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An Assessment of the Introduction of Summer Steelhead into Michigan

David G. Fielder

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AN ASSESSMENT OF THE INTRODUCTION OF SUMMER STEELHEAD INTO MICHIGAN

by

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A thesis submitted in partial fulfillment
of the requirements for the degree of
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AN ASSESSMENT OF THE INTRODUCTION OF SUMMER STEELHEAD INTO MICHIGAN[1]

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ABSTRACT

Steelhead (Salmo gairdneri) are not native to the Great Lakes but have been introduced since the late 1800s. Steelhead in the Great Lakes make their spawning migrations in the fall or spring. In 1975 the State of Indiana introduced the Skamania strain of steelhead which migrate during the summer months. The Skamania strain has been very successful in Indiana. In 1984 the State of Michigan introduced four stains of summer steelhead (Rogue, Skamania, Siletz, and Umpqua) into several Great Lakes tributaries to expand the existing steelhead river fishing season to the summer. This thesis tested the hypothesis that the introduction of summer steelhead expanded river steelhead fishing into the summer months. Volunteer research anglers were used to report fishing activities as a means of documenting summer steelhead returns. A creel census was also employed on one of the stocked rivers to document returns. The summer steelhead did significantly expand the river steelhead fishing season. Volunteer angler data and creel census results showed first date of river catch was July with a peak in August. This provided for about 2 months of new angling for river steelhead. The Rogue strain returned first (1984) and the other three strains returned by the third summer (1986). Steelhead and salmon sport catches were statistically different between lake and river

locations with salmon generating more of a lake fishery and steelhead generating more of a river fishery. Summer steelhead contributed a significantly greater proportion of lake catch than Great Lakes steelhead. The lengths of fish at a known age were similar between summer and Great Lakes steelhead, indicating similar growth rates. The level of catch per unit effort generated by the summer steelhead introductions was very low. Future stocking efforts will require larger stocking numbers and annual releases in consistent locations. Some additional potential benefits and problems of summer steelhead introductions exist.

INTRODUCTION

Many forms of steelhead (*Salmo gairdneri*) (anadromous rainbow trout) have been introduced into the Great Lakes since the late 1800s (MacCrimmon 1971; MacCrimmon and Gots 1972). Presently some self-sustaining populations of steelhead exist in the Great Lakes (Biette et al. 1981; Seelbach 1986), and sport catch is a combination of both hatchery and wild fish. Steelhead found in the Great Lakes exhibit two primary river migration patterns. Some individuals make their river migration in the late fall and winter months while others enter only in the spring months (Biette et al. 1981; Seelbach 1986). These two groups will be referred to here as fall-run and spring-run Great Lakes steelhead, respectively. These populations of steelhead have provided an excellent sport fishery in the lakes and rivers especially during their spawning migration.

On the Pacific Coast of the United States, steelhead are divided into two types. Winter steelhead make a spawning migration back to their natal rivers during the winter months, usually November through April. Summer steelhead make their spawning migration during the summer months, usually May through September (Withler 1966). The two types differ in other characteristics as well. Winter steelhead are sexually mature when entering the river, while summer steelhead are sexually immature during entrance

(Smith 1960, 1969; Withler 1966; Leider et al. 1984). Spawning is frequently earlier for summer steelhead (Leider et al. 1984) yet this characteristic seems variable and needs further documentation. There may also be slight morphological differences between the two types (Smith 1969). These life history characteristics are different enough that the two types have been frequently identified as separate races of the same species (Smith 1960; Withler 1966; Behnke 1972; McKern et al. 1974; Leider et al. 1984). However, Allendorf and Utter (1979), based on electrophoric data, divided steelhead into "coastal and inland" groups and not by anadromy or season of return to fresh water. For the purpose of this thesis summer and winter steelhead will be considered separate races of the same species. In a particular river system, specific strains of each race may have evolved (i.e., the Rogue River strain) or strains may have been developed artificially in a hatchery. The Skamania strain of summer steelhead was developed at the Skamania Hatchery in Washington where biologists selectively bred individuals for summer return, winter spawning, and large size (older age at return) (Millenbach 1973).

The life history pattern of spring-run steelhead in the Great Lakes is most similar to that of winter-run steelhead (Biette et al. 1981), and it was probably winter strains which were most commonly introduced. Introduced steelhead seem to have retained the major characteristics of their life history from their native range (Behnke 1972; Biette et al. 1981; Seelbach 1986). Michigan's fall-run steelhead differ from spring-run fish mainly in their time of river return but also in the degree of sexual maturity at river entry. Similar to summer steelhead, fall-run Great Lakes steelhead are generally immature sexually at the time of their migration and ripen sometime prior to spawning (Seelbach 1986). Behnke (1972) believed that the two populations are genetically distinct and reproductively isolated. It has been suggested that Great Lakes fall-run steelhead are analogous to coastal summer steelhead with timing differences related to climatic conditions in each locale (Biette et al. 1981). However, there are fall-run steelhead on the Pacific Coast as well as winter- and summer-run steelhead (Neave 1949; Shapovalov et al. 1954; Royal 1972).

In 1975 the State of Indiana introduced summer steelhead into Lake Michigan from eggs imported from the Skamania Hatchery in Washington. Despite only limited stream habitat, Indiana successfully established a summer steelhead fishery. Some of the creeks that receive the hatchery stocks are marginal trout streams at best and are very warm for trout occupation. Nevertheless, large runs of Skamania summer steelhead congregate in Lake Michigan near the river mouths, creating a very popular lake fishery. After the fish run the creeks, some stream fishing takes place. Indiana chose the Skamania summer steelhead for stocking because of its reputation for tolerating warmer water temperatures and from only limited success with other steelhead (W. D. James, Indiana Department of Natural Resources, Indianapolis, personal communication with J. A. Scott, Michigan Department of Natural Resources, 1982; Armstrong 1985).

In 1983 the Michigan Department of Natural Resources (MDNR) imported four strains of summer steelhead. The state's purpose for introducing summer steelhead was to improve steelhead fishing by expanding the existing river fishery to the summer months. This hypothesis of seasonal expansion forms the basis of this thesis. The Skamania strain was imported from Indiana, while the Rogue, Siletz, and Umpqua strains were imported from those rivers in Oregon. Each of these summer steelhead strains will henceforth be termed Skamania steelhead, Rogue steelhead, Siletz steelhead, and Umpqua steelhead for simplicity. By March 1984, the state had 198,000 summer steelhead smolts for release. The fish were approximately 7 to 8 inches in length. Nine Michigan rivers were chosen by MDNR to receive smolts (Figure 1, Table 1). Smolts were fin clipped with distinctive patterns to allow strain identification by biologists and fishermen (Appendix 1).

The objectives of this study were:

1) To statistically compare the numbers returning by month for Great Lakes steelhead and summer steelhead so as to establish a basis for evaluating

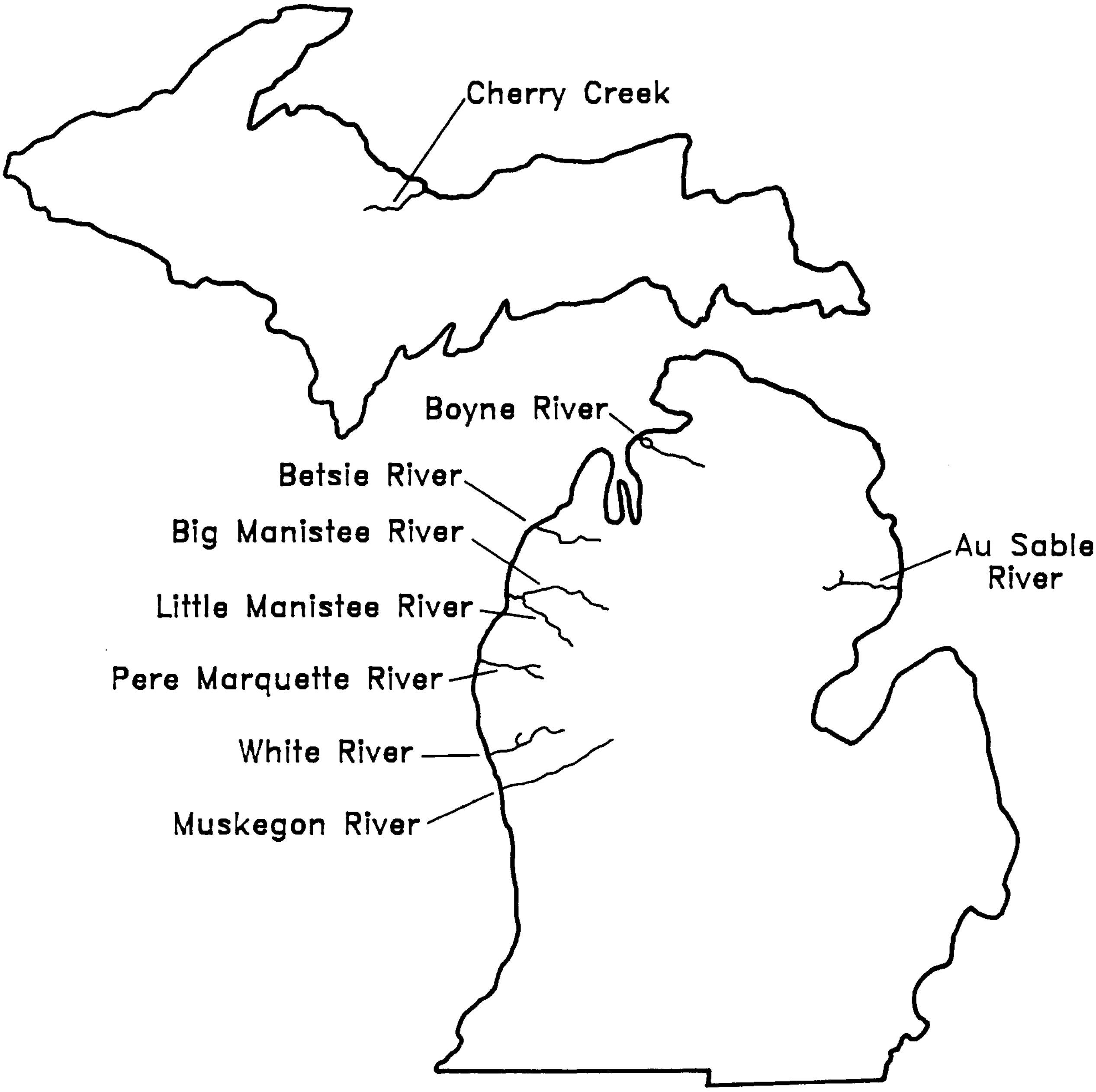

Figure 1. Locations in Michigan where summer steelhead were stocked in 1984

Table 1. Locations and numbers of each summer steelhead strain stocked in Michigan rivers in 1984.

Location	Number	Strain
Muskegon River	20,000	Skamania
	17,000	Umpqua
Big Manistee River	20,000	Skamania
	16,000	Rogue
White River	20,000	Siletz
Betsie River	8,000	Rogue
Boyne River	8,000	Rogue
Au Sable River	19,000	Skamania
	17,000	Rogue
Pere Marquette River	10,000	Skamania
	10,000	Umpqua
Little Manistee River	5,000	Rogue
	5,000	Umpqua
	5,000	Siletz
Cherry Creek	18,000	Siletz

whether summer steelhead did expand river fishing into the summer months.

2) To estimate total sport catch of Skamania and Rogue summer steelhead and Great Lakes steelhead in the Big Manistee River from a creel census conducted in 1985 and 1986.

