

## Effect of Rewards on Lake Trout Tag Returns in Northwestern Lake Michigan

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*Abstract.*—We determined the effect of a reward of one free case of Stroh's beer (retail value of US\$7.50 in 1986 dollars) on lake trout *Salvelinus namaycush* tag returns made by two voluntary-return fisheries (recreational and commercial) in northwestern Lake Michigan during 1984–1990. To examine the effect of the reward, which was offered in 1986 and 1987, we determined the proportion of tags that were returned by assessment, recreational, and commercial fisheries. We used the log-likelihood *G*-statistic to test for homogeneity of recapture rates among years for the three fisheries. Comparison of individual *G*-statistics in the reward years versus the nonreward years yielded the impact of the reward. Recapture rates varied significantly among years for assessment, recreational, and commercial fisheries, and were also significantly different among the three fisheries. The reward of a free case of Stroh's beer increased the recapture rate in both of the voluntary tag-return fisheries (recreational and commercial), but the impact was greater in the commercial fishery. Despite the poor design of the reward program, recapture rates increased with the reward. However, we believe that increased recapture rates can be as much harmful as beneficial without careful a priori consideration of the impact of various types of rewards on response rates.

Fisheries managers often rely on tagged fish for estimating vital statistics and movement (Youngs 1972; Ricker 1975; Jones 1976; Guy et al. 1996). For example, a mark–recapture study can provide estimates of (1) the exploitation rate, calculated from the ratio of recaptures to the number of marked fish, or (2) abundance, calculated from the ratio of recaptures to the number of fish examined for marks (Ricker 1975). However, such estimates typically assume that all recaptured fish are reported (Ricker 1975; Matlock 1981). Many tagging programs rely on the voluntary return of tags from recaptured fish, but the number of recaptured, tagged fish is often underreported (Matlock 1981; Green et al. 1983; Saunders et al. 1990; Guy et al. 1996). Underreporting of tag recovery will lead to

an underestimation of exploitation rates and an overestimation of abundance (Ricker 1975; Matlock 1981; Green et al. 1983).

Rewards are commonly offered as an incentive to increase the number of tags returned (Green et al. 1983; Murphy and Taylor 1991; Nichols et al. 1991; Salant and Dillman 1994; Guy et al. 1996; Pollock et al. 2001). Rewards can increase tag returns by more than 50% (Haas 1990), which can greatly improve the accuracy and precision of population parameters estimated through tag–recapture studies (Guy et al. 1996). High-reward tags are often used to estimate reporting rates in bird banding studies (Henny and Burnham 1976; Conroy and Blandin 1984; Pollock et al. 2001). However, rewards do not necessarily lead to 100% reporting rates (Matlock 1981). Nichols et al. (1991) found that a reward of US\$100 (1988 dollars) was necessary to achieve 100% reporting of duck bands.

Our objectives were to (1) determine the effect of a reward of one free case of Stroh's beer with a retail value of \$7.50 (1986 dollars) on tag returns

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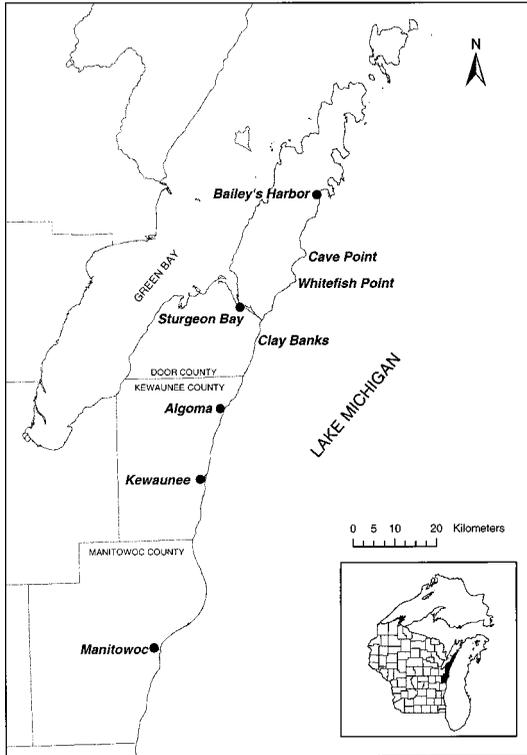


