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HUNGRY HORSE DAM FISHERIES MITIGATION: KOKANEE STOCKING AND MONITORING IN FLATHEAD LAKE

PROGRESS REPORT - 1996

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Executive Summary

Kokanee salmon *Oncorhynchus nerka* were introduced into Flathead Lake in 1916. The kokanee population declined in the 1960s and 1970s, and kokanee disappeared from Flathead Lake in the late 1980s. Their disappearance has been attributed to the long-term effects of the construction and operation of Hungry Horse and Kerr dams, excessive harvest by anglers, and changes in the lake food web induced by the introduction of opossum shrimp *Mysis relicta*. Attempts to reestablish kokanee in the Flathead Lake ecosystem between 1988 and 1991 were unsuccessful.

In 1991, Montana Fish, Wildlife and Parks (MFWP) and the Confederated Salish and Kootenai Tribes (CSKT) wrote a mitigation plan to restore kokanee to Flathead Lake. In 1993, MFWP, CSKT, and the U.S. Fish and Wildlife Service wrote a mitigation implementation plan that initiated a 5-year test program to use hatchery-reared fish to reintroduce kokanee to the lake. Stocking hatchery-reared kokanee into Flathead Lake began in 1993; the 5-year "kokanee test" started in 1994 and is scheduled to continue through 1998. The annual stocking objective is 1 million yearling kokanee (6-8 in long). Criteria used to evaluate the success of the 5-year test are (1) 30% survival of kokanee 1 year after stocking, (2) yearling-to-adult survival of 10%, and (3) annual harvest of 50,000 kokanee (≥11 in) and fishing effort 2100,000 angler hours.

From 1993 through 1995, numbers of kokanee annually released into Flathead Lake have been less than specified by the stocking objective. Annual monitoring has shown that survival 1 year after release and yearling-to-adult survival have not met levels set by Criterion 1 and Criterion 2. Poor survival of stocked kokanee has been largely due to predation by lake trout. Criterion 3 was not evaluated between 1993 and 1995 because the kokanee fishery on Flathead Lake was closed.

In 1996 (the third year of the kokanee test), we stocked 939,000 oxytetracycline-marked kokanee yearlings into South Bay in April and 220,000 oxytetracycline-marked kokanee fingerlings into the lake off Finley Point in August. We also released 790,000 unmarked kokanee fry in April at three sites in the Flathead River system. We conducted system-wide monitoring and used bioenergetics modeling to evaluate Criterion 1 and Criterion 2. Kokanee fishing on Flathead Lake was open in 1996 from May 18 through September 15, and we conducted a creel survey to begin evaluating Criterion 3.

Spring and early summer monitoring (gillnetting, angling, Merwin trapping, electrofishing, and visual surveys) in 1996 revealed considerable mortality of yearling kokanee from lake trout predation during the first month after stocking, loss of yearling kokanee from downstream movement out of Flathead Lake, and

movement of some yearling kokanee north from South Bay into the main body of Flathead Lake. Spring driftnetting revealed that some kokanee fry released at Creston Hatchery emigrated to the Flathead River; however, we did not track their movements beyond that point. We did not track movements of kokanee fry released into the Flathead River system at Brenneman's Slough or Kokanee Bend. Summer monitoring (a hydroacoustic survey combined with gillnetting) located kokanee only in the northwest part of Flathead Lake. The hydroacoustic estimate (47,700 kokanee in the 150-299 mm size stratum) was based, in part, on 13 unmarked kokanee (length range, 170-195 mm) caught in gill nets set near Caroline and Conrad points; the origin of these 13 fish was not determined. Fall monitoring (Merwin trapping, gillnetting, visual surveys) indicated that few kokanee stocked in spring 1995 and few "jack males" from the spring 1996 plant survived to maturity; mature kokanee tended to home to their stocking site. Kokanee fingerlings stocked in 1996 off Finley point were captured in Merwin traps in South Bay and Gravel Bay.

The creel survey showed that a kokanee sport fishery did not develop in 1996. Although 77% (58 of 75 responses) of anglers interviewed knew about the current program to reintroduce kokanee to Flathead Lake, only 45% (115 of 254 responses) knew that kokanee fishing was open on Flathead Lake. Few (<2%) anglers interviewed had fished for kokanee in 1996, and no (0%) anglers interviewed had caught kokanee in Flathead Lake in 1996.

Bioenergetics modeling predicted that nearly all yearling kokanee stocked into Flathead Lake will be eaten by lake trout within 1 year after stocking. Model simulations and monitoring data from 1993-l 996 revealed that much of this predation occurs within the first month after stocking. The 1993-l 996 monitoring data also showed that lake trout (when their movements are not limited by water temperatures > 15°C) move into areas where kokanee are stocked and selectively feed on kokanee.

We concluded that Criterion 1 and Criterion 2 were not met in 1996, and bioenergetics modeling indicated that these criteria cannot be met under current stocking levels (up to 1 million yearling kokanee) and stocking strategies (where large numbers of kokanee are released at one or two sites). We also concluded that Criterion 3 was not met in 1996 and cannot be met unless survival of stocked kokanee increases substantially.

In spring 1997, we will stock yearling kokanee at four sites in the northwest part of Flathead Lake (Appendix D). Stocking will coincide with high, turbid flows from spring runoff in the Flathead River. We will also stock fingerling kokanee into the South Bay area in August. We will continue to monitor system-wide in 1997 in order to more completely evaluate the three success criteria of the 5-year kokanee test.

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Acknowledgments

Kokanee were reared at Creston National Fish Hatchery by U.S. Fish and Wildlife Service employees Mark Maskill (Hatchery Manager), Don Edsall (Assistant Hatchery Manager), Gar Holmes, Dave Bermel, Jim Till, and John Scott; they also stocked the kokanee, assisted with gillnetting in South Bay, and helped check Merwin traps in Flathead Lake. Montana Fish, Wildlife and Parks personnel Jon Cavigli, Gary Michael, Tim Taylor, John Wachsmuth, and Dean Nyberg assisted with field and laboratory work; Terry Werner conducted creel surveys; and Steve Glutting, Rick Hunt, and Rick Malta checked Merwin traps in the Flathead River as part of the Hungry Horse Reservoir Excessive Drawdown Mitigation Program. Confederated Salish and Kootenai Tribes staff Francis Durgeloh, Clint Folden, and Dane Morigeau assisted with field work, creel surveys, and data processing. Dr. David Beauchamp, Utah Cooperative Fishery Unit, Utah State University, provided modeling expertise and helpful comments on sampling design. The Hungry Horse Implementation Group (Larry Lockard, U.S. Fish and Wildlife Service; Brian Marotz, Montana Fish, Wildlife and Parks; and Joe DosSantos, Confederated Salish and Kootenai Tribes) reviewed the manuscript and have guided the study. Funding for the study was provided by Bonneville Power Administration.

Introduction

Kokanee salmon ***Oncorhynchus nerka*** were introduced into Flathead Lake in 1916. Within 30 years of this one introduction, kokanee became self-sustaining in the Flathead Lake ecosystem, the primary sport fish in the lake, and an important part of the Flathead Valley economy. Kokanee abundance declined in the 1960s and 1970s coincident with operation changes at Hungry Horse and Kerr dams and with excessive harvest by anglers (Beattie et al. 1988). Opossum shrimp ***Mysis relicta***, first found in Flathead Lake in 1981, altered the lake food web (Beattie and Clancey 1991), and subsequently lake trout ***Salvelinus namaycush*** abundance and lake trout predation on kokanee increased (Spencer et al. 1991). Kokanee disappeared from Flathead Lake in the late 1980s (Beattie and Clancey 1991), and attempts to reestablish kokanee in the Flathead Lake ecosystem between 1988 and 1991 were unsuccessful (Beattie et al. 1990; MFWP unpublished data).

In 1991, Montana Fish, Wildlife and Parks (MFWP) and the Confederated Salish and Kootenai Tribes (CSKT) wrote a mitigation plan to offset losses of kokanee attributed to the construction and operation of Hungry Horse Dam (MFWP and CSKT 1991). One part of the mitigation goal is to "Replace 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 in Flathead Lake." In 1992 and 1993, MFWP and CSKT, with input from the U.S. Fish and Wildlife Service (USFWS), wrote a mitigation implementation plan (MFWP and CSKT 1993). The implementation plan, adopted in 1993 by the Northwest Power Planning Council (NPPC), specifies activities to help achieve the mitigation goal and protect and enhance resident fishes and aquatic habitats affected by Hungry Horse Dam. The implementation plan focuses on "nonoperational" mitigation activities, i.e., those activities that do not require changes in dam operations. The Hungry Horse Implementation Group (IG), comprised of one, member each from MFWP, CSKT, and USFWS, was formed to collaborate on mitigation implementation activities. The IG established the Hungry Horse Fisheries Mitigation Technical Team (Technical Team), also comprised of personnel from MFWP, CSKT, and USFWS, to conduct field work.

One mitigation activity specified in the implementation plan is a 5-year test to reintroduce kokanee to Flathead Lake. Although stocking of hatchery-reared kokanee began in 1993, the 5-year test started in 1994 and is scheduled to continue through 1998. The IG and Technical Team set an annual stocking objective of 1 million yearling kokanee (6-8 in long) and use the following three criteria to help evaluate the success of the 5-year test: (1) 30% survival of kokanee 1 year after stocking, (2) yearling-to-adult survival of 10%, and (3) annual harvest of 50,000 kokanee (≥ 11 in) and fishing effort ≥ 100,000 angler hours (MFWP and CSKT 1993).

Between 1993 and 1995, numbers of kokanee released into Flathead Lake have been less than specified by the annual stocking objective. In 1993, 210,000 yearling kokanee were stocked into Flathead Lake at Woods and Blue bays. In 1994, 802,000 yearling kokanee were released into Big Arm Bay. In 1995, 502,000 yearling kokanee and 409,000 young-of-year (fingerling) kokanee were stocked into South Bay. Survival of kokanee 1 year after stocking and yearling-to-adult survival of stocked kokanee have been less than specified by Criteria 1 and 2; poor survival of stocked kokanee has largely been due to predation by lake trout (Deleray et al. 1995; Hansen et al. 1996). The MFWP and CSKT closed the Flathead Lake kokanee fishery from 1993 through 1995; consequently, Criterion 3 was not evaluated during that time.

In 1996, the Technical Team continued its stocking and monitoring work as required by NPPC, the Bonneville Power Administration (BPA), and the IG. Stocking objectives for 1996 (Hansen et al. 1996) were to (1) release 1 million yearling kokanee in South Bay in early June and (2) release surplus kokanee fingerlings and fry at several times and sites in Flathead Lake and the Flathead River system. Monitoring objectives for 1996 were to (1) evaluate survival of the six groups of hatchery-reared kokanee present in Flathead Lake (kokanee stocked in 1994 as yearlings; in 1995 as yearlings and fingerlings; and in 1996 as yearlings, fingerlings, and fry); (2) estimate kokanee abundance; (3) estimate the relative amount of predation by lake trout on kokanee, and (4) estimate angler harvest of kokanee. (In 1996, kokanee fishing was open May 18-September 15.) Another objective in 1996 was to model predator-prey interactions between lake trout and kokanee. This report summarizes data collected in 1996 and relates them to data collected between 1993 and 1995 and to the three criteria used to help evaluate the success of the 5-year test.

Study Area

Flathead Lake is located west of the continental divide in northwest Montana (Figure 1). The lake lies in an 18,400-km² drainage, most of which is underlain by nutrient-poor Precambrian sedimentary rock (Moore et al. 1982). The lake has a surface area of 510 km², mean and maximum depths of 50 m and 113 m, and is oligomesotrophic (Zackheim 1983). Researchers have identified recent deterioration in water quality from increased nutrients generated by the increasing human population of the basin (Flathead Basin Commission 1993). Major tributaries to the lake are the Flathead and Swan rivers.

