Marine Resource Economics, Volume 12, 1–10
0738-1360/97 $3.00 + .00

Needles in a Haystack: Cost-Effective Sampling of Marine Sport Anglers

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Abstract *An obstacle to conducting economic studies of marine sport anglers is the difficulty and expense in drawing a representative sample. Unlike inland fishing, where licenses are required in all states, only selected states require a marine sport fishing license and these licenses usually only cover selected marine fishing activities. Currently, there are no low cost methods of obtaining a representative sample of marine anglers because they are generally not licensed, use multiple access points, and represent a small proportion of the general population. The difficulty and expense of drawing a representative sample may have stifled attempts to study marine anglers. We test alternative sampling strategies by comparing the characteristics of a representative sample of experienced marine anglers with the characteristics of two other samples using multivariate and univariate analysis techniques. We conclude a sample of marine anglers drawn from the population of licensed inland anglers is not significantly different from the representative sample of experienced marine anglers.*

Key words Marine sport angling, representative sample, sampling.

Introduction

An obstacle to conducting economic studies of marine sport anglers (marine anglers hereafter) is the difficulty and expense in drawing representative samples. Unlike inland fishing, where licenses are required in all states, only selected coastal states require marine sport fishing licenses and these licenses may only be required for selected marine sport fishing activities.[1] In addition, marine anglers comprise small proportions of the populations in coastal states, which makes it expensive to conduct

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This project was financed in part by the Maine Legislature, the Maine Department of Marine Resources, the Maine Agricultural and Forest Experiment Station, and the University of Maine Sea Grant Program. All errors and omissions are the sole responsibility of the authors. Maine Agricultural and Forest Experiment Station Publication No. 2078.

[1] Only twelve of the twenty-three coastal/island states have some form of marine sport fishing license. However, even in these states coverage of the license requirement is irregular. For example, four states provide exemptions for shore-based fishing, six states exempt all passengers aboard charter and party boats and two states only require a license for fishing specific water areas. However, the lack of a marine fishing license does not indicate that a state deems the license unimportant, rather it indicates the strength of the political opposition. In response, the Atlantic States Marine Fisheries Commission sponsored a workshop in 1994 to help build support for the introduction of marine sport licenses because of the inability of individual states to overcome political obstacles when they attempt to introduce a marine sport licensing program.

surveys of the general populations to identify marine anglers. For example, during 1991 there were an estimated 69,000 resident marine anglers in Maine (USFWS 1992) out of a total resident population of 1,234,000 (USDC 1993). These figures imply a 5.6% sampling rate, or 17,857 people would need to be contacted to identify 1,000 marine anglers.

Given these constraints, researchers are left with a number of approaches to sampling marine anglers, each of which may be less expensive than conducting surveys of the general population, but are unlikely to yield representative samples. On-site intercept surveys can be conducted, however, marine anglers can fish from numerous shore sites or from a boat. Marine anglers who fish from a boat can use public and private boat launches, boat slips at marinas, party boats, and charter boats. Once anglers are identified on site, selecting representative subsamples for each mode/location and determining how subsample estimates should be weighted to derive aggregate population estimates is problematic at best. Another option limits the scope of population surveys to coastal counties with the hope that most marine anglers come from these locations thereby increasing the incidence of marine anglers in the sample frame and reducing the cost of identifying a sample of marine anglers.

The difficulty and expense of drawing representative samples may have stifled attempts to study marine anglers in the past. One reason the Atlantic States Marine Fisheries Commission advocates the establishment of marine fishing licenses is that licenses would "assure the availability of accurate, timely information on recreational fishing activity.... to provide effective law enforcement, quality research and productive habitat enhancement" (ASMFC 1994). Agnello (1988) points out that "most studies have focused on fresh water sports fishing where the data base is generally stronger." Some previous economic studies of marine anglers have focused on particular groups of marine anglers, [*e.g.,* charter boat anglers (Andrews and Wilen 1988)], private boat owners (Liao 1988), steelhead anglers (Johnson and Adams 1989), or use data from the Marine Recreational Fishery Statistics Survey (Milon 1988; Agnello 1988; Huppert 1989; Agnello and Han 1993).

