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Executive Summary

Montana Statewide Angling Pressure

Mail Survey
1982-1985

Montana

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prepared by

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INTRODUCTION

Supporting over 80 species of fish, Montana waters provide a fishing opportunity that is varied and diverse. One of the keys to maintaining the the quality and diversity is to know how much angling pressure is being exerted on each body of water. To conduct individual creel census would prove to be extremely costly, as well as impractical due to man-power requirements.

The Montana Department of Fish, Wildlife and Parks has long been interested in obtaining statewide angling pressure. Bishop (1959, 1960 & 1961)[1] conducted the first recorded mail survey of fishing pressure on a statewide basis for Montana. He found that residents fished 1,323,129 angler days, nonresident season license holders fished 60,632 angler days, and nonresident 6-day permit holders fished 40,933 angler days for the 1958 season. In 1959 residents fished 1,345,000 angler days, nonresident season license holders fished 54,000 angler days, and nonresident 6-day permit holders fished 121,000 angler days. In 1960 the third annual survey was conducted and residents fished 1,356,000 angler days, nonresident season license holders fished 53,000 angler days, and nonresident 7-day permit holders fished 112,000 angler days.

In 1968 the statewide angling pressure mail survey was again initiated by Holton (1970). He found residents had fished 1,519,126 angler days, nonresident season license holders fished 69,653 angler days, and nonresident 6-day permit holders fished 161,772 angler days. Holton (1971) conducted another statewide survey for the 1969 license year. No results were reported because it was felt they were too high due to sampling problems.

In 1975, Gaffney (unpublished data) conducted a statewide survey of angling pressure by mail. He found residents fished a total of 2,314,030 angler days and nonresidents 508,034 angler days for a statewide total of 2,822,093 angler days. An attempt was made to continue that statewide survey in 1976 using the 1975 mailing lists. This did not provide adequate samples for nonresidents, so only resident pressure was obtained.

Holton (1974) stated,

> "The lack of up-to-date fishing pressure information on individual waters has been a handicap in fisheries management. It is recommended that (the) evaluation of (a) mail survey to fill this need be accomplished as soon as feasible."

The surveys were once again started in 1982 with the understanding they would be run for more than a couple of years and then dropped indefinitely. The technique used was similiar to that described by Holton (1974).

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[1]Literature citations are presented at the end of the Main Report.

The data from this effort is compiled and contained in three reports: the Executive Summary, the Main Report, and the Angling Estimates on Individual Waters by Residency by Season.

ACKNOWLEDGEMENTS

A huge and grateful thank you is extended to all those people that were involved with this four year endeavor:

George Holton was instrumental in getting the project started, a great mentor for problems that occurred along the way, and an excellent editor and reviewer. This project would not have been completed without the great many hours of help extended through his generosity.

John "Bud" Gaffney started the project in 1982 and worked out many of the details involved in a survey of this magnitude.

All the fisheries biologists and regional managers that reviewed individual estimates as to their accuracy and soundness.

Candy Post and Leigh Ellis-Neill for their work in making sure the questionnaires were sent, responses opened and tallies correctly recorded. Leigh also was a great help in compiling and analyzing dealer remittance records.

All the work study students that performed all the manual labor involved in the survey.

Finally to my wife, Junelle, my daughter, Shona, and my son, Trask, for putting up with me and helping to sort, code, and recount numerous returns where discrepancies arose.

I would also like to thank the current fisheries staff in Helena, Pat Graham and Tim Gallagher, for their patience and understanding in getting the data and report into print.

RESULTS

A statewide angling pressure mail survey was started in May of 1982 and continued four years until March, 1986. The estimates were based upon the Department's license year. Questionnaires were mailed on a stratified basis usually at monthly or twice a month intervals. For the years 1982, 1983 and 1984 approximately 20,000 surveys were sent annually. In 1985 approximately 45,000 surveys were sent. Estimates were produced for residents and nonresidents by individual waters. For 1982, estimates of pressure were made on 1,408 waters. In 1983, 1,206 waters had pressure estimated. For 1984, estimates were made on 1,135 waters. In 1985, 1,157 waters had pressure estimated. See Tables 1, 2 and 3 for summarized estimates for each angling year.

Table 1. Angling pressure in angler days by season for 1982 through 1985 (licensed anglers only)

Year	Total	Resident	Nonresident
	ANNUAL		
1982	2,723,713	2,104,888 (77.3%)	618,825 (22.7%)
1983	2,624,708	2,080,824 (79.3%)	543,884 (20.7%)
1984	2,197,402	1,834,842 (83.5%)	362,560 (16.5%)
1985	2,443,438	1,916,711 (78.4%)	526,727 (21.6%)
	SUMMER		
1982	2,001,386	1,409,319 (70.4%)	592,067 (29.6%)
1983	1,965,010	1,450,258 (73.8%)	514,752 (26.2%)
1984	1,619,882	1,277,438 (78.9%)	342,444 (21.1%)
1985	1,953,931	1,444,634 (73.9%)	509,297 (26.1%)
	WINTER		
1982	722,315	695,562 (96.3%)	26,753 (3.7%)
1983	659,701	630,553 (95.6%)	29,148 (4.4%)
1984	577,441	557,644 (96.6%)	19,797 (3.4%)
1985	489,337	471,911 (96.4%)	17,426 (3.6%)

The percent of angling pressure in each of the Departments seven regions (Figure 1) remained consistent from year to year (Chart 1). Those regions with cold water fisheries (1, 2, 3, part of 4, and part of 5) received the majority of the angling pressure.

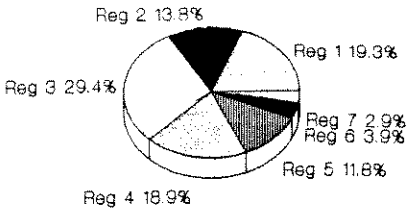
Salmonid stream and lake fishing comprised the overwhelming majority of the angling pressure for all four years (Chart 2). In 1982, 88.1 percent of the annual pressure was on salmonid waters. In 1983, the amount of pressure on salmonid waters was 86.8%. In 1984 and 1985 the percent of annual pressure on salmonid waters was the same at 89.7%.

Table 2. Catch rates in fish/hour for 1984 and 1985 by season and by residency (sample size in parenthesis)			
Year	Total	Resident	Nonresident
	ANNUAL		
1984	1.34 (8,779)	1.41 (5,422)	1.23 (3,357)
1985	1.54 (17,138)	1.57 (9,948)	1.51 (7,190)
	SUMMER		
1984	1.28 (7,226)	1.33 (3,951)	1.24 (3,275)
1985	1.51 (12,733)	1.56 (6,015)	1.48 (6,718)
	WINTER		
1984	1.65 (1,554)	1.69 (1,472)	1.13 (82)
1985	1.63 (4,405)	1.60 (3,933)	1.93 (472)

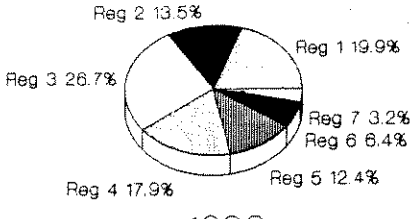
Table 3. Harvest rates (# of fish) for 1984 and 1985 by season and by residency (see Table 2 for sample sizes)			
Year	Total	Resident	Nonresident
	ANNUAL		
1984	6,578,000	5,780,593	797,407
1985	7,254,749	5,621,961	1,632,788
	SUMMER		
1984	4,482,785	3,728,302	754,483
1985	5,401,937	3,821,934	1,580,003
	WINTER		
1984	2,095,215	2,052,293	42,922
1985	1,852,809	1,800,020	52,789