Twenty-five species of fish are known to inhabit Flathead Lake (Leathe and Graham 1982), and 10 of these are native. Native game fishes include bull trout *Salvelinus confluentus*, for which fishing has been closed since 1992, westslope cutthroat trout *Oncorhynchus clarki lewisi*, and mountain whitefish *Prosopium*

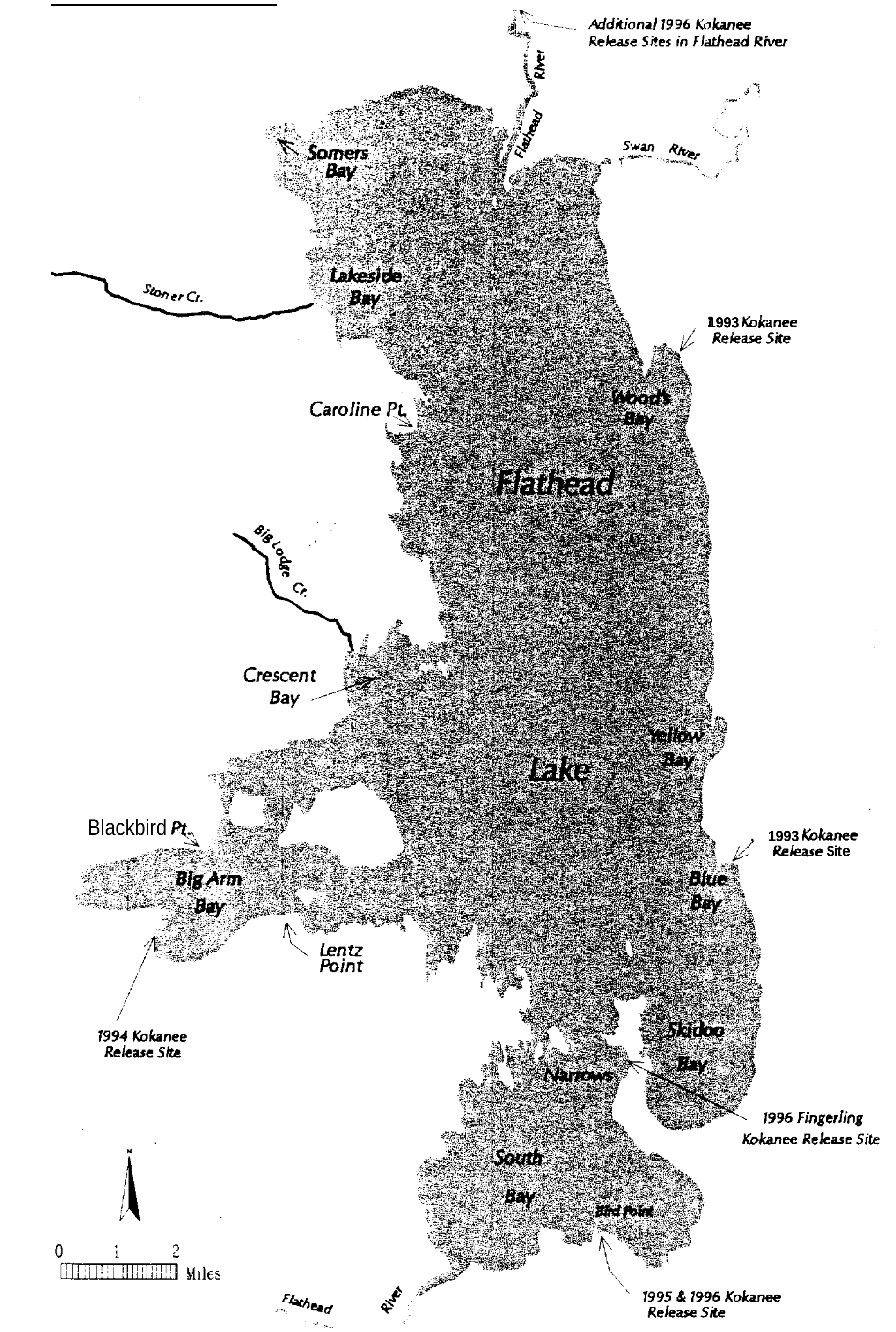

FIGURE 1 .—Flathead Lake, Montana, showing kokanee stocking sites, 1993-1996.

williamsoni. introduced game fishes include lake trout, lake whitefish *Coregonus clupeaformis,* and yellow perch *Perca flavescens.* Native, nongame fishes include northern squawfish *Ptychocheilus oregonensis,* peamouth *Mylocheilus caurinus,* longnose sucker *Catostomus catostomus,* largescale sucker *Catostomus macrocheilus,* redside shiner *Richardsonius balteatus,* and pygmy whitefish *Prosopium coulteri.*

South Bay, at the south end 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 extensive shallow area of the lake, with a surface area of 55 km^2, maximum depth of 11 m, and average depth of 5 m (Cross and Waite 1988). South Bay makes up about 12% of the surface area of Flathead Lake when the lake is at full pool. Because South Bay is shallow, its surface area is reduced 18% in fall and winter when normal Kerr Dam operations reduce the lake level up to 3.3 m. Substrate is primarily mud and silt, and in summer much of the east part of the bay supports rooted aquatic vegetation (e.g., *Potamogeton* sp., *Myriophyllum* sp., and *Chara* sp.). Flathead Lake water passes through South Bay before exiting the lake via the Flathead River. The water usually comes from the surface of the lake because of the shallow (< 7 m deep) passage into the bay. South Bay is normally ice-covered in winter, and surface water temperature often reaches 23°C in summer, which is warmer than surface water in the main lake.

Methods

Kokanee Rearing and Stocking

About 1.95 million kokanee comprised of one group of yearlings, one group of fingerlings, and three groups of fry were stocked into Flathead Lake and the Flathead River system in 1996 (Table I).

Yearling kokanee (spring).—Yearling kokanee (938,629 fish) were produced from broodstock held at the USFWS Creston National Fish Hatchery (Creston Hatchery). Kokanee yearlings were hatched in winter 1994-1995 and reared at the hatchery. Before stocking, bones of yearling kokanee were chemically marked twice with 10-d feed treatments of oxytetracycline (e.g., Nielsen 1992) in order to differentiate them from other groups of kokanee stocked into Flathead Lake between 1994 and 1996. Oxytetracycline was also used therapeutically to treat these fish for furunculosis (a disease caused by the bacterium *Aeromonas salmonicida*); consequently, the number, spacing, and intensity of marks varied. Vertebrae extracted from a random sample of 46 yearlings revealed 1 fish (2%) with one mark, 12 (26%) with two marks, 20 (44%) with three marks, and 13 (28%) with four marks. Number of marks tended to increase with fish length, suggesting that faster-growing fish took up more oxytetracycline. Because the

TABLE 1.-Stocking, marking, and imprinting history of hatchery-reared kokanee released into Flathead Lake and the Flathead River system, 1993-1996.

Stocking dates	Stocking sites	Number stocked	Total weight stocked (kg)	Mean length (mm)	Length range (mm)	Mean weight (g)	Mean condition factor (K)	Oxytetracyline marks and imprinting
1993								
Jun 1-2	Woods Bay and Blue Bay	210,769	8,552	170[a]	127-229	40.6	0.85	50% one mark (light) 50% two marks (light, dark)
1994								
Jun 6-10	Big Arm Bay	802,174	33,563	163[a]	102-229	40.5	0.88	two marks (dark, light)
1995								
May 30-Jun 1	South Bay	501,572	13,250	149[a]	103-208	27.2	0.78	two marks (dark, dark)
Jun 16	South Bay	408,578	1,120	69[b]	48-81	2.7	---	one mark (dark)
1996								
Apr 10	Brenneman's Slough	187,304	30	---[c]	---	---	---	no mark
Apr 15-18	South Bay	938,629	17,598	127[a]	87-173	17.4	0.80	2% one mark; 26% two marks; 44% three marks; 28% four marks[d]
Apr 24	Mill Creek	301,553	49	25[c]	---	0.16	---	no mark; morpholine imprinted
Apr 30	Flathead River at Kokanee Bend	301,553	49	25[c]	---	0.16	---	no mark; morpholine imprinted
Aug 6	Finley Point	219,627	797	76[b]	---	3.6	---	one mark

[a]Yearlings; [b]Fingerlings; [c]Fry
[d]For virtually all 1996 yearling kokanee with two or more marks, the outer two marks were dark.

two intentionally induced marks followed the therapeutic treatments, yearlings from the sample with two, three, or four marks had two dark, closely spaced marks near the outside edge of their vertebrae.

A fish health assessment (Goede 1996) was conducted on 60 yearling kokanee randomly selected from hatchery raceways on April 17. These fish had been exposed to furunculosis; however, under systematic evaluation, their eyes, gills, pseudobranchs, spleen, gut, kidney, fins, opercles, and skin appeared normal. Hematocrit, leucocrit, and blood plasma protein were all within normal ranges. Liver fat was higher than normal (likely due to diet), but this condition did not appear to be a health hazard to the fish.

Yearling kokanee were released from Creston Hatchery trucks into Flathead Lake (off Bird Point in South Bay) on April 15-18 (Figure 1). The mid-April release occurred 6 weeks earlier than planned to minimize in-hatchery losses of yearling kokanee to furunculosis and to allow disinfection of hatchery facilities. (In 1994 and 1995, furunculosis caused substantial in-hatchery losses of yearling kokanee in late April and May.) Mean length and weight of yearling kokanee at release were 127 mm and 17.4 g (Table 1). Surface water temperatures during the daytime releases varied between 4.5 and 5.5°C.

Kokanee fry (spring) .—Kokanee fry were produced from eggs taken in fall 1995 from Lake Mary Ronan, Montana. One group of kokanee fry (187,304 fish) was hatched and reared at the MFWP Flathead Lake Salmon Hatchery (Somers Hatchery), and two groups (301,555 fish each) were hatched and reared at Creston Hatchery. Kokanee fry were not marked with oxytetracycline because of their small size; however, both groups reared at Creston Hatchery were chemically imprinted on morpholine (e.g., Scholz et al. 1975) for about 30 d between hatch and swimup. A concentration of 0.00005 mg/L morpholine was dripped into the rearing water through a peristaltic pump. If imprinted fry survive to maturity (years 1999 or 2000), morpholine could be used to attract them to the hatchery or another site.

On April 10, 1996, the group of kokanee fry from Somers Hatchery was released into Brenneman's Slough, a historical kokanee spawning area in the Flathead River. On April 24, one group of fry from Creston Hatchery was stocked from hatchery rearing tanks into Mill Creek, a Flathead River tributary; these fish were released at dusk to simulate natural, nighttime emigration. On April 30, the other group of fry from Creston Hatchery was released from hatchery trucks into the Flathead River at the MFWP Kokanee Bend fishing access site.

On April 24-26, a drift net (l-m diameter hoop with 2-m long bag and attached screened collecting jar) was placed in Mill Creek near its confluence with the Flathead River to capture kokanee fry moving downstream from the release point at Creston Hatchery. The net was 6 km downstream from Creston Hatchery and 15 km upstream from Flathead Lake. The net was checked morning and evening for 2 d to monitor emigration of kokanee fry. The net strained only a small part (<2%) of the streamflow, and the relatively slow water at the trap site may have allowed some fry to avoid or escape the net. Eleven kokanee fry were captured the first night (April 24-25), and 24 fry were captured the second night (April 25-26). No kokanee fry were captured during the daytime, supporting the observations of Fraley and Clancey (1988) that most kokanee fry emigrate at night. Thousands of fry stayed near the release point at Creston Hatchery for the first week after stocking, and at least several hundred fry remained near the hatchery for 2 weeks or more after stocking. We did not attempt to trap emigrating fry released into the Flathead River at Brenneman's Slough or Kokanee Bend.

Fingerling kokanee (summer).—Fingerling kokanee (219,627 fish), hatched in winter 1996, were produced from Creston Hatchery broodstock and reared at Creston Hatchery. Fingerling kokanee released in 1996 had one oxytetracycline mark near the outer edge of their vertebrae. Kokanee released as fingerlings in 1995 also had one mark; however, the two groups could be differentiated based on size.

In 1996, fingerlings were released into Flathead Lake (off Finley Point-near the Narrows) on August 6 (Figure 1). These fish were loaded from Creston Hatchery trucks into a boat-mounted, aerated tank and taken about 0.6 km offshore before release. Lake conditions were favorable for a mid-summer surface release because recent cold weather had reduced surface water temperature from 23 to 17°C. Mean length and weight of fingerling kokanee at release were 76 mm and 3.6 g (Table 1).

Monitoring Kokanee Survival

Zooplankton sampling in South Bay of Flathead Lake (spring, summer).-Zooplankton were collected (usually biweekly) from prior to stocking kokanee until mid-August. Zooplankton were collected with a Wisconsin-type sampler having a 118 mm opening and 80 micron mesh netting. The sampler was pulled vertically through the water from 5 m depths at 1 m/s. Three zooplankton samples were collected on each date, and each field sample was subsampled three times in the lab for enumeration. Zooplankton were identified to genus.

Angling in Flathead Lake (spring).-After yearling kokanee were stocked in South Bay in mid-April, several USFWS employees from Creston Hatchery fished volunteered (on their own time) to fish for lake trout in South Bay. The anglers fished April 15-May 14, and most of their time was spent trolling the eastern part of the bay near the area known as the Willows. On each trip, they recorded date, number of anglers, number of hours fished, species and lengths of fish caught, and weather conditions. Stomachs were removed from nearly all legal-length fish caught, stored in plastic bags, and later checked for kokanee.

Between April 13 and June 1, several anglers, in cooperation with MFWP, fished for lake trout in Flathead Lake; these anglers fished mostly on the south half of the lake. Anglers removed stomachs from all legal-length lake trout caught and recorded the date, location, and length of each lake trout caught. On June 22-23, MFWP collected stomachs from lake trout caught on the north half of the lake during an annual fishing tournament.

