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FLATHEAD LAKE ANGLER SURVEY

Final Report FY 1992 - 1993

MONITORING ACTIVITIES FOR THE HUNGRY HORSE FISHERIES MITIGATION PLAN

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ABSTRACT

A roving creel survey was conducted on Flathead Lake in northwestern Montana from May 17, 1992 to May 19, 1993. The primary objective of the survey was to quantify the baseline fishery and exploitation rates existing prior to Hungry Horse Dam mitigation efforts. Anglers were counted on 308 occasions, comprising 5,618 fishing boats, 515 shore anglers, and 2,191 ice anglers. The party interviews represented 4,410 anglers, made up of 2,613 boat anglers, 787 shore anglers, and 1,010 ice anglers. A total of 47,883 angler days (190,108 angler hours) of pressure and a harvest of 42,979 fish (including lake trout, lake whitefish, yellow perch, bull trout, and westslope cutthroat trout) were estimated. Pressure was distributed between shore, boat, and ice anglers as 4%, 87%, and 9%, respectively. Seventy-nine percent of the total effort was directed at lake trout during the study period. Limited comparisons were made to previous creel surveys on Flathead Lake due to differences in methods and radical changes in the fishery. Potential sources of bias are explained in detail. Future creel surveys must employ methods consistent with this survey to obtain estimates that are statistically distinguishable.

ACKNOWLEDGEMENTS

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INTRODUCTION

Hungry Horse Dam was constructed in 1952 and isolated 38 percent of the Flathead Lake drainage area from the remainder of the lake-river system. On November 12, 1991, the Northwest Power Planning Council approved the "Fisheries Mitigation Plan for Losses Attributable to the Construction and Operation of Hungry Horse Dam" (Fraley et al. 1991). A creel survey on the Flathead Lake-River system was a component of that mitigation plan. This document summarizes the creel survey conducted on Flathead Lake, Montana, from May 17, 1992, to May 18, 1993. This study was funded through Bonneville Power Administration as part of the overall fisheries mitigation for the Hungry Horse Dam.

The primary purpose of this survey was to quantify the baseline fishery and exploitation rates existing prior to further mitigation efforts in the drainage. An additional objective was to identify a survey methodology that can be replicated in the future and be used to measure the success or failure of mitigation activities. Potential biases are identified and their effects on the accuracy and precision of the estimated population parameters are quantified.

DESCRIPTION OF STUDY AREA

Flathead Lake, located in northwestern Montana, is the largest natural fresh water lake in the western United States. Flathead Lake has a maximum length of 43.9 km, a maximum width of 24.9 km, and an area of 462.3 km^2. It has a mean depth of 32.5 meters and a maximum depth of 113 meters. Much of the lake exceeds 20 meters in depth except South Bay, which has a maximum depth of 10 meters. The south half of Flathead Lake lies within the Flathead Indian Reservation (Figure 1). The lake is surrounded by state highways and access is good. A total of 15 public access sites, including boat ramps, are well-distributed around the lake.

The lake has a drainage basin of 18,379 km^2 (Figure 1) comprised primarily of public lands, such as national forests, parks, and wilderness areas. The primary tributary to the lake is the upper Flathead River, which consists of three forks (North, Middle, and South), with an average annual flow of 9,675 cubic feet per second (cfs) at Columbia Falls (USGS 1992). Other large tributaries include the Swan, Stillwater, and Whitefish Rivers, which have average annual discharges of 1,163, 339, and 190 cfs, respectively (USGS 1992). The lower Flathead River flows out of the lake in a southwest direction near the town of Polson. Kerr Dam is located 6.4 km downstream from the outlet, regulating the upper 3 meters of Flathead Lake.

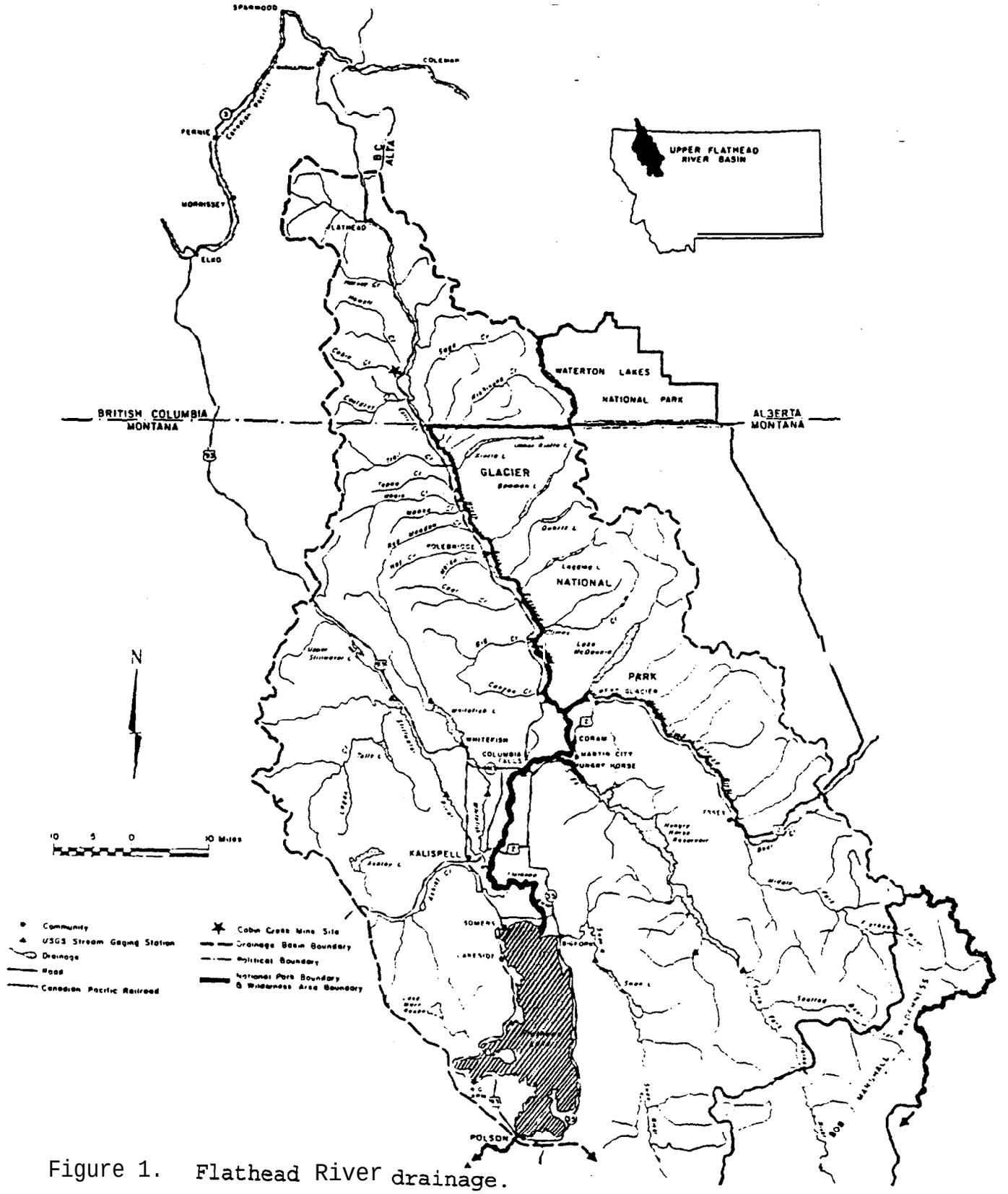

Figure 1. Flathead River drainage.

Flathead Lake is known for its pristine nature and popular fishery. It is oligomesotrophic (Wetzel 1983) having average primary production between 100 and 120 $gC/m^2/yr$ in 1992 (Stanford et al. 1992) and has an average secchi disk reading of 9 meters. Until recently, kokanee, a landlocked form of sockeye salmon, was the most abundant sport fish in the lake. In 1982, 92% of the estimated 536,870 fish harvested from the lake were kokanee (Graham and Fredenberg 1983). The other important sport fish in the lake are bull, lake, and westslope cutthroat trout, lake whitefish, and yellow perch. Fishing regulations and regulation changes during the study period are provided in Appendix A.

The kokanee population has decreased dramatically in recent years and they are now rarely caught by anglers. Several factors are responsible for this decline including: hydroelectric operations, overharvest, predation, and the introduction of opossum shrimp (*Mysis relicta*). There have been dramatic changes in the lake food web and fishery since the appearance of Mysis. Lake trout and lake whitefish numbers have increased, kokanee have collapsed, and bull and cutthroat trout, appear to be declining.

METHODS

Flathead Lake presents a complex survey problem because of its size, political jurisdictions, fish assemblage, angler access, and morphometric character. Roving survey procedures were used because of the large size of the lake and widely dispersed access points. Roving surveys permit contact with all types of fishermen (rental boat, private boat, shore) in proportion to their actual abundance. Four creel clerks collected data April through August, and two clerks worked September through March. Fishing pressure estimates were based on random instantaneous angler counts. Catch and angler characteristics were collected by interviews. Harvest was estimated as the product of pressure and catch.

SURVEY SAMPLE DESIGN

Stratified simple random sampling was selected for the survey design. Stratified sampling was used to address seasonal use differences, angler diversity, lake size, and higher recreational use on weekends and holidays than weekdays. Stratified sampling is a technique that reduces sampling variance by grouping homogenous sub-populations (strata) together. The survey data were expanded within each stratum and summed. The data were stratified by angler type (shore, boat, and ice anglers), area fished (lake section), month, and day type (weekend/holiday and weekday). Stratification by angler type was necessary since shore, boat, and ice anglers are very distinct populations.

Spacial Stratification

The lake was divided into five sections based on differing political jurisdiction and morphometric character and numbered one through five counterclockwise from the northwest corner (Figure 2). The Flathead Indian Reservation boundary divides the main body of the lake into north and south halves with separate licensing requirements and regulations. On the north half of the lake, only a state fishing license is required and charter fishing and commercial harvest of lake whitefish are allowed. The south half of the lake lies within the reservation and is under tribal jurisdiction. A person who is not a member (nonmember) of the Tribes and wishes to fish on the reservation must possess a tribal recreation and fishing license. Commercial whitefish harvest and charter fishing were not permitted on the south half of the lake during the survey period.

The main lake body is further divided into east and west halves by a line from the mouth of the Flathead River to Finley Point. This line separates the deeper east half of the main lake body from the rest of the lake.

South Bay is significantly different from the main lake body (Figure 2) as it is shallower (lo-meter maximum) and the water is warmer in the summer. South Bay provides a popular yellow perch fishery that does not exist elsewhere on the lake. For this study, South Bay was separated into a separate section.

The five lake sections (strata) were used throughout this study for comparisons and data analysis. However, adjustments to the procedures for data expansion for the winter months of November through March were necessary. During this period shore angling was nearly nonexistent, boat angling was reduced and sporadic, and ice angling initiated. Ice cover reduced the open water area and limited boat ramp access during this period. Because of the limited number of boat interviews and the small ice-free area, the main lake body was treated as a whole (sections 1, 2, 4, & 5) for the purposes of data expansion. After data expansion, boat pressure and harvest estimates were proportioned among the sections based on section count data. The areas that developed an ice fishery were treated as independent sections.

In three unconnected areas of the lake an ice fishery developed (Table 1). These were Somers Bay (section 1) in the northwest corner of the lake, Big Arm Bay (section 2) on the west side, and South Bay (section 3). The ice fishing period for these areas was defined as the period from first to the last observation of an angler on the ice actively fishing.

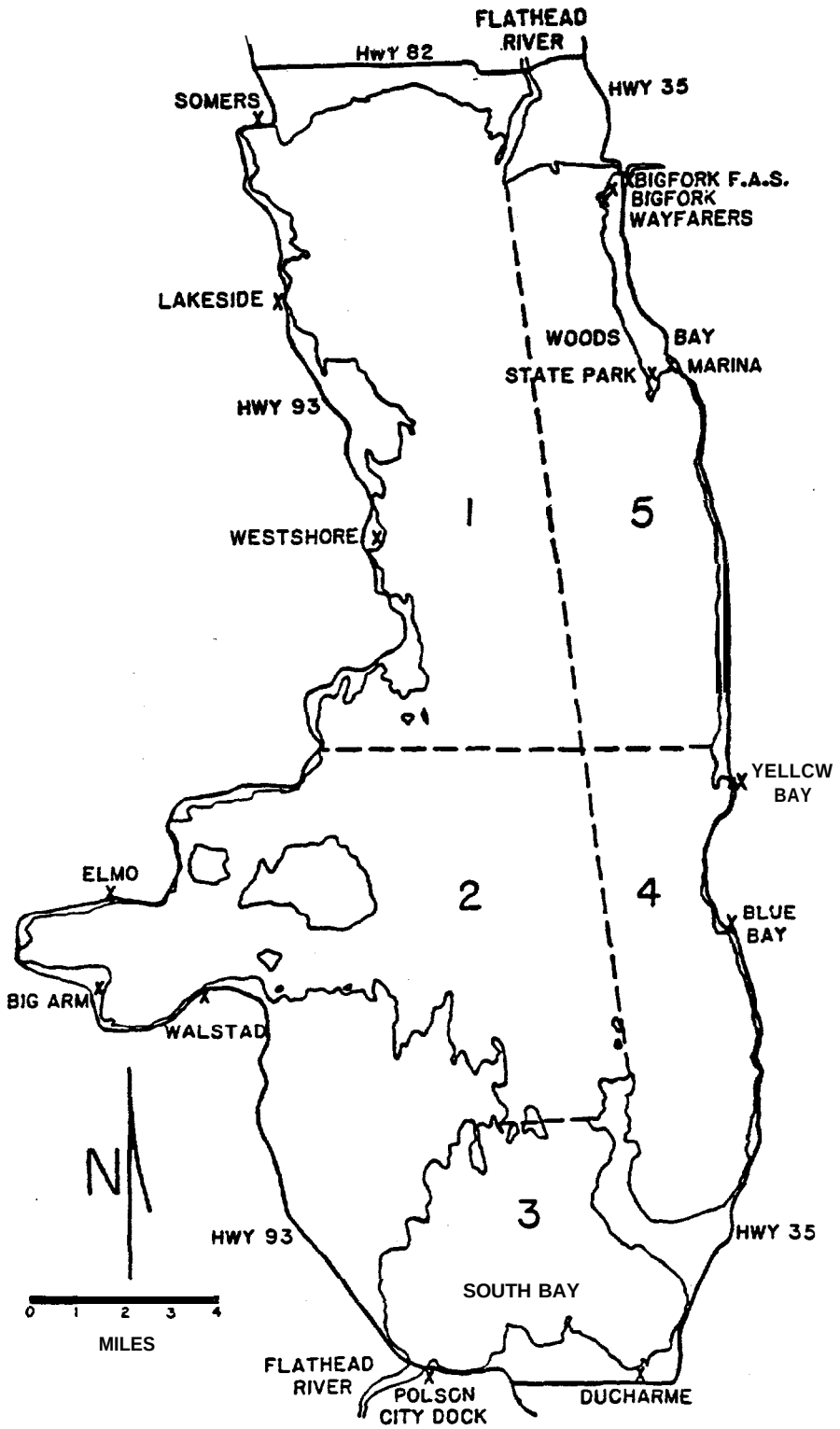

Figure 2. Flathead Lake with numbered lake sections and access sites used in the creel survey.

Table 1. Dates and areas ice fishing occurred on Flathead Lake during the creel survey.

Section (Area)	Dates		
Section 1 (Somers Bay)	December 29	through	March 22
Section 2 (Big Arm Bay)	January 10	through	March 13
Section 3 (South Bay)	December 12	through	March 21

Temporal Stratification

The data were expanded (stratified) on a monthly basis. Monthly units were selected because they allowed an adequate sample size without extending into periods with dissimilar fishery parameters (angler pressure, catch rates, day length, etc.). Exceptions to monthly data expansion include May 1992, May 1993, and the time periods encompassing the ice fisheries. The creel survey was initiated and ended in the middle of May, resulting in half-month periods in the analysis. The timing of initiation and close of the ice fishery varied between areas (see Table 1), resulting in partial months. Partial months are indicated as such in the text and tables.