The research reported here compares three alternative strategies for sampling marine anglers who are Maine residents.[2] The first sample (hereafter, denoted as the marine sample) is purchased from a survey research firm who identified experienced marine anglers through a random digit dial telephone survey of Maine households. This sample is composed of the most experienced marine angler in the household and results may differ from a truly random sample of marine anglers. However, this sample is likely to be most representative because it will include all marine angling modes, *e.g.,* shore anglers, anglers using their own boats, and anglers using charter/party boats. The second sample (hereafter, denoted as the intercept sample) is drawn from addresses provided from on-site intercept interviews of marine anglers at public boat launches along the Maine coast. While convenient, this sample is not likely to be representative because boat anglers who use alternative access points (*e.g.,* moorings, marinas), charter and party boat anglers, and shore anglers are excluded. The third sample (hereafter, denoted as the inland sample) is drawn from participants in a survey of licensed resident inland anglers who stated they marine fished. This sample is also likely to be most representative because the only group known to be excluded from this sample are marine anglers who do not fish inland waters in Maine.

Mail questionnaires were sent to members of each sample asking them about their marine sport fishing activities in Maine during 1988.[3] The sampling issue is

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[2] This study focuses only on resident anglers because the population from which nonresident anglers might be drawn is much larger than the population of Maine and a substantially lower participation rate makes telephone screening too expensive.
[3] While specific numbers are somewhat dated, insights are not likely affected.

studied by comparing summary statistics (means and proportions) of the socio-economic and fishing characteristics of the marine sample with the corresponding summary statistics from the intercept and inland samples using multivariate and univariate analysis techniques. We focus on means and proportions because these statistics are often used as the basic result in economic and fishery management studies; results that go on to influence public policy. The variables studied are of interest to economists because these variables are often used in contingent-valuation and travel-cost studies. The purpose here is to present the results of the analysis with implications toward further economic research of marine anglers.

Methods

Marine fishing takes place in the tidal portions of Maine's brooks, streams, rivers, coastal bays, and ocean waters. A Maine fishing license is not required to fish these waters and anyone is free to fish these waters as long as they obtain shore or boat access. The lack of a marine sport fishing license results in difficulties for a researcher who wants to develop a representative sample because a comprehensive list of marine anglers does not exist.

Sample Development

We obtained the marine sample from Northeast Research Inc., of Orono, Maine. They conducted a telephone screening survey, using random-digit dialing (RDD), during the fall of 1988 to identify resident marine anglers. The randomness of the dialing process should produce a sample similar to one drawn through the use of probability sampling if there is no telephone noncoverage bias in the area under study and there is no nonresponse bias. In states with poor telephone coverage, an RDD sample may not be representative. However, Maine has one of the highest telephone coverage rates in the country, 96.4%. In addition, the response rate for this sample should be sufficiently high to reduce any nonresponse bias.

The total number of telephone contacts attempted was 1,890, of which 1,550 actual contacts were made. Of these 1,550 contacts, 20% (309 individuals) stated that they had one or more marine anglers in the household. The telephone interviewers identified the angler in the household most knowledgeable of marine fishing. Seventy-six percent of these identified anglers agreed to provide their names and addresses for the marine angler survey. The marine sample consists of 150 individuals randomly selected from this sampling frame.

To draw the intercept sample, three field interviewers collected names and addresses from marine anglers at numerous public boat launches from the Maine-New Hampshire border to Lamoine State Park (omitting charter and party boat launching areas) during the summer of 1988. The field interviewers rotated between all the sites using a mix of times and days so as to obtain a variety of anglers. Most of the names and addresses included in this sample came from the Bath and Kittery Public Boat launches because of the high use rates at these sites (these two boat launches provide access to the best marine sport fishing areas on the Maine coast). The intercept sample consists of 150 individuals randomly selected from those who provided the field interviewers with name and address information.

During the spring of 1988 we conducted a mail survey of anglers who held a 1987 Maine resident inland fishing license. A total of 214,937 resident inland fishing licenses were issued in 1987 and 2,000 of these anglers were randomly selected to participate in the 1988 inland angler study. Design and administration of the inland angler survey followed Dillman (1978), with a response rate of 83%. In the inland angler survey we asked anglers whether they participated in marine sport angling during 1987. The angler sample consists of 100 individuals who were randomly drawn from respondents who answered ‘yes ‘to this question (37% of resident inland anglers stated they marine sport fished in the 1988 inland angler survey). The angler sample may contain more dedicated anglers because this sample consists of individuals who marine sport fished both in 1987 and in 1988.

