Additional Information on the Status of Snake River Sockeye Salmon

Idaho Department of Fish and Game
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KOKANEE DENSITIES - ALTURAS AND REDFISH LAKES

(Bruce Rieman, personal communication)

The Idaho Department of Fish and Game used a 3x3m midwater trawl to sample Alturas and Redfish lakes on 19-20 August 1990. Personnel completed eight trawls in Alturas and five in Redfish. Density estimates were calculated from a rough estimate for the 18m contour in Alturas Lake. Because bathymetric data was not available for Redfish Lake, the same ratio for computing the 18m contour in Alturas was used for Redfish. Rieman felt that may have been a poor assumption.

Age analysis was done by inspection of length frequencies for both lakes. Some otoliths were aged in Alturas Lake that provided some approximate age distribution and growth data.

Alturas Lake -

The total kokanee density estimate for Alturas Lake measured 597/ha (±25%.) Standing crop for kokanee was estimated at 5 Kg/ha with a population estimated of 126,645. Rieman feels this biomass density correlates well with the very low productivity of Alturas Lake. Initial inspection of growth rates indicated very slow growth. Table 1 includes the estimated population numbers by approximate age and length groups.

Redfish Lake -

Rieman measured kokanee density in Redfish Lake at 64/ha (±41%) with a total population estimate of 24,431 (Table 2). Kokanee standing crop was estimated at 1.2 Kg/ha. Kokanee densities in Redfish are among the lowest in the state (Rieman and Meyers 1990). Priest Lake

supports fewer kokanee than Redfish (<50/ha) but is caught in a predator trap with low kokanee densities and a strong abundance of lake trout. Rieman has concerns for Redfish kokanee if predators exist in the lake.

Table 1. Kokanee densities measured in Alturas Lake 19 August 1990. Densities were calculated from the 18 m contour - 212 surface ha.

Approximate age	TL (mm)	Density (Kok/ha)	Population Estimate		95 CI
0	30-50	184.0	39,065	±	8,944
1+	60-80	57.0	12,126	±	3,162
2+	90-110	262.0	55,438	±	14,142
3+	120-180	71.0	15,076	±	3,162
4+	180-230	23.0	4,938	±	1,425
		597.0	126,643		
	30-70	226.0	47,972	±	8,367
	80-140	345.0	73,241	±	14,142
	150-220	26.0	5,432	±	1,222
		597.0	126,645		

Table 2. Kokanee densities measured in Redfish Lake 20 August 1990. Densities were calculated from an estimated 18m contour - 382 surface ha.

TL (mm)	Density	Population Estimate		95 CI
30-60	26.0	10,048	±	3,162
80-130	23.0	8,808	±	2,807
150-200	9.0	3,338	±	1,363
220-240	6.0	2,237	±	1,370
	64.0	24,431		

KOKANEE EMIGRATION - UPPER SALMON RIVER

(Russ Kiefer, personal communication)

Between 10 March and 16 May the Sawtooth trap next to Sawtooth Fish Hatchery, was operating to collect anadromous smolts. Between 25 April and 16 May Idaho Department of Fish and Game personnel captured 504 migrating kokanee. Using a trap efficiency of about 6%, Russ Kiefer estimated that 8,302 kokanee passed through the Sawtooth trap. The logical source of these fish was Alturas Lake which supported high densities of kokanee during the summer of 1990 (Rieman personal communication).

IDF&G personnel PIT tagged 391 of those migrants. They ranged in length from 77 to 127 mm (FL) with a mean of 94.0 mm. Twenty-nine PIT tags were interrogated at Lower Granite Dam with a mean travel time of 15 days. An additional 30 tags were interrogated at Little Goose and 9 at McNary Dam. The total interrogations were 68.

A minimum survival rate from Sawtooth to Lower Granite for the migrating kokanee was 17% (68/391). If additional fish could have been interrogated to Bonneville and one assumed a 15% mortality at each of eight projects (70% cumulative mortality) the survival from Sawtooth to Lower Granite would have ranged from 17 to 30%. Using that range of survival rates, approximately 1,500-2,500 kokanee passing the Sawtooth weir would have arrived at Lower Granite Dam.

Kiefer noted the period of kokanee emigration from Sawtooth ranged from 25 April to 16 May. These dates are very similar to Bjornn's findings at the Redfish Lake Creek trap between 1955 and 1966 (Bjornn et al. 1968).

SMOLT TRAP OPERATIONS - SNAKE AND CLEARWATER RIVERS

The Idaho Department of Fish and Game has been operating smolt collection traps in the Snake and Clearwater rivers since 1983. The Clearwater trap sits 10 km from the confluence from the Snake River. The Snake trap is cabled to the Highway 12 Bridge that connects Lewiston and Clarkston. It rests 0.5 km upstream from the confluence with the Clearwater.

The Snake River trap begins operating in early March and often runs through late June with little down time. Occasional mechanical problems will prevent it from fishing. The Clearwater trap usually begins fishing in mid-March and runs to late May or early June. It is more flow sensitive and must be pulled to the side of the river when discharges exceed 30,000 cfs (Buettner, E. W. and V. L. Nelson 1989). The Clearwater trap operated 55% of its duration in the river in 1989 and 80% in 1990.