FIGURE 1.—Map of the study area in northwestern Lake Michigan, where the impact of a reward on lake trout tag returns was assessed. Lake trout were tagged in the Clay Banks area during 1983–1990.

for lake trout *Salvelinus namaycush* in two voluntary-return fisheries (recreational and commercial) in northwestern Lake Michigan during 1984–1990 and (2) determine the extent to which the two vastly different fisheries responded to the reward. To determine the effect of the reward program, we compared the recapture rate in years before the reward was offered for returned tags (1984–1985), during the reward period (1986–1987), and after the reward period (1988–1990). We used tag recaptures in assessment fisheries, which we assumed were unaffected by rewards, as the basis for determining whether and to what extent the recaptures in recreational and commercial fisheries were affected by the reward.

### Methods

**Tagging.**—Lake trout were collected in the Clay Banks area of northwestern Lake Michigan, off the eastern shore of the Door County peninsula between Algoma, Wisconsin, and the Sturgeon Bay ship canal (Figure 1). Lake trout were sampled with gill nets and pound nets during 1983–1990.

During late October to early November 1983–1989, spawning lake trout were caught in multi-filament-nylon gill nets and were tagged. During early May to late June 1984–1990, lake trout caught in a commercial fisher's pound net were also tagged. Live, untagged lake trout were tagged near the middle of the base of the dorsal fin with Floy anchor tags and were released. Each tag consisted of an anchor and a vinyl tube either with (Floy FD-68BC) or without (Floy FD-67C) a plastic bead on the distal end. A unique number and return address were printed on each vinyl tube (Schmalz et al. 2002).

**Recapture.**—We analyzed the rates at which tags were returned from the main basin of Lake Michigan in waters adjacent to Door, Kewaunee, and Manitowoc counties (Figure 1). These waters were within an 80-km radius of tagging sites, which encompassed over 90% of total tag returns and approximated the home range of tagged lake trout in the Clay Banks area of Lake Michigan (Schmalz et al. 2002). Tag returns from the waters of Green Bay were not included.

Tags from recaptured lake trout were provided by fishery agencies conducting assessment surveys, recreational anglers, and commercial fishers within the study area during 1984–1990. Agency assessment activities included the Clay Banks spring and fall assessments used to tag lake trout. In addition, assessment gill nets were fished in the summer near Bailey's Harbor, Sturgeon Bay, and Manitowoc, Wisconsin, during 1984–1990, and in the fall near Cave Point, Whitfish Bay Point, and Algoma, Wisconsin, during 1984–1989 (Figure 1). All lake trout were examined individually for the presence of tags. Wisconsin commercial fishing regulations during this period prohibited harvest of lake trout and required all incidentally captured lake trout to be returned to the water, dead or alive. For each tag returned by recreational or commercial fishers, a letter was sent to the fisher providing information on the original capture date, recapture dates and locations, and the size of the fish at capture and recapture.

The original design of our tagging studies did not include use of a reward to increase the rate of tag return. However, in 1986 and 1987, the Stroh's Brewing Company, Detroit, Michigan, approached the Wisconsin Department of Natural Resources (WDNR) about offering a free case of Stroh's beer for each tag returned. The reward program was designed as a promotional tool for a new Stroh's factory in Milwaukee, Wisconsin, and was not necessarily designed to increase the return of tags. To

receive a coupon for a free case of Stroh's beer, redeemable at any store that sold Stroh's beer, recreational or commercial fishers sent tags to the WDNR office indicated on the tag. Recapture information was recorded, and the tags were then forwarded to WDNR central office staff in Madison, Wisconsin, who provided the coupons to fishers.