In region 1 salmonid lake fishing was dominate all four years ranging from 65.4% to 52.6% of the total regional pressure (Chart 3). Region 2 had the majority of its pressure on salmonid streams (Chart 4). The pressure ranged from 71.4% to 62.1% of the regional total. Region 3 had the majority of its pressure on salmonid streams ranging from 66.1% to 59.1% of the total regional angling pressure (Chart 5). Region 4, like region 1, had the majority of its pressure on salmonid lakes (Chart 6). It ranged from 45.0% to 51.6% of the total regional pressure. An exception wass the year 1985 when region 4 had its pressure evenly split between salmonid

Statewide Angling Pressure Regional Estimates

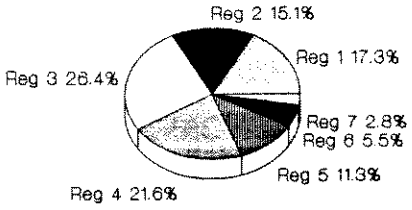


1982

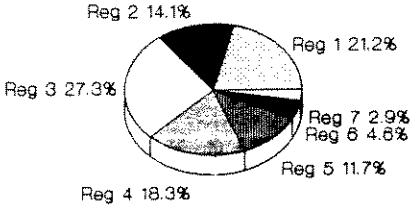


1983

1982 - 1985



1984



1985

Chart 1

lakes and salmonid streams (45.0%). Region 5 had the mass of its pressure on salmonid streams with a range of 65.5% to 60.4% of the regional total throughout the four years (Chart 7). Regions 6 and 7 together produced more nonsalmonid angling pressure than the other five regions combined. Region 6 has most of its pressure on nonsalmonid lakes, ranging from 41.9% to 52.2% of the regional total (Chart 8). Region 7 has the bulk of its pressure on nonsalmonid streams, ranging from 47.2% to 57.6% of the regional total during the four years (Chart 9).

An undesignated stream or lake was one that could not be assigned an individual water code due to lack of information provided by the angler. These waters were then given a generic water code for the drainage and county where the angling was thought to have occurred. Since there was no way to distinguish if it was a salmonid or nonsalmonid water it was given a water type code of undesignated.

For a more detailed description of methods and results see the Main Report.

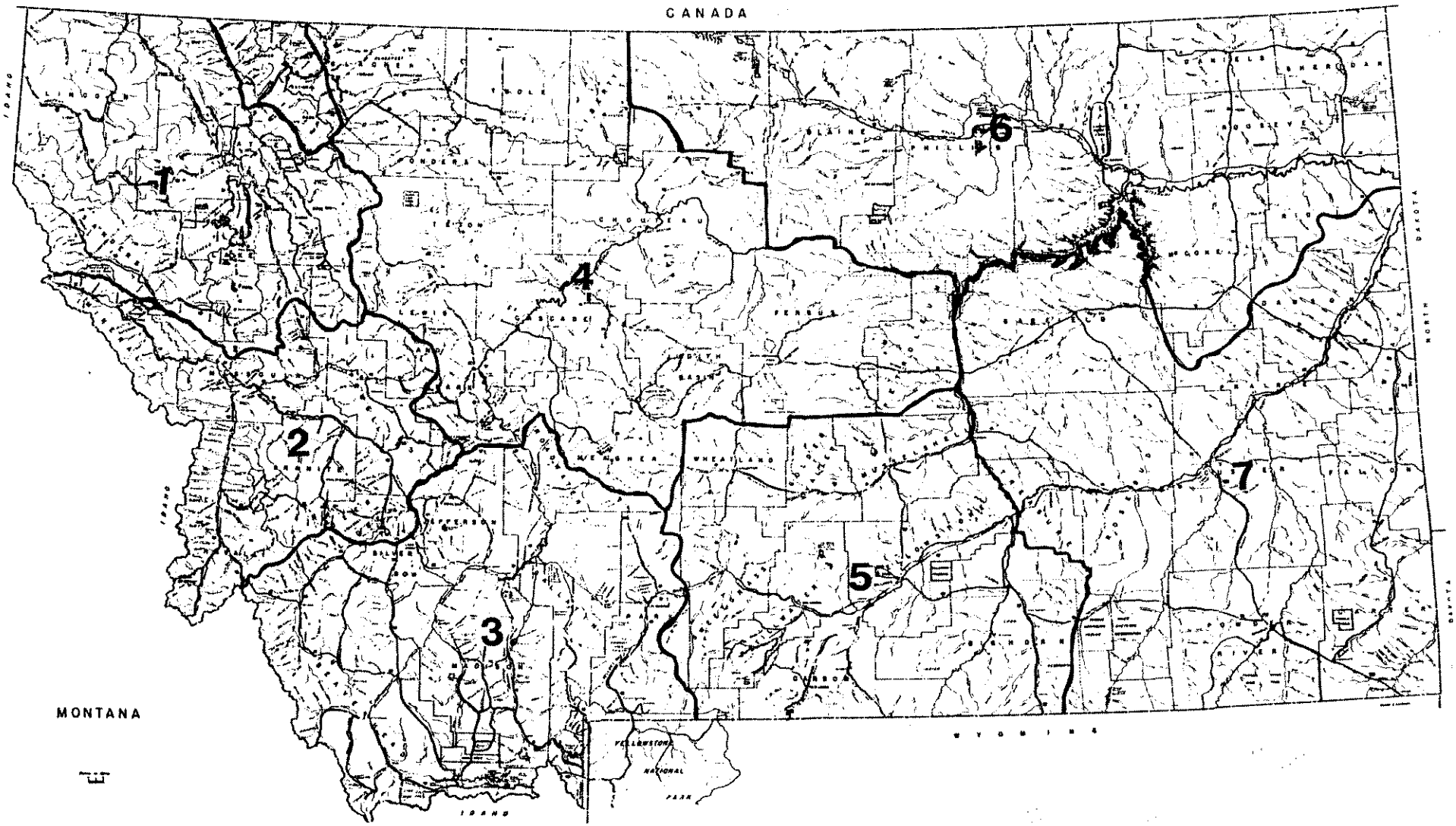


Figure 1. Map of the State of Montana showing the Department of Fish, Wildlife & Parks Regional boundaries.

