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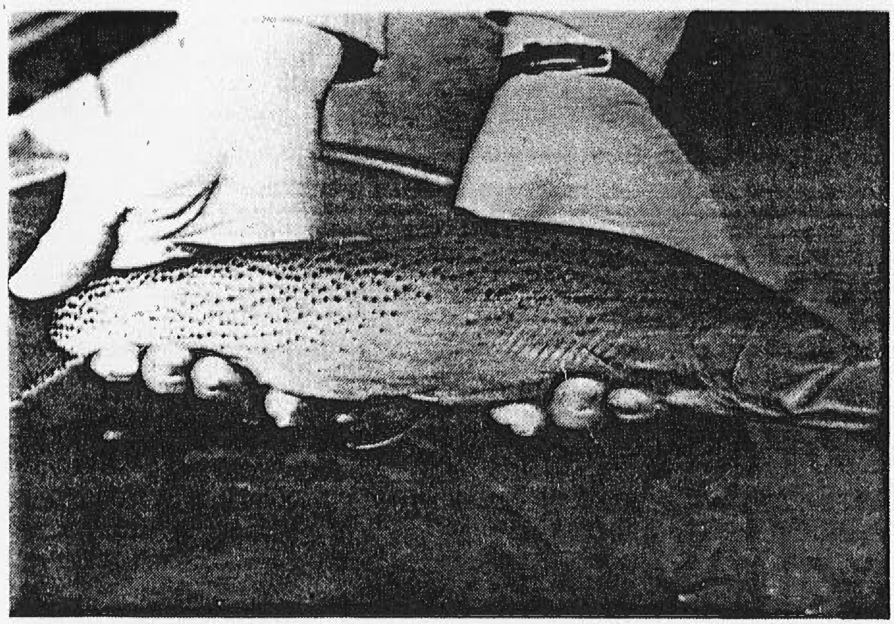
Study Completion Report, Project F-73-R-10
Subproject III: LAKE AND RESERVOIR INVESTIGATIONS
Study III: Fishery Enhancement in Large North Idaho Lakes
Job 2: Enhancement of Trout in Large North Idaho Lakes



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STUDY COMPLETION REPORT

State of: Idaho | Name: LAKE AND RESERVOIR INVESTIGATIONS

Project No.: F-73-R-10 | Title: Enhancement of Trout in Large North Idaho Lakes

Subproject No.: III

Study No.: III

Job No.: 2

Period Covered: March 1, 1987 to February 29, 1988

ABSTRACT

Population dynamics, forage relationships and potential effects of enhancement programs were evaluated for trout fisheries in large northern Idaho lakes. Hayden Lake provided the best opportunity for improving the trout fishery, with a *Mysis* forage base capable of producing trophy fish. Releases of 175 mm fingerlings, at 100/hectare, could improve trout catch rates to 0.2 fish/hour.

Coeur d'Alene Lake had relatively good recruitment of juvenile cutthroat trout produced in tributary streams. The overabundant kokanee population suppressed trout growth and limited the fishery. Exploitation of larger cutthroat was a significant mortality factor during early summer. Kokanee population control and regulation of the trout harvest had the potential to increase the trout fishery to catches of 5,000 fish at rates of 0.4 fish/hour.

Priest Lake had a predator-prey imbalance which limited fishing for all species, including the predominant lake trout. Kokanee stocked as 50 mm fry at a minimum rate of 300/hectare could buffer predation, increase lake trout productivity and maintain catch rates of 0.1 fish/hour for lake trout averaging 2.5 kg or larger.

It would require stocking of 650 to 850 fry/hectare or more, depending on functional predator-prey response, to provide a limited kokanee fishery of 0.3 fish/hour. Releases of 2 million cutthroat trout fry, and 175 mm fingerlings stocked at 10/hectare, could enhance the cutthroat trout fishery to catches of 2,500 fish at rates of 0.4/hour or better.

Except for lake trout in Priest Lake, large northern Idaho lakes supported fewer than 1 trout smaller than 50 cm in length per hectare. Pend Oreille, Hayden, Priest and Coeur d'Alene lakes all had reduced

native westslope cutthroat trout populations, partially due to competition with introduced species which provided most of the fishing opportunity. Enhanced trout fishing on the large lakes would require intensified management.

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INTRODUCTION

The large lakes of northern Idaho (Figure 1) comprise 70% of the surface area of natural lakes in the State. Westslope cutthroat Salmo clarki lewisi were the only trout of the genus Salmo native to large northern Idaho lakes. Mountain whitefish Prosopium williamsoni, bull trout Salvelinus confluentus, and northern squawfish Ptychocheilus oregonensis were the other angler-caught fish indigenous to the drainages.

At the turn of the century, cutthroat trout were the most abundant fish in Priest, Pend Oreille, Hayden and Coeur d'Alene lakes. These lakes probably produced catches of 30,000 to 50,000 trout annually (Bjornn 1957; Mallet 1968; Jeppson 1955). Trout fishing provided most of the angler opportunity prior to depletion of native stocks.

Introductions of competing species, increased harvest and loss of tributary habitat cumulatively reduced native trout populations to remnant levels. By the late 1960s, trout were providing relatively minor portions of total fishing opportunity in large northern Idaho lakes compared to introduced kokanee Oncorhynchus nerka. Native trout populations continued to decline and harvest was probably below 10,000 fish, with catch rates well under 0.3 fish/hour by the mid-1970s.

Trout fishing in the large lakes has remained important to anglers, although utilization has dropped (Gordon 1970a, 1970b; Mallet 1980). Despite quality angling in various other fisheries, including trophy trout and char, fishing for trout smaller than 50 cm was well below potential. Releases of catchable-sized rainbow trout Salmo gairdneri of domesticated stocks and Yellowstone cutthroat Salmo clarki bouveri (from Henrys Lake) did not provide the desired fisheries (Mallet 1968; Beach 1971). Successful use of other trout stocks would have further displaced westslope cutthroat populations mandated, as a native wild stock, for priority consideration in all management decisions involving resident fish (IDFG 1986).

As human population and development increased, good cutthroat trout fisheries were restricted first to unroaded drainages, then to streams managed with special regulations where most or all of the fish caught had to be released and were often subjected to repeated recapture. Under general regulations, size and numbers continued to decline, eventually resulting in poor trout fishing on 62,000 hectares of lakes and lower portions of associated rivers.

Priest Lake

Priest Lake has a surface area of 9,454 hectares, a mean depth of 38 m, a maximum depth of 112 m and a morphoedaphic index of 0.22. Opossum shrimp Mysis relicta were introduced from Kootenay Lake, British Columbia, in 1965 to improve the kokanee fishery. Successful establishment of Mysis

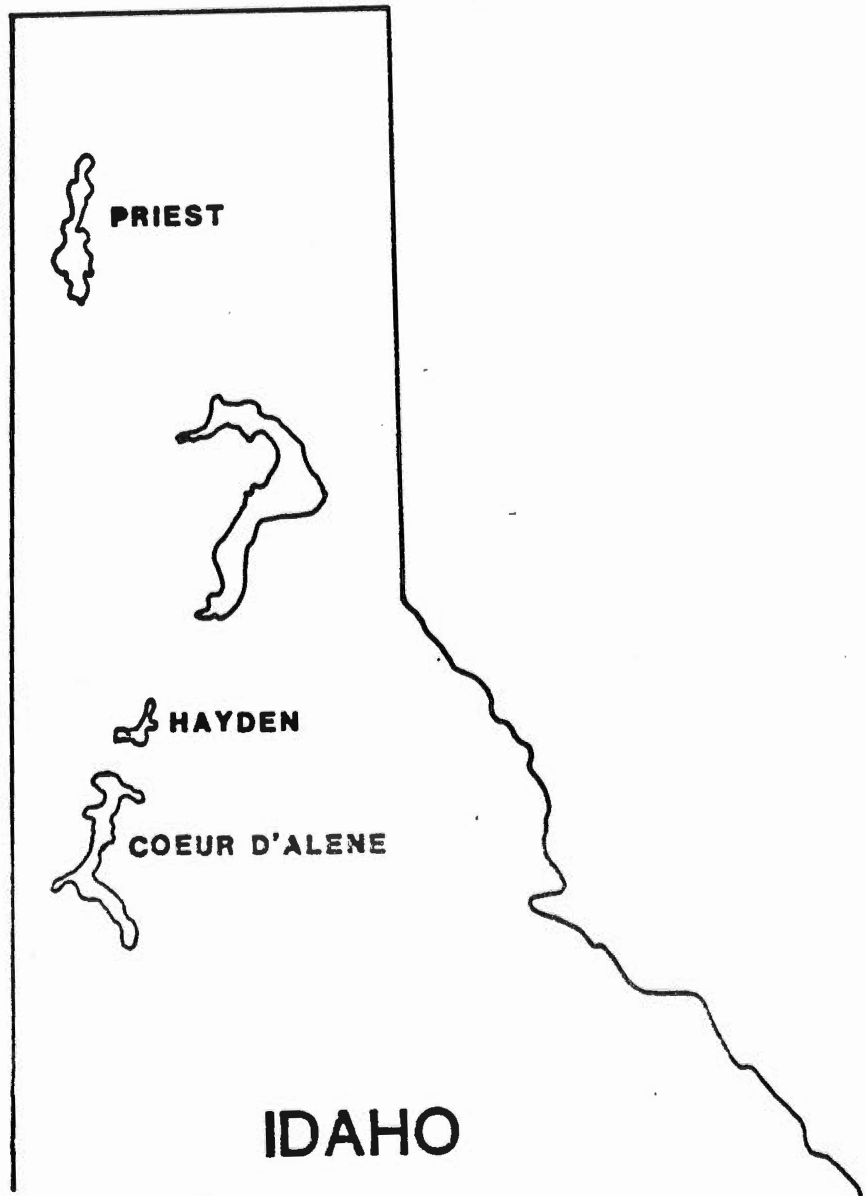

Figure 1. Large northern Idaho lakes.

resulted in a dramatic increase in lake trout Salvelinus namaycush numbers which eliminated popular fisheries for kokanee, bull trout and westslope cutthroat trout (Rieman and Lukens 1979; Mauser et al. 1988). Priest Lake supported a Mysis density of $17/m^3$.

The cutthroat trout fishery had already declined when the first research project was conducted in 1956 (Bjornn 1957; Figure 2). By the time a paved road to Priest Lake was completed in 1957, trout populations had been impacted by overharvest and kokanee had replaced trout, char and whitefish as the primary fishery. Mean size of cutthroat trout in the catch had declined from 33 to 38 cm adults to mostly immature fish averaging 28 cm (Bjornn 1957). Only about 5,000 cutthroat were harvested from Priest and Upper Priest lakes in the 1950s.

Anglers reported that cutthroat trout fishing began to deteriorate as early as the 1930s and 1940s, prior to the introduction of kokanee, when access to the lake was still poor. Priest Lake cutthroat trout are apparently less resilient than other populations because of limited tributary access and low productivity of the watershed. Juvenile fish rear in tributaries for extended periods of one to six years, with most spending three years in a nursery stream before entering the lake at an average size of 178 mm (Bjornn 1957; Mauser 1986a).

Brook trout Salvelinus fontinalis were introduced before the 1920s and replaced cutthroat trout in many tributaries. Bjornn (1957) estimated that brook trout populations reduced cutthroat trout rearing by as much as 50%.

Major factors limiting the cutthroat trout fishery after 1975 were lake trout predation, low tributary seeding and rearing capacity, and fishing mortality (Cowley 1987; Irving 1987; Mauser et al. 1988). Goal of the cutthroat trout program was to manage for catch rates of 0.5 fish/hour (IDFG 1986). Priest Lake was capable of supporting more cutthroat trout, and better fishing, if limiting factors could be overcome.

In 1982, the major rearing streams were closed to fishing and a minimum size limit of 38 cm was implemented for cutthroat trout harvested from Priest and Upper Priest lakes. Cutthroat trout densities increased in the tributaries and fishing improved in the lake, but only temporarily. Lake trout predation was limiting and the fishery did not improve after 1985. Failure of the population to respond to enhancement efforts led to closure of the consumptive fishery in 1988.

Priest Lake supported a good bull trout fishery prior to 1978. Fishing for bull trout was closed in 1984 when the population failed to rebound from an abrupt decline first apparent in the late 1970s. Bull trout spawning escapements remained alarmingly low and bull trout were seldom caught in Priest lake. Bull trout were apparently replaced by the expanded lake trout population.

Lake trout were introduced into Priest Lake in 1925 but were seldom caught until kokanee enhanced the forage base in the late 1940s and early 1950s. Lake trout ranging to 26 kg and averaging 10 kg were caught in a seasonal fishery which produced a few hundred fish until Mysis improved

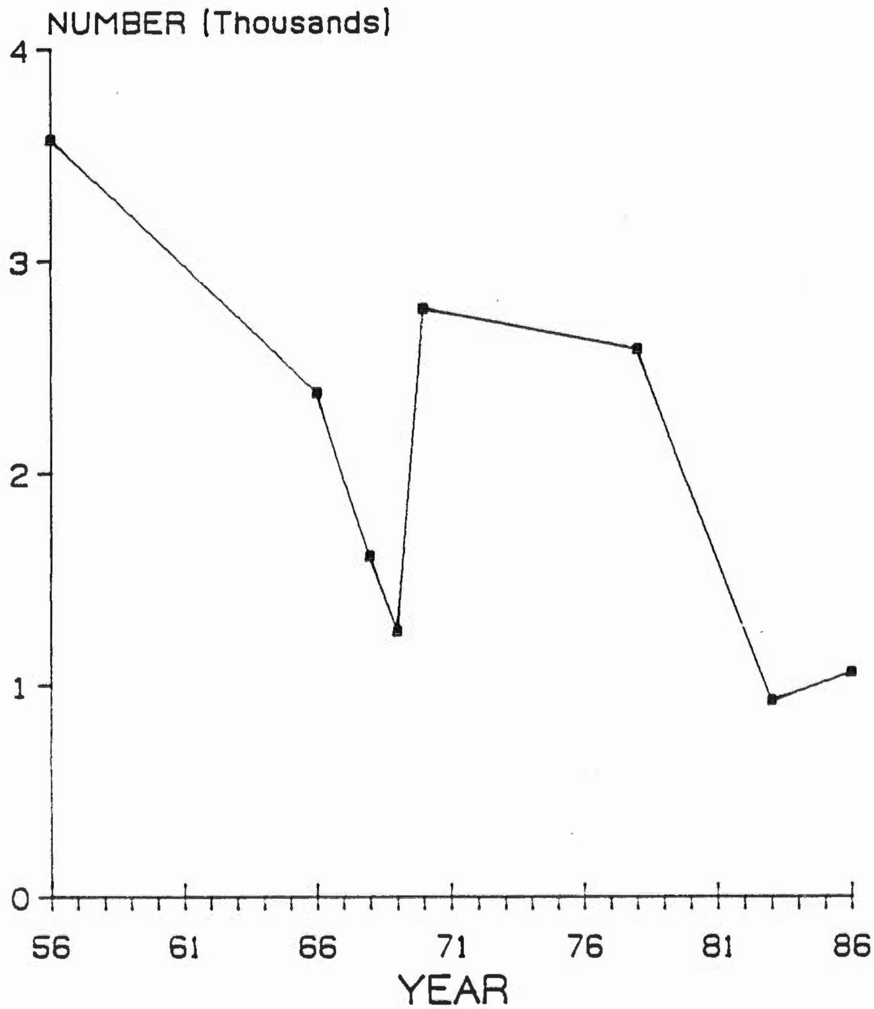

Figure 2. Cutthroat trout catch for Priest Lake, Idaho, 1956-1986.

survival of juvenile lake trout. Size of lake trout caught declined to under 2 kg as catch levels increased to 6,000 and kokanee were virtually eliminated from Priest Lake. Lake trout catch rates improved from 20 to 10 hours/fish with increased population levels. Flesh quality of lake trout was greatly enhanced by the change to a Mysis diet.

Priest Lake provided a high-yield fishery for kokanee from the early 1950s to the early 1970s. Harvests averaged 64,256 fish with a catch rate of 1.2/hour and provided most of the 15,000 angler days on the lake. After 1978 when 4,593 kokanee were harvested, the population was functionally extinct. Lake trout predation was the principle limiting factor along with reduced survival of kokanee fry due to competition with Mysis.

Midsummer releases of more than 5 million fry were considered necessary to provide any kokanee fishing (Bowler 1979; Mauser et al. 1988). A kokanee program of that magnitude would produce a potentially uncontrollable response in the lake trout population; however, minimum levels of 3 million kokanee were needed to provide adequate forage for lake trout.

Pend Oreille Lake

Pend Oreille Lake has a surface area of 38,300 hectares, a mean depth of 164 m, a maximum depth of 351 m and a morphoedaphic index of 0.17. Mysis were introduced in 1965 and subsequently reduced the kokanee population by adversely impacting survival of naturally produced kokanee fry (Bowles et al. 1987).

Mysis densities peaked at $40/m^3$, among the highest reported in the literature (Rieman 1977). Pend Oreille Lake, nonetheless, continued to support fisheries for Gerrard stock rainbow trout introduced from Kootenay Lake and native bull trout, both foraging primarily on kokanee. The cutthroat trout fishery was impacted by other problems, with catch declining steadily through 1985 as juvenile rainbow replaced cutthroat in the subtrophy fishery (Figure 3).

In 1955, westslope cutthroat were the most common trout in Pend Oreille Lake (Jeppson 1955). By 1985, the cutthroat trout fishery appeared functionally extinct with an estimated harvest of 664 fish and all but 49 incidental to kokanee fishing (Bowles et al. 1987). Although fishing for cutthroat trout did occur from the shoreline, on the northern end of the lake, and on the Pend Oreille River where anglers rarely reported to established census sites, the cutthroat fishery decline was more dramatic than any other on Pend Oreille.

Cabinet Gorge and other dams on the Clark Fork River eliminated 90% of the spawning and rearing habitat for Pend Oreille Lake in the 1950s. Cutthroat trout were produced in most of the remaining tributaries, but

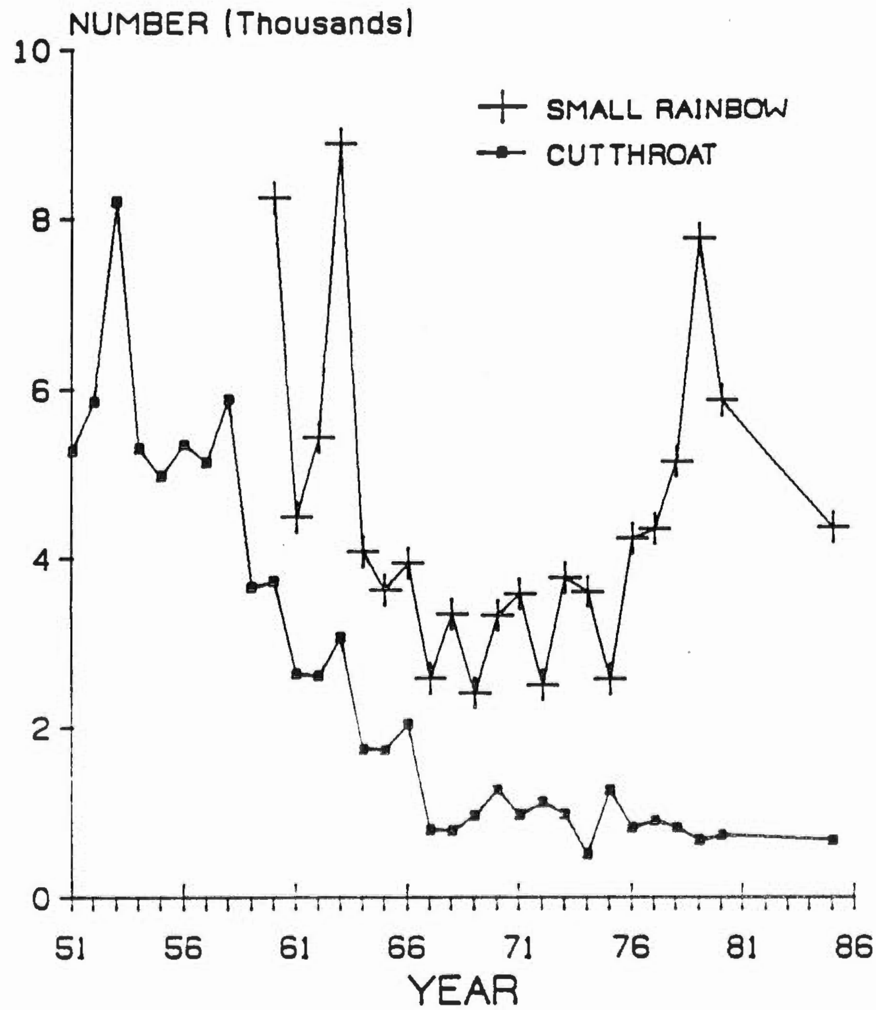

Figure 3. Catch of cutthroat trout and rainbow trout smaller than 432 mm for Lake Pend Oreille, Idaho, 1951-1985 (Bowles et al. 1987).

adfluvial stocks were depleted. Rearing habitat of larger streams was also occupied by Gerrard rainbow (Pratt 1984, 1985). The fishery for cutthroat trout was, therefore, likely to remain at a low level without hatchery support.

Catches of juvenile rainbow trout supplied most of the fishing for trout under 50 cm in length on the main body of the lake. Harvest of rainbow trout over 9 kg in size had declined since the trophy fishery was established in the 1940s (Irving 1986). Restriction of the harvest of juvenile fish and hatchery production of Gerrard rainbow were being explored as options for improving the trophy fishery.

Coeur d'Alene Lake

Coeur d'Alene Lake has a surface area of 12,743 hectares, a mean depth of 24 m, a maximum depth of 61 m and a morphoedaphic index of 0.35. Mysis were introduced several times but failed to survive, probably because of toxic concentrations of heavy metals. Kokanee were introduced from Pend Oreille Lake, with supplemental stocking from the late 1930s to the early 1970s, before the fishery became self-sustaining and kokanee overpopulated the lake. Chinook salmon Oncorhynchus tshawytscha were introduced in 1982 for kokanee population control (Mauser and Horner 1982).

The Spokane drainage provided several seasonal cutthroat trout fisheries which appeared to decline through the 1980s. Census efforts did not target the trout fishery until 1984 and then provided only partial harvest estimates. Although the number of juvenile fish the tributary system was capable of producing was reduced by brook trout populations, habitat degradation and impassable culverts, the drainage still had hundreds of stream miles with rearing potential (Apperson et al. 1988).

Nevertheless, numbers and size of trout in specific harvest fisheries were apparently still declining. Although causes were numerous, it was felt that populations would stabilize with regulations restrictive enough to increase survival rates to sustainable levels.

Major consumptive fisheries may have yielded over 12,000 trout in the early 1970s. With the advent of special regulations, the St. Joe River above Avery supported catches of 15,516 to 21,062 cutthroat (87% released) between 1972 and 1975, up from harvests of 6,460 to 6,964 fish in 1968 and 1971 (Johnson and Bjornn 1978).

Hayden Lake

Hayden Lake produced outstanding trout fishing similar in historical accounts to other lakes of the area, but with fish that were reportedly larger. Surface area of Hayden Lake is 1,520 hectares at summer level. Mean depth is 46 m, maximum depth is 65 m and the morphoedaphic index is

0.22. Hayden Lake supports Mysis densities of $27/m^3$ in the absence of a kokanee population. The cutthroat trout fishery was supplemented and replaced with rainbow trout of several stocks released over four decades (Ellis 1983).

A comprehensive management plan designed to restore the cutthroat trout fishery with tributary closures, a 356 mm minimum size limit and releases of 300,000 westslope cutthroat trout fingerlings annually was adopted by the Fish and Game Commission in 1978. Except for 1982 when 292,805 were released, stocking and survival of cutthroat fingerlings was less than expected. However, cutthroat increased from 9% to 64% of the trout harvested with another 4,677 trout caught and released for a dramatic improvement in the fishery (Figure 4).

The hatchery program was modified in 1983 to include primarily Kamloops rainbow trout available from commercial sources. A total of 625,798 westslope cutthroat and 1,063,561 Kamloops were stocked from 1977 to 1986 (Ellis 1983; Horner et al. 1987).

In 1982, anglers began to report shrimp in trout stomachs. Mysis were introduced in 1965 and 1974. The combination of restrictive regulations, fingerling releases of suitable stocks and Mysis forage produced a good trout fishery which peaked in 1986 with catches of fish to 5 kg. Catch rates were relatively low, however.

OBJECTIVES

1. To assess the potential for the Priest Lake cutthroat trout population to provide an improved fishery.

2. To evaluate the current status of lake trout in Priest Lake and the potential to improve the fishery.

3. To determine the feasibility of re-establishing a kokanee fishery in Priest Lake.

4. To monitor the response of Priest Lake bull trout to fishery closure.

RECOMMENDATIONS

Priest Lake

1. Release 3 million kokanee fry (300/hectare) annually to maintain or improve catch rates of 10 hours/fish for lake trout averaging 2.5 kg or better. Increase size of stocked kokanee fry to 50 mm, with the majority released in Granite Creek. Monitor kokanee survival with annual trawl sampling and relate to lake trout response with population modeling.