Questionnaire Design and Survey Administration

The marine sport angler questionnaire was separated into seven major sections. The first section contains general questions regarding the respondent’s participation in marine sport fishing as well as participation in other consumptive uses of wildlife. The next four sections contain questions regarding the angler’s participation, effort and values associated with fishing for four species of marine fish: bluefish, striped bass, groundfish (cod, pollock, and flounder), and mackerel. Valuation data were collected using an open-ended contingent valuation approach. The questions in the sixth section focused on anglers’ marine sport fishing expenditures. The final section contains questions related to the socio-economic characteristics of the respondent. The marine angler survey was administered by mail during the spring of 1989, again following Dillman (1978). The average response rate for these surveys was 82%.

Data Analysis

Multivariate analysis of variance (MANOVA) was used to test the equivalency of vectors of sample means. Univariate t-tests were used to test the equivalency of individual sample means. These procedures compare means and variances, which are based on the first two moments of a distribution. Under normality, all the information contained in a distribution is in these two moments. If the tests indicate no statistical difference across samples, then the samples can be viewed as being drawn from the same population. Without normality, this may not hold.

MANOVA has an advantage over univariate analysis of variance (ANOVA) because the joint distribution of the means are compared. As a result, MANOVA can reveal differences between groups not shown by univariate approaches (Tabachnick and Fidell 1983). In addition, when a large number of statistical tests are performed, there is a probability that a number of hypotheses will be rejected purely by chance. A benefit of using MANOVA over using multiple univariate tests is that MANOVA decreases the probability of committing a Type I error (Hand and Taylor 1987).

Contingency tables were used to test the equivalence of sample proportions (also called tests of homogeneity). Contingency tables test whether the distribution of proportions is the same across samples and does indicate whether the samples are drawn from the same population. However, knowledge of the equivalence of means or proportions under different sampling strategies is useful regardless of the underlying distributions because these summary statistics are often used in economic studies of fisheries management. The significance level for all tests is set at 10%.

Tests were performed by comparing vectors and individual summary statistics from the marine sample with those of the intercept or angler sample. If the samples are equivalent, then the null hypotheses for the MANOVA analyses H_0: $\hat{\alpha}_{\text{marine}} = \hat{\alpha}_S$ should not be rejected ($\hat{\alpha}$ denotes the vector of sample means, subscripts denote sample, where S = intercept or angler). If we accept the null hypotheses, then the analyses stops for the vector of means under study. If the null hypotheses are rejected, then a series of univariate t-tests are performed for each of the means being studied. For the univariate t-tests, the null hypotheses H_0: $\hat{\mu}_{marine} = \hat{\mu}_S$ should not be rejected ($\hat{\mu}$ denotes individual sample means) and for the tests of proportions, the null hypotheses H_0: $\hat{\rho}_{marine} = \hat{\rho}_S$ should not be rejected ($\hat{\rho}$ denotes sample proportion).

For the MANOVA, we perform the analyses on preselected groups of variables based on the type of information being collected: socio-economic characteristics, general fishing characteristics, aggregate catch and effort across bluefish, striped bass, groundfish, and mackerel fishing; specific catch, effort and economic data related to bluefish fishing, and specific catch, effort and economic data related to mackerel fishing. Analyses were not performed on the catch, effort and economic data related to striped bass and groundfish fishing due to small sample sizes.

Tests of proportions were performed on respondent gender, on the percent of anglers fishing for bluefish, striped bass, groundfish or mackerel, on the percent of bluefish anglers hiring a fishing guide, and on the percent of mackerel anglers using a boat.

Results

Socioeconomic Characteristics

The MANOVA analysis reveals that the marine and intercept samples are significantly different ($F_{(4, 146)} = 2.59$; $p = 0.04$) (see table 1). Follow-up ANOVA indicates age ($F_{(1, 149)} = 4.84$; $p = 0.03$) is the only variable significantly different; education ($F_{(1, 149)} = 0.02$; $p = 0.88$), household size ($F_{(1, 149)} = 2.02$; $p = 0.16$), and income ($F_{(1, 149)} = 0.24$; $p = 0.62$) were not significantly different. There are no significant differences between the marine and angler sample ($F_{(4, 111)} = 1.03$; $p = 0.39$). The gender variable is not significantly different between the marine and intercept samples ($\chi^2_{(1)} = 1.86$; $p = 0.17$), and the marine and angler samples ($\chi^2_{(1)} = 0.65$; $p = 0.42$).