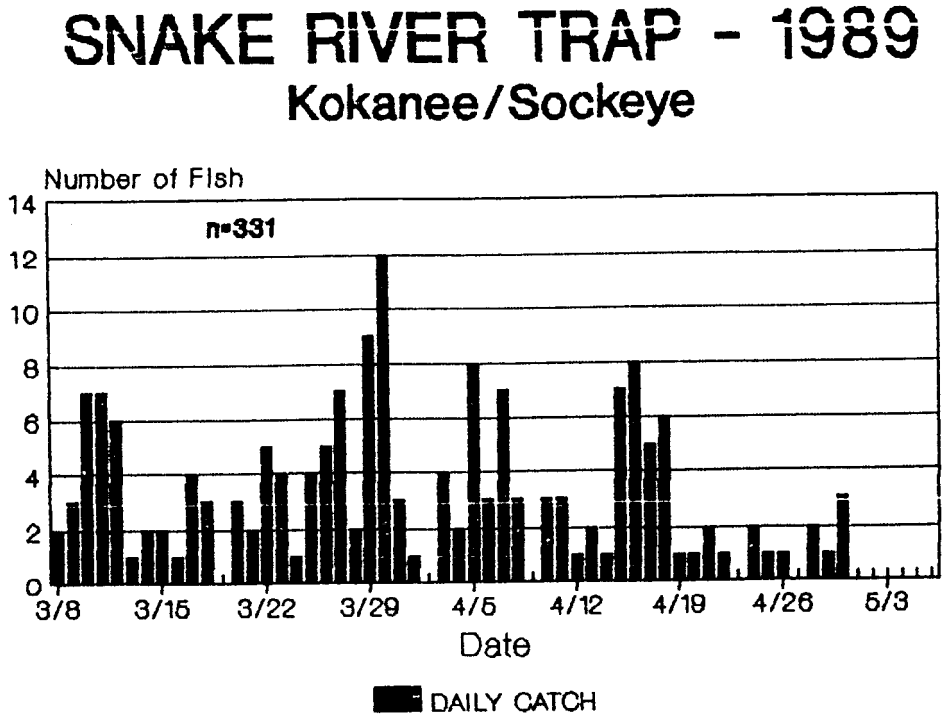
Migration Timing -

Both traps collect kokanee and/or sockeye. The highest recorded count occurred in the Snake trap in 1989 when 331 kokanee/sockeye were enumerated. The Clearwater trap's highest recorded number was 89 in 1990. Lance Nelson (personal communication) believes many of the Snake caught fish originate from the Clearwater. Often when the Clearwater trap increases in numbers the Snake is close to follow. Because of the Snake River trap's proximity to the mouth of the Clearwater, kokanee emigrating from Dworshak mill around the confluence area and subsequently are captured in the Snake trap. (Lance Nelson and Ed Buettner, personal communication).

In 1990 kokanee and/or sockeye were collected at both traps upon installation (Figures 1,2). In both 1989 and 1990 most all of the kokanee/sockeye were collected in the Snake trap prior to the time at which upper Salmon River fish could have arrived at the head of Lower Granite pool. Kokanee/sockeye emigration does not commence in the upper Salmon River until about 20 April (Bjornn et al. 1968; Russ Kiefer, personal communication).

Size of Emigrants -

The kokanee/sockeye length frequencies for both the Clearwater and Snake traps, the Sawtooth trap and Dworshak losses are described in Figures 3, 4. Model lengths for the age 1+ kokanee/sockeye were 80-90 mm for the Dworshak losses and the Snake trap; 70-80 mm for the Clearwater trap and 90-100 mm for the Sawtooth trap.