Days were considered the primary sample units and stratified by weekend/holidays (WE) and weekdays (WD). WEs were sampled at twice the rate of WDs based on information from a survey in 1985 which showed fishing pressure twice as high on the weekends than on weekdays (Hanzel 1986). The 10 holidays that were grouped with weekend days were: New Year's Day, Martin Luther King Day, Presidents Day, Memorial Day, Independence Day, Labor Day, Columbus Day, Veterans Day, Thanksgiving, and Christmas. An sample day was defined as those hours between sunrise and sunset. It was assumed that little or no fishing occurred at night. Random count times within each sample day were generated based on the period between sunrise and sunset on the 15th day of each month.

Sample days were selected randomly within each stratum. Initially, days were sampled at a rate of seven per 14-day period (three weekend/holidays and 4 weekdays). Adjustments to the rate of sampling within and between strata were made periodically, based on seasonal changes in the fishery, weather patterns, preliminary data analysis, and budgetary concerns (Table 2). Adjustments of this nature affected the precision of estimates produced, but were not an alteration of sample design.

Table 2. Allocation of sample days and angler counts between weekend/holidays (WE) and weekdays (WD) for the Flathead Lake creel survey.

Dates	Sample days per 14 day period WD	WE	Counts per day WD	WE
5/17/92 - 9/12/92	4	3	2	2
9/15/92 - 1/09/93	2	2	2	2
1/10/93 - 2/10/93	10	4	1	1
2/11/93 - 5/19/93	10	4	1	2

Angler Counts

Anglers were counted either from the air or the ground. Each random count time equated to a take-off time for the aerial count. Aerial counts are subject to the vagaries of weather and when a flight was canceled, ground counts were substituted. All flights were flown from the Polson Airport in a Cessna 172 fixed-wing aircraft. The count was flown from south to north at an altitude of 150 m above water level and 120 m offshore. The flight route alternated between the east and west sides of the lake. During the summer months the pilot was always accompanied by a clerk who counted and recorded the data. In the winter months the pilot often managed the counts alone because of the small number of anglers.

The time the aircraft entered each section was recorded on the count sheet. Total time to complete a count within each section was less than 0.5 hour. The approximate locations of each boat, shore angler, ice angler and ice shed were recorded on the data sheet (Appendix B). A fishing boat was defined as a boat that was stationary or moving at trolling speed (no wake). Fishing boats moving at a higher speed were not counted. It was assumed that there was no fishing from sailboats. The shoreline was observed for anglers, including those on private docks, public docks and access points. Ice sheds were counted and the number expanded by a mean party size per shed derived from the interview data. Regulations prohibited anglers from leaving ice fishing shelters unoccupied. It was assumed all sheds were occupied unless obviously not the case.

When a flight was canceled because of inclement weather or mechanical difficulty, an attempt was made to do the count from the ground. Ground counts were conducted by two clerks, each driving on an opposite side of the lake, and were completed in approximately one hour ($\approx$ 0.5 hour per section). The direction of travel for ground counts alternated each count between north

and south. Clerks counted anglers from specific vantage points and counted boat trailers at access sites.

When ground counts were necessary, it was assumed: 1) that all angling could be observed from the ground in the form of individual anglers, fishing boats or boat trailers at access sites; 2) there was no boat access to the lake except the boat ramps defined above as public; and 3) that any boat trailer at an access site represented a party actively engaged in fishing. These assumptions are supported by the fact that after mid-October, falling lake levels rendered private dock facilities inoperable. Therefore, boat anglers in winter must have used one of the public facilities. Also, at this time of year, if the weather is poor enough to ground the aircraft, it is unlikely that much pleasure boating was taking place on the lake.

Because of the limited area for ice fishing, clerks were able to count anglers from specific vantage points. During three counts, fog prohibited accurate ice angler counts from these vantage points. For these counts, vehicles at the access sites were counted, then the number expanded by the mean party size per ice angler interview.

Angler Interviews

Roving and access site interviews were conducted. Roving interviews were conducted in the summer by two clerks boating around the lake systematically contacting anglers. In the winter, during the ice fishery, contact was made by creel clerks roving on the ice. The lake section for roving on a particular creel day was picked at random. The clerks systematically covered each section interviewing all anglers they observed. When few anglers were present and the initial lake section had been covered, the clerks moved to an adjacent lake section and repeated the procedure.

Access-site interviews were conducted at predetermined public access points to the lake. A clerk assigned to conduct access-site interviews would wait at access sites and interview anglers as they left the lake. Although all access sites were covered, no predetermined amount of time was spent at a particular access point. The clerks used their discretion to obtain interviews as efficiently as possible while budgeting time for all access sites.

When contact with an angler or party of anglers was made, the following information was obtained and recorded on a data sheet (Appendix B) : 1) whether shore, boat or ice angling; 2) number of anglers in the party; 3) elapsed party fishing time to the nearest 1/4 hour (excluding boat travel time); 4) completed or uncompleted trip; 5) species of fish targeted; 6) area fished; 7) access point and whether public or private; 8) angling

method(s); 9) party catch by number and species; and 10) angler origin. A systematic sample of lengths of fish caught to the nearest mm were regularly recorded. Each party interview was conducted as if the party were a single angler. No effort was made to separate catches by individual members of the party. Similarly, if a party of two consisted of one person who used lures exclusively and another who fished only with bait, the angling method recorded for the party was as if both anglers had used both methods.

CALCTJLATION OF ANGLER PRESSURE, CATCH RATES, AND HARVEST

Harvest and pressure estimates were calculated by a FORTRAN program developed by the Montana Department of Fish, Wildlife and Parks (MDFWP), using formulas from Neuhold and Lu (1957). The estimates for pressure and harvest are expanded within each stratum and summed. Uncompleted interviews with less than 0.5 hour of effort were dropped from the angler pressure and harvest calculations. Uncompleted boat trips of anglers targeting lake trout were not used in the harvest estimates for lake trout.

Ansler Pressure

Mean-total fishing pressure for each month was computed by expanding the mean number of anglers per count by the total possible fishing hours in the month (Neuhold and Lu 1957). This calculation is represented mathematically as

$$P=(A)(H); \quad (1)$$

where P = mean total angler pressure in hours, A = mean number of anglers per count, and H = total possible fishing hours. The variance was calculated as described in Neuhold and Lu (1957). The mean number of anglers per count was calculated from the count data. Day lengths for each month were based on the length of the 15th day of each month (Table 3). Total fishing hours per month was calculated by multiplying the day lengths by the number of days in the month. Angler-hours were converted to angler-days (trips) by dividing by the mean time spent fishing per trip. Independent pressure estimates were calculated for each angler type (shore, boat, and ice) using mean trip length for that type.

The calculation of angler pressure assumes that the number of anglers counted is an unbiased estimate of the number of angler hours in progress at any given instant (i.e. an "instantaneous count"). Most investigations show that shorter count periods provide more accurate estimates. Neuhold and Lu (1957) suggest keeping the duration of counts to less than one hour.

Table 3. Day lengths (hours) obtained from sunrise-sunset tables using the 15th day of the month (Mountain Standard Time).

Month	Sun-rise	Sun-set	Day Length	Month	Sun-rise	Sun-set	Day Length
January	0823	0510	9.6	July	0452	0834	15.7
February	0745	0559	10.2	August	0531	0751	14.4
March	0651	0642	11.8	September	0613	0650	13.0
April	0548	0728	13.7	October	0656	0549	10.9
May	0458	0810	15.2	November	0744	0459	9.3
June	0435	0840	16.1	December	0821	0443	8.4

Catch and Harvest Rates

Catch and harvest rates were determined from interview data. Two types of harvest rates were used to meet different objectives. For the purposes of this survey they are defined as harvest per unit effort (HPUE) and mean party harvest per unit effort (MPHPUE). HPUE was calculated as

$$HPUE = \frac{F}{H}; \qquad (2)$$

where $HPUE$ = the mean rate of harvest; F = the mean number of fish kept per angler; and H = the mean number of hours per trip. HPUE is calculated by the FORTRAN program and used to estimate the numbers of fish in the harvest. The variance was calculated as described in Neuhold and Lu (1957). HPUE was partitioned for species by dividing the recorded harvest of each species into the total measured effort (mean number of hours, H).

HPUE is based on total measured effort and is appropriate for calculating harvest over a period of time (Neuhold and Lu 1957; Malvestuto 1983). This statistic assumes that total effort by anglers fishing for different species is constant during the period of time the estimates are made.

MPHPUE is described by Crone and Malvestuto (1991) and is represented mathematically as

$$MPHPUE = (1/i) \sum_{i=1} (F_i/H_i); \qquad (3)$$

$MPHPUE$ = the mean rate of harvest, F_i = the fish kept associated with the ith fishing party, H_i = the hours associated with the ith party, F_i/H_i is the HPUE for the ith party, and M = the total

number of interviews in the category. The variance for this ratio is calculated as for any set of independent observations.

When the objective is an index of stock abundance or a measure of fishing quality, the most appropriate measure of harvest rate is obtained by dividing the catch of a given species of fish by the angler-hours directed toward that species (Lambou and Stern 1958; Lambou 1966; Von Geldern 1972; Malvestuto 1983). MPHPTJE provides a more meaningful harvest rate for these objectives and has advantages for data analysis and manipulation. An analogous mean party catch per unit effort (MPCPUE) was calculated by substituting fish caught (fish kept + fish released) in the equation in place of fish kept.

Harvest

The estimate of harvest was calculated as the product of HPTJE and total fishing pressure. This is represented mathematically as

$$H=(P)\ (HPUE)\ ; \qquad (4)$$

where H = harvest of fish, P = the mean-total fishing pressure in angler hours (Equation 1), and $HPUE$ = the mean rate of harvest (Equation 2). This calculation is based on total measured effort and is a standard method used to estimate the total harvest or harvest by species over a specific time period (Neuhold and Lu 1957; Malvestuto 1983). The calculation of variance for the estimates is described in Neuhold and Lu (1957).

Completed vs Uncompleted Interviews

Many investigators have expressed concern with using catch and harvest rates derived from uncompleted fishing trips (Malvestuto 1983; Van Den Avyle 1986). Robson (1961) suggests that an unbiased estimate of catch rates can be ensured only by using information from completed fishing trips. There are many published comparisons of catch and harvest rates based on completed and uncompleted fishing trips demonstrating no difference, however, Malvestuto (1983) recommended verification for each fishery.

Mean rates (MPHPUE and MPCPUE) were compared using the non-parametric Mann-Whitney U-test, since assumptions of parametric testing were not met ($P < 0.01$). Comparisons of means for all other statistics were made with the t-test. Estimates of population parameters include standard deviations (SD) and coefficients of variation (CV). CV is the standard error of an estimate divided by the estimate and is expressed as a percentage (Cochran 1977). This statistic provides a measure of the relative variation, or precision, associated with the estimates

over the period. As CV increases, relative variation increases, and precision decreases. All probabilities and confidence intervals (CI) are represent at the 95% level unless otherwise indicated.

RESULTS

A total of 308 angler counts and 2,205 party interviews were conducted on Flathead Lake during the study. A total of 5,618 (67%) fishing boats, 515 (6%) shore anglers, and 2,191 (26%) ice anglers were counted. The party interviews represented 4,410 anglers, including 2,613 (59%) boat anglers, 787 (18%) shore anglers, and 1,010 (23%) ice anglers. An estimated 47,883 angler days (190,108 angler hours) of pressure and a harvest of 42,979 fish (including lake trout, lake whitefish, yellow perch, bull trout, and westslope cutthroat trout) were estimated. Pressure was distributed between shore, boat, and ice anglers as 4%, 87% and 9%, respectively. Seventy-nine percent of the total effort was directed at lake trout during the study period.

CHARACTERISTICS OF THE INTERVIEWS AND ANGLER POPULATION

Distribution of Interviews

Of the 2,205 interviews collected during the study, 1,067 (48%) were conducted on weekdays and 1,138 (52%) on weekend days. Just over half (53%) of the interviews involved completed fishing trips. The interviews were well distributed among the lake sections and angler types (Table 4). The number of interviews collected within each section is highly correlated to the estimated angler pressure within sections. This relationship and the large sample size provide assurance that the interviews reasonably reflect the total population of anglers.

Angler Orisin

Montanans represented 86% of the angler population and 71% of them were from either of the two counties surrounding the lake; Flathead and Lake counties. Only 5% of the Montana anglers came from counties east of the Continental Divide. Nonresidents from 31 other states and Canada represented 13% of the total population. Western states (partially or entirely west of the Continental Divide), primarily Idaho, California, and Washington represented 9.8% of the total. Just less than 2% of the angler population were from states east of the Continental Divide.

Table 4. Number of interviews collected by **lake** section and angler type and the correlation to estimated angler pressure by lake section and type.

Section/ Quadrant	Angler interviews	% of interviews by section	% of estimated angler pressure
Shore Count			
1/NW	**27**	**5.3**	**3.4**
2/SW	11	**2.1**	**5.3**
3/S	379	**74.0**	**68.6**
4/SE	**78**	**15.2**	**22.5**
5/NE	**17**	**3.3**	**1.3**
Total =	**512**		***r* = *0.99***
Boat Count			
1/NW	**280**	**23.8**	**22.7**
2/SW	**185**	**15.8**	**25.7**
3/S	**104**	8.9	**8.9**
4/SE	295	**25.1**	**11.5**
5/NE	**310**	**26.4**	**31.2**
Total = 1,174			***r* = *0.49***
Ice Count			
1/NW	**115**	**22.2**	**30.8**
2/SE	95	**18.3**	**15.5**
3/S	309	59.5	**53.7**
Total =	519		***r* = 0.95**

Target Species

The preferred species among anglers interviewed was lake trout and the second most common response was a combination of species (Table 5). Although not asked directly, anglers fishing for a combination of species were likely fishing for lake trout and either yellow perch (ice anglers) or lake whitefish (boat anglers). If the combination category is included, more than 90% of the anglers targeted lake trout. Thirteen anglers representing eight parties were fishing for suckers or northern squawfish for fun or to be used for bait. Two anglers (one interview) were fishing, unsuccessfully, for salmon.

Methods/Tackle

Creel clerks asked each angling party to identify their method of fishing by selecting one of the following: long line, fishing deep with weighted line; down rigger, fishing deep with standard line; trolling, fishing shallow with monofilament; jigging with lures or lures and bait; casting, fishing shallow with lures; bait fishing, or a combination of these techniques.

Table 5. Target species of anglers fishing Flathead Lake by shore, boat, and ice.

TARGET SPECIES	Shore N	Shore %	Boat N	Boat %	Ice N	Ice %	Overall N	Overall %
Lake Trout	397	77.5	966	82.3	373	71.9	1736	78.7
Lake Whitefish	4	0.8	22	1.9	36	6.9	62	2.8
Yellow Perch	45	8.8	79	6.7	16	3.1	140	6.3
Cutthroat Trout	1	0.2	2	0.2	0	0.0	3	0.1
Bull Trout		0.0	1	0.1	0	0.0	1	0.0
Other	4	0.8	4	0.3	0	0.0	8	0.4
Combination	61	11.9	100	8.5	94	18.1	255	11.6
Totals	512	100%	1174	100%	519	100%	2205	100%

Bait fishing was most popular among shore anglers, trolling was the primary method used by boat anglers, and ice anglers almost exclusively jigged for fish (Table 6).

Table 6. Methods used by shore, boat, and ice anglers on Flathead Lake.

