77,696	17,642	4,746	7,117	Mean 69

[a] - Adjusted models applied to unmodeled reach - models adjusted for width and total area
[b] - Areas adjusted by percentage of total spawning area thought usable in the reach, assuming redd areal requirements must be contiguous
[c] - Numbers derived from Chinook redd area estimate of 3.7 m^2/redd
[d] - Assumes 2.5 fish/redd or 1.5 males/female

Hatching

Chinook eggs incubate through the fall and winter and begin hatching in December and the fry remain in the gravel until the yolk sac is absorbed in February and March of the following spring (Bjornn 1960, NMFS 2011). Tsosie et al. (2009) calculated egg-to-par (juvenile) survival in the West Fork Yankee Fork based on snorkel estimates of juveniles and an assumed 5,594 eggs per female and one female per red. From 1988 to 2008, egg-to-parr survival estimates ranged from 1% to 56% (Table 4; Tsosie et al. 2009). However, these calculations were undoubtedly influenced by movement of juvenile Chinook (see Summer Movement of Juveniles) and the ability to detect juveniles during variable flow and stream conditions.

Table 4. Redd production and egg-to-parr production in strata 6, the West Fork of the Yankee Fork (data from Stark et al. 2009; Tsosie et al. 2009).

Year	Total Redds	Natural Redds	Captive Brood Redds	Egg-to-Parr survival (%)
1988	31			5.2
1989	6			11.0
1990	20			12.5
1991	8			7.0
1992	6			13.5
1993	13			0.7
1994	9			8.1
1995	0			7.7
1996	7			
1997	7			4.7
1998	12		4	19.5
1999	0			22.9
2000	4			
2001	36	18	18	10.9
2002	53	20	33	7.0
2003	24			3.8
2004	15	4	11	30.7
2005	7	5	2	55.8
2006	14[a]	4	8	5.0
2007	10	3	7	11.9
2008	24	7	17[b]	1.0

[a] = unknown why the total does not equal the sum of redd types

[b] = Stark et al. 2009 reported that 13 redds were constructed by Captive Rearing Program adults Tsosie et al. 2009 and Venditti et al. 2011 reported the number as 17 (see Table 1)

Summer Habitat

Summer habitat use by juvenile Chinook salmon relative to microhabitat conditions has not been extensively evaluated in the Yankee Fork, but has been studied in other areas. Holecek et al. (2009) observed that juvenile Chinook in Big Creek, a tributary to the Middle Fork of the Salmon River, selected areas of low-velocity (0 – 25 cm/s) and moderate depth (40 – 80 cm) that were within 80 cm of some type of cover, which predominantly consisted of woody debris (55%) and rock outcrops (24%). Runs were used (39%) in proportion to their availability, while pools were used by 52% of the fish but comprised 18% of the stream area. Juvenile Chinook also selected for complex cover and pocket-water, but against riffles. As juvenile Chinook size increased, they selected areas of increased water velocity, water depth, and focal depth but did not increase their distance from cover. Juvenile Chinook salmon selection of pool habitat was also noted by Roper et al. (1994) in Jackson Creek, a fifth order tributary to the South Umpqua River in Oregon. In Red River, an Idaho stream that was highly embedded with fine sediment, juvenile Chinook salmon used habitat with water velocities less than 20 cm/s, depths of 20 - 80 cm, and were in close association with cover, primarily undercut banks (Hillman et al. 1987).

In the Yankee Fork pond series, juvenile Chinook densities were highest in channel habitat during June, “open-water” habitat associated with cover during July and August, and channel habitat again during September (Rowe et al. 1989, 1991). Given the high selection of pools with cover by juvenile Chinook salmon in other studies (Hillman et al. 1987; Roper et al. 1994; Holecek et al. 2009), and mid-summer selection of open-water containing cover in the Yankee Fork pond series, we assume that the cover and low velocity pool type habitat are the important components of mid-summer habitat selection. The importance of bank and channel habitat relative to pond habitat may change at very high densities, as Rowe et al. (1991) observed greater relative use of pond habitat at higher fish densities. Additionally, Rowe et al. (1991) observed that hatchery reared juvenile Chinook were more likely to be associated with open-water pond habitat than were naturally reared juveniles. Overall, it appears that bank habitat may be the preferred juvenile Chinook habitat but the fish may use open-water in the ponds once the bank habitat is fully occupied. Bank habitat may also be less important during mid-summer (July and August), as Rowe et al. (1989) found juvenile Chinook to utilize open-water pond habitat in relative proportion to its availability.

Aside from microhabitat characteristics, juvenile Chinook habitat selection in the Yankee Fork is influenced, at least initially, by redd locations and stocking locations (Rowe et al. 1989). Fish densities were observed to be high during early summer near areas where spawning or stocking had occurred but decreased by September (Rowe et al. 1989). These reductions in density, which have been as high as 95% in stocked ponds (Rowe et al. 1989), likely reflected both emigration, which has been documented (see Summer Movement of Juveniles), and summer mortality, which has not been quantified. Summer sampling conducted by the U.S. Forest Service showed that Chinook primarily used main-stem and large tributary areas (Figure 6) (Gamett and Bartel 2008).

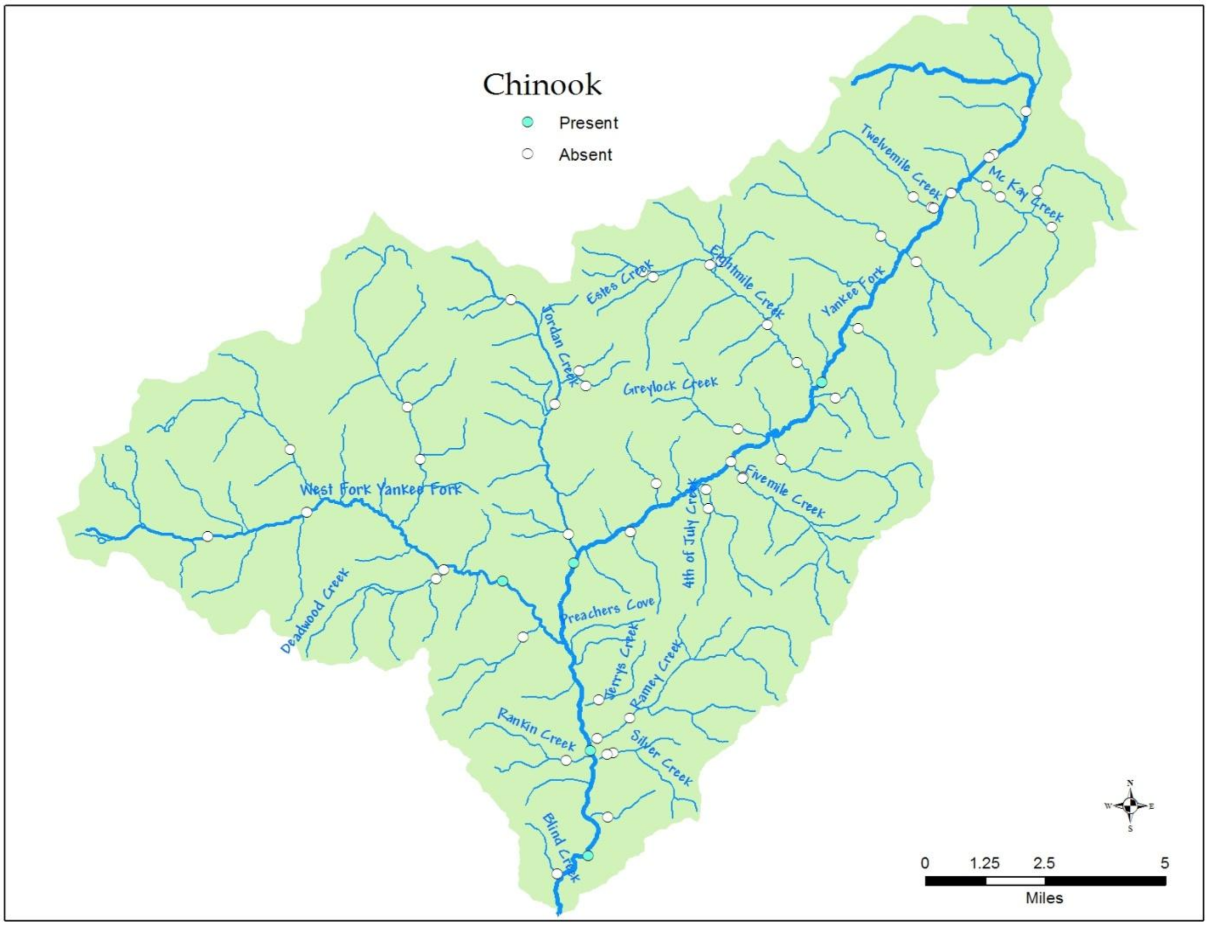

Figure 6. US Forest Service 2006 and 2007 fish sampling location in the Yankee Fork drainage indicating where Chinook salmon were collected (Gamett and Bartel 2008).

Distribution, Density, and Population

Juvenile anadromous fish populations have been monitored and reported separately for the Yankee Fork strata and for pond and channel habitat within each pond series. The Yankee Fork and tributary strata had a combined surface area of 72.39 ha, while the combined pond surface area for the pond series was 2.69 ha and the combined channel habitat surface area the for pond series was 0.29 ha (Figure 7). Population estimates within each habitat unit, averaged over a number of years, is related to the surface area of the habitat unit being reported. For example, juvenile Chinook salmon average population sizes were largest in Strata 4 and 6, which have the greatest surface areas of any of the strata. All of the Yankee Fork strata, excluding Strata 7 (Jordan Creek), had higher abundance of Chinook than the pond series (Figure 8).

Conversely, density estimates within each habitat unit, averaged over a number of years, is related to habitat selection and the locations of redds and out-planting (as outlined above, see Summer Habitat). Juvenile Chinook densities were highest in channel habitat within the pond series, intermediate in the main-stem and tributary strata, and lowest in the ponds (Figure 9). The patterns observed for juvenile Chinook abundance and density estimates appear to indicate that, while the largest proportion of the population is found in Yankee Fork strata, the channels within the pond series are more highly selected.

The population of juvenile Chinook salmon in many of the areas evaluated was likely influenced to some degree during nearly every year by the stocking of hatchery fish. These stocking activities typically included: out-planting eyed eggs, stocking hatchery reared juveniles, or out-planting adult Chinook spawners (Table 5). Juvenile Chinook originating from out-planted eggs or spawned by stocked adults are impossible for snorkelers to differentiate from wild juvenile Chinook. Additionally, stocked juveniles were not always marked and they were not enumerated differently than naturally spawned Chinook. Consequently, the influence of hatchery-origin fish could not be factored into our analysis of Yankee Fork juvenile Chinook salmon populations. However, the abundance and density estimates resulting from our evaluation are still useful for assessing the relative capacity and selection of the available habitat.

Following construction of the Yankee Fork pond series during the 1980's, juvenile hatchery Chinook were planted in Pond Series 1 through 3 in 1989, while Pond Series 4 was left to be seeded naturally by juveniles originating from the main-stem. Snorkel surveys showed that juvenile Chinook densities in Pond Series 4 were similar to those in Pond Series 2 in July, August, and September and were higher than those in Pond Series 1 for all periods except June, although differences were not significant (Rowe et al. 1989). Furthermore, naturally-produced Chinook salmon fry utilized the non-supplemented Pond Series 4 at proportionally greater levels than adjacent main-stem river sites. Pond Series 4 is located just downstream of the West Fork, which is a major contributor to Chinook salmon production in the Yankee Fork system. Rowe et al. (1989) speculated that the West Fork was the major source of fish observed in Pond Series 4. Interestingly, during this time Pond Series 4, and also Pond Series 3, did not yet have inlet connections to the Yankee Fork. Therefore, the fish observed in Pond Series 4 would have entered it from the outflow connection (Rowe et al 1989).

Juvenile Chinook salmon populations from 1984 through 2009 varied widely and were affected by some form of supplementation during nearly every year (Figure 10). Abundance estimates ranged from 0 in 1996, after no adults returned to the Yankee Fork in 1995, to approximately 215,000 during 2004 and 2009, after extensive out-planting of juveniles in both years and out-planting of hatchery adults in 2008. Additionally, the number of juvenile Chinook salmon in the Yankee Fork only exceeded 50,000 during 4 years from 1984 through 2009 (Figure 10). However, even the maximum numbers of juvenile salmon counted represent only slightly more than half of the 425,000 that Kiefer et al. (1990) estimated was the carrying capacity in the Yankee Fork drainage.

