HUNGRY HORSE DAM FISHERIES MITIGATION:

KOKANEE STOCKING AND MONITORING IN FLATHEAD LAKE

ANNUAL PROGRESS REPORT

Prepared by:

The Hungry Horse Mitigation Technical Team

Barry Hansen

Confederated Salish and Kootenai Tribes

Jon Cavigli
Mark Deleray

Montana Fish, Wildlife and Parks

Wade Fredenberg
Dan Carty

U.S. Fish and Wildlife Service

Prepared for:

U. S. Department of Energy
Bonneville Power Administration
Environment, Fish and Wildlife
P.O. Box 3621
Portland, OR 97208-362 1

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EXECUTIVE SUMMARY

The operation of Hungry Horse Dam on the South Fork of the Flathead River rcduccd the reproductive success of kokanee (Oncorhynchus nerka) spawning in the Flathcad River. Montana Fish, Wildlifc and Parks (MFWP) and the Confederated Salish and Kootcnai Tribes (CSKT) authored a mitigation plan to offset those losses (MFWP and CSKT 199 1). The mitigation goal, stated in the Fisheries Mitigation Plan for Losses Attributed to the Construction and Operation of Hungry Horse Dam. is to: "Rcplace lost annual production of 100,000 kukanee adults, initially through hatchery production and pen rearing in Flathcad Lake, partially replacing lost forage for lake trout (Salvelinus namaycush) in Flathead Lake."

Following the Mitigation Plan of 1991 was The Mitigation Implementation Plan (Plan), adopted by the Northwest Power Planning Council on March 10, 1993 (MFWP and CSKT 1993). The Plan details specific activities to protect and enhance resident fish and aquatic habitat affected by Hungry I Horse Dam, including the annual stocking of one million (6-8 inch) yearling kokanee reared at Crcston National Fish Hatchery (Creston) bv the U.S. Fish & Wildlife Service (USFW'S). This program established a 5-year experimental period to "... accumulate sufficient information to detemmine whether the plants were successful, thereby dictating future hatchey operations and facility upgrades". The purpose of this report is to summarize the results of monitoring the kokanee experiment in 1995 for (1) the Northwest Power Planning Council as required in the Implementation Plan, (2) the Bonneville Power Administration as required under the funding contract. and (3) the Hungry Horse Mitigation Implementation Group (consisting of one represcntative from each agency, MFWP, CSKT and USFWS) for planning and decision making.

The lmplementation Plan established that the following criteria for success of the kokanee experiment bc evaluated by 1998:

(1) 30% survival of kokanee I year after stocking;
(2) Yearling-to-adult survival rate of 10%; and
(3 Annual harvest of 50,000 kokanee, 1 1 inches or grcatcr, and a minimum fishing pressure of 100,000 angler hours.

An Implementation Group was cstablishcd to guide the Hungy Horsc Mitigation program. The Technical Team, also with representatives from each agency, was established to monitor the success of the kokancc esperimcnt, and to evaluate and develop adaptive strategies to facilitate that success. The Team uses the success criteria dcfincd in the Implementation Plan to fulfill the mandate of the Plan and provide a relative contest for evaluating monitoring results. The criteria will not be employed to definc the success of the kokancc experiment until final evaluation in

1998 and 1999 (MFWP and CSKT 1993). The team refines its monitoring strategy annuallv to determine (1) if each success criterion is within our capacity to quantify, (2) if WE are monitoring the appropriate biological parameters, and (3) if our evaluations have adequate accuracy and precision.

Kokanee were introduced into Flathead Lake in 19 16, and were the primary spccics in the sport fishery until recently Kokanee densities declined in the 1960s because of changes in operations at Kerr and Hungry Horse dams and harvest by anglers (Bcattie et al. l987), and again in the 1980s after Opossum shrimp (Mysis *relica)* migrated to the lake from upstream sources. *Mysis* radically altered the food web of Flathead Lake, accounting for increased lake trout abundance (Beattie et al. 1990). Kokanee are preferred prey of lake trout, and by the late 1980s kokanee had completely disappeared from Flathcad Lake.

Monitoring of the kokanee fishery began with a lake-wide creel survey in 1992-1993 to describe baseline conditions of the fishery prior to Hungry Horse mitigation. It was estimated that no kokanee were harvested during the baseline period (Evarts et al. 1994).

Efforts to recover the kokanee population began with the release of I I 250.000 young-of-year kokanee into Flathead Lake between 1988 and 199 1. An annual production goal of 1 0,000,000 kokanee fry was postulated as neccssary to overcome lake trout predation After complction of the Mitigation Plan, it was determined that it was not possible to obtain enough kokanee eggs to meet the stocking goal. Managers adapted their restoration strategv to these realities and shifted the program to production of ycarling kokanee.

In 1993, 2 10,000 yearling kokancc were released at two sites on the east shore of Flathead Lake. In the first week following the release, 62% of lake trout caught in gill nets set near the release sites contained kokanee in their stomachs (Deleray et al. 1995). Two male kokanee released in 1993 were the onlv fish recaptured as adults during searches in fall 1994.

In 1994, the first year of the “kokanee experiment”, 802,000 yearling kokanee were released into Flathead Lake. Big Arm Bav was chosen as the release site to facilitate a more rigorous estimate of predation than was possible in 1993. The partial confinement provided in the bav delayed dispersal and enabled us to quantifiy short-w-m lake trout predation on stocked kokance. During the first 8 weeks following the release of kokanee in Big Arm Bav, 37% of captured lake trout contained kokanee, and we estimated that a minimum of 29% of the stocked kokanee were consumed by lake trout. We concluded it was unlikely that 30% of stocked kokanee would survive for 1 year after their release (Deleray et al. 1995). We considered the level of effort expended to monitor first year survival (about 300 employee-days) to be the maximum feasible under this project and questioned if success criterion 1 was within our capability to quantifv. The feasibilitv of cmploying hydroacoustic methods to evaluate criterion 1 will be investigated in 1996. Evaluation of criterion 2 is reported later in this document. Criterion 3 was not evaluated because the kokanee fishery was closed.

Results of a net-pen experiment in 1994 and capture of stocked kokanee indicated to us that hatchery-reared kokanec adjusted to the lake environment, competed for zooplankton, and maintained good physical condition after stocking. We concluded that kokanee were not food-limited in summer, and that predation was the primary factor in kokanee mortality in 1994 (Deleray et al. 1995).

We adapted the stocking plan again in 1995 by selecting South Bay as the new release site, where we expected predation by lake trout to be less than what occurred in 1993 and 199-I. We assumed that South Bay, being shallow and warm during summer, supported fewer lake trout than anv other part of the lake during summer, and we anticipated a reduction in immediate post-stocking losses from predation. On May 30 and June 1, 1995, 502,000 yearling kokanee were released in South Bay, followed by the release of 409,000 young-of-year kokanee on June 16, 1995.

We gill netted South Bav in 1995 and began consistently capturing kokanee about 1 month after their release into the bav. The delav was attributed to the fact that minimum capture size of the nets exceeded the length of most of the kokanee at the time of release. The kokanec we captured were in good condition, with measured K factors increasing progressively from the time of release to the last measurement in August.

Lake trout captured in South Bay during the study period preyed primarily on lake whitefish, followed by kokanee and yellow perch. Sixteen percent of lake trout caught in South Bay contained kokanee in their stomachs. The largest number of kokanee found in a-single lake trout stomach was four, and the average was 0.3 kokanee per lake trout during monitoring in 1995. During monitoring in 1994 in Big Arm Bav, the largest number of kokanee we found in a single lake trout stomach was 2 1, and the average was 0.93 kokanee per lake trout. Lake trout were also present in higher densities (indicated by gill-net catch rates) in Big Arm Bay in 1994 than in South Bav in 1995.

Lake trout abundance in South Bay declined in spring with increasing water temperatures, then increased in fall as water temperatures declined. Avoidance of warmer water appears to be the best explanation for the movement of lake trout out of South Bay.

We documented that hatchery rearing of kokanee to age 1.5 results in about 13% maturing as “jack” males at age 2, about 8 1% maturing at age 3 and the remainder at age 4. We assume this to be true whether they remained in the hatchery or were released into the lake. Therefore, excluding mortalitv, about 8 1% of each kokanee cohort released in Flathead Lake will reside there for about 18 months. Based on growth rates documented in 1994 and 1995 and out-planting in June, released kokanec grow into the fishery (> I I inches TL) in about 4 months, making them available for harvest for about 1 year.

In 1995 we monitored the cohort stocked in 1994 to evaluate criterion 2 (yearling to adult survival rate of 10°/). We conducted a basin-widc search for mature kokanee during October and November, and set Merwin traps near the 1994 and 1995 release sites. We captured 122 kokanee in Big Arm Bav and 223 kokanee in South Bav. We concluded, based on examination of oxytetracyline marks, that 65 kokanee-caught in Big Arm Bav and I kokanee caught at the South Bav site were planted in 1994. We observed no staging nor evidence of spawning at anv of the other historically used lake and river sites and consider it unlikely that large concentrations of spawning kokanee went unnoticed by agency personnel and the public.

We have monitored the survival of released kokanee for 3 consecutive years. Each year we adapted our release strategies to minimize immediate post-stocking predation by lake trout. We documented a lower rate of post-stocking kokanee mortality in South Bay than at the earlier release sites, which we attribute to the existence of a thermal refuge in South Bav from lake trout during summer. Thirty-seven percent of lake trout captured in Big Arm Bay during the first 8 weeks following the release of kokanee in 1994 contained kokanee in their stomachs. During the same 8-week period in 1995, 14% of lake trout captured in South Bav contained kokanee. The abundance of alternate prey for lake trout in South Bay may have additionallv reduced predation on kokanee. The prey fish of lake trout captured in Big **Arm** Bay in 1994 were 8 1% kokanee (numerically), whereas in South Bav in 1995 kokanee comprised only 12% of the prey fish of captured lake trout.

Kokanee released in 1994 and 1995 maintained desirable growth rates and condition during the monitoring period. We conclude, as we did after monitoring in

1994, that lake trout predation is the primary factor limiting the success of kokanee restoration in Flathead Lake. Releasing kokanee in South Bav in 1995 resulted in substantial reductions in immediate post-stocking mortality of kokanee relative to earlier release sites. The degree to which mortality was reduced in 1995 depended on (1) the percentage of the 1995 cohort that remained in South Bay, and (2) the rate **of mortality that occurred after the summer period when lake trout moved back into South Bay: Monitoring in 1996 was designed to detemline if improved post-stocking survival of yearlings in 1995 results in greater adult survival and escapement in 1996.**

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ACKNOWLEDGMENTS

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INTRODUCTION

The operation of Hungry Horse Dam on the South Fork of the Flathead River reduced the reproductive success of kokanee (*Oncorhynchus nerka*) spawning in the Flathead River. Montana Fish, Wildlife and Parks (MFWP) and the Confederated Salish and Kootenai Tribes (CSKT) authored a mitigation plan to offset those losses (MFWP and CSKT 199 I). The mitigation goal, stated in the Fisheries Mitigation Plan for Losses Attributed to the Construction and Operation of Hungry Horse Dam, is to: "Rcplace lost annual production of 100,000 kokanee adults, initially through hatchery production and pen rearing in Flathead Lake, partially replacing lost forage for lake trout (*Salvelinus namaycush*) in Flathead Lake."

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An Implementation Group was established to guide the Hungry Horse Mitigation program. The Technical Team, also with representatives from each agency, was established to monitor the success of the kokanee experiment and evaluate and develop adaptive strategies to facilitate that success. The team uses the success criteria to provide a relative context for evaluating monitoring results, and to fulfill the mandate of the Implementation Plan. The criteria will not be employed to define the success of the kokanec experiment until final evaluation in 1998 and 1999 (MFWP and CSKT 1993). The team refines its monitoring strategy annually to determine (I) if each success criterion is within our capacity to quantify, (2) if we are monitoring the appropriate biological parameters, and (3) if our evaluations have adequate accuracy and precision.