METHOD	Shore Anglers N	Shore Anglers %	Boat Anglers N	Boat Anglers %	Ice Anglers N	Ice Anglers %
Long line	0	0.0	115	9.8	0	0.0
Down rigger	0	0.0	219	18.7	0	0.0
Trolling	0	0.0	416	35.4	0	0.0
Jigging	3	0.6	320	27.3	508	97.7
Casting	208	40.6	27	2.3	0	0.0
Bait	290	56.6	41	3.5	11	2.1
Combination	11	2.1	36	3.1	0	0.0
Totals	512	100	1,174	100	519	100

Party size

The mean party size for the entire population of interviews was 2.0 anglers (Table 7). Boat anglers tended to be in the largest groups and shore anglers the smallest. Mean party size on WEs was significantly higher (mean difference = 0.31; $p < 0.01$) than on WDs. Mean party size for both shore and boat anglers was slightly higher during the summer than winter period, but these differences were not statistically significant ($P > 0.05$).

Table 7. Mean party size of shore, boat, and ice anglers on Flathead Lake by day type.

PARTY SIZE	Mean	SD	N
Shore	1.5	.88	512
Boat	2.2	.88	1,174
Ice	1.9	.91	519
Weekday	1.8	.88	1,067
Weekend/Holiday	2.1	.95	1,138
For Entire Population	2.0	.93	2,205

Trip Length

The mean trip length for all interviews of completed trips was 3.7 hours (Table 8). Boat anglers on average fished longer than shore or ice anglers. Weekend/holiday trips were significantly longer than weekday trips (mean difference = 0.401; $P < 0.01$).

Table 8. Mean trip length of completed trips by angler type and WE/WD strata.

HOURS (Completed trip)	Mean	SD	N
Shore	2.1	1.65	197
Boat	4.3	2.05	763
Ice	3.0	1.71	216
Weekday	3.5	2.07	513
Weekend/Holiday	3.9	2.12	663
For Entire Population	3.7	2.11	1,176

Roving Interviews

Roving interviews were conducted on a random basis from May 17, 1992 to October 10, 1993. After mid-October, most lake access was from public ramps so roving interviews were terminated. Clerks interviewed 402 parties (375 boat and 27 shore). Forty seven percent of the boat anglers interviewed used private points of access.

COMPOSITION OF THE CATCH AND CATCH RATES

Interviewed anglers caught 6,271 -fish and kept 4,537 fish (72.3% of the catch). In order of numerical abundance, the creel consisted of lake trout (48%), yellow perch (35%), lake whitefish (14%), nongame fish (2%), cutthroat and bull trout (c 1%). The overall catch rate for all game fish and yellow perch was 0.45 fish per hour. Fish length data collected during the surveys are displayed as length-frequency histograms in Appendix C. Since clerks measured a non-random sample of fish, the length data may not be representative of fish in the harvest. Anglers and clerks may have been more willing to show and/or measure larger fish.

Lake Trout

During the survey period, the bag limit on lake trout was 10 fish under 26 inches (660 mm), or 9 fish under 26 inches and 1 fish over 36 inches (915 mm). It was illegal to harvest lake trout between 26 and 36 inches (referred to as the "slot"). For the entire population of interviews (N = 2,205) a total of 3,022 lake trout were reported caught and 2,002 (66%) were kept (Table 9). There were 69 fish (2.3%) greater than 36 inches and 357

Table 9. Reported numbers and sizes of lake trout in the anglers' creel on Flathead Lake.

Angler Type	Number Caught	Percent of Total	Number Kept	Percent Kept
Shore N = 512				
less than 660 mm (26")	297	**98.0**	280	**94.3**
660 mm to 915 mm (26-36" slot)	5	1.7	0	**0.0**
greater than 915 mm (36")	1	0.3	0	**0.0**
Boat N = 1,174				
less than 660 mm (26")	1,681	80.7	1,118	66.5
660 mm to 915 mm (26-36" slot)	340	16.3	9	2.6
greater than 915 mm (36")	63	3.0	27	42.9
Ice N = 519				
less than 660 mm (26")	618	**97.3**	561	**90.8**
660 mm to 915 mm (26-36" slot)	12	1.9	2	16.7
greater than 915 mm (36")	5	0.8	5	100.0
For Entire Population N = 2,205				
less than 660 mm (26")	2,596	**85.9**	1,959	75.5
660 mm to 915 mm (26-36" slot)	357	11.8	11	3.1
greater than 915 mm (36")	69	2.3	32	46.4
Totals	3,022	100.0	2,002	66.2

fish (11.8%) in the slot. Shore and ice anglers kept more than 90% of their catch, and boat anglers kept 55.4% of their catch. Boat anglers reported that nearly 20%-of their catch was over 26 inches. Less than 3% of the catch reported by shore and ice anglers was greater than 26 inches.

A total of 1,225 lake trout were measured during the survey. The mean size of lake trout measured under the slot was 521 mm (SD = 73.4). Eleven "trophy" lake trout (> 915 mm) were measured and had a mean length of 970 mm (SD = 48.6; range = 915 - 1060 mm).

The overall MPCPUE for lake trout anglers for the survey was 0.26 (SD = 0.602) fish per hour (Table 10). Shore anglers had the highest MPCPUE, and boat anglers the lowest. The higher catch rate calculated for shore anglers is largely attributed to anglers fishing Polson City Docks were the MPCPUE was 0.39 (SD = 0.835) lake trout per hour. Catch rates (MPCPUE) for boat anglers on the north half (sections 1 & 5) were significantly higher than those on the south half (sections 2, 3, & 4) of the lake (P c 0.01) when grouped together. MPCPUE in section 5 for lake trout was significantly higher than section 1 ($P = 0.0352$). Catch rates between ice fishing areas showed no significant differences.

Table 10. Catch rates by angler type and method for anglers specifically fishing for lake trout.

LAKE TROUT CATCH RATES	MPCPUE	SD	N
ANGLER TYPE			
Shore	0.33	0.882	397
Boat	0.23	0.461	966
Ice	0.28	0.553	373
For Entire Population	0.26	0.602	1736
LAKE SECTION (boats)			
1 /NW	0.23	0.370	252
2 /SW	0.11	0.251	167
3 /S.BAY	0.11	0.215	30
4 /SE	0.18	0.338	256
5 /NE	0.37	0.682	261
For Entire Population	0.23	0.461	966

There was no significant difference in harvest rates between completed and uncompleted trips for shore or ice anglers. However, completed trip interviews of boat anglers indicated significantly higher harvest rates than for uncompleted interviews (Table 11).

Table 11. Lake trout harvest rates calculated from uncompleted-trip and completed-trip interviews. Significant differences are indicated by an asterisk (P < 0.01).

	MPHPUE(SD)		
Trip	Shore	Boat	Ice
Uncompleted	0.31(0.765)	*0.10(0.234)	0.23(0.364)
Completed	0.28(0.709)	*0.14(0.269)	0.29(0.574)

Lake Whitefish

Sixty-two (2.8%) of the angler parties surveyed specifically fished for lake whitefish, and 36 (58%) of these were ice anglers. Ice anglers had the highest MPCPUE and kept nearly all of their catch (Table 12). The MPCPUE for all angler types was 1.01 whitefish per hour (SD = 1.58). The **mean** length of whitefish measured in the creel was 470.3 mm (SD = 43.47) (Appendix C). Tests between uncompleted and completed interviews in MPHPUE were not significantly different ($P < 0.01$) for lake whitefish.

Yellow Perch

The majority (56%) of interviews of perch anglers were collected from boaters in South Bay during the spring. Ice and shore anglers represented 11% and 32% of the interviews, respectively. Overall anglers kept 71% of their catch, shore anglers tended to keep a higher percentage of their catch than did boat or ice anglers (Table 12). The MPCPUE of all perch anglers was 1.86 fish per hour (SD = 5.19). The mean length of yellow perch measured in the creel **was 248** mm (SD = 36.0) (Appendix C). Tests of MPHPUE between uncompleted and completed trips were not significantly different (P **c** 0.01) for yellow perch.

Westslope Cutthroat Trout

Only three parties interviewed specifically targeted cutthroat. Because none of the anglers in these parties were successful, no target specific MPCPUE is presented in Table 12. However, 15 cutthroat were reported caught in 10 party interviews. Eight of the parties were fishing for a combination of species, and two were fishing for lake trout. The MPCPUE for the 10 interviews was 0.50 cutthroat per hour (SD = 0.615). Five cutthroat measured had a mean length of 939 mm (SD = 1273.0).

Table 12. Catch, MPCPUE, and mean length (mm) of lake trout, lake whitefish, yellow perch, westslope cutthroat and bull trout in anglers' creel.

Species Type	Number Caught	Number Kept	Percent Kept	MPCPUE	SD	N	Mean Length	SD	Min	Max	N
Lake trout	3,022	2,002	66.2	0.26	0.602	1,736	527	88.4	240	1,060	1,227
Shore	303	280	92.4	0.33	0.882	397	547	64.6	310	676	136
Boat	2,084	1,154	55.4	0.23	0.461	966	531	104.0	240	1,060	527
Ice	635	568	89.4	0.28	0.553	373	519	75.8	328	960	564
Whitefish	901	884	98.1	1.01	1.58	62	470	43.5	214	663	672
Shore	11	7	63.6	.30	.360	4	484	25.1	458	508	3
Boat	196	184	93.9	.96	1.60	22	430	72.2	214	560	47
Ice	694	693	99.9	1.13	1.65	36	473	39.2	351	663	623
Perch	2197	1573	71.6	1.86	5.19	140	248	36.0	138	389	563
Shore	230	189	82.2	2.43	8.66	45	215	24.2	175	235	5
Boat	1705	1196	70.1	1.72	2.30	79	249	36.0	138	389	483
Ice	262	188	71.8	1.02	2.31	16	246	38.2	152	332	75
Cutthroat	15	9	60.0	0.0	0.0	0	370	46.5	302	405	4
Shore	3	3	100.0	0.0	0.0	0	393	0.0	393	393	1
Boat	12	6	50.0	0.0	0.0	0	362	53.7	302	405	4
Ice	0	0	0.0	0.0	0.0	0	0	0.0	0	0	0
Bull trout	13	8	61.5	0.0	0.0	0	612	82.0	533	736	5
Shore	2	1	50.0	0.0	0.0	0	533	0.0	533	533	1
Boat	11	7	63.6	0.2	0.0	1	632	80.0	558	736	4
Ice	0	0	0.0	0.0	0.0	0	0	0.0	0	0	0
Non-game fish	123	59	48.0	0.0	0.0	0	0	0.0	0	0	0
Shore	93	48	51.6	0.0	0.0	0	0	0.0	0	0	0
Boat	27	8	29.6	0.0	0.0	0	0	0.0	0	0	0
Ice	3	3	100.0	0.0	0.0	0	0	0.0	0	0	0

Bull Trout

Only one interviewed party of two anglers reported they were fishing for bull trout. They caught and kept one bull trout with six hours of effort. A total of 13 bull trout were reported caught and eight were kept (Table 12). Of the 10 interviewed parties who caught bull trout; six were fishing for a combination of species, two where fishing for lake trout, one was fishing for whitefish, and one party was fishing for bull trout. The MPCPUE for bull trout for these 10 parties was 0.24 bull trout per hour (SD = ***0.278).*** Of the eight bull trout kept, five were measured by clerks and had a mean length of 612 mm (SD = 82.0). Bull trout fishing was closed on July 6, 1992 in response to declining spawning populations.

FISHING PRESSURE

Anglers on Flathead Lake fished an estimated 47,883 angler-days (190,108 hours) between May 17, 1992, and May 19, 1993 (Table 13). Fishing pressure increased steadily from the initiation of the survey in mid-May and peaked in July (Figure 3). June and July represented 45% of the total pressure for the year (Appendix D). Fishing pressure decreased from the end of July through November. November had the least total pressure of any month with 1,688 hours.

Table ***13.*** Shore, boat, and ice angler pressure in hours, by lake section on Flathead Lake.

Sections	Shore	Boat	Ice	Section Totals	S. D.	95% C.I. Lower	95% C.I. Upper
Section 1	181	37,333	5,529	43,043	2,403-l	38,333	47,753
Section 2	401	42,332	2,779	45,511	2,701.3	40,217	50,806
Section 3	5,247	14,624	9,634	29,504	1,935.9	25,710	33,299
Section 4	1,725	18,865	0	20,590	1,935.5	16,796	24,383
Section 5	97	51,363	0	51,460	3,364.0	44,867	58,054
Totals	7,650	164,517	17,941	190,108	5,646.0	179,041	201,175

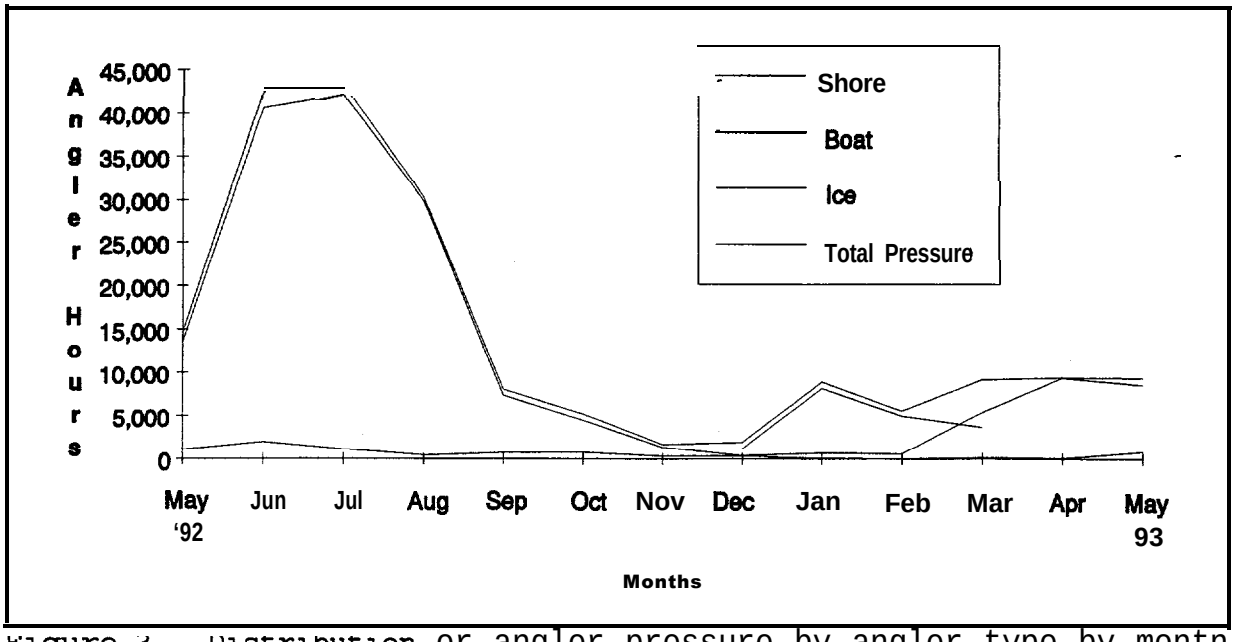

Figure 3. Distribution of angler pressure by angler type by month on Flathead Lake.

Shore, boat, and ice anglers represented, 4%, 87%, and 9% of the total pressure, respectively (Figure 4). The north half (sections 1& 5) of the lake represented 50% the overall fishing pressure (Figure 5). Section 4 had the least amount of overall fishing pressure with 11% of the total. Approximately 60% of the total fishing pressure occurred on the weekends and holidays.