Electro fishing, visual surveys, and angling in the Flathead River downstream from Kerr Dam (spring). - On April 22, we electrofished and visually searched the Flathead River downstream from Kerr Dam for yearling kokanee stocked the previous week that may have passed through or over the dam. On four occasions between April 23 and June 28, anglers *were* recruited to fish a river site near Buffalo Rapids (about 9 km downstream from Kerr Dam) in an attempt to catch kokanee and other fish. Stomachs of lake trout and brown trout *Salmo trutta* caught were checked for kokanee.

Merwin trapping in Flathead Lake (spring).—In spring 1996 (April 15-May 14), a Merwin trap (Hansen et al. 1996) was placed in the eastern part of the Narrows to capture newly released yearling kokanee moving north from South Bay into the main part of Flathead Lake. Captured kokanee were measured to the nearest 1 mm total length (TL); a few of these fish were collected to verify that they were 1996 yearling kokanee, and the rest were released. Other fishes captured were measured for length (or counted) and released.

Gillnetting in Flathead Lake (spring, summer, fall).-Sinking, horizontal gill nets were set in South Bay from April into October (Table 2). Sampling usually occurred weekly in spring and monthly in summer and fall. A single gill net was 38 m long, 2 m deep, and comprised of five panels of different mesh sizes (19, 25, 32, 38, and 51 mm bar measure). Two single gill nets were tied end-to-end to make one paired net (76 m long), which was set in water O-6 m deep. A total of 45 paired nets were set in South Bay during the sampling period. Paired nets were set overnight (10-27 h). Kokanee and lake trout caught were measured to the nearest 1 mm TL and weighed to the nearest 10 g. Kokanee vertebrae were extracted to identify oxytetracycline marks, and lake trout stomach contents were identified and counted.

In spring (April 30 to May 14; before temperature stratification) and late fall (December 3-13; after fall overturn), gill nets were set lakewide at three sites in each of five areas of Flathead Lake (total, 15 sites). The nets were fished in designated areas and depths to provide comparable data among years. At each

TABLE 2.-Gill nets set in Flathead Lake in 1996 to monitor kokanee, lake trout food habits, and lake trout predation on kokanee.

Location and date	Gill nets used	Number of paired nets set'	Depth range (m)
South Bay			
Mar 29 - Oct 15	Paired, sinking horizontal nets	45	O - 6
Lakewide			
Apr 30 - May 2	Paired, floating and paired, sinking horizontal nets	60	Floating nets: surface Sinking nets: 10 - 35
Aug 21 - 23	Vertical nets and paired, sinking horizontal nets	39	0 - 46
Dec 3 - 13	Paired, sinking horizontal nets	13	10 -35

• 1 paired net = 2 single nets tied end-to-end

site, one floating, horizontal, paired net and one sinking, horizontal, paired net were set. Net mesh sizes were 19, 25, 32, 38, and 51 mm (bar measure). Floating nets were set near shore, and sinking nets were set at depths > 10 m. Floating and sinking nets were set perpendicular to shore and fished overnight. We counted the number of each species caught, measured them for total length and weight, and collected stomach contents.

Lakewide gillnetting in summer (August 19-September 5; after temperature stratification) accompanied a hydroacoustic survey. Lakewide gillnetting was used to describe fish species composition (for fish "targets" near the lake bottom), and the hydroacoustic survey (described below) was used to estimate species abundances. Gillnetting methods used August 19-September 5 were similar to those used in 'spring; however, we only used paired, sinking nets and increased the number of areas and depths sampled. In areas where we observed suspended fish targets during the hydroacoustic survey, we fished vertical gill nets to the bottom or to a maximum depth of 46 m. Mesh sizes for vertical nets were 15, 20, 25, 30, and 35 mm (bar measure). Vertical nets were fished overnight. We collected length, weight, and species composition data from 12.5 m depth strata.

Hydroacoustic survey of Flathead Lake (summer).-We **conducted a lake-wide hydroacoustic survey (August 19-22) from an 8-m boat equipped with a Biosonics Model 105 Echosounder (420 KHz) and a Biosonics Model 281 Echo Signal Processor (Deleray et al. 1995). Dual-beam circular transducers (6" and 15") were mounted into the hull of the boat, We recorded acoustic information on a Sony digital audio tape recorder, processed tapes using Biosonics ESP.V3.2 software, and calculated targets strengths, distribution, and densities using Biosonics ESPTS program. We surveyed from about 2200 to 0300 hours. In areas with many suspended targets, we conducted vertical gillnetting. If we caught kokanee, we estimated target strengths and densities to produce estimates of kokanee abundance.**

We partitioned Flathead Lake into 10 areas, based on bottom morphology, depth, and location. Such partitioning allowed us to more accurately estimate fish densities, direct netting operations, and compare our results to previous studies (Beattie et al. 1990). We followed 42 pre-determined transects, all of which were perpendicular to shore, but not connected to each other. We traveled at a constant speed (6 knots) and used radar to follow the transects. We collected 9.17 h of data in four nights of sampling.

Flathead Lake is thermally stratified in August, the period that provides the best conditions for hydroacoustic surveys of kokanee (L. Hanzel, MFWP, personal communication). The thermocline was established at approximately 12 m at a temperature of 20" C (Deleray et al. 1995). For analysis,. we used 12 m depth strata; however, we did not differentiate fish species in the upper stratum because we assumed lake trout, lake whitefish, kokanee, and bull trout were below 12 m in depth. This minimized gill-net sampling and reduced the catch of nongame fish species.

A digitized, bathymetric map of Flathead Lake, generated with Geographic Information System software, allowed us to estimate surface area' for each of the 10 areas and all 12 m depth strata in each area. We calculated fish abundance by multiplying the surface area of each depth stratum by the weighted mean fish density for each depth stratum by area. For each area and depth stratum, mean fish density was estimated by weighting density estimates by transect length. Similarly, we calculated variance for densities by combining transects in each area.

To determine species abundance, we separated targets into four length groups (< 150 mm, 150-300 mm, 300-500 mm, and > 500 mm). Minimum target strength used for fish was -60 dB. We estimated fish length from target strength based on a modification of Love's equation: TS_{45} = 18.4 Log(L)-1.6 Log(f)-61.6, where L equals fish length (cm) and f equals frequency of hydroacoustic system (420 kH_2) (Love 1977; Burczynski and, Johnson 1986). We used -60 to -46 dB to describe fish < 150 mm in length, -44 to -40 dB for fish 150 to 300 mm, -38 to

-36 dB for fish 300 to 500 mm, and -34 to -24 dB for fish over 500 mm in length. By combining all transects within each area, we determined the proportion of targets in each of the size groups. By multiplying these proportions by the fish abundance estimate, we estimated the number of fish in each size group for each area.

Creel survey on Flathead Lake {summer, fall).-A creel survey was conducted on Flathead Lake in 1996 to (1) estimate kokanee catch rates; (2) determine mean length, weight, and condition of kokanee caught; (3) estimate lake trout catch rates comparable to a previous survey (Evarts et al. 1994), and (4) exchange information with anglers about the goals and objectives for kokanee reintroduction under Hungry Horse Dam mitigation. The survey was conducted May 18-September 15, which coincided with the 1996 kokanee fishing season.

Anglers were contacted at 13 access sites (11 public, 2 private), which accounted for most of the public access to Flathead Lake. Interviews were usually conducted as anglers pulled their boats from the water or returned to their vehicles after fishing from shore. Only anglers who had completed their fishing trips and had fished for ≥0.5 h were interviewed. Timing of interviews and site locations were selected on a rotating basis to ensure even coverage of most sites each week. Weekends were sampled at about three times the rate of weekdays, and we targeted time periods likely to maximize the number of interviews.

Interviews consisted of fishing-trip questions and angler-awareness questions (Appendix A). Fishing-trip questions included angler origin, hours fished, species targeted, and species and number of fish caught and kept. Angler-awareness questions provided data on (1) whether anglers knew they could fish for and harvest kokanee in 1996 in Flathead Lake and (2) anglers' opinions on the kokanee reintroduction program.

Visual surveys of historical kokanee staging and spawning areas in Flathead Lake and the Flathead River system upstream from Flathead Lake (fall).—In fall 1996, most known historical kokanee staging and spawning areas in Flathead Lake and the Flathead River system were visually searched for spawning kokanee and kokanee redds (Table 3). Lakeshore surveys (28 man-days) were conducted from a boat during daylight when the lake was calm and the lake bottom was visible in up to 6 m of water. The river was searched by snorkeling and canoeing in selected river reaches.

Merwin trapping in Flathead Lake (fall).—In fall 1996 (October lo-December 5), five Merwin traps were placed in Flathead Lake primarily to capture kokanee spawners. One trap was placed at each of the two sites where kokanee were stocked in 1994-1996 (Big Arm Bay, 1994; Bird Point, 1995, 1996), and one trap was placed at each of two historical kokanee spawning areas (Gravel Bay and

TABLE 3.-Locations, methods, and dates of kokanee staging and spawning surveys conducted in Flathead Lake and the Flathead River system, 1996.

Location	Survey method	Date surveyed	Comments
Flathead River			
Main stem	Boat, snorkel	Oct 18, Nov 8	Searched 29 of 39 historical staging and spawning areas (about 22 km)
North Fork	Snorkel, boat	Oct 23	Searched about 7 km
Middle Fork	Snorkel, boat	Nov 1	Searched about 8 km from West Glacier to Blankenship Bridge
South Fork	Snorkel	Oct 30	Searched 1.5 km and five historical staging and spawning areas
Flathead Lake			
East Shore and Skidoo Bay	Boat	Nov 13	Searched all known (> 15) historical spawning areas (about 7 km)
West Shore	Boat	Nov 26	Searched all six historical spawning areas (about 5 km)
Big Arm	Boat	Nov 14	Searched about 16 km of shoreline and six historical spawning areas
South Bay	Boat	Nov 18	Searched about 6 km of shoreline, including four historical spawning areas
McDonald Creek	Boat	Oct 31	Searched all 2.8 km of stream
Swan River	Snorkel	Sep 12, Oct 28	Searched historical staging and spawning areas
Whitefish River	Boat, wade	Oct 29, Nov 12	Searched about 12 km in historical spawning and staging areas

Woods Bay). The fifth trap was placed at Somers Bay, near where several kokanee had been caught in gill nets in summer 1996. Traps were checked once, sometimes twice, weekly. Except at Bird Point, all kokanee were killed and collected when captured. At Bird Point, juvenile kokanee were killed and collected when captured; however, mature kokanee were held in a live cage until the end of the sampling period and then killed and collected. All other game fish captured were measured to the nearest 1 mm TL and released; nongame fish were counted and released. Water temperature was measured each time a trap was checked.

Vertebrae were extracted from all kokanee collected and placed in individually marked envelopes. Vertebrae were checked for oxytetracycline marks under a black light and binocular scope. Number, pattern, and intensity of marks were used to assign each fish to one of five groups of kokanee stocked into Flathead Lake from 1994 through 1996. If no marks were visible, a fish was not assigned to a group. Vertebrae were checked without knowing fish length or capture location, except in two cases where length and capture location were used to verify the classification made by the observer.

Merwin trapping in the Flathead River upstream from Flathead Lake (fall) .—In fall 1996 (October-November), three Merwin traps were placed in the Flathead River system as part of the MFWP Hungry Horse Reservoir excessive drawdown mitigation program. The traps were used to evaluate fish species composition and movement, did not target kokanee, and were located 9.5-24 km upstream from Flathead Lake. One trap was at Foy's Bend (main river channel), one about 1.6 km upstream from Mill Creek (main river channel), and one in Church Slough. The Foy's Bend trap was fished for 7 d between October 1 and October IO; the Mill Creek trap was fished for 21 d between October 1 and November 11; and the Church Slough trap was fished for 11 d between October 1 and November 1. Traps were checked daily while in service.

Bioenergetics modeling (fall).—Bioenergetics modeling was used to examine predator-prey interactions between lake trout and kokanee in Flathead Lake. Model simulations and sensitivity analysis were conducted by Dr. David Beauchamp, Utah Cooperative Fisheries Research Unit, Utah State University, with data collected by MFWP, CSKT, USFWS, and the University of Montana Flathead Lake Biological Station (Beauchamp 1996).

Lake trout consumption demand on kokanee and alternative prey was calculated by applying a bioenergetics model (Hewett and Johnson 1992) parameterized for lake trout (Stewart et al. 1983) in Flathead Lake. Methods to estimate growth, survival, size- and season-specific diets, thermal experience, and lake trout population parameters are described in Beauchamp (1996). Lake trout diet patterns used in the model were based on data collected in Flathead Lake in 1994, when yearling kokanee were stocked into Big Arm Bay (Deleray et al.