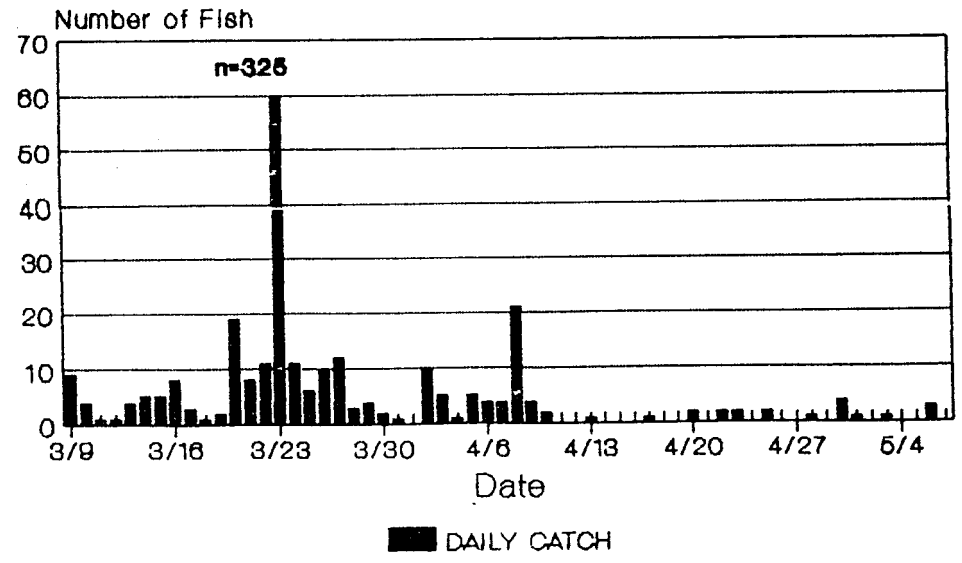
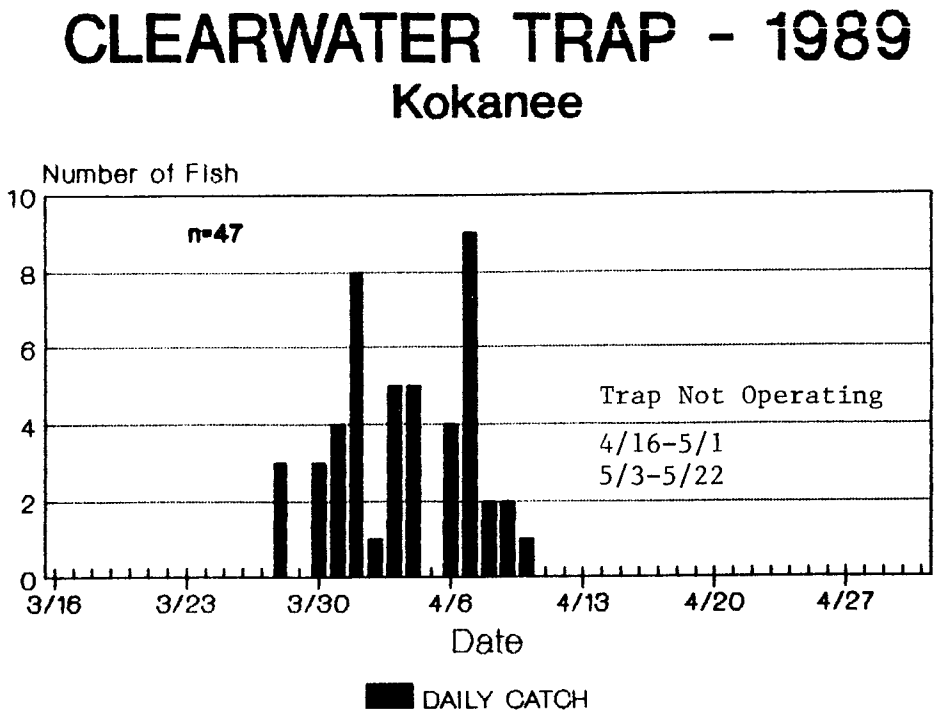


Figure 1. Numbers of kokanee/sockeye trapped by date in the in the Snake River trap in 1989 and 1990.



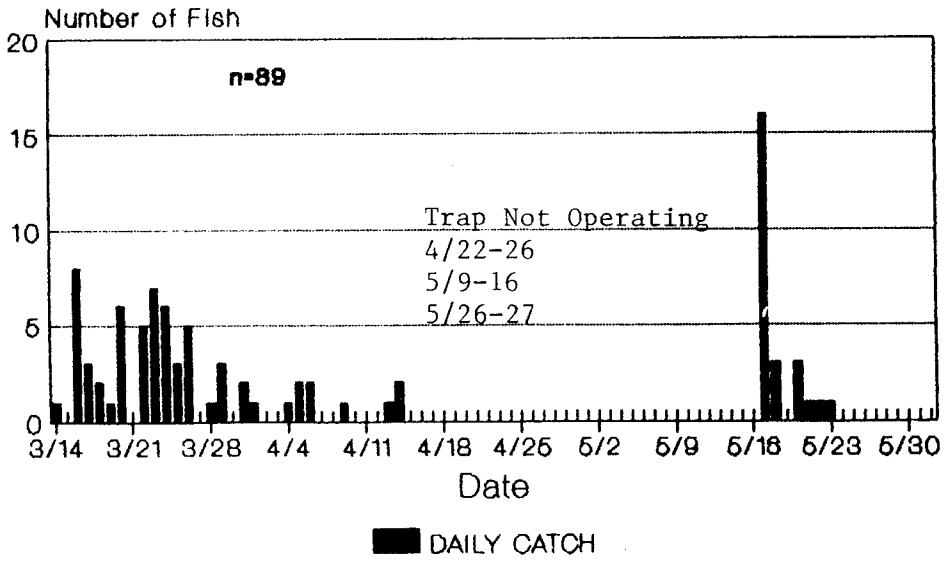


Figure 2. Numbers of kokanee trapped by date in the Clearwater trap in 1989 and 1990.