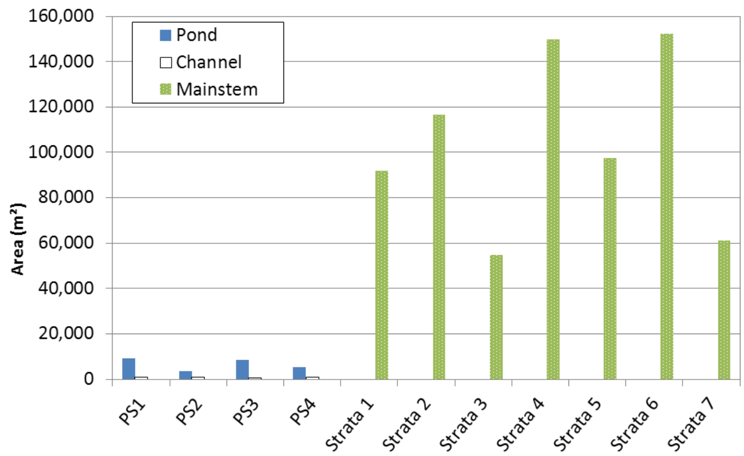

Figure 7. Surface area of various habitat types and strata within the Yankee Fork drainage.

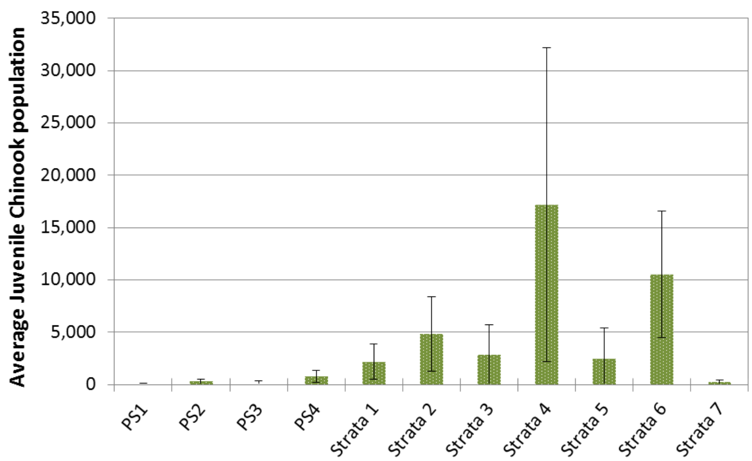

Figure 8. Average population size, for all years of available data, of juvenile Chinook in various locations throughout the Yankee Fork drainage.

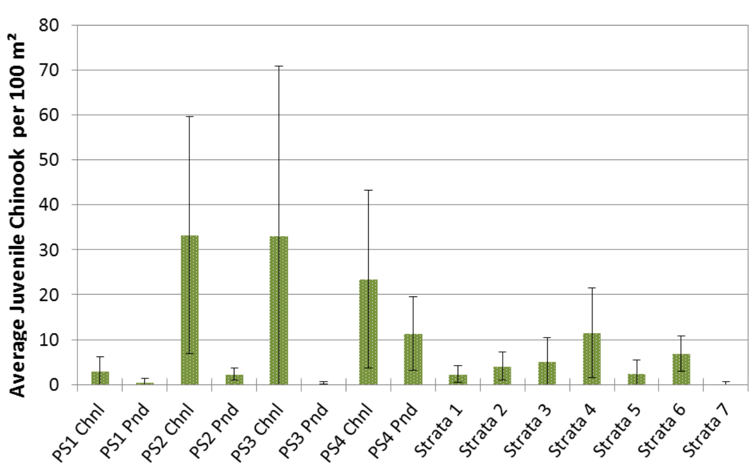

Figure 9. Average density, for all years of available data, of juvenile Chinook in various locations throughout the Yankee Fork drainage.

Table 5. Number of Chinook salmon stocked in the Yankee Fork watershed.

Year Stocked	Age Class			
	Eyed Eggs	Juveniles	Smolts	[b]Adults
1977		56,700		
1978		75,036	51,120	
1985				[c]720
1986		386,348		[c]1,566
1987		315,877		[c]600
1988		50,100	725,500	[c]397
1989		125,000	198,200	41
1990		792,090	200,800	
1991		354,600		19
1994		25,025		
1998	3,393			49
1999	2,297			
2000	1,266			
2001				89
2002				215
2003				88
2004				70
2005				116
2006			135,934	179
2007				253
2008				1,623
2009				1,620
2010		[a]211,833	398,544	14
2011			397,828	

[a] This is the estimated number of fry seeded in 2010 resulting from eyed-eggs planted in 2009. The estimate is based on counts of remaining dead eggs in hatchboxes.

[b] These numbers include only hatchery adults transported from hatchery facilities and out-planted in Yankee Fork and West Fork Yankee Fork. Additional numbers of hatchery adults that returned naturally to Yankee Fork, which either originated from juvenile out-plants in previous years or were adult strays, were not included.

[c] Hatchery adults out-planted in these years may have been part of an effort to supplement the ceremonial fishery of the Shoshone-Bannock Tribes. The degree to which these fish contributed to reproduction in the Yankee Fork is unknown.

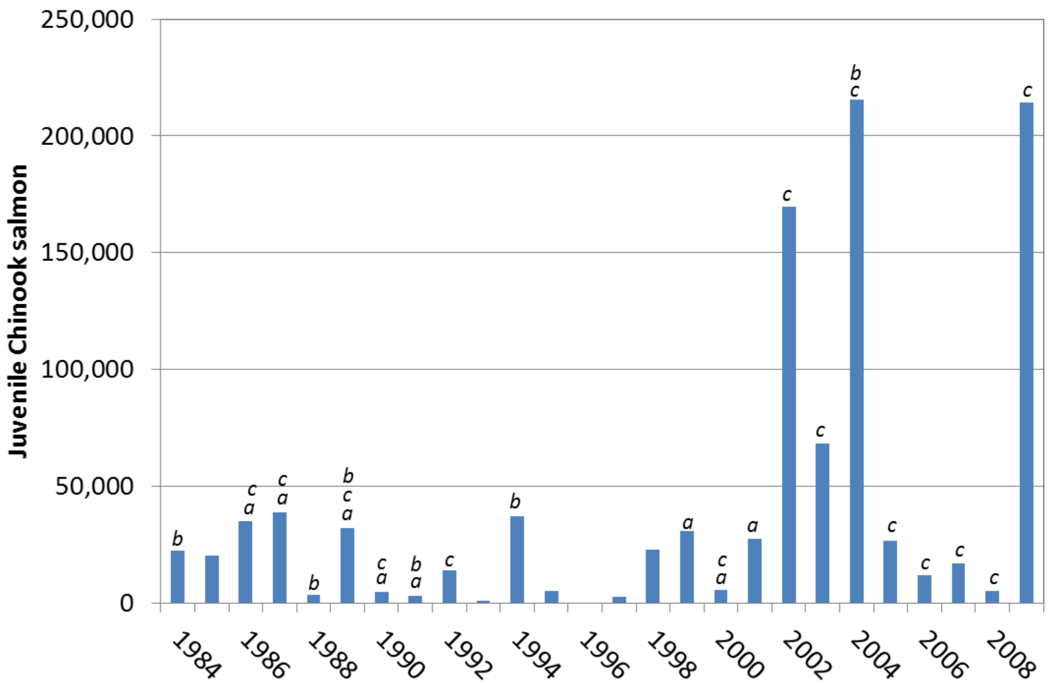

Figure 10. Population of juvenile Chinook salmon in the Yankee Fork drainage as determined by applying Tribal snorkeling fish density estimates to strata and pond series surface areas and summing all strata and pond series estimates for the drainage for each year. a = numbers influenced by planted fish. b = years where not all strata were surveyed. c = numbers influenced by adult out-plants in the previous year.

Supplementation

The supplementation of hatchery-origin Chinook salmon in the Yankee Fork has been extensive and has included the out-planting of Chinook salmon eggs, juveniles, smolts, and adults (Table 5). In fact, from 1984 – 2009, there were only seven years when snorkel counts in the Yankee Fork were not influenced by first generation hatchery progeny (offspring of hatchery adults that returned to a hatchery). Densities of juvenile Chinook were among the lowest observed during those years (Figure 10).

Supplementation was primarily aimed at establishing naturally returning stocks of fish but was also done to support a Tribal ceremonial fishery in 1985 to 1988 (Rowe et al. 1989). In 1985, some of the adults out-planted for the fishery were suspected of having spawned successfully (Richards and Cernera 1987), and this may have also occurred in other years.

Although supplementation of hatchery-origin fish in the Yankee Fork has been extensive, evaluation of its success has not been thoroughly completed. In 1991, the ISS project was established by the IDFG, the Nez Perce Tribe, the Shoshone-Bannock Tribes, and the U.S. Fish and Wildlife Service to 1) assess the use of hatchery Chinook salmon to increase natural populations, and 2) evaluate the genetic and ecological impacts of hatchery Chinook salmon on naturally reproducing Chinook salmon populations (Hanna et al. 2003). The ISS project included the West Fork as a treatment stream. In early years, the ISS project was plagued by substantial set-backs including insufficient brood-stock to adequately seed treatment streams, hatchery adults that strayed into control streams, and insufficient data collection on important parameters (Hanna et al. 2003). Final analysis of the results obtained by ISS will occur after migration estimates have been obtained for BY 2012 Chinook (Venditti et al. 2006).

Hatchery Chinook salmon have been out-planted into the Yankee Fork and/or the West Fork as part of the ISS program (Hanna et al. 2003), the Captive Rearing program (Stark et al. 2008), Yankee Fork Spring Chinook Supplementation Program (Denny and Tardy 2010), and for tribal ceremonial fisheries (Rowe et al. 1989). Additionally, Chinook salmon have been out-planted into the Yankee Fork in a general effort to increase the Yankee Fork Chinook salmon population.

Given the number of years that juvenile Chinook counts in the Yankee Fork were influenced by the out-planting of hatchery juveniles and the observation that juvenile Chinook population numbers were low in years when hatchery juveniles were not planted (Figure 10), it seems that the Yankee Fork Chinook salmon population is being maintained with hatchery fish. This is substantiated by recent adult Chinook returns, half of which were hatchery-origin fish (Figure 3).

The West Fork, and the Yankee Fork between the Pole Flat Weir and the Strata 4 weir, may be slightly less affected by hatchery fish than is the remainder of the Yankee Fork drainage. However, exclusion of hatchery Chinook from this area has been incomplete (Tardy and Denny 2011) and hatchery fish have intentionally been planted in that area as eyed eggs (Ray et al. 2004) and captive reared adults (Hassemer et al. 1999). Additionally, the West Fork was supplemented with Rapid River stock Chinook salmon fry-fingerlings in 1977 (NMFS 2011; Tardy and Denny 2011). Furthermore, many of the "natural fish," fish that are not hatchery fish, could be first generation hatchery offspring. Therefore, it seems that even this area may be being maintained with hatchery fish.

Summer Movement of Juveniles

Juvenile Chinook salmon are often first observed in June, and are frequently still in close proximity to redds where they presumably were spawned (Richards and Cernera 1992, Rowe et al. 1989, 1991). Likewise, no juvenile Chinook were observed in the West Fork and main-stem Yankee Fork upstream from Strata 2 in 2000, when no redds were found in those areas during 1999 (Anderson et al. 2001).

There is evidence that some juvenile Chinook do not remain in areas associated with redds throughout the summer, but instead move downstream. Juvenile migrants have been captured in screw traps in the West Fork and in the Yankee Fork at Polecamp Creek (see Out-migration vs. Retention of Juveniles; Tardy and Denny 2010, 2011; and Tardy 2011). Also, juvenile Chinook have been observed in the pond series during years when no hatchery-origin fish were stocked and no spawning was observed in those areas (Rowe et al 1989). When redds are produced in close proximity to the pond series, snorkel counts in those areas during June of the following year are generally higher than those in later months (Rowe et al. 1989, 1991). Additionally, the number of parr/redd in the Yankee Fork is greater in downstream areas than upstream areas (Figure 11), even though upstream areas, including the West Fork and the main-stem Yankee Fork upstream from Jordan Creek, contain what is widely believed to be higher quality spawning and rearing habitat (Rowe et al. 1989; USFS 2006; BOR 2012). This supports the premise of downstream juvenile fish movement. For juvenile Chinook in the Yankee Fork, it is unclear whether this movement pattern represents a life-history trait or a search for quality habitat. Alternatively, as hypothesized by Rowe et al. (1989), this may be caused by high flow conditions which could displace the recently emerged fish and flush them downstream.

The downstream movement of juvenile Chinook in the Yankee Fork creates a problem when estimating egg-to-parr production, as it makes survival appear higher in the Yankee Fork on average (5.3%) than in the West Fork (1.7%; Ray et al. 2004). Average parr per redd estimates also show this pattern of high redd numbers in good habitat (Strata 4 and 6), but highest parr/redd in strata 3, where few redds were observed (Figure 11). These results likely reflect movement of juveniles before counting occurs.