Statewide Angling Pressure
Comparing Water Types
1982 - 1985

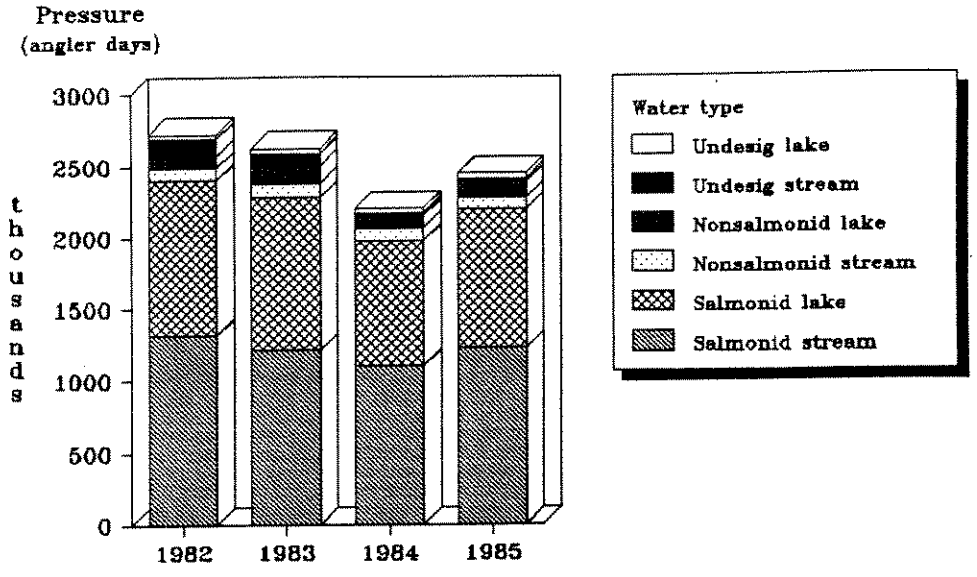


Chart 2

Region One Angling Pressure
Comparing Water Types
1982 - 1985

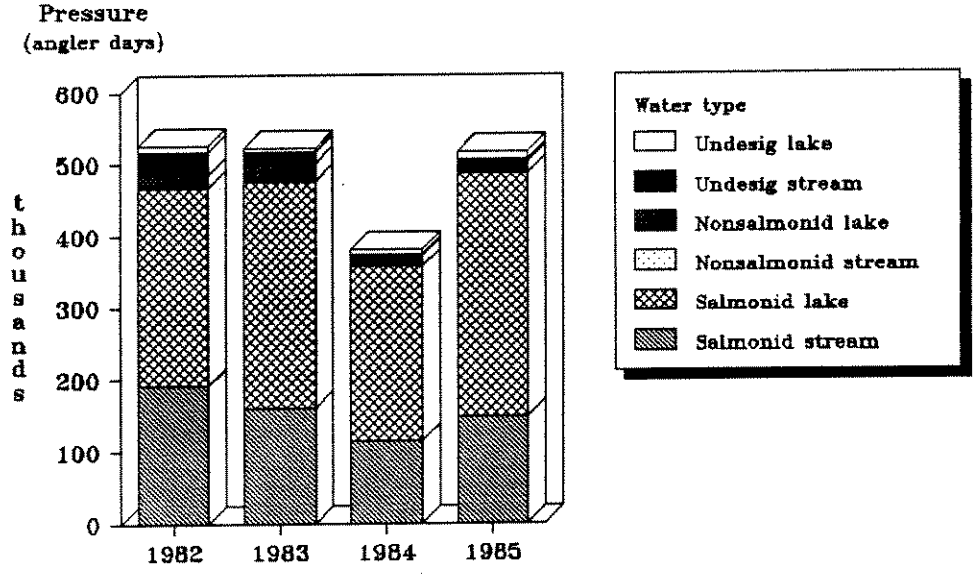


Chart 3

Region Two Angling Pressure
Comparing Water Types
1982 - 1985

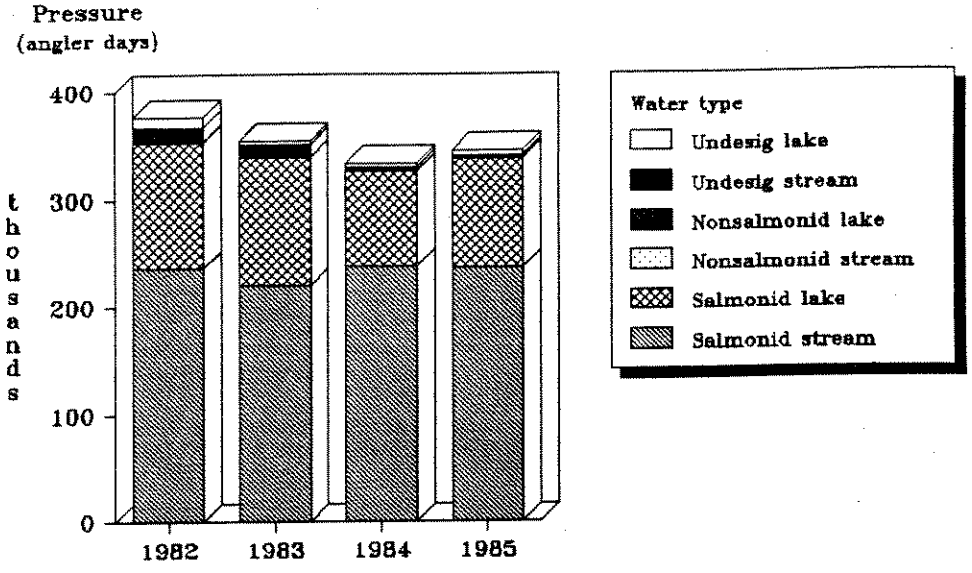


Chart 4

Region Three Angling Pressure
Comparing Water Types
1982 - 1985

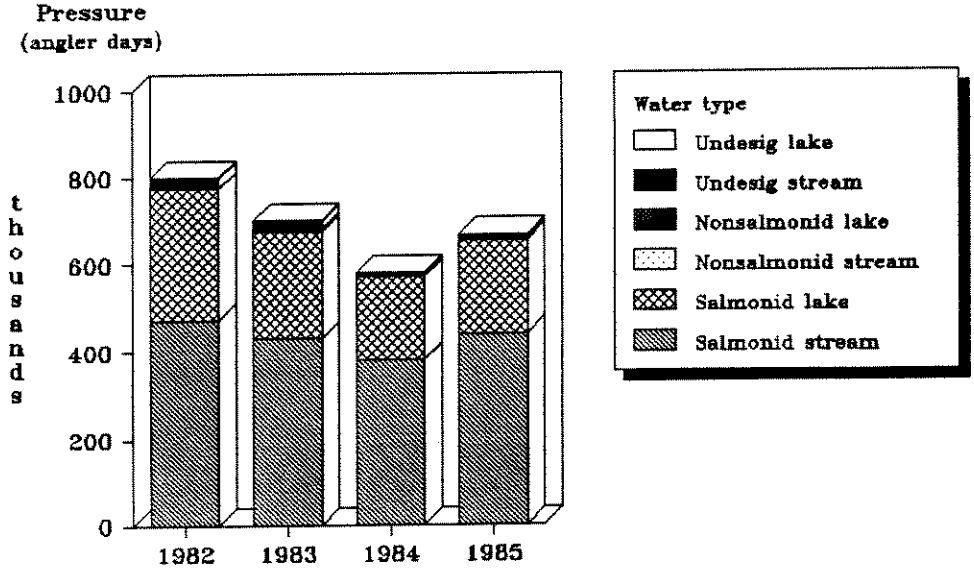


Chart 5

Region Four Angling Pressure
Comparing Water Types
1982 - 1985

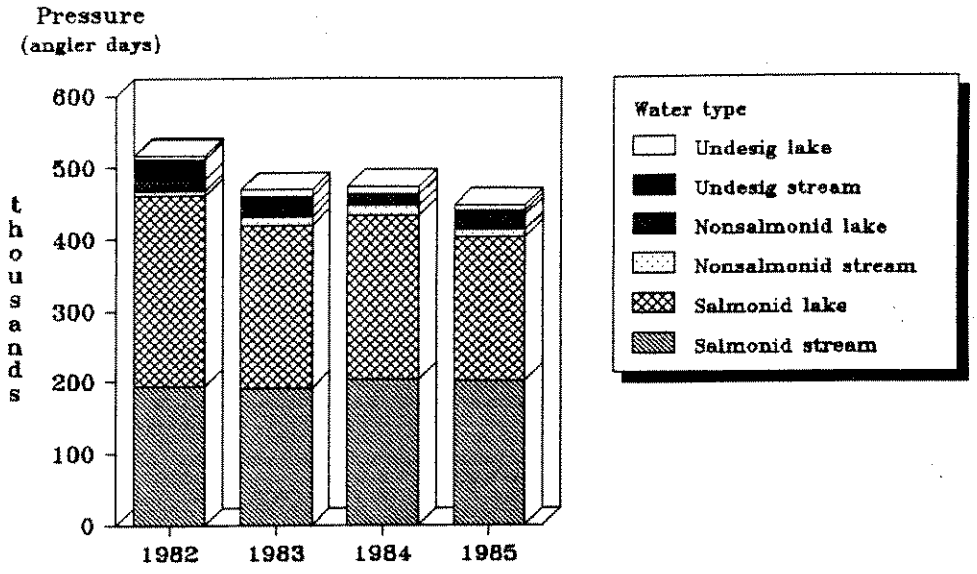


Chart 6

Region Five Angling Pressure
Comparing Water Types
1982 - 1985

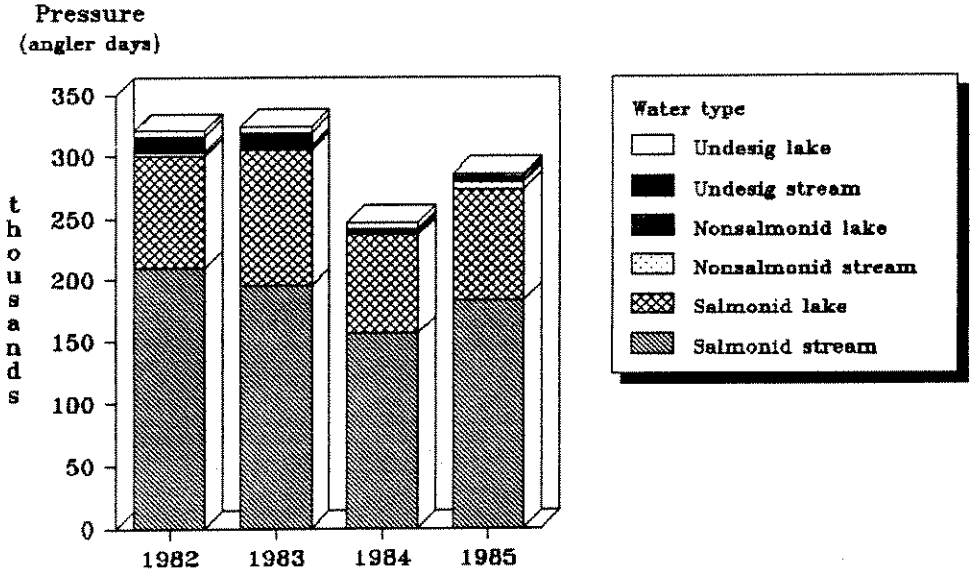


Chart 7

Region Six Angling Pressure
Comparing Water Types
1982 - 1985

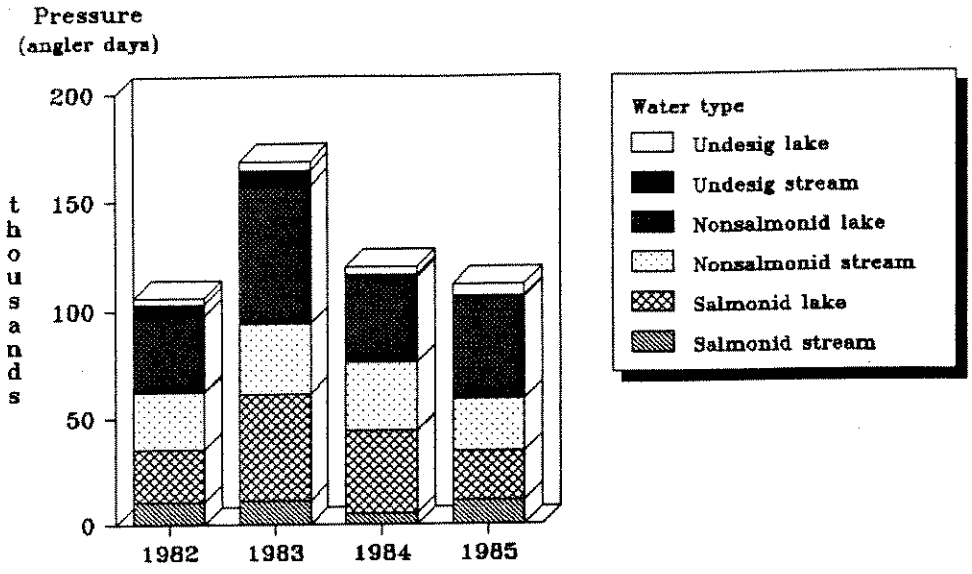


Chart 8

Region Seven Angling Pressure
Comparing Water Types
1982 - 1985

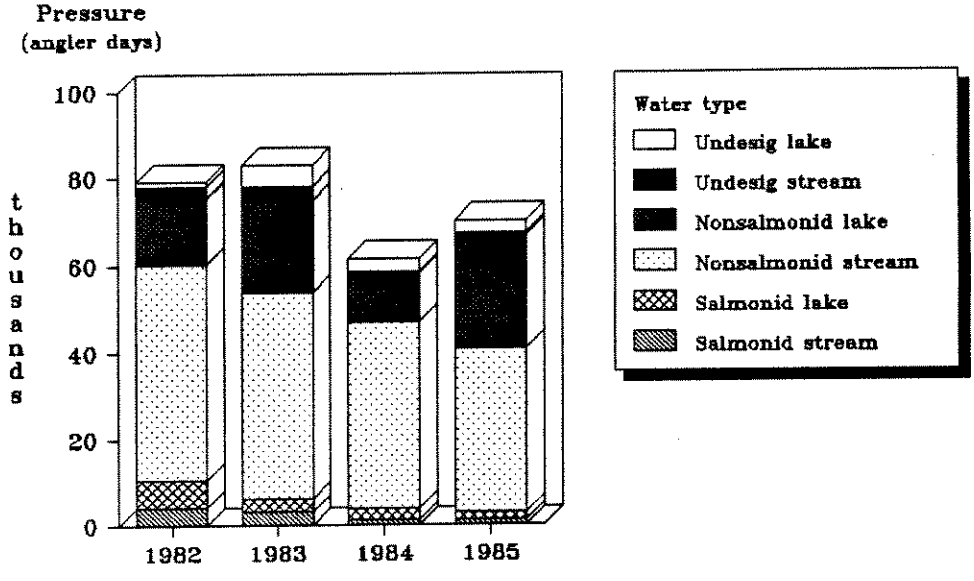


Chart 9

SCOPE OF ANGLING PRESSURE

Statewide angling pressure surveys were conducted annually from May, 1982 through February, 1986. Estimates of pressure by residents and nonresidents were for licensed anglers only. In 1982 and 1983 this would encompass anglers 15 years of age and older. For 1984 and 1985 this would include anglers 12 years of age and older. Spence (1971) found that the unlicensed angler (ages 2- 14) comprised 9% of the pressure on Rock Creek near Missoula. Peterson (1970) found that the unlicensed angler accounted for 21% and 19% of the total number of anglers on Big Spring Creek near Lewistown during 1968 and 1969 respectively. On the Bighorn River near Hardin, Stevenson (1975) found that the unlicensed angler accounted for 14.2% and 15.8% of the total number of anglers during 1972 and 1973 respectively. Fredenberg (1984) found that 10% of the anglers on Bighorn Lake and 13% of the anglers on the Yellowtail Afterbay were unlicensed. The 1975 National Fishing and Hunting Survey showed that 23.8% of the anglers nationwide were between the ages of 9 and 17. It appears that the unlicensed angler makes up between 9% to 21% of the fishing pressure depending on the type of water being fished.

Some angling pressure was obtained on Indian reservations and National Parks within Montana. This pressure was incidental to other fishing trips and only included those anglers that had purchased a Montana fishing license. Since national parks and reservations require different licensing, a complete pressure estimate of waters within those regions was not obtained.

RANDOMNESS OF SAMPLE

Drawing a random sample is essential in any survey of this nature to obtain unbiased results. When dealing with over 250,000 licenses to sample from on twice-a-month or monthly basis, this becomes a monumental task.

Samples were drawn by hand for all four years in a systematic random fashion (see Main Report for a detailed description). To assess the validity of this sampling method, the regional distribution of the entire yearly sample throughout the state was compared to the annual regional license sales for the state. This was done since regional distribution of license sales by sampling period was not attainable. License sales are conducted by dealers from all areas of the state. The dealer is required to remit all licenses sold by the 10th of the following month. If a dealer fails to remit the licenses he sold, it will affect the sample pulled and thus the results of the survey. The affect is directly related to the number of licenses not remitted.