1995). By quantifying the temporal-, spatial-, and size-related processes involved in lake trout predation on kokanee, we hoped to predict which segments of the lake trout population impose the greatest predation pressure on kokanee.

Model simulations were made with existing data from Flathead Lake on the diet, distribution, growth, abundance, and survival of lake trout (Beauchamp 1996). Different management scenarios were evaluated to determine the number of kokanee required to satisfy piscivore demand, supply a satisfactory fishery, and meet spawning or egg-take goals. The simulations were designed to evaluate predation under (1) existing kokanee stocking scenarios, (2) alternative stocking scenarios, and (3) changes in lake trout abundance and population structure.

Results

Zooplankton Sampling in South Bay (spring, summer)

Crustacean zooplankton (cladocerans and copepods) densities in South Bay during April and early May did not exceed 8/L and were dominated by copepods (*Diaptomus* spp., *Cyclops* spp.; Figure 2). Cladocerans (primarily *Daphnia* spp.) did not consistently occur in our samples until late June, after which their densities increased. *Bosmina* spp. (cladocerans) were present in very low densities. Hydracarina (water mites), although not typically in the diets of fish, were the most common organism in our samples; their abundance peaked at 15/L in June.

Angling in Flathead Lake (spring)

In spring 1996 (April 15-May 14), USFWS anglers caught 129 lake trout (mean, 0.87 fish/h), 63 northern squawfish (mean, 0.42 fish/h), and 4 yellow perch (mean, 0.03 fish/h) during 149 h of fishing in South Bay. Mean total lengths of angler-caught fish were 575 mm for lake trout (range, 432-960 mm), 454 mm for northern squawfish (range, 388-516 mm), and 258 mm for yellow perch (range, 241-295 mm). Yearling kokanee were first found in angler-caught lake trout stomachs on April 18 and last found on May 6. Stomachs from 122 of the lake trout caught were checked for kokanee, and one or more yearling kokanee were found in 73 (59.8%) of these stomachs (Table 4). Number of kokanee per lake trout stomach checked averaged 2.8 (range, O-17). Stomachs from 58 of the northern squawfish caught were checked for kokanee, and kokanee were found only in 2 (3.4%) of the 14 northern squawfish caught on April 22. One of these northern squawfish (a female 396 mm long) had one kokanee in its stomach, and the other (a female 457 mm long) had two kokanee in its stomach. No kokanee were found in the stomachs of the four yellow perch caught by anglers.

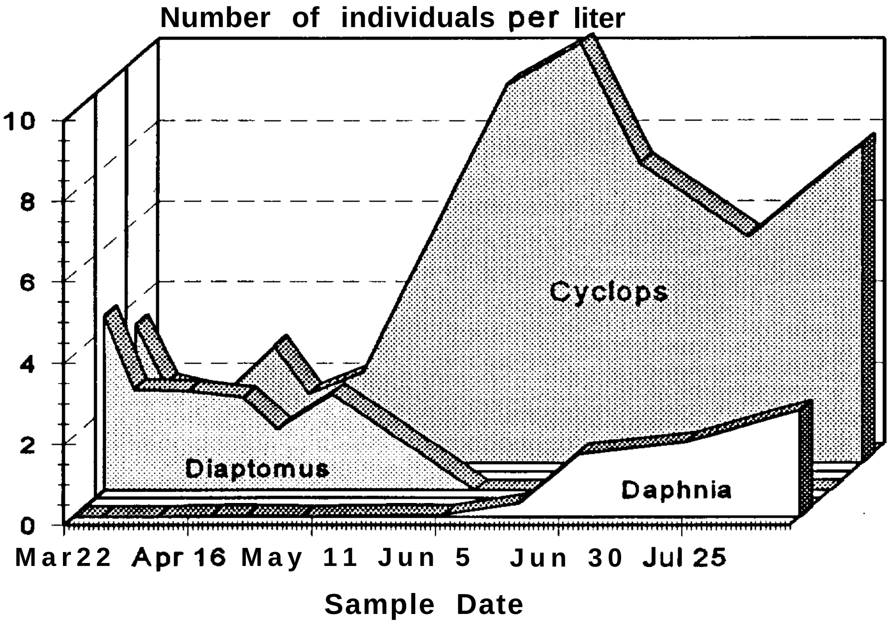

FIGURE 2.-The most common crustacean zooplankton collected in South Bay, Flathead Lake, 1996.

Sixty-one lake trout stomachs (from fish 406-749 mm TL) were obtained from anglers fishing in cooperation with MFWP between April 13 and June 1. Twelve of the stomachs were from fish caught in South Bay, 34 were from fish caught north of the Narrows but south of the CSKT Reservation boundary, and 15 were from fish caught north of the CSKT Reservation boundary and in the eastern half of the lake. Six of the stomachs contained kokanee, and all six were from fish caught north of the Narrows but south of the CSKT Reservation boundary. Eighty-four lake trout stomachs (from fish 405-794 mm TL) were collected during an annual fishing tournament on June 22-23. All of the stomachs were from fish caught north of the CSKT boundary, and two of the stomachs contained kokanee.

Electro fishing, Visual Surveys, and Angling in the Flathead River Downstream from Kerr Dam (spring)

No kokanee were found during an April 22 electrofishing survey of a 2-km reach of the Flathead River downstream from Kerr Dam. During the survey, we visually located about 15 dead kokanee in a slack-water area about 10 km downstream from Kerr Dam. These kokanee averaged 140 mm TL, and all had oxytetracycline marks on their vertebrae.

Anglers who were enlisted to sample the Flathead River downstream from Kerr Dam fished 41 hours and caught 18 lake trout (mean, 0.44 fish/h). All lake trout caught in April had kokanee in their stomachs (Table 5). Sixty percent of

TABLE 4.-Summary of kokanee found in stomachs of lake trout and northern squawfish caught by anglers in South Bay, Flathead Lake, April 15-May 14, 1996.

	Lake trout					Northern squawfish				
Date	Number caught	Number of stomachs checked	Number of empty stomachs	Total number of kokanee in all stomachs checked	Mean number of kokaneel stomach checked	Number caught	Number of stomachs checked	Number of empty stomachs	Total number of kokanee in all stomachs checked	Mean number of kokaneel stomach checked
Apr 15	5	0	---	---	---	0	---	---	---	---
Apr 18	2	2	0	5	2.50	11	8	1	0	0
Apr 19	4	4	0	3	0.75	14	14	4	0	0
Apr 20	6	6	0	75	12.50	4	4	1	0	0
Apr 21	1	1	0	8	8.00	6	5	1	0	0
Apr 22	1	1	0	0	0.00	14	14	3	3	0.21
Apr 25	1	1	0	8	8.00	0	---	—	---	---
Apr 28	31	31	0	176	5.68	2	2	0	0	0
Apr 30	24	22	0	51	2.32	1	0	---	- -	---
May 03	8	8	3	2	0.25	1	1	0	0	0
May 04	25	25	10	10	0.40	1	1	0	0	0
May 06	14	14	1	4	0.29	3	3	0	0	0
May 09	1	1	0	0	0.00	0	---	---	---	---
May 14	6	6	0	0	0.00	6	6	1	0	0
Composite	129	122	14	342	2.80	63	58	11	3	0.05

TABLE 5.-Date and length of angler-caught lake trout and number of kokanee found in the stomach of each angler-caught lake trout, Flathead River downstream from Kerr Dam, April-June, 1996.

Date lake trout caught	Total length of lake trout (mm)	Number of kokanee in lake trout stomach
Apr 23	491	1
Apr 23	434	4
Apr 23	527	12
Apr 23	434	5
Apr 23	428	5
Apr 30	476	1
Apr 30	491	6
Apr 30	446	3
May 10	413	0
May 10	512	0
May 10	476	2
May 10	432	2
May 10	486	1
Jun 28	440	0
Jun 28	468	0
Jun 28	440	0
Jun 28	424	0
Jun 28	417	0
Composite (N = 18)	(mean = 458; range, 413-527)	(mean = 2.3; range, O-1 2)

the lake trout caught in May contained kokanee, and none of the lake trout caught in June contained kokanee. The anglers also caught two kokanee (347 and 268 mm TL) in the river while fishing for lake trout. Both kokanee had two oxytetracycline marks, indicating they had been stocked by Creston Hatchery.

Merwin Trapping in Flathead Lake (spring)

In spring 1996 (April 15-May 14), eight kokanee (mean length, 124 mm) were captured in the Merwin trap in the Narrows (Table 6); all eight were yearlings

TABLE 6.—Summary of fish captured in Merwin trap set in the eastern part of the Narrows of Flathead Lake, April 15-May 14, 1996.

		Kokanee yearlings			Number of other fish species captured						
Date	Surface water temperature (“Cl	Number caught	Mean length (mm)	Length range (mm)	Westslope cutthroat trout	Northern squawfish	Lake whitefish	Yellow perch	Slimy sculpin	Large-scale sucker	Red-side shiner
Apr 15’	3.3	---	---	---	---		---	---	---	---	---
Apr 16	2.8	0	---	---	0	0	0	1	0	0	1
Apr 18	2.8	0	---	---	0	0	0	0	0	0	0
Apr 19	---	5	124	102-l 65	0	0	0	0	0	0	0
Apr 21	2.8	0	---	---	0	0	0	0	0	0	0
Apr 23	2.8	3	124	109-l 54	1	2	0	0	0	1	6
Apr 25	---	0	---	---	0	0	0	0	0	0	0
Apr 29	3.3	0	---	---	0	0	0	0	2	2	1
Apr 30	3.3	0	---	---	0	0	0	0	0	0	0
May 2	3.3	0	---	---	0	0	0	0	0	0	0
May 7	3.9	0	---	---	0	0	1	0	0	0	0
May 9	3.9	0	---	---	0	0	0	0	0	0	0
May 14’	---	0	---	---	0	0	0	0	0	0	0
Composite	---	8	124	102-l 65	1	2	1	1	1	3	8

• Trap installed April 15 and removed May 14.

stocked in April 1996. Seven other species of fish were also captured (Table 6). Surface water temperature ranged from 2.8 to 3.9°C during the trapping period.

Gillnetting in Flathead Lake {spring, summer, fall)

South Bay.-Twelve kokanee yearlings were caught in gill nets in South Bay during the study period. Eight were caught on April 19 (within days of their release off Bird Point), and four were caught between July and September (Appendix B). This sample was too small to draw conclusions about growth rates of stocked kokanee during the study period.

Sixty-four lake trout were caught in gill nets in South Bay during the study period. Length distribution of these lake trout (Figure 3) was similar to that of lake trout caught in gill nets in South Bay in 1995 (Hansen et al. 1996); however, the peak of the length distribution was about 50 mm greater in 1996 than in 1995. Of the lake trout caught in 1996, 34% had only fish in their stomachs, 31% contained only invertebrates, 10% contained a combination of fish and invertebrates, and 25% of the stomachs were empty.

Lake trout caught in South Bay contained kokanee only during the first three weekly sampling periods following the mid-April release of yearlings (Appendix C). Sixty-seven percent of lake trout (2 of 3) caught in the first week following release of yearling kokanee contained kokanee in their stomachs, 100% (5 of 5) caught during the second week contained yearling kokanee, and 14% (2 of 14) caught during the third week contained yearling kokanee. The average number of yearling kokanee contained in each lake trout caught in South Bay was 15 during the first week following the release of kokanee, 20 during the second week, and 0.6 during the third week. None of the 34 lake trout caught in South Bay after May 7 contained kokanee. Other fish prey of lake trout in South Bay were yellow perch and lake whitefish, which numerically represented 7% and 2% of the identifiable fish prey.

We also found invertebrates in lake trout stomachs from the start of sampling until late June, except when lake trout were preying mostly on kokanee. Macroinvertebrates found in lake trout stomachs included terrestriat or aquatic members of the following groups: Annelida, Gastropoda, Amphipoda *(Gammarus* sp.), Hemiptera, Hymenoptera, Coleoptera, Ephemeroptera, Odonata, Trichoptera, and Diptera. No opossum shrimp were found in any of the lake trout caught.

Lake trout abundance and period of use in South Bay in 1996 were similar to that documented in 1995 (Figure 4). In both years, lake trout catches in gill nets generally decreased through spring until late June, when lake trout were nearly absent from South Bay. Also in both years, catch rates of lake trout increased immediately following the release of yearling kokanee.

