Angler Surveys on Lake Billy Chinook, Oregon, 1990-1993

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ABSTRACT

Anglers on Lake Billy Chinook, in central Oregon, were surveyed to estimate angler effort and harvest of kokanee *Oncorhynchus nerka*, bull trout *Salvelinus confluentus* and smallmouth bass *Micropterus dolomieui* during segments of a four-year period, 1990-1993. Anglers were surveyed from March through October during 1990 and 1991, from May through October in 1992, and during March and April in 1993. An estimated 27,000 to 30,000 anglers fished 130,000 to 150,000 angler hours/year. Most of the effort was expended by boat anglers who fished primarily for kokanee, followed by smallmouth bass and bull trout. Kokanee anglers fished for 95,168 to 136,176 hours annually. Estimated harvest of kokanee ranged from 60,000 and 85,000 fish annually, resulting in a harvest yield of 6.9 kg/ha in 1990 and 12.9 kg/ha in 1991. Estimated angler effort directed at bull trout in March and April almost doubled from 1991 to 1993, increasing from 4,376 to 8,108 hours, respectively. The estimated harvest of bull trout increased from 863 in 1990 to 1,205 in 1992. However, the percentage of bull trout released by anglers has increased steadily. This change is attributed to reducing the creel limit to one bull trout per day and a greatly increased awareness by anglers to the trophy potential of bull trout and the conservation problems facing bull trout in the Pacific Northwest. Smallmouth bass anglers fished from 5,086 to 13,761 hours annually, comprising 14% of the effort in 1990. An estimated 2,070 to 4,189 smallmouth bass were harvested annually. However, a far greater number of smallmouth bass were released by anglers, ranging from 2,532 to 17,290 fish annually.

INTRODUCTION

Lake Billy Chinook is a very popular spring and summer recreation area, and is the most heavily used lake or reservoir for boating recreation in the state (Oregon State Marine Board 1993). The Cove Palisades State Park, one of the highest use state parks in Oregon, and a U.S. Forest Service Campground, Perry South, are located on the Crooked River and Metolius River arms, respectively. Lake Billy Chinook is a popular reservoir with anglers pursuing relatively abundant naturally occurring populations of kokanee *Oncorhynchus nerka*, smallmouth bass *Micropterus dolomieui*, and bull trout *Salvelinus confluentus*. Due to an increasing concern regarding the status of bull trout populations in Oregon, a series of creel surveys was initiated on Lake Billy Chinook to monitor the harvest of bull trout. The objectives of these surveys were (1) to estimate the number of bull trout harvested from Lake Billy Chinook and harvest trends in anticipation of a petition for a federal Endangered Species Act status review of this species; (2) to describe the major recreational fisheries on Lake Billy Chinook including harvest numbers and effort over time; and (3) to help educate anglers to the conservation problems and trophy potential for bull trout.

STUDY AREA

Lake Billy Chinook was created in 1964 by the construction of Round Butte Dam on the Deschutes River, approximately 176 kilometers upstream from the Columbia River. The dam is part of the Pelton Hydroelectric Project operated by Portland General Electric Company. The reservoir has a surface area of 1,619 hectares and extends 19, 13 and 10 km up the Metolius, Deschutes and Crooked River canyons, respectively (Figure 1). Lake Billy Chinook has a maximum depth of 127 meters. Over 60% of the reservoir has a depth greater than 30 m (Mullarkey 1967). Total shoreline of the reservoir is approximately 100 km. Much of the shoreline is basalt cliffs and steep talus slopes. The reservoir usually becomes thermally stratified during May each year, with the thermocline near a depth of 5 m, and becomes homothermal again in late September or early October. The Federal Energy Regulatory Commission (FERC) operating

license for the Pelton Hydroelectric Project requires that Lake Billy Chinook be operated within 0.3 m of full pool from June 1 through the Labor Day weekend.

Bank access to the reservoir is limited due to the steep shoreline topography. Boat access includes six ramps and two marinas (Figure 1). Boat ramps are located in the Crooked River Arm at the Cove Palisades State Park (Crooked River Boat Ramp) and at a privately operated marina that is leased from the state park. Two additional state park boat ramps are located in the Deschutes River arm (Upper and Lower Deschutes River Boat Ramps). The only public ramp on the Metolius River arm is at Perry South Campground, while another ramp is available at a private recreation area. This recreation area includes a houseboat rental operation.

Kokanee and bull trout spawn in the Metolius River system (Ratliff 1992). Kokanee also spawn to a lesser extent in the Crooked River upstream to the dam at Opal Springs and in the Deschutes River upstream to Steelhead Falls. Smallmouth bass spawn along the shallower margins of the reservoir. Kokanee are abundant and are generally harvested at ages 2+ or 3+ (200-400 mm). Lake Billy Chinook, Lake Simtustus, and the Deschutes River just upstream of Lake Billy Chinook are currently the only place in Oregon where bull trout harvest is permitted. The state record bull trout, which exceeded 10 kg, was harvested from Lake Billy Chinook in 1989. Bull trout exceeding 2 kg are relatively common. Most of the bull trout effort and harvest occurs in the Metolius River arm. Smallmouth bass are generally small, less than 300 mm, but abundant (Shrader 1992).

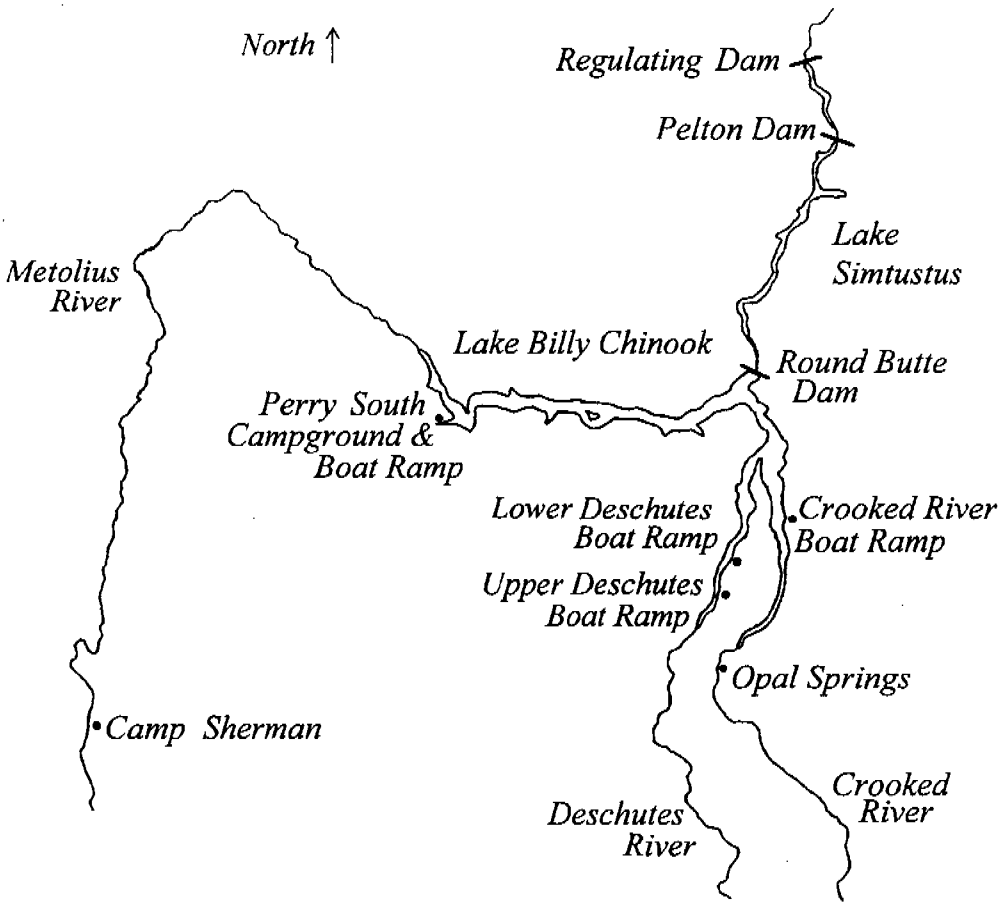

Figure 2. Lake Billy Chinook in central Oregon.

The Crooked River and Deschutes River arms are open to angling year around, whereas the Metolius River Arm is open from March 1 through October 31. The trout daily limit was five per day until 1992, when it changed to five per day of which only one could be a bull trout. The kokanee daily limit is 25 per day, while five smallmouth bass can be harvested daily.

Other game fish present in the reservoir include rainbow trout *O. mykiss*, brown trout *Salmo trutta*, Atlantic salmon *S. Salar*, landlocked chinook salmon *O. tshawytscha*, mountain whitefish *Prosopium williamsoni*, black crappie *Pomoxis nigromaculatus*, bluegill *Lepomis macrochirus*, and largemouth bass *M. salmoides*. No hatchery fish are stocked in the reservoir. However, approximately 5,000 fin clipped hatchery (> 150 mm) rainbow trout are released annually in the Crooked River at Opal Springs (km 11), just above Lake Billy Chinook, and 17,500 fin clipped hatchery rainbow are released in the Metolius River below Camp Sherman (km 39). Some of these fish migrate downstream and enter the reservoir fishery.

METHODS

We interviewed and counted anglers to estimate catch, effort, and catch rate in Lake Billy Chinook, and to spend time educating anglers. The surveys were conducted from March through October in 1990-1992 and during March and April in 1993. Sampling was randomized within two levels of temporal stratification--month and day type (weekdays and weekends/holidays). Two randomly selected weekend or holiday days and two randomly selected weekdays were sampled each week. The creel surveyor was on the lake approximately eight hours on each sampled day. The surveyor was randomly assigned either a morning shift, beginning on the lake at 7 a.m. - 9 a.m. or an afternoon shift ending at sunset. During any shift, the surveyor was assigned a route to travel to ensure random sampling of the study area.