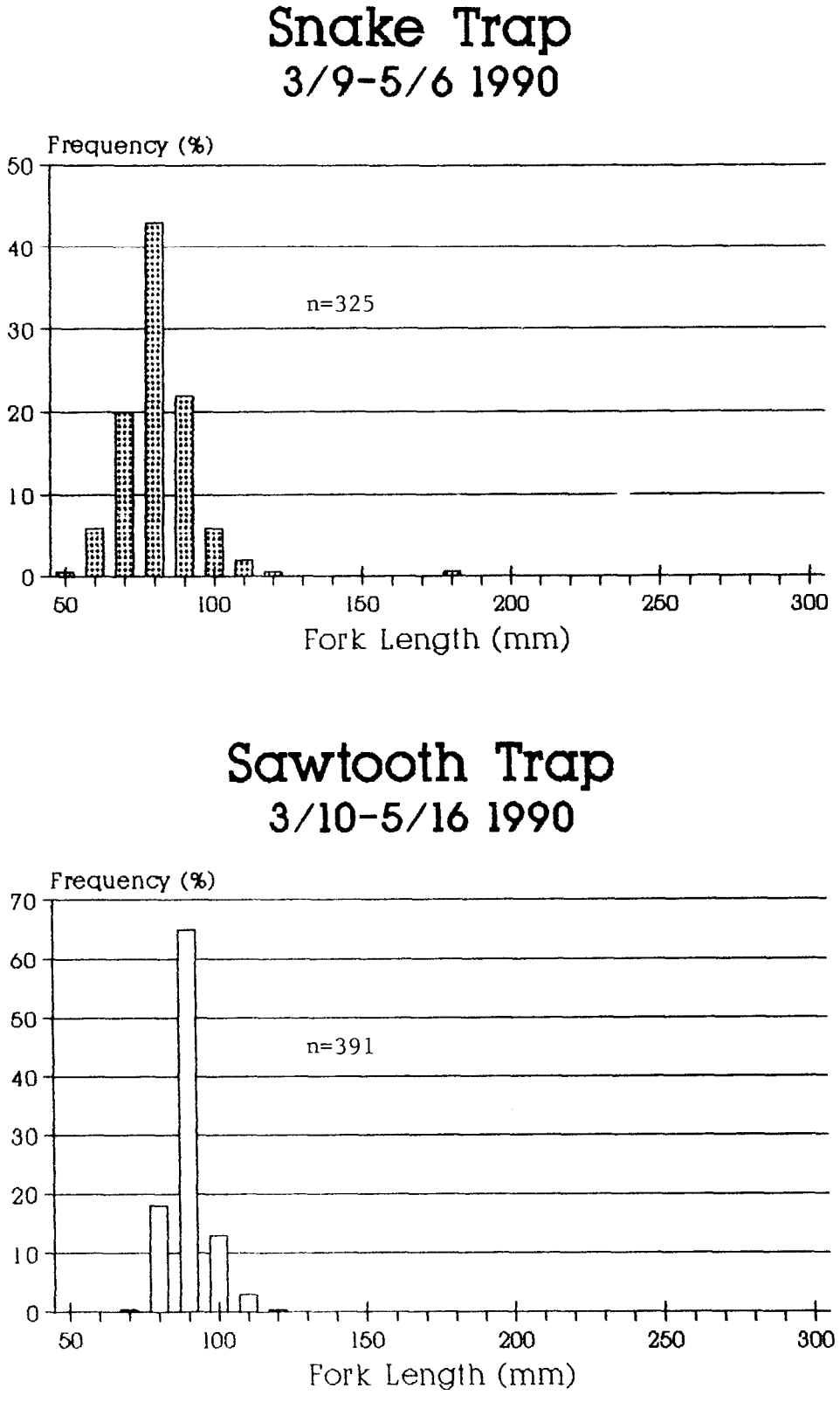
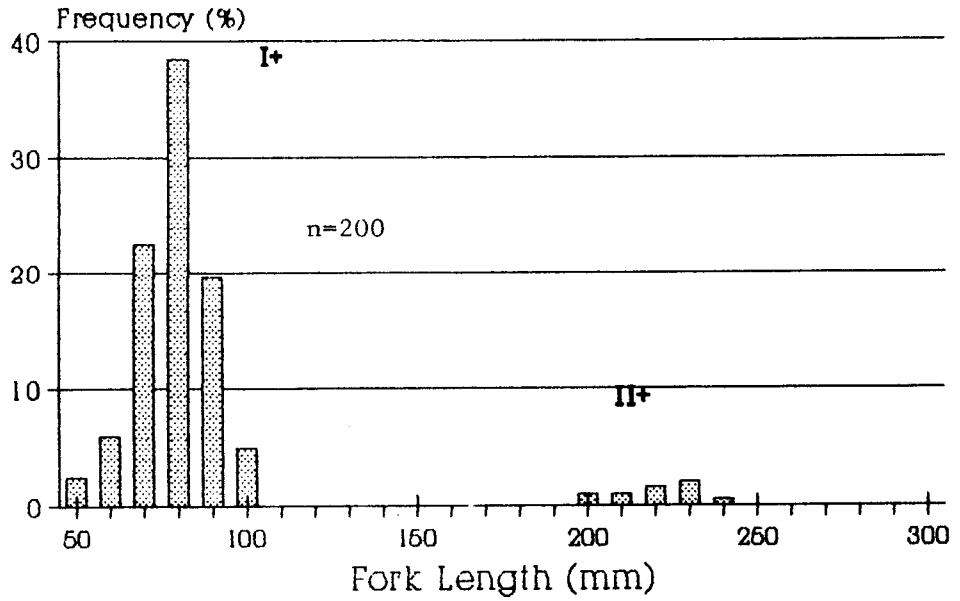


Figure 3. Length frequency of kokanee/sockeye trapped in the Snake River and the Sawtooth trap in 1990.