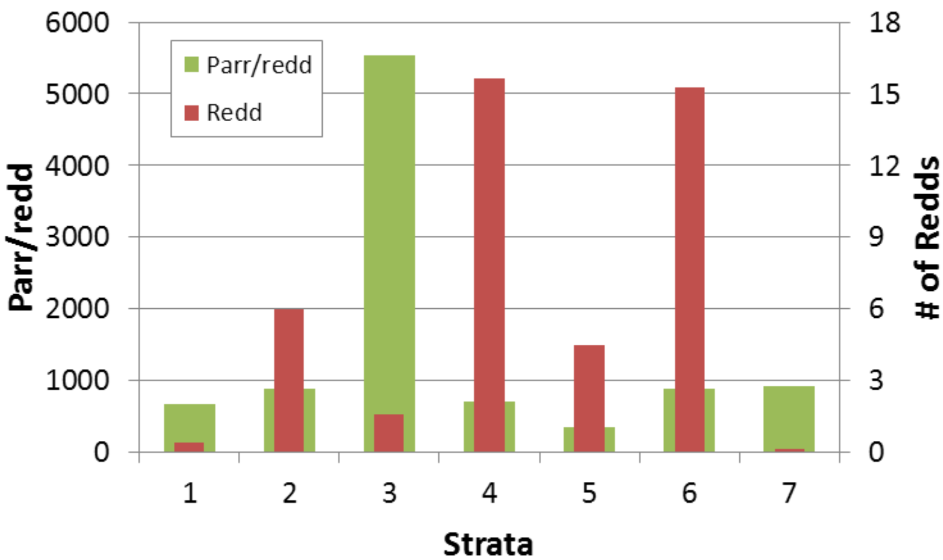

Figure 11. Number of Chinook redds and number of juvenile Chinook/redd observed in Yankee Fork strata.

Out-migration vs. Retention of Juveniles

Out-migration of juvenile Chinook has been evaluated using screw traps in the West Fork since 2002 (Venditti et al. 2005b - 2011) and in the main-stem Yankee Fork since 2009 (Tardy and Denny 2010, 2011; Tardy 2011). However, estimating the number of Chinook that out-migrate from the Yankee Fork is problematic, as emigration overlaps with periods when it is too cold or flows are too high to operate screw traps and some out-migrants are too small to tag (Lutch et al. 2003; Tardy and Denny 2011). Nevertheless, trapping data shows that many Chinook emigrate from the Yankee Fork as juveniles: fry, parr, and pre-smolts (Table 6). An unknown, and likely smaller, number of Chinook emigrate as smolts (Tardy 2011). Emigration of juvenile Chinook occurs throughout the trapping period (Figure 12, Figure 13), and smolts emigrate during the spring. Chinook that emigrate as smolts are about twice as large as those that emigrate as juvenile fry, but are similar in size to out-migrating pre-smolts (Figure 14). Relative survival of the various Yankee Fork emigrant types to Lower Granite Dam has been evaluated (Table 8) but is not directly comparable between types because winter survival, which is included for parr and pre-smolts but not for smolts, has not been determined.

In the Pahsimeroi River, a spring-fed tributary to the Salmon River downstream from the Yankee Fork, Copeland and Venditti (2009) found that some juvenile Chinook out-migrated during the spring, migrated to the ocean during that same year, and entered the ocean at a time when Waples et al. (2004) hypothesized that conditions are not conducive to survival and growth. Copeland and Venditti (2009) did not detect any of this emigrant type returning to the Pahsimeroi River as adults.

Copeland and Venditti (2009) also found that Pahsimeroi River “fall parr” (juveniles that emigrated from the Pahsimeroi River beginning in August) did not pass Lower Granite Dam until the following spring and had a median survival 27%. Few Chinook remained in the Pahsimeroi through their first winter to emigrate as age 1 smolts. Survival of age 1 smolts to Lower Granite Dam was often similar to survival of juvenile spring emigrants (median survival 50%), however, age 1 smolts did return to the Pahsimeroi as adults.

The survival pattern outlined above would seem to indicate that it is advantageous for Chinook to remain in their natal streams through their first winter and emigrate as smolts. However, it must be remembered that in the studies cited, survival was measured from the time of tagging to detection at Lower Granite Dam and that juvenile emigrants were tagged before their first winter while smolts were tagged after their first winter. Winter mortality for Chinook salmon in the Yankee Fork is unknown, but winter, and particularly icing conditions during winter, can affect fish survival (Brown et al. 2011)

Emigration of hatchery Chinook from Pond Series 1 was monitored with traps in 1990 and two peaks in emigration were observed. The first occurred right after volitional movement was permitted in late July. The second smaller peak occurred in the first week of October and was concurrent with the decline in mean daily water temperature below 9° C (Rowe et al. 1991). A fall peak in emigration of age-0 Chinook has also been observed in the main-stem Yankee Fork (Tardy 2011). Similar fall movement has been hypothesized to be a response to lack of adequate winter habitat availability (Bjornn 1971).

Similarly, Copeland and Venditti (2009) found that most Chinook salmon in the Pahsimeroi left their natal streams as juveniles. They hypothesized that this may have occurred because winter rearing areas were limited in most of their study streams and that juveniles preferred to congregate in more suitable winter habitats downriver of natal streams. These fish that wintered downriver from natal streams arrived at Lower Granite Dam well in advance of juveniles that left their natal streams as smolts. This may indicate that larger, main-stem rivers are important overwintering areas for juvenile Chinook spawned in the Upper Salmon River basin.

The Yankee Fork drainage is high in elevation and experiences harsh winter conditions. There are minimal groundwater inputs in the areas where Chinook reside in the Yankee Fork and anchor, frazil, and surface ice are common throughout that area. Chinook that emigrate late in the summer and spend the winter between the Yankee Fork and Lower Granite Dam likely experience more mild winter conditions than do fish that remain in the Yankee Fork. Therefore, survival may be enhanced if juvenile Chinook emigrate from the Yankee Fork prior to the onset of winter. While this is an untested hypothesis in the Yankee Fork, Smith and Griffith (1994) showed that survival of juvenile trout is reduced under severe winter conditions even when favorable habitat was present. If this is true in the

Yankee Fork, it may be counterproductive to enhance winter habitat in the Yankee Fork as it may ultimately encourage fish to remain in an area where survival is reduced. This question remains an important "data gap" that needs to be addressed.

Table 6. Number of juvenile Chinook salmon estimated to have passed the Pole Flat screw trap from 2009 – 2011 (data from Tardy and Denny 2010, 2011, and Tardy 2011).

Trap year	Trap in	Trap out	Days operated	Brood Year	Estimated Juveniles	Standard Error
2009	2 July	13 November	133	2008	534,024	17,348
2010	27 April	2 June	37	2009	129,733	5,619
2010	21 August	16 November	88			
2011	13 April	5 May	23	2010	31,201	4,446
2011	13 July	2 November	113			

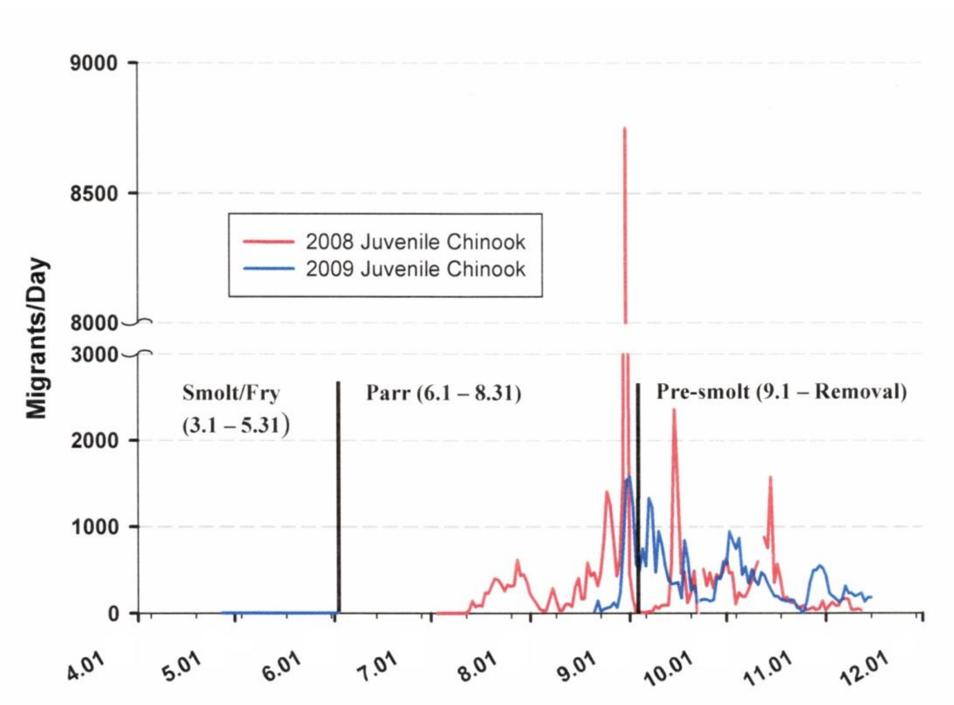

Figure 12. Migration timing of juvenile Chinook salmon during (mm/dd) 2009 and 2010 (figure from Tardy and Denny 2011).

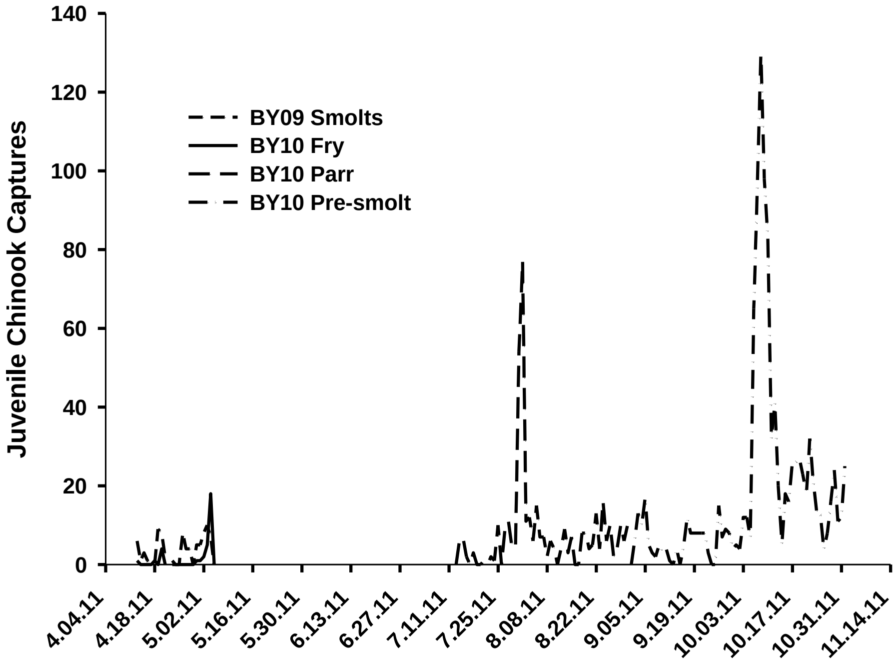

Figure 13. Migration timing of juvenile Chinook salmon during 2011 (figure from Tardy 2011).

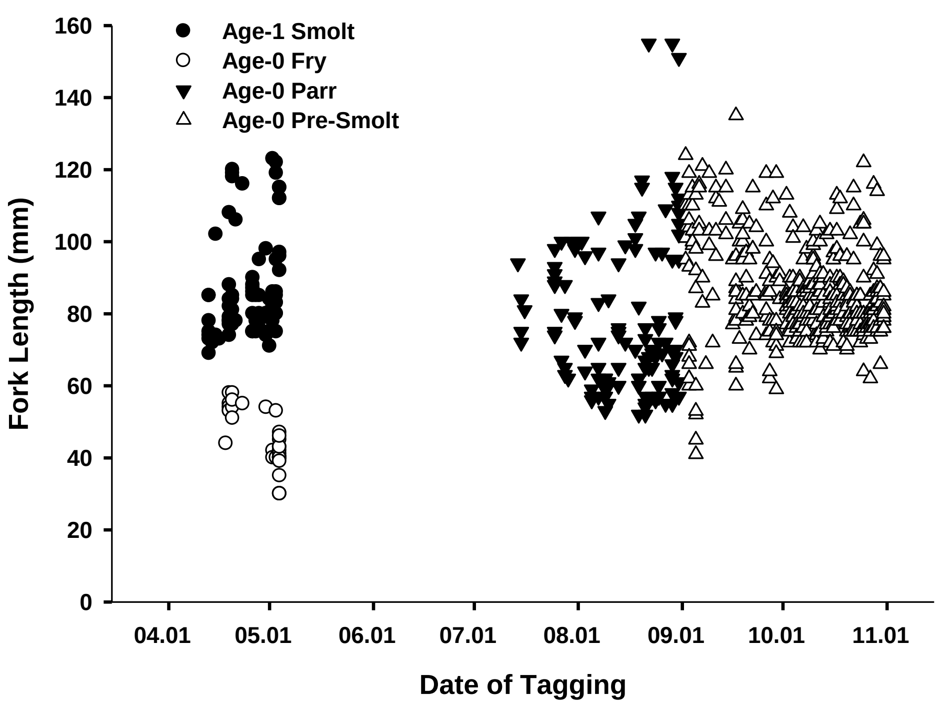

Figure 14. Fork length versus date of tagging (capture) by emigrant type for juvenile Chinook salmon tagged at the Pole Flat screw trap during 2011 (Figure from Tardy 2011).