Kokanec were introduced into Flathead Lake in 19 16. Within 30 years kokanee had become a self-sustaining species in the Flathead Lake ecosystem, an important part of the area economy, and the primary species in the sport fisher-v. Kokanec densities began declining in the 1960s because of changes in Kerr and Hungry Horse dam operations and harvest by anglers. Opossum shrimp (Mysis relicta) first appeared in the lake in 198 1, after having been introduced in small lakes upstream of Flathead Lake as early as 1968. Mysis radically altered the food web of Flathead Lake and ended the apparent stability that had existed prior to their appearance. Densities of Mysis peaked in 1986, while *Daphnia spp.* severly declined (Spencer et al. 199 I). Mysis are ideal prey for lake trout, accounting for increased survival of juvenile lake trout and subsquent increases in lake trout abundance (Beattic et al. 1990). By the late 1980s kokance had completely disappeared from Flathead Lake.

The first effort to recover the kokanee population was the release of 1 1,250.OOO young-of-year kokanec into Flathead Lake between 1988 and 199 I. These fish did not survive to reproduce and the lack of survival was attributed to competition with Mysis for zooplankton (unpublished MFWP files). Mysis densities declined between 1986 and 199 1, while cladoccran densities (especially *Daphnia spp.)* increased (Spencer et al. 199 1). Beattie et al. (1990) proposed that poor survival of kokanee was more the result of predation by lake trout and lake whitefish (Coregonus *clupeaformis)* than the competitive interaction with Mysis. Kokanee recovery efforts thereafter were aimed at producing and stocking enough kokanee to overcome lake trout predation. An annual production goal of 1 O,OOO,OOO kokanec fry was postulated. After completion of the Mitigation Plan, it was determined that obtaining enough kokanee eggs to meet the stocking goal was not possible. Managers adapted their restoration strategy to these realities and shifted the program to production of yearling kokancc.

Monitoring of the kokanee experiment began with a lake-wide creel survey in 1992- 1993 to describe baseline conditions of the fishery prior to Hungry Horse mitigation. It was extimated that no kokancc were harvested during the baseline period (Evarts et al. 1994).

In 1993, 2 10,000 kokanee yearlings were released at two sites on the east shore of Flathead Lake. Monitoring was brief because of rapid dispersal of these fish into the main body of the lake. In the first week following the release, 62% of lake trout caught in gill nets set near the release sites contained kokanee in their stomachs (Dcleray et al. 1995). We were unable to quantify losses attributed to predation because we were not able to estimate lake trout abundance; therefore, we could not evaluate criterion I . Criterion 2 was evaluated in 1994 by surveying all major historical kokanee spawning sites. We confirmed the presence of at least one male kokanee in Mill Creek and one male below Bigfork Dam that were released in 1993, and concluded that escapement was insufficient to meet the program objective. Criterion 3 was not evaluated because the kokanee fishery was closed to harvest.

In 1994, the first year of the "kokanee experimcnt", 802,000 yearling kokanee were released into Flathead Lake. Big Arm Bay was chosen as the release site to facilitate a more rigorous estimate of predation than was possible in 1993. The partial confinement provided in the bay delaved dispersal and enabled us to quantily short-term lake trout predation on stocked kokanee. We estimated predator (lake trout) abundance and the rate of predation in the bay. We estimated that a minimum of 29% of the stocked kokanee were consumed by lake trout in Big Arm Bay during the first 8 weeks following their release, and concluded it was unlikely that 30% would survive for 1 year after their release (Deleray et al. 1995). We limited the period of quantification to 8 weeks due to the confounding effect of lake trout and kokanee movement out of the studv area. We considered the level of effort expended (about 300 employee-days) to be the maximum feasible under this project and questioned if criterion 1 was within our capability to quantify The feasibility of emploving hydroacoustic methods to evaluate criterion 1 will be investigated in 1996. Evaluation of criterion 2 is reported in this document as a result of the 1995 monitoring. Criterion 3 was not evaluated because the kokanee fishery was closed.

A net-pen experiment in 1994 demonstrated that in the absence of predation, hatchery-reared kokanee adjusted to the lake environment, competed for zooplankton, and maintained good phvsical condition during the first month after stocking. Kokanee captured in the wild during the same time period also exhibited good growth and condition. We concluded that kokanee were not food-limited in summer, and predation was the primary factor in kokanee mortality in 1994 (Deleray et al. 1995).

We adapted the stocking plan again in 1995 by selecting South Bay as the new release site, where we expected predation by lake trout to be less than what occurred in 1993 and 1994. We assumed that the shallow and warm bay would contain a lower density of lake trout during summer, and anticipated a reduction in immediate post-stocking predation on kokanee. On May 30 and June 1, 1995, 502,000 yearling kokanee were released in South Bay, followed by the release of 409,000 young-of-year kokanee on June 16, 1995.

In 1995 we evaluated attainment of success criterion 2 by the cohort stocked in 1994 We did not attempt to evaluate criterion I for kokanee released in 1995 because of the difficulties in enumerating kokanee cohorts in Flathead Lake. Additional monitoring activities in 1995 were designed to (I) evaluate the suitability of South Bav for kokanee, (2) qualitatively describe predation rates on kokanee in South Bay, and (3) evaluate the growth, imprinting, and time of maturitv of kokanee released in 1994 in Big Arm Bay

STUDY AREA

Flathead Lake is roughly 5 10 km^2 in surface area (Figure 1), oligomesotrophic, has a mean depth of 50.2 m, and a maximum depth of 1 13.0 m (Zackheim 1983). Most of the 18,400 km^2 drainage area is underlain by nutrient-poor Precambrian sedimentary rock (Moore et al. 1982). In recent vears researchers have identified a deterioration in the water quality of Flathead Lake from increased nutrients generated by the rapidly increasing human population of the basin (Flathead Basin Commission 1993). Major tributaries to the lake are the Flathead and Swan rivers.

There are 25 species of fish known to occur in Flathead Lake (Leathe and Graham 1982), 10 of which arc native Introduced game species include lake trout, lake whitefish, and yellow perch (Perca flavescens). Native gamcfish include bull trout *(Salvelinus confluentus),* for which the fishing season was closed in 1992, and westslope cutthroat trout *(Oncorhynchus* clarki lewisi). Native, nongame species include northern squawfish (Ptychocheilus *orqonensis),* peamouth (Mylocheilus caurnus) , longnosc sucker (Ccrtostomus catostomus) , largescale sucker (Catostom us macrocheilus), and redsidc shiner (Richardsonius *balteafus).*

South Bay, the southernmost lobe of Flathead Lake, is connected to the main lake by an island-dotted channel known as the Narrows (Figure I). South Bay is the most exstensive shallow area of the lake, with maximum depth of 10.6 m, average depth of 4.6 m, and surface area of 54.5 km (Cross and Waite 1988). South Bay composes I 1.8 % of the surface area of Flathead Lake at full pool and is slightly larger than Big Arm Bay, where kokanee were planted and monitored in 1994. However, because the bay is shallo\v, its surface area is reduced 18% during fall and Winter

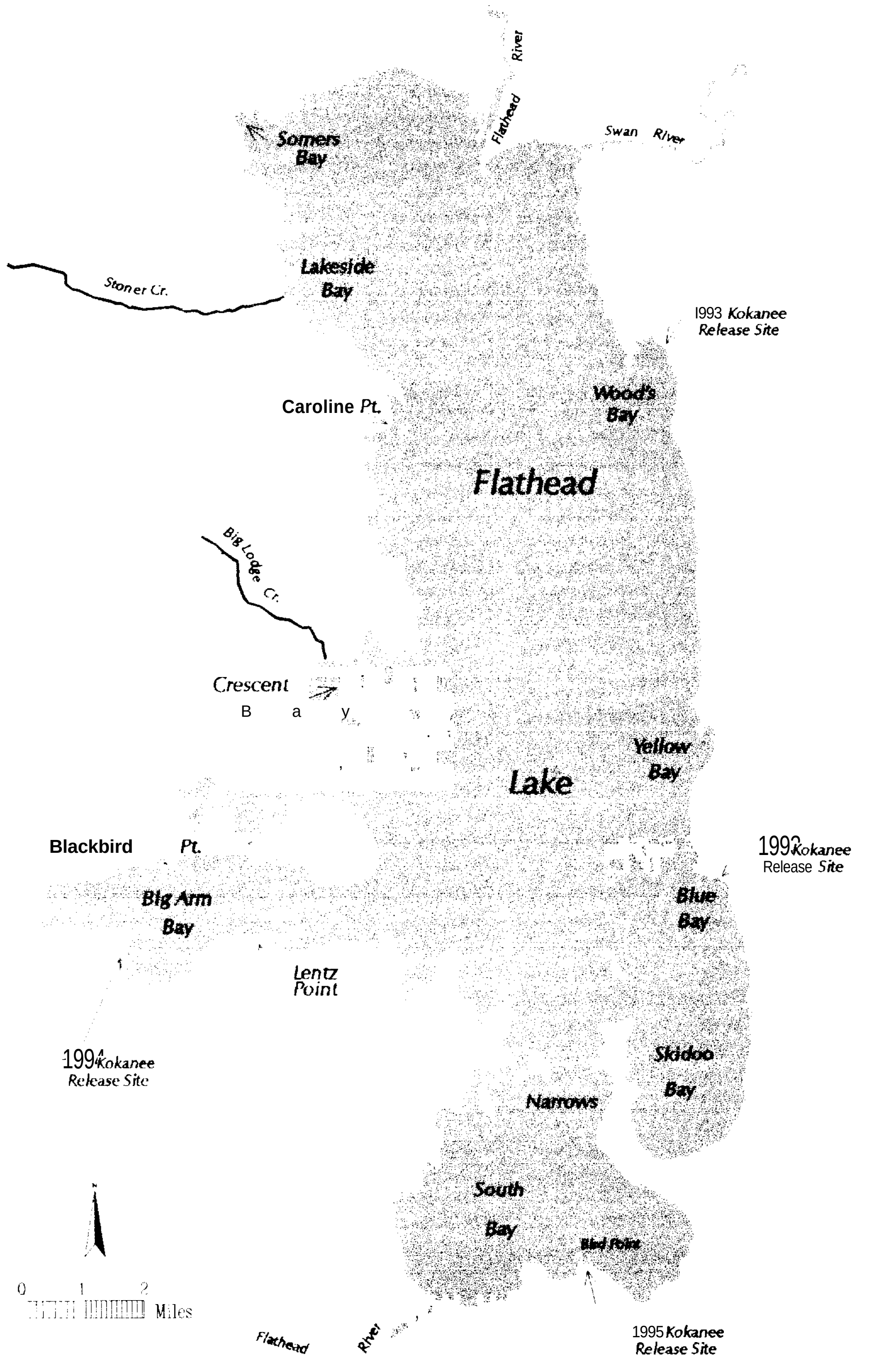

Figure 1. Kokanee release sites and *survey* locations on *Flathead* fake

when normal operations reduce the lake level 3.3 m. The substrate is primarily mud and silt, and much of the bay supports rooted aquatic vegetation (*Potamogeton*, *Myriophyllum*, and *Chara*) in the summer months. Flathead Lake water passes through South Bay before exiting the lake via the Flathead River. This water usually comes from the surface of the lake because of the shallow (< 7 m) passage into the bay. South Bay is frequently ice-covered in winter, and surface water temperatures often reach 23°C in summer, which are atypical conditions in the main lake.

METHODS

Kokanee Rearing and Stocking

Kokanee stocked in Flathead Lake in 1994 were progeny of lolanee from Granby Reservoir in Colorado. They were shipped in December 1992 to Creston National Fish Hatchery as eyed eggs from Glenwood Springs State Fish Hatchery in Colorado. The eggs hatched in late January and early February of 1993, and fish grew to an average length of 163 mm total length (TL) when stocked at 16 months old. The Granby lolanee originated from Flathead Lake stock in 195 1 (Martinez 1991).

Kokanee stocked in 1995 were collected in 1993 and originated from three sources. Approximately 77% were progeny of Swan Lake kokanee collected during November. Swan Lake, in the Swan River drainage upstream from Flathead Lake, contains a self-sustaining kokanee population that spawns primarily along the lakeshore. About 15% of the yearling kokanee came from eggs collected at Lake Mary Ronan during October and November. Lake Mary Ronan is a small, eutrophic lake-located west of Flathead Lake, that is stocked annually. Both groups of eggs were collected by crews from the State of Montana's Flathead Lake Salmon Hatchery and eyed at that facility before being transferred to Creston in early spring 1994. The remaining 8% of yearling lolanee stocked in 1995 came from Granby Reservoir in Colorado. The young-of-year kokanee stocked in 1995 originated from Sheep Creek in Flaming Gorge Reservoir, Wyoming, and were collected in late August and September 1994. Approximately 700,000 eyed eggs from this source were incubated at Auburn State Fish Hatchery in Auburn, Wyoming, and shipped to Creston Hatchery in October 1994. These fish originated from the New Fork Lake stock (Wyoming), which was established with fish from Meadow Creek, a tributary to Kootenay Lake in British Columbia.