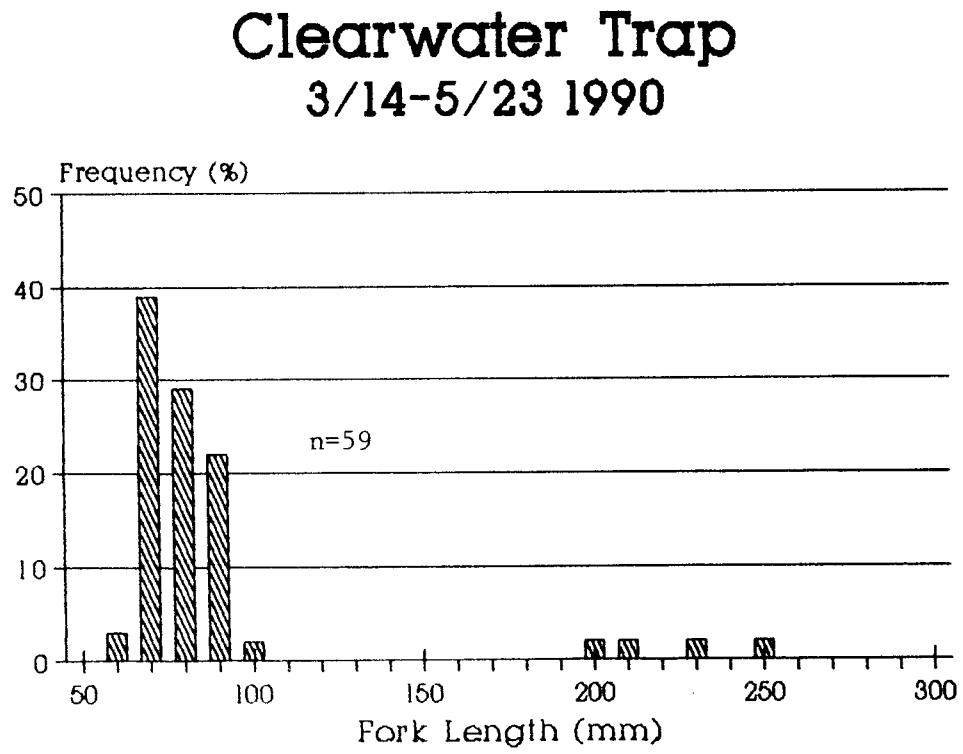


Figure 4. Length frequency of kokanee collected in the North Fork of the Clearwater River and the Clearwater trap in 1990.

KOKANEE EMIGRATION FROM DWORSHAK RESERVOIR -

The Idaho Department of Fish and Game is currently assessing the status of kokanee populations in Dworshak Reservoir. Part of that study is addressing the loss of kokanee from the reservoir. Dworshak Dam's powerhouse capacity ranges between 1,000 and 10,000 cfs. Above 10,000 cfs the dam must spill to increase discharge. In years in which the reservoir spills water during the winter/spring period, kokanee of all age classes can be found in the Lower Clearwater River. In the years of no or little spill, primarily age 1+ kokanee can be found in the Lower Clearwater (Gregg Mauser, personal communication). Figure 3 depicts the size of kokanee found in the river in 1990.

Mauser (unpublished) described a relationship between discharge at Dworshak Dam and cumulative kokanee loss in the lower Clearwater River (Figure 5). It was difficult to obtain good quantitative numbers on the actual kokanee in the river but based on the population dynamics of kokanee in the reservoir, Mauser feels annual losses of 100,000 may be common. It is unclear as to the relationship between entrainment and propensity to emigrate. Obviously when discharge exceeds powerhouse capacity, kokanee of all ages tend to be lost suggesting entrainment. At lower discharge there may be a propensity of age 1+kokanee to emigrate.

KOKANEE STOCKING HISTORY IN THE STANLEY BASIN LAKES

Table 3 includes the kokanee stocking history of lakes within Stanley Basin (Stocking records IDFG library). Stocking records are missing from 1946 to 1950. Known sources of the kokanee stocked are very limited. A major source of late spawning kokanee beginning in the