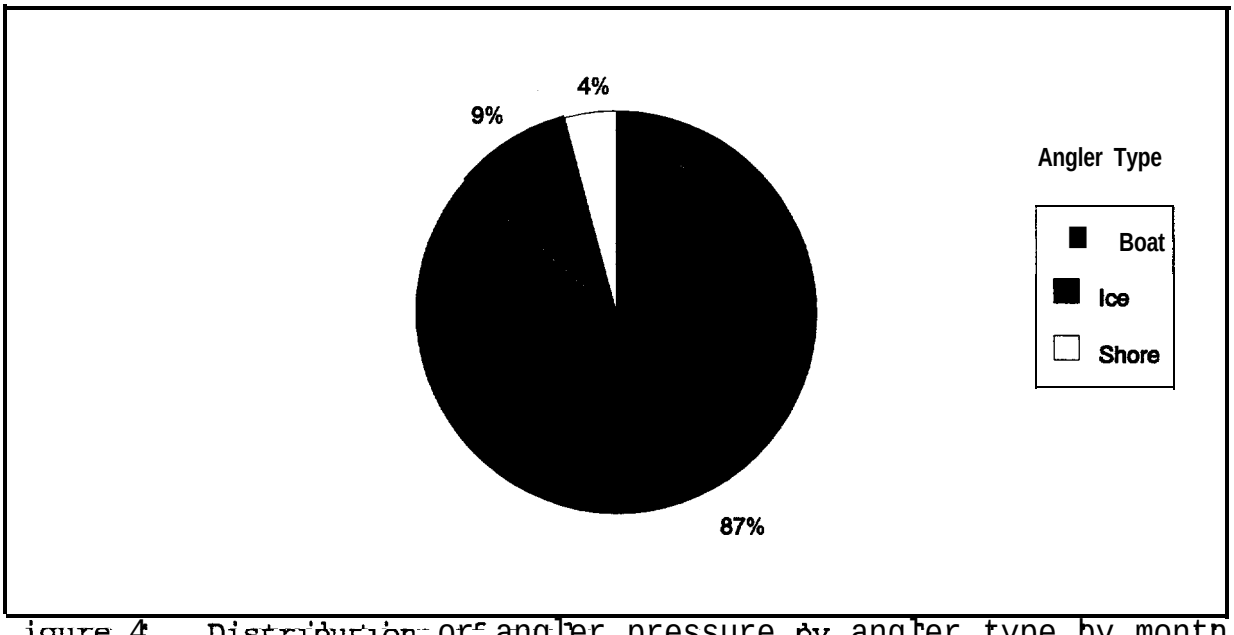

Figure 4. Distribution of angler pressure by angler type by month on Flathead Lake.

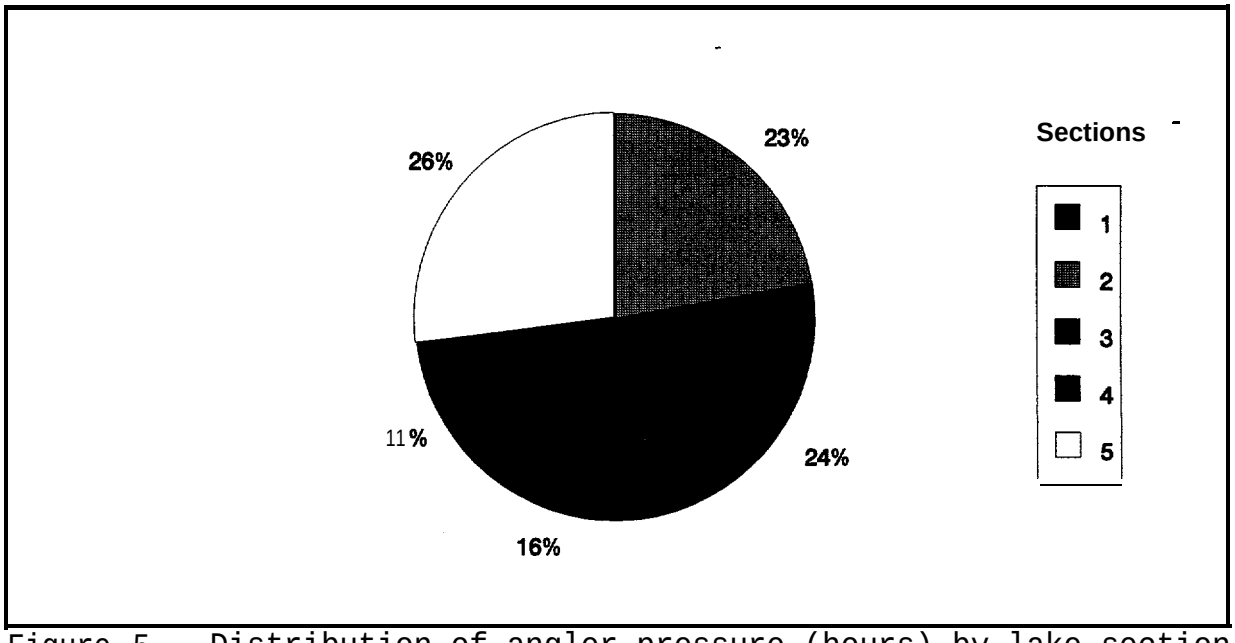

Figure 5. Distribution of angler pressure (hours) by lake section on Flathead Lake.

Boat Angler Pressure

Boat anglers spent an estimated 38,260 angler days (164,517 hours) of effort fishing Flathead Lake. Section 5 constituted the largest portion of the pressure with 31.2% and together with section 1 (22.7%), the north half of the lake represented 53.9% of the total boat angler pressure. South Bay (section 3) recorded the least amount of boat angler pressure with 8.9%. Boat angler pressure is the largest component of the total pressure (87%).

Shore Angler Pressure

An estimated total of 7,650 hours of effort (3,643 angler days) were spent by shore anglers fishing Flathead Lake. More than 90% of the total shore pressure occurred in sections 3 and 4. South Bay (section 3) accounted for 68.6% (5,247 hours) of the total shore pressure with 91.8% of this pressure occurring at the Polson city dock. Section 4 was popular among shore anglers because of good public access along Highway 35 and the dock at Blue Bay. Less than 5% (278 hours) of shore angler pressure occurred on the north half of the lake. The seasonal distribution of shore angler pressure is influenced by water temperatures in South Bay. Warm water temperatures exclude lake trout from the bay resulting in less pressure during mid-summer.

Ice Angler Pressure

Flathead anglers fished an estimated total of 17,941 hours (5,980 angler days) on the ice between December 12, 1992 and March 22, 1993 (Table 14). Three separate areas of the lake froze hard enough to allow ice fishing. South Bay accounted for 53.7%; Big Arm Bay, 15.5%; and Somers Bay, 30.8% of the total ice angler pressure (Figure 6). However, considering the number of available ice fishing days, Somers Bay had the highest concentration of pressure with 104 angler hours per day and Big Arm Bay had the least concentrated pressure. The primary target species of ice anglers in all three areas was lake trout.

Table 14. Ice angler pressure estimates for three areas on Flathead Lake.

Area	Dates			Angler Hours	Available Days	Hours/ Day
South Bay	December 12	to	March 21	9,634	100	96
Big Arm Bay	January 10	to	March 13	2,779	63	44
Somers Bay	January 29	to	March 22	5,529	53	104

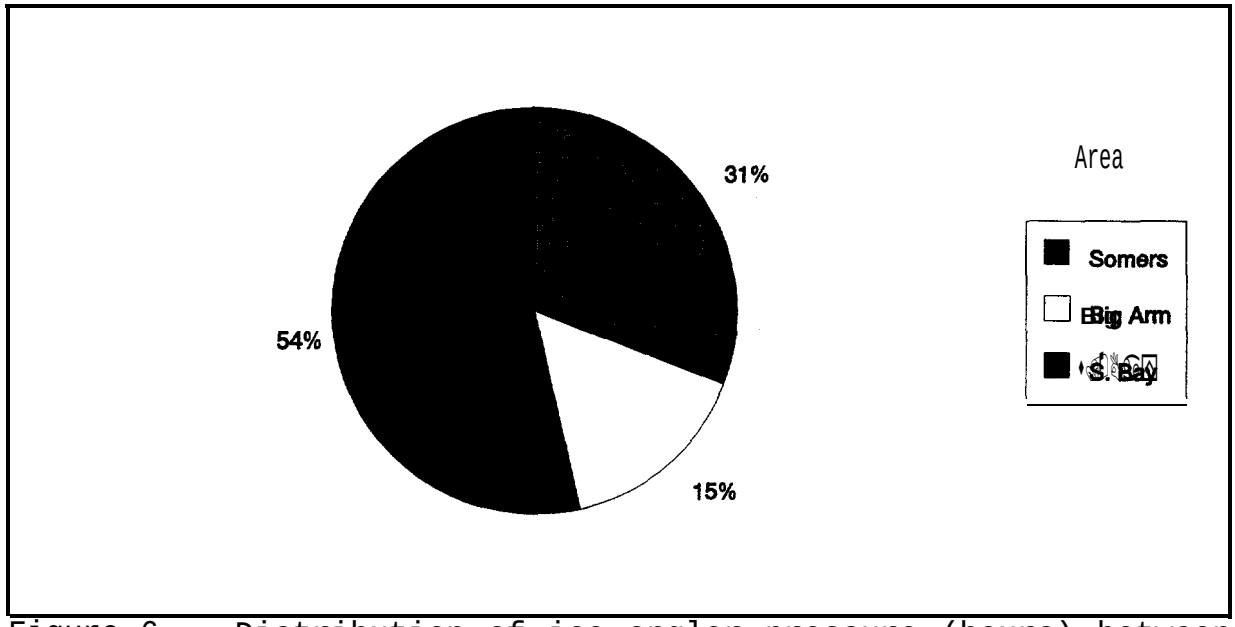

Figure 6. Distribution of ice angler pressure (hours) between three areas on Flathead Lake.

FISH HARVEST

Flathead Lake anglers harvested an estimated 42,979 fish from May 17, 1992, through May 19, 1993 (Table 15). The harvest consisted of 23,605 (54.9%) lake trout, 11,795 (27.4%) yellow perch, 7,265 (16.9%) lake whitefish, 196 bull trout, and 118 westslope cutthroat trout. Boat anglers accounted for 74.7%, ice anglers 18.7%, and shore anglers 6.6% of the total harvest. Monthly estimates of fish harvest from May 17, 1992 to May 18, 1993 are presented in Appendix D.

Table 15. Species harvest by angler type in Flathead Lake.

Species	Shore Harvest	% of total	Boat Harvest	% of total	Ice Harvest	% of total	Species Totals	% of Total
Lake Trout	855	3.6	19,621	83.1	3,129	13.3	23,605	54.9
Perch	1,915	16.2	8,617	73.1	1,263	10.7	11,795	27.4
Whitefish	40	0.6	3,572	9.2	3,653	50.3	7,265	16.9
Cutthroat	21	17.8	97	2.2	0	0.0	118	0.3
Bull Trout	4	2.0	192	8.0	0	0.0	196	0.5
Totals	2,835	6.6	32,099	4.7	8,045	18.7	42,979	100.0

Lake Trout Harvest

An estimated 23,605 lake trout were harvested during the survey period. Based on the relative percentages in the creel, the lake trout harvest consisted of 23,098 fish less than 660 mm, 130 fish in the slot (660 - 915 mm), and 377 fish greater than 915 mm. Anglers kept 74% of all legal sized lake trout, however they kept only 36% of the trophy size fish.

Boat anglers accounted for 83.1% of the total lake trout harvest. The majority (74%) of harvest from boats was from the north half of the lake (section 1 and 5) because of higher pressure and catch rates. Section 5 alone accounted for 50% of the entire harvest of lake trout by boat anglers (Figure 7). Boat anglers kept 65.5% of their catch under 660 mm (26") and 42.9% over 915 mm (36") (see Table 9).

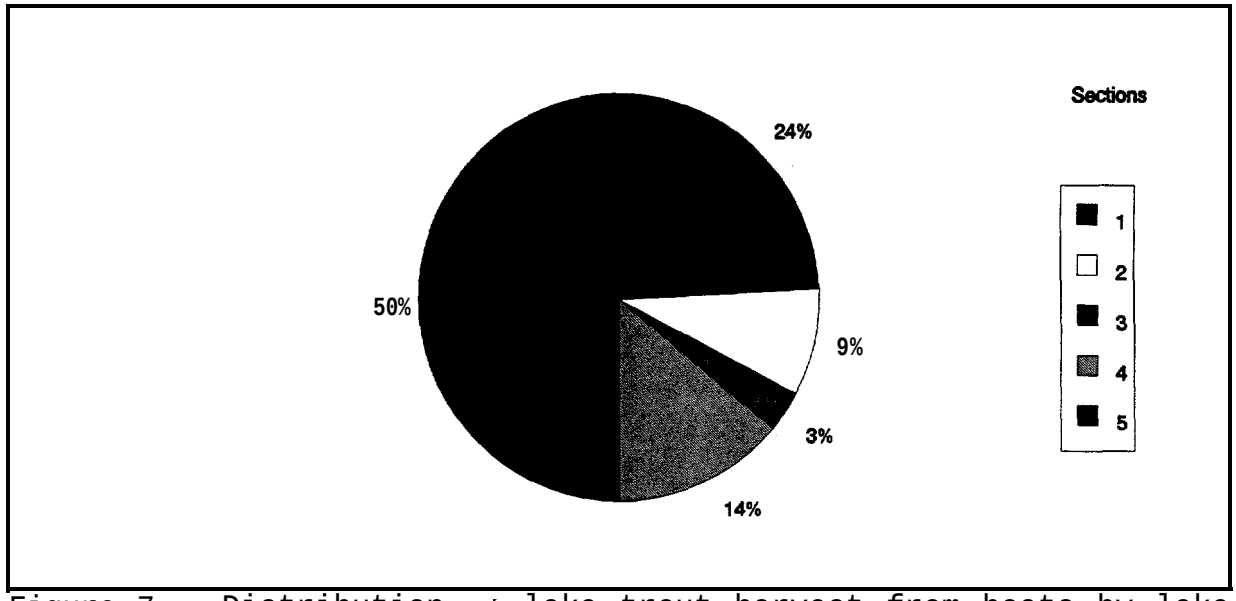

Figure 7. Distribution of lake trout harvest from boats by lake section on Flathead Lake.

Thirteen percent (3,129) of the total lake trout harvest was through the ice (see Table 15). South Bay accounted for the majority (57%) of the ice fishing harvest because of the longer period of ice cover than the other areas (Figure 8). The majority of shore angler harvest of lake trout was also in South Bay from the Polson city docks.

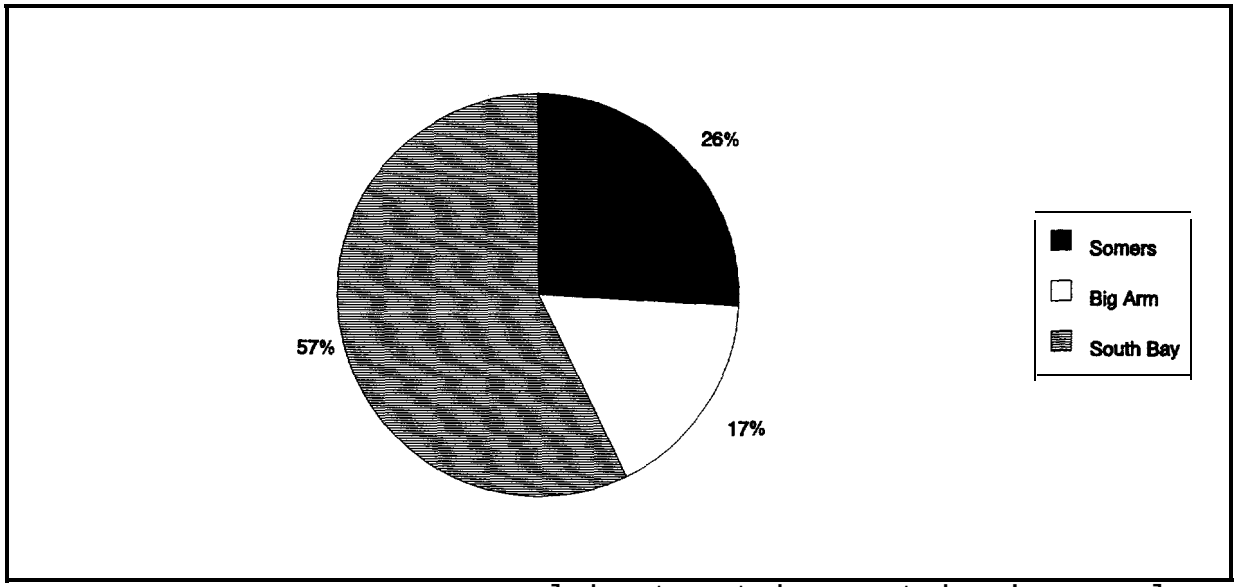

Figure 8. Distribution of lake trout harvest by ice anglers fishing Flathead Lake.