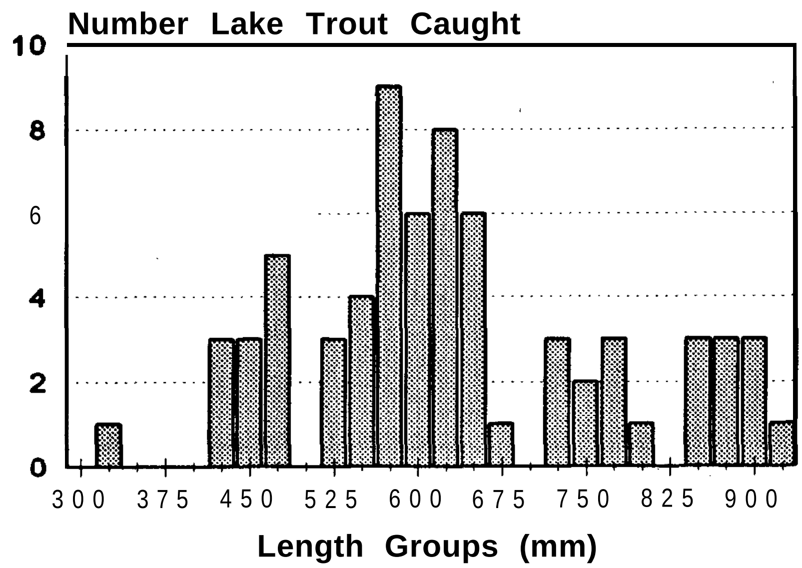

FIGURE 3.-Length frequency (label marks lower end of group) of lake trout caught by gillnetting in South Bay, Flathead Lake, 1996.

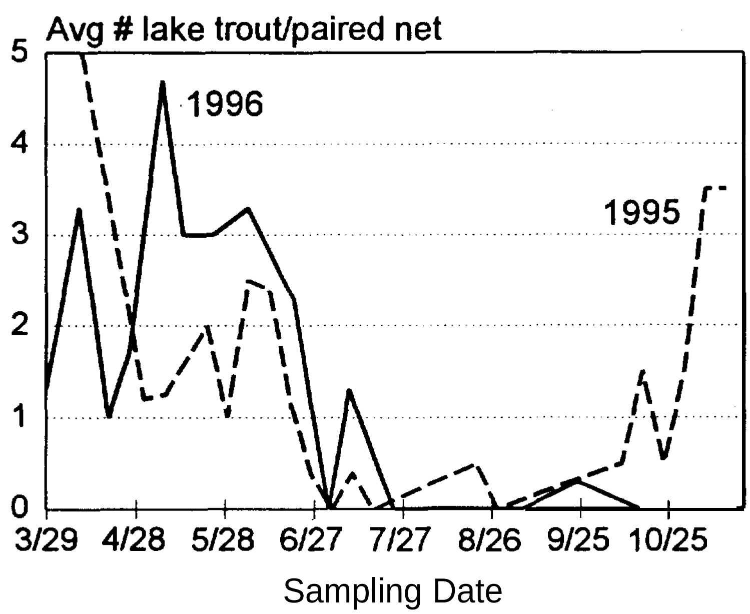

FIGURE 4.-Average number of lake trout caught per paired gill net in South Bay, Flathead Lake, 1996.

Lakewide.-We did not catch kokanee in either sinking or floating gill nets during spring sampling (Table 7). Lake whitefish (75%) and lake trout (14%) were the dominant species caught. Sinking gill nets (N = 15 paired nets) caught an average of 2.6 lake trout and 14.2 lake whitefish per paired net. Four of the 49 lake trout caught (length range, 350-754 mm) had kokanee in their stomachs.

In the August sinking gill-net survey, we did not catch kokanee. Lake whitefish constituted 50%-97% of the catch at depths > 12.2 m and for fish ranging from 150 to 500 mm TL. Lake trout catch was second to lake whitefish for these strata. For fish > 500 mm TL, lake trout dominated the percent catch (88%-100%) for depth strata > 12.2 m. Because of the mesh sizes used, we rarely caught fish < 150 mm TL. None of the 107 lake trout caught (length range, 187-863 mm) had kokanee in their stomachs.

We did not catch kokanee in vertical gill nets (N = 15) set in the Blue Bay or Narrows areas (Table 8). In the northwest part of the lake (Caroline and Conrad points near Lakeside; Figure 1), we caught 13 kokanee in vertical gill nets in two depth strata (9.1-18.3 m and 18.3-27.4 m). Total lengths of kokanee caught ranged from 170 to 195 mm (i.e., all kokanee caught were in the 150-299 mm size stratum). Vertebrae from each of these kokanee were examined by three fishery biologists, but no oxytetracycline marks were found.

In the 9.1-18.3 m depth stratum, kokanee accounted for 5.3% of all fish caught and 7.7% of fish caught in the 150-299 mm size stratum. In the 18.3-27.4 m depth stratum, kokanee made up 6.0% of all fish caught and 12.1 % of fish caught in the 150-299 mm size stratum. Lake whitefish dominated the catch in all depth strata except the 27.4-36.6 m stratum, where pygmy whitefish composed 65% of catch. All pygmy whitefish were < 150 mm TL. Kokanee appeared to be either interspersed with or in close proximity to schools of juvenile lake whitefish.

A total of 168 lake trout were caught during lakewide gillnetting in December. Length of these fish ranged from 260 to 912 mm, and none had kokanee in their stomachs.

Hydroacoustic Survey of Flathead Lake (summer)

We used four transects in the northwest part of Flathead Lake (Somers Bay south to Angel Point) to estimate kokanee abundance. The target strength distribution along these transects showed that 23.1% of fish targets were in the 150-299 mm size stratum. Areal fish target densities ranged from 0.004 to 0.027 fish/m^2. Weighted mean densities for the 9.1-18.3 m and 18.3-27.4 m depth strata were 0.023 and 0.021 fish/m^2, respectively. By combining these values with results from the vertical gillnetting and with estimates of surface acreage, we

TABLE 7.-Game fish caught in spring gill-net survey, Flathead Lake, 1996.

	Sinking nets (1 5 paired)		Floating nets (15 paired)	
Species	Fish/Net	% Comp.	Fish/Net	% Comp.
Lake trout	2.6	13.6	0.4	12.2
Lake whitefish	14.2	74.8	co.2	2.4
Bull trout	0.2	0.7	0.4	17.1
Kokanee	0.0	0.0	0.0	0.0
Westslope cutthroat trout	0.0	0.0	0.4	17.1

TABLE 8.-Fish caught in vertical gill nets set in the northwest part of Flathead Lake, summer, 1996.

		Number in each length group (mm)						
Depth strata (m)	Species*	<150	150-299	300-499	≥ 500	Total	Percent of catch	Fish per set
O-9.1	LWF	2	6	8	0	16	61.5	4.0
	PEA	2	5	0	0	7	26.9	1.8
	NSQ	0	1	1	0	2	7.7	0.5
	RSS	1	0	0	0	1	3.8	0.3
9.1-18.3	BT	0	1	0	0	1	1.1	0.3
	LT	0	0	2	1	3	3.2	0.8
	KO	0	5	0	0	5	5.3	1.3
	LWF	4	59	21	0	84	88.4	21.0
	PWF	2	0	0	0	2	2.1	0.5
18.3-27.4	KO	0	8	0	0	8	6.0	2.0
	LWF	23	58	9	0	90	67.7	22.5
	PWF	35	0	0	0	35	26.3	8.8
27.4-36.6	LT	0	0	0	2	2	10.0	0.5
	LWF	0	5	0	0	5	25.0	1.3
	PWF	13	0	0	0	13	65.0	3.3
36.6-45.7	LT	0	0	0	1	1	33.3	0.3
	LWF	0	2	0	0	2	66.7	0.5

* LWF = lake whitefish; PEA = peamouth; NSQ = northern squawfish; RSS = redside shiner; BT = bull trout; LT = lake trout; KO = kokanee; PWF = pygmy whitefish

estimated that on August 19 there were 47,686 kokanee (150-299 mm TL) in the northwest part of Flathead Lake. We estimated that 19,675 kokanee were in the 9.1-l 8.3 m depth stratum, and 28,011 were in the 18.3-27.4 m depth stratum.

Creel Survey on Flathead Lake (summer, fall)

We interviewed 254 parties (representing 594 anglers) between May 18 and September 12, 1996. Forty-seven (18.5%) of the interviews were with anglers who had participated in professionally guided trips. Almost all (96.5%) of the interviewed anglers stated they were fishing for lake trout. Only three anglers reported they were targeting a species other than lake trout (e.g., cutthroat trout or yellow perch); six anglers stated no preference, but rather were fishing for whatever they could catch. Average party size was 2.3 anglers, and average trip length was 3.8 h. Twenty-five (9.8%) of the 254 anglers interviewed were contacted more than once during the survey period.

Forty-five percent (115 of 254 responses) of the anglers contacted were aware that the kokanee fishing season was open, but only four of those anglers had fished for kokanee in 1996. None of the anglers we contacted had caught a kokanee either on the day of the interview or at any time in 1996. Seventy-seven percent of anglers interviewed (58 of 75 responses) were aware of the current program to reintroduce kokanee to Flathead Lake.

Average lakewide catch rates for 1996 were 0.33 lake trout/h (SD = 0.44) for the total sample, 0.56 lake trout/h (SD = 0.35) for guided anglers, and 0.28 lake trout/h (SD = 0.43) for unguided anglers. The catch of lake trout consisted of 807 fish < 762 mm, 18 fish in the 762-914 mm slot, and 1 fish > 914 mm. Sixty-four percent of interviewed anglers caught at least one lake trout smaller than the slot length, and 9.5% (15 of 157) released their entire catch. Those anglers that harvested lake trout smaller than the slot limit harvested an average of 77.3% of the lake trout they caught. Anglers caught an average of 1.38 lake trout per trip, and none of the 254 parties interviewed averaged more than nine lake trout caught per angler per trip. Because interviews were conducted with only one angler per group of anglers, it was not possible to determine if an individual angler caught a daily creel limit of lake trout.

Visual Surveys of Historical Staging and Spawning Areas in Flathead Lake and the Flathead River System Upstream from Flathead Lake (fall)

We located 11 kokanee in the basin-wide search for redds and spawning adults. One dead female (333 mm) was retrieved from Skidoo Bay on November 13. Ten kokanee and two small kokanee redds were observed near the Days Inn motel (just east of the Kwatuknuk resort) in South Bay on November 18, but none of these fish were captured. No other kokanee or redds were observed.

Merwin Trapping in Flathead lake (fall)

In fall 1996 (October 2-December 5), 47 kokanee were captured in Merwin traps set in Flathead Lake (Table 9). Kokanee were captured at Bird Point (N = 35), Big Arm Bay (N = 5), and Gravel Bay (N = 7), but not at Woods Bay or Somers Bay. Eighteen of the kokanee captured were mature males (mean TL, 342 mm), 11 were mature females (mean TL, 333 mm), and 18 were juvenile fish (mean TL, 146 mm; Table 10). Mature males and females were captured only at Bird Point (N = 15 and 9) and Big Arm Bay (N = 3 and 2). Juvenile kokanee were captured only at Bird Point (N = 11) and Gravel Bay (N = 7).

Based on our analysis of oxytetracycline marks on kokanee vertebrae, we assigned the 47 kokanee captured in fall 1996 to one of five groups of kokanee stocked into Flathead Lake between 1994 and 1996 (Table 11; Figure 5). Four of the kokanee were stocked as yearlings in 1994 at Big Arm Bay, 20 were stocked as yearlings in 1995 at Bird Point, 2 were stocked as fingerlings in 1995 at Bird Point, 4 were stocked as yearlings in 1996 at Bird Point, and 16 were stocked as fingerlings in 1996 off Finley Point. One kokanee captured in fall 1996 was unmarked and not assigned to a group.

Other game fishes captured in Merwin traps in fall 1996 included westslope cutthroat trout, bull trout, lake trout, rainbow trout, and brook trout (Table 9).

Merwin Trapping in the Flathead River Upstream from Flathead Lake (fall)

One kokanee was captured in a Merwin trap (Mill Creek trap, November 14) on the lower Flathead River. The total captured in all traps also included 162 peamouth, 49 pygmy whitefish, 39 mountain whitefish, 39 northern squawfish, 38 yellow perch, 26 westslope cutthroat trout, 8 largescale suckers, 6 longnose suckers, 6 redside shiners, 5 pumpkinseed sunfish, 3 lake trout, 2 largemouth bass, 1 black bullhead, 1 bull trout, and 1 lake whitefish.