METHODS

Sport angler catch was the primary data collected in order to monitor migration runs and the contribution of summer steelhead to the state's steelhead fishery. Sport catch was a convenient source of data because the data were readily available through volunteer research anglers, and sport catch was the goal of these introductions. The use of volunteer anglers also allowed the monitoring of a large geographical area. Catch data were also obtained through a MDNR creel census on the Big Manistee River. Some additional summer steelhead reports were supplied from MDNR biologists through weir or field operations and from the general public.

Volunteer Research Anglers

Volunteer fishermen were usually recruited by attending meetings of clubs such as the Michigan Salmon and Steelhead Fishermen's Association. A slide presentation was given explaining the project and requesting help. Volunteers' names, addresses, and telephone numbers were collected and they were supplied with an assessment kit. This kit consisted of an explanatory brochure, a project diary to document their catch, and a button designating them as a Summer Steelhead Research Angler (see Appendices 2, 3, and 4). Some additional volunteers were recruited through the mail.

Volunteers were allowed to fish as they normally would, but were asked to check for fin clips on any steelhead caught. In order to monitor effort, fishermen were told to make an entry on one diary page for each fishing trip even if no fish were caught. Data recorded were: date of trip, hours fished, location, number of fish caught, and species of fish caught. If a fin-clipped steelhead was caught, additional data recorded included clip pattern, total length, and specific location.

The goal of this analysis was to have each stocked river and port (except Cherry Creek) covered with enough research anglers to provide reports for at least two weekdays and one weekend day every week, continuously from July 1984 through November 1986. Approximately 180 volunteers were registered from mid-1984 through late 1985 and about 300 from late 1985 through late 1986. Active participation was defined as the percent of volunteers who actually returned diaries. Anglers were requested to return diaries as they became filled. Blank replacement diaries and thank you letters were mailed in response. Twice during the project, approximately halfway through and near completion, all diaries (including partially filled diaries) were recalled. Anglers who did not return diaries were mailed a postcard, again requesting the return of their diaries. Anglers who still did not return diaries were contacted by telephone. If diaries were then not returned, it was assumed that the volunteer angler had not participated.

Volunteer research angler catch (both lake and river) for salmon and steelhead was used to calculate percent monthly catch. The percent for each month was determined by dividing the monthly catch for each species or strain by the project total for that species or strain. Percent monthly catch of summer steelhead utilized all reports of summer steelhead, not just those of the diaries. Percent monthly catch is partly dependent on changes in effort but allows for a comparison of seasonal return for steelhead types despite large differences in total numbers returning. Volunteer angler catch for all types was also subdivided into total frequencies between open water (lake) and river. These are termed volunteer angler catch frequencies and utilize all summer steelhead reported.

Catch data for summer steelhead strains were used to calculate percent of each strain in the total summer steelhead catch. This portrays the contribution of each strain to the monthly river catch of summer steelhead throughout the project and utilizes all summer steelhead reported. This percent was calculated by dividing the monthly catch of each strain by the total monthly catch of all summer steelhead strains combined and was termed percent composition. This should not be confused with the previously mentioned percent monthly catch of each strain. Catch per unit effort (CPUE) of volunteer anglers for summer steelhead was extremely low and missing for many months (except on the Boyne River for part of the project) because many of the reported summer steelhead came from sources other than the volunteer diaries. Some reasons for this are discussed later and volunteer angler CPUE is not presented. Boyne River volunteer CPUE is used in some later calculations and explained then.

For the purpose of the hypothesis test, seasonal expansion in the state river steelhead fishery was defined as the establishment of summer steelhead catch in a monthly proportion significantly greater than that for Great Lakes steelhead. Because Michigan already benefits from steelhead returns in fall through spring, summer (late May through early September) is the only season available for expansion. If the summer steelhead strains were collectively caught in greater proportions during a month other than the Great Lakes steelhead, then there would be an expansion.

Two time periods were chosen for comparison of steelhead catch. They were July through December 1985 and July through November (end of sampling) 1986. The two time periods effectively allow for the comparison of summer steelhead returns to that of fall-run Great Lakes steelhead. The fall run of Great Lakes steelhead is closest in timing to summer runs and represents the best comparison for summer steelhead. Summer steelhead may continue to be caught in the river during the winter and spring months but this represents no seasonal expansion. There was insufficient summer steelhead returns to allow a comparison during the first summer and fall of the project in 1984.

The statistical procedure used for the comparison of steelhead types in each month of each time period was the Chi-square test using a 2x2 contingency table for comparison of proportions in two independent samples (Snedecor and Cochran 1971). The data used in the test were volunteer angler catch frequencies for summer and Great Lakes steelhead caught in the rivers. Summer steelhead strains were combined for the test. The procedure was applied to each month in each time period. The procedure effectively compares two proportions, in this case the proportion of each type of steelhead caught in a specific month relative to the total steelhead caught of each type for the entire time period. The table was structured with steelhead type (summer or Great Lakes) versus number caught for that month and number not caught (the remainder caught for the rest of that time period). The observed frequencies are compared to expected frequencies calculated under the null hypothesis of equal proportions. The expected frequencies are determined by multiplying the corresponding row and column totals and dividing by the sample size (Snedecor and Cochran 1971). This and all statistical tests were run using a significance level of 0.05.

Other comparisons performed between steelhead types included catch frequencies between open water and rivers and an examination of length at age. Volunteer angler catch frequencies were compared in order to determine if summer steelhead and Great Lakes steelhead or salmon (salmon were included as a point of reference) differ in their tendency to generate a lake or river fishery. The Chi-square test (Snedecor and Cochran 1971; Remington and Schork 1985) was again used. The expected values were calculated with the hypothesis that the row and column classifications were independent. The expected frequencies were calculated the same as described above for the comparison of proportions. Patterns of dependence were identified by the difference between the observed frequencies and those expected if both locations were equally represented in all three groups.

Mean length for a known age was also compared between the summer steelhead strains and fall-run Great Lakes steelhead using a test of equality of the means of two samples whose variances are assumed to be unequal (Sokal and Rohlf 1981) referred to hereon as t tests. The procedure compared total length in inches for the summer steelhead strains reported by volunteer anglers from August through November 1986, to Great Lakes fall-run steelhead of the same age collected at the Little Manistee River weir during fall 1983 and 1984. The age of comparison for steelhead was 2.5 years after smolting. This procedure allowed some comparison of growth rates.

Creel Census

A stratified creel census was conducted on the Big Manistee River in 1985 from April to mid-November, and in 1986 from May to mid-October. The survey was conducted by the MDNR and followed methods and calculations described by Ryckman (1981). The study area was from Tippy Dam (the first upstream barrier) down to and including Manistee Lake at Stronach, Michigan. The census provided estimates of seasonal catch per unit effort (CPUE) and total catch for each species and strain by month. For all estimated catches, 95% confidence limits were also calculated (Ryckman 1981).

The 1986 census included separate catch estimates for summer steelhead strains but the 1985 census did not. Summer steelhead catch estimates for the 1985 census were derived monthly from the ratio of steelhead with summer steelhead fin-clip patterns to steelhead without fin clips. Total steelhead catch, estimated by the creel census, was multiplied by this ratio to determine summer steelhead catch.

Some estimates of monthly and seasonal summer steelhead catch were also possible for the Boyne River because volunteer effort was relatively large and consistent enough to provide meaningful CPUE data. These estimates were calculated from a ratio of volunteer to creel census effort from the Big Manistee River. That ratio was multiplied by the volunteer effort on the Boyne River for an estimate of total effort on the Boyne. This was then multiplied by the CPUE of volunteers on the Boyne River, which yielded an estimate of total summer steelhead caught. A correction factor, based on the different efficiencies of volunteers and average anglers, was calculated from the ratio of volunteer angler steelhead CPUE to the estimated steelhead CPUE for the 1985 Big Manistee River creel census. This was multiplied by the total estimate above to determine the actual number of summer steelhead caught on the Boyne River.

The estimates generated by the creel censuses and the extrapolations are useful in two ways. The monthly estimates could confirm timing trends identified in the volunteer angler data. Secondly, the total estimates and CPUE allow for a measure in magnitude of the contribution made to the fishery by the summer steelhead plants. This information may be useful in determining future stocking effort needed to generate adequate returns.

RESULTS

Active participation of the volunteers was 30% (54 anglers) from July 1984 to September 1985. There was 16% (47 anglers) active participation of the volunteers from September 1985 to November 1986. A total of 10,879 hours of effort was logged in project diaries by volunteer anglers. This effort included 51% on open water and 49% in rivers. Effort was not evenly distributed throughout the project duration (Appendix 5). Rivers receiving the most consistent annual effort were the Big Manistee and Boyne. Ports receiving the most consistent effort throughout the open-water seasons were Manistee and Muskegon. The effort objective of two weekdays and one weekend day of angling trips per weeks was not achieved consistently on any of the study rivers although the Big Manistee River came very close. This inconsistency in effort for most rivers makes seasonal return data for that specific location tenuous. Sport catch and effort combined for all rivers or ports should allow inferences about individual strains.

Total catch of all species reported during the project was 8,490 fish (Table 2). Of this, 59% were caught in open water and 41% in rivers. Out of the total, 280 (3%) were summer steelhead. This total includes 198 reported by sources other than volunteer diaries. Salmon caught by volunteers consisted primarily of chinook (<u>Oncorhynchus</u>

Table 2. Number of summer steelhead and other species caught by volunteer anglers in lakes and rivers, July 1984 to November 1986. Percent of total number in parentheses.

Location	Summer steelhead[1] Ro	Sk	Um	Si	Total	Great Lakes steelhead	Salmon	Other trout	Other species	Total
Lake	2	34	10	14	60 (21)	239 (12)	3,274 (80)	1,339 (69)	68 (27)	4,980 (59)
River	83	79	26	32	220 (78)	1,694 (88)	819 (20)	590 (31)	187 (73)	3,510 (41)
Combined	85	113	36	46	280 (3)	1,933 (23)	4,093 (48)	1,929 (23)	255 (3)	8,490 (100)

[1]Ro: Rogue, Sk: Skamania, Um: Umpqua, Si: Siletz.

tshawytscha) and coho (Oncorhynchus kisutch). Other trout caught in the open water were usually lake trout (Salvelinus namaycush) and brown trout (Salmo trutta). Other trout caught in the rivers were usually brown and rainbow trout.

The majority of the volunteer angler catch for both summer steelhead and Great Lakes steelhead occurred in the rivers (78% and 88%, respectively). Contrarily, the majority of salmon were caught in the lake (80%). Lake catch was defined as any catch in a Great Lake or shoreline lake such as Manistee Lake. In an effort to determine if the proportion of lake or river catch varied with species, the Chi-square contingency test was applied to these data (Table 3). The species caught was strongly dependent on location ($P<0.0001$). Salmon were more readily caught in lakes, while Great Lakes and summer steelhead were more readily caught in rivers. Summer steelhead had 21% of their total catch occurring in the lakes while only 12% of Great Lakes steelhead were caught there (Table 2). The proportion of summer steelhead caught in lakes (Table 3) was significantly greater than Great Lakes steelhead ($P<0.0001$).

Lake catch in the Great Lakes for salmon and steelhead is largely restricted to the open-water season (approximately May through September). Peak lake catch by volunteers of both summer steelhead and salmon occurred in August. The peak year for summer steelhead catch in the lakes was 1986 (Appendix 6). Volunteers' catch of Great

Table 3. Chi-square contingency table for salmonids compared between locations. X^2=2,593.584, $P<0.0001$. Comparison done also between steelhead lake catch, X^2=16.429, $P<0.0001$. Data were collected from 1984 through 1986.

	Observed frequencies		Expected frequencies	
Species	Lake	River	Lake	River
Salmon	3,274	819	2,319	1,774
Great Lakes steelhead	239	1,694	1,095	838
Summer steelhead	60	220	159	121

Lakes steelhead in lakes was slightly higher in September than August for 1986, but the reverse was the case in 1985.