*Data analysis.*—To examine the effect of rewards offered in 1986 and 1987, we examined the proportion of tags that were returned by assessment, recreational, and commercial fisheries. We defined the recapture rate ( $R/M$ ) as the ratio of the number of tags returned within one fishing season and within 80 km of the tagging location ( $R$ ) to the number of lake trout tagged at the beginning of each year ( $M$ ). We used only returns within one fishing season to standardize the time-at-large for all groups of tagged fish (grouped by year) to minimize the effects of differential survival and tag loss between years (Fabrizio et al. 1996). Mark-recapture studies often report  $R/M$  to compare recapture rates among years (Jones 1959; Pollock et al. 2001). The ratio  $R/M$  also provides an estimate of the minimum rate of exploitation of a fishery (Ricker 1975). The fishing season was April–December of a calendar year, so the number of tagged lake trout ( $M$ ) available in a given year included the number of fish tagged during the spring of that year plus the number of fish tagged during fall spawning surveys in the previous year. Tags returned from November through May represented less than 5% of all returns, which justified calculating the total number of marked fish available in a given year as the number of fish tagged at the end of the prior fishing season (fall gillnetting) and the beginning of the current fishing season (spring poundnetting).

We tested the homogeneity of recapture rates among years in assessment, recreational, and commercial fisheries with the log-likelihood  $G$ -statistic (Sokal and Rohlf 1995). Expected numbers of recaptures in each fishery for each year were calculated as the numbers of lake trout tagged in fall and spring assessment fisheries ( $\hat{f}$  below was equal to the number of fish tagged in fall in year  $x$  plus the number of fish tagged in spring in year  $x + 1$ ). Observed numbers of recaptures in each fishery for each year were then compared to expected numbers of recaptures by use of the log-likelihood  $G$ -statistic:

$$G = 2 \log_e L = 2 \left( f \log_e \frac{f}{\hat{f}} \right),$$

TABLE 1.—Number of lake trout tagged in fall and spring assessment fisheries and number recaptured within 1 year and 80 km of the tagging location in assessment, recreational, and commercial fisheries in northwestern Lake Michigan during 1984–1990. The years in which a reward was offered for tag returns (1986 and 1987) are shown in bold italic type.

Tagging year	Number tagged		Number recaptured		
	Fall	Spring	Assessment	Recreational	Commercial
1984	1,247	7,928	207	299	52
1985	2,232	10,464	349	236	45
<b>1986</b>	<b>1,654</b>	<b>5,124</b>	<b>136</b>	<b>152</b>	<b>219</b>
<b>1987</b>	<b>1,814</b>	<b>6,676</b>	<b>198</b>	<b>230</b>	<b>162</b>
1988	1,088	7,046	216	143	71
1989	801	5,510	193	105	15
1990	869	5,566	174	86	21

where  $f$  values are the observed numbers of recaptures in each fishery for each year and  $\hat{f}$  are the expected numbers of recaptures in each fishery for each year. To test homogeneity of recapture rates among years ( $n = 7$ ) for each fishery ( $m = 3$ ),  $G$ -statistics were summed for 1984–1990 and compared to a chi-square distribution with six degrees of freedom ( $n - 1$ ). To test homogeneity of recapture rates among fisheries, the pooled  $G$ -statistic for recaptures from all fisheries was subtracted from the sum of  $G$ -statistics for the three fisheries and compared to a chi-square distribution with 12 degrees of freedom ( $[n - 1] \times [m - 1]$ ). We used 0.05 as the significance level. The effect of the reward was determined by comparing individual  $G$ -statistics in years when the reward was offered to  $G$ -statistics in the years before and after the reward. The relative impact of the reward on the different fisheries was determined by comparing individual  $G$ -statistics among fisheries during the reward years.