Electrophoretic analysis of these populations, performed by the University of Montana Wild Trout and Salmon Genetics Lab, indicated that the Granby, **Swan,** and Mary Ronan populations were genetically similar (pers. comm., K. Sage, U. of Montana, Missoula). The Wyoming population, which is not derived from Flathead Lake stock as are the others, was genetically distinct, having two unique alleles.

About 502,000 yearling lolanee were stocked from May 30 through June 1, 1995, at a private access **on** Bird Point in South Bay. Winds were calm, and mid-day air temperature was about 27°C. All fish were transported before 2:00 PM to minimize thermal stress. The fish were transported in 11 °C water, requiring 11 truck loads. Water temperature at **the** stocking site was 15°C. Because of the warm, calm weather, the shallow shoreline waters warmed to about 2 1 °C at midday, and some fish that swam along shore were scavenged by gulls. Losses were estimated to be less than 1%.

A prestocking random sample of 200 yearling kokanee was taken from 5 of 16 raceways on May 24, 1995. Average length was 149 mm, ranging from 103 to 208 mm. Average weight was 27 g, ranging from 8 to 80 g. Condition factor (K) averaged 0.78 (C = 27.98).

Young-of-year lolanee were stocked on June 16, 1995, at the same site as the yearling kokanee. Two trucks delivered 409,000 **fish** at 9:30 AM. Due to a previous cold front, the lake temperature was 15°C. Water in the trucks was 10°C. A random sample of 112 fish collected prior to stocking averaged 68 mm TL, ranging from 47 to 83 mm. Mortality was low; about 200 dead kokanee were observed.

All stocked **fish** were fed 10 dav doses of a diet mixed with 10% oxytetracycline, a common antibiotic, to develop distinctive rings on their bones **that** fluoresce under long wave ultraviolet light (black light). These rings (hereafter referred to as a mark) are permanent and enabled us to identify fish of hatchery origin. Kokanee planted in 1994 received doses of oxytetracycline in late August and again in early November 1993 at average lengths of 102 and 119 mm, respectively. Kokanee planted in 1995 were marked in late February 1995, at an average length of 114 mm. In mid-May 1995 a second dose of oxytetracycline was administered to the yearling fish (which averaged 145 mm TL), to arrest a bacterial outbreak at the hatchery. Because of this treatment, fish stocked in 1995 carried marls similar to **those** stocked in 1994. A single mark was applied to the young-of-year kokanee in early June when they averaged 68 mm TL.

Kokanee cohorts released in 1994 and 1995 were generally distinguishable by length. However, some of the fast-growing "jack" males stocked in 1995 were as large as a portion of the fish planted in 1994. We used oxytetracycline marls to assist in the separation of intermediate lengths in the bimodal distribution of lolanee caught in the Big Arm trap. Intensity of oxytetracycline marls is largely a function of metabolism, which in turn is a function of water temperature and rate of feeding. Kokanee planted in 1994 had a darker mark (applied in August) and a lighter mark (applied in November). Fish planted in 1995 had two marks of equal intensity (applied in February and May). To reduce bias, the analyst viewing the marls was unaware of the length of the fish from which the vertebrae came. We could not quantify the error in this subjective method, but consider the ramifications of incorrectly identifying year classes to be small due to the small number of returning kokanee captured.

We examined oxytetracycline marls on vertebrae from 8 1 kokanee collected in Big Arm Bay, South Bay, and Mill Creek, and separated the kokanee into cohorts based on intensity and pattern of marls. We extrapolated from the subsample of 64 fish we examined from Big Arm Bay to the entire sample of 122 fish captured at that site to estimate the relative number of fish from 1994 and 1995 cohorts caught in the trap. We also extrapolated from the 13 marked fish that we examined from South Bay to the 223 fish captured there.

Monitoring Kokanee Survival

We used horizontal, sinking gill nets to capture lake trout and lolanee during four different sampling periods in 1995. We set nets in South Bay in April through November, lakewide in April and August, and in Big Arm Bay in June (Table 1).

Table 1. Summary of gillnetting in Flathead Lake, 1995.

Date	Area	Number of single nets	Depth range (m)
April 25 - 27	lakewide	66	0 - 20
June 12 - 16	Big Arm	32	19-34
April 13 - Nov 17	South Bay	154	O - 6
Aug 25 - Sept 7	lakewide	70	12 - 61

Nets were 38 m long, 2 m deep, and consisted of five individual panels. Each panel differed in mesh size with bar measures of 19, 25, 32, 38, and 5 l mm. Each set consisted of two nets tied end to end. Catch rates are reported as catch per paired net set. Sampling was conducted at the inlet to South Bay, at the river outlet from the bay, and mid-bay, beginning on April 13, 1995, to characterize the fish community present prior to release of kokanee. Samples were collected on three additional days in May prior to the release. Sampling intensity increased in June to 3 days per week to better characterize the post-release period. From mid-July through November sampling occurred 1 day per week, with intensity varying from two to five paired nets per day. The last samples were collected on November 17, 1995. A total of 154 single nets (77 pairs) were set. Duration of sets ranged from 10 to 27 hours, and nets were always left overnight. All captured lake trout were sacrificed for analysis of stomach contents. Temperature profiles were measured weekly at mid-bay sites. Zooplankton were collected at the time of kokanee release and on three later dates (6/ 1, 6/1 6, 7/25, and 8/23). Zooplankton were collected with a Wisconsin-type sampler having a 118 mm opening and 80 micron mesh netting, pulled vertically from 5 m depths at 1 m/s. Three samples were collected on each date, and each field sample was subsampled three times in the lab for enumeration. Zooplankton were identified to order.

Over half of the known historical kokanee spawning areas in the river system and nearly all the historical lakeshore areas were surveyed in fall 1995 for returning spawners (Table 2). About 14 employee-days were invested in the search.

We installed Merwin traps near the sites where stocking occurred in 1994 and 1995 to evaluate the return of mature fish to the release sites. The Merwin traps consist of two fvked compartments, each 2.4 m square and 3 m deep, ("pot" and "spiller") attached to a floating support platform and constructed of 6 mm nylon mesh. Attached to the pot is a "heart" section with v-shaped, 4.6 m long wings. A 3.0 m deep floating lead, up to 61 m long, was attached to the shore, and the trap was anchored perpendicular to the shore. The heart and leads are constructed of 1 0-mm square, knitted-nylon mesh. Fish swimming along the shoreline encounter the lead, travel parallel to it, enter through the first fyke, into the spiller, and through the second fyle, into the pot. In a previous experiment, fish were held in these traps for 1 month with no obvious ill effects (Deleray et al. 1995).

On September 19, 1995, a Merwin trap was placed in Big Arm Bay about 50 m north of the site where kokanee were stocked in 1994, and removed 78 days later on December 6. The trap was shifted twice by wind, requiring that it be repositioned. Typically, the Big Arm trap was checked twice per week, except on two occasions when longer intervals occurred between checks (Nov. 7 - 20 and Nov. 29 - December 6). Surface water temperature and time of day were recorded. Lake trout and cutthroat trout were measured and released, except in a few instances when large lake trout were killed and stomach contents examined. Stomachs from large northern squawfish were also examined. Captured kokanee were measured, weighed when conditions allowed, finclipped (to separate newly captured fish from previous catches), assessed for sexual maturity, and returned to the pot. Immature kokanee were usually collected immediately because they were likely to become prey if left in the trap. Previously clipped kokanee were assessed for sexual maturity to better define the spawning period.

Table 2. Location, method and date of redd surveys conducted in the Flathead Lake and River System, October-November 1995.

Location	Survey Method	Date	Comments
Flathead River			
Upper Middle Fork	Bank	October 23	Surveyed 4 of 10 historical staging and spawning areas
South Fork	Bank	October 23	Surveyed 4 of 5 historical staging and spawning areas
Main Stem	Boat, Wade Boat, Wade, Snorkel, Wade	October 27 November 8 November 9	Surveyed 30 of 42 historical spawning areas and 6 staging areas
Whitefish River	Wade, Bank	October 3 1	Surveyed 2 of 4 historical spawning areas
Swan River	Snorkel	November 13	Surveyed both historical staging and spawning areas
McDonald Creek	Bank Snorkel	October 4 November 14	Walled all 2.8 km of stream Surveyed all 2.8 km of stream
Flathead Lake			
West Shore	Bank	November 14	Surveyed 2 of 4 historical spawning areas
East Shore	Boat	November 15	Surveyed 16 of 17 historical spawning areas
Big Arm	Boat	November 2 9 December 6	Surveyed 14.5 km of shoreline Surveved 0.8 km of shoreline

A second Merwin trap was placed in South Bay on September 20, 1995, and it fished for 62 days until November 2 1. The trap was positioned about 50 m south of where kokanee were stocked. The trap was checked on a schedule similar to the Big Arm trap. The trap was dislodged **once** by high winds, but generally fished effectively throughout **the** period.

RESULTS

Gillnetting

Gillnetting in South Bay prior to the release of lolanee in 1995 produced **one** kokanee that had been released in 1994, and an average of 1.9 lake trout per paired net (Figure 2). For the 2 weeks following the kokanee release, **catch** rates averaged

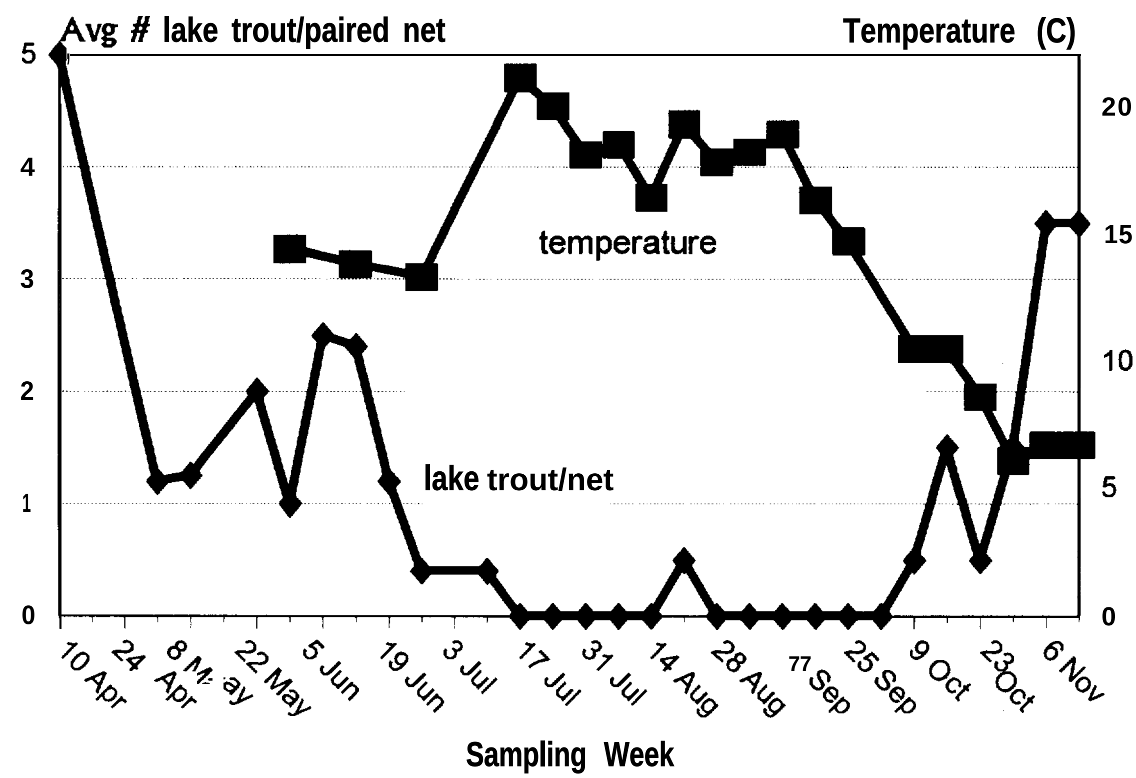

Figure 2. Average number of lake trout caught per paired gill **net** set, and 1 m depth water temperatures, South Bay, 1995.