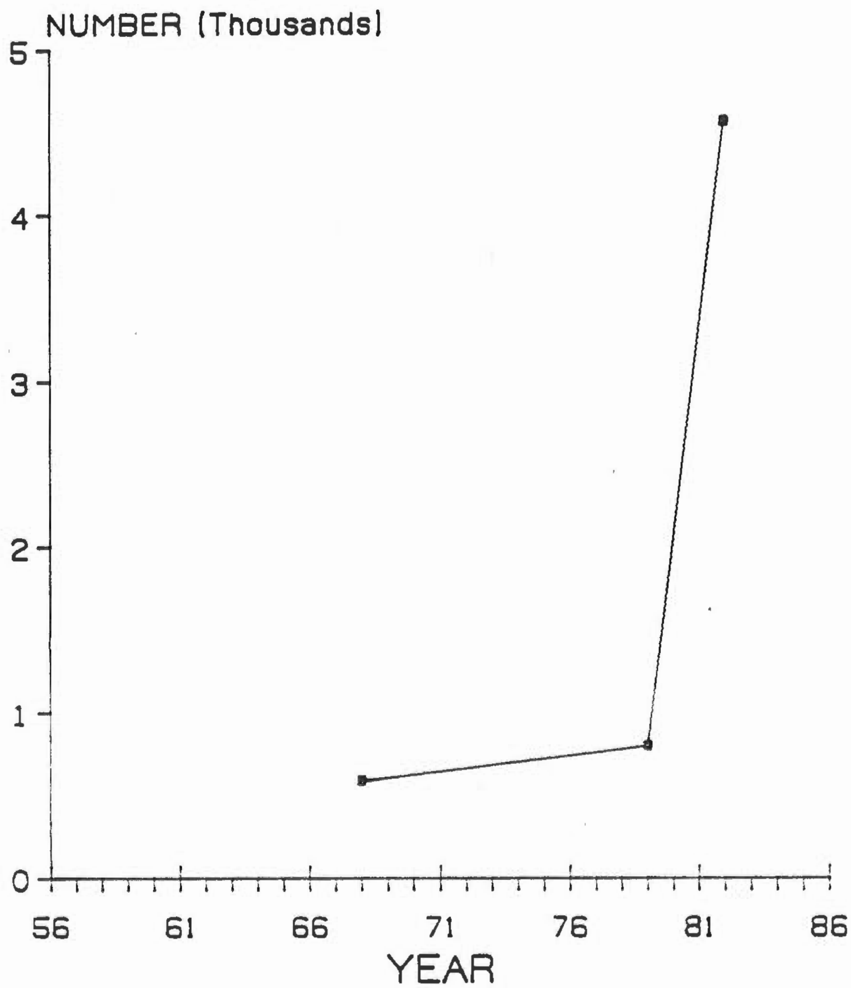

Figure 4. Cutthroat trout catch for Hayden Lake, Idaho, 1968-1982.

2. Maintain existing lake trout regulations until monitoring or population models indicate the need for changes. Then, adjust lake trout limits and kokanee stocking as necessary to maintain the desired fishery for lake trout.

3. Increase kokanee stocking levels to at least 6 million (650/hectare) to determine costs, benefits and feasibility of providing a limited kokanee fishery with a catch of 4,500 at rates of 0.3 fish/hour for 28 cm kokanee. Fry stocked must be 50 mm in size. Evaluate impacts on all species and adjust the management program accordingly.

4. Maintenance stock 2 million cutthroat trout fry at average densities of $5/m^2$ in Priest Lake tributaries (Appendices R and S) to produce a catch-and-release fishery of 2,500 at a rate of 0.4 fish/hour in Priest Lake. Increase the stocking program as additional eggs become available and re-evaluate limiting factors.

5. Release 100,000 cutthroat fingerlings (10/hectare), 175 mm in size, to supplement the fry stocking program and provide a harvest fishery. Stock fingerlings in Hunt Creek to supply additional recruitment to the lower portion of the lake and to reduce spawning of hatchery-reared fish with wild or natural stocks. Once the cutthroat trout population has responded, re-evaluate the potential of wild, natural and hatchery stocks to sustain a consumptive fishery.

Coeur d'Alene Lake

1. Reduce the kokanee population to 100 catchable fish/hectare with chinook salmon to provide catch rates of 2 fish/hour for 25 cm kokanee.

2. Maintain a 356 mm minimum size limit for cutthroat trout to produce a catch of 5,000 fish at a rate of 0.4 fish/hour.

3. Initiate brook trout removal programs and stock cutthroat fry in selected streams to improve tributary production of adfluvial fish.

Hayden Lake

1. Release 150,000 Kamloops rainbow and westslope cutthroat (100/hectare), 175 mm in size, to provide a catch rate of 0.2/hour for trout. Utilize Kamloops rainbow which provided good fishing during 1986 for 2 to 3 kg trout.

Pend Oreille Lake

1. Release 200,000 Gerrard rainbow and westslope cutthroat fingerlings (5/hectare), 175 mm in size, to evaluate limiting factors and the potential of a hatchery program to supplement the fishery for trout smaller than 50 cm.

METHODS

Priest Lake was the focus of the research program for trout enhancement in large northern Idaho lakes from 1983 to 1986, with methods and results summarized in annual reports (Mauser and Ellis 1985; Mauser 1986a, 1986b; Mauser et al. 1988).

During 1987, we sampled fish in Priest, Pend Oreille, Hayden and Coeur d'Alene lakes. A boat-count, angler-interview census was conducted on Priest Lake from May 9 to July 17 (Table 1). The census was spatially stratified, with counts and interviews conducted on different sections daily (Figure 5). An angler opinion survey was conducted during the census (Appendix A).

Priest Lake was sampled for cutthroat trout with purse seine gear from September 29 to October 8. We trawled Priest and Upper Priest lakes for kokanee density estimates on September 21 and 22. Tango Creek, a small tributary entering the northern portion of Priest Lake, was trapped from April 21 to June 17 for returns of hatchery-reared cutthroat trout.

A total of 750,288 kokanee fry (79/hectare) were released into Priest Lake on July 14 and 17 (Table 2). Adipose-clipped, grit-marked cutthroat fingerlings were reared in net pens at the mouth of Granite Creek from April 22 to June 5. A release of 19,090 fingerlings was then made at night, with an additional 24,975 adipose-clipped fish from the Clark Fork Hatchery, for a total of 44,065 two-year-old cutthroat trout (5/hectare) in Priest Lake in 1987 (Table 3).

Coeur d'Alene Lake was sampled with purse seine gear from April 1 to July 20, 1987 and November 4 to 7, 1986 to assess cutthroat stock status. Cutthroat trout over 250 mm total length were marked with Floy FD-68B anchor tags. Returns to the fishery and sampling gear were used to estimate short-term exploitation and approximate population size. Ten thousand (10,005) cutthroat fingerlings (1/hectare) were stocked into the Fernan Lake outlet on April 29 to assess growth, movement and relative abundance of cutthroat trout in Coeur d'Alene Lake.

Hayden Lake was sampled with purse seine gear on May 20, July 17, October 13 and November 5, and with hook and line October 17 to November 29 to relate trout densities and fishing success to other large lakes. A total of 406,879 trout (268/hectare) from three sources were stocked into

Table 1. Dates and mean day lengths for 5 census intervals on Priest Lake, Idaho, in 1987.

Interval number	Dates	Mean daylight hours
3	May 9 - May 22	15.0
4	May 23 - June 5	15.5
5	June 6 - June 19	15.5
6	June 20 - July 3	15.5
7	July 4 - July 17	15.5

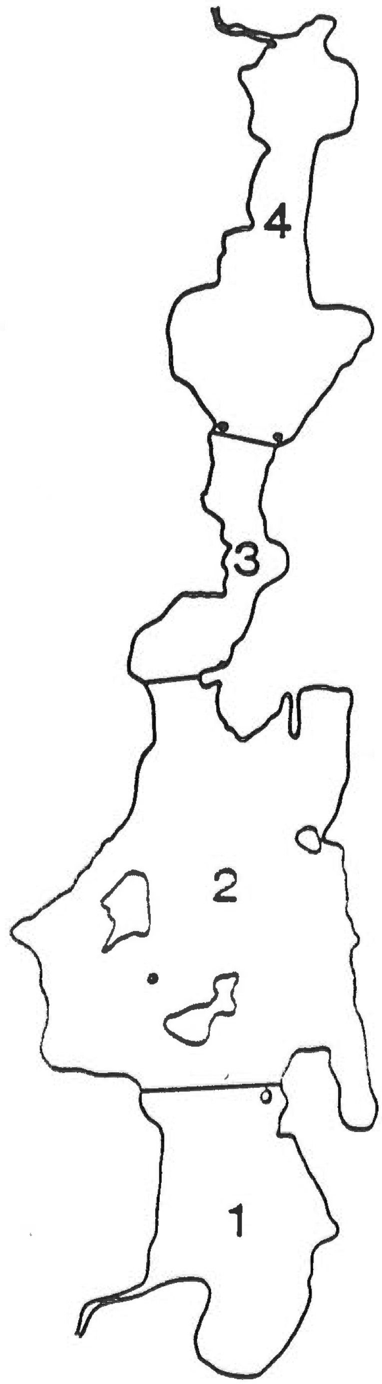

Figure 5. Priest Lake, Idaho, showing 1987 creel census sections.

Table 2. Late-spawning kokanee fry released into Priest Lake, Idaho, in 1987.

Date	Location	Number	Mark	Mean length (mm)
July 14	Granite Creek	380,688	None	35
July 17	Granite Creek	369,600	None	35
Total		750,288		35

Table 3. Two-year-old hatchery-reared westslope cutthroat trout released into Priest Lake, Idaho, in 1987.

Date	Location	Number	Mark	Mean length (mm)
June 5	Granite Creek Marina	19,090	Adipose yellow grit	132
June 5	Granite Creek Marina	24,975	Adipose	123
Total		44,065		

Hayden Lake in 1987 (Table 4). Pend Oreille Lake was sampled with purse seine gear on July 13 and October 22 to 29 to examine the feasibility of evaluating trout populations with purse seine gear.

Trout populations were modeled with an inland fisheries simulator (Taylor 1981).

RESULTS

Priest Lake

Creel Census

Anglers fished Priest Lake 27,903 hours from May 9 through July 17, 1987. Lake trout fishing comprised 97% of the effort and cutthroat trout 3%, with kokanee effort a negligible 31 hours. Lake trout effort declined 20%, and cutthroat effort decreased threefold compared to the same time period in 1986 (Table 5), with numerous complaints about the fishing.

Lake trout catch was 2,969 fish with 2,118 harvested. Cutthroat catch was 11 fish with none harvested. No kokanee were caught by interviewed anglers (Table 6).

Lake trout fishermen experienced catch rates of 9.1 hours/fish caught and 11.8 hours/lake trout harvested (Table 7). Census estimates are included in Appendices B to P.

Angler Opinions

One hundred anglers responded to questions concerning management of the Priest Lake fishery in 1987. Most (84%) were fishing for lake trout, with 8% seeking any species, 4% cutthroat and 3% kokanee. A majority (52%) fished Priest Lake five or fewer days per year, with 53% having fished the lake 10 years or less (Appendix A).

Slightly more fishermen (49%) seeking lake trout preferred increased kokanee stocking and harvest of lake trout to try and produce some kokanee fishing than preferred the present program (42%), with 9% undecided (Figure 6). Although sample sizes were small, cutthroat fishermen preferred increased kokanee stocking by a margin of 2:1, as did all kokanee anglers.

All cutthroat anglers interviewed (4) favored catch-and-release regulations to maintain or improve cutthroat size and numbers. Kokanee fishermen offered no opinion, and lake trout fishermen favored catch-and-release (49%), with 29% opposed and 22% offering no opinion (Figure 6). Of the total sample, 50% favored catch-and-release regulations, 26% were opposed and 24% offered no opinion (Appendix A).

Table 4. Trout fingerlings released into Hayden Lake, Idaho, in 1987.

Date	Location	Number	Source	Mark	Mean length (mm)
April 23	Hayden Creek	33,880	Fish Lake cutthroat	None	153
April 23	Honeysuckle Beach	50,000	Mt. Lassen rainbow	Adipose	153
April 24	Hayden Creek	6,160	Fish Lake cutthroat	None	153
May 5	Honeysuckle Beach	273,600	Trout Lodge Kamloops	None	91
Sept 9	Honeysuckle Beach	43,239	Trout Lodge Kamloops	None	86
Total		406,879			

Table 5. Estimated fishing pressure (hours) for major game fish species in four sections of Priest Lake, Idaho, May 9-July 17, 1987. Data from 1986 in parentheses.

Lake section	Species sought: Lake trout	Species sought: Cutthroat trout	Species sought: Kokanee	Total
1	2,947 (1,426)	367 (254)	0 (0)	3,314 (1,680)
2	10,660 (21,346)	9 (1,024)	0 (0)	10,669 (22,370)
3	3,487 (2,448)	146 (597)	0 (0)	3,633 (3,045)
4	9,875 (7,243)	381 (858)	31 (0)	10,287 (8,101)
Total	26,969 (32,463)	903 (2,733)	31 (0)	27,903 (35,196)

Table 6. Estimated numbers of game fish caught (C) and harvested (H) by all anglers in four sections of Priest Lake, Idaho, May 9-July 17, 1987.

Lake section	Lake trout C	Lake trout H	Cutthroat C	Cutthroat H	Kokanee C	Kokanee H	Total C	Total H
1	412	55	0	0	0	0	412	55
2	1,030	759	11	0	0	0	1,041	759
3	304	286	0	0	0	0	304	286
4	1,223	1,018	0	0	0	0	1,223	1,018
Total	2,969	2,118	11	0	0	0	2,980	2,118

Table 7. Catch (C) and harvest (H) rates (hours/fish) for interviewed anglers seeking lake trout, cutthroat trout and kokanee, Priest Lake, Idaho, May 9-July 17, 1987.

Lake section	Species sought: Lake trout C	Lake trout H	Cutthroat C	Cutthroat H	Kokanee C	Kokanee H	Total C	Total H
1	11.4	30.5	0.0	0.0	0.0	0.0	12.3	32.8
2	10.9	14.5	0.8	0.0	0.0	0.0	10.6	14.6
3	9.7	11.4	0.0	0.0	0.0	0.0	10.3	11.1
4	6.4	7.6	0.0	0.0	0.0	0.0	6.5	7.7
Total	9.2	11.8	11.7	0.0	0.0	0.0	9.3	12.0

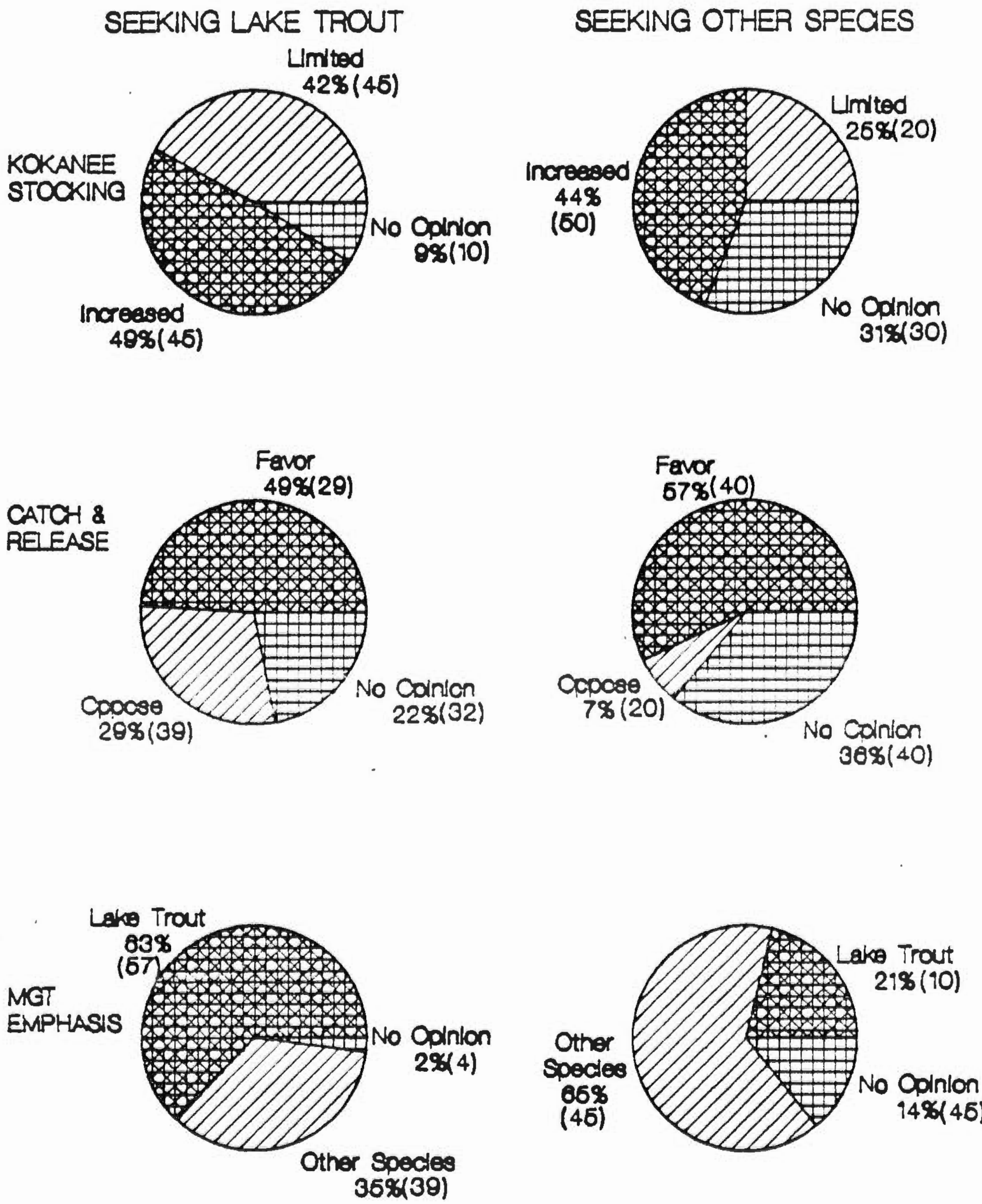

Figure 6. Angler response, by species sought, to questions regarding kokanee stocking levels, catch-and-release regulations for cutthroat trout and management emphasis on lake trout compared to other species for Priest Lake, Idaho, in 1987. Data from 1986 in parentheses.

As expected, lake trout anglers preferred that Priest Lake were managed for lake trout (63%), while cutthroat and kokanee fishermen preferred that lake trout numbers and fishing success were reduced in an attempt to improve fishing for other species (Figure 6).

Lake Trout

Harvested lake trout averaged 55.7 cm and 1.6 kg, considerably smaller than the 62.7 cm, 2.5 kg fish of 1986 (Figure 7). Lake trout condition had declined slightly from 1986 to 1987 (Figure 8). A large percentage (46%) of the fish examined in 1987 had empty stomachs. Of those containing food items, 66% had <u>Mysis</u>, 19% fish and 13% insects, similar to 1983 (Figure 9). Recognizable fish remains were 50% cutthroat and 50% kokanee.

Lake trout abundance was modeled using four size limits, existing regulations, 40% exploitation and three growth rates related to kokanee forage abundance (Appendix Q). A minimum size limit of 50 cm was relatively ineffective in reducing harvest (Figure 10). A 60 cm minimum size limit reduced harvest levels (Figure 11), but did not produce major benefits in the population or fishery (Table 8).

From the model, a 60 to 75 cm slot limit, or an effective minimum size limit of 75 cm, was necessary to produce appreciable changes in catch, harvest and abundance (Figures 12 to 14; Table 8).

Age at maximum biomass was estimated for lake trout at three growth rates, utilizing the procedure of Fry (1964). Percent weight added each year intersected the natural mortality rate of 14% used to model the lake trout population at ages 10 to 13, depending on growth rate (Figure 15).

The point where mortality intersects growth estimates the age at which a year class reaches its peak biomass with no fishing. Average ages of the harvest to the left of the point of intersection correspond with gains in biomass that would have occurred had the population not been fished. Ages to the right show natural mortality losses that could have been harvested. Age-length at maximum biomass is useful for setting minimum length regulations.

Optimum lengths for minimum size limits were quite large with the low natural mortality of 14% in the model: about 74 cm for limited growth, 88 cm for moderate growth and 102 cm for good growth (Figure 15; Appendix Q). Greater natural mortality or lower growth rates would result in significantly smaller sizes for length limits.

With effective size limits restricting the harvest, increased lake trout abundance would result in a greater forage requirement for the predator population. Lake trout were already declining in condition due to lack of fish forage.

Additional kokanee forage would also create a response in the predator population. More kokanee would be needed to maintain lake trout at higher levels of abundance and condition. Otherwise, lake trout

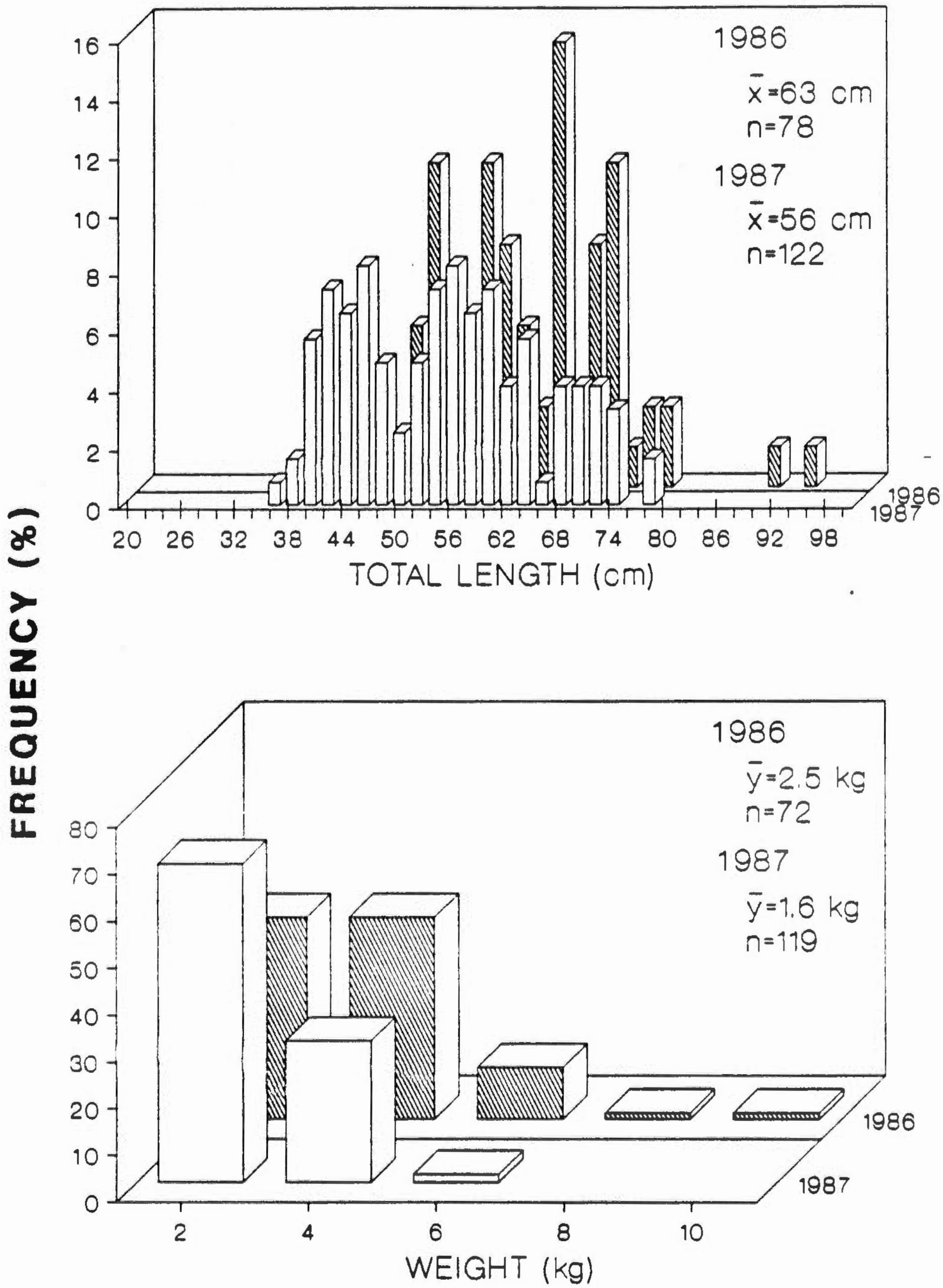

Figure 7. Length and weight distributions of lake trout representative of the harvest from Priest Lake, Idaho, between May 9 and July 4, 1986-1987.

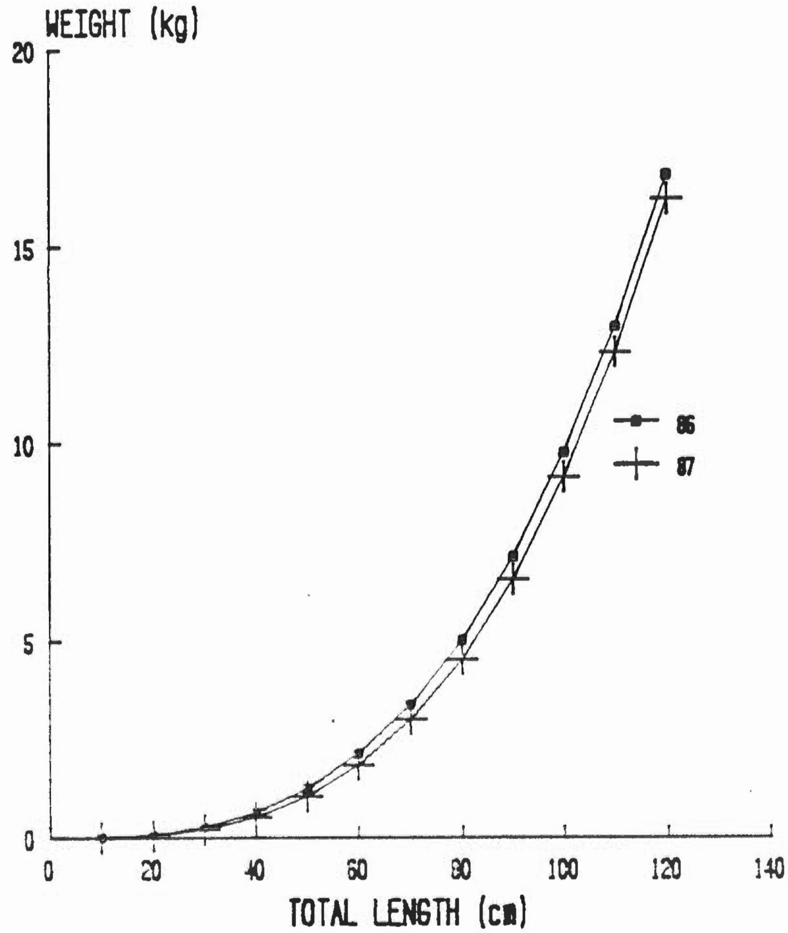

Figure 8. Length-weight relationships for lake trout sampled from May 5-July 12, 1986-1987, Priest Lake, Idaho.