Lake Whitefish Harvest

An estimated 7,265 lake whitefish were harvested during the survey period. The whitefish harvest was distributed among shore, boat, and ice anglers as 0.6%, 49.2%, and 50.3% respectively (see Table 15). Of anglers specifically targeting whitefish, the majority were ice anglers. Ice anglers also had the highest MPCPUE among angler types (see Table 12). The most popular (88.7%) method of fishing for whitefish was jigging. Whitefish anglers kept essentially all of their catch (98.1%).

Yellow Perch Harvest

An estimated 11,795 yellow perch were harvested during the survey period. The majority (73.1%) of the harvest occurred in the spring (April and May) by boat anglers. All perch harvested by interviewed anglers (shore, boat, & ice) were caught in South Bay. Anglers catching perch kept 71.6% of their catch.

Cutthroat and Bull Trout Harvest

An estimated 118 cutthroat and 196 bull trout were harvested during the study period. Most of this harvest was incidental catch by boat anglers. Few anglers specially targeted these species (see Table 5). An emergency closure was imposed on bull trout harvest on July 6, 1992 in response to evidence indicating declining populations.

DISCUSSION

Several creel surveys have been conducted on Flathead Lake over the last three decades that provide some measure of change in the fishery. No quantitative comparisons between estimates are made here because of either a lack of detailed information on methods used, or a difference in methodologies and assumptions that incorporated different biases. If sources of bias are recognized and understood they may be held constant between surveys making the results comparable. Because an objective of this study was to set a baseline to measure future mitigation efforts, it must be comparable to future surveys. To meet this objective, the methods and assumptions were described in detail. Additionally, it is necessary to explain potential sources of bias in this study.

COMPARISONS TO PAST SURVEY INFORMATION

Yearlong creel surveys were conducted in 1962-63 by the Bureau of Sport Fisheries and Wildlife (Robbins 1966), and again in 1981-82 by MDFWP (Graham and Fredenberg 1983). Comparing the results of those surveys to this survey is difficult because of the different methods employed. A creel survey conducted by MDFWP during the summer of 1985 (Hanzel 1986) employed a similar design as this study.

The 1962-63 survey used a combination of postal questionnaires and personal angler interviews, and the 1981-82 survey used car counters to measure angler pressure, and angler interviews to estimate success. The different sampling designs required different assumptions and therefore have different biases. These differences do not allow direct comparison of the pressure and harvest estimates between the annual creel surveys. Comparisons between the results of this survey and any of the surveys prior to 1986 are further complicated by the dramatic changes in the fishery. Despite these problems, some relative comparisons of the estimates and general trends are possible when viewed in the context of the historical fishery and with the proper qualifiers.

The fishery that existed prior to 1986 was primarily a kokanee fishery (Robbins 1966; Graham and Fredenberg 1983; Hanzel 1986). Kokanee became well-established in the first half of this century, spawning at first in the lake and later in upper river tributaries. Snagging the migratory spawners became popular in the 1960s and continued into the 1980s. The kokanee fishery that had been so popular for decades disappeared abruptly in 1986. MDFWP redd count data are indicative of how precipitous was the population decline. An average of 80,000 redds were counted in the lake and river system between 1979 and 1985. The peak redd count was 141,000 in 1985, then declined to 24,000 in 1986, and 600 in 1987 (Vashro et al. 1989). Some of the angling pressure may have shifted to other local kokanee fisheries. In the late 1980s lake whitefish and lake trout were increasing in numbers (Hanzel 1990). MDFWP has made efforts to educate the public to new angling techniques for whitefish and lake trout.

Pressure Estimates

Seasonal trends and distribution of pressure among angler types were somewhat similar among all three yearlong studies. Boat anglers represented 93% and 87% of the angler pressure in 1981-82 and 1992-93, respectively. Angler pressure peaked in early summer in 1992-93 (June and July) as compared to the 1981-82 and 1985 surveys when the highest monthly pressure occurred in August.

Although direct quantitative comparisons of the annual creel survey pressure estimates cannot be made, an additional source of data is available from the MDFWP statewide angler pressure mail surveys. These surveys are conducted with consistent methods between years (Bob McFarland, Systems Analyst MDFWP, personal communication) and provide angler pressure estimates in angler days for a particular year. Because the mail surveys are more numerous than the direct creel surveys, and employ the same method in all years, they are useful for identifying trends. The statewide angler pressure mail surveys are currently conducted every other year. Future mail survey estimates will be important in verifying angler pressure trends on Flathead Lake. Greater variation exists between the independent survey results, which employed different methods, than the mail survey results which employed consistent methods (Figure 9).

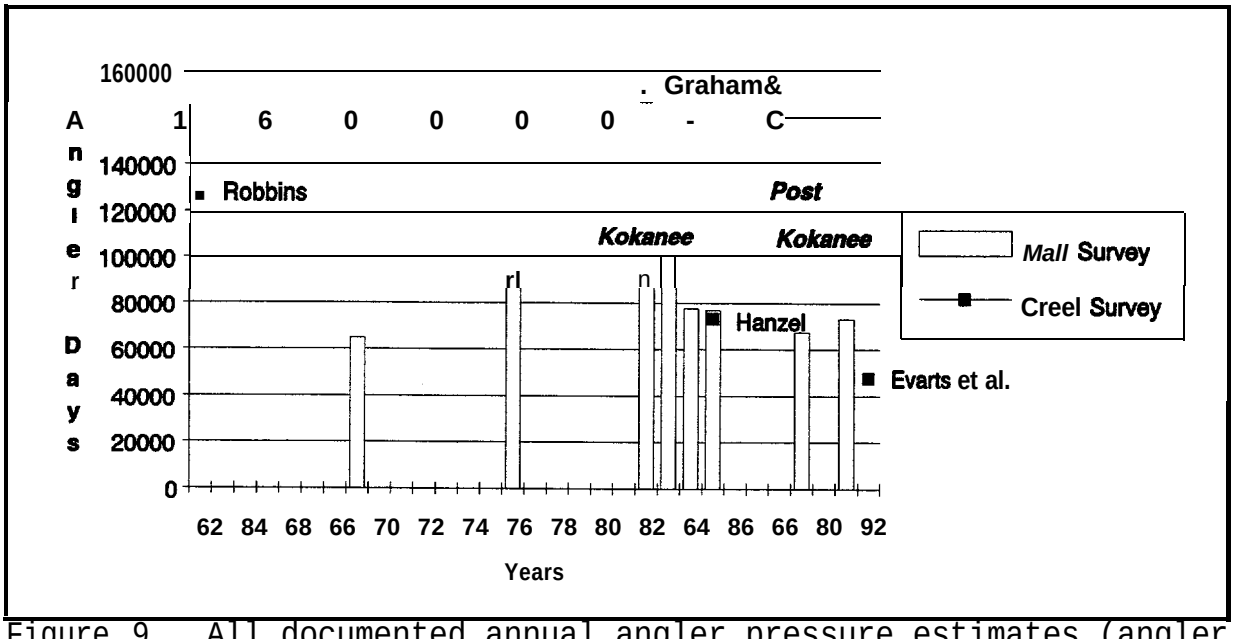

Figure 9. All documented annual angler pressure estimates (angler days) for Flathead Lake, Montana.

Eight years of mail survey estimates are available between the 1961-62 and the 1992-93 creel survey (Table 16). Grouping the mail survey estimates into kokanee and post-kokanee years allows for a comparison of angler pressure between the two distinct fisheries in Flathead Lake's recent history (Figure 9). Although the mean difference between groups was nearly 15,000 angler days, the difference is not significant ($P = 0.22$).

Table 16. Eight years of pressure estimates (angler days) for Flathead Lake taken from the MDFWP's statewide angler mail surveys.

KOKANEE FISHERY			POST-KOKANEE FISHERY		
Year	Ang-days	SE	Year	Ang-days	SE
1969	***64,996***	na			
1976	97,774	na			
1982	91,944	12,312	1989	***67,737***	***4,208***
1983	103,319	14,412	1991	73,393	***4,427***
1984	***77,734***	***12,587***			
1985	***76,876***	9,091			
Mean	85,441		Mean	***70,565***	
Mean Difference = 14,876				***P = 0.22,*** CI = 95%	

na = not available

Imperfections in this comparison include the data set being small, and variable, as kokanee fisheries typically experience strong and weak year classes. It seems likely that the high variability between years in the mail survey estimates masks any real differences between periods. The large mean difference in angler days is noteworthy and warrants additional analysis.

A more direct comparison is afforded by the aerial count data from the 1985 and 1992-93 creel surveys. The 1985 creel survey was limited to 12 weeks during the summer, however its design and methods were similar to the 1992-93 survey. Aerial counts in 1985 were conducted from June 16 to September 7, but did not include shore anglers. Sample days were picked at random at a rate of four weekday and three weekend days per 14 day period (Hanzel 1986) similar to the rates used in this survey (see Table 2).

The mean number of fishing boats counted in 1985 was 31.1 greater than in 1992 (P = 0.001; 99% CI) (Table 17). This represents a 46% decrease in the mean number of fishing boats per count from 1985 to 1992. However, mean completed trip length and party size were not significantly different between survey years. Both surveys also counted sail boats and other recreational boating, which showed no difference in this type use during the same period.

Table 17. Comparison of fishing boat counts in Flathead Lake creel surveys from mid-June to early September of 1985 and 1992.

Summer 1985				Summer 1992			
Day	Mean	SD	N	Day	Mean	SD	N
Weekday	47.5	37.23	42	Weekday	25.4	14.64	50
Weekend	94.4	56.15	39	Weekend	59.0	35.56	34
Combined	70.1	52.55	81	Combined	39.0	30.08	84

Mean Difference (Combined) = 31.1 $P = 0.001$, CI = 99%

The highly significant differences between mean boat counts provide assurance that the boat angler pressure in the summer of 1985 exceeded that in the summer of 1992. Further comparison to include total pressure is not possible due to differences between surveys in definition of parameters such as day length, stratification, etc.

Expanding the summer 1985 boat count data set by a proportional factor to generate an annual estimate of pressure for comparisons carries a lower level of confidence. While the comparison of this count data between 1985 and 1992 is conclusive, it should not be construed as a 46% reduction in annual angler pressure between the two creel survey years. This 12 week period represented 49% of the total annual pressure estimate in the 1992-93 creel survey, while Hanzel (1985) estimated this period represented 75% of the total annual pressure. The differences in seasonal patterns of kokanee versus lake trout fisheries likely result in different seasonal patterns of angler pressure.

Harvest Estimates

Harvest estimates have a greater potential for error than pressure estimates, because they are the product of two statistics: the pressure and harvest rate estimates. Experimental error in both estimates contributes to experimental error of the product: the estimate of total harvest. Since quantitative comparison is not possible, a contrast of the relative composition of the harvest between surveys best demonstrates the change in the fishery. Kokanee represented 76%, 92%, 97% and 0% of the harvest in the 1962-63, 1981-82, 1985, and 1992-93 survey results, respectively. The bulk of the rest of the harvest in the previous surveys was yellow perch. The 1985 survey did not include the yellow perch fishery, therefore this kokanee harvest estimate represents an artificially higher percentage of the harvest.

Harvestable populations of lake, bull, and cutthroat trout were present during all four creel surveys. Bull and cutthroat trout represent the "native species" component of the fishery and hold a special status with both the state and tribes. The relative contribution of native species to the total harvest was 4.9%, 2.3%, 1.7% and 0.08% in 1962-63, 1981-82, 1985, and 1992-93 surveys, respectively. Lake trout represented 0.5%, 1.3%, 1.7%, and 54.9% of the total harvest in 1962-63, 1981-82, 1985 and 1992-93 surveys, respectively.

In addition to the past creel surveys already discussed are three creel surveys directed specifically at the South Bay perch fishery. These surveys were conducted by CSKT in 1985 and 1986 (Cross and Waite 1988) and used similar methods to the 1992-93 creel survey. The 1985 survey targeted the winter (ice) perch fishery and the harvest was predominately perch (99%). However, the investigators did document "incidental" catch of mountain whitefish, lake whitefish, largemouth bass, cutthroat and bull trout (Pajak et al. 1985). By comparison, the 1992-93 ice fishery in South Bay was dominated by whitefish and lake trout. Lake trout dominated the harvest in December and tapered off by March, while whitefish and perch became more abundant in the harvest in February and March (see Appendix E, Table E2). This pattern may be the result of perch being more dispersed, not associated with open water, or simply not as abundant while lake trout are concentrated in South Bay during the winter.

Lake trout provided a popular ice fishery and were the target species of the majority of ice anglers (see Table 5). Although whitefish were not as frequently targeted, they represented the majority of the fish harvested through the ice (see Table 15). There was no documented catch of bull trout through the ice during the 1992-93 survey.

The perch harvest estimates from the 1985 and 1986 winter creel surveys were 16 and 25 times higher, respectively, than estimated in the winter of 1992-93. In the 1985 survey alone, clerks measured 1,430 perch (N = 409 interviews), exceeding the total estimated harvest of fish in the winter of 1992-93 (see Table 15). Catch rates for perch through the ice were 3.2, 3.9, and 1.0 perch per hour in 1985, 1986, and 1993, respectively.

CSKT creeled the 1986 spring boat fishery directed at spawning perch and estimated a similar harvest as in the spring of 1993. Catch rates in 1986 and 1993 were 4.0 and 1.7 perch per hour, respectively. Cross and Waite (1988) did not provide an estimate of angler pressure, but this comparison suggests that

angler pressure on the South Bay perch fishery was lower in the spring of 1986 than in 1993.

Angler opportunity and harvest has changed significantly since 1986. In 1992-93 there was essentially no opportunity to fish for kokanee, however, opportunity to fish for lake trout and lake whitefish increased manyfold. The opportunity to catch native species has declined. The yellow perch fishery has changed significantly and the opportunity to catch perch through the ice has decreased.

EVALUATION OF THE 1992-93 SURVEY METHOD

Stratification

The stratified design used in this study produced precise and accurate estimates. Differences in both party size and trip lengths between the WD and WE strata were identified, which verified the importance of temporal stratification in reducing bias in the pressure estimates. Differences in catch and harvest rates between lake sections were identified which verified the importance of spacial stratification in producing a more accurate estimate of total harvest. In addition, significant differences in harvest rates between interviews of completed and uncompleted trips by boat anglers fishing for lake trout were identified. Based on this information, the data set was further stratified and only completed trip information was used for lake trout harvest estimates.

Bias

A potential source of bias in this study, which was not conclusively evaluated, was the difference in angler populations entering the fishery from private versus public accesses. Anglers using private access, including those using charter boat services, represented ***47%*** of the total angler population. Charter boat anglers may have higher catch rates because of the fishing experience of the crew. Anglers entering the fishery from their own private docks may fish for shorter lengths of time or more frequently than those anglers who trailer their boats to a public access.