The only year when data was kept on regional distribution of the samples was 1985. Cumulative license sales were recorded for each FWP region (Table 4). These numbers were then compared to the sample drawn for the same region using a Chi-square test (Snedecor & Cochran, 1971).

The combined samples sizes from region to region throughout the year were significantly different from the combined regional licenses sales throughout the year. This could be the result of one of three factors: one - the samples being drawn were not random and thus not representative of the population; two - the remittance of licenses from the dealers was not timely enough and the sample drawn represents that population of licensees that were remitted; or three - the samples drawn were on a stratified basis throughout the year and were combined for comparison purposes to the annual license sales by region. This summation could mask the true stratified distribution and thus produce a invalid test statistic.

Table 4. License sales and total sample size for 1985 by FWP region

REGION	LICENSE SALES	SAMPLE SIZE	
1	32,773	5,532	
2	32,841	5,644	
3	38,092	6,868	
4	41,250	7,713	
5	34,059	6,930	
6	10,170	2,146	Chi-sqr = 169.4
7	11,489	2,329	P-value < 0.005

To more accurately assess which is correct, records should be kept on future surveys to track sample size by wave and by region for the entire season. The effect this bias, if any, has will be on pressure between regions and waters within the regions. This bias will have little or no affect on statewide estimates.

ACCURACY

SAMPLING

Samples were drawn and questionnaires sent to the selected anglers as soon as possible. This was usually 15-20 days after the wave being sampled had ended (see discussion under Methods in the Main Report for details). In 1984 the samples were pulled and questionnaires sent 1-2 days after the wave being sampled had ended. Since license dealers are not required to remit copies of licenses sold until the 10th of the following month, the samples did not contain all anglers who had purchased a license during the period being sampled. This is reflected in the fact that 1984 produced the lowest overall statewide angling pressure estimate (2,197,402 angler days). This situation was corrected for 1985 and resulted in a 11.2% increase in overall angling pressure. The months of May through October were the most affected by this sampling scheme.

The months of March and April 1984 overlapped with the 1983 license year due to a legislative change in the license year. These months contained

a large enough sampling pool so they could be sampled independenly for each survey year. Once through October the sampling pool was again large enough to minimize the impact of the reduced number of licenses. Also, license sales naturally curtail after September. This increased the reliability later in the year since the pool of anglers to be sampled is no longer rapidly expanding.

In 1982 no reminder was sent to the two-day nonresident license holder due to fiscal restraints. This had little or no affect on the pressure since there was no significant difference in number of respondents fishing between initial and remail for nonresidents in 1984 and 1985 (1984 t=-0.122 P=0.904; 1985 t=1.461 P=0.163).

Beginning in 1984 the sampling period changed from monthly to twice a month to help alleviate memory bias. Since fiscal constraints did not allow a doubling in sample size this effectively cut the sample in half. This is depicted in the number of waters on which estimates were made for each of the years: 1982 - 1408, 1983 - 1206, 1984 - 1135, 1985 - 1157 and by the number of trips reported for each year: 1982 - 20,230, 1983 - 16,863, 1984 - 8,779, 1985 - 17,379. In 1985 the number of questionnaires was doubled to bring the sampling level back to that used in 1982 and 1983.

CATCH RATES AND HARVEST

Catch rate and harvest information were estimated for individual waters beginning in 1984 and continued in 1985. Questions were included in the survey to ascertain from the angler the number of hours fished, the number of trout/salmon caught and kept, and the number of other sport species caught and kept.

Catch Rates. The catch rates estimated from the statewide angling survey were higher than those reported in on-site creel censuses for stream fisheries (Table 5). This was probably a result of a combination of reasons. One - the angler underestimating the hours fished; two - the angler overestimating the number of fish caught do to memory bias; three - the statewide stream fisheries survey asked the angler to include whitefish and generally they weren't incorporated in many creel census catch rates; and four - Lyden (1973) reported higher catch rates for voluntary creel card returns over personal interviews.

The lake fisheries catch rates estimated from the statewide angling survey were fairly close to those reported from on site creel censuses. The exception was Flathead Lake where the statewide survey estimated catch rate was 1.98 for the license year of 1985 compared to catch rates between 0.426 and 0.907 for the summer of 1985 (depending on the area of the lake fished) as reported by Hanzel (1986). Since the two surveys do not coincide exactly no conclusion can be drawn as to the accuracy of the mail survey. Lake Mary Ronan showed a similar discrepancy but due to the surveys being done 5 years apart this may be real.

Overall statewide catch rates (1.34 fish/hour in 1984 and 1.54 fish/hour

Table 5. Comparison of catch rates (fish/hour) between the statewide angling survey and on-site creel census for selected waters

Water	Period	Creel Census Catch Rate[2/]	Survey Catch Rate (sample size) 1984	1985
Alva Lake	8/71	1.10	4.95	1.04
			(9)	(21)
(Marcoux, 1973)				
Big Hole R.	5/77 - 9/77	0.41 - 0.66	1.07	1.80
	5/78 - 9/78	0.38 - 0.73	(113)	(165)
(Kozakiewicz, 1979)				
Bighorn R.	4/73 - 7/73	0.30 - 0.71	2.15	1.28
			(108)	(418)
(Stevenson, 1975)				
	10/82-9/83	0.42 - 0.71		
(Fredenberg, 1985)				
Big Spring Cr	5/68 - 9/68	0.31 - 1.24	1.36	1.11
	5/69 - 9/69	0.43 - 0.92	(46)	(32)
(Peterson, 1970)				
Flathead Lk.	6/85 - 9/85	0.43 - 0.91	1.17	1.98
			(277)	(481)
(Hanzel, 1986)				
Flathead R.	5/75 - 4/76	0.16 - 1.99	0.73	0.84
			(67)	(87)
(Hanzel, 1977)				
	5/81 - 11/81	0.07 - 1.15		
(Fredenberg & Graham, 1982				
Gallatin R.	5/71 - 9/71	0.43 - 0.63	1.08	2.15
	5/72 - 9/72	0.46 - 0.72	(243)	(575)
(Lyden, 1973)				
Hyalite Res.	6/81 - 9/81	0.28	0.51	0.70
	6/82 - 9/82	0.23	(17)	(20)
(Zubik, 1983)				
Inez Lake	8/71	1.70	0.00	1.31
			(1)	(14)
(Marcoux, 1973)				
L. Mary Ronan	5/68 - 11/69	0.22	0.99	2.49
			(120)	(184)
(Domrose, 1970)				
Lake Koocanusa	5/85 - 10/85	1.15	1.03	1.96
			(153)	(1310)
(Chisholm & Hamlin, 1987)				
Madison R.	5/66 - 9/66	0.54 - 1.00	1.37	1.71
	5/67 - 9/67	0.53 - 0.90	(722)	(1241)
(Vincent, 1969)				
M.F. Flathead R	5/75 - 4/76	0.32 - 0.58	0.53	0.73
			(5)	(32)
(Hanzel, 1977)				
	9/81 - 11/81	1.90		
(Fredenberg & Graham, 1982)				
N.F. Flathead R	5/75 - 4/76	0.24 - 0.74	1.93	1.38
			(15)	(46)
(Hanzel, 1977)				

Table 5. Comparison of catch rates (fish/hour) between the statewide angling survey and on-site creel census for selected waters (continued)