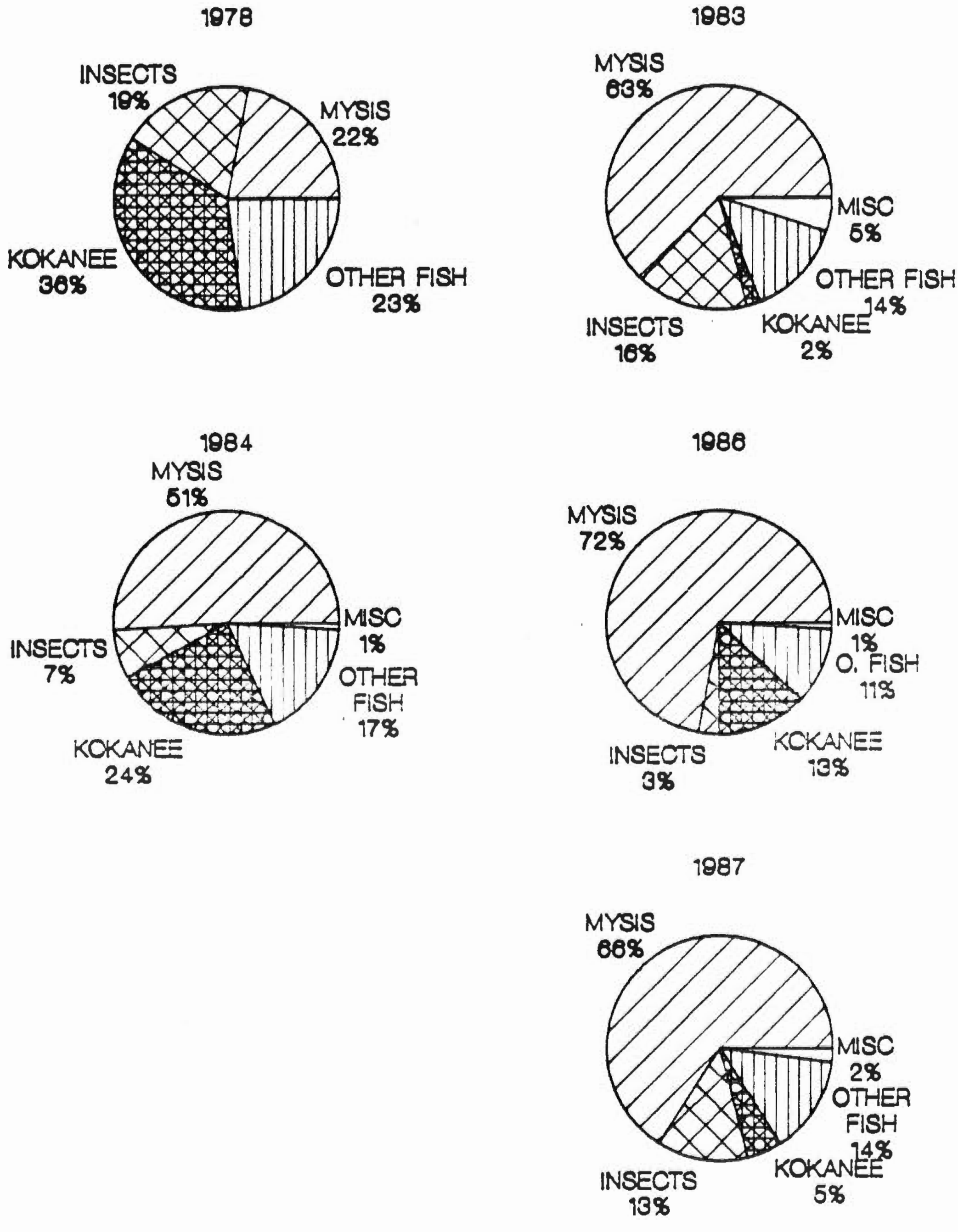

Figure 9. Stomach contents of lake trout sampled from Priest Lake angler creels.

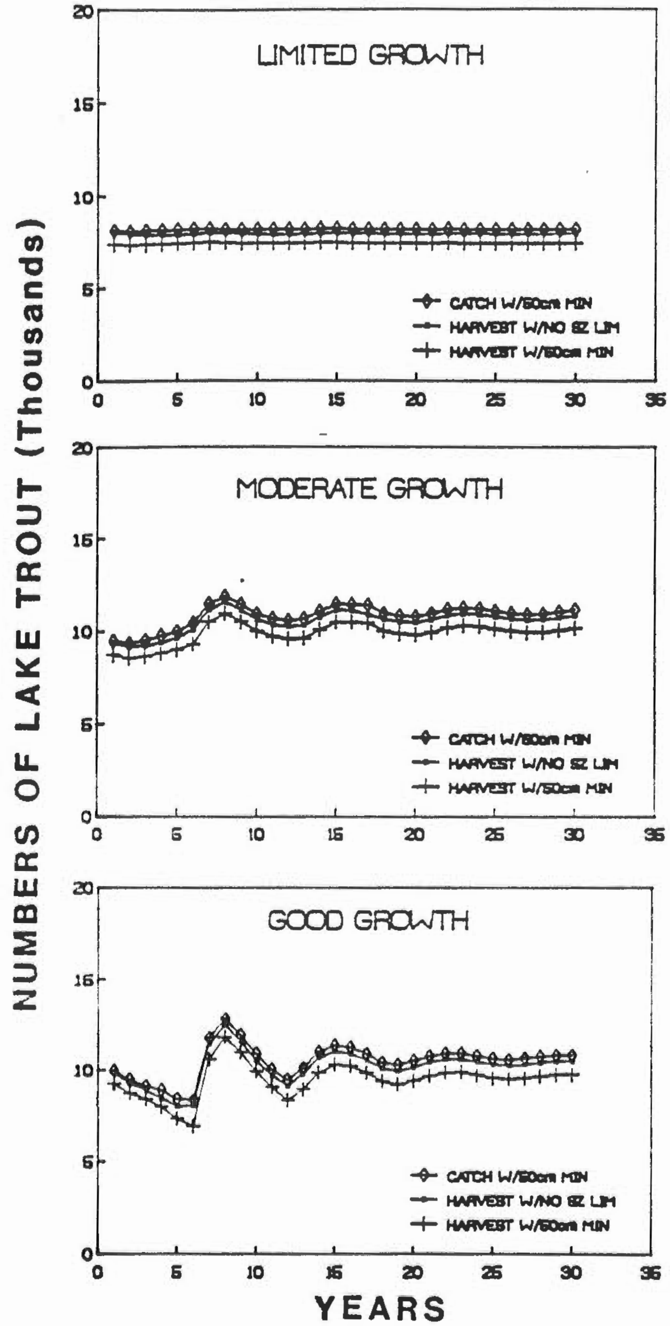

Figure 10. Total lake trout catch, harvest at 40% exploitation with a 50 cm size limit, harvest with no size limit and 3 growth r[illegible]s [illegible] over 30 years for Priest Lake, Idaho.

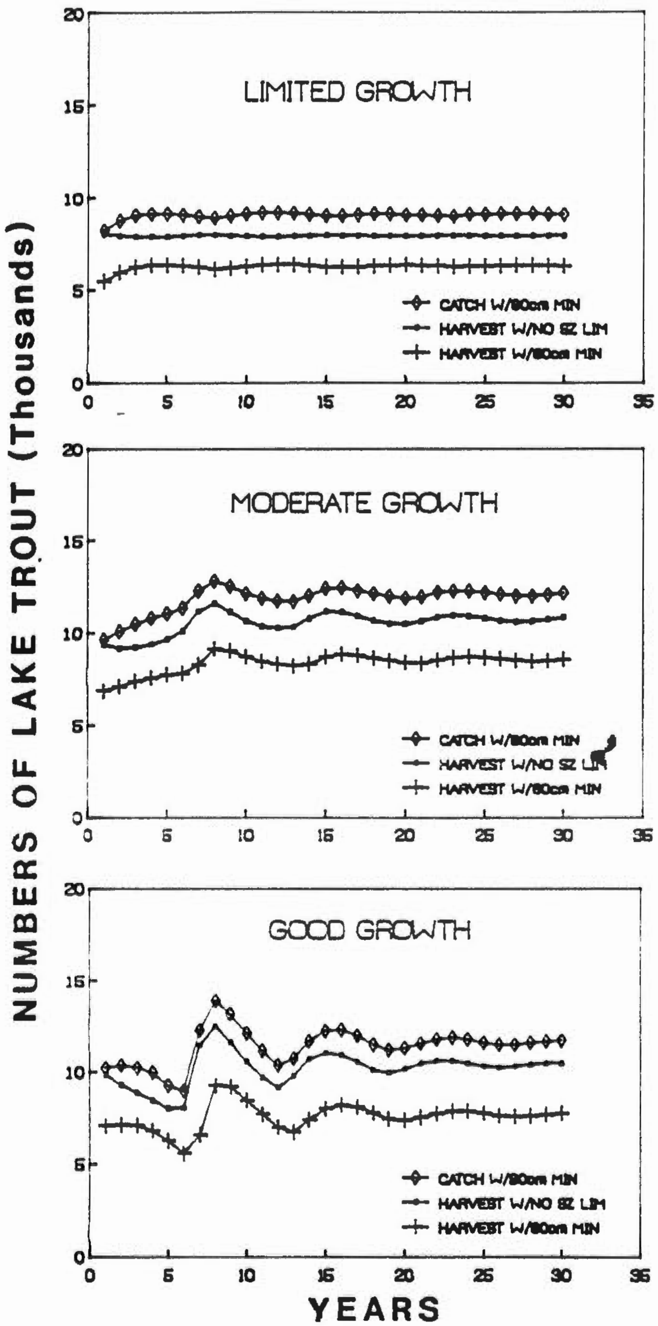

Figure 11. Total lake trout catch, harvest at 40% ex[redacted]60 cm minimum size limit, harvest with no size [redacted]it and 3 growth rates projected over 30 years for Priest Lake, [redacted]

Table 8. Mean lake trout abundance, biomass and yield modeled over 30 years with 3 levels of growth and 5 regulations for Priest Lake, Idaho. Survival = 46%, exploitation = 40% and expectation of natural death = 14%.

Minimum length & slot limit	Total population ages 1-15	Total biomass (kg)	Biomass (kg/hectare)	Catch	Harvest	Mean weight of fish in creel (kg)	Total yield (kg)	Yield (kg/hectare)
			LIMITED KOKANEE FORAGE					
	1,634,710	180,444	19.1	8,008	8,008	2.256	18,040	1.9
500 mm	1,654,730	182,028	19.3	8,250	7,502	2.358	17,666	1.9
600 mm	1,828,398	192,170	20.3	9,086	6,292	2.575	16,192	1.7
600-750 mm	2,865,544	236,390	25.0	10,956	3,938	2.489	9,856	1.0
750 mm	3,138,784	248,094	26.2	12,100	1,672	4.097	6,864	0.7
			MODERATE KOKANEE FORAGE					
	2,426,050	191,268	20.2	10,538	10,538	2.710	28,534	3.0
500 mm	2,454,254	192,852	20.4	10,846	9,878	2.860	28,248	3.0
600 mm	2,699,598	202,862	21.5	11,836	8,360	3.255	27,192	2.9
600-750 mm	3,915,582	239,140	25.3	13,310	6,182	3.239	20,108	2.1
750 mm	4,284,412	250,954	26.5	14,586	3,388	5.132	17,402	1.8
			ABUNDANT KOKANEE FORAGE					
	4,426,994	241,230	25.5	10,208	10,208	3.857	39,292	4.2
500 mm	4,477,902	242,880	25.7	10,538	9,482	4.127	39,006	4.1
600 mm	5,028,584	256,058	27.1	11,418	7,546	5.025	37,884	4.0
600-750 mm	5,187,754	259,468	27.4	11,308	8,250	4.315	35,596	3.8
750 mm	5,838,624	274,428	29.0	12,452	5,258	6.381	33,572	3.6

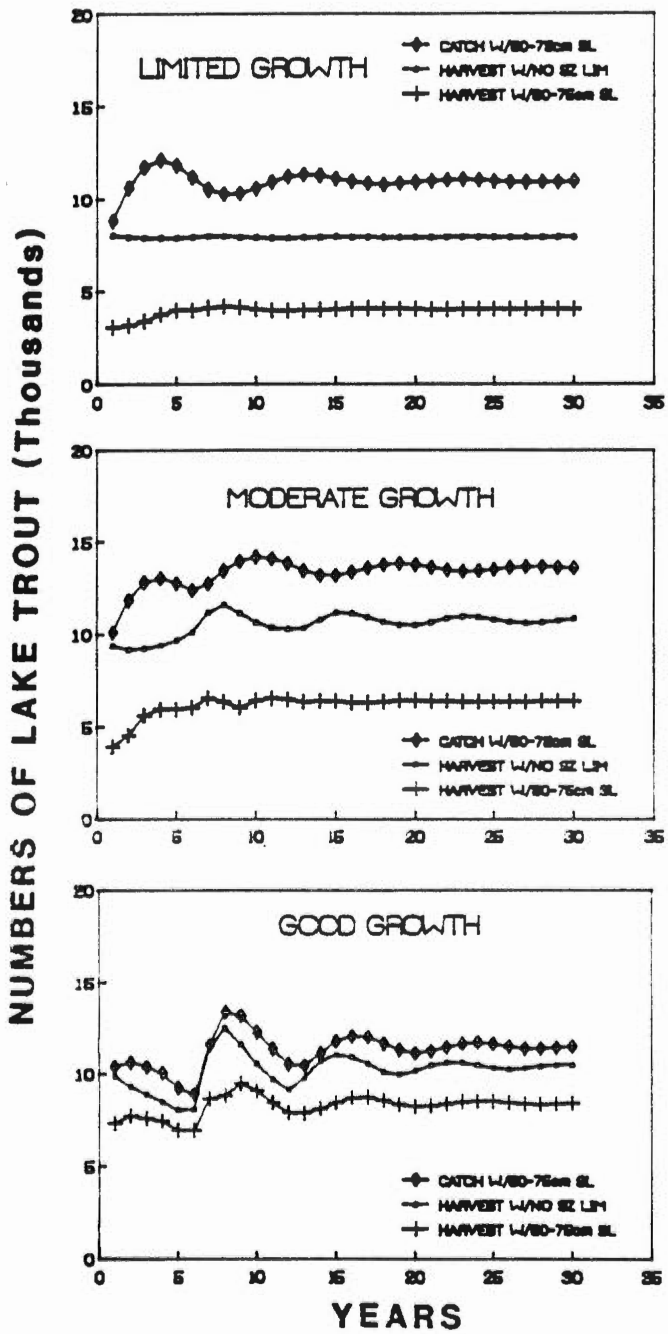

Figure 12. Total lake trout catch, harvest at 40% exploitation with a 60-75 cm slot limit, harvest with no size limit and 3 growth rates projected over 30 years for Priest Lake, Idaho.

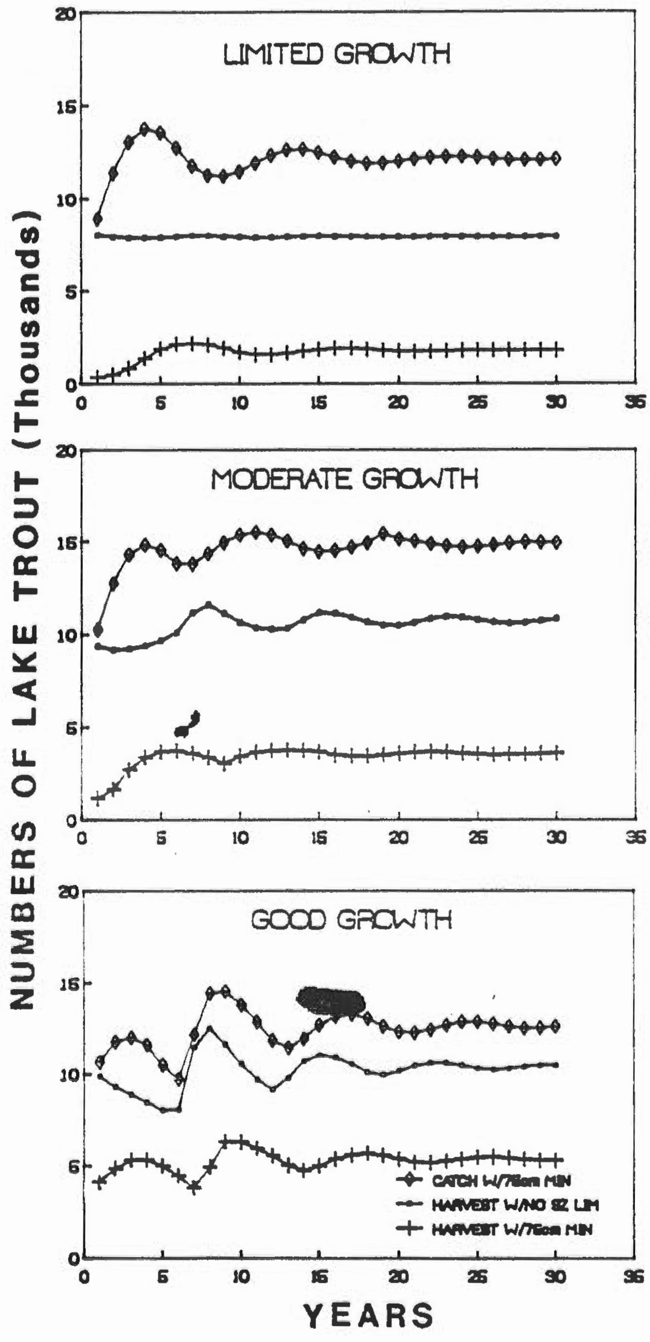

Figure 13. Total lake t[redacted]t at 40% exploitation with a 75 cm minimum size[redacted]it, harvest with no size limit and 3 growth rates projec[redacted]ears for Priest Lake, Idaho.

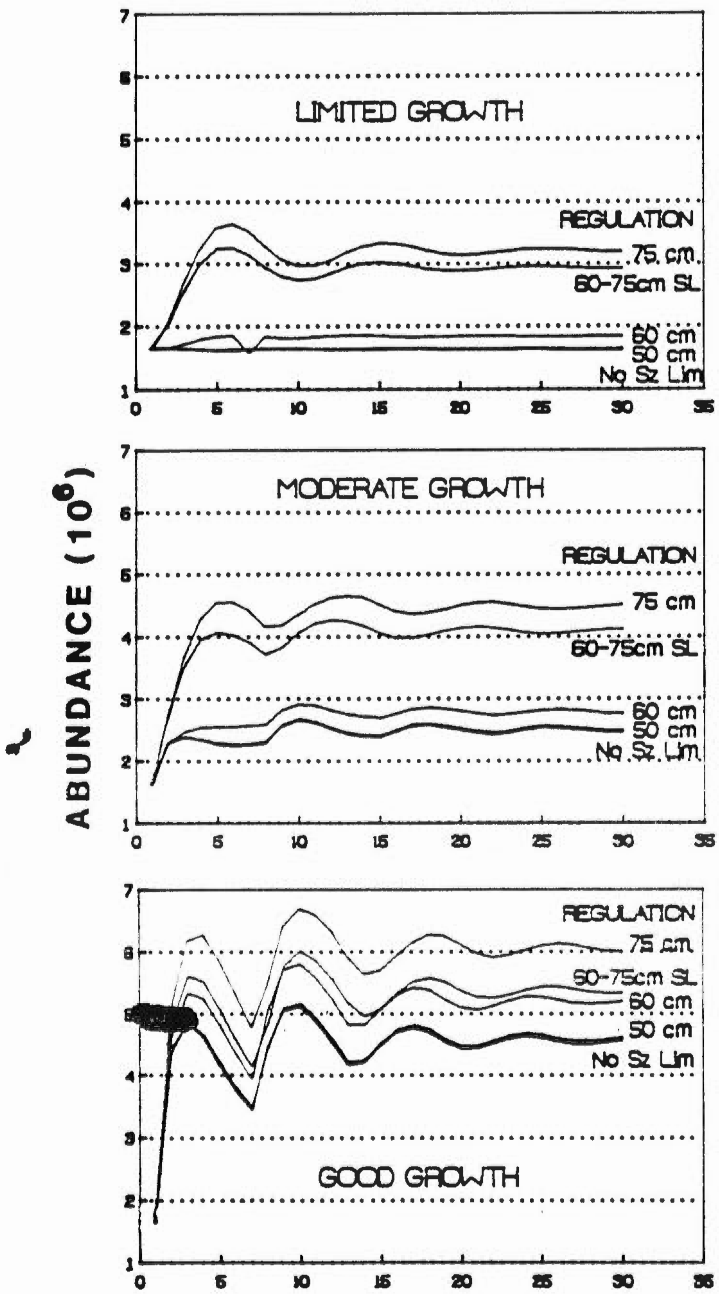

Figure 14. Lake trout abundance at 40% exploitation with 50, 60, 60-75 [redacted]its compared to no size limit projected over [redacted]years for Priest Lake, Idaho.

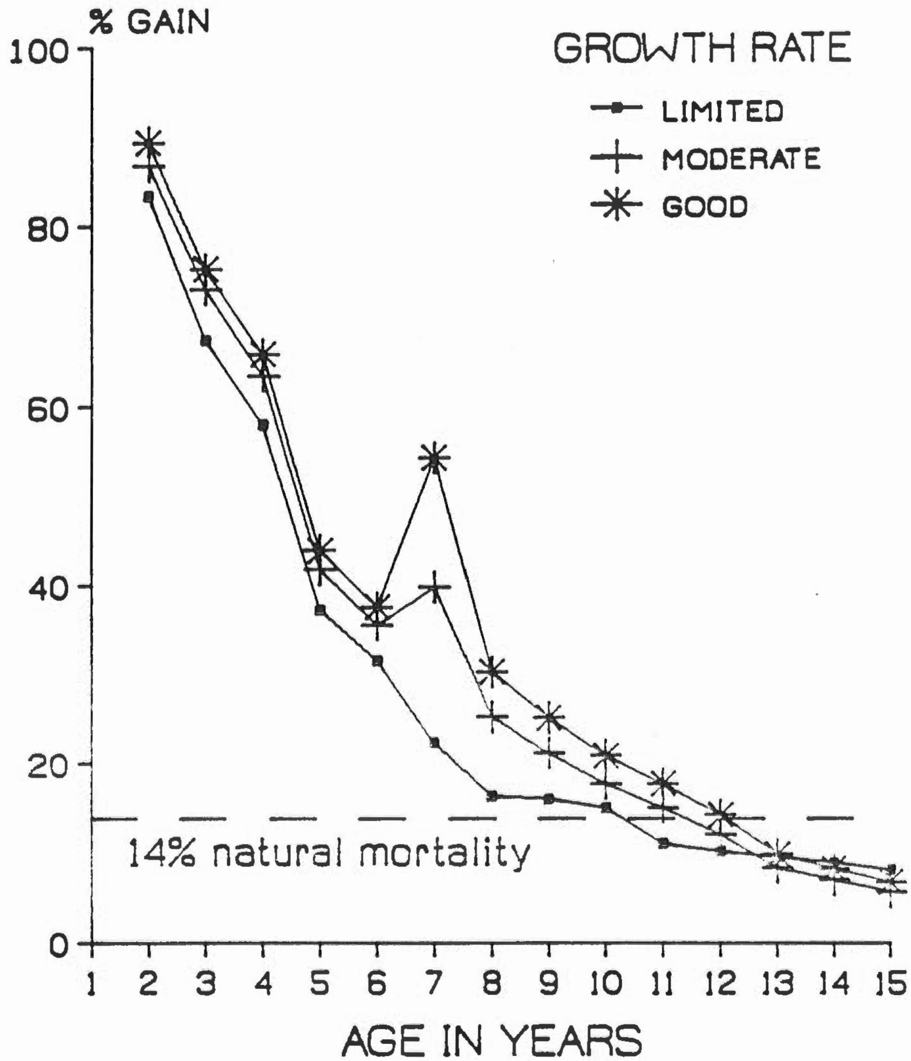

Figure 15. Estimated age at maximum biomass (where natural mortality intersects percent weight gain) for lake trout at limited, moderate and good growth rates, Priest Lake, Idaho.

numbers and growth would decline from initial enhanced levels until a new equilibrium was reached. In the modeled population, an increase from limited to moderate growth and condition would produce an additional 18,238 kg of 6- to 15-year-old lake trout with existing regulations at 40% exploitation (Figure 16). An increase from moderate to good growth would result in another 16,742 kg of older lake trout.

Higher levels of exploitation would reduce lake trout biomass (Figure 16). Exploitation would have to increase from the present estimated level of 40% to around 60% to offset the modeled response of the predators to additional kokanee forage (Figure 17). If lake trout response to increased forage was overestimated because growth and condition factor projections were too liberal, fishing pressure required to contain the lake trout population would be less.

A stocking level of 3 million kokanee fry would enhance growth rates and increase lake trout catch from 8,000 to 10,500 fish averaging 2.7 kg if exploitation remained at the present estimated level of 40% (Mauser et al. 1988). Catch rates would increase initially and eventually stabilize, probably near present levels of 10 hours/fish as effort increased with better fishing. If exploitation increased to 50%, lake trout catch was predicted at 12,000 fish averaging 2.5 kg.

The 1983 release of 3 million kokanee was followed by an increase in mean size of harvested lake trout from 1.8 kg in 1983 to 2.3 kg in 1984 and 2.4 kg in 1986. The initial response probably resulted from increased catchability of larger lake trout. The increase occurred too rapidly for a growth response, especially since kokanee consumption was the lowest measured to date throughout the growing season in 1983. Availability of kokanee forage declined again after 1984, so long-term response of the enhanced predator population to fish forage has not been observed.