2.5 lake trout per paired net, then declined to zero by the week of July 17. Only two lake trout were caught in South Bay while water temperatures exceeded 15.5 °C. **Catch** rates increased after the week of October 2, peaking at 3.5 lake trout per paired net in the weeks of November 9 and 17.

Kokanee were consistently captured in gill nets in South Bay beginning about 1 month after release (Figure 3) . Minimum capture size of kokanee in the 19 mm mesh was about 160 mm TL; therefore, we assume that the average length of sampled lolanee exceeds the average length of the population. The average length of kokanee captured in gill nets increased from 175 mm in early July to 260 mm in mid- November (Figure 4). Forty-seven lolanee captured on July 19 averaged 195 mm TL, ranging from 167 to 247 mm. The average condition factor (K) was 0.95 (C = 34.3), a substantial increase from the average condition (I<) of 0.78 when the fish were stocked 7 weeks earlier. All fish collected in the nets were in excellent condition, their flesh was orange (changed from white at the hatchery), and

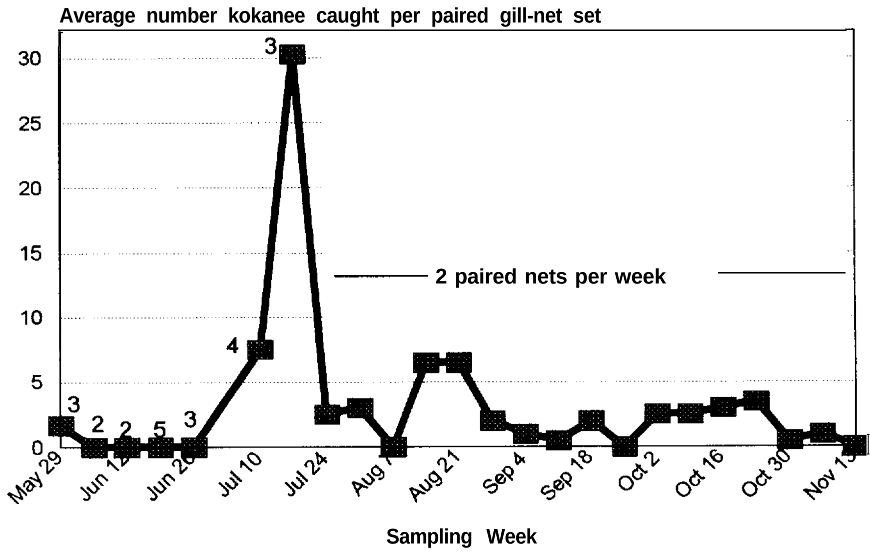

Figure 3. Average number of lolanee caught in paired gill nets in South Bay, 1995. Superscripts are number of nets.

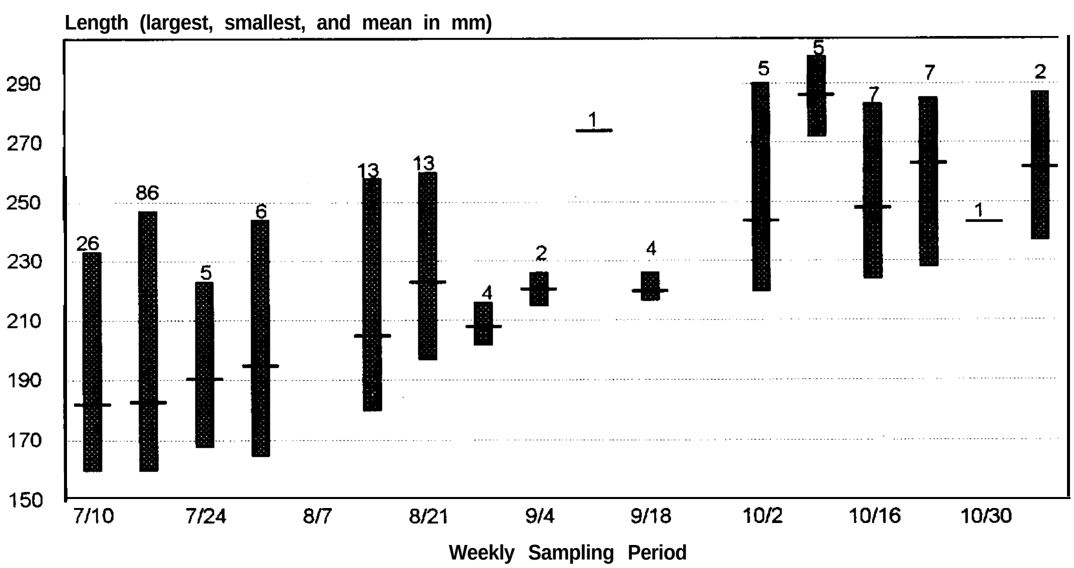

Figure 4. Largest, smallest, and mean lengths of kokanee caught in gill nets in South Bay, 1995. Superscripts are sample sizes.

several of the stomachs were distended with *Daphnia spp.* About one-third of these fish were "jack" males with maturing gonads and were longer than the rest of the fish in the sample.

A second group of 26 kokanee collected on August 17 (13 fish) and August 23 (13 fish) averaged 208 mm TL, and ranged from 175 to 257 mm. Average condition factor (I<) was 1.07 (C = 38.66). This represents an increase of 0.29 (K) from the time of stocking, and 0.12 (K) from the previous month. In this sample, six fish (23%) were jack males, including six of the seven largest.

A total of 127 lake trout were captured in South Bay during the study period (Figure 5). Of these, 55% had fish in their stomachs, 34% had empty stomachs, and 1 1% contained only invertebrates. Of the 92 lake trout caught in South Bay following the release of kokanee in June, 16% contained lolanee. The largest number of lolanee found in a lake trout stomach was four, and the average was 0.2 lolanee per lake trout.

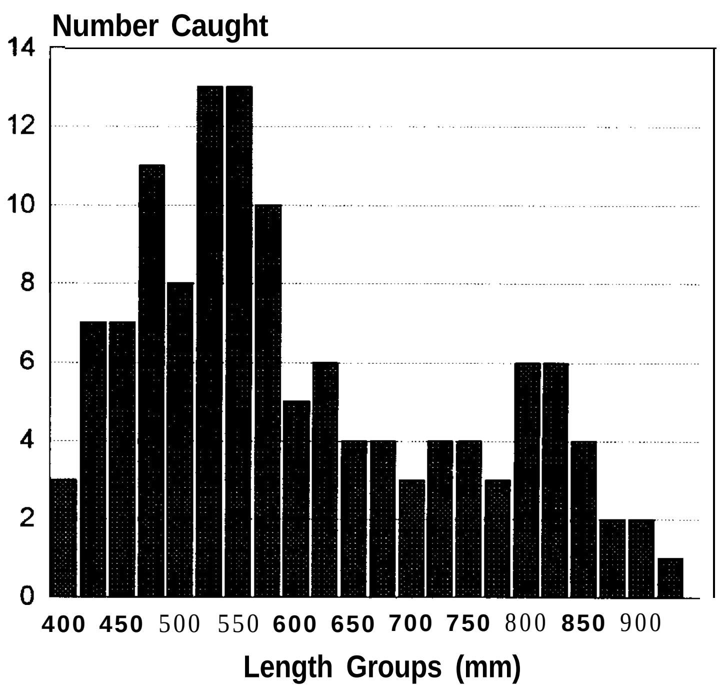

Figure 5. Length groups (label marls lower end of group) of lake trout gill-netted in South Bay, 1995.

Lake whitefish were the most abundant species caught in gill nets in South Bay (Appendix A). The average length of lake trout containing lake whitefish at time of capture was 742 mm TL, and those without lake whitefish in their stomachs averaged 585 mm TL. Twenty percent of all lake trout caught in South Bay contained lake whitefish, 12% contained kokanee, 9% contained yellow perch, and 2 1% contained unidentified fish (without marks).

Lake-wide spring gillnetting, conducted on April 25 to 27, 1995, produced 39 lake trout that averaged 552 mm TL, ranging from 3 11 to 900 mm. We analyzed stomach contents from 38 of these lake trout; 12 were empty, and 11 contained fish. No kokanee were caught in these nets or observed in the stomachs of the captured lake trout.

We gillnetted Big Arm Bay in June 1995 to duplicate a portion of the monitoring procedure used in 1994, and caught five fish species: lake whitefish, lake trout, peamouth, longnose sucker, and northern squawfish (Appendix A). Eighty-eight lake trout (1.4/paired net) were caught, ranging in length from 207 to 1,020 mm. We examined 84 lake trout stomachs and found 48 empty. No kokanee were caught in these nets or observed in any of the lake trout stomachs in this sample from Big Arm Bay.

Lake-wide gillnetting in late summer yielded 703 lake whitefish (5.0/paired net), 144 lake trout (1 . l/paired net), 2 bull trout (0.02/paired net) and 3 kokanee (0.02/paired net; Appendix A). The three kokanee were 174, 268, and 280 mm TL. Two **were** caught north of Blue Bay and were confirmed by the presence of marks to have been planted in 1994. One kokanee was caught in Somers Bay and was not marked. We examined the stomachs of 134 lake trout and l bull trout; none contained kokanee.

In late August we identified with hydroacoustics a concentration of fish near Caroline Point at the depth of the thermocline that we suspected were kokanee. Vertical gill nets were set that spanned from the surface to a depth of 27.4 m. One marked kokanee (stocked in 1995) and many juvenile lake whitefish were caught between the depths of 9.1 and 18.3 m (Appendix A).

Zooplankton

We measured an average of 2.9 cladocerans per liter and 34.9 copepods per liter in South Bay when lolanee were released. The trend through the rest of the summer was toward lower densities of both (Table 3).

Table 3. Cladocerans and copepods collected in South Bay, 1995.

Date	Cladocerans	Copepods
June 1, 1995	2.9 per liter	34.9 per liter
June 16, 1995	1.5 per liter	12.1 per liter
July 25, 1995	1.3 per liter	3.5 per liter
August 23, 1995	1.9 per liter	3.5 per liter

Surveys to Detect Kokanee Spawning

The basin-wide search for mature kokanee in 1995 (see Table 2) yielded none, except at the planting sites and Mill Creek. We snorkeled six deep runs of the Flathead River where conditions are suitable for staging spawners and counted 270 lake whitefish, 32 mountain whitefish, 3 westslope cutthroat trout, 1 bull trout, and 1 lake trout. No lolanee or evidence of spawning (redd construction) was observed. Kokanee were not observed in Brenneman and Siderius sloughs. Twenty lake whitefish, 10 mountain whitefish, and 1 westslope cutthroat trout were observed during bank surveys of the Middle Fork Flathead River. Two snorkelers surveyed McDonald Creek on November 14, from Lake McDonald outlet to the confluence with the Middle Fork, and observed only one rainbow trout. No lolanee staging or evidence of redd building was confirmed in McDonald Creek.

No lolanee or signs of spawning activity were observed during programmed searches of the shoreline of Flathead Lake. On November 20, 1995, a contractor working on a dock at Big Arm Resort, on the south shore of Big Arm Bay, reported seeing a school of 30-40 kokanee in shallow water near the marina. On December 6, 1995, we searched 800 m of shoreline by boat from Big Arm State Park to the Resort. We identified freshly dug depressions in the gravel that resembled redds, but no fish were seen. We excavated the sites, did not find eggs, and do not believe they were lolanee redds.

Kokanee were first observed in Mill Creek on August 23. One lolanee was captured there on September 14 (305 mm ♀), one on October 1l (273 mm ♂), and two on November 27 (269 mm ♂ and 281 mm ♂). Oxytetracycline marks indicated that the first two were planted in 1994, and the second two in 1995. Flesh color of the captured fish was orange, further indication of a zooplankton diet and period of residence in the lake. A few other kokanee were also observed in the creek, but were not captured. No redds were found in Mill Creek in 1995.

Surveys of Anglers

We examined stomachs of 59 lake trout obtained by fishing guides at Woods Bay Charters on July 10 through July 14, 1995. These fish were caught in the north half of Flathead Lake and ranged from 400 to 72 1 mm TL. Twenty-five stomachs contained lake whitefish ranging from 100 to 300 mm TL, and none contained kokanee. Unconfirmed reports were also received from the guides that lolanee were common in the stomachs of lake trout they caught in the northeast portion of the lake during June. We confirmed the presence of a kokanee (planted in 1994) in the stomach of a lake trout caught in Woods Bay by an angler on October 14, 1995.