The Rogue steelhead dominated the volunteer angler catch of summer steelhead for the first 22 months of the project (Figure 2). The Rogue strain was caught in the rivers from fall 1984 through early 1985. No river catch was observed in June 1985. Peak river catch of Rogue steelhead occurred in July 1985 and tapered off through the fall months. River catch of Rogue steelhead increased again in early 1986 but dropped off by June. Rogue steelhead were again caught in the river starting in August 1986 and continuing through the fall (Figure 2).

The Skamania, Umpqua, and Siletz steelhead were largely absent from the river catch until July 1986 (Figure 2). Peak river catch of Skamania steelhead occurred in August 1986, 2.5 years after stocking. Peak river catch of the Umpqua and Siletz steelhead also occurred in August 1986 (Figure 2). The river catch for all summer steelhead strains combined peaked in August 1986 (Figure 3). Most of these were the Skamania steelhead, but some of each strain were caught at this time.

River catch of Great Lakes steelhead by volunteers started in fall 1984 and continued through the early summer, peaking in November 1985 (Figure 3). In 1985, the lowest percent of river catch for Great Lakes steelhead occurred in August. This was almost exactly opposite the summer steelhead catch for 1985 which peaked in July. River catch

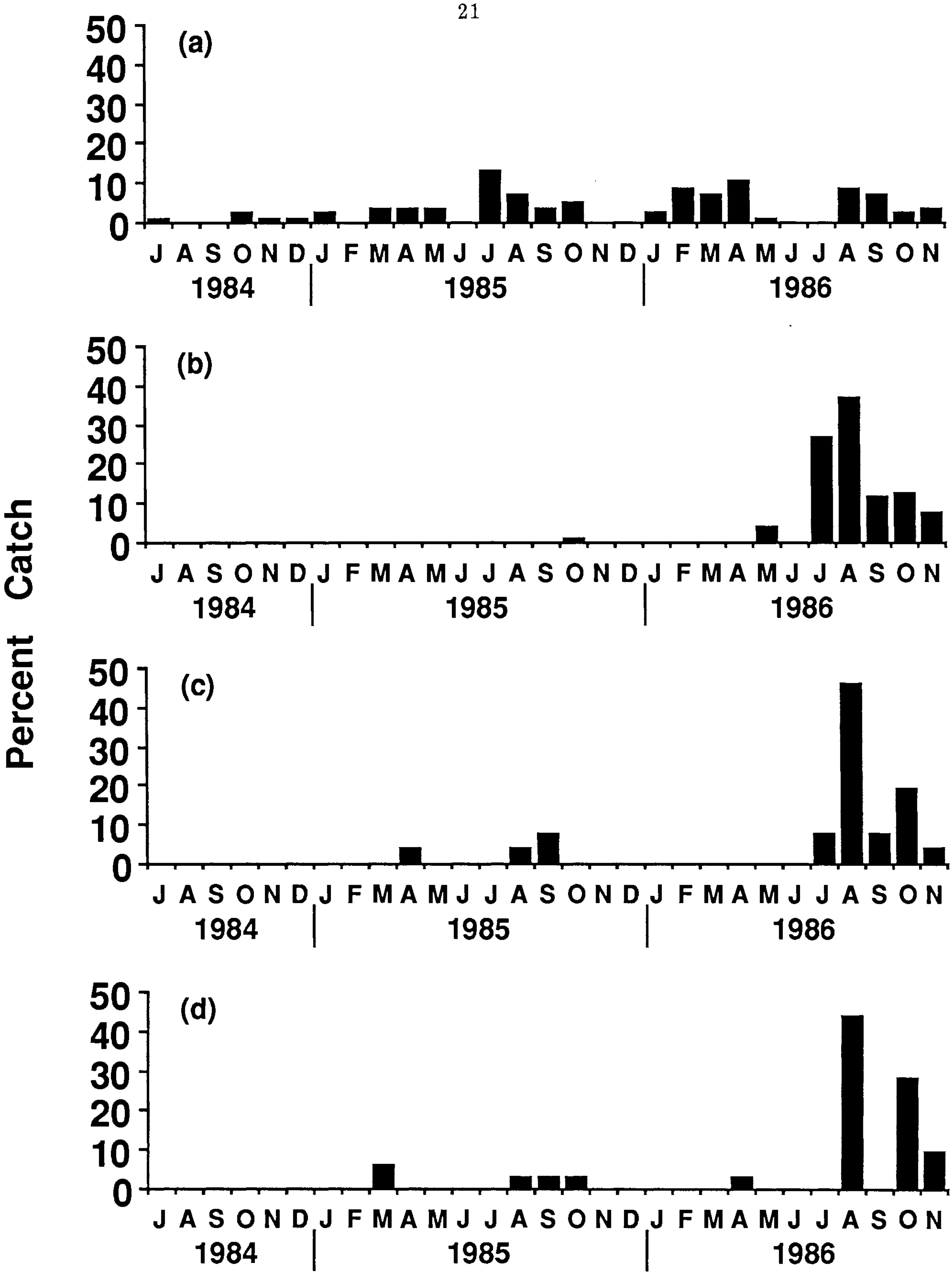

Figure 2. Percent monthly catch in rivers from July 1984 to November 1986 for the four strains of summer steelhead: (a) Rogue, (b) Skamania, (c) Umpqua, and (d) Siletz.

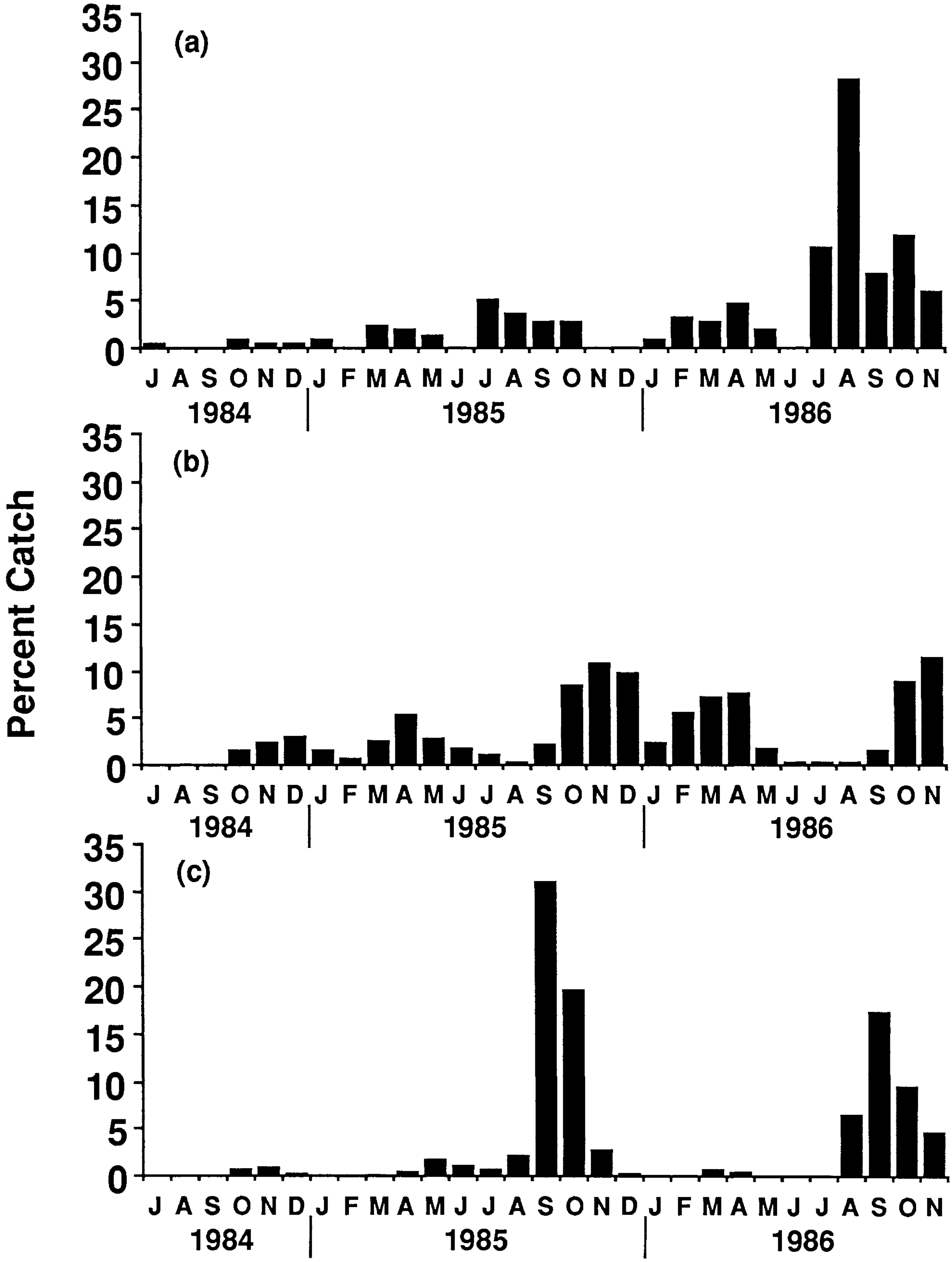

Figure 3. Percent monthly catch in rivers for (a) summer steelhead (strains combined), (b) Great Lakes steelhead, and (c) salmon, from July 1984 to November 1986.

of Great Lakes steelhead increased again in fall and continued through winter and spring. The lowest river catch of Great Lakes steelhead in 1986 occurred June through August, opposite again of peak summer steelhead river catch at this time. River catch of salmon peaked in September 1985 and 1986 with river catch of salmon beginning at least by August each year (Figure 3).

The test for seasonal expansion was applied to the last two summers and falls during the project span. Within each of these two time periods the proportion of summer steelhead caught were tested by month with the proportion of Great Lakes steelhead caught. The stain composition of summer steelhead returns, however, varied throughout the project (Figure 4). The first summer and fall of 1984 river catch of summer steelhead was comprised entirely of Rogue steelhead. During time period one (July to December 1985) river catch was dominated by Rogue steelhead but included some of the other three strains. Time period two (July to November 1986) showed a dramatic shift in river catch to a mixture of all four strains. Skamania steelhead comprised the largest proportion of fish caught in time period two.