Kokanee and Whitefish

Priest Lake trawling in 1987 produced too few kokanee to estimate abundance. No kokanee were captured in eight transects on the southern end of the lake with only two fish, 165 mm and 180 mm, from an additional six transects north of the narrows. This was the first time kokanee fry were not captured in the trawl following a hatchery fry release (Figure 18). Results of experimental enhancement on Pend Oreille Lake indicate that 50 mm is the optimum size at release for kokanee fry (Bowles et al. 1988). The 35 mm fish released into Priest Lake were smaller than any other group of kokanee stocked in northern Idaho lakes in 1987.

Kokanee were sampled on six of eight days with purse seine gear (Figure 19; Table 9). Four age classes appeared to be present. Kokanee fry were not vulnerable to the gear. Fish ranged from 107 to 388 mm and averaged 211 mm (Figure 20). Kokanee were generally caught in combination with mountain whitefish.

A total of 97 kokanee and 259 mountain whitefish were sampled with purse seine gear. This was the first time any number of mountain whitefish were sampled from Priest Lake during the project.

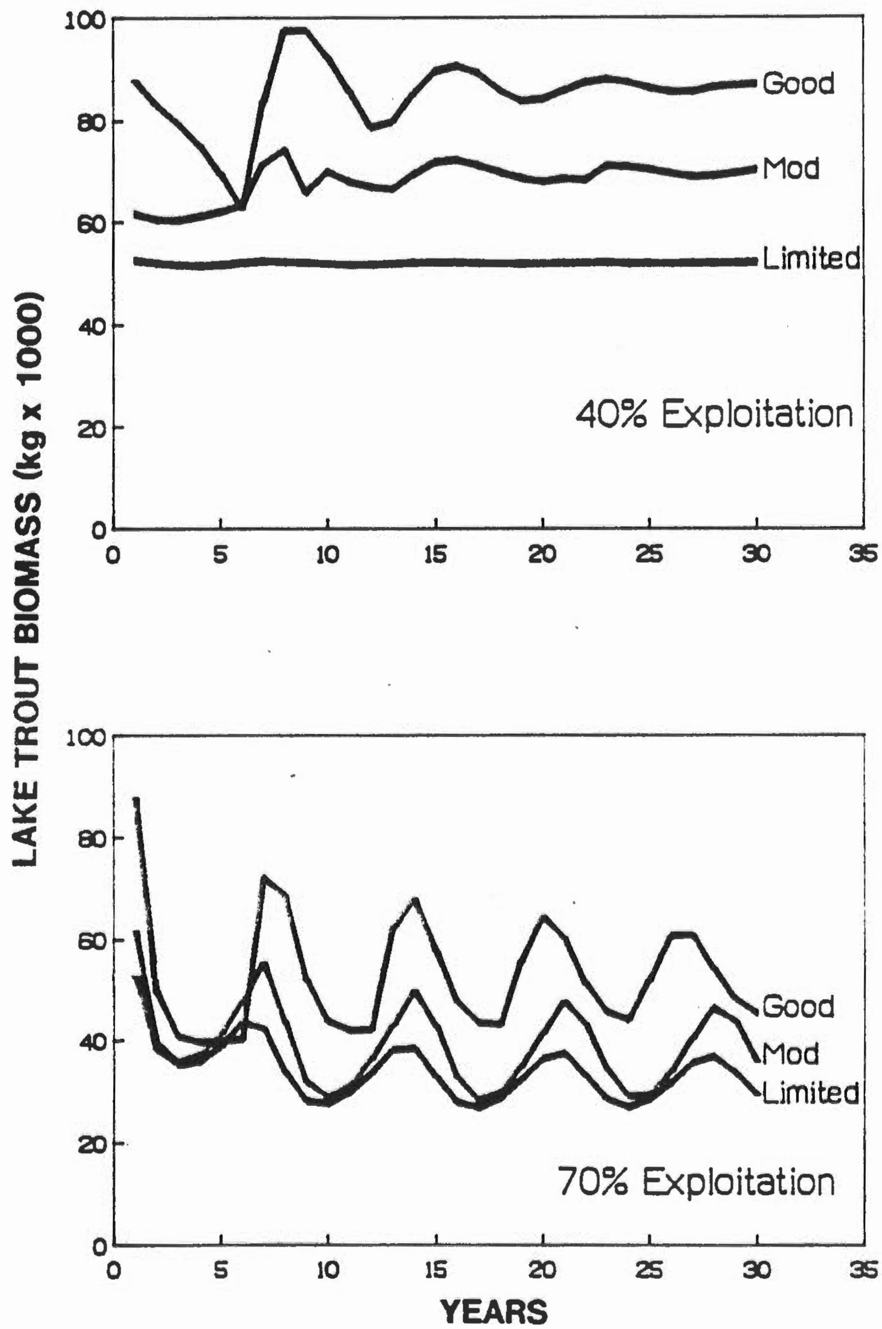

Figure 16. Biomass of 6- to 15-year-old lake trout at 40% and 70% exploitation, and 3 growth rates projected over 30 years for Priest Lake, Idaho.

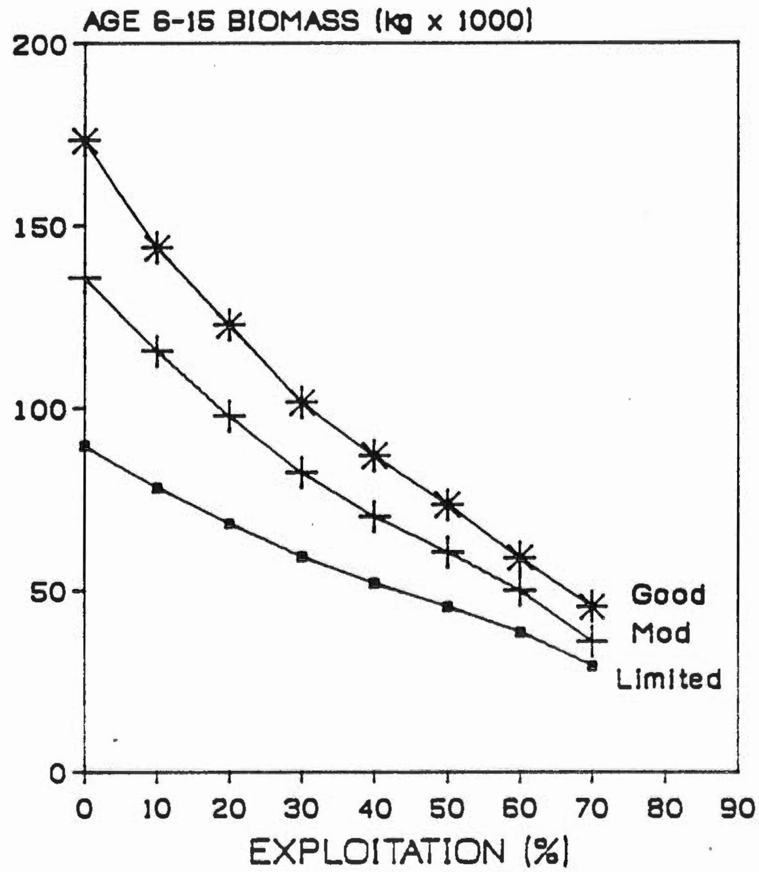

Figure 17. Effect of exploitation on biomass of 6- to 15-year-old lake trout at 3 growth rates for Priest Lake, Idaho.

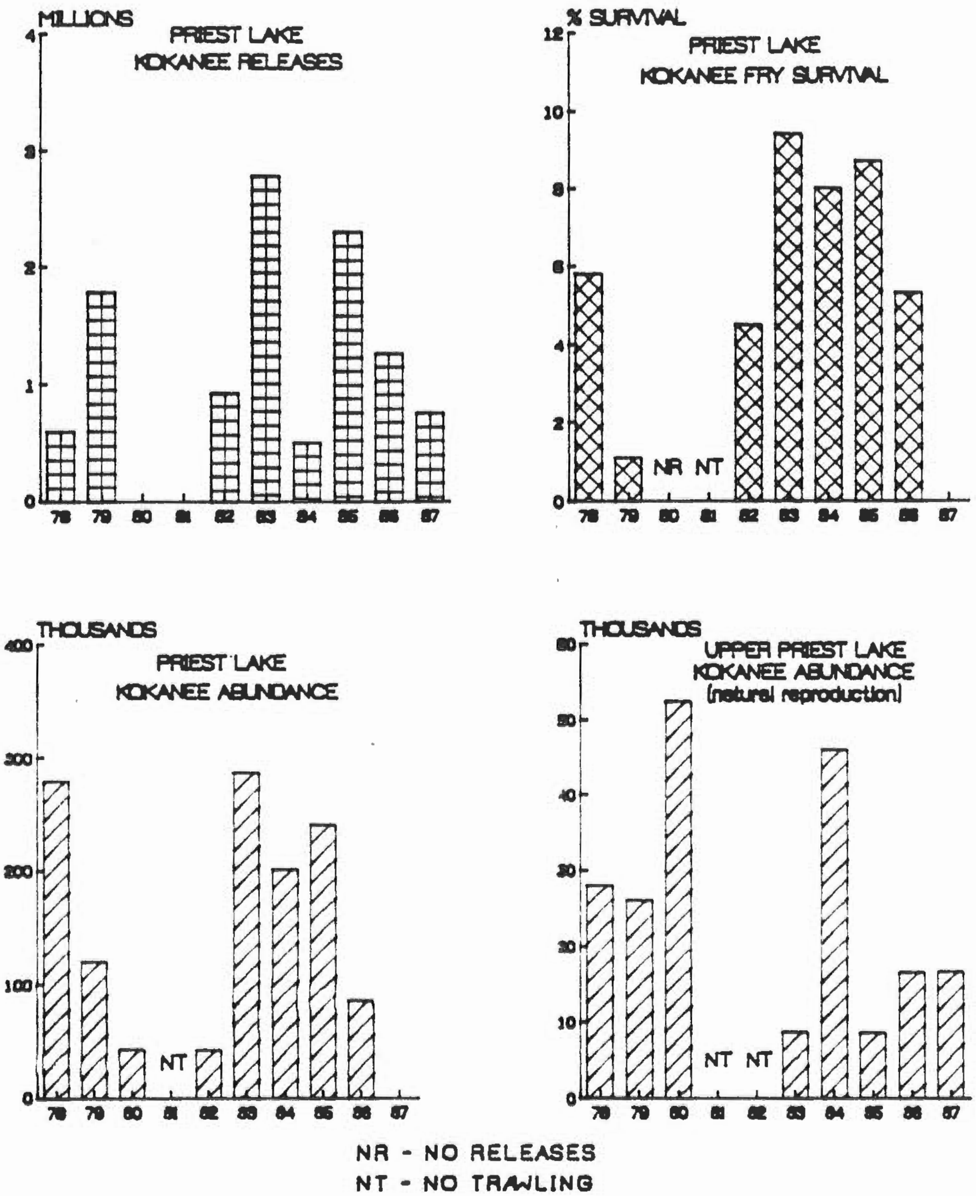

Figure 18. Kokanee fry releases, summer survival and estimated abundance in Priest and Upper Priest lakes, Idaho, 1978-1987.

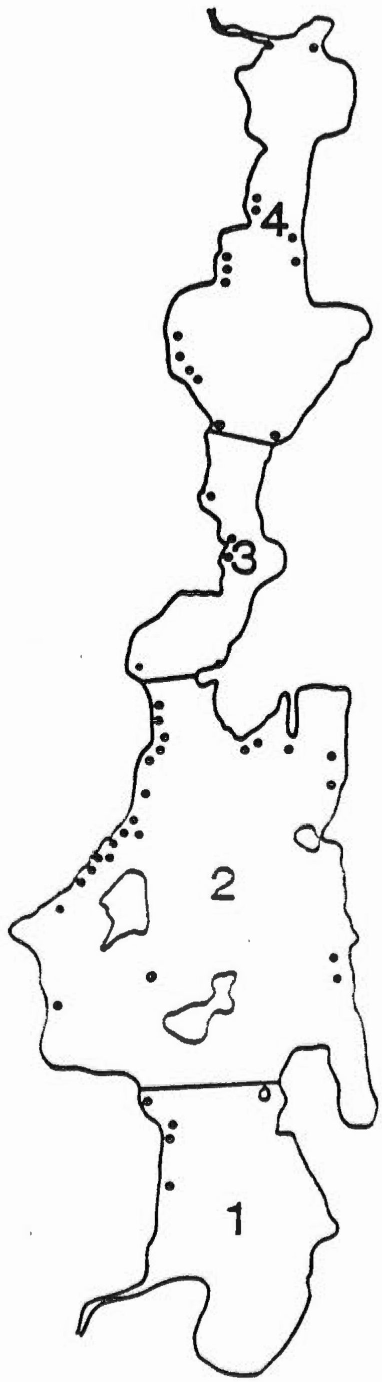

Figure 19. Purse seine sites on Priest Lake, Idaho, in 1987.

Table 9. Results of purse seine sampling conducted on Priest Lake, Idaho, in 1987.

Date	Lake section(s)	Number of sets	Wild cutthroat	Hatchery cutthroat	Kokanee	Mountain whitefish	Other[a]	Total
September 29	4	4	11	6	3	11	0	31
30	2,1	5	7	10	13	101	0	131
October 1	1,2	4	6	5	0	140	0	151
2	4	4	16	11	2	2	0	31
3	2,3	5	38	39	31	2	0	110
6	3,2	7	16	6	12	0	0	34
7	3,2	5	14	7	22	2	2	47
8	2,4	9	14	13	0	1	0	28
Total		43	122	97	83	259	2	563
Fish/set			2.8	2.3	1.9			13.1

[a]Rainbow-cutthroat hybrids.

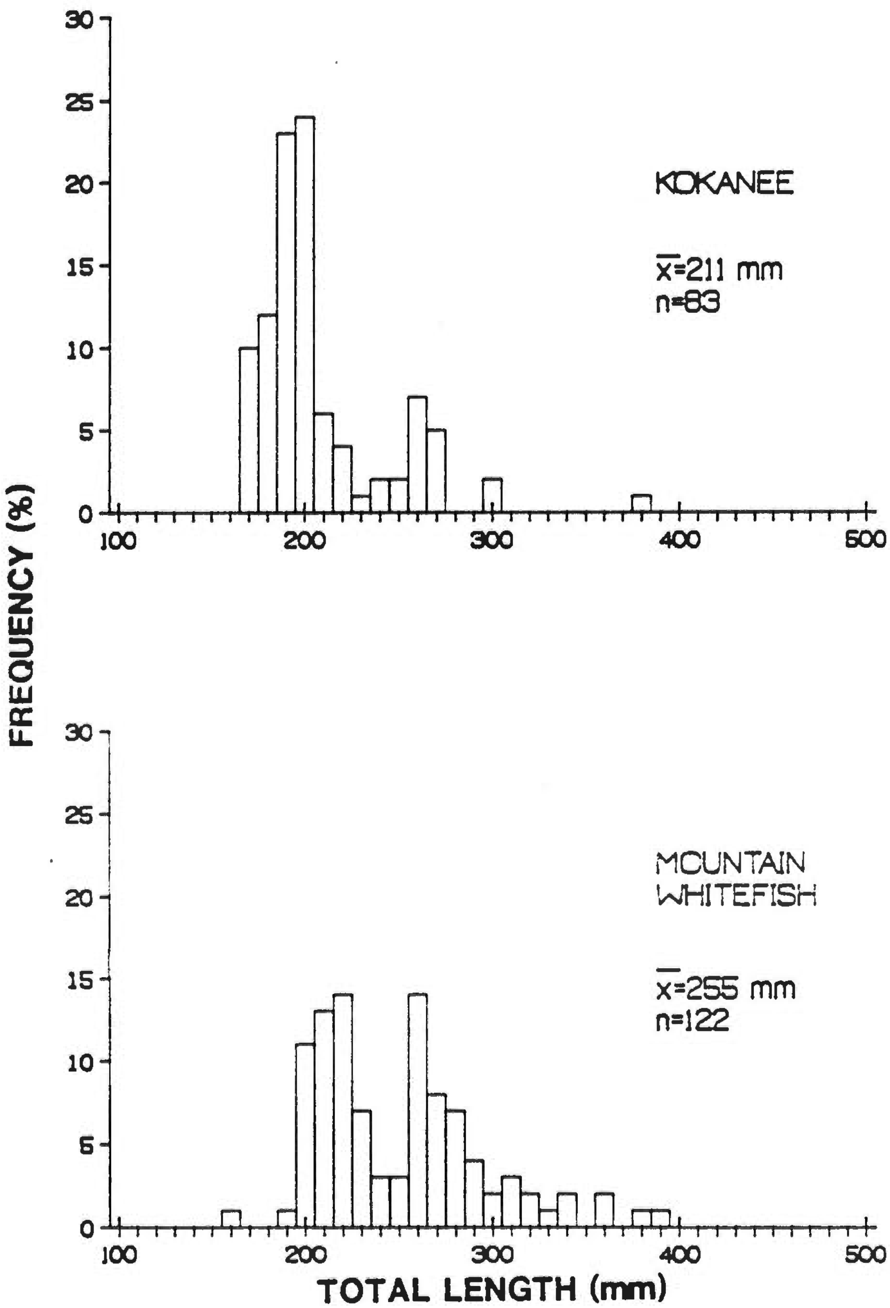

Figure 20. Length frequency distributions for kokanee and mountain whitefish sampled with a purse seine on Priest Lake, Idaho, in 1987.

Mountain whitefish numbers may be increasing, or conditions in 1987 may have resulted in unusual near surface feeding activity. Historically, large northern Idaho lakes supported major populations of mountain whitefish. In Priest Lake as well as Pend Oreille, mountain whitefish abundance declined catastrophically as kokanee populations became established.

Whitefish were larger than the kokanee sampled, with fish ranging from 169 to 395 mm and averaging 255 mm (Figure 20). Both species had cladoceran zooplankton in their stomachs.

Trawl sampling of Upper Priest Lake provided an estimate of 16,657 kokanee in 1987 (Figure 18). Four or more age classes made up the estimate, including 5,553 fry, 6,385 yearlings, 1,943 two-year-olds and 2,776 mature kokanee (Figure 21).

The Priest Lake kokanee population was modeled to define potential benefits of various stocking levels. Egg-to-yearling survival and the proportion of natural mortality applied in the model reflected the probable depensatory nature of lake trout predation (Rieman and Lukens 1979) with the proportion of growth applied in a normal density-dependent fashion (Figure 22).

Because functional response of lake trout to increased kokanee forage would reduce the buffering effect that additional kokanee should have on predation, I set density-dependent relationships at minimal levels. Annual survival rates were also set at low levels (22% to 24% for ages 2 to 5, depending on total kokanee biomass) to reflect a major predatory impact.

Survival of stocked kokanee fry from the time of release to the beginning of the next calendar year was set at higher levels than used for naturally produced fry (1%) to reflect the advantage of midsummer releases. I increased survival of hatchery fry from 2% to 6% as stocking levels were raised. The increases were made to reflect the possible buffering effect of greater numbers of fry and older kokanee on predation. Survival rates used for stocked fry were lower than normal for Pend Oreille Lake (Bowles et al. 1987) and similar to those estimated for Priest Lake (Table 10).

A conservative estimate of response to kokanee fry stocking resulted. Total kokanee biomass and natural mortality (kg) were minor below a stocking rate of 3 million fry annually (Figure 23). Higher stocking levels produced considerable biomass and minor harvests (Figure 24). I increased exploitation of 2- to 5-year-old kokanee from 0.1% to 2.0% as stocking levels increased. Under these conditions and those of the lake trout model, improvements in lake trout size were predicted to occur before kokanee fishery response until stocking levels of 15 million (Mauser et al. 1988; Figure 25). Kokanee harvest was negligible below a threshold stocking level of 6 million; however, actual response has not been tested.

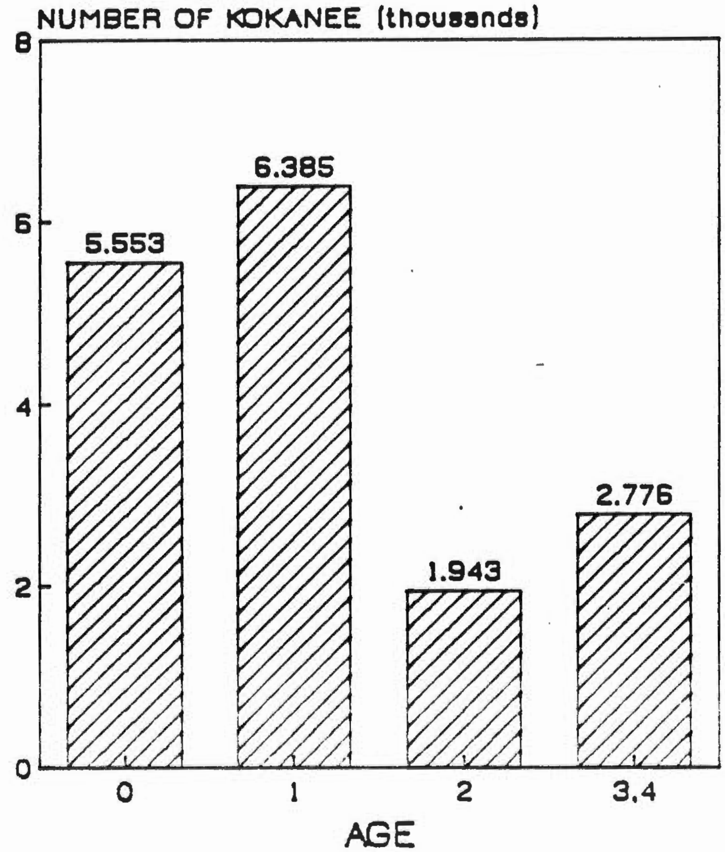

Figure 21. Age composition of kokanee sampled by trawling Upper Priest Lake, Idaho, in 1987.

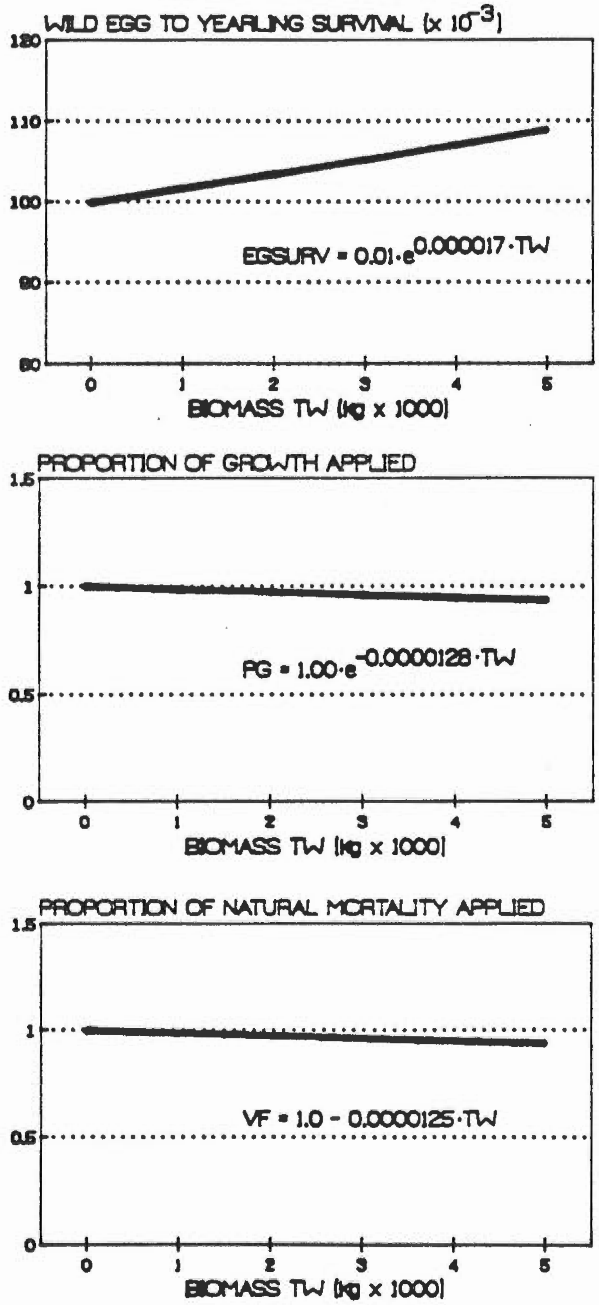

Figure 22. Density-dependent egg-to-yearling survival, growth and natural mortality used to model the kokanee population of Priest Lake, Idaho.

Table 10. Kokanee fry releases, fall abundance estimates and survival rates for Priest Lake, Idaho.

Year class	Number stocked	Hatcheries	Mean TL (mm)	Site	Survival (%)	Fall fry	Survival (%)	Age I	Survival (%)	Age II	Survival (%)	Age III	Age IV, V
1972													7,694
1973													
1974												37,268	
1975										77,686	(8)	5,963	
1976								85,513	(12)	10,199			
1977	590,224	Sandpoint Clark Fork	36	Granite Cr	(11)	70,661	(108)	76,389	(4)	2,695			
1978	1,780,525	Mullan	25	Granite Cr	(1)	27,721	(145)	40,103					
1979	0												
1980	0												
1981	925,368	Eagle Mullan	44 24	Granite Cr Open water	(5)	42,000	(58)	24,253	(37)	8,930			
1982	2,779,420	Sandpoint Clark Fork	38	Granite Cr[a] Open water	(9)	261,936	(58)	151,823	(15)	22,242			
1983	500,368	Sandpoint	39	Kalispell Cr	(8)	40,188	(44)	17,773					
1984	2,294,591	Sandpoint	40 45	Granite Cr Indian Cr[b]	(9)	200,174	(9)	17,983					
1985	1,263,554	Clark Fork	31	Granite Cr	(5)	67,438							
1986	750,288	Clark Fork	35	Granite Cr									
TOTAL	10,884,338				(7)		(49)		(13)		(8)		

[a]Granite Creek release of 501,266 fry survived at 28%. Open water release of 2,278,154 fry survived at 5%.
[b]Indian Creek release of 624,365 fry survived at 17%. Granite Creek release of 1,670,226 fry survived at 8%.