Angler Interviews

Anglers were interviewed at the completion of their fishing trip or as they were encountered on the lake. Angling trips were classified as boat, houseboat, or bank. The creel surveyor asked a representative from each party a standard set of interview questions about the number of anglers, hours fished, area fished, target species, catch (kept and released) of each species, and any fin clips observed. Lengths of a random subset of kept fish were measured. In March of 1990, anglers were not asked which species they were fishing for, and lengths were recorded in 50-mm increments. In 1990, the creel surveyor was assigned structured travel routes to ensure sampling of the entire lake. To increase the number of angling parties interviewed and because greater interest was placed on the bull trout fishery, the creel routes after 1990 were less structured. Each sampling day was assigned a general activity, and the creel surveyor determined areas and anglers to interview. Within each day, the creel surveyor interviewed bull trout anglers whenever possible and attempted to interview anglers at locations in rough proportion to their occurrence. During 1993, anglers were interviewed only at Cove Palisades State Park boat ramps and Perry South Campground as they completed their fishing trips. Differences in sampling methods between years were accommodated in the data analysis.

Angler Counts

Counts of fishing boats, bank anglers and vehicles with boat hauling devices were made at approximately 3-4 hour intervals on scheduled survey days. The state campground facilities on the

upper and lower Deschutes River arms were not checked for vehicle/trailer combinations, but often boat trailers were parked there, away from the reservoir. The creel surveyor traversed the lake by boat counting fishing boats and bank anglers (angling pressure). Creel surveyors visually determined if a boat was fishing or pursuing other recreation such as waterskiing or cruising. During some pressure counts, boats and bank anglers were counted only on the Metolius arm. Linear regression was used to estimate the total lakewide angling pressure from pressure counts on the Metolius arm. During 1993, the number of angling parties (angling pressure) was estimated using only counts of vehicles with trailers at the Cove Palisades State Park boat ramps and Perry South Campground.

Analyses

Data were stratified by month, day type, and whether the party fished from the bank or a boat, for analysis. Length frequency distributions were computed for each species for each month using 10-mm intervals (e.g., 1-10, 11-20). Due to the low number of smallmouth bass observed in the survey, length frequency distributions were computed annually.

Catch per angler hour (catch rate) for a species, kept or released, was estimated within each stratum as the sum of angler catch divided by the sum of angler hours fished. Catch from both complete and incomplete angler trips was calculated using:

$$C / f_k = \sum_{i=1}^{n} \sum_{j=1}^{m} C_{ijk} / \sum_{i=1}^{n} \sum_{j=1}^{m} H_{ij}$$

where

C/f_k = catch per angler hour (catch rate) of species k,

C_{ijk} = catch of species k by angling party j on day i (i = 1,2,3,...,n) (j = 1,2,3,...,m), and

H_{ij} = hours fished by angler j on day i.

To estimate hours of angler effort, the day was divided into three time periods (prior to 11 a.m., 11 a.m.-4 p.m., and after 4 p.m.) and the average daily boat and bank pressure for each time interval for each stratum was calculated. The time intervals were adjusted slightly throughout the season to accommodate changing day lengths. Average daily angler hours of effort for a stratum were estimated by calculating the area under the curve (AUC) formed by the figure with time on the horizontal axis and angling pressure counts on the vertical axis. Angling pressure was assumed to be zero at the legal start (Time 1) and end (Time 5) of the fishing day.

$$AUC = 1/2 \sum_{h=1}^{5} (T_h - T_{h-1})(E_h + E_{h+1})$$

where

T_h = average time of day of count h during stratum h = 1,2,3,4,5, and

E_h = average stratum count of boats, bank anglers, vehicles at count h.

Total stratum pressure was estimated by multiplying the estimated average daily pressure by the number of days in the time strata.

Average party size was estimated for each time strata for boat anglers. Total boat hours of effort was multiplied by the average party size to estimate total boat angler hours of effort. We estimated catch of kept and released fish of each species, k, as the product of angler hours of effort and catch per angler hour for each stratum.

$TC_k = AUC * C/f_k$

where

TC_k = total catch of species k.

Total number of angler trips was estimated by dividing total estimated hours of effort by the average angler trip. Average length of an angler trip was estimated from completed angler trips for each time stratum. If less than five completed trips were sampled in a time stratum, time strata were successively pooled until at least five completed trips were sampled.

Angler effort and catch were generally estimated using the approach described above, but each year had some unique characteristics as follows.

1990

To reduce the time required for pressure counts, the pressure counts that traversed the lake were conducted on approximately one-third of the sampled days. On the remaining days, pressure counts were made only in the Metolius River arm. Lakewide pressure on the days with reduced sampling was estimated using a regression of pressure counts of the whole lake on pressure in the Metolius River Arm for boat and bank anglers (r^2 =0.83, 0.80, respectively). The average daily angler hours for each stratum was calculated using both actual and estimated counts. Lakewide catch rates were estimated for each month, day type, and angler type.

1991 and 1992

As a result of increased interest in the bull trout fishery, we directed sampling effort toward intercepting bull trout anglers. Separate angling pressure counts and average daily angler hours estimates were made for each arm of the lake with most pressure counts on the Metolius River arm and less frequent and abbreviated pressure counts on the Deschutes River and Crooked River arms. Subjective estimates of the percentages of lakewide anglers targeting bull trout as opposed to other species were made for each month to account for the lack of survey data on the Deschutes River and Crooked River arms (Table 1). Total angling pressure was apportioned into the two groups for each month and area of the lake.

Each angling party interviewed was identified according to two characteristics: (1) primary arm of the lake where fishing occurred, and (2) those that targeted bull trout and those that did not target bull trout. We calculated catch per angler hour (catch rate) of each species for each time strata, primary arm, and primary target species. These catch rates were multiplied by the estimated total effort for the respective strata to estimate total catch.

Table 1. Estimated percentages of anglers targeting bull trout relative to other species on Lake Billy Chinook, 1991-1992.

Month	Percentage Targeting Bull Trout
March	90%
April	40%
May	30%
June	10%
July	2%
August	2%
September	5%
October	10%

During the course of the creel surveys, it became clear that the shape and size of Lake Billy Chinook greatly increased the complexity of estimating effort and harvest. Two additional sources of bias were introduced into this survey that created problems with estimating bull trout harvest. The first source of bias occurred when we focused on the Metolius River arm starting in 1991. Because the other two arms were less intensively surveyed, the results underestimated angler use and harvest for those areas. The second potential source of error is that the 1992 survey did not start until May 1. Therefore a large portion of the bull trout harvest was likely missed, underestimating harvest that year by as much as 40%.

1993

Anglers were surveyed during March and April only. Angling pressure was estimated by counting vehicles with trailers at the Crooked River boat ramp, the Upper and Lower Deschutes River boat ramps, and the Perry South Campground boat ramp. An AUC was calculated as described above. Anglers were interviewed at the completion of their trips at either the Crooked River or Perry South boat ramps.

Angler Education

We used the creel survey interviews as an opportunity to educate anglers about the low abundance of bull trout and the need for the population to increase to maintain a fishery. Creel surveyors often discussed the status of bull trout with anglers. Informational pamphlets were handed out that discussed the status and harvest of bull trout. Bull trout anglers were also asked to comment on proposed angling regulations, including a reduction in the bull trout daily limit.

Kokanee Harvested Yield (kg/ha)

The large data base generated for kokanee allowed us to estimate kokanee harvested yield (kg/ha). We used unpublished data of Lake Billy Chinook kokanee lengths and weight captured in

April with a variable mesh gill net to calculate separate length-weight relationships for 1990 and 1991. Using the length-weight relationships, a weight was computed for the midpoint of each length interval in the length frequency distributions and multiplied by the estimated number of fish harvested in that interval. Interval weights were summed to calculate a total monthly weight. Monthly weights were summed to calculate the total estimated weight of harvested fish. Yield was calculated by dividing the total weight by the lake surface area (1,619 ha).

RESULTS AND DISCUSSION

General Trends

The greatest amount of fishing effort was expended by boat anglers. The houseboat and bank angler effort (and harvest) accounted for less than 5% of the pressure and were frequently zero. Therefore, this report will focus on analyzing trends in boat angler effort and harvest.

Total boat angler effort during the survey period ranged between 130,000 and at least 150,000 hours during 1990 to 1992 (Table 2). The number of angler trips was fairly constant between 27,000 and 30,000 trips annually. Effort peaked in July all three years, but in 1992, effort remained high through August and September. The greatest angling effort was directed at kokanee (Figure 2). However, both bull trout and smallmouth bass angling were also popular on the reservoir. Bull trout angling effort peaked in March, although many anglers were also fishing for kokanee. Starting in late April, kokanee anglers began to dominate the effort, with smallmouth bass anglers also contributing to the effort (Tables 3 - 6). Peak effort usually occurs in the mid to late summer by kokanee anglers.

Table 2. Estimated number of boat anglers and angler hours at Lake Billy Chinook, 1990-1993. All angler types and areas combined.