The analysis of boat anglers using public versus private access was inconclusive. The difference in MPHPUE between public and private access anglers was not highly significant ($P = 0.03$). While this difference is significant at $\alpha = 0.05$, the results are inconclusive because they are masked by the differences in harvest rates between completed and uncompleted trips. All private access boat interviews were collected by roving clerks, and therefore were of trips in progress (uncompleted trips). There was no difference ($P < 0.01$) in MPHPTJE between uncompleted public and uncompleted private access interviews. Future creel

surveys might address this question with a follow up mail survey. Roving clerks who interview boat anglers entering the fishery from private accesses could provide postage-paid postcards to be returned upon completion of the fishing trip. One representative from the fishing party should be asked to fill in the catch, harvest, and total trip length, before mailing the card.

The aerial angler counts may also be a source of bias. All counts were initiated from the southern end of the lake and flown in a northerly direction. This was done to coordinate flights (and reduce expenses) with a concurrent creel survey on the Upper Flathead River. Lambou (1961) suggests that when using instantaneous counts where the body of water is divided into areas, the starting points for counts should be selected randomly. Because the flights were never initiated on the north end of the lake, the angler counts in sections one and five tended more toward mid-day. If there were more or less anglers on the lake during the first and last hours of the day, the count data for the north sections may be biased accordingly.

Another limitation of aerial angler counts is the need for backup counts. Only two flights were canceled between May 17, 1992 and October 15, 1992. During the fall and winter months canceled flights were frequent; over half were canceled in November and December. Fortunately the assumptions necessary for winter ground counts were easily met because falling lake levels in mid-September rendered private dock facilities inoperable, so all anglers were using public facilities.

It is important that future creel surveys address potential biases in a similar fashion. Similar stratification should be used, tests between completed and uncompleted trips made, and the public versus private access issue addressed. Similarly, definition of variables must be standardized. For example, any change in the definition of an angler, the length of the fishing day, or the calculation of harvest rates could change estimates of pressure and harvest. It is important that data are collected and stored in a manner that is retrievable, affording reanalyzation and comparisons to future creel surveys.

Future Creel Surveys

The design used in this survey can be modified and adjusted to accommodate smaller survey budgets. Similar methods could be used in a smaller scale survey by limiting the sampling to a specific time period (the summer season or a particular month), for a specific area (section) of the lake, or for a particular stratum (weekend boat anglers). These results could then be compared to the same time period, lake area, or stratum in this survey. Such surveys may be useful for spot checking the fishery or to determine if a full lake-wide creel survey is warranted.

Caution must be used with limited scope surveys in a system that is rapidly changing. As the fishery shifts, the distribution of pressure both spatially and temporally may change, confusing any comparisons. This is particularly true if there is a significant change the in species preference of anglers. For example, the areas fished, and/or seasonal pattern of a kokanee fishery may be quite different than with the current lake trout fishery. Future mitigation sponsored creel surveys will likely be designed around the objective of measuring the success or failure of kokanee supplementation (DosSantos et al. 1993). The utility of scaled-down surveys will depend on the specific objectives and the dynamics of the fishery. If the objective is overall annual estimates of angler pressure and harvest, then a scaled down survey is not recommended.

Kokanee supplementation is a five year experiment. The most useful creel statistic for monitoring the progress of this effort may be catch and harvest rates. Catch and harvest rates have often been used as an index of stock density (Ricker 1975; Everhart and Youngs 1981; Farman et al. 1982). Catch and harvest rates are easily obtained and comparable across fisheries, while other useful data on the fishery can be collected at the same time. The rate estimator used depends on study objectives. This survey used two types of harvest estimators to achieve different objectives. Crone and Malvestuto (1991) compare five different calculations of harvest rate estimators and demonstrate the wide range of values that can be obtained. They conclude that the best methods for calculating HPUE are the ones that are the most precise.

A simple method for monitoring future harvest is to couple a harvest rate estimator with the MDFWP statewide mail pressure surveys.. The statewide mail pressure surveys are conducted every other year and did not coincide with this survey. A relationship could be established between the pressure estimate for this survey and for the 1993-94 fishing season, assuming no (significant) change in angler pressure between the 1992-93 and 1993-94 fishing seasons. The 1995-96 mail survey pressure estimate can then be correlated with that from this 1992-93 creel survey and the 1993-94 mail survey estimates. A similar correlation could be established to estimate harvest by using harvest rates collected during the same time periods. The estimates would likely not be precise enough to measure the criteria for success of kokanee supplementation, but they may be useful in determining the need for another creel survey of the current magnitude.

SUMMARY AND CONCLUSIONS

The objective of this survey was to document the current fishery and provide a benchmark against which mitigation efforts may be measured. It was also important that this study be reproducible so that future surveys may be directly compared. Therefore thorough documentation of the procedures used here and their effects on the accuracy and precision of the estimates were included. If future surveys are to be directly comparable to this benchmark, managers must require consistency in methods and estimates precise enough to be meaningful.

An estimated 47,883 angler days were spent fishing Flathead Lake resulting in a harvest of 42,979 fish from May 17, 1992, to May 18, 1993. Lake trout were the primary target species and represented 54.9% of the total harvest. Although these estimates are not directly comparable to past annual creel surveys, it is obvious that a dramatically different fishery exists today. Prior to 1986, kokanee was the primary fishery in the lake, utilized by boat anglers with specialized tackle. Comparatively, the fishery that exists today is more diverse in species harvest and angling methods. The MDFWP statewide mail angler pressure surveys suggest little difference between angler use of the current fishery and the kokanee fishery that existed prior to 1986. In contrast, a comparison of fishing boat count data between 1985 and 1992 suggests a dramatic decline pressure during the summer season.

Creel survey statistics may be valuable to future monitoring of the Flathead Lake fishery and its response to mitigation efforts. Depending on the specific objectives, the scope of future creels could be narrowed to a shorter time frame or a smaller portion of the lake. However, the use of limited-scope surveys to measure angler pressure and harvest should be used with caution in an unstable fishery. Catch and harvest rates may be the most valuable and cost effective parmeters available to managers in a rapidly shifting fishery. Whatever the measure, sample sizes must be large enough to produce standard errors small enough to document changes of desired magnitude.

The estimates generated by this survey are precise enough for management/mitigation purposes; the accuracy of any creel estimates depends on the assumptions and proper use of statistical procedures. Harvest and pressure information (even if accurate) is of little value for documenting change in a fishery unless it is also precise. An effort to keep relative standard errors as small as possible should be made; values in excess of 20% are not desirable. Because bias is inherent in creel surveys, consistency of methodology and precision of the estimators becomes the logical focus for future comparisons.

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APPENDIX A

State and Tribal Flathead Lake fishing regulations during the period May 17, 1992 through May 18, 1993

Flathead Indian Reservation

Salmon: 10 fish, open May 1 through November 30. Snagging of salmon not permitted.
Lake trout: 10 under 26 inches or 9 lake trout under 26 inches and one over 36 inches.
Cutthroat or rainbow trout: 2 cutthroat or 2 rainbow, or 1 of each.
Lake whitefish: 50 fish. Commercial sale is not permitted.
Bass: 5 fish, only 2 over 15 inches and all bass between 12 and 15 inches must be released.
Bull trout: a) 1 fish. An angler must release or kill immediately the one bull trout to be kept. It is unlawful to possess a live bull trout.
b) closed to harvest July 6, 1992 through study period.
Yellow perch: a) No limit.
b) 50 fish (effective March 1, 1993).

Possession Limit: An angler may have no more than two times the daily limit of any species in possession at any location at any time.

State of Montana

Salmon: 10 fish daily and 20 in possession. Open May 1 through November 30. Snagging of salmon not permitted.
Lake trout: 'Same as Flathead Indian Reservation'
Cutthroat or rainbow trout: 'Same as Flathead Indian Reservation'
Lake whitefish: 50 fish. Open third Saturday in May through March 31 for the catching of whitefish for commercial sale in nonreservation waters only.
Bass: 'Same as Flathead Indian Reservation'
Bull trout: 'Same as Flathead Indian Reservation'
Yellow perch: No limit.

Possession Limit: Unless stated otherwise, the possession limit is the same as the daily bag limit.

APPENDIX B

Creel data forms used in the Flathead Lake creel survey.

INTERVIEW SHEET

Date ___-___-___ (mm-dd-yy) Interview ID Number _-_____ __ (clerk-interview-sub)

Day: 1=wd 2=we Type: 1=shore 2=boat Interview: 1=roving 2=access ,site_____

Area: A,B,C,D and/or E Trip: 1=complete 2=incomplete Time: _____

---

1) How many anglers are in your group? _____

2) How many hours have you been fishing?

3) What species are you fishing for? (circle below)

4) What have caught (and kept) today? (fill in table)

Species fished (circle one)	# Caught <26"	# Caught >36"	# Harvested (#In slot <26"	# Harvested >36"	Healthy C	Healthy H	Healthy Y	Healthy N
Lake trout								
Lake whitefish								
Perch								
Cutthroat								
Bull trout								
Other: _____								

5) What methods are you using? (circle)
Long line Down rigger Trolling Jigging Casting Bait

6) Where did you launch your boat? _____
Access Point: 1=public, 2=private Post card: 1=yes, 2=no

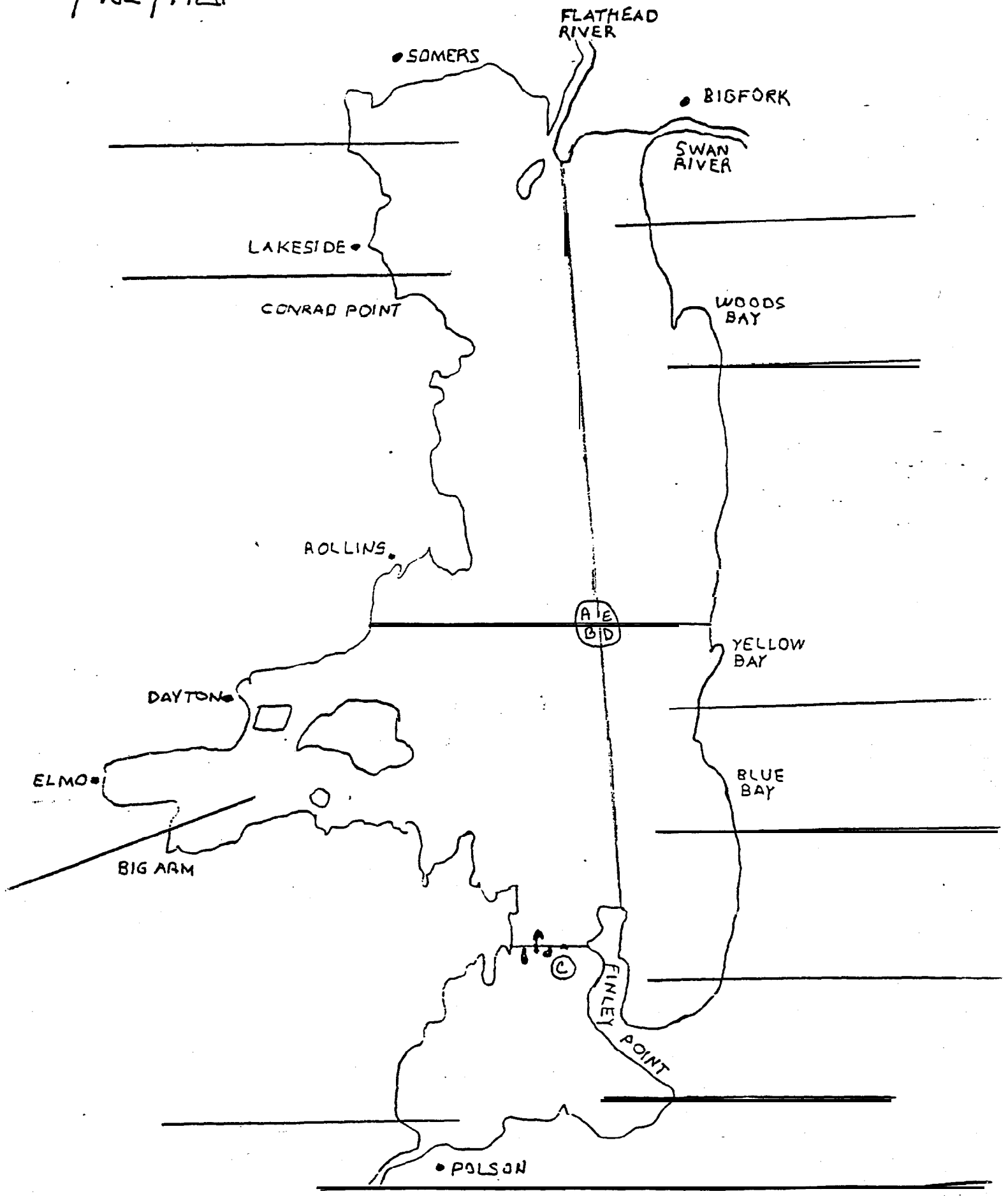
7) Have you fished anywhere else today? NW, SW, SE, NE S.Bay No
(circle) A B D E C

8) Where are you from? #
Angler Origin: State ___ City _____ ___
Angler Origin: State ___ City _____
Angler Origin: State ___ City _____ ___

Comments: (commercial,tags,addresses,questions . ..>

Date:

WD / WE / Hol



APPENDIX C

Length frequency histograms of fish measured during the Flathead Lake creel survey.

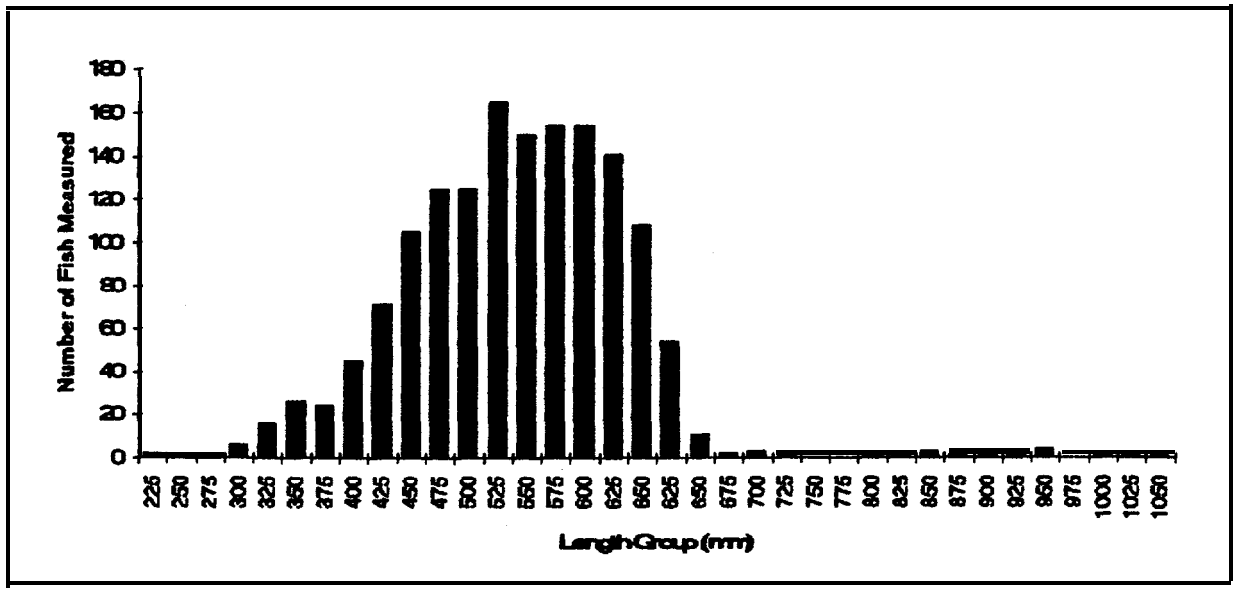


Figure C-1. Length frequencies of lake trout measured in anglers creel on Flathead Lake (N = 1,225).