We examined stomachs of 90 lake trout, ranging from 391 to 895 mm TL, obtained from anglers in the MacMania fishing derby held on August 5 and 6, 1995. Angling was restricted to the north half of the lake. No kokanee were observed in any lake trout stomachs from this sample.

A fishing guide reported catching four or five lolanee (200 to 330 mm TL) while flyfishing in the Middle Fork of the Flathead River at the mouth of McDonald Creek on about September 10, 1995. We were not able to confirm the presence of kokanee in the McDonald Creek area during our surveys.

Merwin Trapping to Target Returning Kokanee

One hundred twenty-two kokanee were captured in the Merwin trap in Big Arm Bay in 1995. Kokanee were first caught in early October, **soon** after surface water temperatures dropped below 15°C and about 2 weeks after the trap was installed. Most lolanee (55%) were captured after November 7, when surface water temperatures were 5 to 8°C (Figure 6). Nearly all adult lolanee sampled after November 7 were sexually mature (Appendix B). Fifty-eight of 59 kokanee in the trap on December 6 were sexually mature.

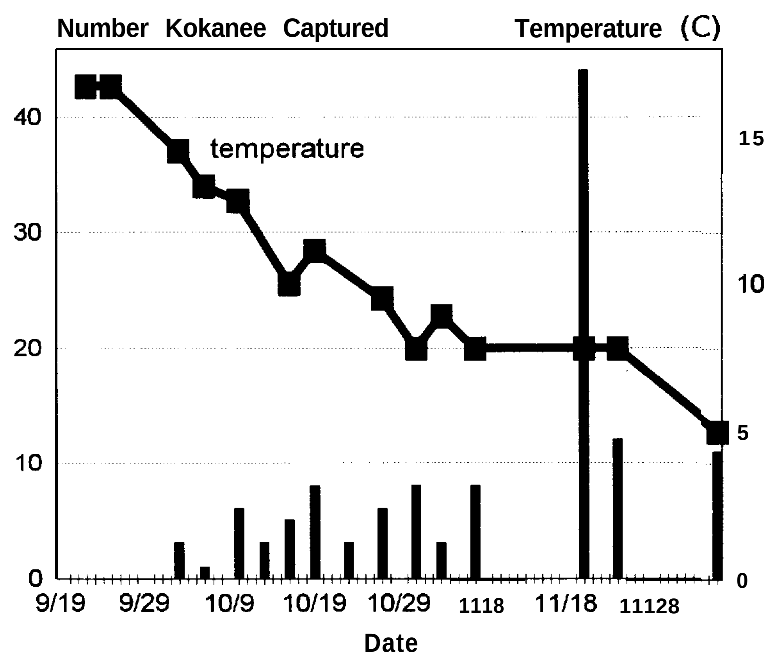

Figure 6. Number of kokanee captured in a Merwin trap (bar), and water temperatures at the trap (line), Big Arm Bay, 1995.

We analyzed oxytetracycline marls from 64 lolanee collected in the Big Arm trap and extrapolated the results to the total number of kokanee captured. We estimated that 53% of the lolanee caught in Big Arm Bay in 1995 were stocked at Big Arm as yearlings in 1994, 45% were stocked in South Bay as yearlings in 1995, and 2% were stocked in South Bay as fingerlings in 1995 (Figure 7).

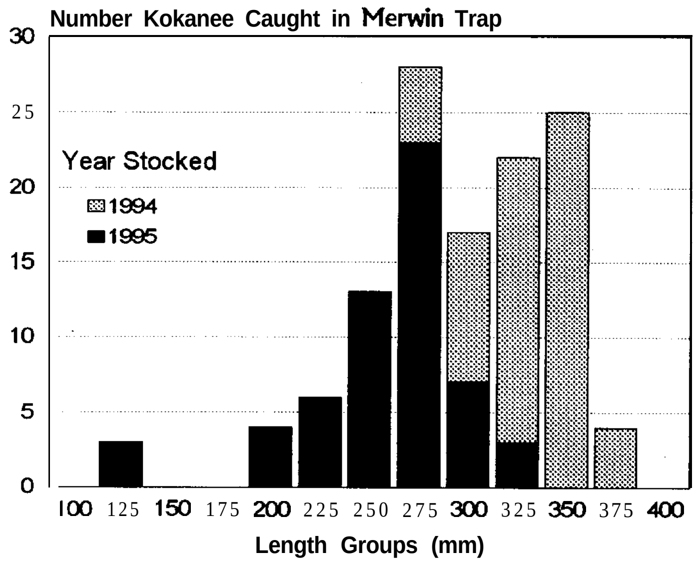

Figure 7. Length groups of lolanee (label represents the lower end of group) caught in a Merwin trap, Big Arm Bay, 1995.

Thirty-five mature lolanee (18 ♀ : 17 ♂) that were planted in 1994 were removed from the Big Arm trap on December 6. Average length of the males was 350 mm (range 292-390 mm), and average length of the females was 336 mm (range 313-364 mm). Nineteen kokanee removed from the Big Arm trap on December 6 **were** determined by oxytetracycline marks to have been planted in 1995 in South Bay. Sixteen of those were "jack" males, three were females, and average length was 294 mm.

Nine other fish species were captured in the Merwin trap in Big Arm Bay during the monitoring period. Lake trout were first captured on October 3, when water temperature was 14.5 °C. We verified predation of kokanee in the trap by the presence of finclipped kokanee in predators' stomachs.

Two hundred twenty-three kokanee were caught in the Merwin trap off Bird Point in South Bay in 1995. Kokanee were first captured almost immediately after the trap was installed in late September, when surface water temperature was 15.5°C. Most kokanee (69%) were captured after October 23, when surface water temperature had dropped to about 6°C (Figure 8). Most adult kokanee sampled after October 23 were sexually mature (Appendix B).

One of the kokanee captured at the Bird Point site (a female, 367 mm TL) was confirmed by its mark to have been planted in 1994 in Big Arm Bay. Only one other mature female was caught in this trap (285 mm TL), and it was confirmed to have been planted in 1995. One young-of-year kokanee (149 mm TL) planted in 1995 was also captured at this site. Based on size frequency, preponderance of males, and analysis of marls, we assume that all other lolanee captured at the Bird Point site (200-325 mm TL) were either "jacks" or immature fish planted in 1995 (Figure 9).

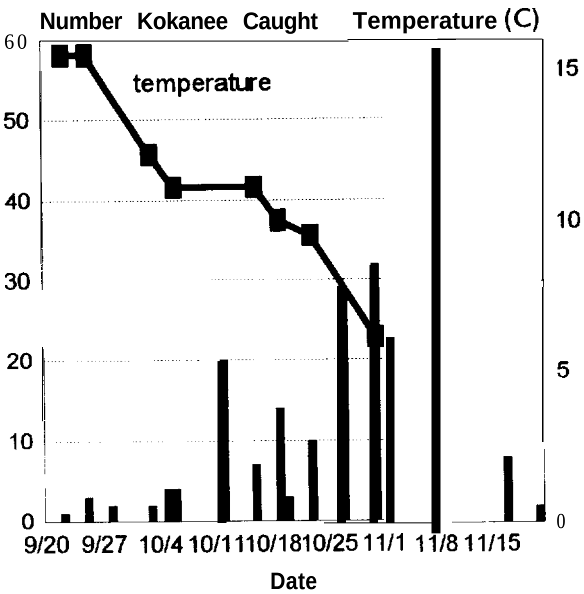

Figure 8. Number of ltolanee caught in a Merwin trap (bar), and water temperatures at the trap (line), South Bay, 1995.

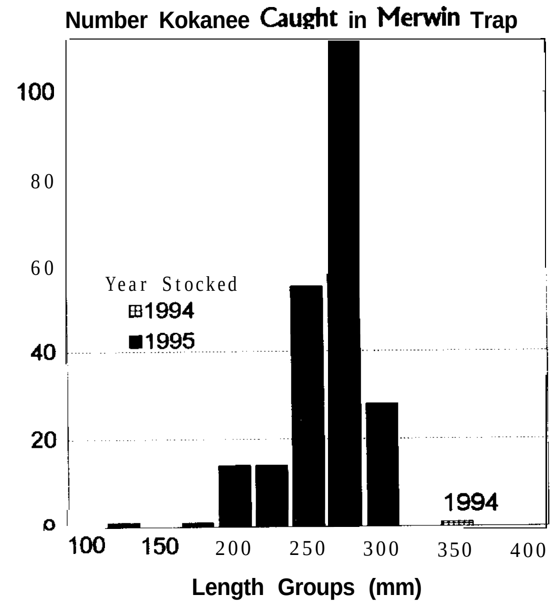

Figure 9. Lengths of kokanee caught in a Merwin trap, South Bay, 1995.

Lake trout were first captured in the Bird Point trap on October 12, when the water temperature was 11 °C. These fish may have preyed on kokanee before entering the trap, but predation in the trap was also verified.

We received no reports of kokanee immediately downstream from Kerr Dam. A single ltolanee of unrecorded size was captured in a gill net set in Noxon Rapids Reservoir (245 km downstream) on about October 1, 1995, and because no ltolanee are normally found there it was assumed to have come from Flathead Lake (J. Huston, pers. comm. MFWP, Kalispell).

DISCUSSION

Monitoring of South Bay in 1995 allowed us to define the period of lake trout presence and describe kokanee movement and persistence in the bay. On May 31, 1995, 1 day after the release of kokanee, we caught one ltolanee in a gill net in the Narrows, which is the outlet from South Bay to the main lake. On June 6, 1995, three lake trout were caught in a gill net in the Narrows, and each contained two kokanee. These captures indicated immediate movement of an undetermined number of released ltolanee out of South Bay and into the main lake. We received several unconfirmed reports from anglers of lake trout caught in the main lake in June that contained lolanee in their stomachs.

Although an unknown number of the released kokanee moved to the main lake, some of them remained in South Bay throughout the study period. Gill-net catch rates of kokanee in South Bay were highest in July, after which they declined, but persisted throughout the study period (See Figure 4) .

Lake trout abundance in South Bay declined in spring with increasing water temperatures and increased in fall with declining water temperatures (See Figure 2). Avoidance of warmer water appears to be the best explanation of the movement of lake trout out of South Bay. We caught only two lake trout in our gill nets in South Bay during the 11 weeks that water temperatures exceeded 15.5°C.

South Bay does not appear to provide habitat for juvenile lake trout, at least during the period we sampled. During the study period we caught only two lake trout less than 400 mm TL in South Bay, which represented 1.6% of the lake trout catch. In contrast, 19.5% of the catch of lake trout in Big Arm Bay in 1994 was less than 400 mm. Seasonal changes in abundance of lake trout in Big Arm Bay in 1994 were similar to that in South Bay in 1995, although in Big Arm Bay lake trout persisted through the summer. Catch rates of lake trout were higher in Big Arm Bay on most sampling dates than in South Bay (Figure 10). The depth of Big Arm Bay provides thermal refuge below the thermocline for lake trout, while South Bay is isothermal in summer and warmer water appears to exclude lake trout. Not only were there higher densities of lake trout in Big Arm Bay than in South Bay (as evidenced by higher gill-net catch rates), but lake trout consumed kokanee at higher rates than in South Bay. Through the 8 week period following the release of kokanee in Big Arm Bay in 1994, 37% of

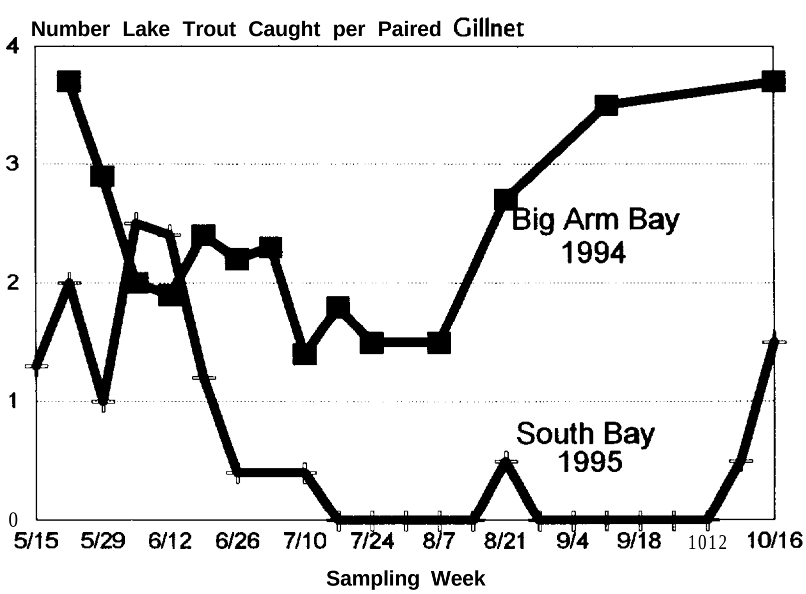

Figure 10. Paired gill-net catches of lake trout in Big Arm and South bays, 1994 and 1995.

captured lake trout contained lolanee, at an average of 2.5 lolanee per lake trout. Through the 8-week period following the release of lolanee in South Bay in 1995, 14% of lake trout captured contained kokanee, at an average of 0.3 lolanee per lake trout.