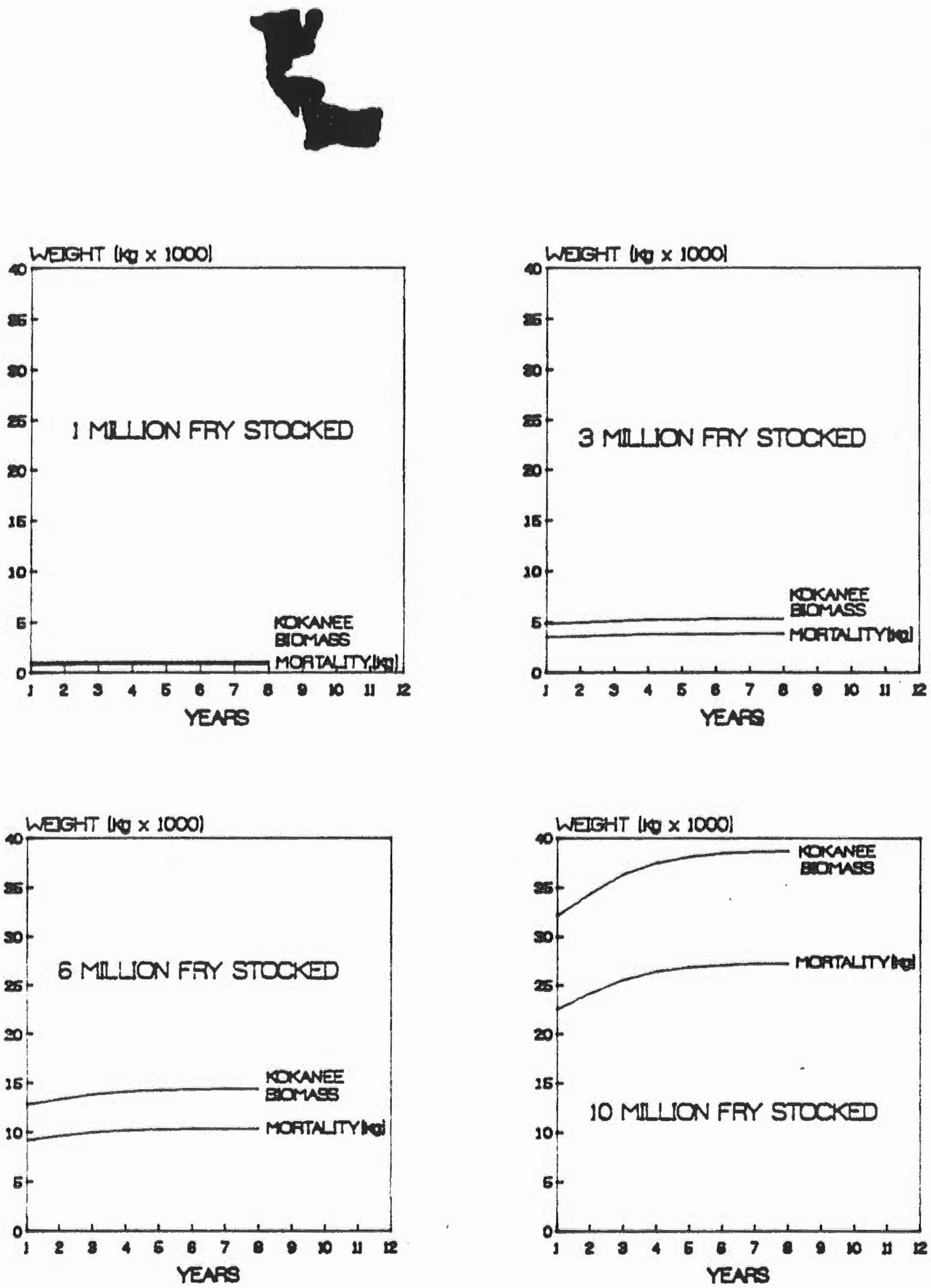

Figure 23. Kokanee biomass and mortality (kg/year) at four stocking levels for Priest Lake, Idaho.

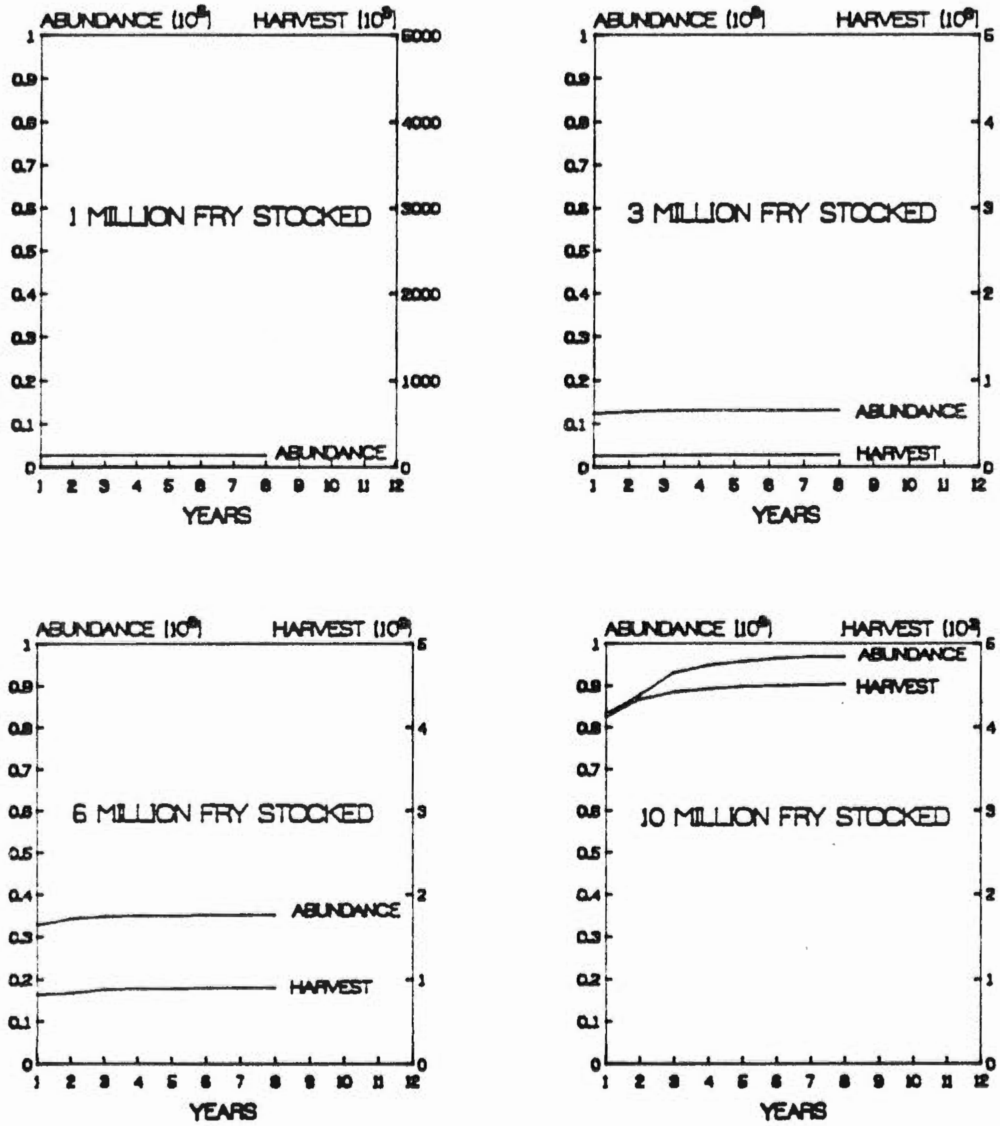

Figure 24. Kokanee abundance and harvest produced by four stocking levels for Priest Lake, Idaho.

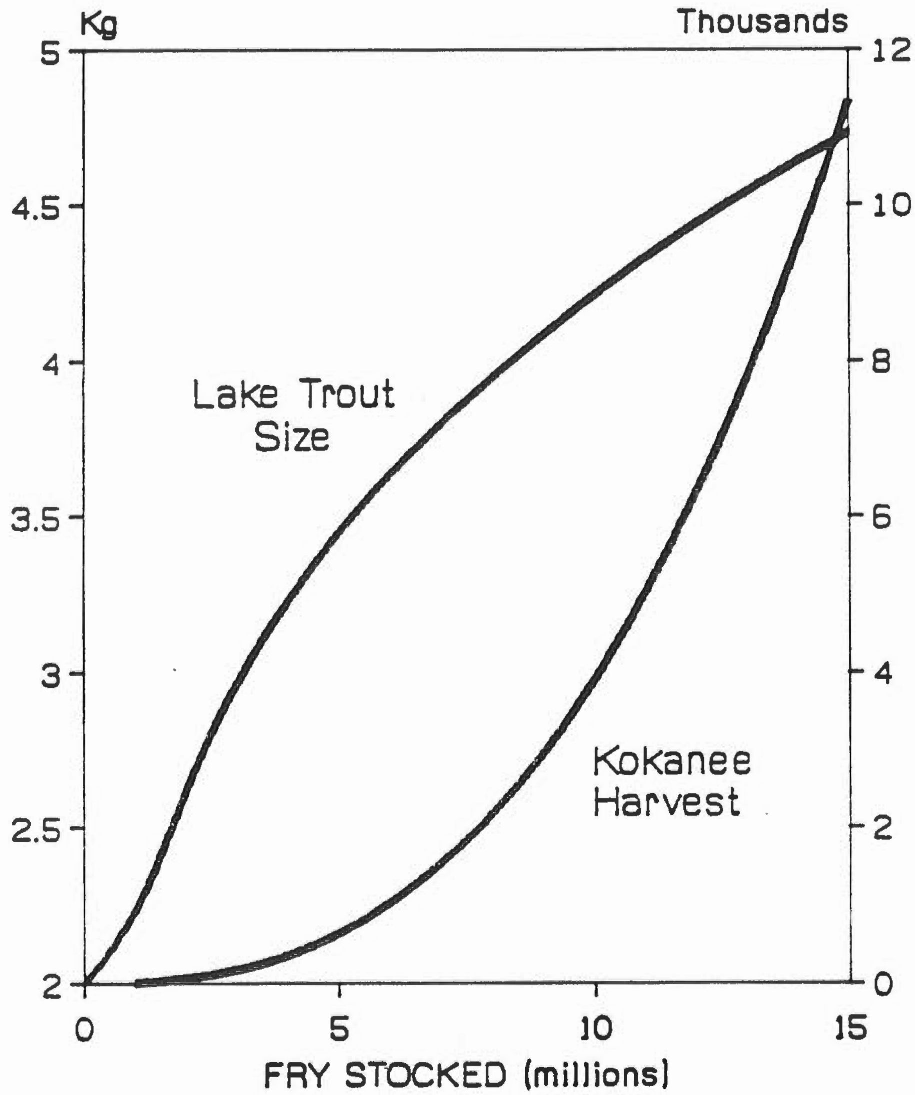

Figure 25. Effect of kokanee fry stocking on mean size of lake trout harvested and number of kokanee caught from Priest Lake, Idaho.

The model indicated a harvest of 4,640 kokanee averaging 28 cm would occur with stable stocking levels of 10 million fry annually. In 1978, 15,792 hours of effort expended by anglers specifically seeking kokanee resulted in a harvest of 4,593 fish at a catch rate of 0.3 fish/hour. A good, consistent stocking program might produce a similar response at lower release levels, or lake trout response might eliminate the kokanee fishery at any feasible stocking rate. Response of the entire fishery to stocking levels above 3 million fry annually should be evaluated in an experimental program as additional kokanee become available.

Additional increases in kokanee stocking levels, or decreases in lake trout biomass, would become necessary to maintain predicted responses to kokanee stocking programs. Exploitation necessary to stabilize lake trout productivity would depend on complex interactions between kokanee survival and stocking benefits, predator impacts and the fishery. I used a gross efficiency of 21.8% for lake trout food conversion (Stewart et al. 1983), both lake trout and kokanee models, and a range of stocking likely to produce the appropriate growth responses (Mauser et al. 1988), to arrive at some predictions.

Exploitation ranging from 58% to 63% would be necessary to balance a stable biomass of 6- to 15-year-old lake trout with a consistent kokanee stocking program of 3, 6 or 10 million fry annually (Figure 26). In the absence of increased exploitation of the predators, long-term effects of kokanee stocking would be less than indicated. Increased exploitation was likely to result from and partially offset better growth (Mauser et al. 1988).

Cutthroat Trout

A total of 38 adult cutthroat were trapped at the mouth of Tango Creek between May 5 and 31, 1987. Known four-year-old fish from a 1985 release of 31,125 fingerlings in Tango Creek comprised 84% of the run for an overall return rate of 0.1%. An additional three fish, also four-year-olds, apparently strayed from release sites at Granite Creek. Two larger hatchery-reared fish were trapped: a 410 mm six-year-old fish from the 1983 release and an unmarked fish 421 mm long. The run also contained a single wild fish.

The hatchery-reared fish from the Tango Creek weir averaged 353 mm (Figure 27). Fish that averaged 168 mm at release returned at 0.225%, while those stocked at 112 mm came back at 0.006%. Based on the performance of the larger fish released in 1985, 100,000 cutthroat fingerlings 175 mm in size would adequately stock Priest Lake (Mauser et al. 1988).

A total of 98 hatchery-reared cutthroat trout were captured with the purse seine. The majority (92%) were adipose-clipped two-year-old fish released in 1987. These fish ranged from 220 to 291 mm, with a modal size of 250 mm and a single fish that was 150 mm (Figure 27). Two-year-old fish reared their final 45 days in net pens were sampled at the same rate

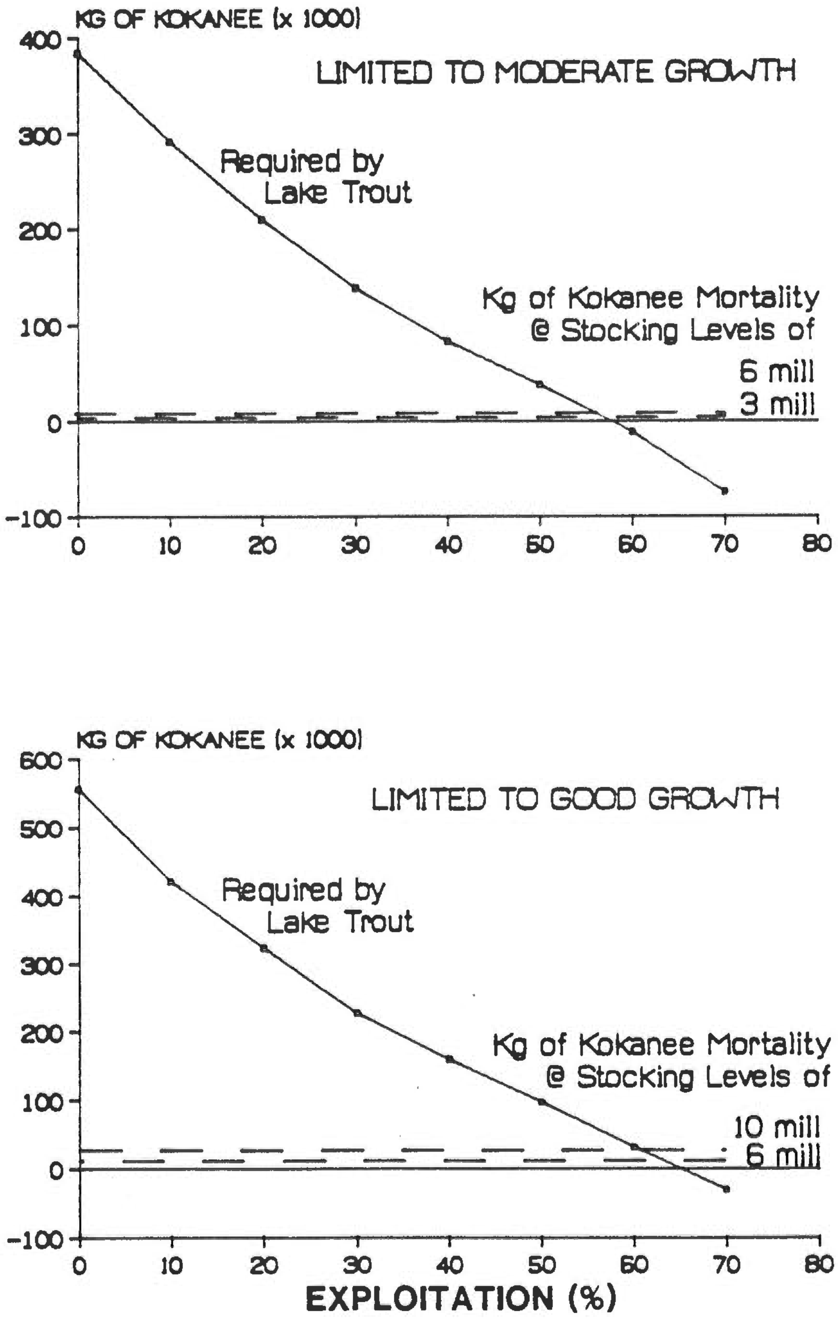

Figure 26. Effect of lake trout exploitation on the kokanee biomass required for 2 growth levels in 6- to 15-year-old lake trout at 21.8% gross efficiency in Priest Lake, Idaho. (Range of exploitation necessary to balance predators with kokanee forage is described by the intersection of kokanee requirement (solid lines) and kokanee availability (dashed lines) at 3 kokanee stocking levels.)

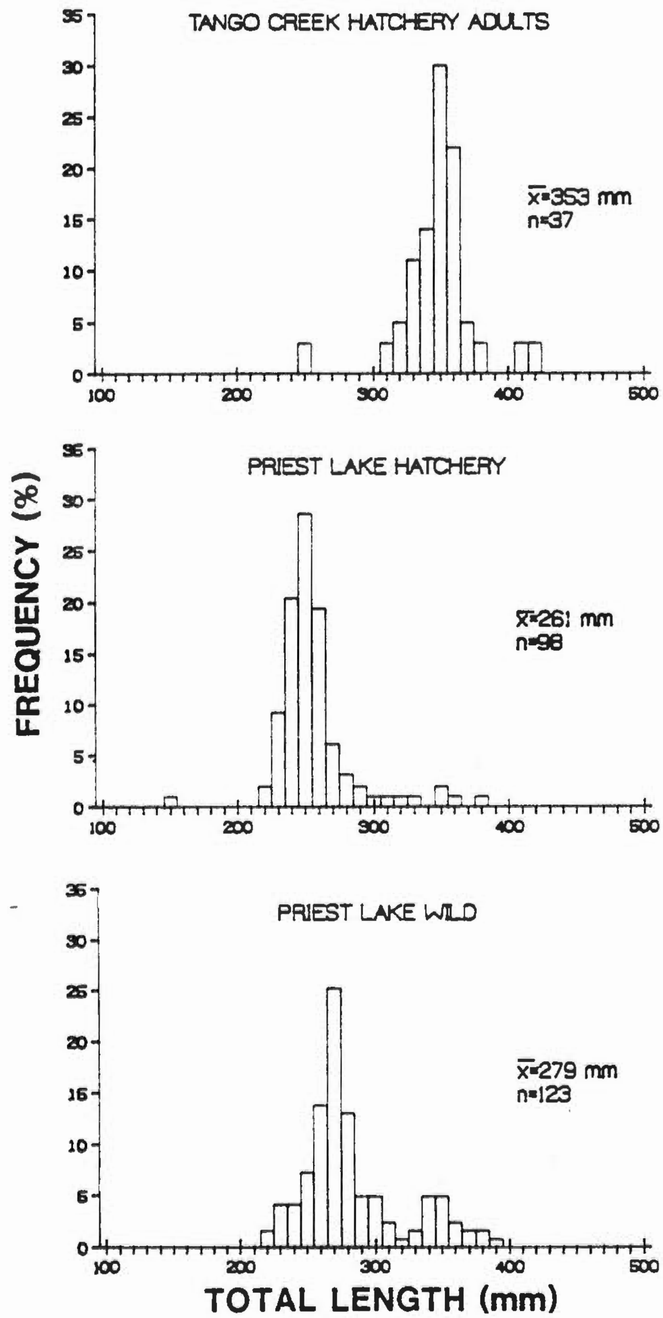

Figure 27. Length frequency distributions for hatchery-reared and wild origin cutthroat trout sampled with weir and purse seine, Priest Lake, Idaho, 1987.

(0.16% of the number released) as fish reared at the Clark Fork Hatchery (0.15%), even though the pen-reared fish averaged 10 mm larger at release (132 mm). Neither group contained substantial numbers of 175 mm fish when they were released.

Older age classes of hatchery fish sampled in the lake ranged in size from 309 to 380 mm. Most were four-year-old fish released in 1985. Three-year-olds released in 1986 were present in low abundance, a continued reflection of their small size at release (104 mm) and resultant poor survival (Table 11).

Cutthroat trout were captured at a rate of five per purse seine haul, with three wild cutthroat per haul (Table 9; Figure 19). The contribution of wild cutthroat trout was 123 fish, or 56% of the sample. Wild cutthroat ranged in size from 216 to 318 mm with a mean size of 279 mm. Wild fish were larger than hatchery fish in their first season in the lake (Figure 27).

The Priest Lake cutthroat trout population was modeled to predict potential benefits of stocking 2, 5, 7 and 10 million fry in tributary streams. Abundance of fully recruited cutthroat trout 30 cm and larger was estimated at 1,400 fish (0.1/hectare) in 1985 (Mauser 1986b), with a peak population of 5,093 fish (0.5/hectare) when juvenile fish enter the lake during early summer. Density-dependent relationships (Figure 28) were added to the basic model developed from 1985 data (Mauser et al. 1988).

Under the conditions specified, catch-and-release regulations maintained the remnant cutthroat population without supplemental stocking (Figure 29). This was a more conservative interpretation of the status of adfluvial cutthroat stocks in the Priest Lake drainage than the initial simulation.

Fry were added to the population at a constant survival rate of 2% from time of stocking to the beginning of the next calendar year. I used a constant rate because 2.4 million m^2 of tributary habitat were available in the Priest Lake drainage for distribution of fry at optimum densities of 5 to $10/m^2$, for stocking levels of 12 to 24 million (Irving 1987). Survival of stocked fish after the first year was governed by the same density-dependent functions developed to model the population in the absence of stocking (Figure 28).

The population responded with increased abundance and catch (ages 4 to 10 were fished at average rates, which decreased from 26% to 21%) as fry were added (Figure 29). Major increases continued (Table 12) as natural mortality rates (v) rose from 35% to 46% for ages 4 to 10. Increased mortality began to limit catch improvements at stocking levels below 1 million fry (Figure 30). If lake trout predation or other mortality agents were actually less severe, population response and optimum stocking levels would be greater.

A response in the fishery should be obvious at catch levels of 2,500 or more which correspond to a stocking level of approximately 2 million fry in the model. However, 2 million fry would only seed a fraction of

Table 11. Cutthroat trout fingerling releases and percent contribution of hatchery-reared cutthroat trout in Priest Lake, Idaho.

Release				Cutthroat sample	Contribution in year				
Year	Time	Number	Size TL (mm)		1	2	3	4	Total
1981	Aug Oct	38,802	108	0	--	--	1%	0	(1%)
1982	Jun Sep	142,845	126	0	--	2%	0	0	(2%)
1983	Apr Jun	421,528	114	641	29%	4%	0.1%	0.3%	33%
1984	Mar May	266,216	120	652	1%	1%	0.4%	0	2%
1985	Apr May	338,650	135	3,161	64%	36%	3%	0	103%
1986	May Jun	283,080	104	753	26%	1%	--	--	(27%)
1987	Jun	44,065	127	221	41%	--	--	--	(41%)
TOTAL		1,535,186	119	5,428	32%	10%	0.7%	0.3%	43%

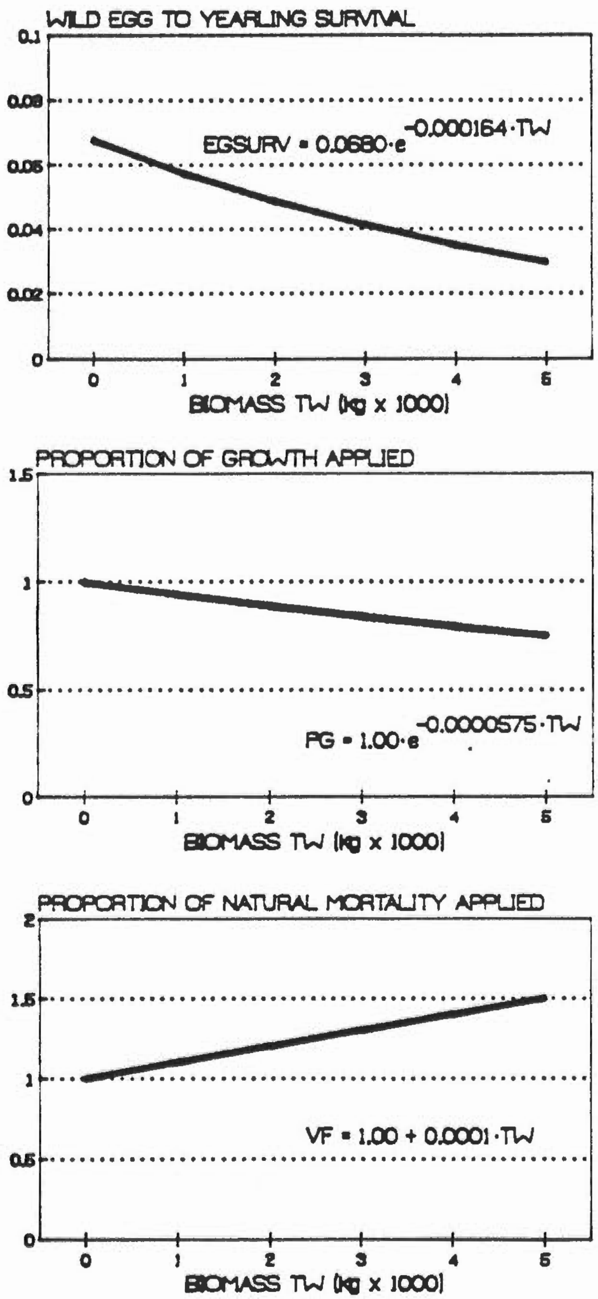

Figure 28. Density-dependent juvenile survival, growth and natural mortality used used to model the cutthroat trout population of Priest Lake, Idaho.