Besides strain contribution, the summer steelhead catch in the three seasons also differed in relative magnitude (Figure 3). The first summer and fall consisted of only five Rogue steelhead, time period one--31 summer steelhead, and time period two--141 summer steelhead. The increase in

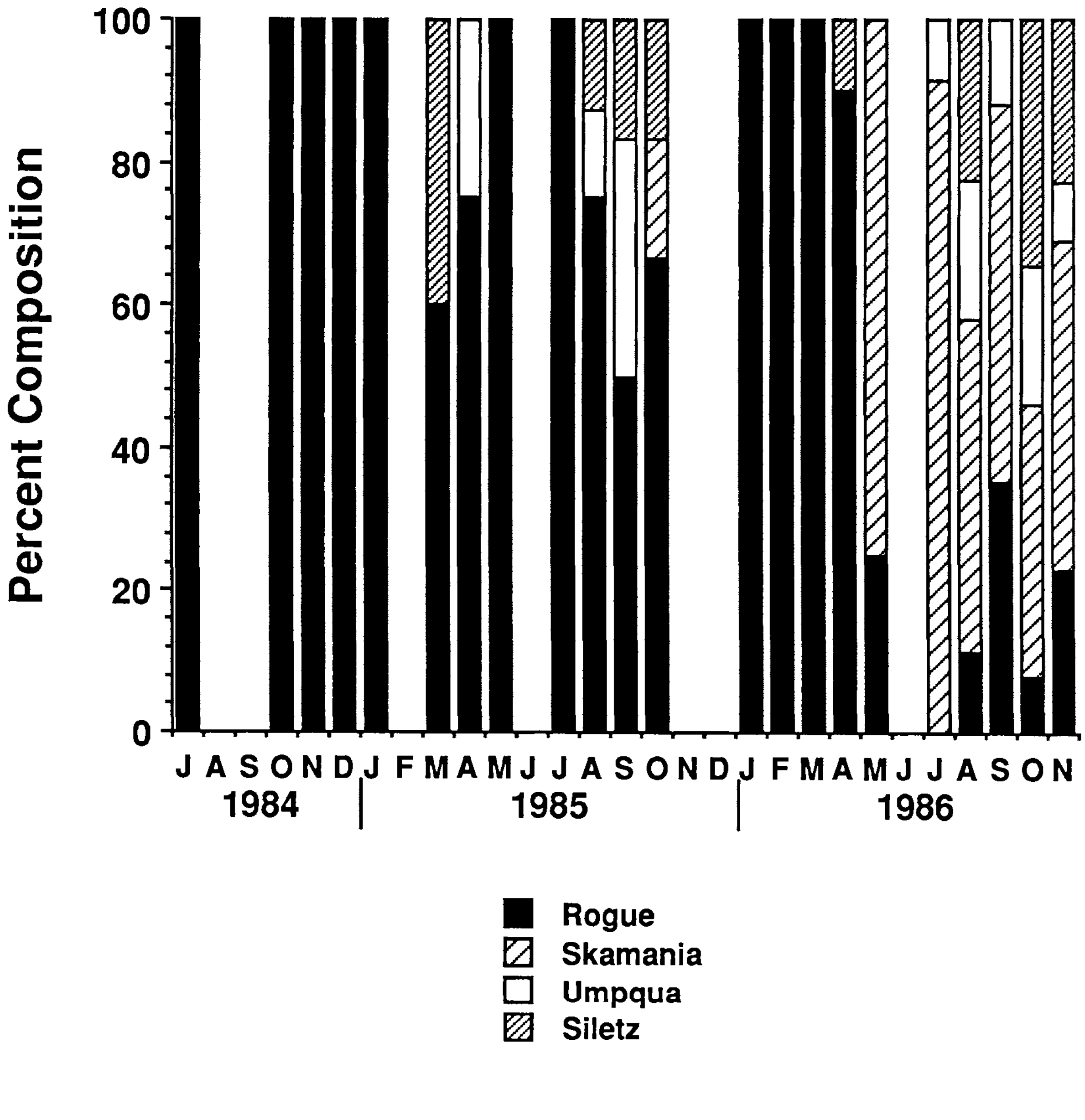

Figure 4. Percent composition by strain of summer steelhead catches from rivers, July 1984 to November 1986.

magnitude was attributed to the increase in number of strains returning (Figure 4).

The results of the Chi-square test for seasonal expansion (Table 4) indicated a significant expansion in both time periods. In time period one, more summer steelhead than Great Lakes steelhead were caught in rivers during July through September 1985. No difference was found between steelhead catch for October 1985, while Great Lakes steelhead were caught in greater proportions in November and December 1985. The seasonal expansion found in time period two occurred in July and August 1986. No difference in catch proportions for the two steelhead types was detected for September 1986. Great Lakes steelhead catch was proportionately greater in October and November 1986.

The hypothesis of seasonal expansion in the river steelhead fishing season by summer steelhead was accepted. When graphically illustrated (Figure 5), it is evident that there are two different components of the seasonal expansion achieved by summer steelhead. There is new river steelhead fishing in July and August, and increased opportunity in September. Under this increased opportunity, both steelhead types contributed to the fishery but summer steelhead expanded it. The new opportunity in river steelhead fishing was created by summer steelhead returns late in the summer before Great Lakes steelhead begin substantial returns.

The 1985 Big Manistee creel census detected few summer steelhead, except during April 1985 when an estimated 31

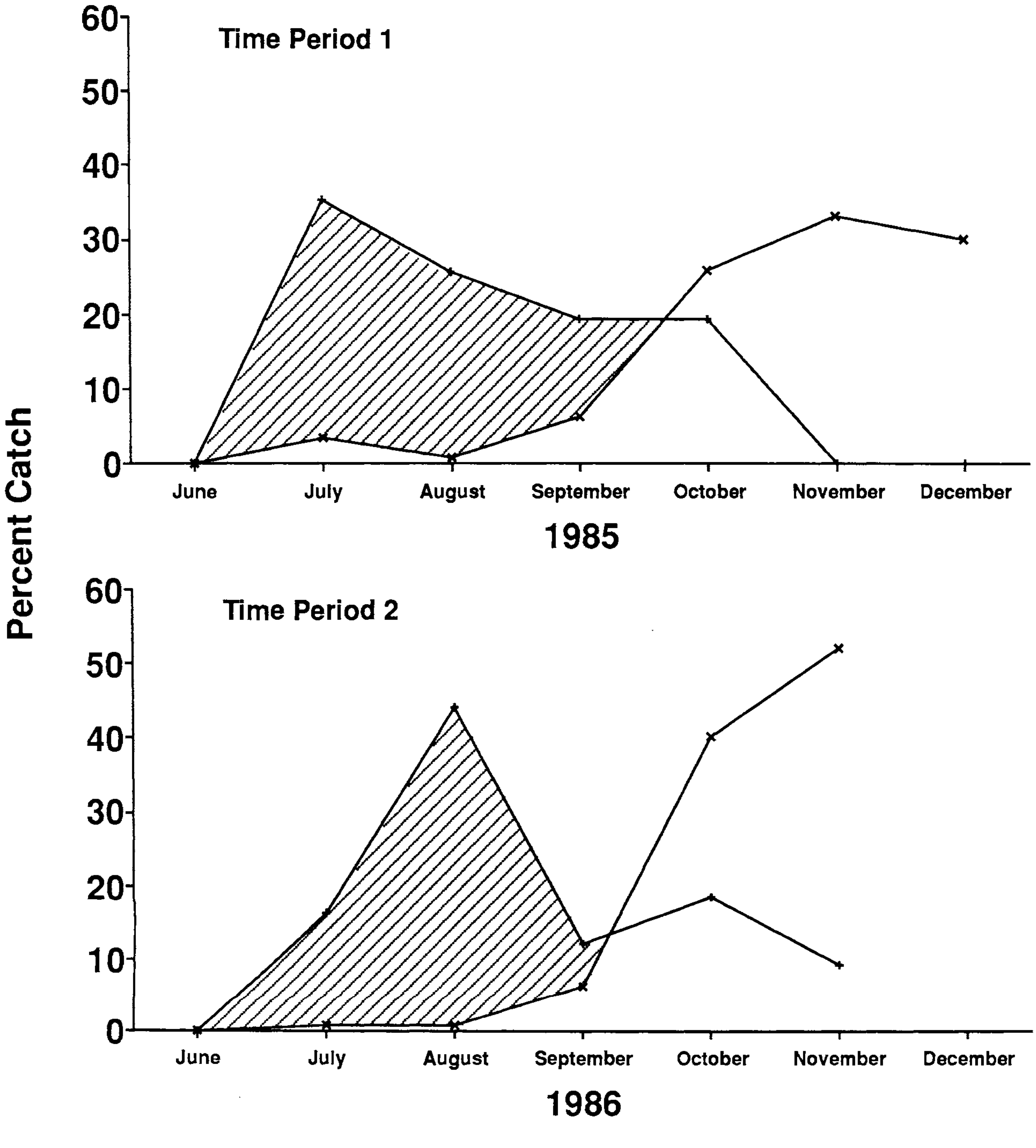

Figure 5. Monthly seasonal expansion of river steelhead fishing created by summer steelhead (+ indicates summer steelhead percent, x indicates fall-run Great Lakes steelhead percent).

Table 4. Chi-square test of monthly steelhead proportions for a seasonal expansion in steelhead catch.

Time period	Date	Steelhead percent: Summer	Steelhead percent: Great Lakes	X^2	P	Seasonal expansion
1	Jul	35.4	3.3	56.98	0.0001	Yes
(1985)	Aug	25.8	0.9	71.47	0.0001	Yes
	Sep	19.4	6.4	5.59	0.0180	Yes
	Oct	19.4	26.0	0.38	0.5358	No
	Nov	0.0	33.3	13.51	0.0002	No
	Dec	0.0	30.1	11.61	0.0006	No
2	Jul	16.3	0.8	48.06	0.0001	Yes
(1986)	Aug	44.0	0.8	168.72	0.0001	Yes
	Sep	12.1	6.4	3.67	0.0553	No
	Oct	18.4	40.2	20.59	0.0001	No
	Nov	9.2	51.8	75.28	0.0001	No

Rogue steelhead were caught (Table 5, Appendix 7). No other strain was detected by the 1985 census. The creel census was more successful in sampling summer steelhead in 1986 than 1985 (Table 5, Appendix 7). All four strains were sampled by the 1986 census even though the Skamania and Rogue steelhead were the only strains stocked in that location. The first month summer steelhead were sampled by the 1986 census was August. Although Great Lakes steelhead were sampled throughout the summer, numbers remained very low until September. Salmon were first detected by the 1986 census in August and even earlier in 1985 (Table 5).

By using effort ratios, two extrapolated catch estimates were possible for the Boyne River. An estimated 141 Rogue steelhead (with a 95% confidence limit of 64) were caught in the Boyne River in August 1986. As in the creel census for 1986, this was the first month Rogue steelhead were detected for that summer. The total catch of 628 Rogue steelhead in the Boyne River was estimated for 1986 (Table 6). Despite a lower stocking density of the Rogue steelhead in the Boyne river, estimated total catch in 1986 was much greater in the Boyne than in the Big Manistee.

The average lengths of summer and fall-run Great Lakes steelhead showed little variation (Table 7). Summer steelhead strains all had mean lengths less than fall-run Great Lakes steelhead. Fish compared at 2.5 years after smolting all had means, however, within 1.81 inches of each other. T-test results indicated significant differences

Table 5. Estimated number of Great Lakes steelhead, summer steelhead, and salmon caught in the Big Manistee River (excluding Manistee Lake), from April to November 1985 and from May to October 1986 (95% confidence limits in parentheses).

Species	Catch per hour	Month: Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Season total
1985										
Great Lakes steelhead	0.0587 (0.0202)	1,090 (447)	188 (352)	188 (209)	358 (439)	0 (0)	1,316 (988)	11,161 (5,383)	2,756 (907)	17,057 (5,598)
Rogue steelhead	0.0005 (0.0005)	31 (37)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	31 (37)
Salmon	0.0961 (0.0284)	0 (0)	93 (189)	0 (0)	1,607 (1,414)	1,358 (975)	17,934 (6,592)	6,837 (3,618)	69 (68)	27,898 (7,716)
Angler hours		16,280 (3,160)	9,791 (2,068)	5,271 (1,510)	7,514 (1,709)	22,898 (6,513)	113,337 (20,335)	98,686 (20,249)	16,640 (4,634)	290,417 (30,115)
1986										
Great Lakes steelhead	0.0239 (0.0267)	--- ---	20 (29)	27 (42)	160 (143)	43 (46)	1,920 (2,051)	3,052 (5,402)	--- ---	5,222 (5,780)
Rogue steelhead	0.0001 (0.0001)	--- ---	0 (0)	0 (0)	0 (0)	13 (25)	0 (0)	0 (0)	--- ---	13 (25)
Skamania steelhead	0.0014 (0.0026)	--- ---	0 (0)	0 (0)	0 (0)	34 (43)	281 (566)	0 (0)	--- ---	315 (568)
Umpqua steelhead	0.0011 (0.0023)	--- ---	0 (0)	0 (0)	0 (0)	239 (507)	0 (0)	0 (0)	--- ---	239 (507)
Siletz steelhead	0.0029 (0.0062)	--- ---	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	637 (1,342)	--- ---	637 (1,342)
Salmon	0.1167 (0.7165)	--- ---	0 (0)	0 (0)	0 (0)	2,280 (2,028)	11,956 (13,876)	11,302 (5,418)	--- ---	25,538 (15,034)
Angler hours			2,387 (664)	3,406 (866)	9,996 (2,846)	27,943 (10,121)	92,630 (24,868)	82,496 (26,490)	--- ---	218,858 (37,840)

Table 6. Estimated total catch for Skamania and Rogue steelhead in the Big Manistee and Boyne rivers in 1986. The estimates for the Big Manistee River were determined by the 1986 creel census. The estimate for the Boyne River was determined by extrapolation from effort ratios in the 1986 census (95% confidence limits are in parentheses).