	1990		1991		1992		1993	
	Anglers	Hours	Anglers	Hours	Anglers	Hours	Anglers	Hours
March	1,156	5,836	1,545	8,084	---	---	1,978	10,162
April	3,099	16,801	1,986	9,888	---	---	3,983	18,469
May	5,729	24,296	4,700	23,002	5,412	29,294	---	---
June	2,946	14,139	5,386	26,667	5,992	33,612	---	---
July	6,881	31,710	6,553	32,272	6,533	31,475	---	---
August	2,983	15,312	3,876	16,473	4,222	21,039	---	---
September	3,192	15,958	3,474	11,028	5,472	25,484	---	---
October	1,794	8,448	2,625	7,323	1,359	6,648	---	---
Total	27,780	132,500	30,145	134,737	28,990	147,552	5,961	28,631

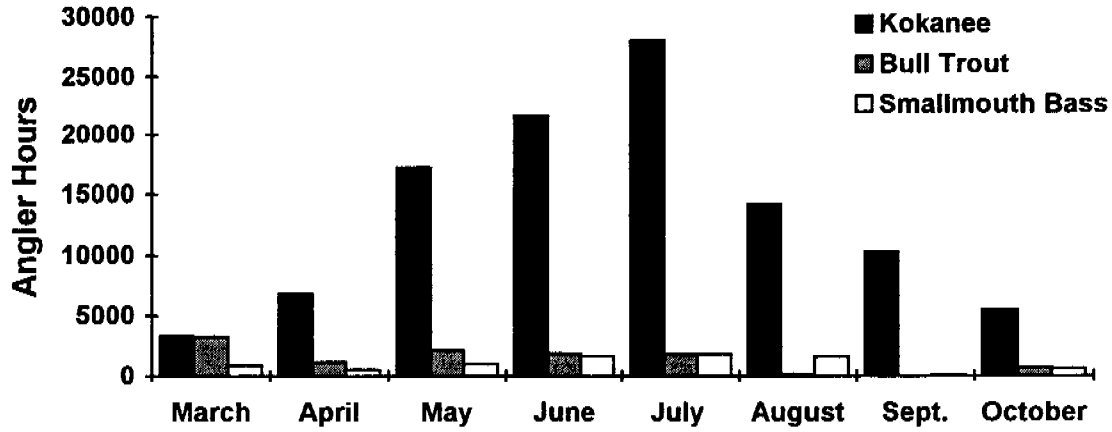

Figure 2. Distribution of estimated angler hours by species for anglers at Lake Billy Chinook in 1991.

Table 3. Estimated angler hours and the percent of the monthly effort by species for Lake Billy Chinook, 1990.

	Kokanee		Bull trout		Smallmouth bass		Other/any	
	Percent	Number	Percent	Number	Percent	Number	Percent	Number
April	42.2	7,090	18.4	3,091	29.2	4,906	10.3	1,731
May	72.4	17,590	3.0	729	8.5	2,065	16.1	3,912
June	74.1	10,477	2.0	283	10.8	1,527	13.2	1,866
July	78.8	24,987	2.4	761	10.0	3,171	8.8	2,790
August	84.7	12,969	0.0	0	6.5	995	8.7	1,332
September	85.9	13,708	0.6	96	10.5	1,676	3.0	479
October	97.0	8,195	1.5	127	0.7	59	0.9	76
Total		95,016		5,087		14,399		12,186

Table 4. Estimated angler hours and the percent of the monthly effort by species for Lake Billy Chinook, 1991.

	Kokanee		Bull trout		Smallmouth bass		Other/any	
	Percent	Number	Percent	Number	Percent	Number	Percent	Number
March	40.8	3,298	39.7	3,209	10.9	881	8.7	703
April	69.4	6,862	11.8	1,167	5.2	514	13.6	1,345
May	75.6	17,390	8.9	2,047	4.3	989	11.2	2,576
June	81.3	21,680	6.9	1,840	6.2	1,653	5.5	1,467
July	86.8	28,012	5.5	1,775	5.6	1,807	2.1	678
August	86.1	14,183	0.7	115	9.4	1,548	3.8	626
September	93.3	10,289	0	0	0.6	66	6.1	673
October	75.0	5,492	10.2	747	8.6	630	6.3	461
Total		107,206		10,900		8,088		8,529

Table 5. Estimated angler hours and the percent of the monthly effort by species for Lake Billy Chinook, 1992.

	Kokanee		Bull trout		Smallmouth bass		Other/any	
	Percent	Number	Percent	Number	Percent	Number	Percent	Number
May	93.7	27,448	2.2	644	3.6	1,055	0.5	146
June	94.3	31,696	1.3	437	2.2	739	2.2	739
July	91.8	28,894	3.9	1,228	0	0	4.3	1,353
August	97.5	20,513	1.0	210	1.5	316	0	0
September	84.8	21,610	4.0	1,019	11.2	2,854	0	0
October	92.2	6,129	4.6	306	1.9	126	1.3	86
Total		136,290		3,844		5,090		2,324

Table 6. Estimated angler hours and the percent of the monthly effort by species for Lake Billy Chinook, 1993.

	Kokanee		Bull trout		Smallmouth bass		Other/any	
	Percent	Number	Percent	Number	Percent	Number	Percent	Number
March	28.2	2,866	54.7	5,559	3.6	366	13.5	1,372
April	64.2	11,857	13.8	2,549	12.1	2,235	9.9	1,828
Total		14,723		8,108		2,601		3,200

Kokanee

Effort

Over 95,000 hours were spent fishing for kokanee annually. Kokanee anglers were the most abundant anglers on Lake Billy Chinook (Tables 3 - 6). From May through October, over 70% of the fishing effort was directed toward kokanee each year. Peak kokanee effort was expended in August, September, or October. A high percentage of the anglers fishing in March and April were also fishing for kokanee, even though we had speculated that bull trout anglers were the most abundant during that period.

Harvest

Between 60,000 and 85,000 kokanee were harvested annually from Lake Billy Chinook from 1990 to 1992 (Table 7). Peak kokanee harvest usually occurred in July, although June was the high month in 1992. Very few kokanee were released. We observed that kokanee congregated in large numbers near the mouth of the Metolius River during late summer and many were harvested there. The kokanee catch rate generally peaked in August and September (Table 8) and was very high during the fall of 1990, and again during the summer of 1991, when it peaked at over 1.5 fish/hour.

Table 7. Estimated catch (kept and released) of kokanee from Lake Billy Chinook, 1990-1993.

	1990		1991		1992		1993	
Month	Kept	Released	Kept	Released	Kept	Released	Kept	Released
March	158	85	2,363	88	---	---	854	157
April	380	172	2,322	23	---	---	4,330	1,361
May	2,722	382	8,872	185	10,839	0	---	---
June	10,252	129	8,903	81	13,583	175	---	---
July	15,539	86	21,760	35	12,439	183	---	---
August	8,441	0	25,947	65	12,214	360	---	---
September	14,164	40	10,652	389	10,265	1,156	---	---
October	12,132	73	3,477	6	1,796	735	---	---
Total	63,788	967	84,296	872	61,136	2,609	5,184	1,518

Table 8. Boat angler catch per angler hour (harvest) for kokanee from Lake Billy Chinook, 1990 - 1993.

	1990	1991	1992	1993
March	0.017	0.292	---	0.084
April	0.023	0.235	---	0.234
May	0.112	0.386	0.370	---
June	0.725	0.334	0.404	---
July	0.490	0.674	0.395	---
August	0.551	1.514	0.581	---
September	0.888	0.966	0.403	---
October	1.436	0.475	0.270	---

Kokanee length-at-age relationships in Lake Billy Chinook have previously been determined (ODFW, unpublished data). Based upon these relationships, it appears that few Age 3+ kokanee were available in 1993 and Age 2+ kokanee made up the majority of the catch. The majority of the kokanee harvested were less than 300 mm throughout the year (Figure 3). The strong cohort carried over to 1991, as the kokanee harvest was comprised almost entirely of Age 3+ fish, and most of the harvested kokanee exceeded 300 mm by July (Figure 4). A small proportion of Age 2+ fish then began to enter the fishery as the older age class left the reservoir to spawn. Few Age 3+ fish were available again in 1992, and a strong Age 2+ cohort comprised the majority of the harvest (Figure 5). Most of the Age 3+ kokanee exceeded 300 mm by June, but a large portion of the kokanee harvest were Age 2+. Two age classes were available for kokanee fishermen early in 1993 (Figure 6).