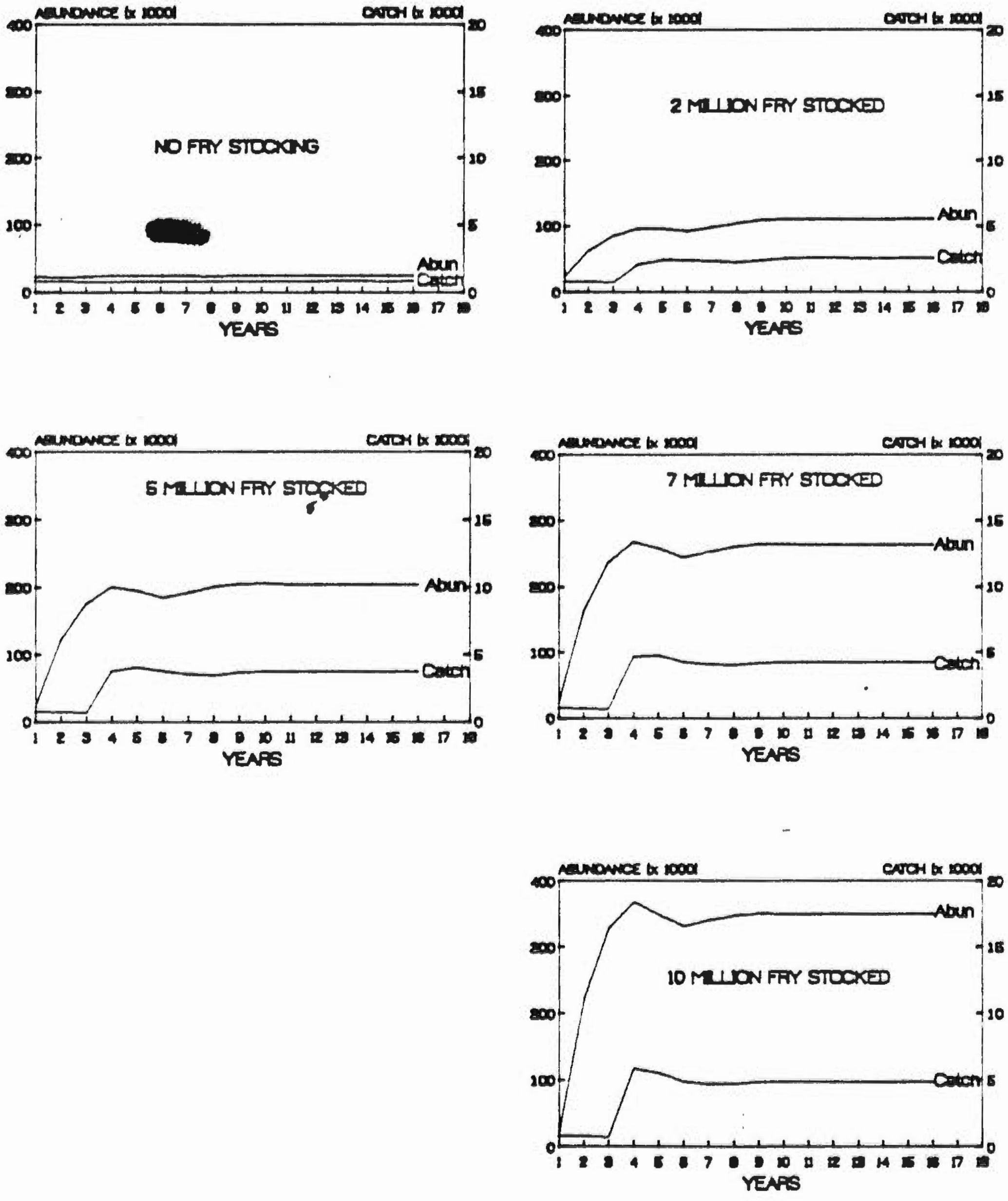

Figure 29. Abundance and catch of cutthroat trout with catch-and-release regulations and four stocking levels for Priest Lake, Idaho.

Table 12. Mean cutthroat trout abundance, biomass and catch modeled over 16 years with 5 fry stocking levels and catch-and-release regulations for Priest Lake, Idaho.

Fry stocked (millions)	Average number of fish in population	Average population biomass (kg)	Average number of fish caught and released annually
0	24,641	802	818
2	95,914	2,028	2,131
5	183,269	3,043	3,158
7	238,242	3,553	3,630
10	318,367	4,194	4,168

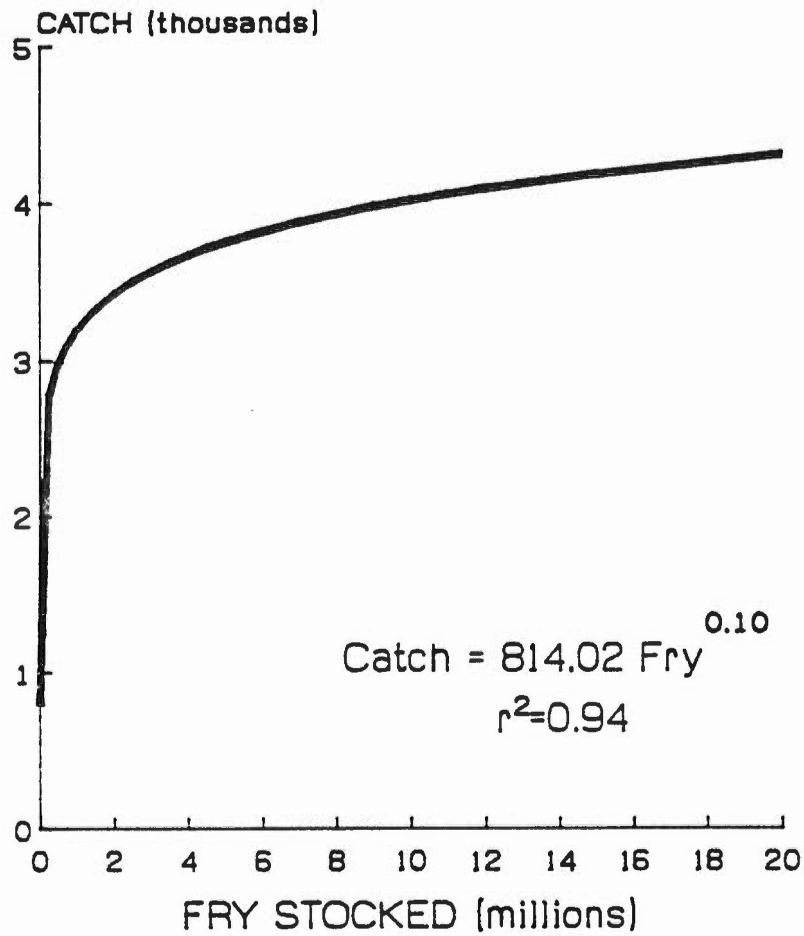

Figure 30. Relationship between number of cutthroat trout fry stocked in tributary streams and resultant catch-and-release fishery in Priest Lake, Idaho.

the available rearing habitat, and higher sto[redacted] should be evaluated. Areas best suited for fry releases and brook[redacted]ut removal were recommended by the Idaho Cooperative [redacted]dlife Unit (Appendices R and S).

If fishing pressure expended by anglers specifically seeking cutthroat increased from the 1986 level of 4,564 hours to 1978 levels of 7,200 hours, catch rates would average 0.4 fish/hour in a sustainable nonconsumptive fishery with annual catches of 2,500 cutthroat. Addition of hatchery-reared fingerlings could further enhance the fishery and provide a harvest of marked hatchery fish.

Coeur d'Alene Lake

Purse seining conducted on Coeur d'Alene Lake (Figure 31) yielded 329 cutthroat trout, 13,934 kokanee, eight chinook salmon and occasional spiny-rayed and nongame fish (Table 13). Seven of the chinook were unmarked wild fish 143 to 275 mm long and one was an adipose-clipped hatchery fish 505 mm long.

Tag recoveries were insufficient for reliable population estimates, but provided rough approximations for cutthroat trout abundance of 4,352 to 6,528 fish 200 mm and larger, 2,618 to 3,928 cutthroat 250 mm and larger and 290 to 580 fish 300 mm and larger.

Combined spring and fall samples produced a slightly convex catch curve for older cutthroat trout (Figure 32). Total annual mortality (A) was estimated at 60% for ages 4 to 7 and 68% for ages 5 to 7.

Angler tag recovery data indicated cutthroat trout moved throughout the lake and were quite vulnerable to harvest during early summer. Fishermen returned 9% of 46 tags attached to cutthroat trout prior to the trout season in April 1987. The majority (87%) were tagged in Wolf Lodge and Beauty bays, part of the lake closed to cutthroat harvest in 1987 (Figure 31). If half the tagged fish were vulnerable to harvest (in open areas) after marking, and tag reporting was also 50%, short-term exploitation would have been 35%.

Cutthroat trout from Coeur d'Alene Lake enter the lake primarily as two-year-old fish and grow more slowly during their first year in the lake environment, but faster in subsequent seasons, than cutthroat in Priest Lake (Figure 33; Appendix T). Fish from our samples averaged 233 mm and ranged to 350 mm, with a small contribution of larger cutthroat (Figure 32). The larger fish weighed less for their length than fish from Priest Lake, a less productive system with a shorter growing season.

Scale examination revealed that some of the fish larger than 350 mm displayed rapid growth patterns similar to those of cutthroat from the Coeur d'Alene River (Apperson et al. 1988) and were not older than typical lake resident fish. The larger cutthroat were encountered infrequently, but more often in the southern end of the lake closer to the Coeur d'Alene River.

[redacted]

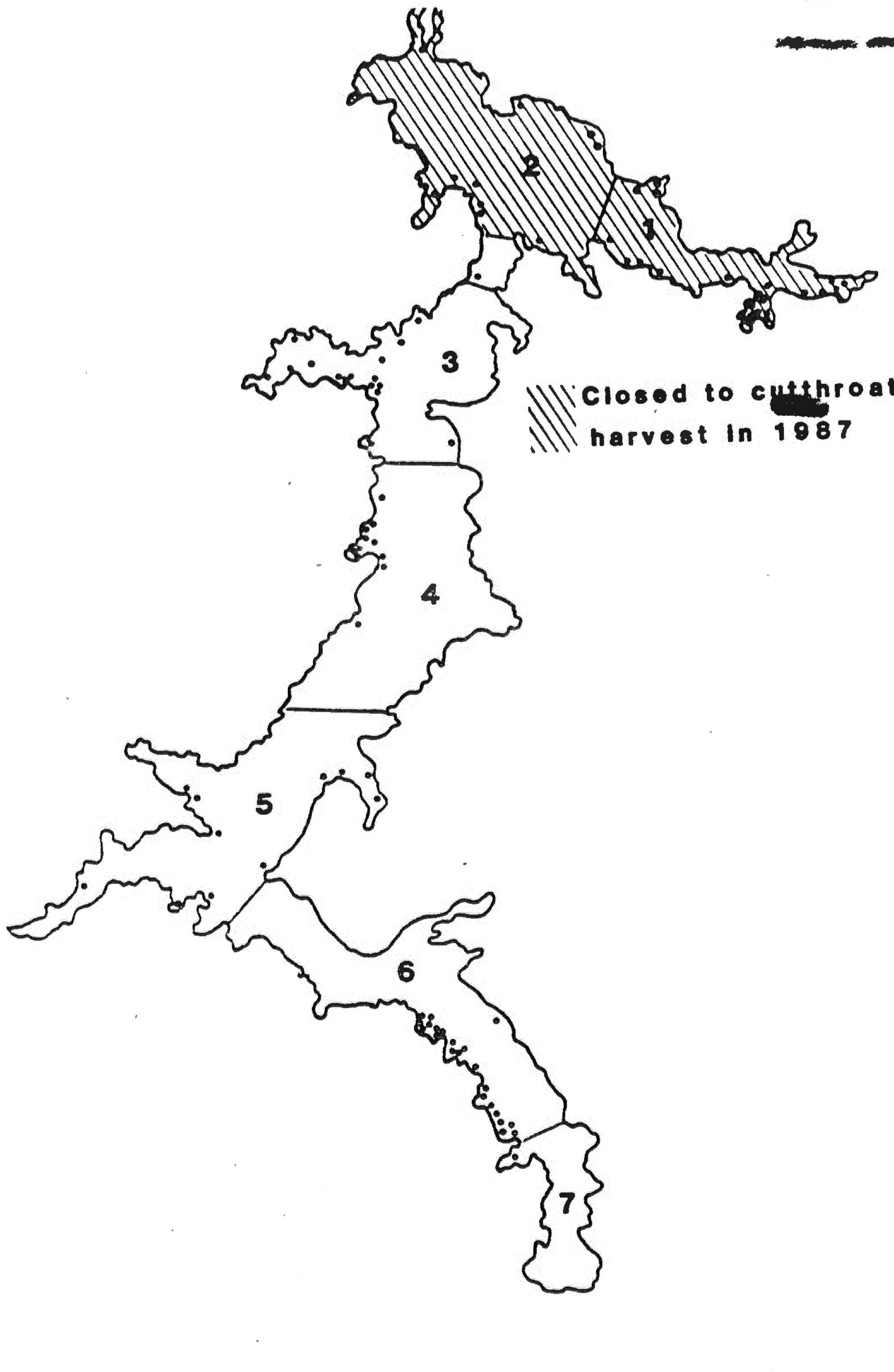

Figure 31. Purse seine sites on Coeur d'Alene Lake, Idaho, in 1986-1987.

Table 13. Results of purse seine sampling conducted on Coeur d'Alene Lake, Idaho, in 1987.

Date	Lake section(s)	Number of sets	Wild cutthroat	Hatchery cutthroat	Kokanee	Chinook	Other[a]	Total
November 4, 1986	6	4	30	0	576	2	0	608
5	6	6	10	0	304	0	0	314
6	5	4	0	0	450	0	0	450
7	4,3,2	6	0	0	100	0	0	100
Fall total		20	40		1,430	2	0	1,472
April 1, 1987	1	3	25	0	1	0	0	26
2	1	2	0	0	350	0	0	350
10	1	3	15	0	45	1	1	62
23	3	2	6	0	0	0	0	6
30	1	1	3	0	315	0	0	318
May 6	1	3	7	0	1,473	0	9	1,489
7	3	2	11	0	1,289	0	0	1,300
11	1	3	8	0	415	1	12	436
13	3	2	5	0	242	0	0	247
19	2	4	5	0	795	0	2	802
22	2,1	2	18	0	243	0	0	261
26	6	3	13	0	947	0	1	961
June 3	4,3	4	15	0	866	0	0	881
4	6	4	11	0	855	0	4	870
8	4,3	4	30	0	314	0	0	344
9	5,3	4	14	0	442	0	0	456
10	1	2	3	0	416	0	0	419
11	4,3	4	20	0	239	0	0	259
15	3,2	3	15	0	201	0	0	216
17	4,3	5	34	0	244	0	0	278
18	2	2	10	0	356	0	0	366
22	6	2	1	0	335	0	0	336
23	6	3	3	0	390	1	0	394
24	5	4	3	0	1,073	0	1	1,077
25	6	1	6	0	114	1	0	121
30	1,2	4	1	0	507	1	1	510
July 20	1,2	4	6	1	37	3	0	47
Spring total		80	288	1	12,504	8	31	12,832
Grand total		100	328	1	13,934	10	31	14,304
Fish/set			3.3		193.3			143.0

[a]Crappie, perch, bullhead, tench and squawfish.

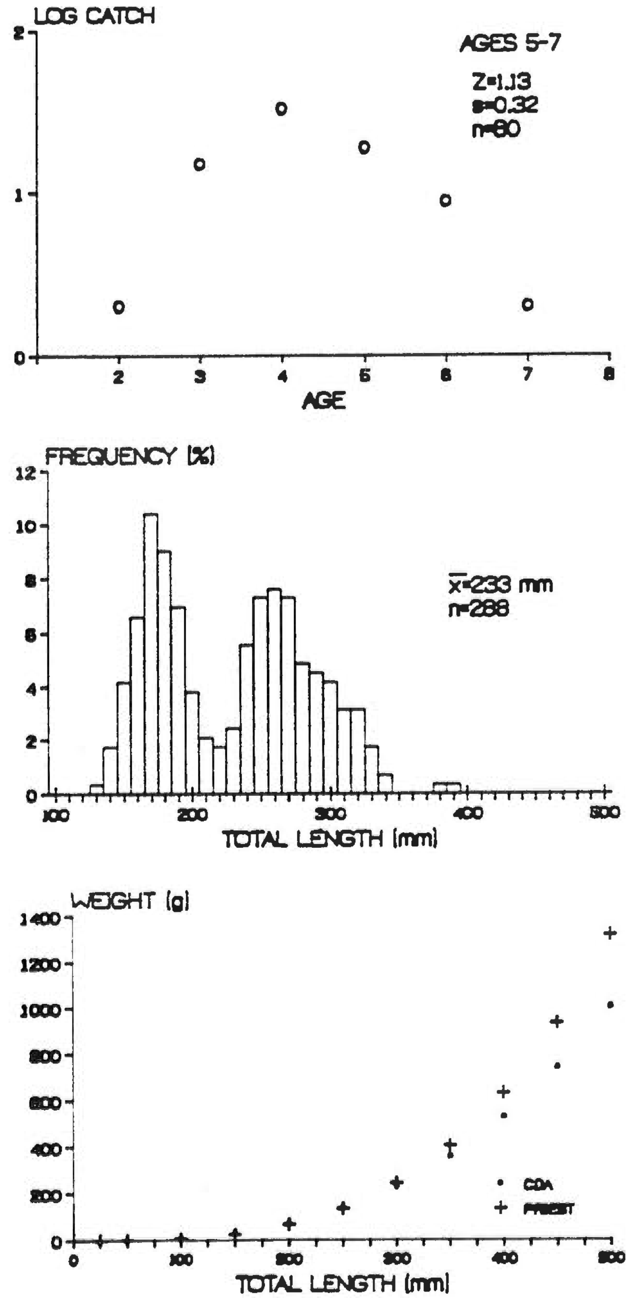

Figure 32. Catch curve, length frequency distribution and length-weight relationship for cutthroat trout sampled from Coeur d'Alene Lake with a purse seine in 1986-1987.

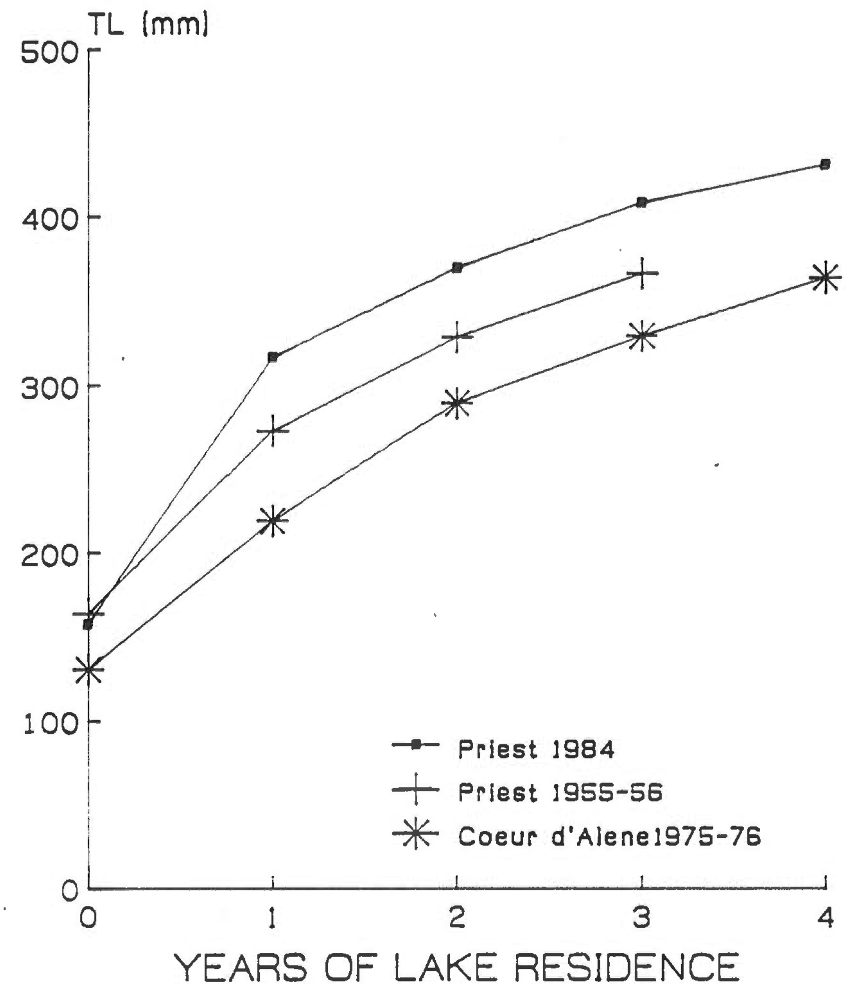

Figure 33. Length at (lake) age for westslope cutthroat trout from Priest Lake, Idaho, in 1955-1956 (Bjornn 1957) and 1983-1984 (Mauser 1986a): and from Coeur d'Alene Lake, Idaho, in 1975-1976 (Lukens 1978).

The Coeur d'Alene cutthroat trout population was modeled to predict effects of restrictive regulations. Density-dependent relationships (Figure 34) were adapted from the Priest Lake model. Size and age structure of the population were modified from data presented by Lukens (1978) to reflect longevity observed in fish tagged in the late 1970s (Idaho Department of Fish and Game, unpublished data).

I used a base population of 4,000 fish age 4 and older to correspond with the mark-recapture estimate of 3,928 fish 250 mm and larger. Peak abundance was modeled at 25,975 cutthroat trout (2/hectare) in Coeur d'Alene Lake when juvenile fish entered the lake each spring.

Under these conditions, abundance of 1- to 10-year-old cutthroat and total catch (including caught and released fish) increased dramatically with more restrictive regulations (Figure 35). However, initial exploitation of older age classes had to be set at 60% to 65% to provide annual catches that exceeded the underestimates made from partial census data (Figure 36; see also Rieman and Horner 1984 for upper Spokane River (Coeur d'Alene Lake outlet) harvest estimate). Natural mortality rates for fish of ages 4 to 6, therefore, had to be minimal (7% to 20%) or total annual mortality would have been far greater than suggested by age structure of 1986-1987 samples.

If natural mortality were actually greater in the population, then our abundance estimates were too low and exploitation too high in the model. These effects would overestimate the benefits of harvest restrictions for Coeur d'Alene Lake. Reduction of harvest was still probably necessary to arrest the population decline.

Average catch levels increased from 2,400 to 7,400 with harvest restrictions in the model (Figure 35). A more conservative doubling of current catch to 5,000 fish annually at catch rates of 0.4 fish/hour or better should be attainable with adequate regulations and compliance. Retention and evaluation of the 1988 regulation of a 356 mm minimum size limit are important to learn if the population will respond as modeled.

Pend Oreille Lake

In five days of sampling with purse seine gear, we caught 7 cutthroat trout, 11 rainbow trout, 2,768 kokanee and 1 mountain whitefish in 16 hauls on Pend Oreille Lake (Figure 37, Table 14). Cutthroat trout ranged from 285 to 345 mm with a mean size of 297 mm. Most of the cutthroat sampled were in relatively poor condition with a length-weight relationship of $W=0.04\ TL^{1.53}$. Rainbow trout had a similar condition factor until they reached greater lengths ($W=0.000047\ TL^{2.68}$; Figure 38). The rainbow sampled ranged from 177 to 420 mm and averaged 312 mm.

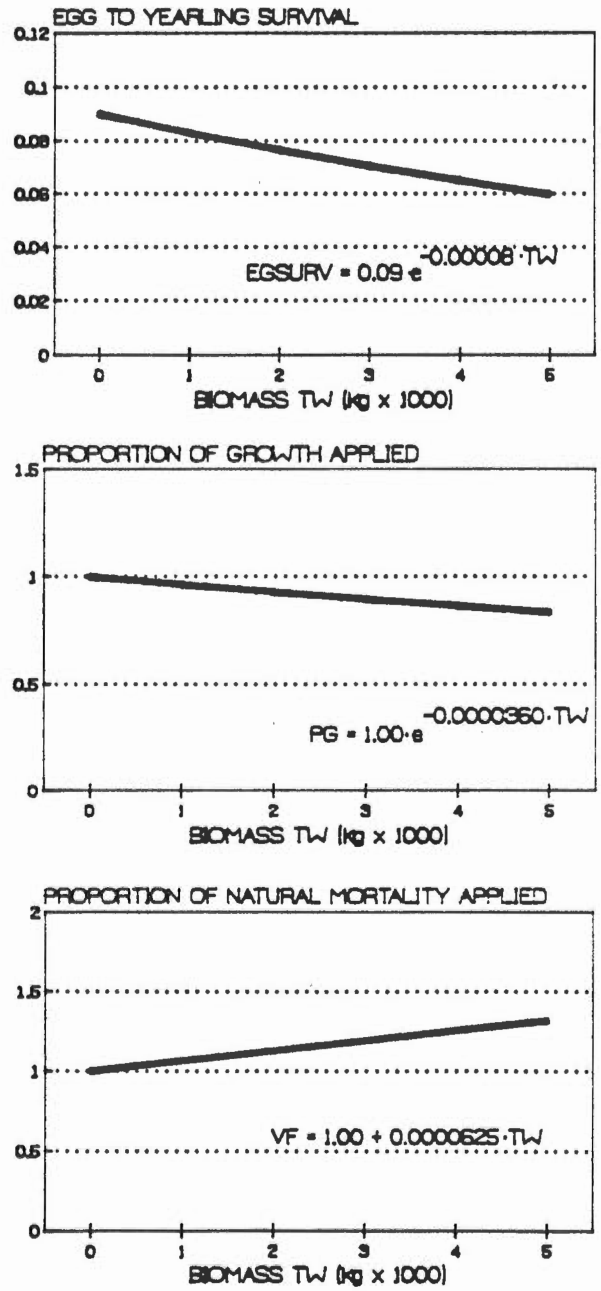

Figure 34. Density-dependent relationships used to model the cutthroat trout population of Coeur d'Alene Lake, Idaho.