River	Strain	Estimated total catch	Catch per hour	Number stocked	Percent caught
Big Manistee	Skamania	315 (568)	0.0014 (0.0026)	20,000	1.58 (2.84)
	Rogue	13 (24)	0.0001 (0.0001)	16,000	0.08 (0.16)
Boyne	Rogue	624 (302)	0.0154 (0.0001)	8,000	7.80 (3.78)

Table 7. Mean total lengths (inches) at age 3+ for each steelhead type considered in this study.

Steelhead type	Mean total length	Variance	Sample size
Fall-runs Great Lakes	28.71	1.70	513
Rogue	26.92	3.57	13
Skamania	26.90	7.84	50
Siletz	27.67	7.24	21
Umpqua	27.10	12.11	19

between fall-run Great Lakes steelhead and all summer steelhead strains. There were no significant differences in mean lengths between summer steelhead strains.

DISCUSSION

The summer steelhead introduction was successful in expanding the river steelhead fishery into the summer months. No other known studies have examined the introduction of summer steelhead for this purpose. Withler (1966) reported British Columbia rivers with both summer and winter steelhead populations have year-round fisheries. Indiana's original purpose for introducing the Skamania strain was to establish a steelhead fishery, but summer expansion in river steelhead fishing season was not the primary objective (D. C. Brazo, personal communication, 1987, Indiana Department of Natural Resources, Michigan City).

July and August were key months for summer steelhead fisheries and river migrations in Michigan (Figure 2, Table 5). Similarly these are also important months on the Pacific Coast (Withler 1966; Everest 1973; Leider et al. 1986) and in Indiana (Armstrong 1985). This timing of river return in summer steelhead accounts for approximately 2 months of new angling opportunity in rivers for steelhead in Michigan. There was considerable overlap in the return and river residence of summer and Great Lakes steelhead (Figure 3). This overlap has been documented for steelhead populations on the Pacific Coast (Smith 1960; Withler 1966; Chilcote et al. 1980; Leider et al. 1985). During some months of overlap (i.e., September 1985) summer steelhead were caught in proportions greater than Great Lakes steelhead. This also allowed a seasonal expansion but in magnitude as opposed to new fishing opportunity.

The expansion in river fishing opportunity generated by returning summer steelhead may not be as great when salmon are considered. Salmon in the Great Lakes begin entering the rivers on their spawning migration as early as August. The salmon river fishery is very large by September (Figure 3, Table 5) and provides extensive opportunity for river anglers. Although the August salmon fishery is just the beginning of the fall fishery, it does provide some opportunity for river anglers. The early migration of salmon may reduce the new fishing opportunity provided by summer steelhead and should be considered in future planning.

The early return pattern of Rogue steelhead (first river catch by volunteer anglers was July 1984, just 4 months after stocking, Figure 2) is characteristic of that strain and is an important part of its life history. In the Rogue River of Oregon, summer steelhead regularly make such an early return and are known as "half-pounders" (Everest 1973). These fish return from the sea about 3 months after smolting and remain in the river about 6 months. The same fish return the following summer to the Rogue River on a true spawning migration (Everest 1973).

Rogue steelhead in the Great Lakes also demonstrated this early return in 1984. Fish caught at this time were twice the length (about 15-18 inches) they were at release, suggesting these fish spent some time in the lake and were not residual smolts. The duration of their catch exceeded 6 months but basically paralleled the Pacific Coast population. Half-pounder Rogue steelhead generally do not spawn and remain sexually immature (F. H. Everest, personal communication, 1985, United States Department of Agriculture Forest Service, Corvallis, Oregon).

Summer steelhead caught in the rivers during time period one were again primarily Rogue steelhead and apparently entered the river for a true spawning migration. In time period two, when all four strains of summer steelhead made some river returns, the fish were 3.5 years old and likely entering the river for a spawning run. For Rogue steelhead this run may have been composed of repeat spawners or of individuals which had not returned the previous summer. Summer steelhead repeat spawners usually comprise only a small proportion of the run in the Rogue River (F. H. Everest, personal communication, 1985, United States Department of Agriculture Forest Service, Corvallis, Oregon).

The Skamania, Siletz, and Umpqua steelhead did not exhibit the same early return pattern as the Rogue and took longer to return prior to their first migration. Those fish were 3+ years old at first return with 2+ of those years being in the lake. In Indiana, the Skamania runs are largely comprised of 4+ and 5+ fish but a proportion of the run is 3+ fish (D. C. Brazo, personal communication, 1986, Indiana Department of Natural Resources, Michigan City). The 1986 summer returns of the Skamania, Siletz, and Umpqua steelhead (Figure 2) were likely first spawning runs. In 1987 returning summer steelhead will be comprised of age 4+ individuals with possibly some 4+ aged repeat spawners. Skamania steelhead have also been reported to achieve ages of up to 6 years (D. C. Brazo, personal communication, 1987, Indiana Department of Natural Resources, Michigan City).

The Siletz and Umpqua steelhead did not comprise as large a percent of the total summer steelhead returns (Figure 4) as did the Rogue and Skamania steelhead. Fewer of these two strains were initially stocked (43,000 and 32,000 versus 54,000 and 69,000, respectively). Another possible reason for lower returns is that none of the Umpqua and Siletz steelhead were stocked in the two rivers which had the most consistent reporting levels (Big Manistee and Boyne). There were no unbiased data to adequately compare the Umpqua and Siletz steelhead to other strains for relative survival or return to the creel.

The 1986 creel census also confirmed the volunteer anglers' summer increase in river catch of summer steelhead by also detecting returns starting in August (Table 5). This served to confirm August as an important month for the time summer steelhead return. The 1986 census sampled each of the four strains of summer steelhead even though the Rogue and Skamania were the only strains stocked in that river. The Umpqua and Siletz steelhead sampled by the 1986 creel census were undoubtedly stray or misidentified fish. The Umpqua steelhead in the 1986 census were taken first in August, but the Siletz strain steelhead were not encountered until October. The estimated numbers of Great Lakes steelhead from the creel census for May through August (Table 5) were very low compared to September, indicating primary returns in fall and winter.

The 1985 Big Manistee creel census sampled few summer steelhead relative to Great Lakes steelhead (Table 5), most likely because of a low level of summer river effort by anglers, the small number of smolts originally stocked, and returns of only single year classes. Volunteer research anglers did catch some Rogue steelhead in summer 1985 (Figure 2), but returning numbers indicated no large run in any river with the possible exception of the Boyne. The 1986 census did detect summer steelhead, which may have been due to a larger number of returning fish. Summer 1986 produced returns of all four strains while only the Rogue strain was detected during summer 1985 (Table 5).

The magnitude of the summer fishery generated for Rogue and Skamania steelhead was extremely small compared to that for Great Lakes steelhead. Runs of Great Lakes steelhead in northern Lake Michigan are largely comprised of wild fish and consist of multiple year classes (Seelbach 1986).

Seasonal CPUE for summer steelhead in the Big Manistee River (Table 6) was 14 times lower than for Great Lakes steelhead (Table 5). Small plants (5,000-10,000) of hatchery steelhead may not result in much increase in CPUE. A higher stocking number alone might generate a greater CPUE, however, as factors affecting steelhead returns are complex (Seelbach 1986). Multiple year classes would also increase summer steelhead CPUE through repeated stockings.

The CPUE of Rogue steelhead in the Boyne River (Table 6) comes closer to approximating Great Lakes steelhead returns. The Boyne River was a major source of summer steelhead return information with many volunteer angler reports. It appears that the Boyne River was very successful in generating summer steelhead returns to the angler. The Big Manistee River was not necessarily poor in producing returns, as other rivers which received the Rogue strain had return rates similar to the Big Manistee River. It is impossible from current information to determine why the Boyne River had better return to the angler for the Rogue strain, but other strains may also do well if stocked in that river.

Salmon and steelhead differed by location in the fisheries they generated. Salmon tended to generate more of an open-water fishery in Michigan while steelhead tended to create more of a river fishery (Table 3). This trend has been identified in the past (Borgeson 1977). Although both summer and Great Lakes steelhead tended to create more of a river fishery, a significantly greater proportion of the summer steelhead catch occurred in the lake. In Indiana, Skamania steelhead generate a large portion (~80%) of their total fishery in the lake (D. C. Brazo, personal communication, 1987, Indiana Department of Natural Resources, Michigan City). The tendency of an anadromous salmonid to generate more of one type of fishery may partly lie in their life history and their timing of migrations in relation to fishing pressure.

Summer steelhead mean lengths were significantly smaller than fall-run Great Lakes steelhead (Table 7). The mean lengths of summer steelhead were similar to those reported for other summer steelhead on the Pacific Coast (Withler 1966) and specifically Skamania steelhead which averaged 28 inches after 2 years of ocean growth (Millenbach 1973). Skamania steelhead on the Pacific Coast are reported to have a slightly slower growth rate as juveniles but a longer residence at sea compared to other steelhead strains. In the ocean, Skamania steelhead are reported to spend up to 4 years before returning to the river (Millenbach 1973). This accounts for that strain's reputation of a large average size and frequent trophy individuals in migration runs. Because of the small difference between the means, it is apparent that growth rates of summer steelhead and fall-run Great Lakes steelhead are at last similar. The extra 2 months spent in the lake prior to migration by fall-run Great Lakes steelhead may account for the slight difference in growth. The slightly larger mean length for Siletz steelhead compared to the other summer strains may be due in part to an abundance of individuals entering the river in October, as suggested by the volunteer catch data and creel census results (Figure 2, Table 5).

All strains exhibited some straying, including two Skamania steelhead collected by the Ontario Ministry of Natural Resources in Young Creek in the eastern half of Lake Erie, which were probably strays from the Au Sable plant in Lake Huron (M. F. McKenzie, personal communication, 1986, Ontario Ministry of Natural Resources, Simcoe). There may have been heavy straying of Siletz and Umpqua steelhead from the Little Manistee River into the Big Manistee River (Table 5). The 1986 census estimated returns of those two strains in numbers equal to or even surpassing, the strains that were stocked there. Possibly the close proximity of the two adjacent rivers encourages substantial straying. This has been observed for steelhead on the Pacific Coast (Royal 1972).

In Indiana, Skamania smolts are stocked in some streams which are marginal trout streams at best. In the summer months, when Skamania adults return, stream temperatures will occasionally exceed 70°F, yet the steelhead seem to tolerate these conditions (W. D. James, personal communication, Indiana Department of Natural Resources, Indianapolis, with J. A. Scott, Michigan Department of Natural Resources, Lansing). Similar observations have been made for other summer steelhead on the Pacific Coast as well (Withler 1966). There are many rivers in southern Michigan which have poor steelhead fisheries or none at all. One reason for a lack of steelhead fishery in these rivers may be temperatures too warm for Great Lakes steelhead. As in Indiana, Skamania steelhead may prove successful in these rivers, which means Skamania steelhead may prove successful in expanding Michigan's river steelhead fisheries in latitude as well as in season.