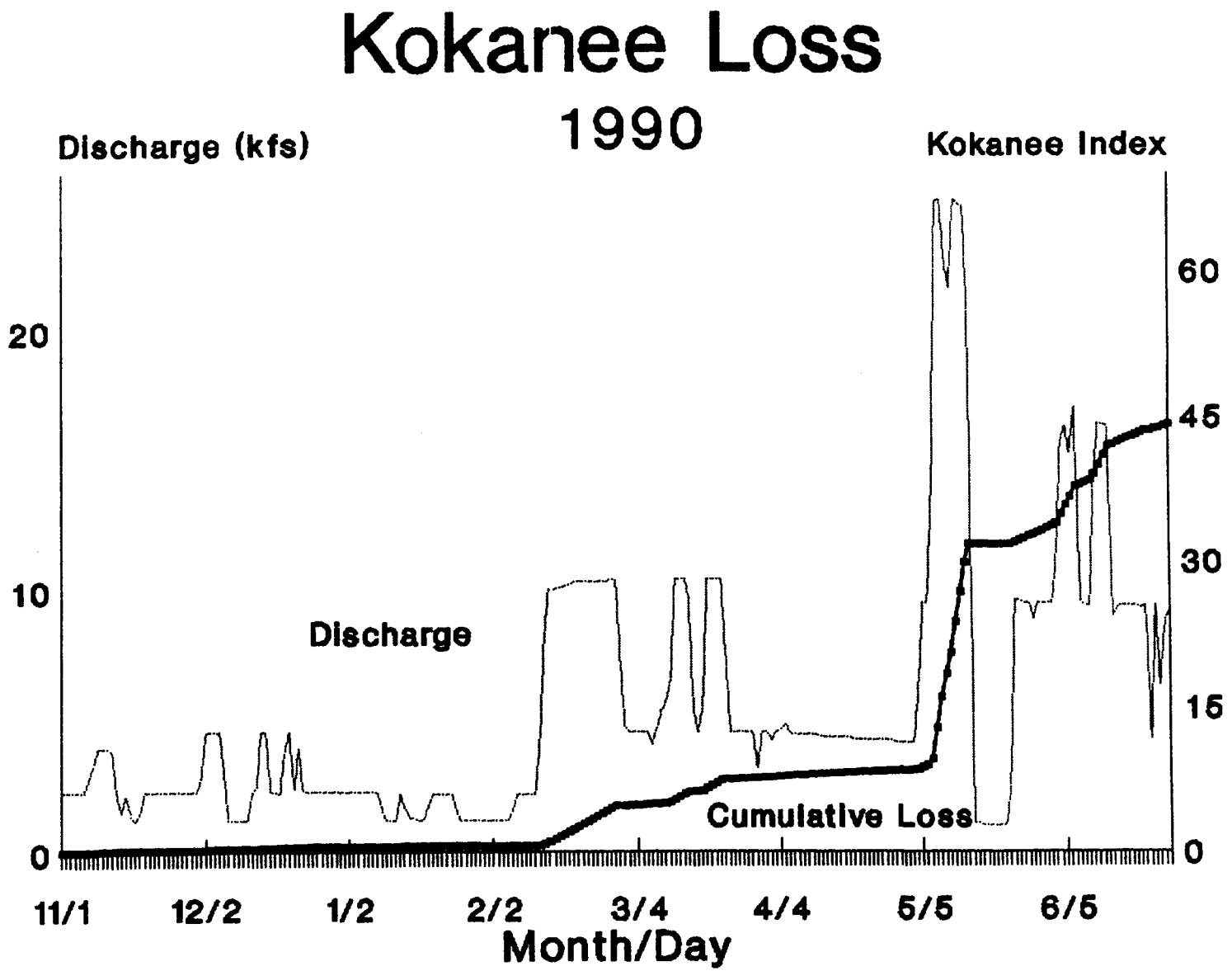


Figure 5. Relationship of discharge through Dworshak Dam vs cumulative loss of kokanee from Dworshak Reservoir in 1990. (Mauser unpublished)

1940s was Granite Creek, a tributary to Pend Oreille Lake. Kokanee were first identified in Pend Oreille in 1933. They drifted down the Clark Fork River from Flathead Lake (Jeppson 1963). Kokanee were first introduced into Flathead Lake in 1916, likely from Oregon. In 1933 a second release was made into Flathead from the Quinnat Fish Hatchery in Oregon (Laney Hanzel, personal communication). The Summers Hatchery on the banks of Flathead Lake was used as a source for late-spawning kokanee eggs for years (Laney Hanzel, personal communications).

During the 1940s and 1950s from one to two million kokanee eggs were taken annually from Pend Oreille Lake and distributed around the state, including Big Payette Lake, Warm lake and in 1950 Anderson Ranch Reservoir (Simpson 1948; Idaho Wildlife Review Dec/Jan 1950, pg. 8). Warm Lake was stocked with kokanee between 1951 and 1962 (IDFG stocking records). Many of those were likely from Pend Oreille Lake. IDFG personnel gill netted 50-100 mature late spawning kokanee in Warm lake in October 1990 (Don Anderson, personal communication).

A common source for early spawning kokanee in Idaho was Moose Creek, a tributary to Island Park Reservoir in eastern Idaho. Island Park received kokanee from Kootenay Lake, British Columbia in 1944 and 1946 (Culpin 1969). Island Park kokanee were released into the South Fork of the Boise River above Anderson Ranch Reservoir in 1963 (Stacy Gebhards, personal communication). Stacy thinks Frank Graver of the Eagle Fish Hatchery stocked kokanee into Fall Creek, a tributary to Anderson Ranch in 1958 or 1959. That release produced some 18 inch kokanee ranging to 2.5 lbs. The likely source was Island Park Reservoir. Island Park was treated chemically in 1958 and subsequently

restocked in 1959 likely with eggs taken in 1958 prior to the treatment (Paul Jeppson, personal communication). Additional kokanee releases into Anderson Ranch Reservoir are reported in Table 4.

Kootenay Lake, British Columbia was the probable source of early spawning kokanee throughout the northwest. Eggs were collected as early as 1916 from the Meadow Creek Hatching Channel. They were widely distributed within British Columbia and the United States (Harvey Andrusak, personal communication). Pend Oreille Lake supports an early spawning population in Trestle Creek that dates back to the 1940s or 1950s (Paul Jeppson, personal communication).

Table 3. Kokanee stocking records for the Stanley Basin lakes 1921-1990 (IDFG stocking records).