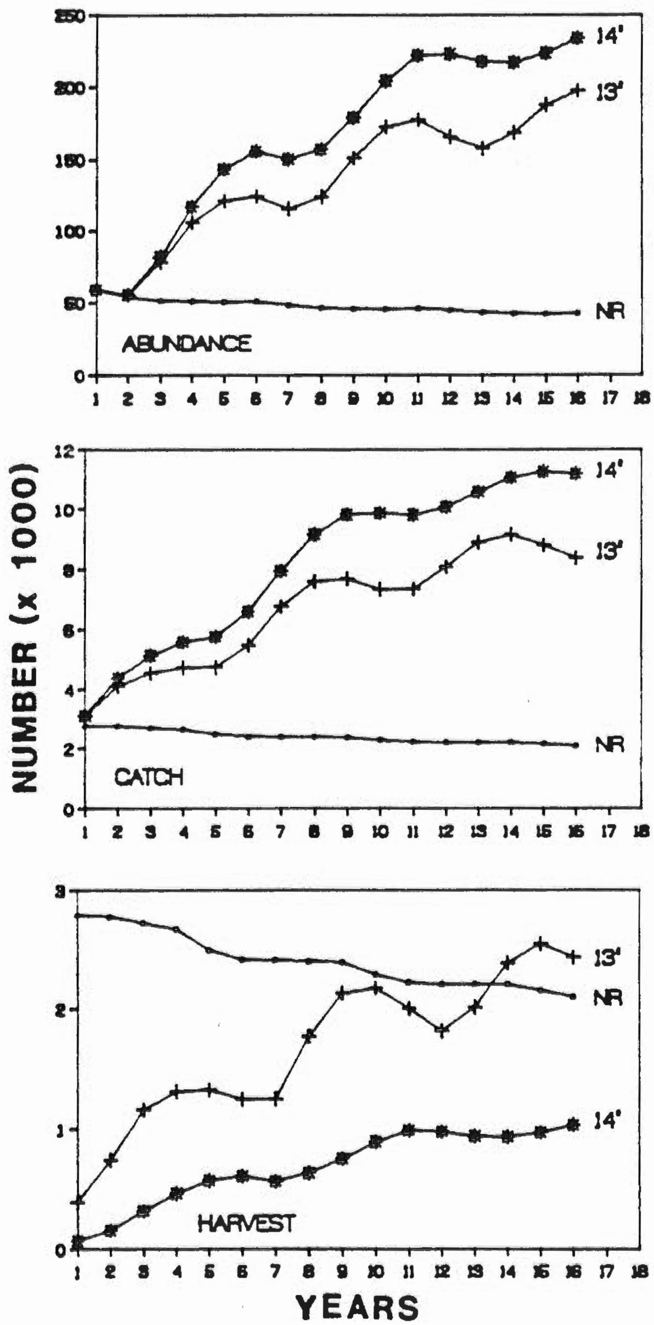

Figure 35. Predicted abundance, catch and harvest of cutthroat trout with 13 inch and 14 inch minimum length regulations and no special regulations for Coeur d'Alene Lake, Idaho.

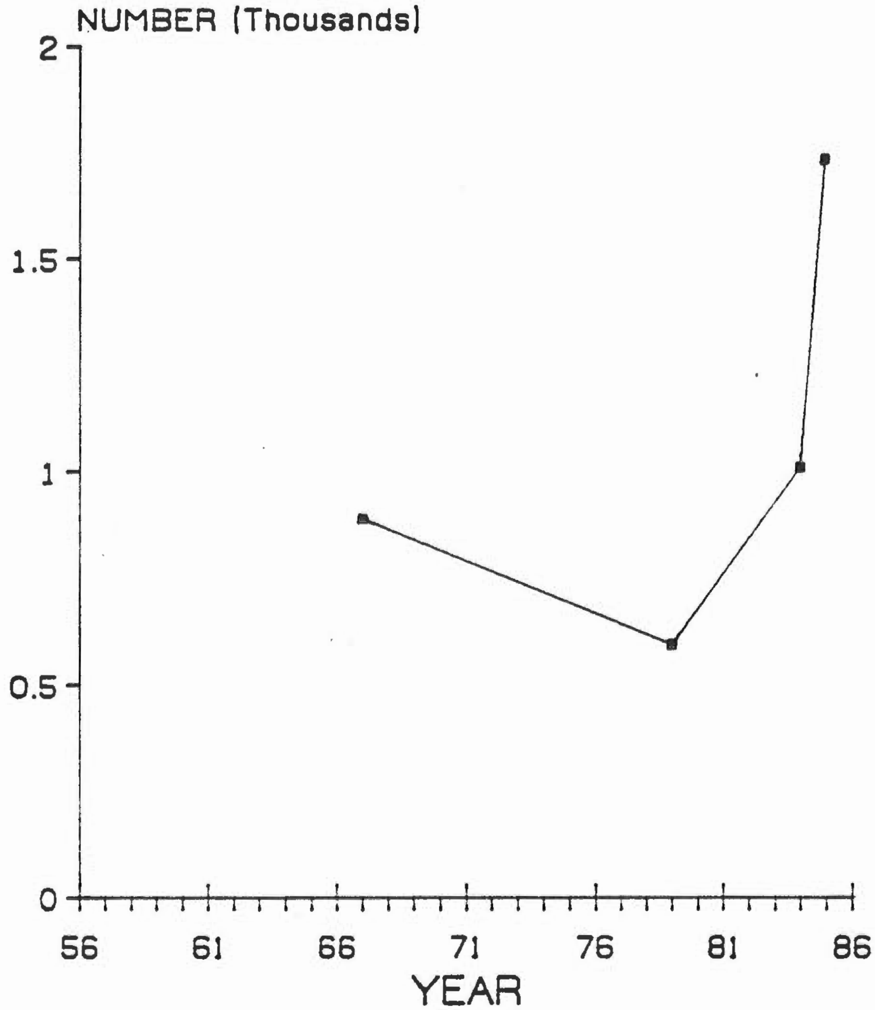

Figure 36. Cutthroat trout catch for Coeur d'Alene Lake, Idaho, 1967-1985 (Mallet 1968; Rieman and LaBolle 1980; Horner and Rieman 1985; Horner et al. 1986).

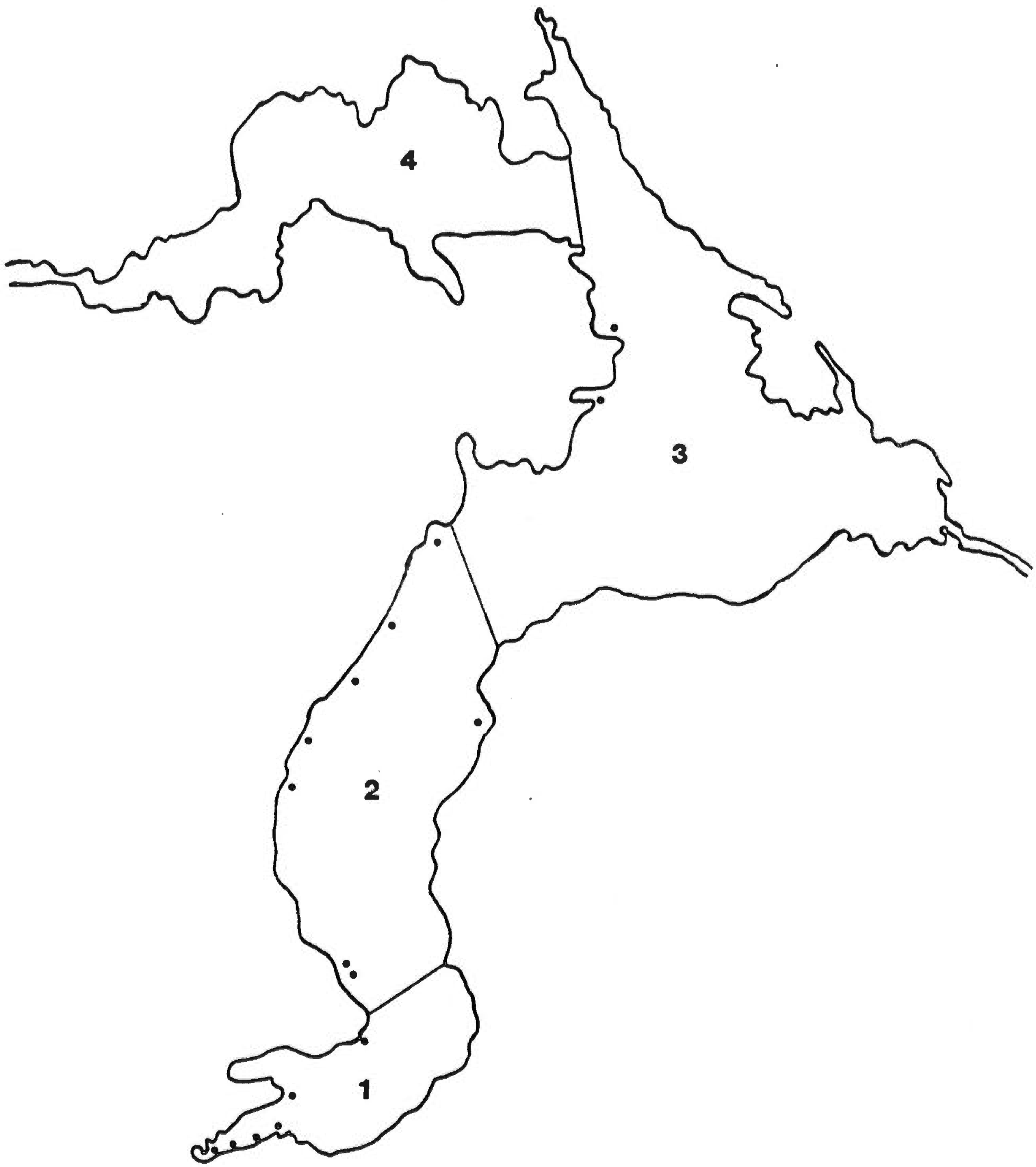

Figure 37. Purse seine sites on Lake Pend Oreille, Idaho, in 1987.

Table 14. Results of purse seine sampling conducted on Pend Oreille Lake, Idaho, in 1987.

Date	Lake section(s)	Number of sets	Wild cutthroat	Wild rainbow	Kokanee	Other	Total
July 13	2	2	0	4	34	0	38
October 22	1	5	0	1	2,406	0	2,407
23	1	1	0	0	12	0	12
27	2	6	6	5	139	1	151
29	3	2	1	1	177	0	179
Total		16	7	11	2,768	1	2,787
Fish/set			0.4	0.7	173.0		174.2

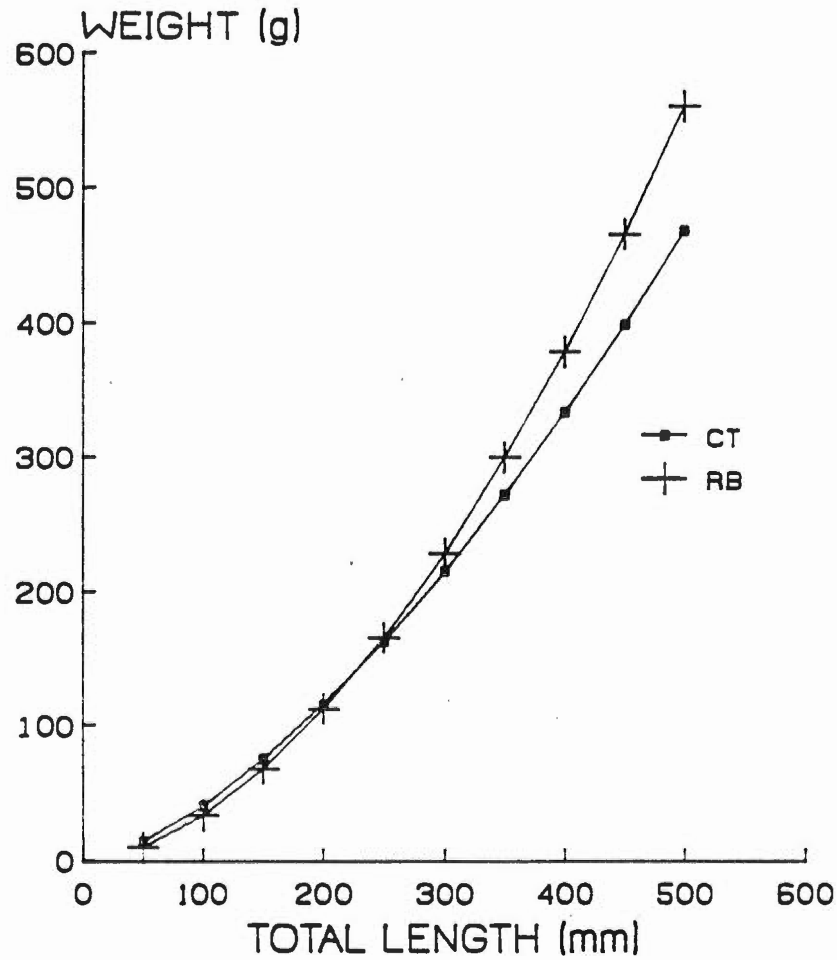

Figure 38. Length-weight relationships for cutthroat trout ($W=0.04\ TL^{1.53}$, $r^2=0.81$, n=7) and rainbow trout ($W=0.01\ TL^{1.76}$, $r^2=0.92$, n=7) sampled from Lake Pend Oreille, Idaho, in 1987.

Hayden Lake

In four days, we caught 40 juvenile and subadult trout with purse seine gear at a rate of 3.6 trout per set (Table 15). Purse seine sampling was limited to the southeastern portion of the lake (Figure 39). Another 13 trout, including some adult fish, were sampled from the catch. Most of the fish taken on hook and line were caught at depths of 12 to 19 m. Wild rainbow trout sampled from the harvest in recent years have demonstrated an increase in growth due to utilization of *Mysis* (Figure 40).

All trout stomachs examined in 1987, including recently stocked Mount Lassen rainbow, contained *Mysis*. Kamloops fingerlings were not sampled, possibly due to limited size, distribution, abundance or sampling.

Trout Abundance

Relative abundance of trout vulnerable to purse seine gear was estimated using catch per unit of effort for all lakes sampled and peak abundance estimates for Priest and Coeur d'Alene lakes. Although extrapolation of mark-recapture data may underestimate trout abundance in large lakes, preliminary indications were that lakes supported fewer than 60,000 trout under 50 cm, or about 1 fish/hectare (Table 16).

DISCUSSION

The large lakes of northern Idaho provide considerable diversity of opportunity for the angling public. Good fishing for trout under 50 cm, however, was limited to seasonal hot spot fisheries. Except for the harvest of small rainbow trout on Pend Oreille Lake and small lake trout in Priest Lake, remnant populations of westslope cutthroat trout provided the nontrophy trout fishing because of their vulnerability to harvest.

Harvest was one of the major factors limiting the fishery for native cutthroat trout, along with competition with introduced species, habitat losses and underseeded habitat. Reduction or elimination of consumptive fishing could stabilize declining cutthroat trout populations, but trout fishing will remain limited on the large lakes unless management efforts are intensified.

Priest Lake

Priest Lake became primarily a lake trout fishery once *Mysis* were established. *Mysis* enhanced the survival of juvenile lake trout to such an extent that other species were unable to maintain reasonable levels of abundance due to predation and low production. Impacts of predation on other game fish might be reduced with adequate forage for lake trout.

Table 15. Results of purse seine sampling conducted on Hayden Lake, Idaho, in 1987.

Date	Number of sets	Wild cutthroat	Hatchery cutthroat	Rainbow-cutthroat hybrids	Wild rainbow	Hatchery rainbow	Total
May 20	3	-----14-----		---------11----------			25
July 17	2	0	2	-------2------		6	10
October 13	3	0	1	0	0	0	1
November 5	3	0	0	2	0	2	4
Total	11	-----17-----		---------23----------			40
Fish/set			1.5		2.1		3.6

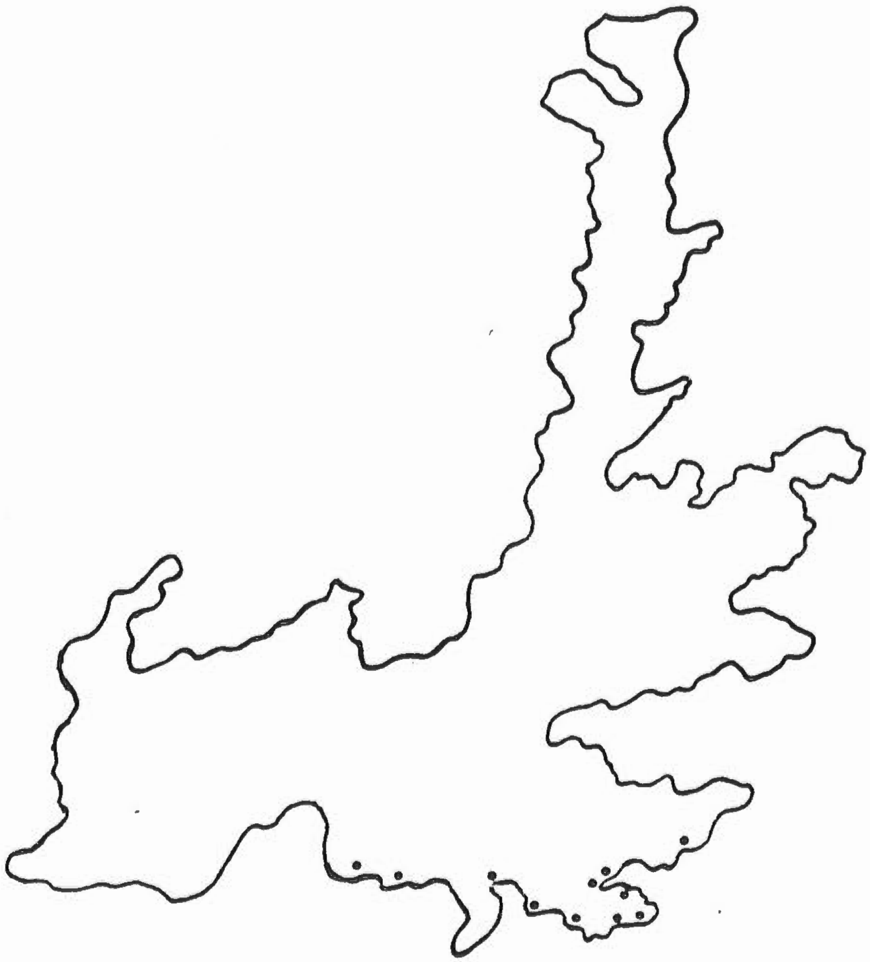

Figure 39. Purse seine sites on Hayden Lake, Idaho, in 1987.

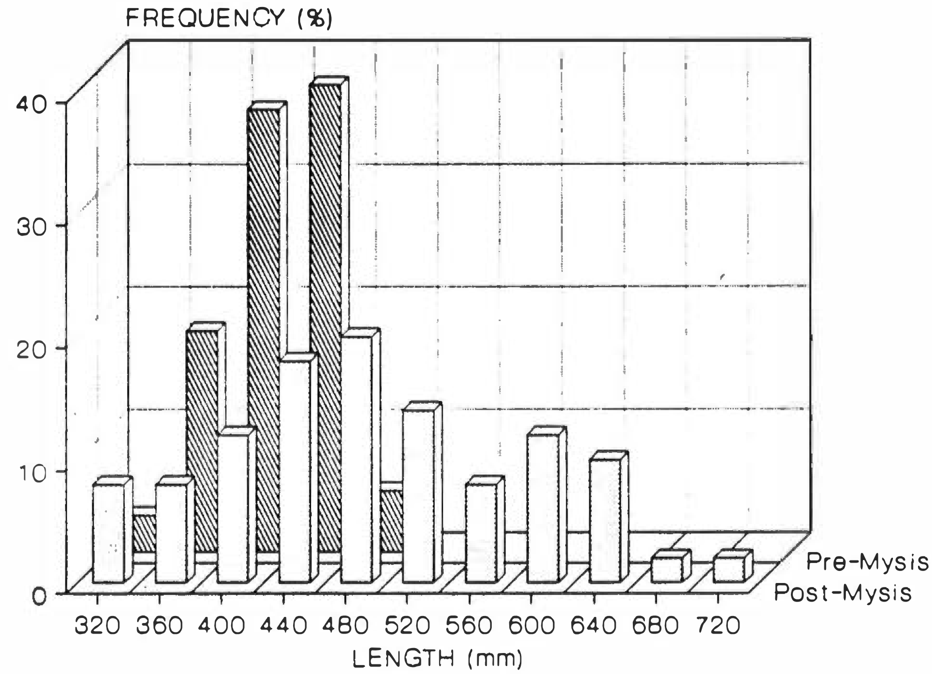

Figure 40. Length-frequency of harvested rainbow trout before and after *Mysis* establishment in Hayden Lake, Idaho (Ellis 1983, Idaho Department of Fish and Game, unpublished data).

Table 16. Relative abundance of trout at maximum (spring) densities derived from mark-recapture estimates and catch/effort indices for large North Idaho lakes.

Body of water	Surface area (hectares)	Estimated abundance (number of trout)	Density (trout/ hectare)	Catch/effort (trout/purse seine haul)	Relative density (trout/ hectare)	Relative abundance (number of trout)
Priest Lake	9,454	5,093	0.54	5.1	0.54	5,093
Hayden Lake	1,520			3.6	0.38	579
Coeur d'Alene Lake	12,000	25,975	2.16	3.3	2.16	25,975
Pend Oreille Lake	38,300			1.1	0.72	27,576
Total	61,274				0.97	59,223

Kokanee stocked as fry in midsummer had the potential to buffer lake trout predation, but programs necessary to maintain adequate kokanee forage could rise to prohibitive levels as the predators respond with increased size, fecundity and abundance.

A similar problem could occur with a goal to maintain desirable size lake trout in the catch. Lake trout averaging 2.5 kg or better would probably be optimum, with smaller fish resulting in low yields to the fishery and significantly larger sizes resulting in overcropping of food sources. Computer models offered the opportunity to develop a balance of lake trout and kokanee that would result in a stable lake trout fishery with acceptable success rates and size of fish in the creel.

Prospects for providing a kokanee fishery, along with impacts on other species, would have to be evaluated at higher stocking levels. Allocation of additional hatchery-reared kokanee fry would be necessary to achieve either goal. It did not appear advisable to restrict lake trout harvest with existing forage deficiencies.

The Priest Lake bull trout fishery was likely to remain functionally extinct as long as lake trout abundance was high. The Upper Priest population was healthy and probably provided some of the few fish still found in the main lake.

Larger cutthroat trout fingerlings released in 1985 performed well and indicated the potential benefits of additional hatchery experimentation. The larger fish outperformed their counterparts in the Priest Lake system and provided the only spawning run trapped in Tango Creek. Survival was still low, but performance improved enough that additional gains seemed possible with larger fingerlings.

With the wild cutthroat trout population at such low levels, closure of the consumptive fishery may have been necessary to maintain a viable population. Releases of hatchery fry into tributary streams had the potential to enhance the lake fishery, as described by our model and the one developed by Cowley (1987). Optimum levels for supplemental stocking should be determined by testing larger releases, beginning with 2 million fry annually.

Fry releases offer the advantage of natural selection in the first years of life, which should make the resulting juvenile cutthroat migrants more fit to survive the rigors of the lake environment. The limited number of fish that result from normal survival rates and extended rearing in unproductive nursery streams was probably always a limiting factor (Bjornn 1957).

Habitat above natural falls that is unavailable to adfluvial fish could be seeded with hatchery fry. Another program would be brook trout removal followed by cutthroat fry stocking to reclaim stream sections lost to cutthroat trout production (Cowley 1987). Use of cutthroat trout rearing streams by introduced brook trout populations was recognized as a problem in the 1950s (Bjornn 1957), and brook trout range has expanded considerably since (T.C. Bjornn, Idaho Cooperative Fish and Wildlife Unit, personal communication).

Distribution of cutthroat trout fry throughout available habitat would be a substantial task. The stock of fish used would have to be capable of surviving the tributary environment as well as in the lake.

Improvement of fingerling releases should continue so that viable programs are available to supplement fry stocking. The egg requirement for a fingerling stocking program is far less than for fry which sustain high mortality in the wild (McFadden 1969).

Our modeling, as well as that developed at the Idaho Cooperative Fish and Wildlife Unit, confirmed the results of tributary and lake research conducted to date. The cutthroat fishery would have to remain closed to harvest for the population to improve in the absence of supplemental stocking. Releases of hatchery-reared fish could increase the cutthroat population, depending on numbers and performance of stocked fish.

With tributary limitations and lake trout predation, it was unlikely that successful stocking programs could be discontinued without declines in the cutthroat trout fishery. Kokanee forage could buffer lake trout predation on cutthroat, or have adverse impacts by increasing predatory inertia.

Coeur d'Alene Lake

Data collected from Coeur d'Alene Lake indicated the cutthroat trout population could respond to harvest restriction. Based on the tributary work conducted at Priest Lake, more intensive tributary management, including brook trout removal and fry releases, could also be beneficial. Many tributaries have lost most of their adfluvial component to overfishing in the streams, as well as in the lake, along with habitat and biological problems. Exploitation was high enough in the lake that the conditions used to model the population appeared valid. However, harvest was not the only limitation on the fishery.