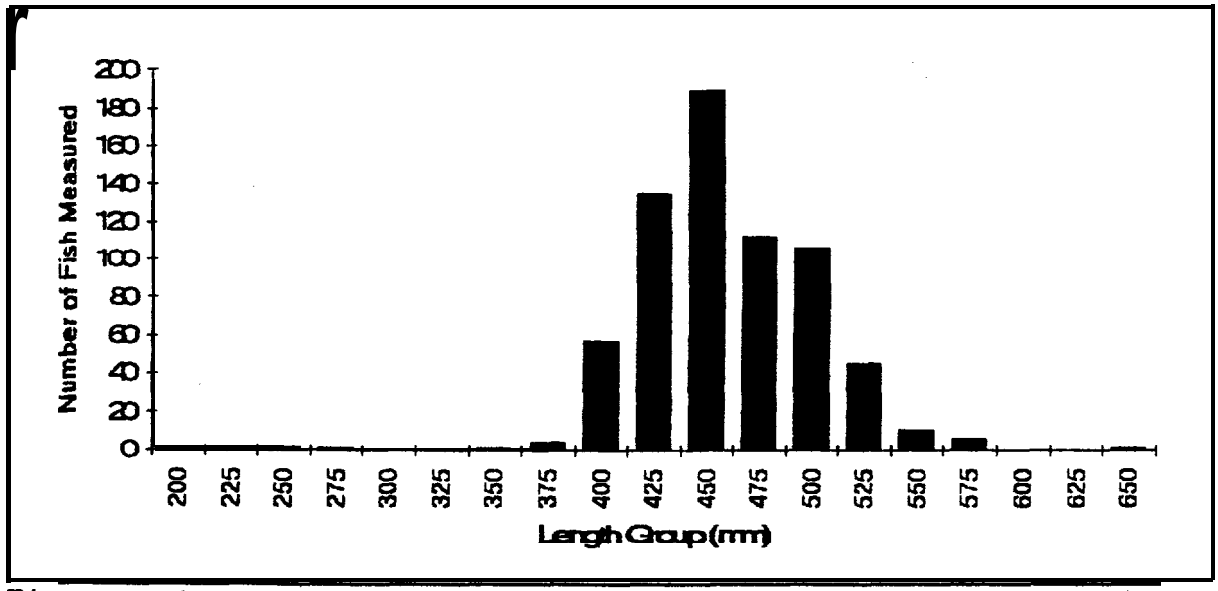


Figure C-2. Length frequencies of lake whitefish measured in anglers creel from Flathead Lake (N = 672).

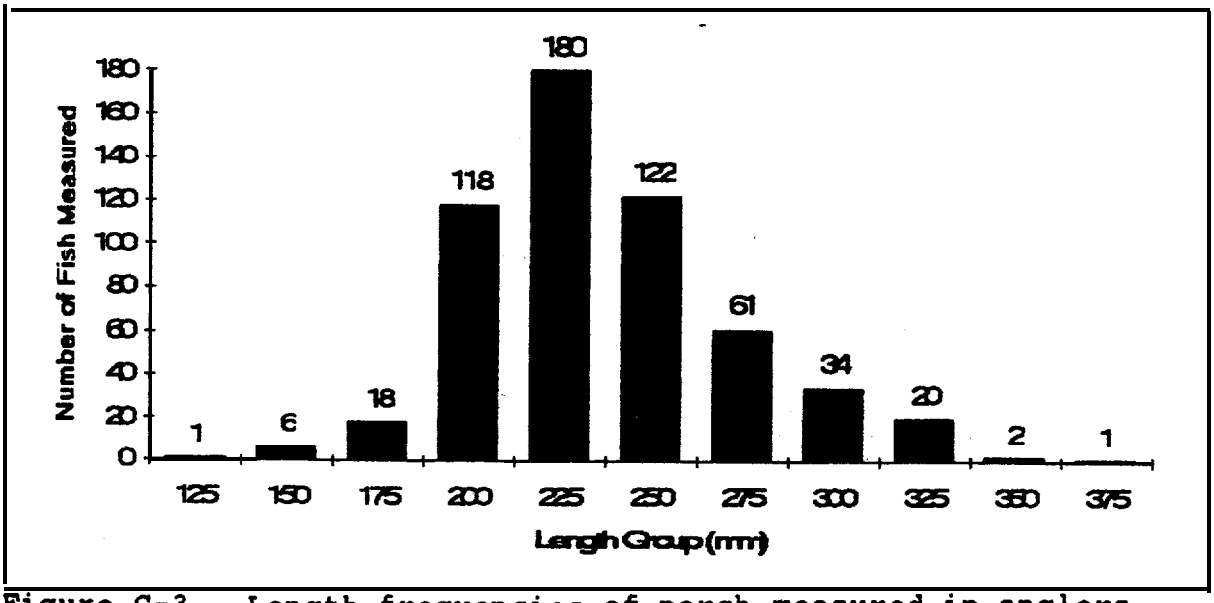


Figure C-3. Length frequencies of perch measured in anglers creel from Flathead Lake (N = 563).

APPENDIX D

Pressure estimates by lake section and angler type.

Table D1. Angler pressure by lake section and month.

SECTION 1						
Month	Ang-hrs	SD	Confidence Interval		CV	Angdays
May 1992 *	3.158	631.4	1.921	4,396	20%	751
June 1992	5,305	784.7	3.767	6,843	15%	1,241
July 1992	8.019	1,042.4	5,976	10,062	13%	1,869
August 1992	6.889	1,022.8	4,865	8.874	15%	1.597
September 1992	1.378	595.3	211	2.545	43%	320
October 1992	1.867	446.3	992	2,741	24%	445
November 1992	782	240.5	310	1,253	31%	182
December 1992	184	88.2	11	357	48%	43
January 1993	3,743	825.8	2.124	5,361	22%	1,232
February 1993	1.425	267.1	901	1.9481	19%	465
March 1993	4.389	769.7	2.880	5.8981	18%	1.083
April 1993	3,314	588.5	2.160	4,467	18%	771
May 1993 **	2.611	562.6	1.509	3.7143	22%	611
Section total	43.043	2,403.1	38.333	47,753	6%	10.611

SECTION 2						
Month	Ang-hrs	SD	Confidence Interval		CV	Angdays
May 1992 *	2.703	712.6	1.306	4,100	26%	669
June 1992	10.451	1.673.0	7.172	13,730	16%	2,475
July1992	13.448	1,438.4	10.629	16,268	11%	3.128
August 1992	10.136	1,085.9	8.008	12,264	11%	2,361
September 1992	2,376	629.3	1,143	3.61 0	26%	556
October 1992	389	140.9	113	665	36%	90
November 1992	270	141.2	-7	546	52%	83
December 1992	82	58.8	-33	197	72%	19
January 1993	1.411	252.8	915	1,906	18%	461
February 1993	1.239	249.5	750	1,728	20%	408
March 1993	387	147.2	99	675	38%	118
April 1993	1.008	214.9	587	1,429	21%	240
May 1993 . *	1,611	330.0	964	2,258	20%	375
Section total	45,511	2,701.3	40,217	50,806	6%	10,962

SECTION 3						
Month	Ang-hrs	SD	Confidence Interval		CV	Anqdays
May 1992 *	1.854	439.1	994	2.715	24%	563
June 1992	3.718	769.4	2.210	5,226	21%	1,090
July 1992	2,349	543.8	1,784	3,915	19%	628
August 1992	2.763	764.3	1,265	4,291	28%	707
September 1992	640	175.91	295	984	28%	293
October 1992	922	176.6	576	1,268	19%	361
November 1992	368	99.4	173	563	27%	170
December 1992	1,503	326.7	863	2.143	22%	548
January 1993	3.299	800.0	2.123	4.475	18%	1.105
February 1993	2.443	335.1	1,791	3.105	14%	816
March 1993	2.856	535.0	1,807	3,904	19%	967
April 1993	3.301	876.0	1.563	5,018	27%	773
May 1993 **	2,983	615.0	1,778	4,188	21%	870
Section total	29.504	1,935.9	25.710	33,299	7%	9.111

*May 17, 1992 to May 31, 1992

● *Mayl,l993toMayl9,1993

Table D1 mntinued. Angler pressure by lake section and month.

SECTION 4						
Month	Ang-hrs	SD	Confidence	Interval	CV	Anadavs
May 1992 *	1,704	308.7	1,099	2,309	18%	483
June 1992	7.333	1,692.8	4.015	10.651	23%	1.883
July 1992	4.470	536.9	3.418	5.522	12%	1.126
August 1992	3.055	504.1	2,067	4,043	16%	742
September 1992	530	136.2	263	797	26%	148
October1992	376	110.2	160	592	29%	93
November 1992	81	77.3	-71	232	96%	19
December 1992	61	50.91	-38	161	83%	14
January 1993	185	110.0	-30	401	59%	48
February 1993	262	187.2	-105	629	71%	66
March 1993	312	210.3	-100	724	67%	78
April1993	1.208	252.0	714	1,702	21%	264
May 1993 **	1.011	220.7	578	1.444	22%	248
Se&ion total	20.590	1,935.5	16.796	24,383	9%	5,209

SECTION 5						
Month	Ang-hrs	SD	Confidence	Interval	CV	Ang-days
May 1992 *	5,249	1.024.1	3,242	7,256	20%	1,221
June 1992	15.778	2.303.9	11.263	20.2941	15%	3.684
July 1992	14.461	1,586.2	11.352	17,570	11%	3.369
August 1992	7.488	907.4	5,710	9.2673	12%	1,741
September 1992	3.206	977.5	1.290	5,122	30%	746
October-1992	1.679	546.2	808	2.749	33%	390
November1992	189	118.1	-43	420	63%	44
December 1992	61	50.9	-38	161	83%	14
January 1993	282	134.1	-1	525	51%	61
February 1993	165	153.7	-136	466	93%	38
March 1993	1.206	428.8	366	2,047	36%	280
April 1993	599	228.7	151	1,047	38%	142
May 1993 **	1.117	268.7	590	1.643	24%	262
Section total	51,460	3,364.0	44.667	58,054	7%	11.991

ALL LAKE SECTIONS COMBINED						
Month	Ang-hrs	SD	Confidence	Interval	CV	Angdays
May 1992 *	14,669	1,497.8	11.733	17,604	10%	3,667
June 1992	42.566	3,490.0	35.745	49,426	8%	10.373
July 1992	43,247	2,501 .1	38.346	48.150	8%	10.318
August 1992	30,312	1,971.5	26.447	34,176	7%	7.149
September 1992	8.131	1,324.9	5.534	10,728	16%	2,063
October1992	5.232	746.8	3,765	6,700	14%	1.400
November 1992	1.689	328.0	1.046	2.331	19%	478
December 1992	1,891	350.9	1.204	2,579	19%	838
January 1993	8.901	1,065.8	6.812	10,990	1 %	2.905
February 1993	5,539	551.9	4.457	6,620	10%	1.792
March 1993	9.150	1,062.3	7,067	11.232	1 %	2.527
April 1993	9.430	1,129.5	7.216	11.644	1 %	2,210
May 1993 . *	9.333	961.61	7,448	11.218	10%	2,363
Total for year	190.108	5,646.4	179.041	201.175	3%	47,893

* May 17, 1992 to May 31, 1992

** May 1, 1993 to May 19, 1993

Table D2. Angler pressure from shore. boat ice by month.

SHORE ANGLERS

Month	Ang-hrs	SD	Confidence	Interval	CV	Angdays
May 1992 *	1.049	232.8	593	1,505	22%	499
June 1992	1.925	334.4	1.270	2,581	17%	917
July1992	1,071	230.0	820	1,522	21%	510
August 1992	410	113.8	187	633	28%	195
September 1992	706	184.6	344	1,068	26%	336
October 1992	753	150.7	458	1,049	20%	359
November 1992	348	97.4	157	539	28%	166
December 1992	330	154.7	26	633	47%	157
January 1993	47	28.4	-9	103	60%	22
February 1993	20	20.4	-20	60	100%	10
March 1993	130	50.5	31	229	39%	62
April 1993	89	35.6	-1	138	52%	33
May 1993 . *	792	152.6	493	1,091	19%	377
Total for year	7.650	591.9	6.490	8,810	8%	3.643

BOAT ANGLERS

Month	Ang-hrs	SD	Confidence	Interval	CV	Angdays
May 1992 *	13,620	1479.6	10,720	16.5201	11%	3.167
June 1992	40,660	3474.0	33.851	47.469	9%	9,458
July1992	42.176	2490.5	37,295	47.058	8%	9.808
August 1992	29.901	1968.2	26.043	33,759	7%	6,954
September 1992	7,425	1312.0	4.853	9.996	18%	1.727
October1992	4,479	733.5	3.042	5,917	16%	1.042
November 1992	1.340	275.6	800	1.880	21%	312
December 1992	389	128.1	137	640	33%	90
January 1993	678	215.5	255	1,100	32%	158
February 1993	571	286.1	10	1,132	50%	133
March 1993	5,375	952.5	3.508	7,241	18%	1.250
April 1993	9,362	1128.9	7.149	11,574	1%	2.177
May 1993 **	8,541	890.2	6.797	10.286	10%	1.986
Total for year	164.517	5461.8	153.812	175,222	3%	38.280

ICE ANGLERS

Month	Ang-hrs	SD	Confidence	Interval	CV	Angdays
December 1992	1.173	287.8	809	1,737	25%	391
January 1993	8.176	1043.4	6.131	10.221	13%	2,725
February 1993	4,947	471.4	4.023	5.871	10%	1.849
March 1993	3,645	553.5	2.560	4,730	15%	1.215
Total for year	17941	1303.9	15.386	20.497	7%	5.980

* May17,1992toMay31,1992

** May 1, 1993 to May 19, 1993

APPENDIX E

Harvest estimates by lake area and angler type.

Table El. Fish harvest from shore and from boats by month.

MAY 1992 (May 17, 1992 through May 31, 1992)

Shore

Species	Harvest	SD	Confidence Interval		# interviews	CV
Lake trout	39	25.5	-11	89	21	88%
Lake whitefish	0	0.0	0	0	21	0%
Yellow parch	38	18.5	0	72	21	5 %
w. cutthroat trout	15	11.3	-7	37	21	75%
Bull trout	0	0.0	0	0	21	0%
Boat						
Laketrout	3,117	1,023.1	1.112	5,123	14	33%
Lake whitefish	31	40.1	-47	110	58	128%
Yellow perch	827	662.6	472	2.126	58	80%
w. cutthroat trout	23	25.3	-27	721	56	11%
Bull trout	149	113.7	-74	372	58	76%

JUNE 1992

Shore

Species	Harvest	SD	Confidence Interval		# interviews	CV
Lake trout	81	32.0	18	144	54	40%
Lake whitefish	0	0.0	0	0	54	0%
Yellow perch	0	0.0	0	0	54	0%
w. cutthroat trout	0	0.0	0	0	54	0%
Bull trout	4	3.2	-2	10	54	83%
Boat						
Lake trout	7.042	1,869.4	3,378	10,706	95	27%
Lakewhitefish	1,666	1,040.3	-373	3,705	197	6 %
Yellow perch	0	0.0	0	0	197	0%
w. cutthroat trout	21	20.5	-19	62	197	96%
Bull trout	32	24.4	-16	791	197	77%

JULY 1992

Shore

Species	Harvest	SD	Confidence interval		# interviews	cv
Lake trout	25	15.4	-5	55	58	62%
Lake whitefish	0	0.0	0	0	58	0%
Yellow perch	343	194.5	-38	724	58	57%
W. cutthroattrout	0	0.0	0	0	58	0%
Bull trout	0	0.0	0	0	58	0%
Boat						
Lake trout	1,729	376.93	990	2,468	162	22%
Lake whitefish	1.257	663.2	42	2.557	190	53%
Yellow perch	0	0.0	0	0	190	0%
w. cutthroat trout	0	0.0	0	0	190	0%
Bull trout	0	0.0	0	0	190	0%

Table El continued. Fish harvest from shore and from boats by month.