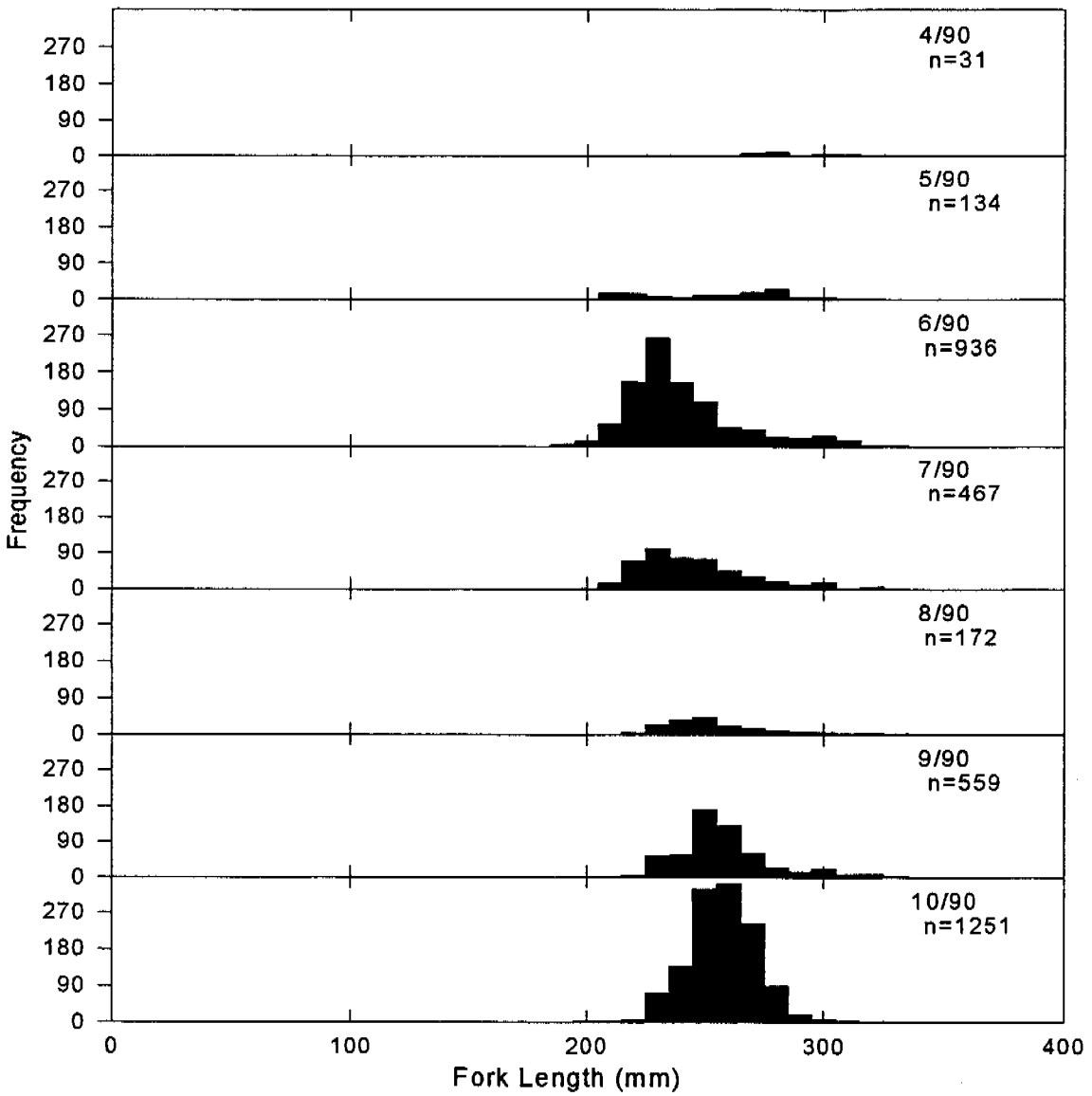

Figure 3. Length frequency distributions of kokanee harvested from Lake Billy Chinook, Oregon, during 1990.

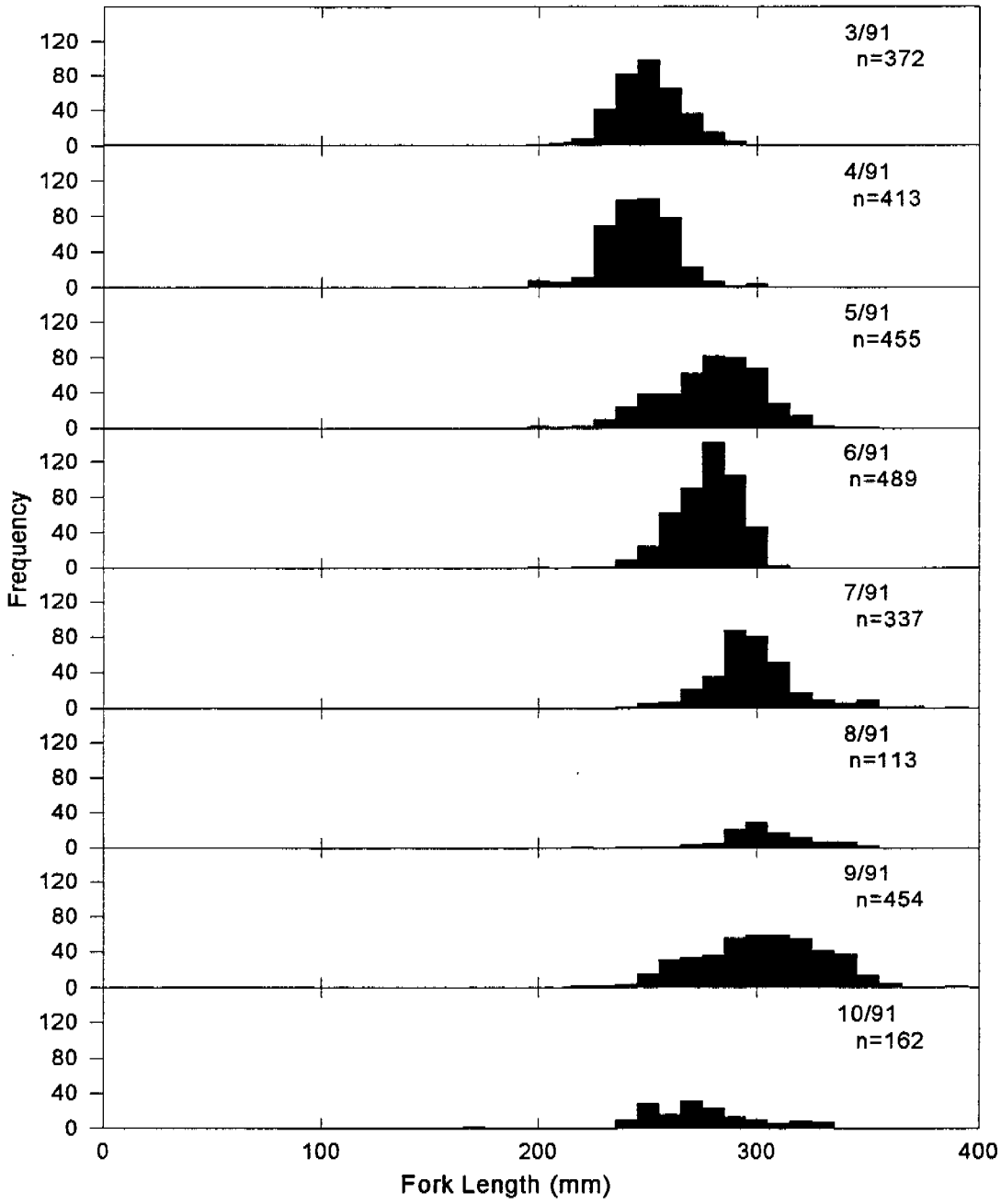

Figure 4. Length frequency distributions of kokanee harvested from Lake Billy Chinook, Oregon, during 1991.

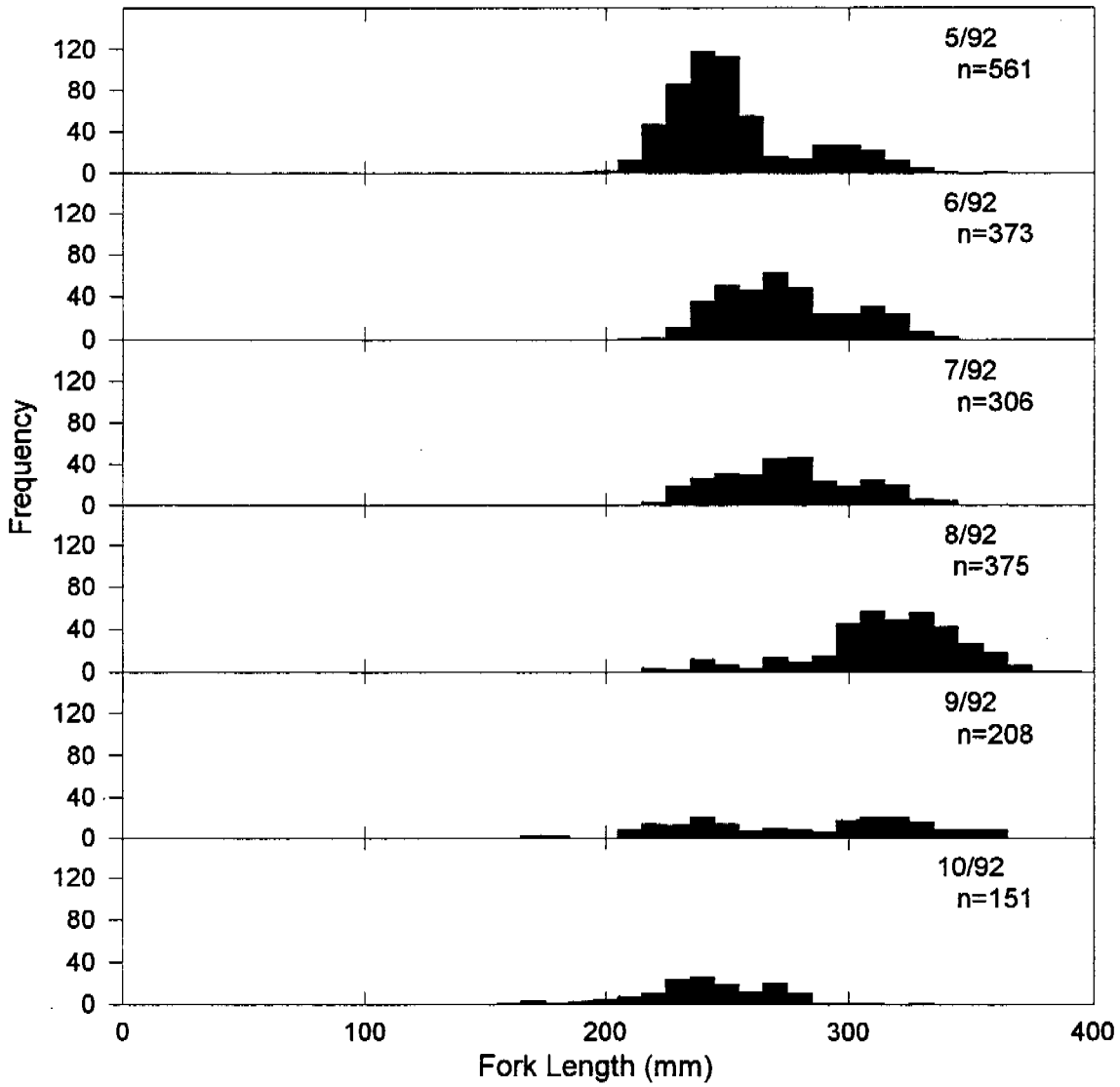

Figure 5. Length frequency distributions of kokanee harvested from Lake Billy Chinook, Oregon, during 1992