Bioenergetics Modeling (fall)

Bioenergetics model simulations for Flathead Lake (Beauchamp 1996) suggested that lake trout predation imposed substantial losses on stocked yearling kokanee within the first year of their release. The model predicted that most predation in 1994 occurred during the first month after stocking (i.e., June). Kokanee losses during this time exceeded losses accrued from July through September. Lake trout in the 626-750 mm and 501-625 mm size classes were responsible for 34% and 30% of the estimated predation, and lake trout 376-500 mm in length accounted for another 21%. Lake trout < 375 mm were responsible for 12% of the predation loss, and lake trout > 750 mm were responsible for 3%. Modeling higher-than-observed acute (i.e., short-term) predation versus lower-

TABLE S.-Fish captured in five Merwin traps set in Flathead Lake, October 2 - December 5, 1996.[a]

Trap site	Counts of each species caught[b,c]																	
	KO	CT	BT	LT	RBT	BRK	LWF	MW	PWF	LB	YP	PS	NS	PM	RS	LN	LS	BB
Bird Point	35	2	0	28	1	0	68’	0’	0’	1’	1,554’	2’	874’	31’	31’	331*	291’	1’
Big Arm	5	21	0	6	0	0	10	1	11	0	0	0	66	25	293	0	1	0
Gravel Bay	7	8	2	2	1	1	43	15	16	0	1	0	171	13	646	0	1	0
Somers Bay	0	2	0	2	0	0	2	0	67	0	55	0	20	95	1,406’	2	6	0
Woods Bay	0	12	0	0	0	0	3	0	2	1	30	0	30	38	869	2’	0	0
Totals	47	45	2	38	2	1	126’	16’	96’	2’	1,640’	2’	1,161’	202’	3,245’	335’	299’	1’

“Bird Point trap fished Oct 4 - Nov 22 (50 d); checked 1 1 times; 14 species caught.
Big Arm trap fished Oct 7 - Dec 5 (60 d); checked 11 times; 10 species caught.
Gravel Bay trap fished Oct 10 - Nov 21 (43 d); checked 10 times; 14 species caught.
Somers Bay trap fished Oct 2 - Nov 25 (55 d); checked 9 times; 10 species caught.
Woods Bay trap fished Oct 8 - Dec 4 (58 d); checked 13 times; 9 species caught.

[b] Abbreviations:

KO - kokanee
CT - westslope cutthroat trout
BT - bull trout
LT - lake trout
RBT - rainbow trout
BRK - brook trout
LWF - lake whitefish
MW - mountain whitefish
PWF - pygmy whitefish
LB - largemouth bass
YP - yellow perch
PS - pumpkinseed sunfish
NS - northern squawfish
PM - Peamouth
RS - Redside shiner
LN - longnose sucker
LS - largescale sucker
BB - black bullhead

[c]An asterisk (*) indicates a minimum count, and no asterisk indicates an exact count.

TABLE 10.-Mean length, weight, and condition of kokanee captured in Merwin traps in Flathead Lake, October 2 - December 5, 1996.[a]

Sex and maturity	Total length (mm) n	Mean	Range	Weight (g) n	Mean	Range	Condition factor (K) Mean	Range
Males (mature)	18	342	269-405	7	431	328-522	0.91	0.79-1.01
Females (mature)	11	333	309-355	4	354	348-368	0.97	0.91-1.04
Juveniles	18	146	116-207	15	25	4-64	0.68	0.26-0.91

[a]Kokanee were caught in Merwin traps at Bird Point (N = 35), Big Arm Bay (N = 5), and Gravel Bay (N = 7). No kokanee were caught in Merwin traps at Woods Bay or Somers Bay.

TABLE 11.-Plant of origin[a] for kokanee captured in Merwin traps in Flathead Lake, October 2 - December 5, 1996.[b]

Sex	Year and age group when stocked: 1994 yearlings	1995 yearlings	1995 fingerlings	1996 yearlings	1996 fingerlings	1996 fry	Unknown	Totals
Male	3	10	2	3	0	0	0	18
Female	1	10	0	0	0	0	0	11
Juvenile	0	0	0	1	16	0	1	18
All kokanee	4	20	2	4	16	0	1	47

[a]Based on oxytetracycline analysis.

[b]Kokanee were captured at Bird Point (N = 35), Big Arm Bay (N = 5), and Gravel Bay (N = 7). No kokanee were captured at Woods Bay or Somers Bay.

than-observed chronic (i.e., long-term) predation resulted in no kokanee surviving past midsummer in the acute predation scenario, and kokanee survival over the first year in the chronic predation scenario was less than in the nominal run.

Lake trout abundance and size classes used in the model were based on the results of a hydroacoustic survey conducted in August 1995. Lake trout abundance was probably underestimated because standard hydroacoustic methods cannot detect fish ≤1 m from the bottom. When a 10% larger lake trout population was modeled, kokanee survival declined substantially. When a 50% increase in the lake trout population was modeled, 0% survival of kokanee was predicted.

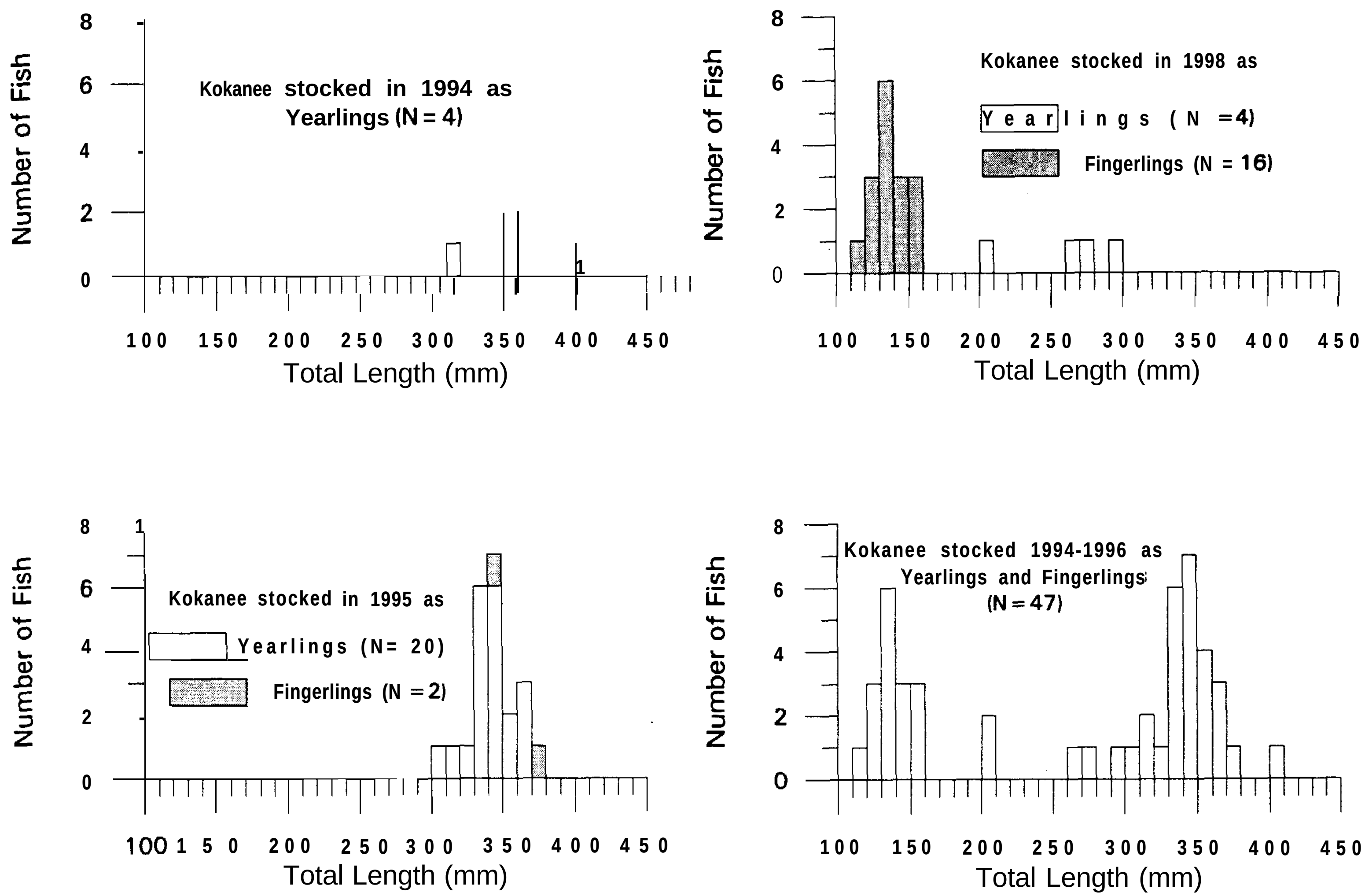

FIGURE 5.-Length frequencies of kokanee captured in Merwin traps in Flathead Lake, October 2-December 5, 1996 (Data are partitioned by year and age at time of stocking).

Discussion

Kokanee Stocking

Number and mean length of yearling kokanee stocked into Flathead Lake in 1996 were less than specified by the stocking objective of the 5-year kokanee test. Number of yearlings stocked was less because of furunculosis-related mortality in the hatchery, and mean length was less because the yearlings were stocked 6 weeks earlier than planned. (They were stocked in mid-April rather than in early June). Stocking kokanee fingerlings and fry in 1996 was accomplished with surplus fish.

Monitoring Kokanee Survival

Short-term survival and movement of yearling kokanee [spring).-Visual observations revealed little (< 1%) initial mortality of yearling kokanee when they were released from hatchery trucks into South Bay in mid-April; however, spring sampling in South Bay revealed substantial short-term (3-4 weeks post stocking) mortality of yearling kokanee from predation by lake trout. Short-term mortality of stocked yearling kokanee from lake trout predation was also documented in 1993 in Woods and Blue bays (Deleray et al. 1995), in 1994 in Big Arm Bay (Deleray et al. 1995), and in 1995 in South Bay (Hansen et al. 1996). In 1996, short-term mortality of yearling kokanee from lake trout predation in South Bay was probably greater than in 1995, when the fish were stocked between May 30 and June 1. South Bay is most suitable for lake trout when water temperatures are < 15°C (conditions that usually exist between September and June; Hansen et al. 1996), and we observed greater lake trout abundance in South Bay in April 1996 than in June 1995.

Downstream movement out of Flathead Lake represented another source of short-term loss of yearling kokanee in 1996. Stocking in 1996 coincided with unusually high spring flows through Kerr Dam, and stocking may also have occurred during "smoltification," a life-history stage in which there is an increased tendency for kokanee to move downstream (Tilson et al. 1995). Stocking during high flows and smoltification probably increased downstream movement over that expected if stocking had occurred in early June.

An indirect indicator of the extent of short-term losses from lake trout predation and downstream movement was that only four yearling kokanee were caught in gill nets in South Bay between July and September. In contrast, 208 yearling kokanee were caught in gill nets in South Bay in summer and fall 1995 (Hansen et al. 1996). In 1996, spring sampling revealed that some yearling kokanee moved north into the main body of Flathead Lake soon after they were stocked; however, the extent of this movement was not quantified.

Short-term survival and movement of kokanee fry (spring).-Spring **driftnetting in Mill Creek showed that some of the kokanee fry stocked into the creek emigrated to the Flathead River; however, we did not determine if any of these fish survived to reach Flathead Lake. We did not monitor kokanee fry stocked into the Flathead River at Breneman's Slough or Kokanee Bend; consequently, their short-term movements and survival are not known.**

Hydroacoustic abundance estimates of kokanee (summer).-We **estimated there were 47,686 kokanee in the 150-299 mm length group in the northwest part of Flathead Lake in August 1996. The estimate was derived from hydroacoustic density estimates and 13 kokanee (length range, 170-195 mm) caught in vertical gill nets set near Caroline and Conrad points. Because these 13 fish were not marked, they probably did not come from Creston Hatchery plants. We speculate that these kokanee escaped as fry from Creston Hatchery or Somers Hatchery in spring 1995 or were products of natural reproduction (1995 year class). No abundance estimates were made for kokanee in other length groups because no kokanee < 150 mm or > 299 mm were caught during summer gillnetting.**

Creel survey (summer, fall).**—In 1996, kokanee fishing was allowed on Flathead Lake for the first time since 1993, and our creel survey covered the May 18-September 15 open season. Nearly all anglers interviewed (96.5%) had fished specifically for lake trout, few (< 2%) had fished for kokanee, and none had caught kokanee at any time in 1996; these results indicate that a kokanee fishery did not develop in 1996. Although 77% of anglers interviewed (58 of 75 responses) were aware of the current program to reintroduce kokanee to Flathead Lake, only 45% (115 of 254 responses) were aware that kokanee fishing was open on Flathead Lake.**

Returns of mature and juvenile kokanee **(fall).-In fall 1996, 29 mature kokanee were captured during fall Merwin trapping in Flathead Lake, and one group of spawning kokanee (N = 10 fish) was found during visual searches of historical kokanee spawning areas. These results were similar to those of Deleray et al. (1995) and Hansen et al. (1996), who found that few kokanee stocked into Flathead Lake between 1993 and 1995 survived to maturity. Twenty-six of the 29 mature kokanee captured in fall 1996 were captured where they were stocked (Bird Point or Big Arm Bay), supporting the findings of Hansen et al. (1996) that mature kokanee tend to home to their stocking site. No mature kokanee were captured in Merwin traps set at Gravel Bay, Woods Bay, or Somers Bay, although these traps were located at or near historical kokanee spawning areas. The origin of the one group of spawning kokanee detected was not determined; however, these fish may have been stocked into South Bay because they were found spawning near that stocking site. No information about spawning or homing was obtained from the one female kokanee found dead in Skidoo Bay or from the one kokanee captured in the Merwin trap in the Flathead River upstream from the lake.**

The few juvenile kokanee (N = 18 fish) captured in Merwin traps in Flathead Lake in fall 1996 provided limited information about the survival and movements of kokanee stocked as yearlings or fingerlings into Flathead Lake in 1996. One of the juvenile kokanee captured had been stocked as a yearling in South Bay, had moved north, and was captured in the Merwin trap at Gravel Bay. Some kokanee stocked as fingerlings off Finley Point apparently moved south (11 were captured at Bird Point), whereas others moved north (five were captured at Gravel Bay). The one unmarked juvenile kokanee captured at Gravel Bay provided no movement information.