General Fishing Characteristics

General fishing characteristics between the marine and intercept samples are significantly different ($F_{(4, 137)} = 3.39$; $p = 0.01$) (see table 2). Fishing frequency is significantly different ($F_{(1, 140)} = 8.36$; $p = 0.00$), while the year first fished ($F_{(1, 140)} = 0.12$; $p = 0.73$), number of juvenile anglers ($F_{(1, 140)} = 2.06$; $p = 0.15$), and number of adult anglers ($F_{(1, 140)} = 1.93$; $p = 0.16$) are not significantly different. The marine and an-

Table 1. Socioeconomic Characteristics of Samples

	Test = MANOVA				Test = χ^2
Sample	Age	Years of Education	Household Size	Household Income ($)	Percent Male
Marine	40	14	3	36,000	92
	(12)	(2)	(2)	(16,000)	
Intercept	44	13	3	37,500	96
	(11)	(2)	(2)	(20,100)	
Angler	43	13	3	35,000	86
	(17)	(2)	(2)	(21,500)	

Notes: Sample sizes for the MANOVA are: Marine (74), Intercept (77), Angler (42); sample sizes for the Chi-square test are: Marine (80), Intercept (83), Angler (45).
Standard deviations in parentheses.

Table 2. General Fishing Characteristics of Samples

	Test = MANOVA			
Sample	Year First Marine Sport Fished	Percent of Years Actually Marine Fished	Number of Juvenile Anglers	Number of Adult Anglers
Marine	1970	41	1	2
	(13)	(49)	(1)	(1)
Intercept	1970	65	1	2
	(15)	(48)	(1)	(1)
Angler	1969	66	1	2
	(13)	(48)	(1)	(1)

Notes: Sample sizes are: Marine (68), Intercept (74), Angler (35).
Standard deviations in parentheses.

Table 3. Percent of Samples Fishing for Specific Species

	Test = χ^2 Percent Fishing For:			
Sample	Bluefish	Striped Bass	Groundfish	Mackerel
Marine	62	28	51	72
Intercept	81	51	40	86
Angler	54	28	28	78

Notes: Sample sizes are: Marine (81), Intercept (85), Angler (48).

gler samples are significantly different in terms of fishing characteristics ($F_{(4, 98)}$ = 2.16; p = 0.08). Fishing frequency variable is significantly different ($F_{(1, 101)}$ = 5.76; p = 0.02), while the year first fished ($F_{(1, 101)}$ = 0.14; p = 0.70), number of juvenile anglers ($F_{(1, 101)}$ = 0.90; p = 0.34), and number of adult anglers ($F_{(1, 101)}$ = 0.94; p = 0.34) are not significantly different.

Percent Fishing for Specific Species

The marine and intercept samples are significantly different in the percent fishing for bluefish ($\chi^2_{(1)}$ = 7.78; p = 0.00), striped bass ($\chi^2_{(1)}$ = 9.61; p = 0.00), and mackerel ($\chi^2_{(1)}$ = 3.63; p = 0.06) (see table 3) while not significantly different in the percent fishing for groundfish ($\chi^2_{(1)}$ = 2.13; p = 0.14). In contrast, the marine and angler samples are significantly different in the percent fishing for groundfish ($\chi^2_{(1)}$ = 6.25; p = 0.01), but not significantly different in the percent fishing for bluefish ($\chi^2_{(1)}$ = 0.43; p = 0.51), striped bass ($\chi^2_{(1)}$ = 0.01; p = 0.93), or mackerel ($\chi^2_{(1)}$ = 0.15; p = 0.70).

Aggregate Fish Catch and Fishing Effort

The results presented in this section are the sum of the total number of fish caught and kept along with the total fishing effort associated with marine sport fishing for four individual species: bluefish, striped bass, groundfish, and mackerel (see table 4).