## Results

Of the 58,019 lake trout tagged in northwestern Lake Michigan during 1984–1990, 3,309 were recaptured in assessment, recreational, and commercial fisheries (Table 1). Of the lake trout tagged during 1984–1990, 9,705 were caught in assessment gill nets fished in the fall and 48,314 were caught in assessment pound nets fished in the spring. The number of tagged lake trout at the beginning of each fishing season peaked at 12,696 in 1985, and ranged from 6,311 to 9,175 in other years. Of the lake trout recaptured during 1984–1990, 1,473 were recaptured in assessment fisheries, 1,251 were recaptured in the recreational fishery, and 585 were recaptured in the commercial

TABLE 2.—The  $G$ -statistics for numbers of lake trout recaptured within 1 year and 80 km of the tagging location in assessment, recreational, and commercial fisheries in northwestern Lake Michigan during 1984–1990. Expected numbers of recaptures for each year in each fishery were based on numbers of marked lake trout tagged in fall and spring assessment fisheries (Table 1). The years in which a reward was offered for tag returns (1986 and 1987) are shown in bold italic type.

Year	Assessment	Recreational	Commercial	Total
1984	-48.9	247.0	-59.9	133.2
1985	55.5	-70.0	-94.1	-200.9
<b>1986</b>	<b>-64.0</b>	<b>11.9</b>	<b>510.1</b>	<b>406.6</b>
<b>1987</b>	<b>-33.6</b>	<b>105.0</b>	<b>206.7</b>	<b>296.2</b>
1988	19.4	-58.4	-20.5	-79.0
1989	71.8	-54.4	-43.4	-122.3
1990	21.9	-82.3	-47.4	-137.7
Total	22.2	98.8	451.5	296.1
$P$	0.001	0.000	0.000	0.000

fishery. The number of lake trout recaptured each year by all fisheries ranged from 281 to 630 during 1984–1990. Annual returns from assessment fisheries ranged from 136 in 1986 to 349 in 1985, and exceeded numbers of tags returned by recreational or commercial fisheries in four of the seven years. Annual returns from the recreational fishery ranged from 86 in 1990 to 299 in 1984, and exceeded returns from assessment or commercial fisheries in 1984 (a nonreward year) and 1987 (a reward year). Annual returns from the commercial fishery for lake whitefish *Coregonus clupeaformis* ranged from 15 in 1989 to 219 in 1986 and exceeded returns from assessment and recreational fisheries only in 1986 (a reward year). Tags were returned from commercial gill-net, trap-net, and pound-net fisheries targeting lake whitefish. Commercial fishers targeting bloaters *Coregonus hoyi* and yellow perch *Perca flavescens* also returned tags, but these returns comprised less than 1% of commercial fishery returns.

The total recapture rate and the recapture rates in assessment, recreational, and commercial fisheries varied significantly among years (Table 2), and recapture rates varied significantly among fisheries ( $G = 276.4$ ;  $df = 12$ ;  $P \leq 0.001$ ). The total recapture rate peaked in 1986 (7.5%) and then declined to a low in 1990 (4.4%; Figure 2). The recapture rate from assessment fisheries was lower in 1984 (2.3%) and in the reward years (1986–1987; 2.0–2.3%) than in other years (2.7–3.1%). In contrast, the recapture rate in the recreational fishery was higher in 1984 (3.3%) and in the reward years (2.2–2.7%) than in other years (1.3–1.9%). The recapture rate in the commercial

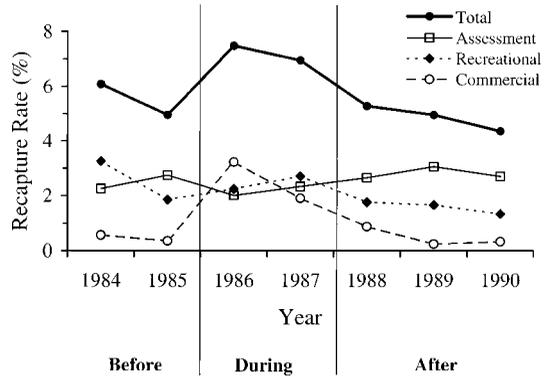


FIGURE 2.—Recapture rate (%) of lake trout tagged in northwestern Lake Michigan during 1984–1990 and recaptured within 1 year and within 80 km of the tagging location. The study period is divided into the years before, during, and after the offer of a reward for tag returns.

fishery was higher in reward years (1.9–3.2%) than in nonreward years (0.24–0.87%).