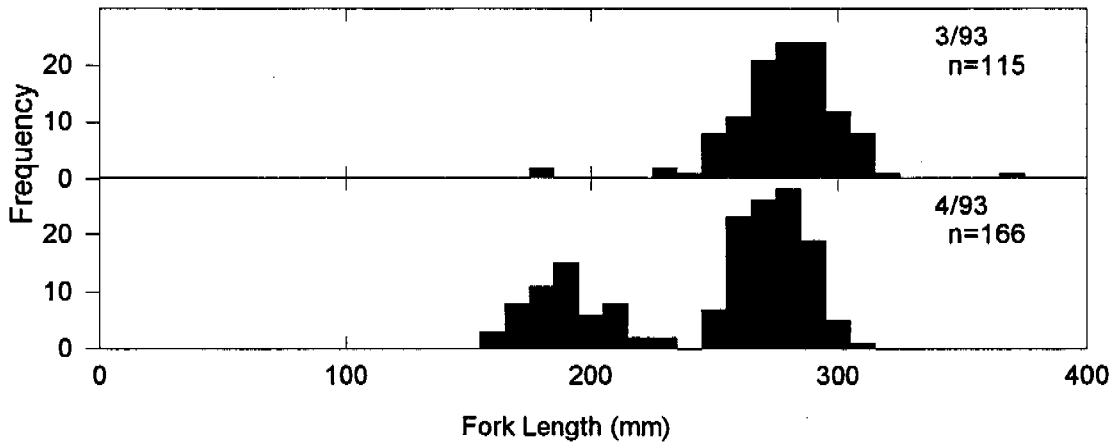

Figure 6. Length frequency distributions of kokanee harvested from Lake Billy Chinook, Oregon, during 1993.

Kokanee Harvested Yield

The total weight of angler-harvested kokanee was estimated at 11,160 kg in 1990 and 20,956 kg in 1991. Thus the kokanee harvested yield was 6.89 and 12.944 kg/ha, respectively. The 1991 yield was higher than any yield published in the summary by Myers and Rieman (1990) and the 1990 yield exceeded that reported for all but three of the lakes (Table 9).

Table 9. Calculation of kokanee yield estimates for 28 lakes and reservoirs in Idaho, Washington, British Columbia, Montana, Utah, Colorado and Oregon (from Myers and Rieman, 1990); and Lake Billy Chinook, Oregon.

Water body	Mean length in catch (mm)	Mean weight in catch (g)	Number harvested	Total weight (kg)	Lake surface area (ha)	Yield (kg/ha)	Comments
Alturas	210	71.85	107	8	339	0.023	1986-87 mean
Anderson Ranch	—	247.00	33,600	8,299	1,918	4.327	1985 mean only
Coeur d'Alene	215	77.74	521,517	40,544	12,743	3.182	1979-80 mean
Dworshak	258	143.13	206,976	29,624	6,920	4.281	1988 only
Island Park	330	326.25	158	52	3,153	0.016	Winter Fishery
Payette	288	206.84	1,276	264	2,160	0.122	1987-88
Pend Oreille	245	120.38	838,460	100,935	38,348	2.632	1958-62
Priest	—	140.00	84,131	11,778	9,454	1.246	1968-70
Redfish	240	112.35	1,400	157	608	0.259	1968-87
Spirit	245	128.10	59,480	7,619	598	12.741	1981 only
Stanley	194	55.11	150	8	74	0.112	1986
Banks	364	453.02	60,740	27,516	11,008	2.500	7 year mean
Billy Clapp	260	146.88	6,126	900	405	2.222	1978 only
Chelan	285	199.72	6,000	1,198	13,355	0.090	Represents Decline
Deer	411	680.24	584	397	445	0.893	1938-40
Loon	387	556.15	584	325	457	0.711	1938-40
Merwin	300	237.13	4,693	1,113	1,619	0.687	1978-82
Sammamish	—	442.00	359	159	1,982	0.080	Represents Decline
Yale	305	250.62	10,919	2.737	1,538	1.779	Represents Decline
Koocanusa	307	256.17	29,480	7,552	18,160	0.416	1987, BC only
Okanagan	—	174.00	156,00	27,144	35,112	0.773	1971, 1978-80
Flathead	312	270.40	495,910	130,095	51,039	2.627	1981-82
Flaming Gorge	—	623.00	30,294	18,873	17,000	1.110	1985-88
Porcupine	—	300.00	1,580	474	80	5.925	1979 only
Dillon	276	179.38	67,575	12,121	1,300	9.324	1975-79
Green Mountain	351	401.09	14,200	5,696	850	6.701	1975-79
Grandby	317	285.18	58,000	16,541	2,938	5.630	1975-79
Odell	—	230.00	64,000	14,720	1,454	10.124	1965-77 mean
Lake Billy Chinook[1/]	—	217.52	73,822	16,058	1,619	9.918	1990-91 mean

1/. Calculations for total weight differed from those reported by Myers and Rieman (1990). See text for details.

Kokanee are the most abundant and widely distributed species in Lake Billy Chinook. The bulk of the Lake Billy Chinook fisheries was supported by harvest of kokanee. However, most of the larger reservoirs reported by Myers and Rieman (1990) had much higher harvests. Mean harvest in Lake Pend Oreille exceeded 800,000 kokanee from 1958-62. Kokanee catch rate was only fair compared to Lake Pend Oreille, where catch rate was 1.45 fish/hour during 1991 (Paragamian et al. 1991). Kokanee catch rate averaged 0.41 fish/hour in Odell Lake from 1965-77 (Lindsay and Lewis 1978). The Lake Billy Chinook kokanee harvest was entirely supported by a naturally spawning population of fish and not supplemented by a hatchery program.

The high harvested yield suggests that kokanee are abundant in Lake Billy Chinook. The high abundance of kokanee appeared to restrict growth rates, and individual cohorts with a very high abundance appeared to affect the next year's cohort through competition for zooplankton species. We believe this is the mechanism by which the harvest shifted from Age 2+ to Age 3+ kokanee, and back, on a yearly basis. Rieman and Myers (1990) found density dependent effects between older kokanee (Ages 2+ and 3+), but not in yearling fish. Nearby reservoirs with lower kokanee abundance, such as Lake Simtustus and Haystack Reservoir, typically have kokanee that reach 450-500 mm by late summer, and weigh 0.9-1.4 kg (ODFW, unpublished data). Mean length of kokanee harvested in Odell Lake was 230 mm (reported in Myers and Rieman 1990). To encourage additional harvest in Lake Billy Chinook, bag limits were increased in 1986 to 15 kokanee/day and again in 1988 to 25 kokanee/day with no size restriction.

Bull Trout

Effort

Bull trout angling comprised only a small percentage of the total fishing effort in Lake Billy Chinook (Tables 3 - 6). March was the month with the greatest bull trout fishing effort and by 1993, most of the effort in March was directed at bull trout. Effort toward bull trout during March and April increased from 4,376 hours in 1991 to 8,108 hours in 1993. Most bull trout fishing effort occurred along the shoreline in the Metolius River arm in March and April, and near the mouth of the Metolius River in June and July.

Harvest

Bull trout harvest increased from approximately 803 fish in 1990 to a minimum of 1,097 fish in 1992. During March and April of 1993, 1,579 bull trout (79%) were released (Table 10). Bull trout harvest peaked three times during the year. The first peak occurred in March when the Metolius River arm opens for fishing. A second peak usually occurred in June and/or July as fish congregate around the mouth of the Metolius River. Finally, a third peak occurred in August and September when large numbers of mostly smaller bull trout were harvested incidentally by the large number of kokanee anglers fishing in the upper portion of the Metolius River arm.

The March and April catch rate of harvested bull trout was very stable throughout the survey period, even though effort increased almost twofold (Table 11). The combined catch rate for bull trout that were harvested and released increased throughout the survey period (Table 12), suggesting that bull trout abundance increased.

Table 10. Estimated catch, kept and released, of bull trout from Lake Billy Chinook, 1990-1993.

	Year							
	1990		1991		1992		1993	
Month	Kept	Released	Kept	Released	Kept	Released	Kept	Released
March	194	85	166	67			203	948
April	145	172	172	102			210	631
May	39	19	82	535	265	11		
June	40	0	215	141	50	72		
July	204	0	17	19	138	31		
August	36	0	125	7	286	0		
September	129	0	21	11	330	84		
October	16	15	94	22	28	96		
Total	803	291	892	904	1097	294	413	1579

Table 11. Boat angler catch per angler hour (harvested) for bull trout from Lake Billy Chinook, 1990 - 1993.