Water	Period	Creel Census Catch Rate[2/]	Survey Catch Rate (sample size) 1984	1985
Rock Cr.	5/58 - 11/58	0.89	1.29	2.24
	5/59 - 11/59	0.91	(116)	(184)
	5/60 - 11/60	0.89		
	5/61 - 11/61	0.69		
	5/62 - 11/62	0.65		
	5/63 - 11/63	0.61		
	5/64 - 11/64	0.60		
	5/65 - 11/65	0.67		
	5/66 - 11/66	0.63		
	5/67 - 11/67	0.72		
(Spence, 1971)				
	5/72 - 11/72	0.45		
(Marcoux, 1974)				
Swan Lk.	5/83 - 5/84	0.21 - 1.68	0.77	0.49
(Leathe & Enk, 1985)			(31)	(39)
Swan R.	5/83 - 11/83	0.046 - 0.33	1.60	1.50
(Leathe & Enk, 1985)			(22)	(37)
Yellowstone R	3/82 - 9/82	0.64	1.06	1.76
(Javorsky, 1984)			(113)	(246)
Yellowtail Aftby	4/82 - 3/83	0.37	0.42	0.39
(Fredenberg, 1984)			(19)	(21)

[2/] Catch rate by stratum and/or river section.

in 1985) appear high when compared to on-site creel census, however, they compare favorably with rates reported from the Department's Fisherman Log program for 1984 and 1985 -- 1.7 fish/hour for each year. Log catch rates are calculated from a diary kept by individual anglers. Logs are issued upon request and represent all types of waters and all parts of the state. The log catch rates would expectantly be higher since it is generally the more avid angler that keeps a log and sends it for the capturing of the data.

Harvest. The harvest estimates for streams were divided by the number of miles and then by the number of days of census for both on-site creel census and the statewide angling survey estimates (Table 6). In this way a comparable number could be used in equating the two harvest statistics. On the statewide survey for streams, the length in days was calculated for the time that a particular water was open to fishing.

The Harvest rates (fish/mile/day) were comparable between the statewide angling survey and on-site creel census for the Big Hole River and Bighorn River. The statewide survey showed lower harvest rates for the upper

Table 6. Comparison of harvest rates (fish/mile/day) between the statewide angling survey and on site creel census for selected rivers

Water	Period	Creel Census Harvest (fish/mile/day)	Survey Harvest (sample size) 1984	1985
Big Hole R. (Kozakiewicz, 1979)	5/77 - 9/77	3.696	2.902 (288)	2.514 (315)
	5/78 - 9/78	2.554		
Bighorn R. (Fredenberg, 1985)	10/82 - 9/83	1.705	1.691 (154)	1.881 (457)
Flathead R. (Fredenberg & Graham, 1982)	5/81 - 11/81	8.112	2.797 (67)	2.027 (87)
M.F. Flathead R (Fredenberg & Graham, 1982)	9/81 - 11/81	23.892	0.305 (5)	1.508 (32)
Swan R. (Leathe & Enk, 1985)	5/83 - 11/83	0.389	1.066 (22)	1.758 (37)
Yellowstone R (Javorsky, 1984)	3/82 - 9/82	0.977	5.121 (113)	2.771 (246)

Flathead River and the Middle Fork Flathead River. For the Swan River and Yellowstone River, the statewide survey showed higher harvest rates than the on-site creel census.

Some differences in harvest rates may be due to the difference in the year of census. In the Middle Fork Flathead creel census, the harvest rate was for spawning kokanee which would be expectedly higher than the annual harvest rate. On the Yellowstone, Javorsky (1984) did not report the whitefish harvest which may account for some of the discrepancy.

For lakes, the harvest was divided by the number of days of census (Table 7). Since all surveys included the entire body of water there was no need to break the estimates down by acre. The length of survey for the statewide angling estimates were all assumed to encompass 240 days for the lakes or reservoirs. This was selected to allow for ice up in the winter and thawing in the spring. The harvest rates for Lake Mary Ronan were based upon the season length set in the regulations of the third Saturday in May through March 15th of the following year.

The harvest rate (fish/day) for lakes and reservoirs was comparable between the statewide angling survey and on-site creel census for Flathead Lake, Lake Mary Ronan, Swan Lake and Yellowtail Afterbay.

Table 7. Comparison of harvest rates (fish/day) between the statewide angling survey and on-site creel census for selected lakes

Water	Period	Creel Census Harvest (fish/day)	Survey Harvest (sample size) 1984	1985
Flathead Lk. (Hanzel, 1986)	6/85 - 9/85	1,613.2	1,024.0 (277)	1,469.4 (481)
Hyalite Res. (Zubik, 1983)	6/81 - 9/81	61.25	26.84 (17)	27.92 (20)
	6/82 - 9/82	42.90		
L. Mary Ronan (Domrose, 1986)	1/86 - 3/86	245.1	248.16 (120)	294.59 (184)
Lake Koocanusa (Chisholm & Hamlin, 1987)	5/85 - 10/85	3,695.2	754.2 (153)	4,797.9 (1,310)
Swan Lk. (Leathe & Enk, 1985)	5/83 - 5/84	46.51	32.76 (31)	41.06 (39)
Yellowtail Aftby (Fredenberg, 1984)	4/82 - 3/83	14.56	17.43 (19)	8.49 (21)

In Hyalite Reservoir, the statewide harvest was less than that found by Zubik (1983). This difference may be attributable to the difference in years that estimates of harvest were made.

For Lake Koocanusa the statewide harvest rate was higher than that shown by Chisholm and Hamlin (1987). Considering the variability between years on Lake Koocanusa (754 to 4,797) this does not appear out of line.

Without an estimation of the variation associated with all the estimates there is no way of telling if the differences shown in harvest rates for streams and lakes are real. In future surveys variances should be calculated so more meaningful comparisons can be made.

PRESSURE

For comparison purposes the angling pressure was converted into angler days per mile per day (Table 8 and Table 9). Javorsky (1984) conducted a creel census on the upper Yellowstone River in 1982 but made no estimate of angler days. The Yellowstone River figures in Tables 8 and 9 were calculated by taking the total hours of angling pressure and dividing it by the average length of completed trip.

No significant difference was found (chi-square = 3.819 P-value = 0.70) for rivers between the creel census and the statewide estimates. This assumes the creel census are the actual numbers and the statewide estimates are the expected.

The statewide survey pressure estimates for the Big Hole River appear too low. These calculations were based upon 365 or 366 days in the season since there is an extended whitefish season. If the estimates were based upon the normal season (193 to 197 days) the number of angler days per mile per day would then become 5.169 for 1982, 5.172 for 1983, 5.840 for 1984, and 4.913 for 1985. This would place them right in-line with what Kozakiewicz found in 1977.

The statewide survey estimates for the Bighorn River are lower than that found by Fredenberg (1985) in 1982 and 1983. In this same report he estimated the total pressure for the upper 40 miles of the Bighorn River to be between 1.3699 and 1.7123 angler days/mile/day. This would compare favorably with that found in the statewide survey.

Fredenberg also found a decrease in pressure on the Bighorn River during the summer and fall of 1984. The summer of 1984 was considered a drought year and the publicity may have affected the nonresident pressure. The ever lower mail fishing pressure estimate for 1984 has in some part to do with the sampling procedure, but the extent of this bias can't be accurately determined due to other circumstances.

The upper Flathead River was estimated to have 3.266 angler days/mile/day by Fredenberg during the 1981 fishing season. This was higher than any estimate from the statewide survey. No conclusions can be drawn since the estimates were made for different years. Without calculating variances one can't tell if the difference is real. The Middle Fork Flathead River was estimated to have a pressure of 2.557 angler days/mile/day for the kokanee spawning run of 1981. This short season of 80 days provides the bulk of the pressure on the Middle Fork (Fredenberg and Graham, 1982). This would then account for some of the reason that the on-site creel census was much higher than those found in the statewide survey.

The Swan River estimates compare favorably, especially when the same year of census are equated. The difference (0.0652) is within 12% of the estimate.

When comparing the same year and same section on the Yellowstone River the two estimates are less than 3% apart.