Historically, cutthroat trout in the drainage attained large size. Exploitation and habitat losses have had an effect. Competition with kokanee may have imposed an additional limitation on the population. If competition with kokanee was less severe for larger cutthroat than for the smaller fish spending their first year in the lake, it may have been because the diet of larger cutthroat was primarily larger insects not utilized by kokanee.

Hayden Lake

Hayden Lake offered the best potential for trout enhancement with existing management capabilities. Hayden Lake tributaries were well seeded with juvenile trout in contrast with most other systems in the region (Apperson et al. 1988; Gamblin 1988; Irving 1987; Pratt 1985). Trout were protected with tributary closures and a 356 mm size limit in the lake fishery. Productivity of the trout population was enhanced by the Mysis forage base.

Releases of trout fingerlings 175 mm or larger could improve catch rates and yield by infusing the Hayden Lake fishery with stocks more vulnerable to harvest. Catch rates for rainbow-cutthroat hybrids, which comprised most of the fishable population of wild trout, were low at 25 or more hours/fish (Horner et al. 1986) and may have been the result of reduced vulnerability or low density. Commercially available Kamloops rainbow provided exceptional growth and, with cutthroat fingerling releases, improved catch rates in years when survival was adequate to provide recruitment to the fishery.

In 1982, 7,073 trout were caught at a rate of 0.32 fish/hour with 34% harvested. The harvest rate was 0.11 and was made up of 64% cutthroat trout, 59% of which were hatchery fish (Ellis 1983). Catch rates of 0.2 fish/hour or better should be attainable when the contribution of hatchery-reared trout is high.

Survival of juvenile trout in Hayden Lake was apparently low and limited by size. Fish 75 to 125 mm long made up the bulk of wild and hatchery rainbow trout production (Goodnight and Mauser 1981; Horner et al. 1987). The fishery might be improved by releasing larger fingerlings.

In 1983, 95,550 Kamloops fingerlings 153 mm in size were released in October. These fish may have supported the improvement in catch rates from 0.03 to 0.05 fish/hour between 1983 and 1985 when effort doubled in response to the trophy fishery. Releases of 150,000 large (175 mm) fingerlings of the proper stocks should improve recruitment to the fishery dramatically if Priest Lake results have application to other systems.

Exploitation may also limit the trout population. The 356 mm size limit resulted in the harvest of most larger trout and protected only those fish spending their first year in the lake. However, if tributaries were fully seeded, restrictive angling regulations in the lake to provide additional spawning escapements might not improve the fishery. Juvenile trout densities in tributaries should be further evaluated to identify limiting factors.

Increased hatchery supplementation would provide higher catch rates for trout in Hayden Lake (Ellis 1983). More restrictive regulations could do the same, but harvest reduction would have to be substantial. An enhanced hatchery program would not restrict angler harvest.

The Hayden Lake fishery has undergone several major changes, most recently due to establishment of Mysis. From the 1930s to the 1960s, growth rates similar to those resulting from Mysis were the result of insect production, including the large mayfly *Hexagenia limbata limbata*. The large hexageniads, locally called sandflies, are still present in limited numbers in Hayden Lake, but their influence on the fishery has been minimal in recent decades.

Besides contributing to production of large trout, mayfly hatches produced tremendous fly fishing. Presently, trout are caught primarily by other methods, including deep-water trolling. Because of the *Mysis* diet, trout catchability may have decreased, which would help maintain the wild trout population at the expense of angler success.

Because specialized techniques are required to catch trout in Hayden Lake and effort is relatively high, catch rates are low. Effort increased from 40,500 hours in 1983-1984 to 80,776 hours in 1985 (Horner et al. 1986) because of the trophy aspects and local nature of the fishery. In 1983, Ellis recommended the fishery be monitored periodically with creel census. Catch, mortality and spawning escapements should be evaluated to determine if the fishery shows signs of overharvest. Additional work should also be conducted to determine the most efficient stocking strategies.

Because of the unique high quality trout fishery, Hayden Lake should not be considered for introduction of any species that could replace existing trout stocks through competition or predation. One reason for the successful trout fishery may be the absence of uncontrollable fish like kokanee or lake trout. Landlocked Atlantic salmon could provide a high quality introduction that could be easily controlled through stocking levels and spawntaking. If established they would utilize the fish forage base, but their impact could be easily managed at desirable levels.

ACKNOWLEDGEMENTS

I would like to thank all the people interested in Priest Lake for their understanding of the difficult nature of the fishery and the limitations the expanded lake trout population imposes on management of the system. Gracious hospitality and excellent cooperation extended us over five years of the study made our work much easier. Accumulated years of knowledge willingly shared with us furthered understanding of a tough problem. Hopefully, a better picture of the fishery has emerged that will provide the best possible benefits to resource users.

A number of people gave extra assistance on the project. Some of these are Mike Barber, Dan Beers, Ed Buettner, Don Carr, Bruce Heiner, Larry LaBolle, Gene McPherson, Sally Rau, Carole Smith, Steve Sonntag, Bob Vogelsang and Denise Washick. All employees and volunteers worked hard to provide high quality information deserved by the public.

I would like to extend special thanks to Bill and Peggy Mehs, Dean and Carla Stevens, Gary Rude, Randall Lemburg and all the Priest Lake Sportsman's Association members for their help over the years. Anna Marie Halpern also deserves special recognition for typing the many documents necessary to record and relate the results of our efforts. I also wish to give extra appreciation to Laurie and Jane Mauser, who helped me in more ways than I can ever repay.

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A P P E N D I C E S

Appendix A. Results of an opinion survey with 100 interviews conducted on Priest Lake, Idaho, in 1987.

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1. How many years have you fished Priest Lake?

0-5	6-10	11-15	16-20	20+
52%	13%	6%	12%	17%

2. About how many days per year do you fish Priest Lake?

28%	23%	11%	9%	29%

3. What species would you prefer to fish for? (Rank)

   #1 Mackinaw #2 Cutthroat #3 Kokanee #4 Dolly Varden

4. We now have a well established mackinaw population in Priest Lake that is supported by *Mysis* shrimp. Limited kokanee stocking is increasing mackinaw size. It does not appear that kokanee fishing can be re-established without a reduction in mackinaw numbers and a significant increase in kokanee stocking.

   39% Would you prefer limited kokanee releases to provide fishing for mackinaw of about the present size?

or

   48% Would you prefer greatly increased kokanee stocking and harvest of mackinaw to try and produce some kokanee fishing? (Not guaranteed)

   13% No opinion.

5. It appears that mackinaw may also be limiting the cutthroat fishery. Would you favor or oppose a catch-and-release regulation to maintain or improve cutthroat size and numbers?

   50% Favor 26% Oppose 24% No opinion

6. Overall, would you prefer that Priest Lake were managed primarily to protect and improve the mackinaw fishery, or that mackinaw numbers and fishing success were reduced to try and improve fishing for other species?

   57% Mackinaw
   39% Other (cutthroat, kokanee, bull trout)
   4% No opinion

Appendix B. Estimated angler hours expended for each census interval, by species, Priest Lake, Idaho, 1987.

Census interval	Lake trout	Cutthroat	Kokanee	Total
May 9 - May 22	5,721	49	0	5,770
May 23 - June 5	7,875	146	0	8,021
June 6 - June 19	3,131	0	0	3,131
June 20 - July 3	9,474	531	0	10,005
July 4 - July 17	768	177	31	976
Total	26,969	903	31	27,903

Appendix C. Estimated angler hours expended for each census interval, by species, Section 1, Priest Lake, Idaho, 1987.

Census interval	Lake trout	Cutthroat	Kokanee	Total
May 9 - May 22	1,135	9	0	1,144
May 23 - June 5	0	0	0	0
June 6 - June 19	465	0	0	465
June 20 - July 3	1,049	191	0	1,240
July 4 - July 17	298	167	0	465
Total	2,947	367	0	3,314

Appendix D. Estimated angler hours expended for each census interval, by species, Section 2, Priest Lake, Idaho, 1987.

Census interval	Lake trout	Cutthroat	Kokanee	Total
May 9 - May 22	1,461	9	0	1,470
May 23 - June 5	4,518	0	0	4,518
June 6 - June 19	1,891	0	0	1,891
June 20 - July 3	2,790	0	0	2,790
July 4 - July 17	0	0	0	0
Total	10,660	9	0	10,669

Appendix E. Estimated angler hours expended for each census interval, by species, Section 3, Priest Lake, Idaho, 1987.

Census interval	Lake trout	Cutthroat	Kokanee	Total
May 9 - May 22	750	0	0	750
May 23 - June 5	1,652	146	0	1,798
June 5 - June 19	775	0	0	775
June 20 - July 3	310	0	0	310
July 4 - July 17	0	0	0	0
Total	3,487	146	0	3,633

Appendix F. Estimated angler hours expended for each census interval, by species, Section 4, Priest Lake, Idaho, 1987.

Census interval	Lake trout	Cutthroat	Kokanee	Total
May 9 - May 22	2,375	31	0	2,406
May 23 - June 5	1,705	0	0	1,705
June 6 - June 19	0	0	0	0
June 20 - July 3	5,325	340	0	5,665
July 4 - July 17	470	10	31	511
Total	9,875	381	31	10,287

Appendix G. Estimated catch (C) and harvest (H) by species for each census interval for Priest Lake, Idaho, 1987.

Census interval		Lake trout	Cutthroat	Kokanee	Total
May 9 - May 22	C	826	11	0	837
	H	763	0	0	763
May 23 - June 5	C	883	0	0	883
	H	529	0	0	529
June 6 - June 19	C	243	0	0	243
	H	182	0	0	182
June 20 - July 3	C	894	0	0	894
	H	611	0	0	611
July 4 - July 17	C	123	0	0	123
	H	33	0	0	33
Totals	C	2,969	11	0	2,980
	H	2,118	0	0	2,118

Appendix H. Estimated catch (C) and harvest (H) by species for each census interval, Section 1, Priest Lake, Idaho, 1987.

Census interval		Lake trout	Cutthroat	Kokanee	Total
May 9 - May 22	C	55	0	0	55
	H	55	0	0	55
May 23 - June 5	C	0	0	0	0
	H	0	0	0	0
June 6 - June 19	C	0	0	0	0
	H	0	0	0	0
June 20 - July 3	C	283	0	0	283
	H	0	0	0	0
July 4 - July 17	C	74	0	0	74
	H	0	0	0	0
Totals	C	412	0	0	412
	H	55	0	0	55

Appendix I. Estimated catch (C) and harvest (H) by species for each census interval, Section 2, Priest Lake, Idaho, 1987.

Census interval		Lake trout	Cutthroat	Kokanee	Total
May 9 - May 22	C	102	11	0	113
	H	90	0	0	90
May 23 - June 5	C	538	0	0	538
	H	340	0	0	340
June 6 - June 19	C	195	0	0	195
	H	134	0	0	134
June 20 - July 3	C	195	0	0	195
	H	195	0	0	195
July 4 - July 17	C	0	0	0	0
	H	0	0	0	0
Totals	C	1,030	11	0	1,041
	H	759	0	0	759

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Appendix J. Estimated catch (C) and harvest (H) by species for each census interval, Section 3, Priest Lake, Idaho, 1987.

Census interval		Lake trout	Cutthroat	Kokanee	Total
May 9 - May 22	C	141	0	0	141
	H	141	0	0	141
May 23 - June 5	C	115	0	0	115
	H	97	0	0	97
June 6 - June 19	C	48	0	0	48
	H	48	0	0	48
June 20 - July 3	C	0	0	0	0
	H	0	0	0	0
July 4 - July 17	C	0	0	0	0
	H	0	0	0	0
Totals	C	304	0	0	304
	H	286	0	0	286

Appendix K. Estimated catch (C) and harvest (H) by species for each census interval, Section 4, Priest Lake, Idaho, 1987.

Census interval		Lake trout	Cutthroat	Kokanee	Total
May 9 - May 22	C	528	0	0	528
	H	477	0	0	477
May 23 - June 5	C	230	0	0	230
	H	92	0	0	92
June 6 - June 19	C	0	0	0	0
	H	0	0	0	0
June 20 - July 3	C	416	0	0	416
	H	416	0	0	416
July 4 - July 17	C	49	0	0	49
	H	33	0	0	33
Totals	C	1,223	0	0	1,223
	H	1,018	0	0	1,018

Appendix L. Interview catch rates (C) and harvest rates (H) (hours/fish) for anglers specifically seeking lake trout, cutthroat trout and kokanee, by census interval, for all sections, Priest Lake, Idaho, 1987.

Census interval	Lake trout		Cutthroat		Kokanee	
	(C)	(H)	(C)	(H)	(C)	(H)
May 9 - May 22	7.9	8.7	2.0	0.0	0.0	0.0
May 23 - June 5	9.4	14.9	0.0	0.0	0.0	0.0
June 6 - June 19	10.3	14.7	0.0	0.0	0.0	0.0
June 20 - July 3	12.1	14.7	0.0	0.0	0.0	0.0
July 4 - July 17	8.1	16.3	0.0	0.0	0.0	0.0
Average (weighted)	9.2	11.8	11.7	0.0	0.0	0.0

Appendix M. Interview catch rates (C) and harvest rates (H) (hours/fish) for anglers specifically seeking lake trout, cutthroat trout and kokanee, by census interval, for Section 1, Priest Lake, Idaho, 1987.

Census interval	Lake trout		Cutthroat		Kokanee	
	(C)	(H)	(C)	(H)	(C)	(H)
May 9 - May 22	20.5	20.5	0.0	0.0	0.0	0.0
May 23 - June 5	0.0	0.0	0.0	0.0	0.0	0.0
June 6 - June 19	0.0	0.0	0.0	0.0	0.0	0.0
June 20 - July 3	3.7	0.0	0.0	0.0	0.0	0.0
July 4 - July 17	4.0	0.0	0.0	0.0	0.0	0.0
Average (weighted)	11.4	30.5	0.0	0.0	0.0	0.0

Appendix N. Interview catch rates (C) and harvest rates (H) (hours/fish) for anglers specifically seeking lake trout, cutthroat trout and kokanee, by census interval, for Section 2, Priest Lake, Idaho, 1987.

Census interval	Lake trout		Cutthroat		Kokanee	
	(C)	(H)	(C)	(H)	(C)	(H)
May 9 - May 22	14.3	16.3	0.8	0.0	0.0	0.0
May 23 - June 5	8.4	13.3	0.0	0.0	0.0	0.0
June 6 - June 19	9.7	14.1	0.0	0.0	0.0	0.0
June 20 - July 3	14.3	14.3	0.0	0.0	0.0	0.0
July 4 - July 17	0.0	0.0	0.0	0.0	0.0	0.0
Average (weighted)	10.9	14.5	0.8	0.0	0.0	0.0

Appendix O. Interview catch rates (C) and harvest rates (H) (hours/fish) for anglers specifically seeking lake trout, cutthroat trout and kokanee, by census interval, for Section 3, Priest Lake, Idaho, 1987.

Census interval	Lake trout		Cutthroat		Kokanee	
	(C)	(H)	(C)	(H)	(C)	(H)
May 9 - May 22	5.3	5.3	0.0	0.0	0.0	0.0
May 23 - June 5	14.3	17.1	0.0	0.0	0.0	0.0
June 6 - June 19	16.0	16.0	0.0	0.0	0.0	0.0
June 20 - July 3	0.0	0.0	0.0	0.0	0.0	0.0
July 4 - July 17	9.5	14.3	0.0	0.0	0.0	0.0
Average (weighted)	9.7	11.4	0.0	0.0	0.0	0.0

Appendix P. Interview catch rates (C) and harvest rates (H) (hours/fish) for anglers specifically seeking lake trout, cutthroat trout and kokanee, by census interval, for Section 4, Priest Lake, Idaho, 1987.

Census interval	Lake trout (C)	Lake trout (H)	Cutthroat (C)	Cutthroat (H)	Kokanee (C)	Kokanee (H)
May 9 - May 22	4.5	5.0	0.0	0.0	0.0	0.0
May 23 - June 5	7.4	18.5	0.0	0.0	0.0	0.0
June 6 - June 19	0.0	0.0	0.0	0.0	0.0	0.0
June 20 - July 3	12.8	12.8	0.0	0.0	0.0	0.0
July 4 - July 17	9.5	14.3	0.0	0.0	0.0	0.0
Average (weighted)	6.4	7.6	0.0	0.0	0.0	0.0

Appendix Q. Total length (mm) at age and length-weight relationships (g and mm) used to model the lake trout population of Priest Lake, Idaho, with three levels of growth.

L-W	Limited growth $W=0.000149L^{2.57}$	Moderate growth $W=0.0000105L^{2.98}$	Good growth $W=0.00000105L^{3.18}$
Age 1	89	89	89
2	178	178	178
3	276	276	276
4	387	387	387
5	464	464	464
6	538	538	538
7	594	638	688
8	637	704	771
9	682	763	845
10	727	815	910
11	761	861	968
12	794	899	1,016
13	826	926	1,050
14	857	949	1,079
15	886	968	1,103

Appendix R. Recommended stocking sites for cutthroat trout fry in tributaries of Priest Lake, Idaho.

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1 & 2. If 2 million cutthroat trout fry or more, first stock fry in the Granite Creek drainage then other tributaries of the lower Priest Lake:

Creek	5 fry/M2	10 fry/M2
Granite Creek drainage:		
Cache Creek	74,355	148,710
Packer Creek	102,701	205,403
Zero Creek	277,955	555,910
N.F. Granite Creek	428,739	857,478
Blacktail Creek	117,857	235,713
S.F. Granite Creek	735,305	1,470,609
Fedar Creek	52,807	105,614
Tillicum Creek	154,4581	309,162
Sema Creek	215,548	431,095
Athol Creek	9,647	19,293
	2,169,495	3,838,987
If additional fry are available:		
Indian Creek	674,100	1,348,200
Two Mouth Creek	858,900	1,717,800
Lion Creek	958,400	1,916,800
	2,491,400	4,982,800
Totals	4,660,895	8,821,781

Refer to Table 24 for additional creeks to be stocked.

Unless cutthroat trout densities in the tributaries of the Upper Priest Lake decline appreciably, I would not recommend any fry stocking in those waters.

3. Which creeks should brook trout be removed from--prioritized?

Granite Creek drainage:
- a. Blacktail Creek
- b. Tillicum and N.F. Tillicum creeks
- c. Sema Creek
- d. Athol Creek

Others:
- e. Soldier Creek
- f. Reeder Creek
- g. Caribou Creek

4. Stocking rate: 5 fry/M2 to 10 fry/M2
Total number for both lakes: 17,654,685 to 35,309,370
Access to stocking sites: Refer to "Idaho Panhandle National Forest Map" and attachment.

Appendix R, continued.

<u>Where to access creeks for stocking</u>:

Cache Creek
- Culvert near creek mouth
- Four primitive roads off Forest Service (FS) 1104
- Culvert at the end of FS 1104, need motorcycle

Packer Creek
- FS 302 near mouth
- FS 1376 to first right, follow to the end and hike approximately 500 feet through woods to creek
- FS 1373 culvert, dry creek-bed during summer, hike approximately 0.5 miles down channel
- FS 1373 pass clearcut to culvert

Zero Creek
- FS 302 near mouth
- Culvert under FS 1376
- Old FS 1376, parallels FS 1376 to the east and stream corridor to the west, need motorcycle
  - --old log bridge
  - --old road ends at trail marker, hike east from sign
  - --gradient zone #3, pool #10--last pool in study section

North Fork Granite Creek
- FS 302--stock from road or hike short distances

Blacktail Creek
- Road-bridge near mouth at intersection of FS 1341/638
- Mouth of Jost Creek--hike down steep hill--flagged on FS 638
- At the end of FS 638, hike down hill trout clearcut
- FS 1341 hike down steep hill approximately 0.5 miles to the source of creek

South Fork Granite Creek--FS 311 and FS 319
Fedar Creek--FS 1340
Tillicum Creek--FS 1104 motorcycle needed
Sema Creek--FS hike in and motorcycle
Athol Creek--FS 1362

<u>East lake tributaries</u>

Indian Creek--good access from Indian Creek Road
Two Mouth Creek--good access from Two Mouth Road
Lion Creek--good access from Lion Creek Road

Appendix S. Estimated numbers and percentages of cutthroat, brook, and bull trout present in streams, stream areas, and number of cutthroat trout fry required to stock below barriers, and entire stream lengths, for Priest Lake drainage (Irving 1987).

Drainage	Estimated trout populations						Area	Cutthroat stocking levels			
	Cutthroat		Brook		Bull			Below barriers		Entire stream	
Stream	No.	%	No.	%	No.	%	m^2	5 fry/m^2	10/fry/m^2	5 fry/m^2	10 fry/m^2
UP PRIEST R	21,068	74.4	517	1.8	6,721	23.7	509,415	2,547,076	5,094,151	3,428,155	6,856,310
Up Priest	763	81.6	0	0	172	18.4	397,614	1,988,068	3,976,135	1,988,068	3,976,135
Malcom Ck	123	73.2	0	0	45	26.8	2,382	11,908	23,816	149,002	298,005
Rock Ck	587	94.2	0	0	36	5.8	2,785	13,927	27,854	76,599	153,197
Lime Ck	3,009	93.0	8	0.3	220	6.8	19,731	98,655	197,309	98,655	197,309
Cedar Ck	374	100.0	0	0	0	0	5,023	25,155	50,229	137,045	274,090
Ruby Ck	2,418	98.0	49	2.0	0	0	9,374	46,868	93,735	100,132	200,265
Hughes Fk	9,691	71.4	28	0.2	3,662	28.4	19,050	95,250	190,500	95,250	190,500
Boulder Ck	767	87.2	25	2.8	88	10.0	4,383	21,914	43,827	221,442	442,885
Gold Ck	667	48.8	407	29.8	293	21.4	29,430	147,148	294,296	342,575	685,151
Muskegon Ck	1,675	98.8	0	0	0	0	7,904	39,521	79,041	39,521	79,041
Jackson Ck	813	44.9	0	0	998	55.1	8,697	43,487	86,974	113,562	227,124
Bench Ck	182	15.6	0	0	987	84.4	3,044	15,218	30,435	66,304	132,608
BEAVER CK	2,830	71.8	1,114	28.3	0	0	33,402	167,011	334,022	167,011	334,022
TANGO CK	212	100.0	0	0	0	0	1,519	7,596	15,191	41,040	82,080

Appendix S, continued.

Drainage	Estimated trout populations						Area	Cutthroat stocking levels			
	Cutthroat		Brook		Bull			Below barriers		Entire stream	
Stream	No.	%	No.	%	No.	%	m^2	5 fry/m^2	10/fry/m^2	5 fry/m^2	10 fry/m^2
GRANITE CK	6,181	36.5	9,677	57.2	1,069	6.3	496,502	2,482,507	4,965,009	3,404,184	6,808,364
Granite Ck	391	96.1	0	0	16	3.9	226,800	1,134,000	2,267,999	1,134,000	2,267,999
Fedar Ck	632	51.6	592	48.4	0	0	2,633	13,166	26,331	52,807	105,614
Blacktail Ck	228	48.8	110	23.6	129	27.6	16,634	83,168	166,335	117,857	235,713
Jost Ck	350	33.7	688	66.3	0	0	8,891	44,457	88,914	64,196	128,392
Athol Ck	40	7.0	531	93.0	0	0	1,401	7,006	14,011	9,647	19,293
Packer Ck	3	7.9	1	2.6	34	89.5	1,113	5,563	11,126	102,701	205,403
Zero Ck	1,363	93.2	99	6.8	0	0	999	4,994	9,989	277,955	555,910
N F Granite	897	38.6	600	25.8	826	35.6	85,748	428,739	857,478	428,739	857,478
Tillicum Ck	4	13.8	22	75.9	3	10.3	2,177	10,886	21,772	154,581	309,162
N F Tillicum	0	0	404	100.0	0	0	4,209	21,043	42,086	36,493	72,986
S F Granite	1,803	82.4	325	14.9	61	2.8	97,708	488,542	977,084	735,305	1,470,609
Sema Ck	428	7.4	5,393	92.7	0	0	43,110	215,548	431,095	215,548	431,095
Cache Ck	41	4.3	912	95.7	0	0	5,079	25,395	50,789	74,355	148,710
KALISPELL CK	3,974	41.3	5,475	56.9	167	1.7	132,712	663,559	1,327,117	680,235	1,360,468
Kalispell Ck	2,272	38.7	3,425	58.4	167	2.9	108,782	543,909	1,087,818	543,909	1,087,818
Bath Ck	37	9.7	344	90.3	0	0	14,174	70,870	141,740	69,849	139,699
Hungry Ck	577	29.3	1,392	70.7	0	0	3,864	19,322	38,643	19,322	38,643
No Name Ck	91	34.1	176	65.9	0	0	1,495	7,477	14,953	7,477	14,953
Mush Ck	0	0	13	100.0	0	0	116	580	1,160	7,540	15,080
Pable Ck	14	51.9	13	48.2	0	0	164	821	1,642	11,557	23,114
Rapids Ck	507	100.0	0	0	0	0	2,343	11,717	23,434	11,717	23,434
Virgin Ck	476	80.8	113	19.2	0	0	1,773	8,864	17,727	8,864	17,717
WEST SIDE	34,264	58.1	16,782	28.4	7,957	13.5	1,173,550	5,867,749	11,735,490	7,720,625	15,441,244
PRIEST LAKE	61,160	58.1	29,956	28.4	14,203	13.5	2,172,392	10,861,959	21,723,918	16,370,249	32,740,491

Appendix T. Back-calculated total length at (lake) age and annual increments of growth (mm) for cutthroat trout in Priest and Coeur d'Alene lakes (calculated from Bjornn 1957; Lukens 1978; Mauser 1986a).

Years of lake residence	Coeur d'Alene 1975-1976	Priest 1955-1956	Priest 1984
0	131	164	158
	(88)	(109)	(159)
1	219	273	317
	(71)	(56)	(53)
2	290	329	370
	(40)	(38)	(39)
3	330	367	409
	(34)		(22)
4	364	--	431

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