Some potential problems may exist with the introduction of summer steelhead into Great Lakes tributaries. Despite the previous presence of other forms of steelhead in the Great Lakes, introductions of new strains still constitute a transplant introduction (Welcomme 1986) and warrant certain precautions (McDowall 1968; Regier 1968; Li 1981; Courtenay et al. 1986). Naturally reproducing populations of steelhead exist in the Great Lakes and contribute significantly to the sport fishery (Biette et al. 1981; Seelbach 1986). Biette et al. (1981) believed that these populations are developing discrete stocks and should be protected. Summer steelhead strains might negatively impact these Great Lakes populations in at least two ways. Summer and winter steelhead on the Pacific Coast overlap in spawning season (Royal 1972). In Michigan, if hatchery summer steelhead should interbreed with wild Great Lakes steelhead, the resulting progeny may have an indeterminate life history pattern. Such hybridization has been identified as a possible result of hatchery introductions on the Pacific Coast (Allendorf and Utter 1979). Temporal and spatial reproductive isolation minimizes such genetic exchange between summer and winter steelhead populations on the Pacific Coast (Smith 1969, Everest 1973, Leider et al. 1984) but may not occur in the Great Lakes.

The second potential problem stems from timing differences in peak spawning periods of steelhead. Skamania steelhead are reported to become ripe and spawn in January (Millenbach 1973), considerably earlier than the characteristic March and April reported for Great Lakes steelhead (Biette et al. 1981). If an earlier hatch date should result from summer steelhead natural reproduction, the summer steelhead juveniles could be larger giving them a competitive advantage over juvenile Great Lakes steelhead of the same year class. Such competitive advantages from earlier hatching strains have been identified as a potential threat to native fish stocks on the Pacific Coast (Allendorf and Utter 1979). Summer steelhead might out compete Great Lakes steelhead juveniles for limited resources such as space and food in nursery areas. Royal (1972) has found that in natural populations on the Pacific Coast, a compensation occurs in growth rates by the fry emergence stage so that juveniles of the two steelhead races are the same approximate size. The two populations, however, still may compete equally for resources as juveniles. In

Michigan, the result could be a lower recruitment of Great Lakes steelhead to the fishery.

Because summer steelhead were sought by sport fishermen, fishery assessment methods were chosen for this project. The creel census is an assessment method usually employed for established fisheries and relies on large numbers of anglers. For a fledgling fishery which attempts to establish a new season, as with summer steelhead, the critical element of a large angling population is missing. Large confidence limits for estimates are a common problem in creel censuses. Low levels of river fishing pressure during the summer contributed to the large confidence limits for the creel census estimates of steelhead catch. Interviews with fishermen (and angling pressure) were completely lacking on some days. If a species or strain was introduced for contributing to an existing fishery, then a creel census might be more successful in assessing those fish.

The use of volunteer anglers for the collection of fishery and biological data is an increasingly popular research method (Green 1985; Ebbers 1987; A. W. Green, personal communication, 1987, Texas Parks and Wildlife Department, Austin). In this project, volunteers were useful in extending the area of study beyond what would have been possible with a single biologist and existing funds. Unfortunately this method is also plagued with problems. It was difficult to persuade volunteers to adjust their usual fishing practices to catch summer steelhead. Specifically, anglers did not want to fish the rivers in the summer months when they are usually void of anadromous fish, until other anglers started to catch summer steelhead. Other problems included errors or inconsistencies in data reporting and a high drop-out rate despite regular instruction and encouragement. Charter boat captains and river guides were among the least cooperative because most felt that diary reporting interfered with business. For some locations, a single angler, who fished regularly and thoroughly reported his catch in a diary, was sufficient to supply the needed information. Returned diaries accounted for only 30% of the project's summer steelhead reports. The other 70% came from nonparticipants, most of which had heard of the project and knew the fin-clip patterns. These additional reports were essential in identifying trends in catch for summer steelhead.

In an attempt to monitor rare or newly introduced species, volunteer anglers can play a useful role, perhaps more so than a creel census. The pressure generated by them, however, was not sufficient or consistent enough (with a few exceptions) to generate usable catch-per-unit-effort data. Because of this, and because most of the usable summer steelhead reports came from nonparticipants, it may be simpler to solicit catch reports for the rare fish. Similar to a tag return, fin-clipped fish reports could be sent to a biologist and supply data similar to those obtained from the diaries. Many of the problems with recruiting and maintaining a list of volunteers would then be avoided. In this project, data were needed on other species (Great Lakes steelhead and salmon) as well, and angler data (like a tag return) would not have supplied this. It may be that for assessing rare and introduced sport species a combination of creel census and sport angler methods are necessary.

Inferences made from volunteer angler catch and creel census results rely on an untested assumption that increases in river catch of anadromous species represent migrations or runs. This assumption is reasonable because other sampling methods such as river weir data (Hay 1986) correspond in timing to increases in angler catch for anadromous salmonids such as salmon and Great Lakes steelhead. It may be possible that increases in angler catch could be due in part to other factors such as a shift in feeding and aggression levels by some strains which could affect catchability. Similarly, summer steelhead caught in the winter and spring months probably migrated into the river during the previous summer or fall months. A distinct winter or spring migration of summer steelhead, however, cannot be ruled out.

Other important assumptions that were untested stemmed from the extrapolated estimates of Rogue steelhead catch for the Boyne River. The effort extrapolations for estimated Rogue steelhead catch in the Boyne River assumed an equal ratio of volunteer angler effort to total effort for both the Big Manistee and Boyne rivers. Another assumption is that the ratio of efficiency for volunteer anglers to the average angler population is the same for 1985 as for 1986. This assumption is due to the correction factor that had to be applied to the 1986 extrapolations using CPUE ratios.

Additional biases may have included a tendency by some volunteer anglers to label any fin-clipped steelhead a Skamania. The Skamania steelhead was the better known and most popular strain among anglers. An effort was made to verify fin-clip patterns when possible.

Some flaws in the data may also have affected the length comparisons for steelhead types. Sample sizes of summer steelhead length data were small (≤ 50) compared to fall-run Great Lakes steelhead. This may partially account for the large variances for summer steelhead data. Summer steelhead length measurements came from anglers over a 4-month period. Some anglers may have estimated lengths and all measurements were rounded to the nearest inch. Fall-run steelhead lengths were measured over approximately a 2-month period and to the nearest 1/10 inch. These differences in the data may have affected the results of the t tests.

The potential problems identified earlier for summer steelhead introductions in Michigan are a result of summer steelhead sharing a river with naturally reproducing populations of Great Lakes steelhead and might be minimized by limiting summer steelhead introductions to rivers without such populations. In addition to encouraging reproductive isolation between summer steelhead and Great Lakes steelhead, summer steelhead should be managed as if a separate species and avoid mixing of hatchery broodstocks with other steelhead types. Genetic markers in hatchery summer steelhead could be used by researchers to monitor genetic flow to wild populations (Allendorf and Utter 1979; Leider et al. 1986). Numbers and locations of summer steelhead plants should be consistent to create reliable annual returns. To prevent loss of returning summer steelhead which precede or coincide with returning salmon, stocking location should avoid rivers with legalized snagging.

Summer steelhead offer several unique characteristics as an introduced sport fish. An earlier migration by summer steelhead expands the state river steelhead fishery by about 2 months, creating new and increased angling opportunity. Compared to Great Lakes steelhead, summer steelhead also contribute more to the lake fishery by expanding relative lake catch. Skamania steelhead also return at later age which results in larger size than most Great Lakes steelhead. The establishment of a stable and reliable summer steelhead fishery in Michigan will require a concerted effort by the MDNR with large annual releases in consistent locations.

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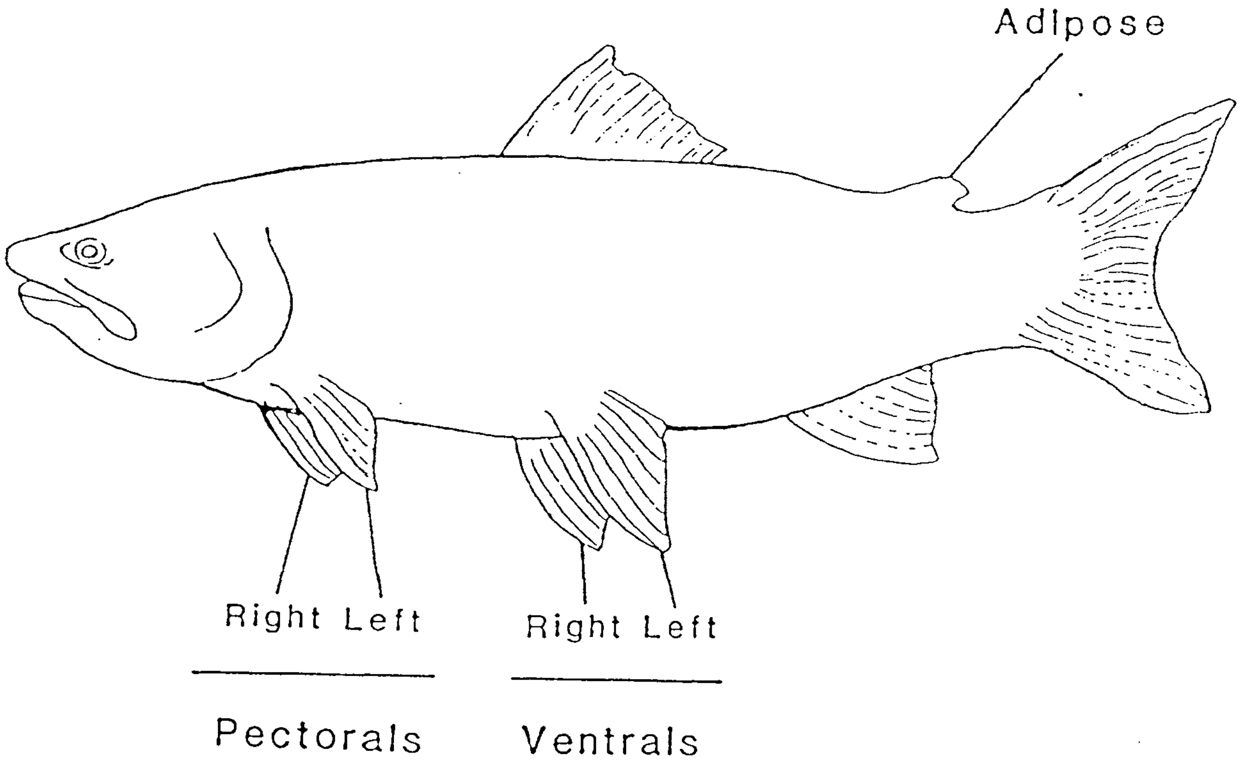
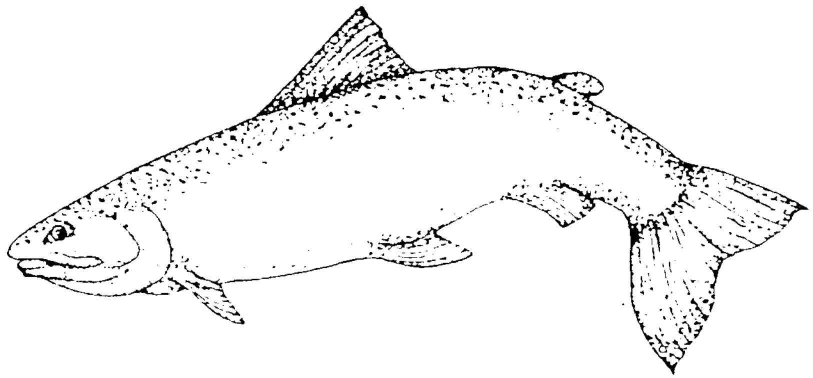
APPENDICES

Appendix 1. Fin-clip patterns for the four summer steelhead strains. Rogue steelhead--left pectoral and right ventral. Skamania steelhead--adipose and right pectoral. Siletz steelhead--adipose and both ventrals. Umpqua steelhead--adipose and left ventral.