Table 8. Comparison of angling pressure (pressure/mile/day) between the statewide angling survey and on-site creel census for selected rivers for 1982 and 1983

Water	Period	Creel Census	Statewide survey 1982 (sample size)	Statewide survey 1983 (sample size)
Big Hole R. (Kozakiewicz, 1979)	5/77 - 9/77	5.020	1.2315 (417)	1.2386 (383)
	5/78 - 9/78	3.708		
Bighorn R. (Fredenberg, 1985)	10/82 - 9/83	2.703	1.4319 (283)	1.3797 (342)
Flathead R. (Fredenberg & Graham, 1982)	5/81 - 11/81	3.266	2.4040 (167)	2.7426 (172)
M.F. Flathead R (Fredenberg & Graham, 1982)	9/81 - 11/81	2.557	0.7486 (28)	0.1713 (17)
Swan R. (Leathe & Enk, 1985)	5/83 - 11/83	0.4671	0.6623 (61)	0.5333 (47)
Yellowstone R (Javorsky, 1984)	3/82 - 9/82	2.2587	2.3227 (285)	1.6764 (227)

All lake and reservoir pressure data was converted into angler days per season length in days (240 days - see Harvest) for consistency and comparison purposes (Tables 10 and 11). On Hyalite Reservoir, Zubik (1983) did not estimate pressure in angler days. To make the data comparable, his estimate of pressure in hours was divided by the length of completed trip to obtain an estimate of angler days.

The statewide estimates under-estimated pressure on Flathead Lake, Hyalite Reservoir, and Lake Koocanusa when comparing the nearest or same year of census. It over-estimated pressure on Lake Mary Ronan, Swan Lake and Yellowtail Afterbay.

Table 9. Comparison of angling pressure (pressure/mile/day) between the statewide angling survey and on-site creel census for selected rivers for 1984 and 1985

Water	Period	Creel Census	Statewide Survey (sample size) 1984	1985
Big Hole R.	5/77 - 9/77	5.020	1.4129	1.2020
	5/78 - 9/78	3.708	(291)	(319)
(Kozakiewicz, 1979)				
Bighorn R.	10/82 - 9/83	2.703	1.0607	1.4616
(Fredenberg, 1985)			(154)	(460)
Flathead R.	5/81 - 11/81	3.266	1.6342	1.4009
(Fredenberg & Graham, 1982)			(67)	(87)
M.F. Flathead R	9/81 - 11/81	2.557	0.2792	0.6492
(Fredenberg & Graham, 1982)			(6)	(32)
Swan R.	5/83 - 11/83	0.4671	0.6154	0.6727
(Leathe & Enk, 1985)			(22)	(37)
Yellowstone R	3/82 - 9/82	2.2587	1.3950	2.0561
(Javorsky, 1984)			(125)	(248)

In 1982 and 1983 coding of questionnaires was done by work study or contract help. This presented some problems on waters such as Bighorn Lake (commonly called Yellowtail Reservoir) where it would be coded as Yellowtail Afterbay. This was corrected for 1984 and 1985 and can be seen in the estimates being more akin to that found by Fredenberg (1984), 10.07 & 6.22 vs 9.164 respectively.

Using (angler days)/(days of census) may not be the best statistic for comparison and could account for the discrepancies shown. This can be shown when looking at Swan Lake. Leathe and Enk showed the pressure to be 7,093 angler days. This was for an entire year of 5/21/83 to 5/18/84. The statewide estimate for that same period (5/01/83 - 4/30/84) was 7,022 angler days. Assuming a variation for the estimate by Leathe and Enk to be comparable to that found on the statewide survey the difference is not significant (t-test = 0.03, p-value > .50). A better statistic would be to determine the angling season length (i.e. account for freeze-up, spring thaw and intensity of ice fisheries) as was done in harvest calculations for each reservoir or lake compared and use this number when determining the pressure per day.

Table 10. Comparison of angler pressure (pressure/day) between the statewide angling survey and on-site creel census for selected lakes for 1982 and 1983

Water	Period	Creel Census	Statewide Survey (sample size) 1982	1983
Flathead Lk. (Hanzel, 1986)	6/85 - 9/85	641.6	383.1 (675)	431.2 (604)
Hyalite Res. (Zubik, 1983)	6/81 - 9/81	68.89	44.90 (78)	28.05 (45)
	6/82 - 9/82	59.33		
L. Mary Ronan (Domrose, 1986)	1/86 - 3/86	50.02	52.76 (118)	74.82 (221)
Lake Koocanusa (Chisholm & Hamlin, 1987)	5/85 - 10/85	559.9	146.9 (251)	143.0 (226)
Swan Lk. (Leathe & Enk, 1985)	5/83 - 5/84	19.49	25.13 (50)	29.26 (60)
Yellowtail Aftby (Fredenberg, 1984)	4/82 - 3/83	9.164	48.98 (110)	49.51 (105)

Chisholm and Hamlin (1987) felt the statewide survey agreed closely with the results they found for Lake Koocanusa when compared on an annual basis. The descrepancy shown in Table 10 for this water arises because their survey was for the peak fishing period, while the statewide was year round. Hanzel (1986) estimated the total annual pressure on Flathead Lake for 1985 to be 73,425 angler days. The statewide estimate of pressure for this same period was 75,964. Assuming a variation from the creel census equal to that of the statewide survey, there is no significant difference in the two estimates ($t=0.28$, p-value > 0.50). Where the same time period can be matched the results of the statewide angling survey agree closely with lake and reservoir creel censuses.

RETURN RATES

Return rates (# of respondents / [# of surveys sent - nondeliverables] * 100) were calculated for every wave and year the survey was conducted (Table 12). The average return rates for residents and nonresidents for 1982 were 74.84% (s.d. = 5.09) and 83.5% (s.d. = 7.37) respectively. In 1983 the average decreased to 67.98% (s.d. = 6.96) for residents and 78.39% (s.d. = 5.48) for nonresidents. This difference was not significant for residents ($t=0.796$, p-value = 0.43) nor nonresidents ($t=0.595$, p-value >

0.50). In 1984 the average return rate for residents was 61.71% (s.d.=4.86) and for nonresidents 71.79% (s.d.=9.10). This was again a decrease from the previous two years. Although the difference

Table 11. Comparison of angling pressure (pressure/day) between the statewide angling survey and on-site creel census for selected lakes for 1984 and 1985

Water	Period	Creel Census	Statewide Survey (sample size) 1984	1985
Flathead Lk. (Hanzel, 1986)	6/85 - 9/85	641.6	323.9 (278)	316.5 (482)
Hyalite Res. (Zubik, 1983)	6/81 - 9/81	68.89	19.84 (17)	18.68 (25)
	6/82 - 9/82	59.33		
L. Mary Ronan (Domrose, 1986)	1/86 - 3/86	50.02	66.69 (122)	60.92 (185)
Lake Koocanusa (Chisholm & Hamlin, 1987)	5/85 - 10/85	559.9	166.4 (156)	476.0 (1,325)
Swan Lk. (Leathe & Enk, 1985)	5/83 - 5/84	19.49	20.78 (31)	31.75 (44)
Yellowtail Aftby (Fredenberg, 1984)	4/82 - 3/83	9.164	15.31 (19)	9.47 (21)

was not significant from the 1982 level for residents (t=1.866, p-value=0.073) and nonresidents (t=1.03, p-value=0.30) it is nearing the significance level for residents. This decrease is probably attributable to the added questions included on the survey for this year. In 1985, the survey was sent out by bulk rate rather than first class mail. This is reflected in the significant drop in return rates for residents (1983 vs 1985 - t=2.65, p-value=0.014; 1984 vs 1985 - t=2.73, p-value=0.01). Nonresidents did not show a significant difference in return rates between 1985 and any of the preceding years (1982 vs 1985, t=1.985, p-value=0.06; 1983 vs 1985, t=1.665, p-value=0.11; 1984 vs 1985, t=0.801, p-value=0.40). The return rate for nonresidents does show a steady decrease from year to year, probably reflecting the addition of questions asked and mailing out by bulk rate. Future studies should consider using first class postage for mailings since mailing bulk rate caused the only significant drop in return rates for residents.