Bioenergetics Modeling

Bioenergetics modeling (Beauchamp 1996) simulations indicated that, under current stocking levels and strategies, nearly all yearling kokanee are eaten by lake trout within 1 year after stocking. Monitoring data from 1994 (Deleray et al. 1995), 1995 (Hansen et al. 1996) and 1996 suggested that much of that predation occurs within 1 month after stocking. Kokanee rapidly disappeared from the diets of progressively larger lake trout over time (within 2 months after stocking), and Beauchamp (1996) hypothesized that stocked yearling kokanee rapidly outgrow the predation threat from relatively small (but abundant) lake trout. We think that stocked kokanee remain highly vulnerable to lake trout predation throughout their life cycle in Flathead Lake, and we hypothesize that kokanee rapidly disappeared from the diets of progressively larger lake trout because predation by lake trout substantially reduces kokanee numbers within 2 months after stocking.

Beauchamp (1996) reported that lake trout in Flathead Lake selectively fed on kokanee even when alternative prey were more abundant. Such feeding behavior was evident from lake trout caught by gillnetting in 1993-I 995 (Deleray et al. 1995; Hansen et al. 1996) and in 1996. In 1996, during the 3 weeks before yearling kokanee were stocked, all lake trout caught by gillnetting in South Bay had some food in their stomachs; prey items included three species of fish and many species of aquatic and terrestrial insects. Such a low incidence of empty stomachs is unusual for lake trout in Flathead Lake, and despite the apparently abundant forage, lake trout captured by gillnetting in South Bay during the 2 weeks after stocking had shifted to a diet consisting almost totally of kokanee (Figure 6). During the shift, the average number of fish eaten by gillnetted lake trout increased greatly. Few lake trout caught during spring gillnetting contained more than one fish, except during the 2 weeks following the release of kokanee, when the average number of fish in lake trout stomachs increased to 21 (Figure 7). Monitoring data from 1995 and 1996 also suggested that lake trout may have moved into South Bay in response to the stocking of yearling kokanee. In both years, catch rates of lake trout in gill nets set in South Bay increased from the

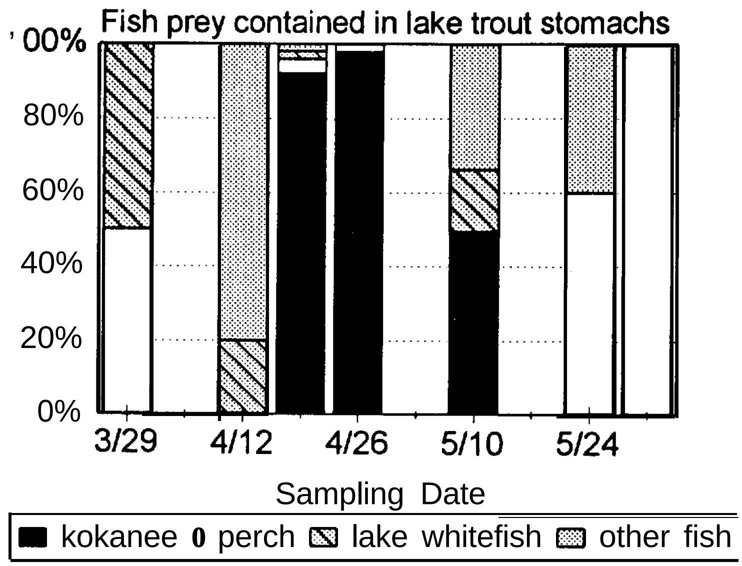

FIGURE 6.—Fish prey (by percent) contained in the stomachs of lake trout caught by gillnetting in South Bay, Flathead Lake, 1996.

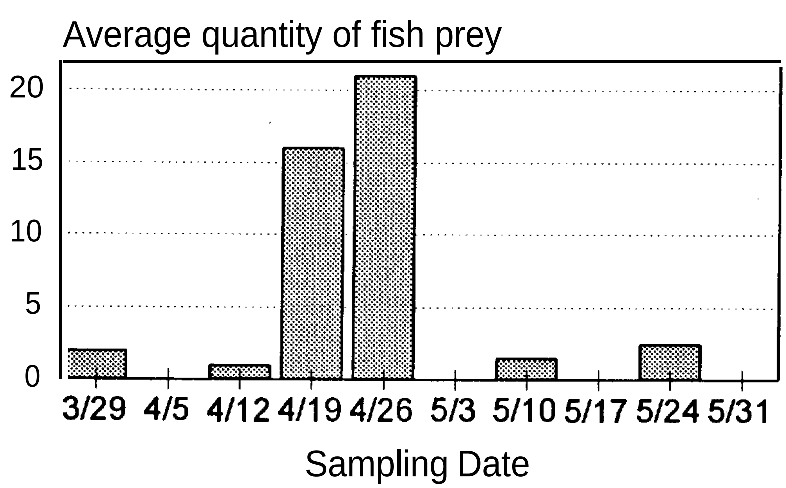

FIGURE 7.-Average quantity (number) of fish prey found in the stomachs of lake trout caught in South Bay, Flathead Lake, 1996

dates yearling kokanee were released (1995, May 30-June 1; 1996, April 15-18) to 2 weeks after the dates of release (Figure 4).

Conclusions

From 1993 through 1995, about 1.52 million kokanee yearlings and 409,000 kokanee fingerlings were stocked into Flathead Lake. Annual monitoring from 1993 through 1995 (Deleray et al. 1995; Hansen et al. 1996) showed that success Criterion 1 (30% survival 1 year after stocking) and success Criterion 2 (10% survival to maturity) were not met. Poor survival of stocked kokanee has been largely due to predation by lake trout. Criterion 3 (annual harvest of 50,000 kokanee ≥ 11 in and angler effort ≥ 100,000 h) was not evaluated between 1993 and 1995 because the kokanee fishery on Flathead Lake was closed.

In 1996, we stocked nearly 939,000 kokanee yearlings and 220,000 kokanee fingerlings into Flathead Lake and released about 790,000 kokanee fry into the Flathead River system upstream from the lake. We continued to evaluate success Criteria 1 and 2, and we also began evaluating success Criterion 3 because kokanee fishing on Flathead Lake was open in 1996 from May 18 to September 15. Spring and early summer monitoring in Flathead Lake and the Flathead River system revealed considerable short-term (3-4 weeks post-stocking) mortality of yearling kokanee from predation by lake trout. In spring, yearling kokanee were also lost from the system by downstream movement out of Flathead Lake. Summer monitoring detected only one group of kokanee (estimated number, 47,700 fish in the 150-299 mm size stratum) in the lake. Fall monitoring indicated that few kokanee stocked into Flathead Lake in 1995 and few "jack males" from the spring 1996 plant of kokanee yearlings had survived to maturity. We conclude from these data that Criteria 1 and 2 were not met in 1996. Bioenergetics model simulations indicated that nearly all yearling kokanee are eaten by lake trout within 1 year of release, and Beauchamp (1996) concluded that Criteria 1 and 2 cannot be met under current stocking levels (up to 1 million kokanee yearlings) and stocking strategies (where large numbers of kokanee are released at one or two sites). The creel survey showed that a kokanee fishery did not develop, and we conclude from this result that Criterion 3 was not met in 1996.

In spring 1997, we will stock yearling kokanee at four sites in the northwest part of Flathead Lake (Appendix D). Stocking will coincide with high, turbid flows from spring runoff in the Flathead River. We will also stock kokanee fingerlings into the South Bay area in August. We will continue to monitor system-wide in 1997 to more completely evaluate the three success criteria of the 5-year kokanee test.

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APPENDIX A

Creel Survey Field Forms

FLATHEAD LAKE CREEL SUMMER 1996

1.______/______/96 ______________________________________CLERK

2.________________INTERVIEW TIME IN MILITARY HOURS

3.______SITE #____SITE NAME

4.________________NUMBER OF ANGLERS IN GROUP

5.________________NUMBER OF HOURS FISHED (PARTY AVERAGE)

6.________________MT Co. # or Name________________Other State or Province

7. ________________WHAT SPECIES DID YOU FISH FOR TODAY?

8. N / S / B Did you fish north or south of the Reservation boundary?

9. # LAKE TROUT (<30") CAUGHT__________NUMBER KEPT__________

LAKE TROUT (in slot) CAUGHT__________

LAKE TROUT (> 36") CAUGHT__________NUMBER KEPT__________

____________________ CAUGHT__________NUMBER KEPT__________

____________________ CAUGHT __________NUMBER KEPT__________

THOSE ARE ALL THE QUESTIONS I HAVE TO ASK CONCERNING YOUR FISHING TODAY. IF YOU ARE WILLING, I WOULD LIKE TO ASK YOU SOME ADDITIONAL QUESTIONS ABOUT KOKANEE SALMON FISHING IN FLATHEAD LAKE. (Move to back page)

COMMENTS: (be liberal, this information is important, anything from ltolanee specifics to general gripes)

FLATHEAD LAKE KOKANEE INFORMATIONAL SURVEY - SUMMER 1996

1. ___________Have we interviewed you before about kokanee?

A five year experiment is currently underway to test the possibility of providing kokanee fishing in Flathead Lake again.

2. ____________Are you aware of this program?

3. ____________Would you care to provide any comments about this program?

4. ____________**Do you know that the** season is now open for kokanee fishing in Flathead Lake?

5. ___________Have you fished for kokanee in Flathead Lake this year?

    5a. ___________How many times?________________Where?

6. ___________Have you caught any kokanee in Flathead Lake this year?

Place **an** x where the kokanee were caught.

7. ____________How many kokanee did you catch?

8. ____________**How** long were **they?** (A range is fine)

9. ____________On what date (s) did you catch the lokanee?

APPENDIX B

Summary of gill-net catches

TABLE **1.** Number, species, and location of fish caught in paired sinking gill nets, South Bay of 'lathead Lake 1996. (Abbreviations listed at end of table.)

Date	LT	LWF	YP	NS	KO	CT	BT	PM	LN	LS	MW	RS
31'29	2	36	2	0	0	0	0	0	0	0	0	0
3/29	0	23	2	0	0	0	0	0	0	0	0	0
3/29	2	35	0	0	0	0	0	0	0	0	0	0
4/09	3	1	0	0	0	0	0	0	0	0	0	0
4/09	3	7	0	0	0	0	0	0	0	0	0	0
4/09	4	29	1	0	0	0	0	0	0	0	0	0
4/19	1	13	0	0	4	0	0	0	0	0	0	0
4/19	0	16	0	0	3	0	0	0	0	0	0	0
4/19	2	14	0	0	0	0	0	0	0	0	0	0
4/26	5	28	0	0	0	0	0	0	0	0	0	0
4/26	0	12	0	0	1	0	0	0	0	0	0	0
4/26	0	20	2	0	0	0	0	0	0	0	0	0
5/07	7	22	0	0	0	0	1	0	0	0	0	0
5/07	5	14	0	0	0	0	0	0	0	0	0	0
5/07	2	18	0	0	0	0	0	0	0	0	1	0
5/14	3	38	1	5	0	0	0	4	0	0	0	0
5/24	2	19	0	0	0	0	0	1	0	0	0	0
5/24	2	29	0	1	0	0	0	2	0	0	0	0
5/24	5	46	0	1	0	0	0	0	0	0	0	0
5/05	3	34	0	0	0	0	0	1	0	0	0	0
5/05	4	33	0	0	0	0	0	0	0	0	0	0
5/05	3	22	0	1	0	0	0	0	0	0	0	0
5/20	2	66	1	0	0	0	0	2	0	0	0	0

TABLE 1, continued.