Species	Harvest	SD	Confidence Interval		# interviews	CV
AUGUST 1992						
Shore						
Lake trout	9	6.8	4	23	49	72%
Lake whitefish	0	0.0	0	0	49	0%
Yellow perch	91	60.5	-27	210	49	86%
w. cutthroat trout	0	0.0	0	0	49	0%
Bull trout	0	0.0	0	0	49	0%
Boat						
Laketrout	2,376	520.6	1.356	3,397	84	22%
lake whitefish	252	214.9	-170	673	234	85%
Yellow perch	2.325	1,913.8	-1,426	6.076	234	82%
w. cutthroat trout	43	44.61	44	131	234	103%
Bull trout	0	0.0	0	0	234	0%
SEPTEMBER 1992						
Shore						
Lake trout	81	33.2	16	146	38	41%
Lakewhitefish	0	0.0	0	0	38	0%
Yellow perch	1,429	675.3	105	2,752	38	47%
W. cutthroat trout	0	0.0	0	0	38	0%
Bull trout	0	0.0	0	0	38	0%
Boat						
Laketrout	793	210.9	360	1.207	48	27%
Lake whitefish	109	116.1	-118	337	109	106%
Yellow perch	0	0.0	0	0	109	0%
W. cutthroat trout	0	0.0	0	0	109	0%
Bull trout	0	0.0	0	0	109	0%
OCTOBER 1992						
Shore						
Laketrout	128	37.1	56	201	83	29%
Lake whitefish	0	0.0	0	0	63	0%
Yellow perch	0	0.0	0	0	83	0%
w. cutthroat trout	0	0.0	0	0	83	0%
Bull trout	0	0.0	0	0	83	0%
Boat						
Lake trout	842	150.43	347	937	51	23%
Lake whitefish	79	106.1	-129	287	61	134%
Yellow perch	0	0.0	0	0	61	0%
w. cutthroat trout	8	8.5	-3	25	61	104%
Bull trout	0	0.0	0	0	61	0%

Table E1 continued. Fish harvest from shore and from boats by month.

NOVEMBER 1992

Shore

Species	Harvest	SD	Confidence Interval		# interviews	CV
Lake trout	92	35.0	24	1611	4s	38%
Lake whitefish	5	4.7	-5	14	45	102%
Yellow perch	0	0.0	0	0	4s	0%
W. cutthroat trout	0	0.0	0	0	45	0%
Bull trout	0	0.0	0	0	45	0%
Boat						
Lake trout	698	277.0	155	1,241	8	40%
Lake whitefish	19	18.0	-16	54	10	95%
Yellow perch	0	0.0	0	0	10	0%
W. cutthroat trout	0	0.0	0	0	10	0%
Bull trout	0	0.0	0	0	10	0%

DECEMBER 1992

Shore

Species	Harvest	SD	Confidence Interval		# interviews	CV
Lake trout	296	146.9	9	584	84	50%
Lake whitefish	3	3.0	-3	9	84	113%
Yellow perch	0	0.0	0	0	84	0%
w. cutthroat trout	0	0.0	0	0	84	0%
Bull trout	0	0.0	0	0	84	0%
Boat						
Lake trout	137	43.9	51	223	4	32%
Lake whitefish	0	0.0	0	0	4	0%
Yellow perch	0	0.0	0	0	4	0%
W. cutthroat trout	0	0.0	0	0	4	0%
Bull trout	0	0.0	0	0	4	0%

JANUARY 1993

Shore

Species	Harvest	SD	Confidence Interval		# interviews	CV
Lake trout	0	0.0	0	0	2	0%
Lake whitefish	0	0.0	0	0	2	0%
Yellow perch	0	0.0	0	0	2	0%
W. cutthroat trout	0	0.0	0	0	2	0%
Bull trout	0	0.0	0	0	2	0%
Boat						
Lake trout	236	42.9	202	370	7	15%
Lake whitefish	37	20.9	-4	78	7	57%
Yellow perch	0	0.0	0	0	7	0%
W. cutthroat trout	0	0.0	0	0	7	0%
Bull trout	0	0.0	0	0	7	0%

Table El continued. Fish harvest from shore and from boats by month.

FEBRUARY 1993

Shore

Species	Harvest	SD	Confidence Interval		# interviews	cv
Lake trout	0	0.0	0	0	1	0%
Lake whitefish	0	0.0	0	0	1	0%
Yellow perch	0	0.0	0	0	1	0%
w. cutthroat trout	0	0.0	0	0	1	0%
Bull trout	0	0.0	0	0	1	0%
Boat						
Laketrout	158	190.8	-216	532	3	121%
Lake whitefish	0	0.0	0	0	3	0%
Yellow perch	0	0.0	0	0	3	0%
w. cutthroat trout	0	0.0	0	0	3	0%
Bull trout	0	0.0	0	0	3	0%

MARCH 1993

Shore

Species	Harvest	SD	Confidence Interval		# interviews	CV
Laketrout	0	0.0	0	0	3	0%
Lake whitefish	0	0.0	0	0	3	0%
Yellow perch	0	0.0	0	0	3	0%
w. cutthroat trout	0	0.0	0	0	3	0%
Bull trout	0	0.0	0	0	3	0%
Boat						
Lake trout	1,190	337.31	529	1,861	49	28%
Lake whitefish	0	0.0	0	0	50	0%
Yellow perch	0	0.0	0	0	50	0%
W. cutthroat trout	0	0.0	0	0	50	0%
Bull trout	0	0.0	0	0	50	0%

APRIL 1993

Shore

Species	Harvest	SD	Confidence Interval		# interviews	cv
Lake trout	74	26.2	22	125	37	36%
Lake whitefish	0	0.0	0	0	37	0%
Yellow perch	0	0.0	0	0	37	0%
W. cutthroat trout	0	0.0	0	0	37	0%
Bull trout	0	0.0	0	0	37	0%
Boat						
Lake trout	841	231 .1	388	1,294	130	27%
Lake whitefish	117		-21		132	60%
Yellow perch	4.602	1,709.2	70.6	1,252 7.952	255 132	37%
W. cutthroat trout	0	0.0	0	0	132	0%
Bull trout	0	0.0	0	0	132	0%

Table El continued. Fish harvest from shore and from boats by month.

MAY 1993 (May 1, 1993 through May 19, 1993)						
			Shore			
species	Harvest	SD	Confidence Interval		# interviews	cv
Laketrout	29	16.8	-4	62	42	58%
Lake whitefish	33	17.4	-1	67	42	53%
Yellow perch	16	16.3	-16	48	42	100%
w. cutthroat trout	6	6.8	-7	19	42	109%
Bull trout	0	0.0	0	0	42	0%
			Boat			
Laketrout	611	183.5	251	971	108	30%
Lake whitefish	5	5.1	-5	15	109	105%
Yellow perch	863	365.3	147	1,579	109	42%
w. cutthroat trout	2	1.7	-2	5	109	102%
Bull trout	12	11.3	-10	34	109	94%

Table E2. Fish harvest by ice anglers by area and month.

AREA A (Somers Bay)

JANUARY 1993 (December 29, 1992 through January 31, 1993)

Species	Harvest	SD	Confidence Interval		# interviews	cv
Laketrout	615	190.4	242	988	81	31%
Lake whitefish	68	45.6	-22	157	81	68%
Yellow perch	0	0.0	0	0	0	0

FEBRUARY 1993

Species	Harvest	SD	Confidence Interval		# interviews	CV
Lake trout	154	63.0	31	277	29	41%
Lake whitefish	99	57.1	-13	211	29	58%
Yellow perch	0	0.0	0	0	0	0

MARCH 1993 (March 1, 1993 through March 22, 1993)

Species	Harvest	SD	Confidence Interval		# interviews	CV
Laketrout	40	23.4	-6	86	5	59%
Lake whitefish	0	0.0	0	0	5	0%
Yellow perch	0	0.0	0	0	0	0

AREA B (Big Arm Bay)

JANUARY 1993 (January 10, 1993 through January 31, 1993)

Species	Harvest	SD	Confidence Interval		# interviews	CV
Laketrout	273	74.8	127	4201	43	27%
Lake whitefish	163	73.3	20	307	43	45%
Yellow perch	0	0.0	0	0	0	0

FEBRUARY 1993

Species	Harvest	SD	Confidence Interval		# interview	cv
Laketrout	189	65.5	60	317	27	35%
Lake whitefish	7	7.8	-8	22	27	113%
Yellow perch	0	0.0	0	0	0	0

MARCH 1993 (March 1.1993 through March 13, 1993)

Species	Harvest	SD	Confidence Interval		# interviews	cv
Lake trout	69	32.5	5	133	25	47%
Lakewhitefish	3	3.2	-3	9	25	105%
Yellow perch	0	0.0	0	0	0	0

Table E2 continued. Fish harvest bv ice anglers on Flathead Lake.

AREA C (South Bay)

DECEMBER 1992 (December 12, 1992 through December 31, 1992)

Species	Harvest	SD	Confidence Interval		# interviews	CV
Lake trout	625	169.8	292	958	45	27%
Lake whitefish	70	27.2	17	124	45	39%
Yellow perch	8	5.6	-3	19	45	71%

JANUARY 1993

Species	Harvest	SD	Confidence Interval		# interviews	CV
Laketrout	667	154.7~	384	990	141	23%
Lakewhitefish	158	59.4	41	274	141	38%
Yellow perch	24	20.4	-16	64	141	85%

FEBRUARY 1993

Species	Harvest	SD	Confidence Interval		# interviews	CV
Lake trout	349	72.1	207	490	81	21%
Lake whitefish	1.100	235.8	638	1,562	81	21%
Yellow perch	38	25.0	-11	87	81	67%

MARCH 1993 (March 1, 1993 through March 21, 1993)

Species	Harvest	SD	Confidence	Interval:	# interviews	CV
Lake trout	128	38.0	53	202	42	30%
Lake whitefish	1,985	421.5	1,159		42	21%
Yellow perch	1.193	950.4	-670	2,81213,056	42	80%

Table E3. Lake trout harvest by boat anglers by month and section.

SECTION 1 Month	Harvest	SD	Lake Total	Percent of Lake	# interviews	CV
May 1992 *	108	154.9	3.117	3%	2	143%
June 1992	1,514	866.8	7.042	22%	8	53%
July 1992	320	104.6	1,729	19%	48	33%
August 1992	327	220.3	2.376	14%	13	67%
September 1992	0	0.0	793	0%	3	0%
October 1992	301	101.0	642	47%	24	34%
November 1992	413	213.1	698	59%	8	52%
December 1992	65	30.2	137	47%	4	47%
January 1993	64	61.6	286	23%	7	96%
February 1993	27	79.4	159	17%	3	289%
March1993	836	282.7	1.190	70%	50	34%
April 1993	442	144.3	841	53%	36	33%
May 1993 . *	351	151.1	611	57%	27	43%
Totals	4,769	961.6	19,621	24%	233	20%

SECTION 2 Month	Harvest	SD	Lake Total	Percent of Lake	# interviews	CV
May 1992 *	0	0.0	3.117	0%	1	0%
June 1992	445	262.2	7.042	6%	22	59%
July 1992	0	0.0	1,729	0%	3	0%
August 1992	678	398.6	2,376	2 %	8	5 %
September 1992	341	129.1	793	43%	1	38%
October 1992	0	0.0	642	0%	0	0%
November 1992	142	125.2	698	20%	8	88%
December 1992	29	20.1	137	21%	4	70%
January 1993	37	46.6	286	13%	7	126%
February 1993	18	64.8	159	12%	3	354%
March 1993	23	47.1	1.190	2%	50	203%
April 1993	0	0.0	641	0%	1	0%
May 1993 **	0	0.0	611	0%	0	0%
Totals	1,713	518.6	19.621	9%	108	30%

SECTION 3 Month	Harvest	SD	Lake Total	Percent of Lake	# interviews	cv
May 1992 *	56	47.0	3.117	2%	3	84%
June 1992	0	0.0	7,042	0%	1	0%
July 1992	0	0.0	1,729	0%	3	0%
August 1992	132	23.4	2,376	6%	2	18%
September 1992	0	0.0	793	0%	0	0%
October 1992	69	38.0	642	11%	1	55%
November 1992	0	0.0	696	0%	0	0%
December 1992	0	0.0	137	0%	0	0%
January 1993	0	0.0	286	0%	0	0%
February 1993	0	0.0	159	0%	0	0%
March 1993	0	0.0	1,190	0%	0	0%
April 1993	224	163.6	841	27%	35	73%
May 1993 . *	141	91 .I	611	23%.	31	65%
Totals	621	198.1	19.621	3%	76	32%

*May 17, 1992 to May 31, 1992

● *MayI.I993toMayI9,1993

Table E3 continued. Lake trout harvest by boat anglers by month and section.

SECTION 4			Lake	Percent		
Month	Harvest	SD	Total	of lake	# interviews	cv
May 1992 *	599	84.3	3.117	19%	1	14%
June 1992	809	349.3	7.042	11%	49	43%
July 1992	519	302.4	1,729	30%	30	58%
August 1992	160	63.5	2,376	7%	22	52%
September 1992	78	77.5	793	10%	5	100%
October1992	138	72.2	642	21%	8	52%
November 1992	43	68.6	698	6%	8	160%
December 1992	22	17.4	137	16%	4	81%
January 1993	74	65.9	286	26%	7	89%
February1993	67	124.1	159	42%	3	185%
March 1993	64	78.1	1,190	5%	50	122%
April 1993	65	26.9	841	8%	53	42%
May 1993 *	71	30.5	611	12%	44	43%
Totals	2.707	520.8	19.621	14%	284	19%

SECTION 5			Lake	Percent		
Month	Harvest	SD	Total	of Lake	# interviews	cv
May 1992 •	2,355	1,006.7	3117	76%	7	43%
June 1992	4,273	1.628.8	7042	61%	15	38%
July1992	890	199.2	1729	51%	78	22%
August 1992	1.080	236.8	2376	45%	39	22%
September 1992	374	147.6	793	47%	39	3 %
October 1992	135	75.9	642	21%	18	56%
November 1992	100	104.7	698	14%	8	105%
December 1992	22	17.4	137	16%	4	81%
January 1993	111	80.7	286	39%	7	73%
February 1993	46	102.5	159	29%	3	224%
March 1993	267	169.8	1190	22%	50	60%
April 1993	111	71.3	841	13%	5	64%
May 1993 **	49	40.1	611	8%	6	83%
Totals	9.811	1.962.2	19621	50%	279	20%

• Mayl7,1992toMay31,1992
May1.1993toMay19.1993

Table E4. Lake trout harvest by boat anglers by month.

Month	Harvest	SD	Confidence Interval		# interviews	CV	Percent of Total
May 1992 *	3.117	1.023.1	1.112	5,123	14	33%	16%
June 1992	7,042	1,869.4	3,378	10,706	95	27%	36%
July 1992	1,729	376.9	990	2.466	162	22%	9%
August 1992	2,376	520.6	1.356	3.397	a4	22%	12%
September 1992	793	210.9	380	1,207	48	27%	4%
October 1992	642	150.4	347	937	51	23%	3%
November 1992	698	277.0	155	1,241	8	40%	4%
December 1992	137	43.93	51	223	4	32%	1%
January 1993	286	129.6	32	540	7	45%	1%
February 1993	159	190.8	-215	533	3	120%	1%
March 1993	1.190	337.3	529	1,851	49	28%	6%
April 1993	841	231 .1	388	1.294	130	27%	4%
May 1993 **	611	183.5	251	971	108	30%	3%
Totals	19,621	2313.9	15.086	24,156	980	12%	100%

* May 17, 1992 to May 31, 1992

● Mayl,?993toMayl9,1993