Appendix 2. Volunteer research angler brochure.

Summer Steelhead for Michigan



An Assessment Program
Conducted by
The University of Michigan
The Michigan Steelheaders
and the Michigan DNR

Forward

In the spring of 1984, the Michigan Department of Natural Resources (DNR) stocked summer steelhead into several Michigan rivers to improve steelhead fishing in the state. An assessment of this stocking program is being done by many persons. This brochure was developed specially as an information source for persons participating in the summer steelhead assessment program. It includes a background section into the summer steelhead stocking, a description of the evaluation methods, and a one-page method summary (which will be widely circulated to fishermen). Research fishermen will also be supplied with a diary, and a button to indicate participation in the program.

This program is being organized by The University of Michigan in conjunction with the Michigan Department of Natural Resources. Funding and manpower for the project are being provided by the Michigan Steelheaders, particularly the Flint River Valley Chapter.

For more information on this program, or to register any results, please contact:

David Fielder
Institute for Fisheries Research
212 Museums Annex Building
Ann Arbor, Michigan 48109
(313) 663-3554

or

Jim Diana
School of Natural Resources
University of Michigan
Ann Arbor, Michigan 48109-1115
(313) 763-5834

Background

Anadromous rainbow trout, commonly called steelhead, are not native to the Great Lakes. Steelhead have been stocked in the Great Lakes since 1883. The strain of steelhead historically stocked were fish that underwent a major spawning migration to streams from winter to early spring. The current steelhead populations in Michigan are a combination of hatchery-reared and naturally spawned fish.

Several years ago, the state of Indiana imported eggs from a different strain of steelhead which were developed at the Skamania Hatchery in Washington. These fish are believed to begin their spawning run in the summer, and remain in the stream until spawning the following spring. They are called

summer steelhead. Fish stocked in Indiana have provided a good fishery in Lake Michigan and several rivers throughout most of the year. What is even more remarkable is that the waters utilized by summer steelhead in Indiana are marginal trout streams at best, with average temperatures that are very warm for trout occupation over the summer. Apparently, the summer steelhead strain has the ability to tolerate these warm summer temperatures.

The state of Michigan imported several strains of summer steelhead for stocking in 1984. The Skamania strain was obtained from Indiana, while strains from the Rogue, Siletz, and Umpqua rivers were imported from Oregon. These fish were experimentally stocked in several rivers to determine their suitability in providing an improved steelhead fishery. The intent of this project is to evaluate the returns and success of these summer steelhead introductions.

Summer steelhead stocked in 1984 were given distinctive fin clips to allow identification of each strain. Michigan hatchery steelhead are generally not fin clipped. The pattern of fin clips (see figure on page 11) made for each strain are:

Skamania	- adipose and right pectoral
Siletz	- adipose and both ventrals
Rogue	- left pectoral and right ventral
Umpqua	- adipose and left ventral

Due to the large numbers of fish marked, some errors are bound to occur. It is important to carefully examine each steelhead caught for the fin-clip

pattern, and to note exactly the combination of fins missing, in order to accurately identify each strain.

The fish were stocked into nine rivers with different strains and combinations in each river as follows:

Muskegon River	- 20,000 Skamania - 17,000 Umpqua
Big Manistee River	- 20,000 Skamania - 16,000 Rogue
White River	- 20,000 Siletz
Betsie River	- 8,000 Rogue
Boyne River	- 8,000 Rogue
Au Sable River	- 19,000 Skamania - 17,000 Rogue
Pere Marquette River	- 10,000 Skamania - 10,000 Umpqua
Cherry Creek	- 18,000 Siletz
Little Manistee River	- 5,000 Umpqua - 5,000 Rogue - 5,000 Siletz

The purpose of this project is to evaluate the returns of summer steelhead to as many of these rivers as possible. The future stocking of these strains is dependent on evaluation of returns from these plants. This project is the only one planned to evaluate returns; therefore, the future of the summer steelhead program in Michigan could be highly dependent on data generated by it and the efforts put out by each participant.

Evaluation Methods

(1) River returns.--River returns of summer steelhead will be evaluated by three operations: 1) catch of research fishing teams on each river, 2) an intensive creel census on the Big Manistee River, and 3) fish returns to the weir on the Little Manistee River.

Research angling teams may be set up to intensively fish each of the

rivers indicated in the background section. The number of anglers per team can vary. The teams will be expected to regularly fish each river and keep records of their catch in diaries provided by the project. Each team will be responsible for insuring that at least one member fishes 1 weekend day and 2 weekdays every week. An entry in the diary should be made even if no summer steelhead are caught that day. In addition to date, biological data on length and clip pattern will be recorded for each steelhead collected (see page 11). It is very important that each river be fished systematically. Since we do not know how soon (in years and in months) to expect returns from each strain, we must regularly fish each river throughout the open-water months.

Persons catching clipped steelhead should contact Dave Fielder soon after, so we can keep track of the status of each run.

Returns from the research angling team on the Big Manistee River will be compared to total catch determined by a creel census on the river. Two census clerks will estimate total catch by counting anglers and evaluating total catch of each angler interviewed. This comparison of team catch will be used to extrapolate results from the Big Manistee to the other river systems. We hope to initiate the creel census by summer 1985.

The weir on the Little Manistee River is normally operated in the fall to collect chinook salmon eggs for the hatchery system. The Michigan DNR plans

to extend the operation of the weir from July through September to evaluate returns of summer steelhead.

(2) Open water returns.--Data of steelhead caught in the open water fishery will be obtained by utilizing charter captains from each source river area as collectors of data, and by utilizing the DNR lake analyses done for Lakes Michigan, Huron, and Superior.

Charter captains and other offshore anglers will be recruited to form local teams again, much like those for the river areas. These people will also be requested to fill in diaries and collect the basic information described for the river analysis. The diagram on page 11 indicates the measurement and fin-clip patterns to be evaluated.

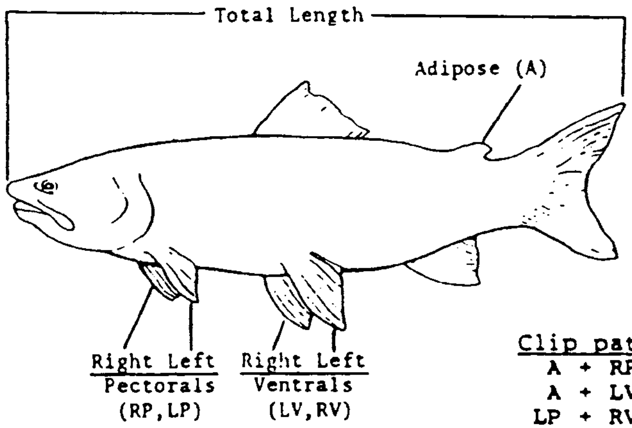
SUMMER STEELHEAD

Summer steelhead have been planted in several Michigan rivers in 1984. They can be identified by distinctive fin-clip patterns. If you catch a fin-clipped steelhead, please collect the following data:

(1) Date
(2) Location
(3) Fin-clip pattern
(4) Total length
(5) Hours fished

Return these data to:

Dave Fielder
Institute for Fisheries Research
212 Museums Annex Building
Ann Arbor, Michigan 48109
(313) 663-3554



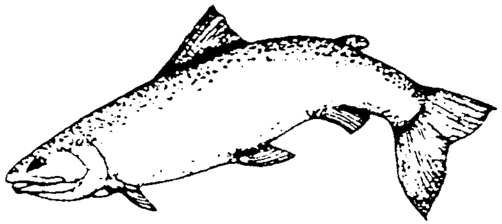
Clip patterns
A + RP
A + LV + RV
LP + RV
A + LV

Study conducted by:

The University of Michigan
Michigan Steelheaders
Michigan Department of Natural Resources

Appendix 3. Research anglers' diary given to volunteer fishermen (actual size). A copy of the cover and all pages are shown. Pages 3 and 4 were filled out for each fishing trip, 24 copies were included in each diary.

Summer Steelhead for Michigan



Angler's Diary

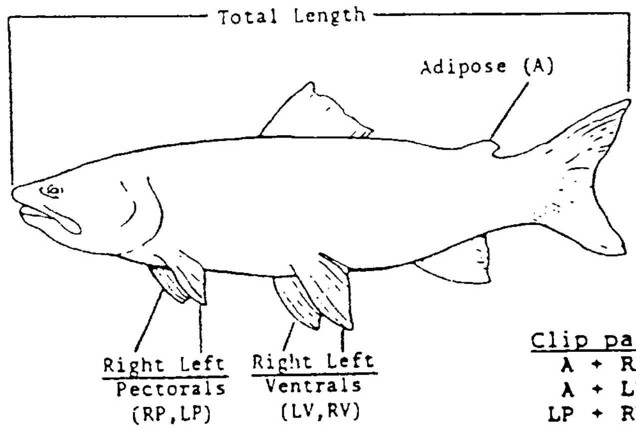
Complete a page of this diary for each day you fish, whether or not you catch steelhead. Also, collect the data for all steelhead caught, clipped, or unclipped.

When finished, return to:

David Fielder
Institute for Fisheries Research
212 Museums Annex Building
Ann Arbor, Michigan 48109
(313) 663-3554

For each Steelhead, please record:

(1) date of catch
(2) location (as specific as possible)
(3) clip pattern
(4) total length
(5) hours fished



Clip patterns
A + RP
A + LV + RV
LP + RV
A + LV

Appendix 3. Continued:

Clips	Length	Location

Date ______________ Start time ______________

Finish time __________ Hours fished __________

Number of fish caught ______________________

Clipped steelhead __________

Unclipped steelhead __________

Salmon ______________________

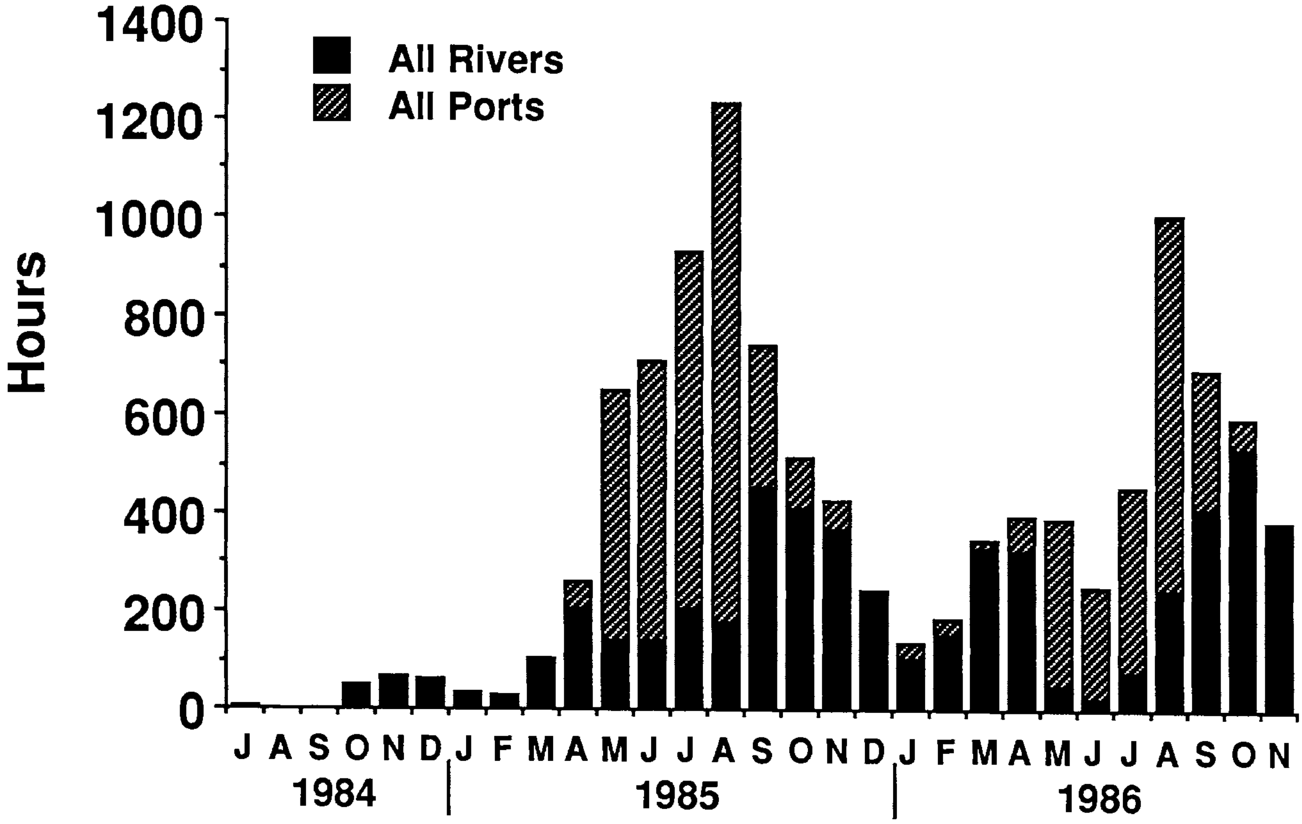
Trout ______________________

Others ______________________

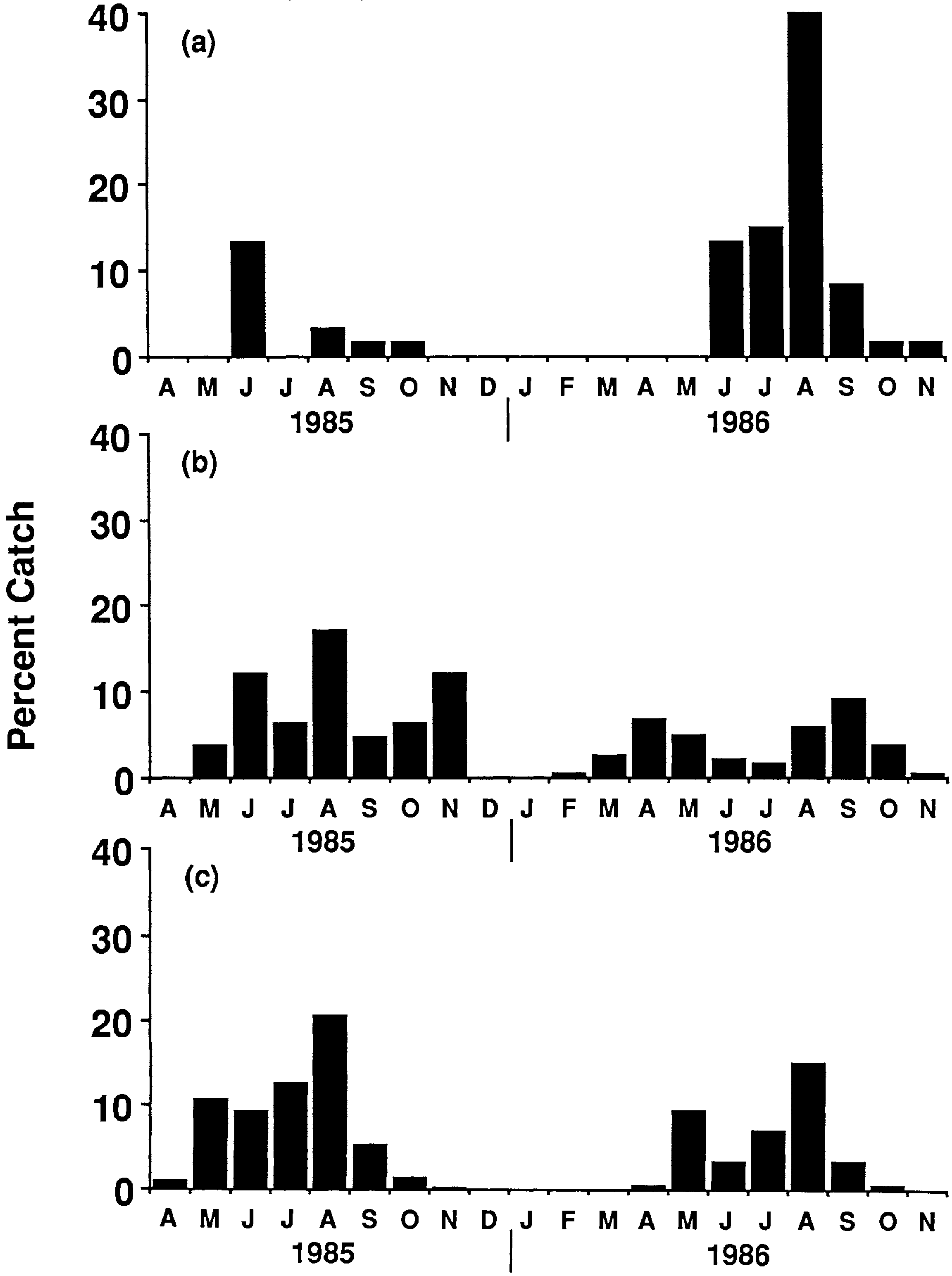
Please record steelhead data on the back.

Appendix 4. A copy of summer steelhead research angler button given to volunteer fishermen. Button was 1 1/2 inches in diameter, color was blue on maize.

Appendix 5. Volunteer research angler effort during the project for all rivers and ports combined. The original effort goal was approximately 36 hours per month.



Appendix 6. Percent monthly catch by volunteer anglers in lakes for (a) summer steelhead (strains combined), (b) Great Lakes steelhead, and (c) salmon.



Appendix 7. Estimated number of Great Lakes steelhead, summer steelhead, and salmon caught in Manistee River from Tippy Dam to Bear Creek, Bear Creek to Manistee Lake, and Manistee Lake, 1985 and 1986 (95% confidence limits are in parentheses).

Species	Catch per hour	Month Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Season total
Tippy Dam to Bear Creek - 1985										
Great Lakes steelhead	0.0522 (0.0268)	1,090 (447)	188 (352)	53 (82)	0 (0)	0 (0)	120 (193)	6,062 (4,623)	2,149 (888)	9,662 (4,746)
Rogue steelhead	0.0008 (0.0008)	31 (37)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	31 (37)
Salmon	0.1021 (0.0361)	0 (0)	93 (189)	0 (0)	0 (0)	343 (621)	11,590 (4,818)	6,837 (3,618)	55 (65)	18,918 (6,060)
Angler hours		14,857 (3,113)	7,015 (1,973)	1,784 (680)	503 (119)	9,595 (3,916)	70,176 (18,645)	68,695 (19,231)	12,593 (4,529)	185,218 (27,701)
Bear Creek to Manistee Lake - 1985										
Great Lakes steelhead	0.0703 (0.0293)	0 (0)	0 (0)	135 (192)	358 (439)	0 (0)	1,196 (969)	5,099 (2,758)	607 (186)	7,395 (2,968)
Rogue steelhead	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Salmon	0.0854 (0.0464)	0 (0)	0 (0)	0 (0)	1,607 (1,414)	1,015 (752)	6,344 (4,499)	0 (0)	14 (20)	8,980 (4,775)
Angler hours		1,423 (545)	2,776 (618)	3,487 (1,348)	7,011 (1,705)	13,303 (5,205)	43,161 (8,117)	29,991 (6,341)	4,047 (981)	105,199 (11,813)

Appendix 7. Continued:

Species	Catch per hour	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Season total
Manistee Lake - 1985										
Great Lakes	0.0154	0	35	70	20	350	2,434	0	44	2,953
steelhead	(0.0135)	(0)	(41)	(85)	(40)	(318)	(2,556)	(0)	(47)	(2,578)
Rogue	0	0	0	0	0	0	0	0	0	0
steelhead	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)
Salmon	0.2219	0	620	602	2,276	5,777	18,622	14,680	0	42,577
	(0.0599)	(0)	(254)	(410)	(1,699)	(2,001)	(9,133)	(4,380)	(0)	(10,474)
Angler		856	8,078	10,149	15,753	29,938	104,265	22,010	773	191,822
hours		(431)	(1,445)	(4,281)	(3,078)	(7,918)	(18,258)	(5,481)	(262)	(21,360)
Tippy Dam to Bear Creek - 1986										
Great Lakes	0.0305	---	20	11	160	36	1,781	2,900	---	4,908
steelhead	(0.0365)	---	(29)	(25)	(143)	(44)	(2,044)	(5,400)	---	(5,776)
Rogue	0.0001	---	0	0	0	13	0	0	---	13
steelhead	(0.0002)	---	(0)	(0)	(0)	(25)	(0)	(0)	---	(25)
Skamania	0.0020	---	0		0	34	281	0	---	315
steelhead	(0.0036)	---	(0)	(0)	(0)	(43)	(566)	(0)	---	(568)
Umpqua	0.0001	---	0	0	0	10	0	0	---	10
steelhead	(0.0001)	---	(0)	(0)	(0)	(21)	(0)	(0)	---	(21)
Siletz	0.0040	---	0		0	0	0	637	---	637
steelhead	(0.0084)	---	(0)	(0)	(0)	(0)	(0)	(1,342)	---	(1,342)
Salmon	0.1288	---	0		0	199	9,365	11,168	---	20,732
	(0.0966)	---	(0)	(0)	(0)	(243)	(13,828)	(5,417)	---	(14,853)
Angler			1,736	2,295	4,551	8,000	67,962	76,477	---	161,021
hours			(534)	(803)	(1,663)	(2,206)	(24,004)	(26,451)	---	(35,839)

Appendix 7. Continued:

Species	Catch per hour	Month						Season total
		May	Jun	Jul	Aug	Sep	Oct	
Bear Creek to Manistee Lake - 1986								
Great Lakes steelhead	0.0054 (0.0042)	0 (0)	16 (34)	0 (0)	7 (15)	139 (167)	152 (155)	314 (231)
Umpqua steelhead	0.0040 (0.0080)	0 (0)	0 (0)	0 (0)	229 (507)	0 (0)	0 (0)	229 (507)
Salmon	0.0831 (0.0438)	0 (0)	0 (0)	0 (0)	2,081 (2,013)	2,591 (1,153)	134 (125)	4,806 (2,323)
Angler hours		651 (395)	1,111 (323)	5,445 (2,309)	19,943 (9,878)	24,668 (6,500)	6,019 (1,446)	57,837 (12,145)
Manistee Lake - 1986								
Great Lakes steelhead	0.0002 (0.0004)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	22 (46)	22 (46)
Salmon	0.0463 (0.0355)	57 (57)	0 (0)	0 (0)	810 (640)	2,788 (3,159)	1,266 (1,536)	4,921 (3,571)
Angler hours		1,804 (595)	5,411 (2,124)	10,549 (6,433)	33,655 (16,588)	38,895 (13,124)	15,932 (14,323)	106,246 (26,435)