Table 4. Aggregate Fish Caught, Percent Kept, and Fishing Effort for Selected Species

	Test = MANOVA			
			Number of Days Spent On:	
Sample	Number of Fish Caught	Percent Fish Kept	Single-Day Trips	Multiple-Day Trips
Marine	40	65	11	4
	(43)	(37)	(10)	(12)
Intercept	60	67	18	1
	(43)	(35)	(15)	(6)
Angler	32	64	8	1
	(28)	(40)	(9)	(2)

Notes: Sample sizes are: Marine (70), Intercept (70), Angler (41). Species are: bluefish, striped bass, groundfish (pollock, cod, flounder), and mackerel.
Standard deviations in parentheses.

Table 5. Bluefish Fishing Characteristics of Samples

	Test = MANOVA					Test = χ^2
Sample	Number Caught	Percent Kept	Single Day Trips	Average Cost Per Trip	Maximum Willingness-To-Pay Per Trip	Percent Hiring Guide
Marine	9	63	4	24	44	10
	(12)	(45)	(3)	(19)	(28)	
Intercept	15	54	8	25	48	2
	(18)	(45)	(6)	(17)	(37)	
Angler	9	54	5	28	50	4
	(12)	(48)	(3)	(25)	(45)	

Notes: Sample sizes for the MANOVA are: Marine (40), Intercept (67), Angler (24); sample sizes for the Chi-square test are: Marine (40), Intercept (65), Angler (24).
Standard deviations in parentheses.

MANOVA indicates the marine and intercept samples are significantly different ($F_{(4, 135)}$ = 3.90; p = 0.00) and ANOVA indicates the difference lies in the number of fish caught ($F_{(1,138)}$ = 4.89; p = 0.00) and the number of single-day trips ($F_{(1, 138)}$ = 9.22; p = 0.00). The marine and intercept samples are not significantly different in the percent fish kept ($F_{(1, 138)}$ = 0.14; p = 0.71) or the number of days spent fishing on multiple-day trips ($F_{(1, 138)}$ = 2.06; p = 0.15). The marine and angler samples are not significantly different ($F_{(4, 106)}$ = 1.01; p = 0.41).

Characteristics of Bluefish Fishing

The bluefish fishing characteristics between the marine and intercept samples are significantly different ($F_{(5,101)}$ = 3.008; p = 0.014) (see table 5). ANOVA analysis indicates the difference lies in the number of fish caught ($F_{(1, 105)}$ = 3.69; p = 0.06) and the number of single trips taken ($F_{(1, 105)}$ = 13.35; p = 0.00). The marine and intercept samples are not significantly different in the percent fish kept ($F_{(1, 105)}$ = 1.03; p = 0.31), the average cost per single-day trip ($F_{(1, 105)}$ = 0.10; p = 0.75) or the average

Table 6. Mackerel Fishing Characteristics of Samples

	Test = MANOVA					Test = χ^2
Sample	Number Caught	Percent Kept	Single Day Trips	Average Cost Per Trip	Maximum Willingness-To-Pay Per Trip	Percent Using a Boat
Marine	27	78	6	18	30	75
	(20)	(34)	(6)	(10)	(23)	
Intercept	40	87	7	20	30	94
	(19)	(28)	(6)	(16)	(27)	
Angler	29	76	5	21	38	82
	(19)	(36)	(5)	(21)	(40)	

Notes: Sample sizes for the MANOVA are: Marine (44), Intercept (64), Angler (27); sample sizes for the Chi-square test are: Marine (40), Intercept (80), Angler (24).
Standard deviations in parentheses.

maximum willingness-to-pay ($F_{(1, 105)}$ = 0.05; p = 0.82). The marine and angler samples are not significantly different ($F_{(5,58)}$ = 0.500; p = 0.78). The marine and intercept samples are significantly different in the percent of anglers hiring a guide ($\chi^2_{(1)}$ = 3.91; p = 0.05), while the marine and angler samples are not significantly different ($\chi^2_{(1)}$ = 0.71; p = 0.40).