Size and Condition

Fish growth and condition varies between years (Table 7) and between locations within the Yankee Fork drainage (Konopacky et al. 1986; Richards and Cernera 1987). Rowe et al. (1989) found that growth was greatest where Chinook salmon densities were lowest. Comparison between Yankee Fork pond series showed that Pond Series 3 had the highest densities and the lowest growth rates, while Pond Series 1 had the lowest densities and the highest growth rates. Pond Series 2 and 4 were intermediate in both categories (Rowe et al. 1989). This relationship was also true for fish in the Yankee Fork where Stratum 1 and 2 had the lowest fish densities and the fastest growing fish while Strata 6 had higher fish densities and slower growing fish. In 1989, fish from the ponds were in significantly (P = 0.05) better condition in September than river fish with condition factors of 0.95 and 0.87, respectively (Rowe et al. 1989). Decreased condition at higher densities may indicate competition for food or feeding territories.

Rowe et al. (1991) found that hatchery out-planted Chinook salmon grew at a slower rate than did naturally-produced salmon sampled in the West Fork. Despite a slower growth rate, hatchery fish were still significantly (P<0.05) larger than wild West Fork fish in late September primarily because they were larger than West Fork fish when they were planted (Rowe et al. 1991).

Table 7. Condition factor of juvenile Chinook salmon from the Yankee Fork drainage during August from 1984 - 1986.

	Total Length (mm)		Weight (g)		Condition Factor (K)		
Year	Aug Min	Aug Max	Aug Min	Aug Max	Aug Min	Aug Max	Source
1984	72.2	89.4	3.8	7.3	0.82	0.95	Konopacky et al. 1986
1985	59.4	73	2.1	4.2	0.96	1.04	Konopacky et al. 1986
1986	66.6	77.3	4	5.3	0.9	1.1	Richards and Cernera 1987

Winter Habitat

During the winter, as water temperatures decline below about 10° C, juvenile salmonids begin to seek cover (Taylor 1988) where they can conceal during the day and come out at night as light levels decrease (Contor and Griffith 1995). This behavior appears to be related to predator avoidance (Gregory and Griffith 1996) rather than seeking shelter from the current (Taylor 1988; Valdimarsson and Metcalfe 1998). Concealment cover consists of interstitial spaces between cobble and boulders (Hillman et al. 1987), or woody debris (Swales et al. 1986; Schrader and Griswold 1992). When these habitats are available, juvenile salmonids are more likely to survive (Smith and Griffith 1994), and where it is not available or not complex enough, juvenile salmonids are likely to emigrate (Bjornn 1971; Hillman et al. 1987). As water temperatures dropped to 4 to 8° C in Red River, an Idaho stream highly embedded with silt, 80% of the juvenile Chinook formerly present emigrated from the study area, apparently because suitable winter habitat was not available. Fish that remained in the study area through the winter selected areas where submerged sedges and grasses overhanging undercut banks provided cover and where water velocities were less than 12 cm/s (Hillman et al. 1987).

In the Yankee Fork drainage, juvenile Chinook have been observed to use pond series habitat throughout the winter, although it was not indicated whether fish were specifically associated with either channel or open water habitat types (Rowe et al. 1991). Rowe et al. (1991) observed no emigration from Yankee Fork pond series by juvenile Chinook from August through September, but as water temperatures dropped below 9° C in October, emigration from the pond resumed. Rowe et al. (1991) assumed that this later pulse of movement was related to Chinook searching for more suitable winter habitat. Emigration of juvenile Chinook during October has also been documented at the Pole Flat screw trap by Tardy and Denny (2011) and may be similarly motivated.

Out-migration of Smolts

Trapping Chinook smolt out-migrants, which likely begin emigrating from the Yankee Fork while it is too cold to operate screw traps, is difficult. Additionally, emigration continues when spring flows are then too high to operate screw traps (Lutch et al. 2003; Tardy and Denny 2011). Consequently, few data are available showing the out-migration timing or number of smolts migrating during winter and spring months (Tardy and Denny 2011). However, during the spring of 2011, smolts were captured in the Pole Flat screw trap from the middle of April to the beginning of May (Figure 13). Estimates for smolt emigrants could not be accomplished because of the low recapture rate (Tardy 2011). Emigration of smolts occurs primarily during the spring (Figure 13).

Survival to Emigration and to Lower Granite Dam

Theoretically, it should be possible to compare Yankee Fork juvenile Chinook populations with those from adjacent streams to evaluate relative survival from the egg to juvenile and from egg or juvenile to emigrant. This would involve using the metrics parr/redd, emigrant/redd, or parr/emigrant and would be useful to assess whether excessive mortality pressures may be present in the Yankee Fork drainage. However, the number of emigrants has been incompletely assessed due to the trapping difficulties outlined above (see sections Out-migration vs. Retention of Juveniles and Out-migration of Smolts) and estimates of parr abundance have been affected in many streams by out-planting of hatchery juveniles.

It is, however, possible and useful to compare survival of Yankee Fork emigrants to Lower Granite Dam with survival estimates from adjacent streams. The ISS project, initiated in 1991, has calculated survival to Lower Granite Dam for various emigrant life-stages of Chinook from locations across the Salmon River basin (Table 8). The main-stem Yankee Fork was not part of the ISS study area but survival estimates were obtained for the West Fork which was part of the study area. Average survival of Chinook emigrants from the West Fork to Lower Granite Dam was near that reported for other Salmon River streams but was the lowest or nearly lowest for all life-stages (Table 8). It is unclear whether this lower survival rate may be related to conditions experienced by fish in the West Fork, the Yankee Fork, or neither.

The Tribes have obtained estimates of hatchery Chinook salmon survival from the Yankee Fork to Lower Granite Dam. Average survival of BY 2009 hatchery smolts from Yankee Fork release sites to Lower Granite Dam was estimated at 50.9% during 2011 (Tardy 2011), and was higher (63.7%) for fish released into Pond Series 1 and allowed volitional emigration after two days vs. (47.7%) those released directly into the Yankee Fork at the mouth of Jordan Creek (Tardy 2011). However, problems with loading the direct release group at the hatchery for transport to the Yankee Fork that caused 2.5% mortality before the study began (Tardy 2011) may have had long term implications. Therefore, these results should be interpreted cautiously, particularly since the survival rate to Lower Granite Dam for BY 2004 hatchery Chinook smolts released directly into the Yankee Fork during 2006 was 64% (Denny and Tardy 2010). These survival estimates are similar to average survival of natural fish from other Salmon River streams (Table 8). Average travel time from the Yankee Fork to Lower Granite Dam for hatchery smolts released during 2006 was 20 days (Denny and Tardy 2010).

Average survival for natural BY 2008 parr and pre-smolts PIT tagged in the Yankee Fork during 2009 and arriving at Lower Granite Dam during 2010 was 12.1% (Tardy and Denny 2011) and was 14.3% during the following year (Tardy 2011). This survival rate is much lower than that exhibited by hatchery smolts and it should be noted that wild fish tagged as migrating parr and pre-smolts (juveniles) at the Yankee Fork fish trap must survive for over half a year including the winter (mean “travel time” of 213 days; see Tardy 2011) before they are detected at Lower Granite Dam. This survival rate of Yankee Fork juvenile Chinook emigrants is also similar to the survival rates for parr and pre-smolts from adjacent Salmon River streams (Table 8).

Table 8. Survival of natural-origin parr, pre-smolt, and age-1 smolts (mean Standard Error in parenthesis) from tagging locations in the Salmon River Basin to Lower Granite Dam (n is the number of years for which data were available and included in the reported means) (Venditti et al. 2005b-2010).

Stream system	Mean Parr	Mean Pre-smolt	Mean Smolt	n Parr	n Pre-smolt	n Smolt
East Fork Salmon	15% (6%)	17% (3%)	53% (10%)	5	10	11
Upper Salmon	15% (2%)	21% (2%)	59% (5%)	11	16	16
West Fork Yankee Fork	11% (5%)	19% (4%)	51% (17%)	2	4	7
Lemhi River*	13% (5%)	34% (2%)	67% (21%)	4	4	5
Marsh Creek*	26% (2%)	32% (2%)	55% (14%)	12	12	14
Pahsimeroi River*	17% (2%)	28% (3%)	55% (8%)	5	12	16

* Out-migrants divided into additional unreported categories, which may affect survival calculations.

Time in the Ocean

The amount of time that Chinook salmon spend in the ocean generally relates to individual growth rates and affects fecundity, as outlined by Quinn et al. (2004). The fastest growing males generally return as jacks (1-ocean fish). Slower growing fish return as 2- and 3-ocean fish. However, since fish that stay in the ocean longer have more time to grow, 3-ocean fish are larger than their younger counterparts. Yankee Fork fish generally remain in the ocean from 1 to 3 years, although a few suspected 4-ocean fish were counted in 2004 and 2006 (Ray et al. 2006, 2007). Larger female fish typically have more eggs and larger eggs, and fish size at emergence is strongly correlated with egg size (Quinn et al. 2004).

From 2008 through 2011, most of the adults returning to the Yankee Fork were 2-ocean fish (Figure 15), as determined based on the length-at-age relationships developed by Kiefer et al. (2001). Proportionally, there were more 2-ocean fish and fewer 3-ocean fish that were of hatchery origin, as compared to the returning Chinook adults of natural origin (Figure 15). However, all three adult age-groups were well represented in the Yankee Fork for both the natural and hatchery fish.

Because adult Chinook return to spawn at various ages, spawners returned to the Yankee Fork in every year from 1998 through 2000, even though no redds were observed in the Yankee Fork during 1995 (Anderson et al. 2001). Ocean conditions also affect Chinook growth rates and may cause a greater than average proportion of 2-ocean fish to return in some years, as was suspected in the Yankee Fork during 2002 (Ray et al. 2004).

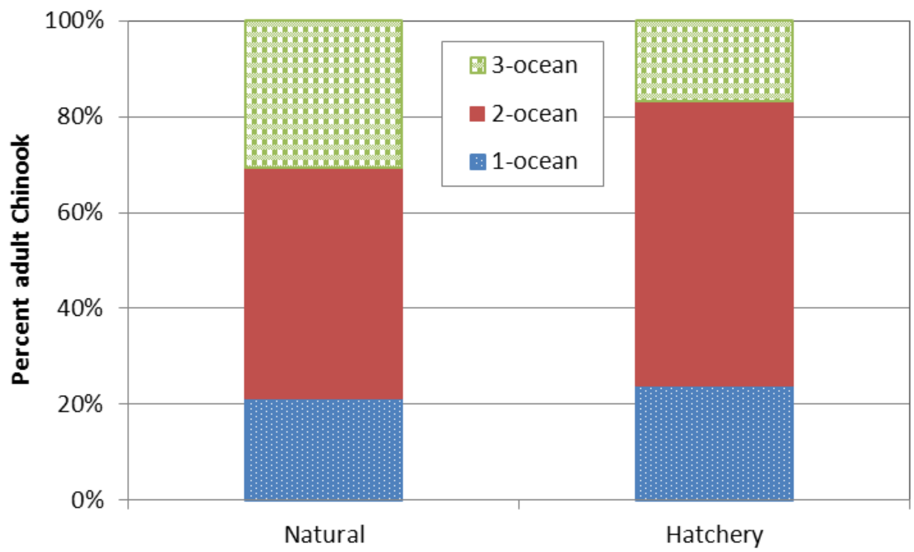

Figure 15. Relative proportion of three age classes of adult Chinook salmon passing the Pole Flat fish weir from 2008 – 2011 (Data from Tardy 2011).

Return Rate and Productivity

Calculation of adult return rates for Chinook in the Yankee Fork is confounded by both the out-planting of multiple life stages of hatchery salmon and the difficulty of trapping out-migrants over the entire migration period. However, the Tribes calculated a smolt-adult return rate for hatchery fish of 0.0016 in 2008 (Denny and Tardy 2010) and 0.0014 in 2009 (Tardy and Denny 2010). This means that 625 and 714 smolts (presumably they mean all released hatchery sub-adults regardless of life-stage) were required to be released in order to return one Chinook adult to the Yankee Fork in 2008 and 2009 respectively.

Adult-adult return rate was not calculated in the literature we reviewed. However, the 10-year (2000 – 2009) geometric mean productivity value for the Yankee Fork, as cited by NMFS (2011), was 0.80 recruits per spawner. This is lower than 10-year geometric mean productivity values in adjacent streams (Table 9).

Table 9. Ten-year (2000 - 2009) geometric mean productivity values reported by NMFS (2011) for Salmon River basin streams.

Stream	10-year geometric mean productivity
Upper Salmon down to Redfish Lake Creek	1.21
Salmon River Redfish Lake Creek to Lemhi	1.16
Valley Creek	1.21
Yankee Fork	0.80
East Fork Salmon River	1.04
Pahsimeroi River	0.58
Lemhi River	0.94

Harvest

The Yankee Fork is an important (and treaty guaranteed) anadromous fishing area for members of the Shoshone-Bannock Tribes (Konopacky et al. 1986). From 1978 to 1984 the Tribes voluntarily chose not to exercise this right in favor of conservation. Beginning in 1985 and continuing through 1988, a weir was constructed in the lower end of Strata 4, upstream from the mouth of Jordan Creek, during late summer and hatchery adult Chinook were out-planted in the Yankee Fork upstream from the weir. These fish were used for a tribal ceremonial fishery (Rowe et al. 1989). Tribal fishing for hatchery fish upstream from the weir did not occur in 1989, presumably because of the lack of available fish. Tribal harvest continued, at least intermittently, from that point to the present but no records are available to indicate when and where harvest occurred or how many fish were harvested (L. Denny Pers. Comm.).