## Discussion

The reward of a free case of Stroh's beer increased the voluntary return of lake trout tags from northwestern Lake Michigan in 1986–1987 by both commercial and recreational fishers. The impact of the reward was greater for the commercial fishery than the recreational fishery. Several factors may have led to the greater effect on commercial fishers than on recreational anglers. First, the amount of extra effort required of fishers to obtain and return a tag may have affected commercial and recreational fisheries differently. Anglers targeted and generally killed lake trout, which facilitated examination for tag presence as well as removal of tags throughout the study period. Conversely, commercial fishers in Wisconsin waters were not allowed to target lake trout during the study period; therefore, in the absence of a reward, commercial fishers did not benefit by spending time handling lake trout to return tags. Without the additional incentive provided by a reward, tag removal may not have been worth the extra time and effort for commercial fishers, but little extra effort was required for recreational anglers to return tags. Recreational tag returns in the nonreward years were relatively high compared to commercial tag returns, so any increases produced by the reward would not have been as pronounced for recreational anglers. Second, differences in the number of lake trout encountered per trip by anglers compared to commercial fishers may have

limited the positive impact that the reward could have on recreational anglers. Anglers were subjected to daily bag limits, so they encountered fewer tagged fish per trip. Therefore, the reward could only have a limited impact on recreational anglers, even if it did provide additional motivation. Commercial fishers, on the other hand, captured many more lake trout per trip than anglers did. Thus, increased motivation to return tags due to the reward was much more obvious in the commercial fishery. Third, the monetary value of the reward may have influenced the fisheries differently. Since the number of fish captured per trip by recreational anglers was limited, the number of tags recovered per trip was low and hence the monetary value of the case of beer may not have been large enough to encourage anglers to return the tags. Commercial fishers were able to return the tags in very large numbers, and thus the monetary value per trip was greater.

The differential effects of the reward on commercial versus recreational fishers were likely related to the diverse motivations of fishery participants. Brown and Wilkins (1978) identified that response rates to mail questionnaires were related to differences among specific audiences, and that higher response rates were obtained from audiences particularly interested and involved in a topic. This same principle of human behavior applies to commercial and recreational fishers returning tags from recaptured lake trout in northwestern Lake Michigan. Recreational anglers made trips that, in many cases, resulted in personal satisfaction from fishing for and catching lake trout, thus generating interest in lake trout tagging studies. Commercial fishers made trips for their livelihood, consequently viewing their activities as work rather than leisure, and therefore they required additional incentive to generate interest.

### Management Implications

Despite the poor design of the reward program, a free case of beer increased recapture reporting rates of lake trout in northwestern Lake Michigan. Although rewards are designed to increase tag returns, inconsistent rates resulting from a reward being offered for only a portion of a study may be as much a hindrance as it is a help. For example, inaccurate or biased estimates of exploitation rate could result from return rates influenced by a reward. We recommend that only fisheries targeting the tagged species be used for tag recovery. In our study, a target fishery (recreational anglers) provided recapture rates that were higher, more con-

sistent, and less impacted by the reward than a nontarget fishery (commercial fishers). Perhaps if the reward had been geared more toward recreational anglers, such as free fishing lures, the results would have differed. Before a reward program is established, it should be carefully planned by the persons responsible for tagging, and the impact of incentives on response rates should be thoroughly considered. Understanding diversity and attitudes of fishery participants is an essential part of fisheries management (Fisher 1997). The use of this knowledge to gain understanding of the diverse motivations among user groups will facilitate successful design of a reward program for voluntary tag returns by providing insight into the likely impact of various incentives on response rates.

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