The results of gillnetting in 1994 and 1995 indicate a higher density of alternate prey species in South Bay than Big Arm Bay. Lake whitefish and unidentified fish (non-kokanee) were both present in lake trout stomachs in higher percentages than were kokanee during the 1995 study period in South Bay. Yellow perch were preved upon by lake trout at roughly the same rate as were kokanee.

The decision to stock lolanee in South Bay in 1995 was supported by the absence of lake trout there during earlier investigations. Extensive gillnetting in South Bay from 1984 to 1986 yielded no lake trout (Cross and Waite 1988). Creel surveys of ice anglers in 1985 and 1986 also indicated the absence of lake trout (none were recorded as caught). Recent investigations indicate that lake trout are now common in South Bay except during summer, reflecting their increased abundance and wider distribution in Flathead Lake. In May 199 1, six paired, sinking gill nets set in South Bay produced 1.2 lake trout per set (unpublished CSKT files). A creel survey of East Bay ice anglers conducted in January 199 1 indicated a catch rate of 0.26 lake trout per hour. A creel survey conducted during 1992 and 1993 indicated catch rates from Polson City Docks of 0.39 lake trout per hour (Evarts et al. 1994). The absence of lake trout in South Bay during summer 1995 is assumed to have reduced immediate post-stocking mortality of lokanee compared to releases on the east shore in 1993 and in Big Arm Bay in 1994.

Kokanee planted in 1994 appeared to have matured at the same time of year as kokanee did historically in Flathead Lake. Beattie et al. (1986) observed kokanee spawning in Flathead Lake from late October to late December, and noted that spawning also occurred at that time in the 1950s. We did not determine time of spawning because no spawning activity was observed, but we first caught ripe males in the Big Arm trap on November 3 and mature females on November 20.

We observed that hatchery-reared kokanee released in Flathead Lake matured at a younger age than wild kokanee did historically in Flathead Lake. For example, in 1984 the lakeshore spawning population of kokanee was comprised of 78% age 3, 18% age 2, and 4% age 4 individuals (Beattie et al. 1986). Yearling kokanee raised at Creston grew to about 140 mm TL at age 1.5. Wild kokanee were typically age 2.5 when they reached 140 mm TL. The first year class of broodstock held to maturity at Creston in 1994 was comprised of 13% age 1 males, 8 1% age 2 (males and females about equally represented), and 6% age 3 individuals. We observed a similar pattern of maturity in the released fish captured in nets. Therefore we expect that a small percentage of lolanee released in 1994 will not mature until 1996 at age 3.

The catch of mature kokanee in Merwin traps at the stocking locations implies that these fish have imprinted on the stocking sites. Tilson et al. (1995) identified **the** alevin/swimup stage and the smolt stage (at 16 months of age) as critical periods for imprinting. However, we did not test the imprinting supposition by placing traps in locations where ltolanee were not stocked. For example, 55 of the kokanee caught in **the** Big Arm trap were not stocked there, but rather in South Bay in 1995.

The highest total zooplankton density that we measured in South Bay was on June 1, 1995, at the time kokanee were released (see Table 3). These densities are comparable to those measured in the main lake prior to the increase in *Mysis* (Beattie et al. 1985). Subsequent samples collected later in **the** summer were much lower and may reflect either natural cycles of zooplankton abundance, or cropping by the released ltolanee and other fish. The condition factors ($K>0.95$) and growth rates of ltolanee measured throughout the summer, in addition to pronounced fat deposits on internal organs, indicated that zooplankton densities were adequate to support the released lolanee.

In 1995 we evaluated one of the three criteria for success of the lolanee experiment: yearling to adult survival of 10% of kokanee stocked in 1994. The Technical Team drew from personnel with experience since 1979 in monitoring **the** historically used staging and spawning habitat in the mainstem Flathead River, McDonald Creek, and Flathead Lake. The number of adult kokanee counted since 1979 at staging and spawning areas in the Flathead River and along the lakeshore ranged from none to over 20,000 spawners. We assume that the quantity of adult lolanee needed to meet success criterion 2 is within our capacity for detection. We found no adult lolanee at the historical spawning areas. We targeted historical spawning areas, but recognize **that** stocked kokanee might pioneer into other areas and escape our surveys. In fact, we did locate adult kokanee returning to the site in Big Arm Bay from which they were released in 1994, which was **not** an important historical spawning area. Nonetheless, we consider the likelihood to be low that kokanee spawned in large congregations in areas that we did not examine in 1995.

The program to restore lolanee in Flathead Lake has exemplified adaptive management. The release sites for lolanee in 1993 were selected because they are near locations ltolanee historically occupied. In 1994 the release site was chosen to facilitate better monitoring of kokanee mortality, and because we assumed that lake trout densities would be lower there than in other parts of the lake. In 1995, South Bay was chosen as the site having the fewest lake trout. We could not quantify total mortality, but the results of monitoring the 1995 ltolanee releases suggest that mortality was less in South Bay for the summer months than what was indicated at the earlier release sites. Risks associated with releasing kokanee in South Bay included downstream loss through Kerr Dam and poor survival due to habitat limitations in the bay, which was not historically occupied by lolanee. These risks appear to be minimal because no kokanee were detected moving downstream out of the lake, and a portion of the released ltolanee remained in South Bay throughout the study period.

CONCLUSIONS

We have monitored the survival of released kokanee for 3 consecutive years. Each year we have adapted release strategies to minimize immediate post-stocking losses to predation by lake trout. We documented lower post-stocking mortality in South Bay than at the earlier release sites, which we attribute to the existence of a thermal refuge from lake trout there during summer. Thirty-seven percent of lake trout captured in Big Arm Bay during the first 8 weeks following the release of lolanee in 1994 contained lokanee in their stomachs. During the same 8-week period in 1995, 14% of lake trout captured in South Bay contained kokanee. The abundance of alternate prey for lake trout in South Bay may have additionally reduced predation on kokanee. The prey fish of lake trout captured in Big Arm Bay throughout monitoring in 1994 were 8 1% lolanee (numerically), while in South Bay in 1995 the prey fish of captured lake trout were 12% kokanee.

We have documented that raising kokanee to age 1.5 in the hatchery results in about 13% of them maturing as "jack" males at age 2, about 81% maturing at age 3, and the remainder at age 4. We have captured many "jack" males during monitoring suggesting that the timing of maturity of lolanee released in Flathead Lake is the same as for kokanee remaining in the hatchery. Therefore, assuming no mortality and maturation schedule similar to that in the hatchery, about 81% of each cohort released in Flathead Lake in June has an 18 month life-expectancy after release and before maturity and death. Based on the average size at release and growth rates documented in 1994 and 1995, released kokanee require 4 months to grow into the fishery (> l 1 inches), making them available for harvest for about 1 year.

We measured a high rate of lolanee mortality in 1994, yet found 65 adults from that cohort returning to the release site 18 months later. We observed no staging and spawning in any of the traditional lake and river sites, and consider it unlikely that large concentrations of spawning kokanee went unnoticed by field personnel and the public.

Kokanee released in 1994 and 1995 maintained desirable growth rates and condition during the monitoring period. We conclude, as we did after monitoring in 1994, that lake trout predation has limited successful restoration of the Flathead Lake kokanee population. Releasing kokanee in South Bay in 1995 resulted in substantial reductions in immediate post-stocking mortality of kokanee relative to earlier release sites. The degree to which mortality was reduced in 1995 depends on (1) the percentage of the 1995 cohort that remained in South Bay, and (2) the rate of mortality that occurred after the summer period when lake trout moved back into South Bay. Monitoring in 1996 was designed to determine if improved post-stocking survival of yearlings in 1995 results in greater adult survival and escapement.

Additions to the monitoring strategy in 1996 include efforts to hydroacoustically enumerate kokanee cohorts, conduct a summer creel survey, and further investigate Flathead Lake trophic ecology to better understand the "predator trap" that presently limits kokanee survival.

REFERENCES

Beattie, W., P. Clancy, J. Decker-Hess, and J. Fraley. 1986. Impacts of water level fluctuations on lolanee reproduction in Flathead Lake. Annual Report DOE/BP-3964 1-2, Bonneville Power Administration, Portland Oregon. Montana Fish, Wildlife and Parks, Kalispell, MT.

Beattie, W., P. Clancy, J. Decker-Hess, and J. Fraley. 1985. Impacts of water level fluctuations on kokanee reproduction in Flathead Lake. Annual report FY 1985 to Bonneville Power Administration. Montana Fish, Wildlife and Parks, Kalispell, MT. 57 pp.

Beattie, W., P. Clancy, and R. Zubick. 1987. Effect of the operation of Kerr and Hungry Horse dams on the reproductive success of lolanee in the Flathead system. Final Report FY 1987 to Bonneville Power Administration. Montana Fish, Wildlife and Parks, Kalispell, MT. 100 pp.

Beattie, W. and J. Tohtz. 1990. Effect of the Operation of Kerr and Hungry Horse Dams on the Reproductive Success of Kokanee in the Flathead System. Technical addendum to the Final Report. Bonneville Power Administration, Contract No. DE-AI79-86BP3964 1. Montana Fish, Wildlife & Parks, Kalispell, MT.

Beattie, W., J. Tohtz, B. Bulantis and S. Miller. 1990. Effect of the operation of Kerr and Hungry Horse dams on the reproductive success of lolanee in the Flathead system. Final report FY 1989 to Bonneville Power Administration. Montana Fish, Wildlife and Parks, Kalispell, MT. 67pp.

Cross, D. and I. Waite. 1988. Lower Flathead system fisheries study, South Bay of Flathead Lake, Volume III. Final report FY 1983-87. BPA Report DOE/BP-39830-3, Portland, OR.

Deleray, M., W. Fredenberg, and B. Hansen. 1995. Kokanee stocking and monitoring, Flathead Lake - 1993 and 1994. BPA Contract No. DE-AI70-87BP65903, Project No. 91- 19. Montana Fish, Wildlife and Parks, Kalispell, MT.

Flathead Basin Commission. 1993. 199 l- 1992 Biennial Report. Kalispell, MT.

Huston, J. 1995. Personal communication. Montana Fish, Wildlife and Parks, Kalispell, MT.

Leathe, S. and P. Graham. 1982. Flathead Lake fish food habits study. EPA Final Report R008224-0 104. Montana Fish, Wildlife and Parks, Helena, MT.

Martinez, P. and W. Wiltzius. 199 1. Kokanee fishery studies. Colorado Div. of Wildlife. Job Final Report F-79, Fort Collins, CO.

Moore, J., J. Jiwan, and C. Murray. 1982. Sediment geochemistry of Flathead Lake, MT. Flathead River Basin Environmental Impact Study, U.S. Environmental Protection Agency Grant #R0083060 1.

Montana Fish, Wildlife and Parks, and Confederated Salish and Kootenai Tribes. 199 1. Fisheries Mitigation Plan for losses attributable to the construction and operation of Hungry Horse Dam, Kalispell MT.

Montana Fish, Wildlife and Parks, and Confederated Salish and Kootenai Tribes. 1993. Fisheries Mitigation Plan for losses attributable to the construction and operation of Hungry Horse Dam, Kalispell MT.

Sage, K. 1995. Personal communication. Wild trout and salmon genetics lab. University of Montana, Missoula, MT.

Spencer, C.N., B.R. McClelland and J.A. Stanford. 199 1. Shrimp stocking, salmon collapse and eagle displacement: cascading interactions in the food web of a large aquatic ecosystem. Bioscience 4 1: 14-2 1.

Tilson, M.B., A. Scholz, R. White, and J. Hendrickson. 1995. Artificial imprinting and smoltification in juvenile kokanee salmon. Implications for operating Lake Roosevelt kokanee salmon hatcheries. Annual Report 1994. UCUT Fisheries Research Center, Cheney, WA. BPA Report DOE/BP-9 18 19-7, Bonneville Power Administration, Portland OR.