Possible Limiting Factors

Several limiting factors for Yankee Fork Chinook salmon have been identified. NMFS (2011) identified the main-stem Columbia River and Snake River hydroelectric system as a regional limiting factor along with: widespread habitat degradation, hatchery effects, fisheries (harvest), estuarine and plume habitat, predation and competition, and climate change.

NPCC (2004) identified the primary limiting factor in the Yankee Fork as potential chemical impacts from mine waste and the secondary limiting factor as massive channel alteration (legacy dredge-mining effect) in the lower section. This channel alteration has eliminated stream access to the floodplain, is causing tributary erosion as tributaries attempt to adjust their elevations to the lowered elevation of the main-stem at their confluences, and is causing down-cutting and sedimentation which reduces the quality of rearing habitat in this section (NPCC 2004).

Chinook salmon that are reared and ultimately spawn in the Yankee Fork spend much of their life-cycle outside the Yankee Fork, and Yankee Fork populations are influenced by substantial mortality factors in those areas. These mortality factors occur in the migration corridor between the Yankee Fork and the Pacific Ocean and in the Pacific Ocean itself. Mortality in these areas is largely independent of conditions in the Yankee Fork. However, conditions in the Yankee Fork can affect the quality and, within some bounds, the number of out-migrants produced. Maximizing the number and quality of Yankee Fork out-migrants requires providing quality conditions in two major areas. First, an adequate quantity and quality of spawning habitat must be present to provide spawning areas for the number of adult

Chinook that return to the Yankee Fork. Second, conditions in the Yankee Fork must be sufficient to maximize survival of juveniles and smolts in the Yankee Fork and produce healthy out-migrants that have the best possible chance for continued survival.

Spawning quantity

Spawning habitat quantity is adequate based on the estimation that 4,746 redds could be present in the Yankee Fork (Table 3; Denny and Tardy 2010). To date, the largest number of redds counted in the Yankee Fork has been 653 (Figure 4).

Spawning habitat quality

Spawning habitat quality is low in much of the dredged area of the Yankee Fork (L. Denny, Pers. Comm.) and may have been historically (Rodeheffer 1935). Recent natural events, like the landslide that resulted from the Rankin Fire that occurred during 2000, have created patches of quality spawning habitat in that area. However, even if we assume that no redds can be supported in that area, Denny and Tardy (2010) estimated that 4,235 redds could be present in the remainder of the basin (Table 3). Most of that area containing higher quality spawning habitat is upstream from dredging and mining effects, and is in locations where the amount of fine sediment in the substrate is low (IDEQ 2011) and cattle grazing and commercial timber harvest no longer occur (USFS 2006).

Conditions to maximize survival of juveniles and produce healthy out-migrants

NMFS (2011) identified factors that were assumed to limit Chinook salmon in the Yankee Fork which included reduced floodplain connectivity, riparian function, and excess sediment. Potential habitat limiting factors and threats were also identified as water quality degradation from new mines, water quality degradation from historic mining, and noxious weeds (NMFS 2011), although it is unclear how noxious weeds may affect Chinook salmon populations.

The population of juvenile Chinook in the Yankee Fork has varied considerably over the time period of record (Figure 10). This is likely largely due to variations in the number of juvenile hatchery Chinook out-planted (Table 5), but also reflects the variation in numbers of returning adult spawners (Figure 4). Densities have been high enough in some areas, particularly planted pond series, that growth has been affected (Rowe et al. 1989), which suggests that increased food and/or space may increase the health (condition factor) of juvenile Chinook in those areas. However, the lack of food can be compensated for by migration to adjacent lower population density areas, including seasonally available main-stem Salmon River habitat. Kiefer et al. (1990) estimated that the Yankee Fork drainage had the habitat capacity to produce 425,000 smolts annually. However, the maximum numbers of juvenile salmon counted over the past several years, even when hatchery juveniles not produced in the drainage are included, was only slightly more than half that number during two years and was less than 50,000 during most years (Figure 10). Reiser and Ramey (1987) and Richards et al. (1992) indicated that juvenile Chinook populations in the Yankee Fork would be limited by rearing habitat if abundant adults returned to spawn. However, since that is not the case, the population remains in a situation where too few spawners produce too few juveniles resulting in too few returns. NMFS (2011) indicates that the population is now at risk of extinction as the 10-year (2000 - 2009) geometric mean abundance of natural-origin spawners is 21 and the 10-year geometric mean productivity for the same period is 0.80 recruits per spawner.

In order for the population to increase, survival at some or all life-stages must increase. Survival of Yankee Fork fish to Lower Granite Dam is similar but on the low end of that for adjacent areas, but the 10-year (2000 – 2009) geometric mean productivity is lower in the Yankee Fork than adjacent areas (Table 9; NMFS 2011). One of the most obvious items that could cause reduced productivity is counting several adults that do not produce redds. This occurred repeatedly for Captive Rearing Program adult out-plants into the West Fork (Table 1). Whether or not these fish were included in the productivity calculation is unknown.

After 25 years of studies on juvenile Chinook in the Yankee Fork, data are still not adequate to determine the life-stage at which survival is limiting the population. Egg to fry survival, fry to parr survival and parr to smolt survival indices are masked by movement, presence of hatchery fish, and incomplete emigration counts. However, based on the available data, it seems that the Yankee Fork Chinook population at its current size, is not limited by summer habitat availability. However, habitat availability including pool frequency, pool quality, large woody debris and instream cover probably does limit the Chinook salmon numbers in the main-stem Yankee Fork downstream from Jordan Creek. Furthermore, there appears to be a general lack of LWD throughout much of the drainage that is occupied by Chinook salmon (Figure 2) (USFS 2010). This was likely caused by past logging activities which would have decreased the wood available to be recruited to the channel (BOR 2012). This lack of wood may limit Chinook populations during the winter and cause fish to emigrate from the drainage as winter approaches. Wood is also an important component of juvenile Chinook summer habitat (Holecek et al. 2009) and lack of it likely causes a reduction in summer habitat quality and availability.

Comparison with other populations

Comparison of survival for various life-stages of Chinook in the Yankee Fork versus those from adjacent populations is problematic. Meaningful comparisons require reasonably accurate counts at various life-stages. In the Yankee Fork, the number of emigrants has been incompletely assessed (due to the trapping difficulties) and parr abundance has been affected by out-planting of hatchery juveniles and downstream movement of juveniles.

Comparison of survival for Chinook from the West Fork versus those from adjacent basins has been limited to such parameters as: survival of smolts from the West Fork trap to Lower Granite Dam (Table 8) and 10-year geometric mean productivity (Table 9). Both of these metrics are reported for naturally spawned fish and are close to, but lower than, those metrics for nearly all other nearby populations.

Survival of hatchery Chinook smolts planted in the Yankee Fork, from release to Lower Granite dam, was 63.7% for BY 2009 volitional emigration group and 64% for BY 2004. These survival rates are higher than those for most nearby stream basins, averaged over all years of available data. However, the survival rate for the volitional emigration BY 2004 group of hatchery Chinook in the Yankee Fork basin is similar to average survival for natural fish in nearby basins for that same brood year (Table 10). Brood Year 2009 smolt survival to Lower Granite Dam for nearby basins is not yet available for comparison.

Table 10. Survival of natural-origin and hatchery (indicated) Chinook smolts from tagging or release locations in the Salmon River Basin to Lower Granite Dam (data from Venditti et al. 2005b-2010).

Stream basin	BY 2004	Mean
East Fork Salmon River	80%	53%
Lemhi River	68%	67%
Marsh Creek	52%	55%
Pahsimeroi River	64%	55%
Upper Salmon River	57%	59%
WF Yankee Fork Salmon River		51%
Yankee Fork (hatchery fish)	64%	

Data Gaps

A study, initiated by the Tribes during 2012, involving PIT tagging juvenile salmon collected throughout the Yankee Fork drainage and logging their passage at an array near the mouth, should help determine parr to smolt survival, survival from the Yankee Fork to Lower Granite Dam, and ultimately smolt-to-adult returns (Pers. Comm. Lytle Denny). This study will also help determine whether survival to Lower Granite Dam is higher for fish that remain in the Yankee Fork through their first winter versus those that emigrate as juveniles during the fall, spend the winter somewhere downstream, and then pass Lower Granite Dam the following spring. These questions should be answered for natural and hatchery fish separately.

Richards and Cernera (1989) indicated that Snake River Spring Chinook typically remain in tributary streams for one full year after emergence; although they may migrate earlier when adequate winter habitat is not available (Bjornn 1971). Many, and maybe even most, Yankee Fork Chinook out-migrate as juveniles, before their first winter. This migration pattern also occurs in the Pahsimeroi River (Copeland and Venditti 2009) a spring-fed stream which maintains relatively warm winter water temperatures but contains minimal winter concealment habitat (J. Gregory, Personal Observation). The Pahsimeroi River is the only population in the upper Salmon River Basin that has a lower 10-year (2000 – 2009) geometric mean productivity than does the Yankee Fork (Table 9). This migration pattern needs to be further evaluated for the Yankee Fork and other upper Salmon River Basin populations to see if it is standard within the basin or may be associated only with certain streams.

Steelhead

Less is known about steelhead in the Yankee Fork than is known for Chinook salmon. The lack of information is likely related to the difficulty of enumerating these fish. Steelhead migrate into the Yankee Fork in the early spring, when the presence of snow and ice make the logistics of fish studies difficult. Following spawning, steelhead redds are typically unobservable due to the high water levels and elevated turbidity associated with spring run-off. By the time run-off has subsided, time and shifting gravel have made it difficult to identify redds and the adults have either died or moved back downstream. The only direct count of natural-origin steelhead in the Upper Main-stem Salmon River population occurs at the Sawtooth Fish Hatchery weir and represents adults returning to a small proportion of total habitat in the population. The average number of natural-origin returns to the Sawtooth Hatchery weir between 1986 and 2007 was 34 fish (CRHRP 2009). During the spring of 2012, the Tribes installed a PIT tag detection array in the Yankee Fork which will provide some information on returns of tagged steelhead.

In the Yankee Fork, steelhead have been classified as being at lower risk for extinction than are Chinook. Yankee Fork steelhead, which are grouped in with the Upper Main-stem Salmon River population, have been designated by NMFS (2011) to be at moderate abundance/productivity risk and moderate spatial structure/diversity risk, while Yankee Fork Chinook have been designated to have high risk in both categories.

However, the level of risk for the Upper Main-stem Salmon River Steelhead Population is based on data from "a surrogate population of A-run steelhead" (NMFS 2011). The lack of data for the majority of steelhead populations in the Salmon River Major Population Group (MPG) necessitates the use of data available from surrogate populations. NMFS (2011) recommended that "… a conservative management approach should be pursued until population-specific data become available to more accurately describe the status of this population." They further suggested that recovery actions in the Salmon River migration corridor, and spawning and rearing habitat actions aimed primarily at spring/summer Chinook, would further reduce the risk for the Upper Main-stem Salmon River Steelhead Population (NMFS 2011). .

Adult Migration and Timing

Steelhead that migrate to the Yankee Fork are part of the Snake River Steelhead Distinct Population Segment (DPS), which are generally classified as summer A-run based on their adult run-timing patterns (NMFS 2011). Summer A-run steelhead predominantly spend one year in the ocean (but may spend up to three), enter the Columbia River from late June to October, overwinter in the Snake and Salmon Rivers, and spawn the following spring, typically from March to May (Good et al. 2005).

Redd Locations

Although complete redd surveys for steelhead have not been conducted in the Yankee Fork, steelhead redds have been observed within Pond Series 1 (J. Gregory pers. observation) and in Jordan Creek (J. Vacirca Pers. Comm.). Steelhead sub-adults have been observed throughout much of the lower drainage (Figure 17), which likely indicates spawning in or near those areas. Steelhead juveniles and sub-adults were not observed upstream from Jordan Creek during the years 1989, 2006, and 2007

(Rowe et al. 1989; Gamett and Bartel 2008), but have been observed upstream in other years (Figure 16).