Date	LT	LWF	YP	NS	KO	CT	BT	PM	LN	LS	MW	RS
6/20	1	35	0	0	0	0	0	0	0	0	0	0
6/20	4	15	0	0	0	0	0	1	0	1	0	0
7/02	0	27	1	17	0	0	0	36	2	0	0	0
7/02	0	49	1	4	0	0	0	9	1	0	0	0
7/02	0	43	7	20	0	0	0	24	0	0	0	0
7/09	0	55	0	15	0	0	1	4	1	0	0	0
7/09	2	43	0	7	0	0	0	1	0	0	0	0
7/09	2	74	0	16	1	0	0	12	0	0	0	0
7/24	0	55	0	12	0	0	0	6	0	0	0	0
7/24	0	34	0	22	0	1	0	6	2	0	0	0
7/24	0	39	0	19	0	1	0	3	2	0	0	0
8/16	0	16	0	90	0	0	0	12	0	2	1	0
8/16	0	47	0	56	0	0	0	0	0	0	0	0
8/16	0	42	0	30	2	0	0	0	1	0	0	0
9/05	0	38	5	45	0	0	0	41	0	1	0	0
9/05	0	45	0	23	0	0	0	7	0	7	1	0
9/05	0	24	0	11	0	0	0	5	0	6	0	0
9/24	0	7	0	6	1	0	0	0	0	2	0	0
9/24	0	0	0	2	0	0	0	0	0	0	0	0
9/24	1	14	0	34	0	0	0	5	0	0	0	0
10/15	0	32	3	7	0	0	0	6	2	0	0	0
10/15	0	57	0	3	0	0	0	3	0	0	0	0

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

APPENDIX C

Summary of stomach contents of lake trout captured in South Bay, 1996

Table 1. Date, length, stomach contents of lake trout gillnetted in South Bay, 1996.

Date	Len	# Kok	#LWF	# YP	#Unid	Inverts
3/29	786	0	1	1	0	0
3/29	576	0	1	1	0	0
4/9	342	0	0	0	0	x
4/9	539	0	0	0	1	0
4/9	595	0	0	0	1	x
4/9	812	0	1	0	0	0
4/9	590	0	0	0	0	x
4/9	665	0	0	0	1	0
4/9	630	0	0	0	1	0
4/19	856	6	0	0	0	0
4/19	738	39	0	1	0	0
4/19	930	0	0	0	1	0
4/26	628	17	0	1	0	0
4/26	601	9	0	0	0	0
04/26	743	18	0	1	0	0
4/26	794	26	0	0	0	0
4/26	854	30	0	0	0	0
5/7	643	3	0	0	0	0
5/7	656	0	0	0	0	x
5/7	596	0	0	0	0	x
5/7	823	0	1	0	0	0
5/7	792	0	0	0	1	0
5/7	597	0	0	0	1	x
5/7	744	0	0	0	0	x

Table 1, continued.

Date	Len	# Kok	#LWF	# YP	#Unid	Inverts
5/7	650	0	0	0	0	x
5/7	594	0	0	0	0	x
5/7	740	0	0	0	0	x
5/7	556	0	0	0	0	x
5/7	549	0	0	0	0	x
5/7	860	0	0	0	0	0
5/14	482	0	0	0	0	0
5/14	432	0	0	0	0	x
5/14	494	0	0	0	0	0
5/24	884	0	0	0	1	x
5/24	662	0	0	0	0	x
5/24	583	0	0	0	0	0
5/24	697	0	0	0	1	x
5/24	614	0	0	0	2	0
5/24	607	0	0	6	0	0
5/24	573	0	0	0	0	x
5/24	753	0	0	0	0	x
6/5	758	0	0	0	0	0
6/5	661	0	0	0	0	x
6/5	638	0	0	0	0	0
6/5	486	0	0	0	1	0
6/5	633	0	0	0	1	x
6/5	588	0	0	0	1	0
6/5	909	0	0	0	0	x

Table 1, continued.

Date	Len	# Kok	#LWF	# YP	#Unid	Inverts
6/5	531	0	0	0	0	0
6/5	615	0	0	0	0	x
6/5	630	0	0	0	0	x
6/20	594	0	0	0	0	0
6/20	618	0	0	0	0	0
6/20	467	0	0	0	0	x
6/20	439	0	0	0	2	0
6/20	443	0	0	0	0	0
6/20	473	0	0	0	0	0
6/20	918	0	0	0	0	0
7/9	617	0	0	0	0	0
7/9	475	0	0	0	0	0
7/9	637	0	0	0	0	0
7/9	563	0	0	0	0	0
9/24	477	0	0	0	0	0

Len = length
Kok = kokanee
LWF = lake whitefish
YP = yellow perch
Unid = unidentified fish
Inverts = invertebrates
x denotes presence

APPENDIX D

Work Plan and Strategy to Achieve 1997 Monitoring and Implementation Goals

The Hungry Horse Technical Team will monitor the fourth year of the kokanee experiment in 1997. We will continue to refine methods to monitor the success criteria and explore new strategies for releasing kokanee. Our intention is to conclusively evaluate the success of the kokanee experiment in 1998 and have field-tested most of the feasible strategies for rearing and releasing kokanee.

Monitoring in 1995 indicated that immediate post-stocking survival of kokanee 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 kokanee and that no other site in Flathead Lake is likely to have fewer lake trout, we released yearling kokanee in South Bay in 1996. Because of concerns over a potential furunculosis outbreak at the hatchery (which has been problematic in recent years in the late spring) and in order to disinfect hatchery rearing facilities between year classes, stocking yearling kokanee in 1996 occurred April 15-l 8 (4-6 weeks earlier than previous plants). As this monitoring report indicates, based on 1996 returns, this release strategy was not favorable for long-term kokanee survival in the lake.

Consequently, based on the 1993-1996 results, we decided to adopt a new stocking strategy in 1997. This strategy was adopted for four reasons:

1. High Turbid Inflow - Expectations for extremely high runoff in the Flathead Basin (approximately 150% of normal snowpack) in 1997 have led to a likelihood of delayed refill of the lake and high summer discharges over Kerr Dam. Thus, the potential for flushing losses or downstream emigration of smolting kokanee are high in the south end of the lake. This "plume" of inflow water on the north end will carry high loads of suspended sediment, creating a turbid condition for several weeks.

2. Facilitating The Test - It was generally agreed by the Technical Team that the 5-year kokanee test would be "incomplete" if we did not evaluate more stocking locations, particularly in the north half of the lake, before concluding the test. It is possible that refugia from lake trout could exist that we have not anticipated, and test stocking of several sites may be our best way to search those opportunities. The existence of a population of kokanee near Caroline and Conrad points suggests there are possible survival strategies or refugia of which we are not aware.

3. South Bay Returns - Despite the encouraging returns of jacks to South Bay in the fall of 1995, we had low returns of adults to Bird Point in 1996. In addition, the early plant of yearlings in South Bay in 1996 yielded very low returns of jacks in the fall of 1996. We have concluded that incremental improvements in survival in South Bay in 1997 will not be sufficient to allow

us to reach program goals. Consequently, the South Bay stocking program is unlikely to result in ultimate success, given existing predator population dynamics.

4. Model Results - The modeling report stated: "Different stocking strategies should be tested before the 5-year evaluation program ends. Dispersed, nocturnal releases in deep, open water areas are suggested to reduce the observed functional and numerical responses by predators to easily detected, localized high densities of stocked kokanee." Evidence to date also indicates that swamping of lake trout by concentrated stocking has not been effective. The report also notes: ". . . we should expect kokanee to represent even higher proportions of the lake trout diet at higher stocking densities." Finally, the report notes: ". . . release strategies that reduce acute (i.e., 3-4 weeks post-stocking) predation losses might translate into greater adult production."

   In analyzing these modeling report conclusions, we are not convinced that "dispersed nocturnal" releases are necessary to achieve the goal of reducing functional and numerical response by predators. The cost of barging hatchery trucks to the middle of lake would be $2,000-4,000, and it would also involve a considerable amount of logistical maneuvering and night work. It was conceded that it was not practical to pursue this option.

Based primarily on those four considerations, we decided that dispersed stocking of yearling kokanee into the northwest quadrant of the lake will occur in 1997. Because of the high turbid inflow expected in late May and June of 1997, we anticipate visibility (and hence foraging ability of lake trout) will be restricted in this entire area of the lake for a period of several weeks. We view this as a unique opportunity to employ adaptive management and test a previously untested hypothesis, i.e., that release of kokanee into turbid water will reduce their vulnerability to predation, and that this reduction in short-term predation may translate into greater survival to the fishery.

Historically, the northwest quadrant of the lake was not used extensively by spawning kokanee, but there were concentrations of spawners near Somers Hatchery (likely due to fry releases from that site), and scattered redds were found around Lakeside. The persistent returns of unmarked kokanee in the Conrad Point-Caroline Point area (1996 hydroacoustic estimate of 47,700 fish) may be an indicator that there are favorable conditions in that area of the lake for kokanee survival.

We will attempt to maintain a dispersed stocking scheme, using up to four available boat ramps, so that fish will not be concentrated at one site. Planting will be rotated from site to site to further reduce opportunities for lake trout to concentrate and inflict acute mortality.

The 1996 monitoring strategy focused on quantifying the three success criteria for the kokanee experiment more completely than was possible in 1993, 1994, and 1995, and we were only partially successful in accomplishing that. Because of the dispersed stocking strategy we have adopted in 1997, with fish being planted into the main basin of the lake, it will be even more difficult to achieve adequate monitoring of those criteria. Consequently, we have chosen to monitor success Criterion 1 (first-year survival) in a different fashion in 1997, focusing on a lakewide survival estimate in conjunction with the August hydroacoustic survey rather than with intensive gill-net surveys. This work entails estimating fish densities, size, and species composition in the main body of the lake and should give us an estimate of lakewide kokanee abundance in August.

A lakewide gill-net series will again be conducted in April 1997. Protocol for this series was established in 1981 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 are set during the spring when the water temperature profile is isothermal. Nets are left overnight in five specific areas in depths ranging from 10 to 35 m. These data provide further insight into the opportunity for reestablishing kokanee and possible changes in the Flathead Lake fish community during the 5-year kokanee test.

As a follow up to the April gill-net series, we will resurvey a number of the sites in the northwest quadrant of the lake in early June, using the same techniques, within 2 weeks following the kokanee plant. We will use this information as a relative indicator to determine changes in lake trout abundance (pre- and post-turbidity), as well as to assess post-stocking lake trout predation rates on planted kokanee for comparison to previous years.

Merwin traps at the stocking locations successfully captured adult kokanee in 1995 and 1996. In order to partially assess success Criterion 2 (adult returns), traps will again be deployed at the 1995 and 1996 stocking site in South Bay to capture age 2 and 3 spawners returning 1.5 or 2.5 years after their release. We will also use Merwin traps to conduct a relative assessment of survival of kokanee from each of the 1997 stocking locations by enumeration of “jack” male spawners. All known historical lakeshore spawning areas and most historical Flathead River spawning sections will again be surveyed in the fall by snorkeling, wading, and searching from boats and shore. We will also search selected non-traditional sites, continue to investigate angler reports, and solicit information from landowners on the lakeshore and river.

Success Criterion 3 (kokanee harvest) was evaluated with a random, access site-based creel survey conducted during the open season in 1996 (May 18 to September 15). Because so few kokanee fishermen were contacted and few, if any, kokanee were caught in 1996, we will not conduct a creel survey in 1997 and will not assess Criterion 3. If reports of kokanee harvest are received, we will target search activities to those areas where kokanee fishing is occurring and attempt to contact anglers to retrieve as much information as possible. A lakewide year-around creel survey is proposed for 1998, and at that time we will fully assess Criterion 3.

Finally, we anticipate having enough surplus fish from the 1996 egg collections to initiate a midsummer plant of about 300,000 fingerlings in 1997. Because 1995 and 1996 investigations have identified South Bay as a thermal refuge for kokanee from lake trout predation (from approximately July 1 through mid-October of each year), this location affords the greatest opportunity for short-term survival of stocked fingerlings. In 1996, fingerling stocking of 220,000 fish off of Finley Point was conducted the first week of August using a boat-mounted tank. A similar approach will be used in 1997 to place about 300,000 2.5in fish into South Bay sometime after July 1, after river outflows have been reduced. A series of fine-mesh gill nets set in the fall will be used to assess whether those fish remain in South Bay. Incidental observations from other sites may provide some insight into possible emigration of these fish from that location.

Table 1. Activities planned for monitoring the success of the kokanee experiment in Flathead Lake in 19.97.

STRATEGY	TARGET KOKANEE POPULATION	MONITORING OBJECTIVE	SITE
Hydroacoustic Survey with Verification Gillnetting (August)	1995 yearling 1995 fingerling 1996 yearling 1997 yearling	Success Criterion #1, Distribution, movement, and habitat preference	Lakewide
Lakewide Gill-net Series (April) Partial (June)	1995 yearling 1995 fingerling 1996 yearling 1996 fingerling	Success Criterion #1, Distribution, movement, and habitat preference	Lakewide
Fall Merwin Trap/ Redd Search & Spawner Inventory	1995 yearling 1995 fingerling 1996 yearling 1996 fingerling 1997 "Jacks"	Success Criterion #2, Distribution, Timing, locations, egg collection	South Bay & 1997 Stocking Sites; Basinwide

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