Zackheim, H. 1983. Final report of the steering committee for the Flathead River Basin Environment Impact Study. Funded by EPA under grant No. R0082220 1, Kalispell, MT.

APPENDIX A

Summary of gill-net catches

TABLE 1. Number, species, and location of fish caught in paired sinking gill nets, South Bay of Flathead Lake, 1995. (Abbreviations listed at end of table.)

DATE	L	LT	LWF	YP	NS	KO	CT	BT	PM	LN	LS	MW	RS
4/13	R	1	2	0		7			0000	0	3	0	0
4/13	S 9	2	6	2	0	0	0	0	0	0	3		00
4/13	B 1	2	3	0		0			0000	0	0	0	0
5/4	S	3	70	9	10	0	0	0	15	3	0	0	0
5/4	B	1	24	0	24	0	0	0	2	5	3	0	0
5/4	S		227	19	0	0		0	31	6	2		00
5/4	S		039	2	8	0	0	0	3	4	0		00
5/4	S	0	4	0	10	0	0	0	20	3	1		10
5/11	S	1	32	0	30	1	2	0	46	27	11	1	0
5/11	S 0		0	4	6	0	0	0	0	0	0	0	0
5/11	B	1	41	77	14	0	0	0	3	2	3	0	0
5/11	B	2	71	30	10	0	0	0	6	4	3	0	0
5/11	S	1	32	24	25	0	0	0	35	7	2	0	0
5/24	R	0	0	0	129	0	0	0	20	0	14	0	2
5/24	S	1	60	0	31	0	0	0	34	3	0	0	0
5/24	S	5	8	0	38	0	0	0	15	0	2	0	0
5/24	S	1	10	3	20	0	0	0	9	9	0	0	0
5/24	N	4	7	0	206	0	0	0	115	5	4	1	0
5/24	B	1	33	0	5	0	0	0	1	2	0	0	0
5/3 1	R	0	5	1	123	0	0	0	50	3	17	0	0
5/3 1	B		038	6	l	3	0	0	0	1	0	0	0
5/31	N	0	3	0	40	1	0	0	39	0	0	0	0
6/1	N	l	18	0	24	0	0	0	39	0	l	0	0
6/1	B		233	1		1			1000	0	0	0	0
6/1	R	l	3	0	94	0	0	0	14	0	3	0	0
6/2	R	0	0	0	68	0	0	0	12	0	1	0	0
6/2	B	l	27	0	1	1	0	1	1	0	o-o		0
6/2	N	3	19	0	21	0	0	0	80	0	3	0	0
6/6	R	l	0	0	14	0	0	0	2	0	0		00
6/6	N	7	10	0	93	0	0	0	189	0	14	0	0
6/6	B	1	43	0		2			0008	0	0	0	0
6/9	N	1	7	0	26	0	0	0	61	1	2	0	0
6/9	N	4	0	0	71	0		10	26	0	1		00
6/9	B		429	0	0	0	0	0	1	0	0	0	0
6/13	N	7	16	0	98	0	0	0	252	9	0	0	2
6/13	B 0	4	7	0	0	0	0	0	0	0	0		10

TABLE 1, continued.

DATE	L	LT	LWF	YP	NS	KO	CT	BT	PM	LN	LS	MW	RS
6/13	R	0	3	0	61	0	0	0	31	0	0	0	0
6/14	B	3	33	0	0	0	0	0	1	0	0	0	0
6/14	R	1	2	1	46	0	0	0	12	0	2	0	0
6/14	N	5	8	0	20	0	0	0	27	2	0	0	0
6/15	R	0	1	0	10	0	0	0	0	0	0	0	0
6/15	N	5	13	0	23	0	0	0	57	1	1	0	0
6/15	B	3	50	0	0	0	0	0	1	0	0	0	0
6/20	R	0	0	0	57	0	0	0	31	0	0	0	0
6/20	B	2	43	0	1	0	0	0	2	0	0	0	0
6/20	N	0	16	0	92	1	0	0	145	9	3	0	0
6/21	B	0	31	0	1	0	0	0	1	0	0	0	0
6/21	N	2	10	0	32	0	0	0	118	5	6	0	0
6/21	B	3	30	0	1	0	0	0	0	0	0	0	0
6/22	N	2	12	0	69	0	0	0	149	4	2	0	0
6/22	B	1	29	0	0	0	0	0	1	0	0	0	0
6/22	B	0	26	9	3	0	0	0	1	0	2	0	0
6/27	S	1	38	0	29	0	0	0	27	0	4	0	0
6/27	B	0	38	3	3	0	0	0	3	3	2	0	0
6/27	N	1	20	0	18	0	0	0	43	0	0	0	0
6/27	B	1	29	2	14	0	0	0	13	1	0	0	0
6/28	N	2	13	0	27	0	0	0	21	0	0	1	0
6/28	B	0	60	1	7	0	0	0	5	0	0	1	0
6/28	S	0	21	2	26	0	0	0	55	0	4	0	0
7/12	B	0	31	0	17	130		0	6	2	0	0	0
7/12	N	0	27	0	27	0	0	0	5	1	0	0	0
7/12	B	0	36	6	10	2	0	0	4	2	1	0	0
7/12	B	1	31	1	26	1	0	0	2	1	0	0	0
7/13	N	1	24	2	20	0	0	0	2	1	0	0	0
7/13	B	0	21	0	22	140		0	5	0	1	0	0
7/13	S	1	26	0	12	1	0	0	4	1	0	0	0
7/19	B	0	0	5	14	15	0	0	27	0	0	0	0
7/19	S	0	50	0	31	690		0	18	3	1	0	0
7/19	B	0	7	0	20	7	0	0	28	10	2	0	0
7/19	N	1	38	1	31	2	0	0	4	0	0	0	0
7/25	B	0	15	1	18	3	0	0	3	4	1	0	0
7/25	B	0	6	5	64	2	0	0	21	7	1	0	0

TABLE 1, continued.

Date	L	LT	LWF	YP	NS	KO	CT	BT	PM	LN	LS	MW	R S
7/25	N	**0**	18	0	36	**0**	0	0	7	0	0	0	0
8/1	N	**0**	25	0	38	**0**	0	0	5	0	2	0	0
8/1	B	**0**	29	0	68	6	0	0	10	1	1	0	0
8/1	S	**0**	0	0	146	0	0	0	0	0	23	4	0
8/1	B	**0**	3	1	0	0	0	0	0	0	0	0	0
8/10	N	**0**	23	0	40	0	0	0	54	0	0	0	0
8/10	B	**0**	10	189	6	0	0	0	0	0	0	0	0
8/10	B	**0**	5	30	57	0	0	0	10	7	2	0	0
8/10	B	**0**	126	27	3	2	0	0	0	0	0	0	1
8/10	B	**0**	8	83	28	0	0	0	6	0	2	0	0
8/17	B	**0**	8	53	19	3	0	0	13	1	2	0	0
8/17	B	**0**	55	41	1	0	0	0	0	0	0	0	0
8/17	B	**0**	34	21	45	10	1	0	3	0	0	0	0
8/17	N	1	37	0	43	0	0	0	93	0	2	1	0
8/23	B	1	20	36	28	9	0	0	8	1	1	0	0
8/23	B	0	151	1	6	0	0	0	0	0	0	0	0
8/23	N	0	16	0	26	0	0	0	145	0	17	0	0
8/23	B	0	5	46	15	4	0	0	7	0	0	0	0
8/30	B	0	5	10	40	0	0	0	8	6	1	0	0
8/30	B	0	21	3	70	4	0	0	24	0	11	0	0
9/7	B	0	14	10	34	1	0	0	4	1	1	0	0
9/7	B	0	12	22	35	1	0	0	28	9	2	0	0
9/13	B	0	2	23	37	0	0	0	61	1	1	0	0
9/13	B	0	22	19	9	1	0	0	8	2	0	0	0
9/20	B	0	13	37	17	1	0	0	1	0	1	0	0
9/20	B	0	3	40	21	3	0	0	6	0	2	0	0
9/28	B	0	52	3	1	0	0	1	0	0	0	0	0
9/28	B	0	19	2	6	0	0	0	1	0	2	1	0
10/5	B	0	9	5	1	0	0	0	3	1	1	0	0
10/5	B	0	19	14	4	5	0	0	0	1	2	0	0
10/12	B	1	35	3	2	2	0	0	0	0	0	0	0
10/12	B	0	19	3	1	3	0	0	0	4	1	0	0
10/20	B	2	47	0	9	6	0	0	0	0	5	0	0
10/20	N	1	20	1	2	1	0	0	2	1	3	0	0
10/25	B	1	12	0	0	6	0	0	0	0	0	0	0
10/25	B	0	21	0	1	1	0	0	1	1	0	0	0

TABLE 1, continued.

DATE	L	LT	LWF	YP	NS	KO	CT	BT	PM	LN	LS	MW	RS
11/2	B	0	10	0	1	0	0	0	0	0	0	0	0
11/2	B	3	12	0	0	1	0	0	0	2	2	0	0
11/9	B	4	9	0	12		00	0		0	0	0	0
11/9	B	3	31	1	1	0	1	0	0	0	2	0	0
11/17	B	1	48	0	1	0	0	0	0	0	0	0	0
11/17	B	6	85	0	0	0	0	0	0	0	0	0	0

L = location
- B = mid-bay
- N = Narrows
- S = shoreline
- R = river

LT = lake trout
LWF = lake whitefish
YP = yellow perch
NS = northern squawfish
KO = kokanee
CT = cutthroat trout
BT = bull trout
PM = peamouth
LN = longnose sucker
LS = largescale sucker
MW = mountain whitefish
RS = redside shiner

TABLE 2. Number and species composition of fish caught in single sinking gill nets in depths greater than 12 m in Big Arm Bay, June 1995. Three peamouth and three longnose suckers were caught that are not included in the table.

Area	n	LT/ Net	Mean Len (mm)	n	LWF/ Net	Mean Len (mm)	n	NS/ Net	Mean Len (mm)
A	16	4.0	526	80	20.0	382	0	--	--
B	11	2.8	552	89	22.3	401	0	--	--
C	10	2.5	704	29	7.3	397	0	--	--
D	15	3.8	554	56	14.0	400	1	0.3	320
E	14	3.5	623	57	14.3	389	0	--	--
F	7	1.8	551	33	8.3	348	1	0.3	381
G	9	2.3	767	57	14.3	398	0	--	--
H	6	1.5	500	22	5.5	407	0	--	--
Total	88	2.8	595	423	13.2	391	2	0.1	350
Length Range	207- 1020 mm				164-536 mm			320-381 mm	

LT = Lake Trout
LWF = Lake Whitefish
NS = Northern squawfish

Area refers to subunits of Big Arm Bay demarcated in 1994 to monitor lake trout predation on kokanee (Deleray et al. 1995).

TABLE 3. Number and species composition of fish caught in single sinking gill nets set throughout Flathead Lake during August and September 1995.

Species	n	Fish/Net	Mean Length (mm)	Length Range (mm)
DV	2	0.03	262	246-278
LT	144	2.10	491	178-950
KOK	3	0.04	240	174-280
LWF	703	10.00	351	168-546
YP	29	0.40	201	155-247
PEA	22	0.30	231	172-309
NS	145	2.10	279	168-526
LNSU	16	0.20	301	169-420
csu	8	0.10	216	162-276
MWF	4	0.06	277	2 12-329

DV = Bull Trout
LT = Lake Trout
KOK = Kokanee
LWF = Lake Whitefish
YP = Yellow Perch
PEA = Peamouth
NS = Northern Squawfish
LNSU = Longnose Sucker
CSU = Largescale Sucker
MWF = Mountain Whitefish

TABLE 4. Number and species composition of fish caught in vertical gill nets near Caroline Point, Flathead Lake, August 1995.

	Depth Interval								
	0-9.1 m			9.1-18.3 m			18.3-27.4 m		
Species	n	Length Range (mm)	Mean Length	n	Length Range (mm)	Mean Length	n	Length Range (mm)	Mean Length
LWF	3	114-120	118	76	50-478	171	27	50-292	164
LT	0	--	--	0	--	--	3	821-881	851
NS	1	248	--	0	--	--	0	--	--
PEA	7	217-317	257	0	--	--	0	--	--
PYG	0	--	--	0	--	--	8	120-135	127
WCT	1	262	--	0	--	--	0	--	--
KOK	0	--	--	1	120	--	0	--	--

LWF = Lake Whitefish
LT = Lake Trout
NS = Northern Squawfish
PEA = Peamouth Whitefish
PYG = Pygmy Whitefish
WCT = Westslope Cutthroat Trout
KOK = Kokanee

APPENDIX B

Summary of captures in Merwin traps

TABLE 1. Sex and maturity of kokanee captured in Merwin trap at Big Arm Bay, Flathead Lake, between September 19 and December 6, 1995 (ND = No data).