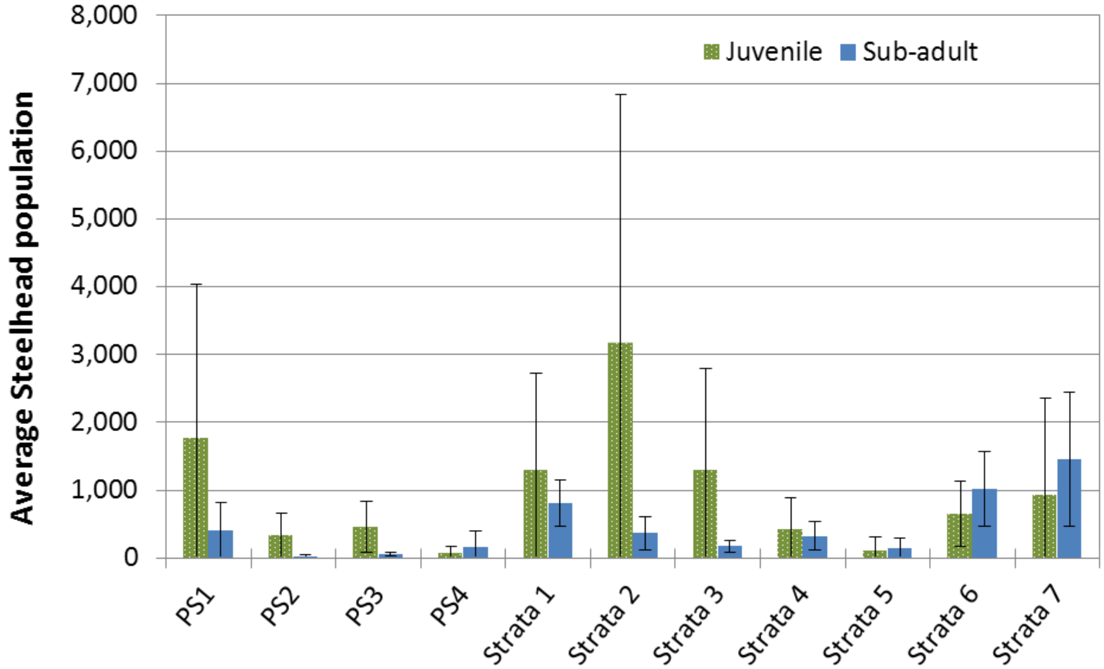

Figure 16. Average population size for all years of available data of juvenile and sub-adult steelhead in various locations throughout the Yankee Fork drainage.

Hatching

Snake River summer run steelhead have been reported to emerge as late as mid-July at high elevations (NMFS 2011). However, no juvenile steelhead were observed during snorkel surveys in the Yankee Fork drainage in June, July, or August, but were first observed during early September snorkel surveys (Rowe et al. 1989).

Distribution, Density, and Population

Sub-adult steelhead have been found throughout many of the larger streams within the Yankee Fork drainage (Figure 16 and Figure 17). Similar to juvenile Chinook, populations of sub-adult steelhead are highest within the main-stem Yankee Fork (Figure 16), but densities are highest within the channel habitat of the pond series (Figure 18). Sub-adult steelhead use Strata 4 and 6 proportionally less than do juvenile Chinook, and use Strata 7 (Jordan Creek) proportionally more than juvenile Chinook (Figure 10 and Figure 16). However, sub-adult steelhead distribution is affected by hatchery out-plants which occurred almost every year that snorkel surveys were conducted (Figure 19).

Juvenile and sub-adult steelhead strongly select channel habitat more than pond habitat within the pond series (Figure 18). In fact, Rowe et al. (1989) indicated that "…very few steelhead were ever observed in pond habitat. Those steelhead observed were likely a combination of hatchery out-planted pre-smolts (age-1) and wild fish (age-0 steelhead)." Habitat selection within the pond series is likely not influenced by the locations of hatchery out-planting, as channel and pond habitats occur in close proximity.

Reiser and Ramey (1987) used habitat measures and Milhous et al.'s (1984) HABTAT model to estimate spawning and rearing habitat availability within the entire Yankee Fork drainage. They then estimated the number of steelhead sub-adults, which they called smolts, that could be produced in the Yankee Fork using the results from the habitat model, fecundity of females, and survival of offspring from egg to alevin, alevin to fry, and fry to sub-adult. Based on these estimates, they concluded that enough spawning habitat was available to produce 295,499 steelhead sub-adults. However, model results showed that there was only habitat available to rear 16,218 sub-adults in the Yankee Fork. Reiser and Ramey (1987) concluded that steelhead production was limited by the availability of rearing habitat in the drainage.

Annual estimates of the sub-adult steelhead population in the Yankee Fork have exceeded the Reiser and Ramey (1987) maximum value of 16,218 sub-adults only once, in 2004, during the entire time period for which estimates have been produced (Figure 19). During that year, steelhead sub-adults production may have been limited by the availability of rearing habitat. However, the Reiser and Ramey (1987) estimate of available habitat did not include the four off-channel pond series, as they had not yet been constructed at that time. It is also likely that some of the fish counted during the 2004 surveys were of hatchery origin and would have used Yankee Fork resources for only a short time prior to out-migration. Based on this information, it is conceivable that the Yankee Fork is generally not sufficiently seeded to the extent that steelhead sub-adults production would be limited by a lack of rearing habitat.

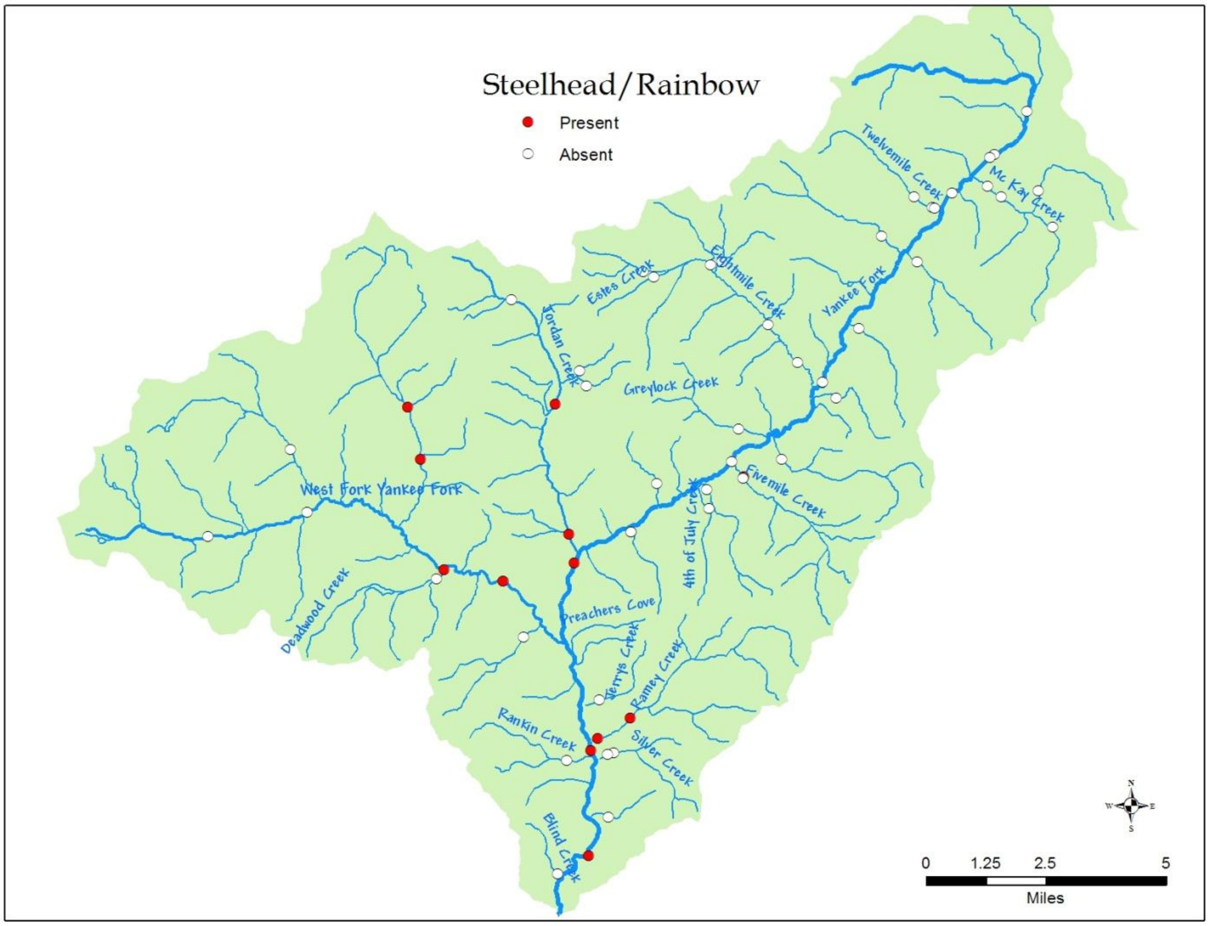

Figure 17. Steelhead/rainbow trout distribution in the Yankee For drainage based on fish species collected by Forest Service crews during 2006 and 2007 (Gamett and Bartel 2008).

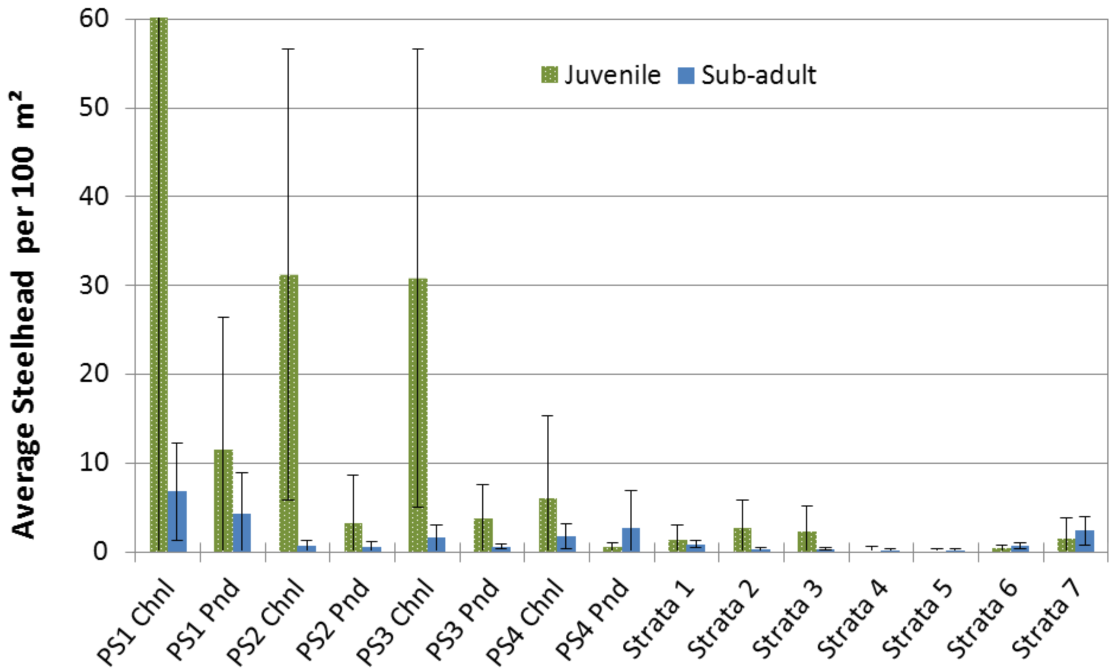

Figure 18. Average density for all years of available data of juvenile and sub-adult steelhead in various locations throughout the Yankee Fork drainage. The average density of juvenile steelhead in the channel portion of PS1 was 106 and the upper confidence interval was 250.

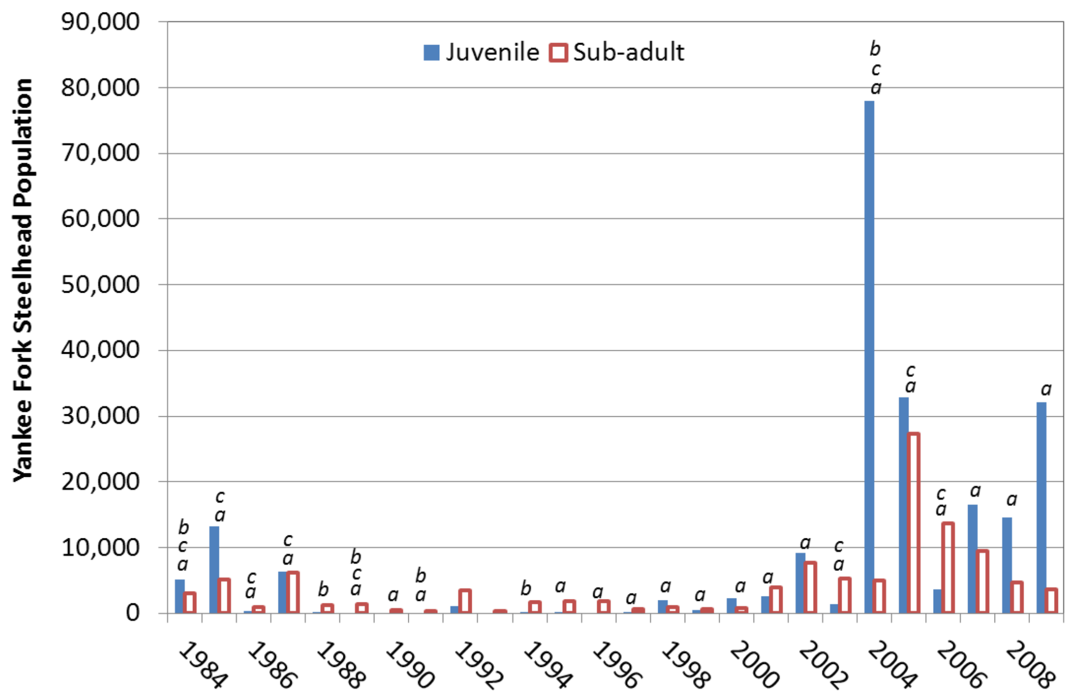

Figure 19. Population of sub-adult steelhead in the Yankee Fork drainage as determined by applying Tribal snorkeling fish density estimates to strata and pond series surface areas and summing all strata and pond series estimates for the drainage for each year. a = numbers influenced by planted fish. b = years where not all strata were surveyed. c = numbers influenced by adult out-plants in the previous year.