The rate of nonresidents returning their surveys is consistently higher than residents. This is probably do to a higher degree of interest and a more willingness to participate.

Table 12. Return rates by residency for the 1982 through 1985 statewide angling pressure surveys

	1982		1983		1984		1985	
WAVE	RES	NRES	RES	NRES	RES	NRES	RES	NRES
1	69.1	73.0	----	----	62.1	75.9	48.6	56.1
2	71.5	75.5	59.3	82.6	66.4	70.0	47.8	59.5
3	70.9	84.5			54.1	67.2	47.7	52.5
4	73.7	84.3			64.8	78.0	50.2	47.8
5	73.4	96.8			61.9	58.3	42.0	57.9
6	87.8	89.4	66.8	76.6	60.5	69.6	46.5	68.7
7	77.2	85.9	73.7	84.9	63.9	72.7	49.0	69.0
8	76.7	80.8	71.0	85.5	65.2	65.5	46.3	57.1
9	76.3	88.5	75.4	81.3	62.3	67.3	45.2	62.0
10	75.8	89.4	76.3	79.0	64.7	59.0	45.1	69.8
11	70.8	74.3	71.9	80.7	59.6	89.5	44.4	76.0
12			73.9	79.0	61.9	74.6	45.1	62.6
13	----	----	----	----	63.6	78.0	47.5	71.1
14			62.1	75.9	62.2	64.1	37.0	51.2
15			66.4	70.0	51.4	69.5	43.8	55.3
16			54.1	67.2	74.2	90.8	45.1	71.4
17			64.8	78.0	58.9	60.0	37.9	65.9
18					60.0	80.2		
19					54.7	73.8		

The percent of residents and nonresidents who said they fished were compared between initial and remail mailings to determine if a significant difference occurred (Table 13). A paired t-test (Snedecor & Cochran, 1971) was used. The residents for both years showed a significant difference in percent fishing (1984 - t=4.581, p-value= 0.00023; 1985 - t=4.255, p-value=0.00060). The percent fishing was consistently higher for the initial mailing. This may represent a bias in the survey if those anglers still not responding had a different percentage of fishing then the combined (initial and remail) rate. If they did differ, it would indicate the statewide survey is over-estimating the pressure.

The nonresidents showed no significant difference in percent fishing between initial and remail mailings for both 1984 and 1985 (1984 - t=-0.122, p-value=0.90439, 1985 - t=1.461, p-value=0.16318).

In future surveys a follow-up survey should be done on resident anglers still not responding to see if their percent fishing response is different than those already received.

NUMBER OF LICENSED ANGLERS VS PRESSURE

The number of fishing licenses sold and thus the number of anglers from 1982 to 1985 has been static to decreasing (Table 14). The number of

Table 13. Percent of resident and nonresident respondents fishing during the 1984 and 1985 seasons sorted by initial and remail mailings and wave

Wave	1984 Initial Res	1984 Initial Nres	1984 Remail Res	1984 Remail Nres	1985 Initial Res	1985 Initial Nres	1985 Remail Res	1985 Remail Nres
1	10.5	2.9	8.8	0.0	31.0	47.5	28.0	57.1
2	8.8	11.4	6.8	14.3	37.8	57.4	29.7	51.3
3	15.2	19.4	14.3	0.0	47.8	68.4	39.1	60.4
4	19.3	8.6	6.0	18.2	46.1	46.8	30.1	35.3
5	58.5	55.1	37.2	72.2	44.6	52.9	30.7	54.5
6	41.2	29.0	32.8	37.5	36.2	31.7	33.1	36.7
7	45.2	35.5	28.0	33.3	32.7	50.8	24.5	30.0
8	45.0	32.0	40.4	36.4	32.6	36.7	27.9	47.8
9	37.0	31.8	28.1	46.7	35.1	32.1	16.6	15.8
10	34.2	30.8	36.1	60.0	19.0	12.7	15.6	12.0
11	32.9	27.3	21.5	11.1	16.6	9.5	17.5	6.3
12	27.4	27.5	17.2	0.0	12.8	11.9	11.8	11.1
13	19.1	12.1	10.0	15.4	11.5	5.3	10.0	0.0
14	14.7	5.9	8.4	0.0	10.0	2.6	6.7	4.1
15	11.2	9.4	11.2	0.0	11.9	4.9	10.9	0.0
16	7.8	7.2	8.2	5.0	14.8	7.7	6.0	0.0
17	9.5	5.0	10.2	6.7	11.1	0.9	11.7	5.8
18	14.0	6.2	6.6	10.0				
19	14.8	2.7	7.8	0.0				

resident licenses sold is equal to the number of resident anglers. For nonresidents, they are not equal because the department sells a 2-day

Table 14. Number licenses sold and number of anglers in Montana by residency for 1982 to 1985

License Year	Licenses sold Residents	Licenses sold Nonresidents	Number of Anglers Residents	Number of Anglers Nonresidents
1982	184,656	206,716	184,656	118,438
1983	187,524	205,500	187,524	113,425
1984	184,398	172,751	184,398	106,266
1985	184,913	178,355	184,913	106,201

permit which can be purchased in any quantity. The average nonresident purchased 2.088 stamps in 1983.

There was no correlation between pressure and license sales for either residents or nonresidents (residents - r=0.52677; nonresidents - r=0.812382). To be significant at the 95% level a correlation coefficient (r) of at least 0.878 would have to be obtained. When comparing number of anglers and pressure the correlation for residents was the same as license sales. For nonresidents the correlation coefficient decreased to 0.781107, again showing no relationship between pressure and number of licensed anglers on a statewide basis.

CONCLUSIONS AND RECOMMENDATIONS

The statewide angling pressure estimates are fairly representative of the actual pressure occurring on each stream. This is borne out by comparing similar time period on-site creel censuses and finding no significant difference. The number of comparisons was small and on waters where there was a fair amount of pressure. On those waters where the pressure was light (less than 10 trips reported), the results of the statewide survey have not been validated and should be used with caution.

The catch rates and harvest follow those found in on-site studies realizing the number presented are totals for all fish species. Overall the catch rates are too high when compared with those done for trout only, but fall in-line with those found in the Fisherman Log program.

Future studies should incorporate a better system of randomly selecting the anglers to be sampled. Keying all the fishing license data and selecting the wave samples by computer would produce a better random sample.

Follow-up surveys should be conducted in future sampling to assess the "yes I fished" response rates for residents. A lower response by anglers who did not fish compared to those who did may be biasing the estimates of pressure, harvest and catch rates upward.

All future surveys should use first class postage for the mailings. This will help assure a higher response rate from both residents and nonresidents.

When practical, on-site creel censuses should be conducted during the same time period to help in assessing the reliability of the statewide survey. This would be particularly useful if a cross section of waters from around the state could be creeled over a span of years.

The statewide survey should be funded to operate annually. This would help in running a consistent and accurate survey. The results would be comparable from year to year. It would help in assessing potential problem waters that may go undetected from sporadic surveys. An annual survey would benefit following a species such as kokanee that are cyclic in their population numbers. Also, it may be possible to combine several years data for individual lightly fished waters to achieve more reliable estimates.

The questionnaire form should be evaluated and all unnecessary questions removed. This will help increase return rates.

A method to more accurately track the number of questionnaires sent for each FWP region needs to be developed. If the dealer number was included in the keying of licenses this would provide an easy way to assign a region to each response. The sampling method used should be tested to see if the proportion of questionnaires by region is equal to the number of licenses sold by region.