		Males		Females		Sex undetermined	Total Kokanee	Water temp (C)
Date	Time	Green	Ripe	Green	Ripe			
Sep 19	1500						Trap in	
Sep 22	0900						0	16.7
Sep 25	1330						0	16.7
Sep 28	1230						0	ND
Oct 03	1000	3					3	14.5
Oct 06	1230						1	13.3
Oct 10	1200	6					6	12.8
Oct 13	ND					2	3	ND
Oct 16	ND					5	5	10.0
Oct 19	ND					8	8	11.1
Oct 23	ND	1				2	3	ND
Oct 27	ND					4	6	9.5
Oct 31	1015	6				2	8	7.8
Nov 03	1215		2			1	3	8.9
Nov 07	1400	4	3			1	8	7.8
Nov 20	1219		23	3	14	4	44	7.8
Nov 24	1420		7	1	3	1	12	7.8
Dec 06	1030		8		2	1	11	5.0
Totals		20	43	8	19	31	121	

TABLE 2. Number of lokanee, lake trout, northern squawfish, and westslope cutthroat trout captured in Merwin trap at Big Arm Bay, Flathead Lake between September 19 and December 6, 1995 (ND= No data).

Date	Kokanee	Lake trout	Northern squawfish	Westslope cutthroat trout	Surface water temp (C)
Sep 19	Trap in				
Sep 22			18		16.7
Sep 25			19		16.7
Sep 28			51		N D
Oct 03	3	2	49		14.5
Oct 06	1	1	44		13.3
Oct 10	6		53		12.8
Oct 13	3	1	15		N D
Oct 16	5	2	31		10.0
Oct 19	8	1	13		11.1
Oct 23	3		9		N D
Oct 27	6	2	5	1	9.5
Oct 31	8	3	4	1	7.8
Nov 03	3	2	10		8.9
Nov 07	8	1	13	3	7.8
Nov 20	44	6		1	7.8
Nov 24	12		1		7.8
Dec 06	11	2	3	1	5.0
Totals	121	23	338	8	

TABLE 3. Sex and maturity of kokanee captured in Merwin trap at Bird Point in South Bay between September 20 and November 21, 1995. (ND = No data).

Date	Time	Males		Females		Unknown sex	Total	Water temp
		Green	Ripe	Green	Ripe	or unchecked	kokanee	(C)
Sep 20	1130						Trap in	ND
Sep 22	1015	1					I	15.5
Sep 25	1215	3					3	15.5
Sep 28	ND					2	2	ND
Oct 03	1145	2					2	12.2
Oct 05	ND					4	4	ND
Oct 06	1415	2	2				4	11.1
Oct 12	ND	10	6			4	20	ND
Oct 16	ND					7	7	11.1
Oct 19	ND					14	14	10.0
Oct 20	ND		3				3	ND
Oct 23	ND					10	10	9.5
Oct 24	ND						0	ND
Oct 27	ND		24			5	29	ND
Oct31	1200		32				32	6.1
Nov 02	ND					23	23	ND
Nov 08	ND		41			16	59	ND
Nov 17	ND					8	8	ND
Nov 21	1030		2				2	ND
Totals		18	110	0	2	93	223	

TABLE 4. Number of lolanee, lake trout, northern squawfish, and westslope cutthroat trout captured in Merwin trap at Bird Point in South Bay between September 20 and November 2 l, 1995 (ND= No data).

Date	Kokanee	Lake trout	Northern squawfish	Westslope cutthroat trout	Surface water temp (C)
Sep 20	Trap in				N D
Sep 22	l		163		15.5
Sep 25	3		185		15.5
Sep 28	2		102		N D
Oct 03	2		156		12.2
Oct 05	4		133		N D
Oct 06	4		521		11.1
Oct 12, 13	20	l	132		N D
Oct 16	7		20		11.1
Oct 19	14	1	113		10.0
Oct 20	3		28		N D
Oct 23	10	l			9.5
Oct 24	0	l	36		N D
Oct 27	29	2	10		N D
Oct 31	32	l	52		6.1
Nov 02	23	l	90	1	N D
Nov 08	59				N D
Nov 17	8	9	168	1	N D
Nov 21	2	3	47		N D
Totals	223	20	1,956	3	

APPENDIX C

Work Plan and Strategy to Achieve 1996 Monitoring and Implementation Goals

The Hungry Horse Technical Team will monitor the third year of the lolanee experiment in 1996. We will explore new methods to monitor the success criteria and new strategies for releasing kokanee. Our intention is to have our methods refined by 1998 to conclusively evaluate the success of the kokanee experiment and to have field-tested all feasible strategies for rearing and releasing kokanee.

Monitoring in 1995 indicated that immediate post-stocking survival of ltolanee released in South Bay exceeded that documented in 1993 on the east shore and in 1994 in Big Arm Bay. Having concluded that South Bay provides suitable habitat for lolanee and that no other site in Flathead Lake is likely to have fewer lake trout, we released the yearling ltolanee in South Bay again in 1996.

Approximately 1 .0 million 5 inch yearling ltolanee were stocked at the Bird Point stocking site during the week of April 15, 1996. This release occurred 6 weeks earlier than in 1995 due to a need to implement disease control measures in the hatchery. The earlier release date in 1996, with different lake conditions than occur later in spring, will broaden the range of stocking scenarios to be tested during the 5-year experiment. For example, we expect a smaller standing stock of zooplankton and a larger number of lake trout in South Bay in April than occurred last June. We will collect zooplankton biweekly from March to November in South Bay to relate zooplankton abundance to lolanee survival and condition. We will determine if there is increased predation by lake trout, and if predation reduces the success of earlv spring releases of lokanee.

In 1996 we will attempt to quantify the three success criteria for the lolanee experiment more completely than was possible in the monitoring years 1993, 1994 and 1995 (Table 1). We will also evaluate more completely the success of the strategy of releasing kokanee in South Bay. Success criterion 1, 30% survival of ltolanee 1 year after stocking, will be evaluated using hydroacoustics combined with vertical and horizontal gillnetting in August. We quantified post-release survival of kokanee in 1994, but only for an 8-week period. In 1996 we will make our first attempt to estimate survival after 1 year, and will determine if hydroacoustics is a suitable technology to accomplish this objective. This work entails estimating fish densities, size, and species composition in several areas of the lake. We will also attempt to determine lake trout abundance with this method.

Success criterion 2, yearling to adult survival of 10%, will be evaluated by a basin-wide search for redds and Merwin trapping of four shoreline areas in Flathead Lake. Prior to population declines in the late 1980s, lolanee were self-sustaining and consistently spawned at certain sites in Flathead Lake and in the upper Flathead River (FHR) basin. We consider it likely that stocked kokanee will also select these sites because they offer favorable staging and spawning habitat. All known historical lakeshore spawning areas and most historical FHR sections (including those in Table 2 of this document) will be surveyed in fall by snorkeling, wading, and searching from boats and shore. Merwin trap results in 1995 indicate that adult lolanee may also imprint and return to stocking sites or congregate in “non-traditional” areas. Therefore, we will also search selected non-traditional sites, continue to investigate angler reports, and solicit information from landowners on the lakeshore and river.

Merwin traps at the stocking locations successfully captured adult lolanee in 1995. A trap will be redeployed at the 1994 stocking site in Big Arm Bay to capture age 3 spawners returning 2.5 years after their release. A second trap will be deployed off Bird Point to capture age 2 spawners released in 1995 and "jack" males released in 1996. Two additional traps will be deployed at sites nearer the north end of Flathead Lake to evaluate the possibility of kokanee moving up the lakeshore toward spawning tributaries in the Flathead or Swan River. These traps, placed far from the lolanee release sites, will also provide a test of our assumption made in 1995 that kokanee captured in Big Arm and South bays were homing to their release sites.

Success criterion 3, which addresses lolanee harvest, will be evaluated with a random, access site-based creel survey conducted during the open season, May 18 to September 15. Creel clerks will interview anglers at all public access points and at the three most heavily used private access points identified in the 1992-93 creel survey (Evarts et al. 1994). Sampling intensity will be equivalent to 24 hours of interviewing per week. If reports of kokanee harvest are received, the random schedule will continue to be followed, but the intensity will be reduced. At such time, creel clerks will target the areas where kokanee fishing is occurring and substitute that activity for a portion of the random creel schedule. Clerks will attempt to collect all stomach contents of lake trout and lolanee encountered while interviewing. The product of this survey will be an estimate of catch rates (foregoing an estimate of pressure), and a description of lake trout food habits.

In addition to evaluating the success criteria, we will investigate many other elements of kokanee ecology in Flathead Lake. We will repeat procedures used in 1995 in South Bay to further assess habitat conditions, period of lolanee residence, timing of out-migration, lake trout predation, and kokanee growth, condition and maturation schedule. We will continue to research lake trout biology by (l)investigating recruitment through sampling of young lake trout cohorts with small mesh gill nets, (2)determining length-at-age relationships for pre- and post-*Mysis* periods through analysis of lake trout otoliths, and (3)investigating age of maturity by sampling during the pre-spawn period in October.

A Merwin trap was deployed in the Narrows (inlet to South Bay) immediately prior to stocking in April to evaluate the timing and magnitude of emigration of stocked kokanee from South Bay. In 1995, we attempted a similar strategy using gill nets, but considered the capture efficiency to be too low to accurately document out-migration.

We will also attempt to locate lolanee outside of South Bay. Current information on lolanee distribution and abundance in Flathead Lake is limited, especially in areas outside intensively sampled stocking locations. We will use creel data, angler reports, and data from other monitoring activities to target lolanee in these areas (outside South Bay). Field protocol will include use of hydroacoustics to locate and estimate the density of suspended fish (potentially lolanee), followed by verification netting with vertical gill nets. Sampling will occur sporadically from March to November, depending on available information. Objectives of this strategy are to 1) gain information on kokanee distribution, movement, and habitat preferences, 2) obtain kokanee samples from outside South Bay to assess age structure, growth, and condition, and 3) estimate local kokanee abundance in targeted areas.

A lakewide gill-net series was conducted in April 1996. Protocol for this series was established in 198 1 to monitor trends in the fish community in Flathead Lake. It primarily targets westslope cutthroat trout and bull trout, but also provides information on kokanee, lake whitefish, lake trout, and other fish species. Both floating and sinking standard experimental gill nets were set during spring when the water temperature profile is isothermal. Nets were left overnight in five specific areas, and in depths ranging from 10 to 35 meters. These data will provide further insight into the opportunity for reestablishing kokanee and possible changes in the Flathead Lake fish community during the 5-year kokanee test.

Table 1. Activities planned for monitoring the success of the kokanee experiment in Flathead Lake in 1996.

STRATEGY	TARGET KOKANEE POPULATION	MONITORING OBJECTIVE	SITE
Gillnetting (biweekly)	1995 yearling 1995 fingerling 1996 yearling	Growth, condition, food habits, predation, species composition	South Bay (3 sites)
Post-stocking emigration (Merwins, ½" mesh nets)	1996 yearling	Emigration rate and magnitude	Narrows and River
Experimental lake-wide search, trawling, vertical nets, hydroacoustics.	1995 yearling 1995 fingerling 1996 yearling	Success Criterion 1, Distribution, movement, and habitat preference	Lakewi de
Random Creel Survey Adjust schedule if kokanee are caught	1994 yearling 1995 yearling	Success Criterion #3, predation outside of S. Bay, lake trout stomachs, distribution	Lakewide
Zooplankton / Water Temperature Monitoring	Long-Term Trend	Zooplankton, Temperature	South Bay (random mid-bay)
Fall Merwin Trap/ Spawner Inventory	1994 yearling 1995 yearling 1996 "Jacks"	Success Criterion #2, Distribution, Timing, locations, egg collection	South and Big Arm bays, NE lakeshore
Fall Redd Search/ Spawner Inventory	1994 yearling 1995 Yearling 1996 "Jacks"		Basinwide