	1990	1991	1992	1993
March	0.023	0.021	---	0.020
April	0.009	0.017	---	0.011
May	0.002	0.004	0.009	---
June	0.003	0.008	0.001	---
July	0.006	0.001	0.004	---
August	0.002	0.008	0.014	---
September	0.008	0.002	0.013	---
October	0.002	0.013	0.004	---

Table 12. Boat angler catch per angler hour (harvested and released combined) for bull trout from Lake Billy Chinook, 1990 - 1993.

	1990	1991	1992	1993
March	0.036	0.028	---	0.113
April	0.019	0.027	---	0.045
May	0.003	0.027	0.009	---
June	0.003	0.013	0.003	---
July	0.006	0.002	0.005	---
August	0.002	0.008	0.014	---
September	0.008	0.003	0.016	---
October	0.004	0.016	0.019	---

In 1990, most of the bull trout harvested were between 200 mm and 450 mm (Figure 7). Most of the smaller fish were harvested in March. In 1991 and 1992, most of the bull trout harvested were also in the 250 mm to 450 mm range, but the catch was spread throughout each

year (Figures 8 and 9). In addition, it appears that more larger fish were harvested. Very few large fish were harvested early in 1993 (Figure 10).

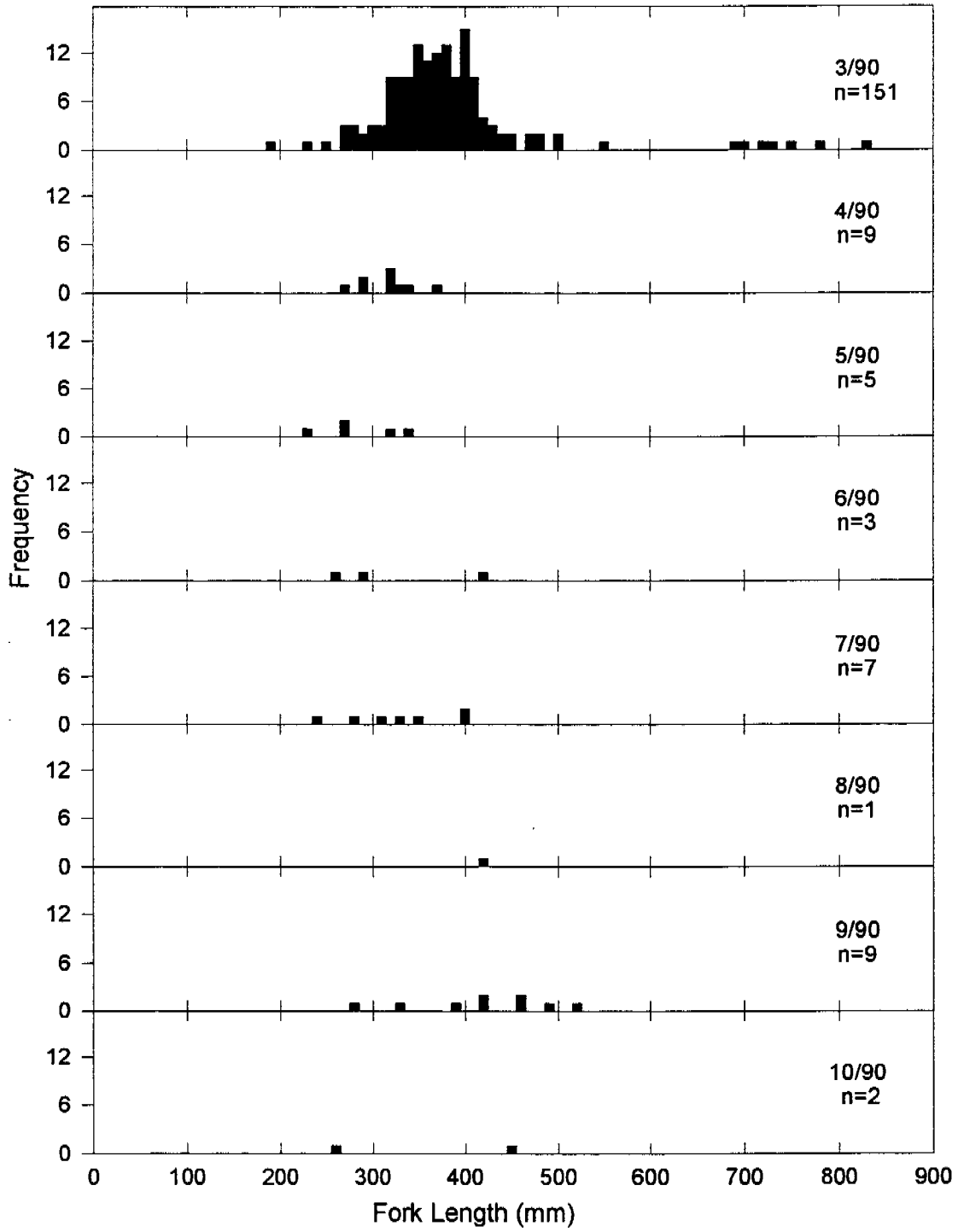

Figure 7. Length frequency distributions of bull trout harvested from Lake Billy Chinook, Oregon, during 1990.

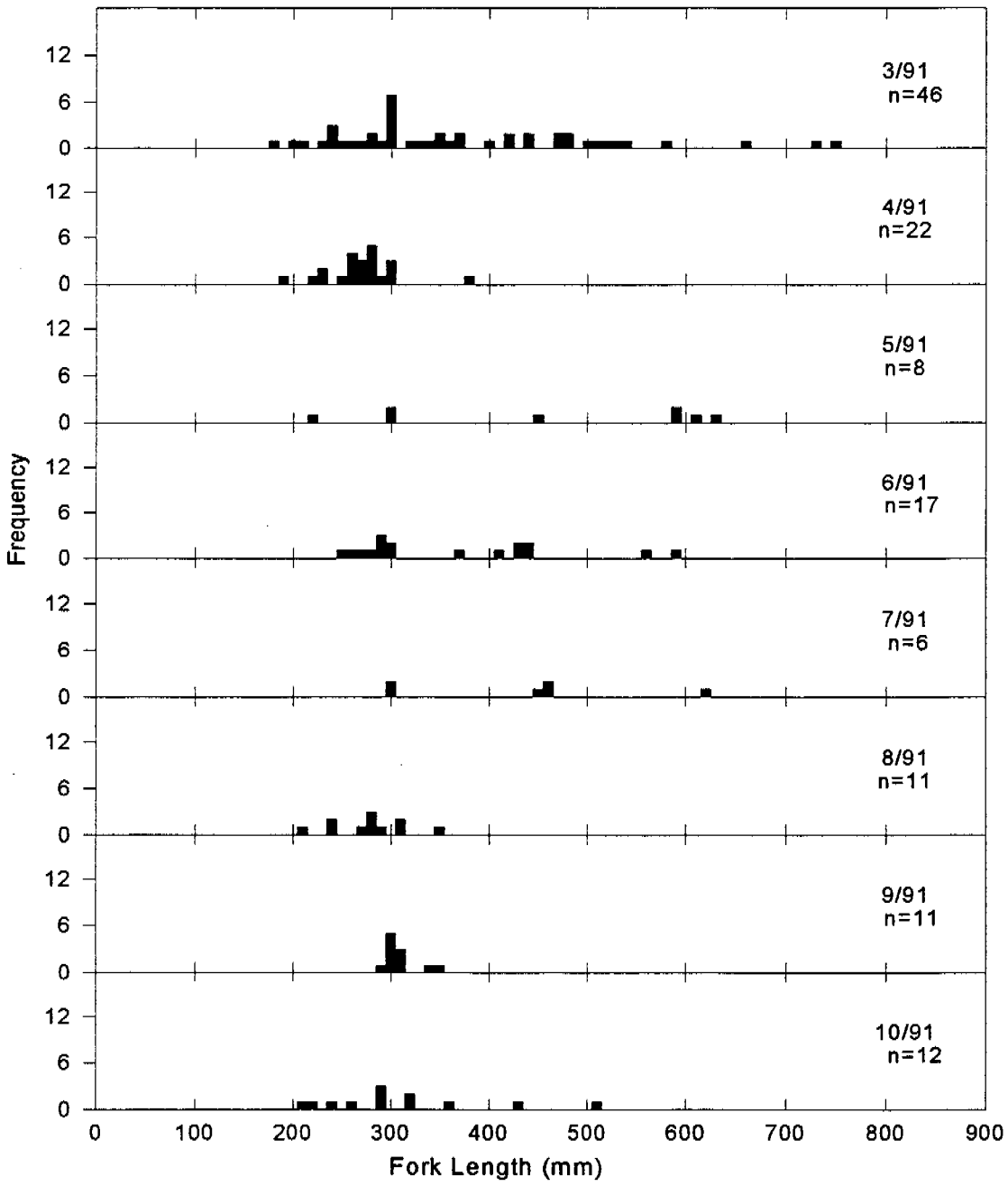

Figure 8. Length frequency distributions of bull trout harvested from Lake Billy Chinook, Oregon, during 1991.