Date	Water	Numbers	Size	Hatchery rearing	Source
6/19-8/2/21	Alturas	40,300		Unknown	Unknown
6/23/30	Alturas, Pettit Redfish, Stanley	17,500		Hayspur	Unknown
6/26/30	Redfish	7,000		Hayspur	Unknown
6/16/32	Redfish	8,000	5"	Hayspur	Unknown
6/17/31	Alturas	9,060	5"	Hayspur	Unknown
6/18/32	Pettit	7,000	5"	Hayspur	Unknown
6/28/33	Redfish	16,150		Hayspur	Unknown
6/29/33	Pettit	11,400		Hayspur	Unknown
6/30/33	Alturas	17,000		Hayspur	Unknown
6/6/44	Alturas	45,000	2-3"	Hayspur	Unknown
6/7/44	Alturas	60,000	2-3"	Hayspur	Unknown
6/12/44	Alturas	60,000	2-3"	Hayspur	Unknown
6/13/44	Alturas	52,500	2-3"	Hayspur	Unknown
6/14/44	Alturas	27,000	2-3"	Hayspur	Unknown
7/6/44	Redfish	54,150	1-1 3/4"	Hayspur	Unknown
7/7/44	Redfish	49,400	1-1 3/4"	Hayspur	Unknown
5/21/45	Little Redfish	55,000	2-3"	Unknown	Unknown
6/9/45	Alturas	85,440	2-3"	Hayspur	Unknown
6/10/45	Alturas	96,000	2-3"	Hayspur	Unknown
6/10/45	Alturas	96,000	2-3"	Hayspur	Unknown
6/11/45	Redfish	91,200	2-3"	Hayspur	Unknown
Stocking records from 1946-1950 are missing from IDFG library					
6/7/52	Alturas	90,000	1-1 1/2"	Hayspur	Unknown
7/13/62	Redfish	43,251	2"	Mackay	Pend Oreille
7/8/65	Pettit	4,560	1-2"	Mackay	Unknown
6/26/68	Alturas	196,000	0-3"	Eagle	North Idaho
6/28/68	Pettit	79,100	0-3"	Eagle	North Idaho
5/28/71	Fishhook Cr.	50,344	0-3"	Mackay early spawning	Unknown
6/17/71	Redfish	45,900	0-3"	Hayspur	Unknown
7/12/72	Redfish	51,435	3-6"	Mackay early spawning	Unknown
6/1/88	Stanley	49,926	3-6"	Eagle early spawning	Unknown
6/15/89	Stanley	60,000	3-6"	Mackay early spawning	Unknown

Table 4. Kokanee releases into Anderson Ranch Reservoir between 1964 and 1967 (from Culpin 1969).

Release date	Number	Source
Nov 1964	686,000	Island Park
May 1965	434,720	North Idaho
April 1966	390,000	British Columbia
April 1967	52,000	Island Park
April 1967	156,000	British Columbia

ADULT MIGRATION AND SPAWNING

Evermann (1896) described the spawning of redfish in Alturas Lake in 1984. He reported that the large ones spawn mostly in the lower part of the inlet while the small ones run upstream. Mr. F. C. Parks - "The small ones run up the inlet at least three miles where the water is so shallow that their backs stick out. The large ones spawn in the lower part of the inlet." Bjornn (personal communication) observed adult sockeye returning to the inlet of Alturas Lake in 1964. He also noted they were spawning near the mouth of the inlet. A request of the local rancher was made that year to release water through the diversion so sockeye that were seen in the Salmon River might make it to Alturas Lake. A total of 45 were seen in the outlet and inlet of Alturas Lake.

In Evermann (1894), a Mr. B. S. Brown of Bliss noted that he had seen the large ones (redfish) in Big Redfish, Stanley and Pettit lakes. He saw them spawning in Big Redfish Lake about 18 August in 1893, about 15 August in 1887, 1888 and 1889. Based on the time at which they were seen spawning, they were likely using a tributary of Redfish Lake. I could find no reference of observations of shoreline spawning of either large ones or small ones in any of the Stanley Basin lakes in the Evermann series. However in Evermann (1894), Mr. W. C. Jennings gave the following report about Big Payette Lake. "They appear about August 10 to 15th each year and continue to be seen up to the last of October, or until the snow comes; have seen them in great numbers late in October. They appear a week or two before they are ready to spawn. The height of the spawning season is throughout September. The principle spawning beds were in the inlet 2 or 3 miles

above the lake; they go up 5 or 6 miles, however. When they were so abundant many used to spawn around the edges of the lake on sandy places where there are springs which makes the water colder. This spawning in the lake took place at same time as that in the inlet. There are both large and small redfish here: The large ones run 4 to 5 pounds undressed or about 2 1/2 pounds dressed."

It could be that October spawning kokanee and sockeye used the shorelines of the Stanley Basin lakes in the late 1800s, but were not readily seen. As early as 1927, sockeye were observed spawning along the shoreline of Redfish Lake in October (Hall-Griswold 1990). In 1942 a survey team of the USFWS observed about 200 spawning sockeye in Redfish Lake (Hauck 1955). A survey of Redfish Lake in October, 1953, gave an estimated spawning population of about 2 to 3 thousand (Hauck 1955). I could find no accounts of sockeye spawning in the Redfish tributaries beyond the late 1800s. The traditional sockeye spawning in Redfish from the 1920s to the present has been the October shoreline spawner.