Characteristics of Mackerel Fishing

The mackerel fishing characteristics between the marine and intercept samples are significantly different ($F_{(5, 102)}$ = 3.06; p < 0.01) (see table 6). ANOVA indicates the differences are due to the number of fish caught ($F_{(1, 106)}$ = 10.86; p = 0.00). The marine and intercept samples are not significantly different in the percent fish kept ($F_{(1, 106)}$ = 1.94; p = 0.17), the number of single trips taken ($F_{(1, 106)}$ = 0.49; p = 0.48), the average cost per single-day trip ($F_{(1, 106)}$ = 1.01; p = 0.32), or the average maximum willingness-to-pay ($F_{(1, 106)}$ = 0.00; p = 0.99). The marine and angler samples are not significantly different ($F_{(5, 65)}$ = 0.64; p = 0.67). The marine and intercept samples are significantly different in the percent of anglers using a boat ($\chi^2_{(1)}$ = 7.92; p = 0.01), whereas the marine and angler samples are not significantly different ($\chi^2_{(1)}$ = 0.34; p = 0.56).

Conclusions

The null hypotheses of no difference was rejected in nine of the ten primary statistical tests made between the marine and intercept samples. If we include all of the follow-up univariate tests, twelve out of twenty-nine variables were deemed to be significantly different between these two samples. In general, the intercept sample is significantly older, fishes more frequently, is more likely to target specific species, catches more fish, takes more single-day trips, is less likely to hire a guide to fish for bluefish, and more likely to use a boat when fishing for mackerel. Several of these variables are important in travel cost and contingent-valuation modeling, and in economic impact analysis. Given that the intercept sample is more avid and successful, results from economic studies based on this type of sample may overestimate the values and impacts associated with marine sport fishing. Conforming to expectations, the intercept sample likely omits significant subpopulations of marine anglers and is not representative of marine anglers.

In contrast, the null hypothesis of no difference was rejected in only two of the ten primary tests made between the marine and angler samples. Furthermore, this represents a significant difference in only two of the twenty-nine variables under study (fishing frequency, and percent targeting groundfish). The inland sample may be composed of more dedicated anglers (this sample represents anglers who fish both marine and inland waters, and fish marine waters more frequently). Any potential overestimation bias from this sample seems to be insignificant.

The random nature of the sampling process used to develop the marine sample ensures that all subgroups of marine anglers be included. The overall similarity between the marine sample and the angler sample is not surprising given that the sampling process used in developing the angler sample should also ensure that all subgroups of marine anglers are included. In fact, the only group known to be excluded from this sample are marine anglers who do not inland fish. In general, two conditions would allow the inland angler sample to be similar to the marine angler sample: the group of marine anglers excluded from the inland angler sample (marine anglers who do not inland fish) is relatively small, or the characteristics of marine anglers who do not fish inland waters are the same as the characteristics of marine anglers who do inland fish.

Given the above results and the political difficulty in introducing marine sport fishing licenses,[4] a possible cost-effective strategy to develop representative samples of marine anglers would be to draw the sample from individuals who have purchased inland fishing licenses. As stated in the introduction, developing a sample of 1,000 resident marine anglers by using a screening of the general Maine population would require making over 17,000 contacts. In contrast, building a marine angler sample from a listing of inland anglers would require contacting only 2,700 anglers (based on this research's 37% contact rate).

There are three caveats. First, the research is based upon samples of resident inland anglers. It is not clear whether the results would carry over to studying nonresident behavior. Secondly, the sample sizes used here are somewhat marginal. However, the p-values are not close in most cases and significantly increasing the sample sizes would probably not affect the general results. In addition, MANOVA test results are robust for samples larger than twenty when only a few variables are being tested (Tabachnick and Fidell 1983). Finally, it is possible that the relationship between marine anglers in Maine and individuals who hold a Maine resident inland fishing license is somehow unique. If so, the results reported here may not be indicative of the situation in other states. However, the basic assumption, that inland anglers (having a demonstrated interest in sport fishing) are the individuals most likely to participate in marine sport fishing, seems intuitively sound.

Due to the declining number of several important marine fish species, many state and federal agencies are currently attempting to equitably allocate fish harvests between the commercial and recreational sectors. In addition, these agencies are continually looking for effective, yet equitable methods of reducing the total fish catch. Economists, using valuation techniques and cost/benefit analysis, can provide assistance in these endeavors. Given states without marine sport licensing programs may be unable to introduce a licensing program in the near future, the sampling results outlined here may help reduce a barrier to economic research of marine sport angling.

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[4] For example, when New York attempted to introduce a marine sport fishing license in 1991, there was strong opposition from anglers and from industries that provide goods and services to those anglers (tackle and bait shop owners, charter and party boat operators). Due to this opposition, the licensing requirement was not approved.

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