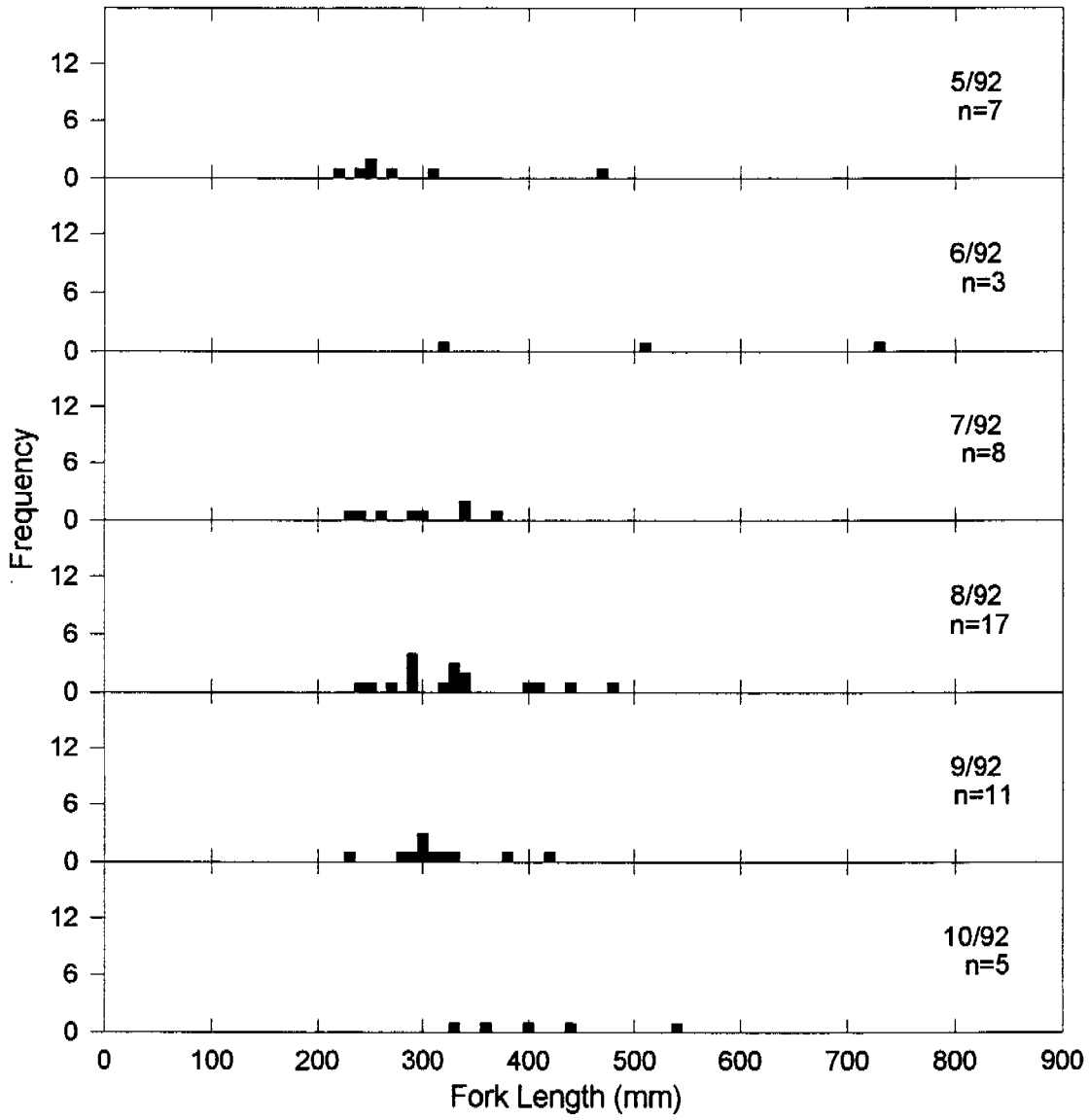

Figure 9. Length frequency distributions of bull trout harvested from Lake Billy Chinook, Oregon, during 1992.

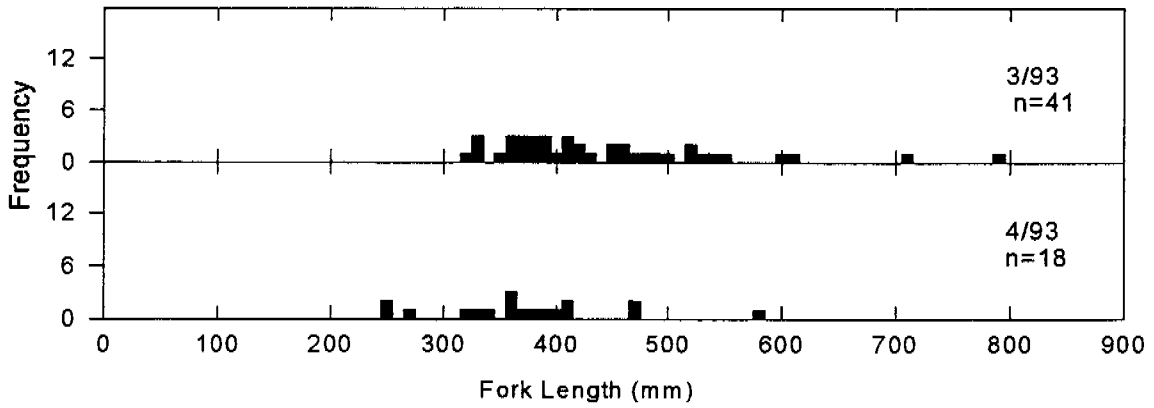

Figure 10. Length frequency distributions of bull trout harvested from Lake Billy Chinook, Oregon, during 1993.

Bull trout harvest in Lake Billy Chinook was slightly lower than the harvest of bull trout observed in Lake Pend Oreille, which was 915 in 1985 and 1,723 in 1991 (Paragamian et al. 1991). Bull trout specific effort doubled during that period from approximately 5,275 to 11,960 angler hours (Paragamian et al. 1991), which is approximately the range observed at Lake Billy Chinook during this study. Bull trout catch rate in Lake Pend Oreille increased from 0.08 to 0.14 fish/hour, slightly higher than the range observed at Lake Billy Chinook. However, the average length of bull trout harvested in Lake Pend Oreille was 492 mm, much larger than the average length of bull trout harvested from Lake Billy Chinook.

Angler Education

Many anglers were contacted during the survey to distribute information to and to discuss the status of bull trout. Other educational efforts were also underway during the survey. Informational signs were posted at the lake, presentations were given to local sporting groups and civic groups, letters were written to anglers who returned tags from bull trout, and a bull trout video was produced (Ratliff et al. In Press). As a result of angler education efforts, it appears that anglers became more aware of the need to release and protect bull trout in order to maintain a fishery. The number of bull trout released during March and April of 1993 indicates that education efforts were successful. Many of the serious bull trout anglers now fish for trophy fish and are releasing fish which do not meet their expectations of a trophy fish. Creel surveyors noted that some bull trout anglers released bull trout exceeding 4.5 kg. However, many bull trout were harvested by kokanee anglers who were not pursuing bull trout and confused them with brown trout. The latter anglers are where we need to focus education efforts in the future. In addition, a catch and kill tournament at a local merchant was changed to a photograph only tournament in 1993 to allow and encourage anglers to release bull trout.

Relationship of Harvest to Bull Trout Abundance

The primary objective of these creel surveys was to estimate the harvest of bull trout and determine the impact of that harvest on the population. It is apparent that the effort and harvest of bull trout has increased steadily over the period of the study. There has been a great increase in publicity and interest in the fishery. The possibility of catching a large resident trout (>500 mm) is a rare opportunity in this state. The potential to catch a large bull trout on Lake Billy Chinook is quite good. However, due to the federal endangered species review, and bull trout now listed as a "Category I" sensitive species, monitoring harvest was and continues to be very important.

In response to increasing concerns about bull trout in Oregon, angling regulations have become more restrictive. Angling regulations requiring the catch and release of all wild trout in the Metolius River were implemented beginning in 1983. The trout (including bull trout) bag limit for Lake Billy Chinook was reduced in 1988 from 10 per day with no more than two over 508 mm to five trout per day with no more than one over 508 mm (20 in) in 1992 to encourage the release of smaller bull trout (Stuart et al. In Press). The bull trout catch limit was further reduced to only one per day in 1992.

As a result of education efforts and more restrictive regulations, the Lake Billy Chinook and Metolius River bull trout population appears to be increasing. Three indices support this conclusion. First, the catch rate of harvested bull trout remained steady in March from 1990 to 1993 under a doubling of effort. Second, the number of bull trout released in the spring fishery suggests that the abundance of juvenile bull trout is increasing. More bull trout were released in March and April of 1993 than for the entire sampling period in 1990 or 1991. Third, the number of spawning adults has increased. Total redd counts in known spawning areas have steadily increased from 27 redds in 1986 to 287 redds in 1993 (Riehle et al. In Press). Based on this evidence, we feel that the current harvest level is allowing this bull trout population to increase.

Smallmouth Bass

Effort

Effort for smallmouth bass was a distant second to kokanee, ranging from 0.7% to 25.4% of the total fishing effort (Tables 3-6). There were no apparent trends in the smallmouth bass fishing effort, except that it appeared to decline after the Crooked River and Deschutes River arms were sampled less intensively starting in 1991. The highest smallmouth bass fishing effort was measured at 13,761 hours in 1990. As discussed in the methods section, effort and catch for smallmouth bass were likely underestimated due to reduced sampling efforts on the Deschutes River and Crooked River arms after 1990.

Harvest

Harvest of smallmouth bass decreased over the survey period (Table 13). Peak catches of smallmouth bass occurred from April through August. Most smallmouth bass caught were released. Smallmouth bass catch rate was erratic throughout the sampling period, but appears to have dropped considerably during 1992 (Table 14). Given the few anglers actually targeting smallmouth bass, the catch rate was very good. Most of the smallmouth bass harvest occurred in the Crooked River arm. Length frequency distributions for smallmouth bass were quite variable.

Table 13. Estimated catch (kept and released) of smallmouth bass from Lake Billy Chinook, 1990-1993.