Supplementation

Steelhead have been planted extensively in the Yankee Fork (Table 11). Historically, many of the releases of hatchery-origin fish, both Chinook and steelhead, have been of unmarked fish through the stocking of eyed eggs and unmarked juveniles (NMFS 2011). The Upper Main-stem Salmon River Steelhead Populations is at an additional risk for the maintenance of genetic diversity given the varied history of releasing unmarked fish, which were likely to volitionally reproduce with natural fish (NMFS 2011).

The current Annual Operating Plan for steelhead in the Salmon River includes the annual out-planting of 440,000 Sawtooth A-run steelhead sub-adults , which were referred to as smolts, into the Yankee Fork Salmon River (USFWS 2011). Currently, the parental source of those sub-adults is adult steelhead trapped at the Sawtooth Fish Hatchery weir. The continued out-planting of steelhead sub-adults from parents returning to the weir at the Sawtooth Fish Hatchery impedes development of a locally adapted population in the Yankee Fork. Moreover, the availability of juvenile fish to support the program can be problematic when the number of adult steelhead trapped at the Sawtooth Fish Hatchery weir is insufficient to meet juvenile release objectives at both the hatchery and in the Yankee Fork (USFWS 2011). Plans are currently in place to develop a new localized broodstock program of A-run steelhead for the Yankee Fork Salmon River. This plan involves construction of a permanent weir structure on the Yankee Fork to trap adult steelhead for broodstock. As the Yankee Fork A-run steelhead program develops, release of Sawtooth Hatchery A-run steelhead sub-adults will be phased out (USFWS 2011). These plans have recently changed to include development of a Yankee Fork broodstock using B-run steelhead (L. Denny, Pers. Comm.).

In addition to receiving out-planted steelhead sub-adults, the Yankee Fork is part of a Shoshone-Bannock Tribes streamside incubator program. In this program, approximately one million eyed steelhead eggs from Sawtooth and Pahsimeroi fish hatcheries are transferred to streamside upwellers in Yankee Fork, Basin Creek, Morgan Creek, Indian Creek and Panther Creek each year. Eggs in the upwellers are incubated on river water to mimic natural conditions and achieve natural hatch timing in the system (CRHRP 2009).

Table 11. Number of steelhead stocked in the Yankee Fork watershed.

Year Stocked	Age Class			
	Eyed Eggs	Juveniles	Sub-adults	Adults
1978		255,142		
1979		208,800		
1980		100,000		
1981		254,600		
1983				610
1984		140,450		1,700
1985		250,000		616
1986		511,401		662
1987				360
1988		100,300	208,000	
1989		50,400	104,500	
1995	-[a]			
1996	121,000			
1997	178,900			
1998	175,600			
1999	155,000			
2000	218,733			
2001	141,246		236,278	
2002	179,355		277,493	
2003	-[a]		430,111	400
2004	-[a]		326,546	400
2005	-[a]		329,835	
2006	214,750		364,316	
2007	358,353		339,090	
2008	483,904		327,546	
2009	513,412		387,266	
2010	571,711		355,072	
2011	525,517			

[a] There were steelhead egg out-plants in these years, but the exact numbers out-planted into the Yankee Fork watershed were not given.

Winter Habitat

The discussion on winter habitat for juvenile Chinook salmon also applies to juvenile steelhead. Both species have specific requirements for winter habitat that include cover consisting of interstitial spaces between cobble and boulders (Hillman et al. 1987), or woody debris (Swales et al. 1986; Schrader and Griswold 1992). Steelhead in the Yankee Fork have been observed to migrate from the main-stem upstream into the pond series during September and October (Rowe et al. 1991). While winter survival in these areas is unknown, juvenile steelhead have been observed in the pond series throughout the winter (Rowe et al. 1991).

Out-migration

Snake River steelhead, of which Yankee Fork steelhead are a part, usually out-migrate at age 2 or 3 (Rowe et al. 1989; NMFS 2011). Out-migrating steelhead have been enumerated at the Yankee Fork screw trap, but captures of natural versus hatchery-origin fish were not reported separately (Tardy and Denny 2010, 2011; Tardy 2011). Out-migration of steelhead sub-adults, sometimes referred to as smolts, from the Yankee Fork takes place from at least 3 July through 13 November (Figure 20) (Denny and Tardy 2008). Over 380,000 hatchery steelhead sub-adults were released into the Yankee Fork during 2009 and Tardy (2009) estimated that over 285,000 of them survived to Lower Granite Dam.

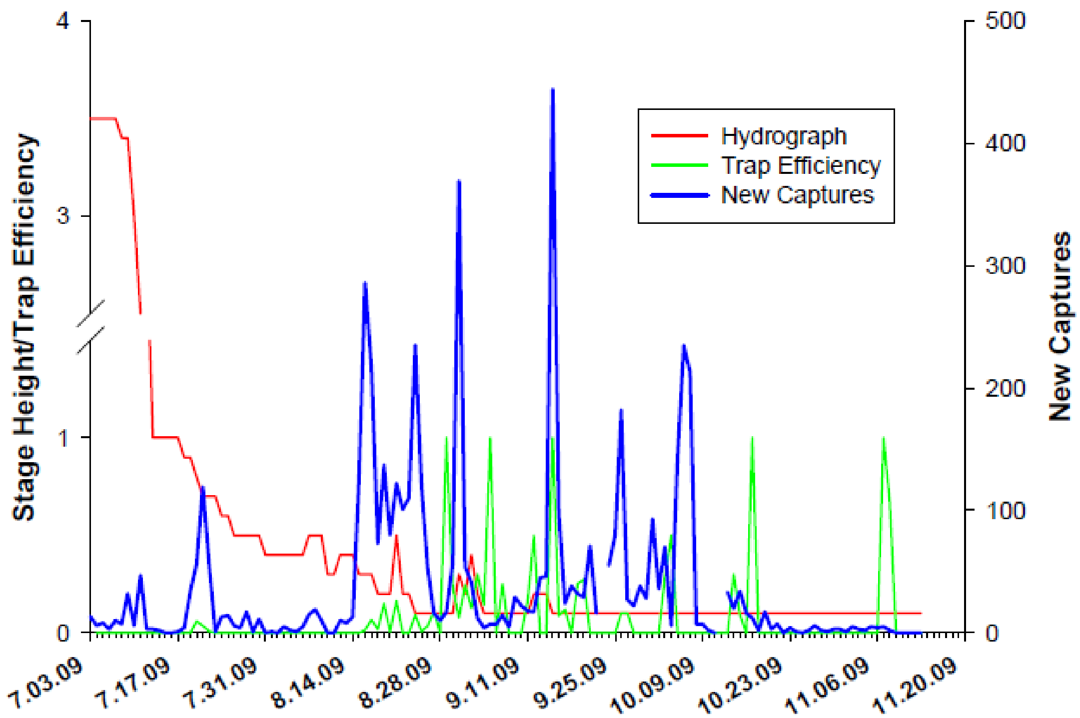

Figure 20. Yankee Fork hydrograph, screw trap efficiency, and migration timing of steelhead juveniles during 2009 (Tardy and Denny 2010).

Return Rate and Productivity

The Upper Main-stem Salmon River Steelhead Population has an estimated recent productivity of 1.86 (adult-to-adult) based on a "surrogate population for A-run steelhead above Lower Granite Dam" (NMFS 2011). Return rates for the Yankee Fork Steelhead, or even the Upper Main-stem Salmon River steelhead, are unknown.

Possible limiting factors

As with Chinook, steelhead that are reared and ultimately spawn in the Yankee Fork spend much of their life-cycle outside the Yankee Fork, where these populations are influenced by substantial mortality factors. The Yankee Fork steelhead population also requires adequate quantity and quality of spawning habitat and conditions sufficient to maximize survival of juveniles and sub-adults. Steelhead use similar spawning habitat, at a different time of year, as Chinook. And, although the actual number of steelhead returning to the Yankee Fork is unknown, the quantity and quality of spawning habitat in the Yankee Fork is likely adequate for the number of returning steelhead. Rearing habitat is also likely adequate for the number of steelhead present in the Yankee Fork. Winter habitat may be more important for steelhead than for Chinook as steelhead may be more likely to remain in the Yankee Fork through the winter.

The lack of data regarding steelhead in the Yankee Fork makes defining limiting factors more difficult than for Chinook. However, it seems likely that the steelhead population in the Yankee Fork is also not limited by habitat.

Data Gaps

As indicated above, less is known about steelhead in the Yankee Fork than is known for Chinook salmon. However, the most important gaps are similar to those for Chinook and include estimates of survival between life stages. Many of these parameters, including survival for juvenile to sub-adult, emigration survival (sub-adult to Lower Granite Dam), ocean/migration survival (Lower Granite Dam to Lower Granite Dam), and return migration (Lower Granite Dam to Yankee Fork), could be evaluated with a PIT tag study similar to that being planned by the Tribes for Chinook. Furthermore, detection equipment is already in place for the Chinook study.

Bull Trout

Schoby (2006), who conducted a movement study on bull trout in the Salmon River drainage using radio tags, found that bull trout began entering tributaries concurrent with the descending limb of the hydrograph, and were often near spawning areas by late-July. The Tribes documented a longer migration period with adult bull trout being captured at the Pole Flat picket weir through July and August (Tardy and Denny 2010, 2011; Tardy 2011) and sometimes into September (Denny and Tardy 2010). Schoby (2006) found that Bull trout remained in spawning areas through the summer months. Spawning began in late August and was generally completed by mid-September. Following spawning, bull trout made rapid migrations downstream to the Salmon River. Several bull trout which spawned in the headwaters of the Yankee Fork drainage returned nearly 38 km to the Salmon River in 3-4 days (Schoby 2006).

Juvenile bull trout were incidentally captured at the Pole Flat screw trap as they emigrated downstream in the Yankee Fork. Bull trout sizes, age-class, and migration timing were not given (Tardy and Denny 2010, 2011; Tardy 2011). Bull trout have been collected from various streams throughout much of the Yankee Fork drainage (Figure 21).

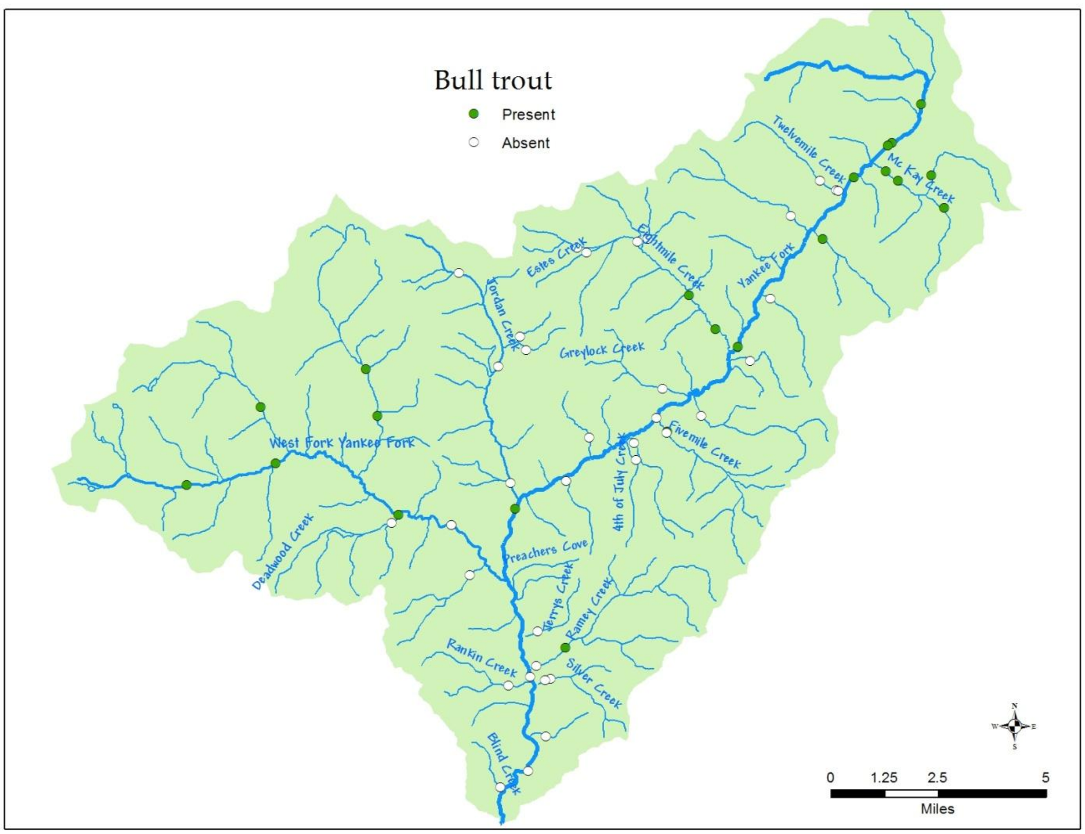

Figure 21. Bull trout distribution in the Yankee For drainage based on fish species collected by Forest Service crews during 2006 and 2007 (Gamett and Bartel 2008).