To date no gill netting has been done in either Alturas or Redfish lakes to determine if mature kokanee can be found in October. Bjornn et al. (1968) noted what appeared to be "residual sockeye salmon" in Pettit and Yellowbelly lakes after a chemical treatment in 1961 and 1962. "The fish were darker in coloration than the bright red kokanee and would have spawned later than the kokanee populations in Redfish and Alturas lakes." No record of kokanee stocking had been reported in either of the lakes prior to treatment (Bjornn et al. 1968).

Stacy Gebhards (personal communication) chemically treated Hell Roaring Lake in the Sawtooths in 1970-71. He noted 4 to 5-inch mature kokanee that were killed during the fall treatment.

Bjornn et al. (1968) describes the run timing of sockeye into Redfish Lake between 1954 and 1966 as first appearing after the middle of July with most of the run passing in August and few into September and some as late as October. Recent returns are similar to Bjornn's findings (Table 5). Evermann's (1894, 1985, 1896) description of spawning in Alturas and Redfish lakes in the late 1800s suggests a run timing earlier than observed by Bjornn or the adults at the turn of the century were arriving ready to spawn. Bjornn et al. (1968) noted a two-month difference between peak arrival and spawning in Redfish Lake. The time of spawning is directly related to the number of temperature units that are available to the embryos. Spawners depositing eggs in the tributary gravels of Redfish or Alturas lakes in October would be at a survival disadvantage compared to those using shoreline gravels.

If there is a real difference in arrival timing between what Evermann noted and what has been the accepted arrival time at Redfish in the past 65 years, there may be an explanation. Bjornn et al. (1968) felt that the lower Columbia River commercial fishery was selective to larger fish and may have taken a disproportionately large share of the fish destined for Redfish Lake. This fishery may also have selected for a later arriving sockeye to the upper Salmon River. Also with limited passage at Sunbeam Dam there may have been selective pressure for a later arriving sockeye. The relationship between arrival time and maturity is not well understood.

Table 5. Trapping dates for sockeye collected at the Redfish and Sawtooth traps 1985-1990.

Trap	Year	Month/Day	Number/Sex
Sawtooth	1985	July 12	1 M
		15	1 M
Redfish		24	1 M
Sawtooth		26	1 F
Redfish		Aug 9	3 M
		10	1 M
		11	1 F
		12	1 M
		17	2 M
		31	1 F
		Sept 20	1 F
		TOTALS	10 M, 4 F
Redfish	1986	July 7	1 M
		29	1 F
		Aug 1	1 F
		2	1 M, 2 F
		3	1 M
		7	3 M, 3 F
		8	2 F
		9	1 M
		10	4 F
		11	1 M
		13	1 M, 1 F
		14	1 M
		15	1 M, 1 F
		23	2 M
		26	1 F
		TOTALS	13M, 16F
Sawtooth	1987	July 26	1 M
Redfish		29	2 F
Sawtooth		Aug 10	1 F
Redfish		10	1 M, 1F
		11	1 M
		12	1 F
		18	1 M
		23	1 F
		25	1 M
		26	1 M
		31	1 F
		Sept 10	1 F
		16	1 F
		22	1 F
		TOTALS	6M, 10F
Sawtooth	1988	July 27	1 F
Sawtooth	1989	Aug 3	1 F
	1990	None	

Redfish trap was not operated in 1988, 1989 or 1990

SUMMARY

The following information collected in 1990

- density estimates of kokanee populations in Redfish and Alturas lakes
- estimates of kokanee emigration from Alturas Lake
- estimates of survival of kokanee to Lower Granite Dam
- timing at which kokanee were collected at the head of Lower Granite pool
- similarity in size of kokanee trapped at the head of Lower Granite pool and the size of kokanee emigrating from Dworshak Reservoir

suggests that the contribution of Alturas and/or Redfish Lake kokanee to those passing Lower Granite Dam was less than 10%.

Assumptions - 10,000 emigrants from Alturas and Redfish

- 30% survival to Lower Granite Dam
- 1990 collection at LGD 14,700

– 33% FGE at LGD

– 45,500 migrants passing LGD

10,000 x .3/45,500 = 7%

Anadromy in Dworshak Kokanee -

Kokanee have been emigrating from Dworshak Reservoir since they became established in the 1970s. Kokanee have had the benefit of a relatively short travel distance to Lower Granite and transport to the lower Columbia River. To date no adult sockeye have been reported in the Clearwater or at Dworshak Fish Hatchery. The Oregon Department of Fish and Wildlife has made similar observations in Wallowa Lake drainage.

Recovery -

The last known sockeye returning to the upper Salmon River were those that spawned along the shoreline of Redfish Lake in October. These fish apparently had the "round trip genes". To assume that the early spawning kokanee in either Redfish or Alturas possess the ability to make the round trip may be speculative at best.

Foote et al. (1989) describes divergence of kokanee and sockeye in sympatric populations through mechanisms of assortive mating and the selective pressure experienced by anadromous and non-anadromous individuals. Oregon Department of Fish and Wildlife suggested a primary factor disrupting the lineage of native kokanee in Wallowa Lake was introductions of non-indigenous hatchery fish. The extent to which

introduced kokanee populations have had on indigenous stocks in Alturas or Redfish is presently being investigated. The stocking history in each lake certainly suggests possible introgression.

Recovery of sockeye stocks in the upper Salmon River will require more information on lake population dynamics, genetic makeup and stock resilience for making the round trip journey.

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