	1990		1991		1992		1993	
Month	Kept	Released	Kept	Released	Kept	Released	Kept	Released
March	142	209	26	95	---	---	18	78
April	764	2,466	192	440	---	---	141	2,579
May	660	1,803	39	4,566	434	79	---	---
June	215	1,552	585	3,993	10	311	---	---
July	727	2,420	1,671	2,142	770	788	---	---
August	892	1,606	851	5,688	853	44	---	---
September	420	281	164	199	0	965	---	---
October	0	0	46	52	0	0	---	---
Total	3,820	10,337	3,574	17,175	2,067	2,187	159	2,657

Table 14. Boat angler catch per angler hour (harvested and released combined) for smallmouth bass from Lake Billy Chinook, 1990 - 1993.

	1990	1991	1992	1993
March	0.022	0.015	---	0.008
April	0.192	0.064	---	0.140
May	0.101	0.201	0.018	---
June	0.125	0.172	0.009	---
July	0.099	0.118	0.049	---
August	0.163	0.397	0.043	---
September	0.044	0.033	0.038	---
October	0.000	0.013	0.000	---

Most smallmouth bass harvested in 1990 were less than 270 mm (Figure 11). Harvest in 1991 generally ranged from 260 mm to 310 mm, while the 1992 was spread throughout a range from 120 mm to 330 mm.

Shrader (1992) analyzed spring electroshocking data from 1990-1992 and speculated that the number of smallmouth bass in Lake Billy Chinook was near carrying capacity. Shrader (1992) also estimated that total mortality was low for smallmouth bass through Age 4. However, few smallmouth bass aged from scales in 1990-1992 were older than Age 4 (ODFW, unpublished data). Shrader (1992) was unable to determine why so few fish in the electroschocking samples were older than Age 4. The low numbers of smallmouth bass harvested suggests that fishing mortality is not the major portion of mortality.

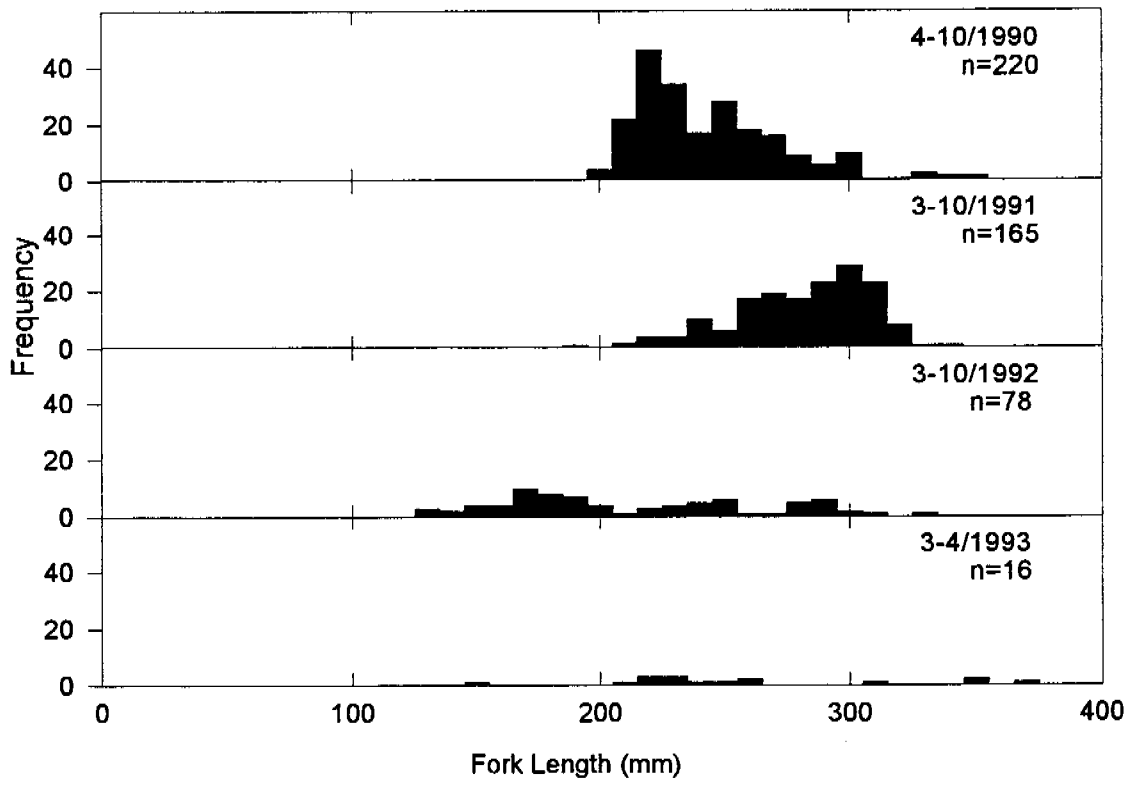

Figure 11. Length frequency distributions of smallmouth bass harvested from Lake Billy Chinook, Oregon, during 1990-1993.

The catch and harvest of smallmouth bass in Lake Billy Chinook was between that for Brownlee Reservoir (6,073 ha) and Owyhee Reservoir (5,625 ha). From May 25 through July 31, 1991, 6,430 anglers fished for 27,672 hours to catch 2,765 smallmouth bass on Owyhee Reservoir (Rien and Beamesderfer 1991). Their catch rate was 0.10 fish/hour during a very low water year. From February 1, 1989 through January , 1990, an unreported number of anglers fished for 851,749 hours to catch 950,786 smallmouth bass on Brownlee Reservoir (ODFW, unpublished data). Their catch rate was 1.12 fish/hour. The Brownlee Reservoir fishery tends to be driven by the tremendous black crappie fishery there; catch exceeded 2 million crappie in 1991 (ODFW, unpublished data). The Lake Billy Chinook smallmouth bass catch rate was similar to catch rate at Owyhee Reservoir, but considerably less than at Brownlee Reservoir. Effort was about 10% of the effort at Brownlee Reservoir, but almost five times higher than at Owyhee Reservoir.

Other Species

Rainbow trout and brown trout were also harvested in modest numbers from Lake Billy Chinook (Tables 15 and 16), although the harvest may have been underestimated after 1990 because most fishing for these species occurs on the Deschutes River and Crooked River arms. Rainbow trout harvested from Lake Billy Chinook were from 240 mm to 270 mm in 1990, from 250 mm to 310 mm in 1991, and from 250 mm to 330 mm in 1992. In 1993, marked hatchery rainbow trout from the stocking program in the Crooked River at Opal Springs comprised 7% of the rainbow trout harvest. Brown trout generally ranged from 270 mm to 350 mm; however, several larger fish (> 400 mm) were observed in the harvest.

Table 15. Estimated catch (kept and released) of rainbow trout from Lake Billy Chinook, 1990-1993.

	1990		1991		1992		1993	
Month	Kept	Released	Kept	Released	Kept	Released	Kept	Released
March	58	33	58	25	---	---	96	73
April	134	221	207	63	---	---	220	11
May	127	50	235	12	374	0	---	---
June	146	0	244	0	75	0	---	---
July	610	0	60	0	162	0	---	---
August	476	0	44	0	14	0	---	---
September	55	0	4	0	167	0	---	---
October	32	0	20	0	31	0	---	---
Total	1,638	304	872	100	823	0	316	84

Table 16. Estimated catch (kept and released) of brown trout from Lake Billy Chinook, 1990-1993.

	1990		1991		1992		1993	
Month	Kept	Released	Kept	Released	Kept	Released	Kept	Released
March	41	10	26	26	---	---	46	72
April	137	34	48	114	---	---	209	94
May	146	19	301	0	243	0	---	---
June	17	0	26	0	21	0	---	---
July	0	0	17	0	0	0	---	---
August	220	0	22	0	26	0	---	---
September	0	0	0	0	0	0	---	---
October	23	15	29	6	0	0	---	---
Total	584	78	469	146	290	0	255	166

Other Trends

The 1990 data indicates that each of the three arms contributes substantially towards the fishery, as the arm with the highest use varied by month (Table 17). The Metolius River arm received over 50% of the angling effort in August, while the Crooked River arm received 50% or more of the angling effort in September and October.

FUTURE INFORMATION NEEDS

Kokanee

Additional needs for future study include enumerating the total lake population, including escapement, and determining what drives individual cohorts. We speculate that competition for zooplankton is a factor, but there is little information to substantiate this.

Table 17. Distribution of monthly angler effort (percent) among the three river arms of Lake Billy Chinook, April to October 1990.

	Crooked River Arm	Deschutes River Arm	Metolius River Arm	Many Areas Fished
April	31	10	36	23
May	32	25	22	21
June	37	23	29	12
July	21	30	30	20
August	13	19	55	14
September	50	16	25	9
October	78	8	10	4

Bull Trout

Future creel surveys will be necessary to monitor the fishery and ensure that the harvest rate is not causing a decline in the population. For most years, monitoring the March and April fisheries should allow us to generally estimate the harvest. However, March through October surveys will also be required at regular intervals. The high incidental catch of bull trout by kokanee anglers demonstrates that we need to focus our educational efforts to these anglers. Specifically, kokanee and other general anglers need to learn (1) how to distinguish bull trout from other salmonids, (2) how small the population is relative to kokanee, and (3) about their trophy potential.

Smallmouth Bass

Smallmouth bass contributed more effort on Lake Billy Chinook than bull trout anglers. A creel survey that also focuses on the Deschutes and Crooked River arms will be necessary to provide a more accurate estimate of smallmouth bass harvest and angler effort. In addition, the growth rates of smallmouth bass need investigation to determine if the quality of the fishery can be improved by habitat improvements or angling regulation changes.

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