Cutthroat Trout

Schoby (2006) found that westslope cutthroat trout used many of the same spawning tributaries and wintering locations as did bull trout in the Upper Salmon River Basin, but displayed different migratory patterns. Cutthroat trout began spawning migrations in March, with significant movement increases during April. Cutthroat trout generally entered tributaries on the ascending limb of the hydrograph and spawning activity occurred shortly thereafter. Cutthroat trout returned to the Salmon River following spawning, in most cases occupying tributaries for less than one month (Schoby 2006).

Juvenile cutthroat trout were incidentally captured at the Pole Flat screw trap as they emigrated downstream in the Yankee Fork, but sizes, age-class, and migration timing were not given (Tardy and Denny 2010, 2011; Tardy 2011). Cutthroat trout have been collected from various streams throughout the Yankee Fork drainage (Figure 22), which may indicate a resident population or that some adfluvial cutthroat trout rear for several years in the Yankee Fork before emigrating to the Salmon River. Interestingly, cutthroat trout have been seen to be the primary salmonids species present in Jordan Creek (Rowe et al. 1989) while bull trout were not collected there (Gamett and Bartell 2008).

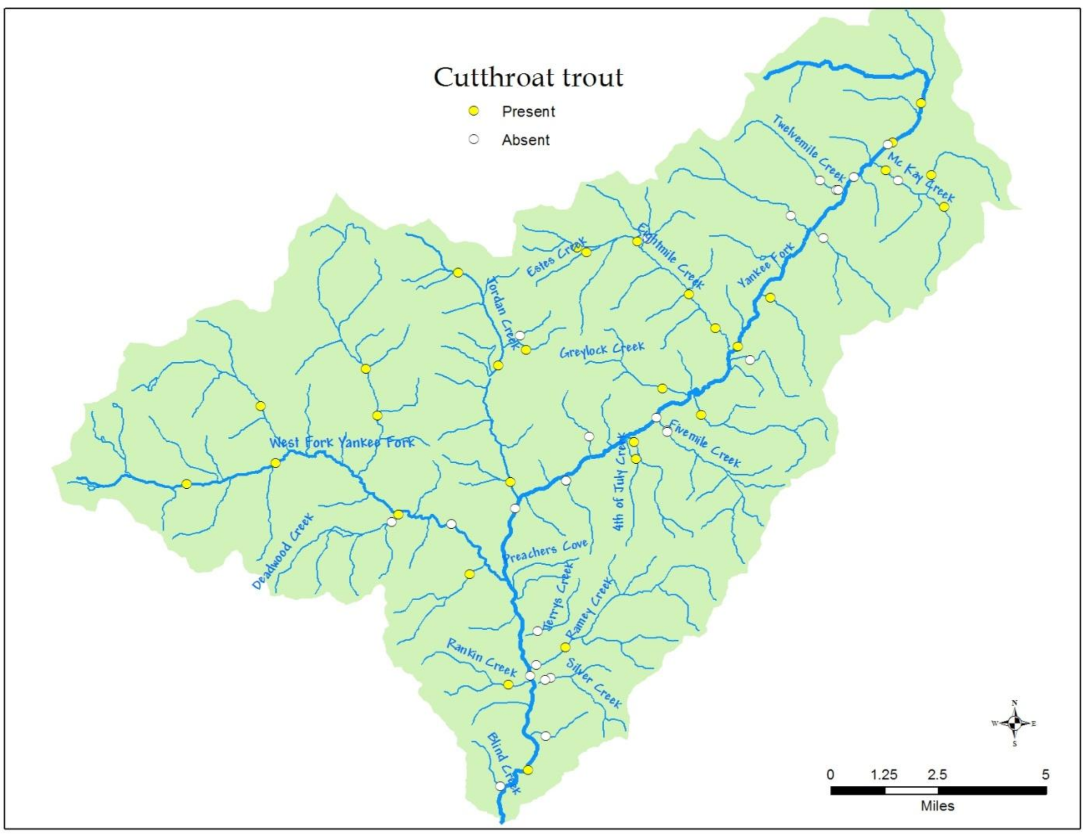

Figure 22. Cutthroat trout distribution in the Yankee For drainage based on fish species collected by Forest Service crews during 2006 and 2007 (Gamett and Bartel 2008).

Whitefish

Mountain whitefish occupy some of the larger tributaries of the Yankee Fork drainage (Figure 23).

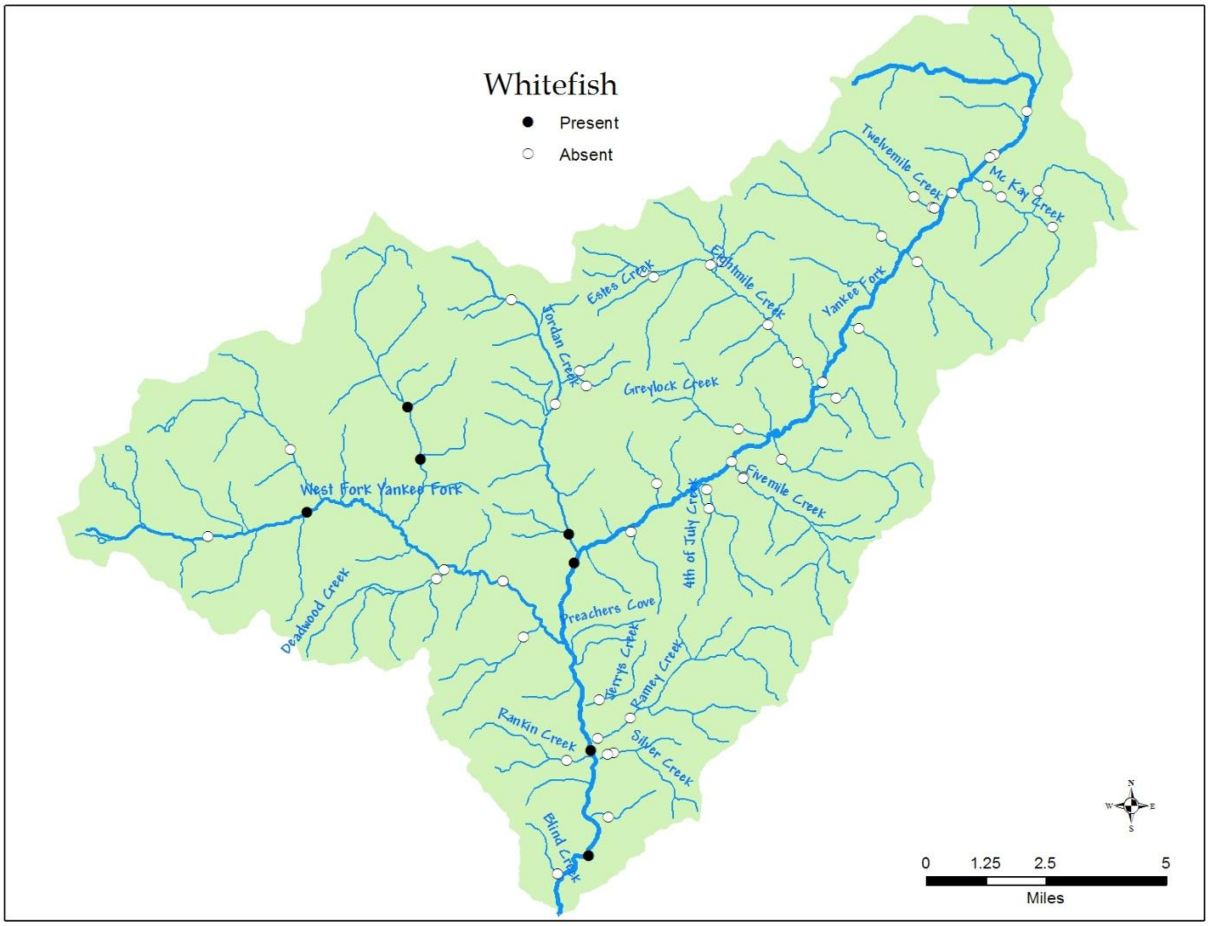

Figure 23. Mountain whitefish distribution in the Yankee For drainage based on fish species collected by Forest Service crews during 2006 and 2007 (Gamett and Bartel 2008).

Other Native Fish

Sculpin have been found through most of the larger tributaries and main-stem of the Yankee Fork (Figure 24).

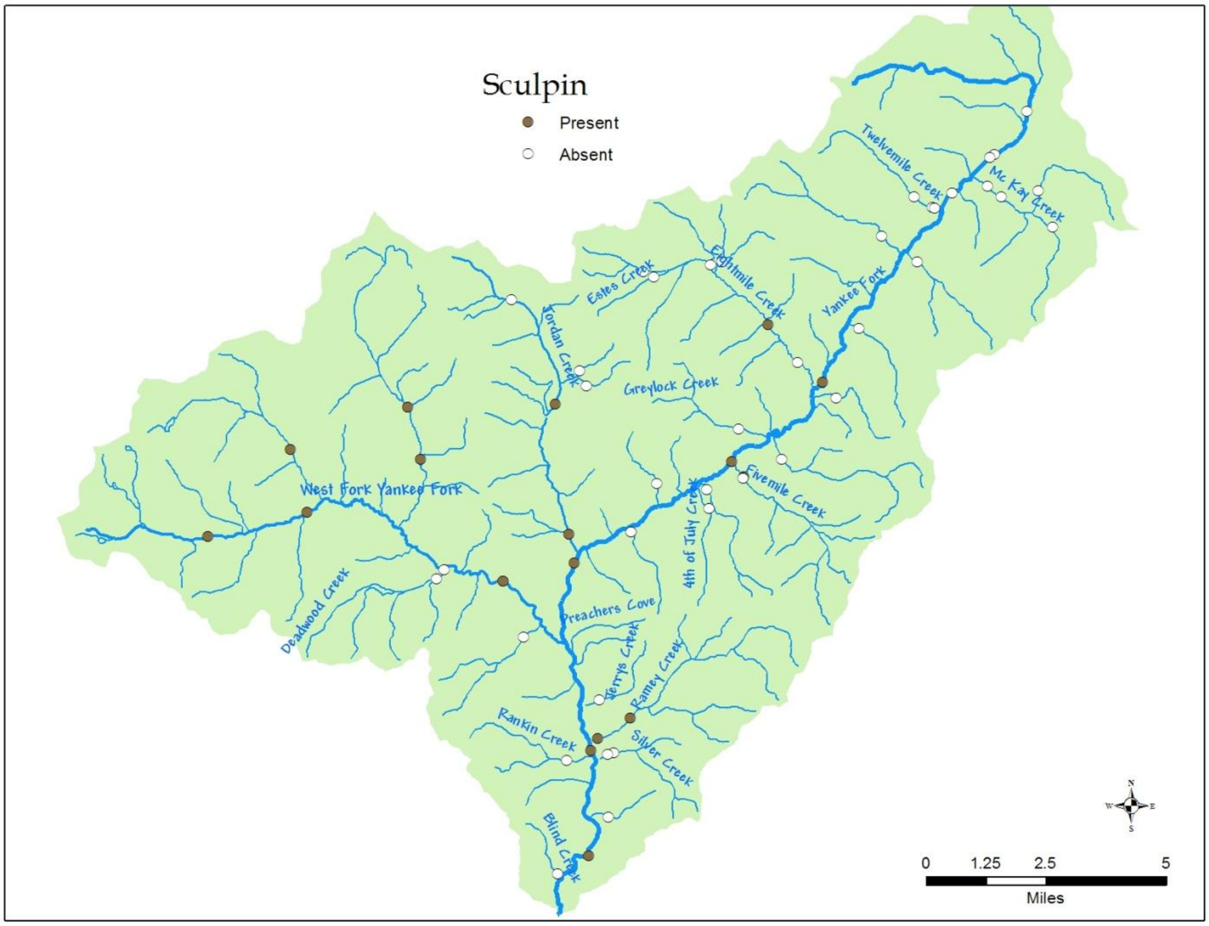

Figure 24. Sculpin distribution in the Yankee For drainage based on fish species collected by Forest Service crews during 2006 and 2007 (Gamett and Bartel 2008).

Non-Native Fish

No non-native fish were collected in the Yankee Fork by the USFS sampling crews at 58 sample sites throughout the drainage (Gamett and Bartel 2008).

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