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Using the Marine Recreational Fishery Statistics Survey (MRFSS) in Stock Assessments

by

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TABLE OF CONTENTS

Page

EXECUTIVE SUMMARY. i

INTRODUCTION 1

REVIEW OF METHODOLOGY. 2

CURRENT USE OF THE MRFSS DATA BASE 2

Calculation of total catch in weight 3

Treatment of catch type B2 4

Length frequency of total catch. 4

Defining species-directed effort 5

Precision of the catch estimates 6

FUTURE UTILIZATION OF THE MRFSS. 7

Stock definition 7

Matching MRFSS catch with U.S. Statistical Areas 8

DISCUSSION 10

REFERENCES CITED 12

TABLES 13-14

FIGURE 15

Executive Summary

The Marine Recreational Fishery Statistics Survey (MRFSS) is a valuable source of data for determining the status of Atlantic coast stocks with significant recreational fisheries. Data are collected by two complementary surveys: a telephone survey of households and an intercept survey of anglers at landing sites. MRFSS catch statistics are derived from these surveys and reported in three categories: 1) Type A - estimates from catch available for identification and measurement of length and weight, 2) Type B1 - estimates from catch not available for identification in whole form, because the fish were either cleaned or discarded dead, and 3) Type B2 - estimates from catch released alive. To date, information in the MRFSS database has been an important component of Northeast Fisheries Center (NEFC) stock assessments of summer flounder and bluefish.

Several issues concerning the current use of the MRFSS are addressed in this paper. Among these are 1) methods of estimation of total catch weight from Type A catch, 2) inclusion/exclusion of Type B2 catch in the estimation of total catch, 3) assignment of intercept length frequencies to estimated catch, 4) defining indices of species-directed effort, and 5) precision of MRFSS catch estimates.

Major recreational fisheries exist for many commercially important species. To date, differences in the catch reporting categories of National Marine Fisheries Service commercial and recreational data bases have hindered utilization of MRFSS data for these stocks. The MRFSS intercept survey data provide details on the origin of recreational catch that will be useful in addressing future issues such as 1) assignment of recreational catch to stocks for species with multiple stocks along the Atlantic coast, and 2) combining commercial and recreational catches to better evaluate the effect of fishery removals on stock status.

Introduction

Estimated recreational catches of U.S. Northwest Atlantic stocks such as black sea bass (*Centropristis striata*), striped bass (*Morone saxatilis*), bluefish (*Pomatomus saltatrix*), and summer flounder (*Paralichthys dentatus*) approach or exceed their respective U. S. commercial landings in weight. For Atlantic cod (*Gadus morhua*), Atlantic mackerel (*Scomber scombrus*), scup (*Stenotomus chrysops*), and winter flounder (*Pseudopleuronectes americanus*), recreational catch is greater than 10% of their total U.S. catch in weight (Table 1). For these species, the Marine Recreational Fishery Statistics Survey (MRFSS) provides an important source of data for determining status of the stocks.

The MRFSS was begun in 1979 to obtain estimates of catch and effort by recreational fishermen in the marine waters of the United States. Data are collected by two complementary surveys: a telephone survey of households and an intercept survey of fishermen at fishing sites. The telephone survey is used to estimate the number of fishing trips made by fishermen, the time and location of these trips, and the number of fishermen in each household. Various catch data, including number, length, and weight of fish caught, and trip information, such as fishing mode (shore or boat) and distance from shore (area) of fishing activity, are recorded in the intercept survey. Data from these two independent surveys are then combined to estimate total catch and effort by recreational fishermen.

Review of methodology

The total number of fishing households is estimated every two months from the telephone survey by deriving the proportion of households with fishing activity in the sample, and multiplying this factor by census data on the total number of households. The proportion of trips by fishing mode and distance from shore (area) in the household sample is then applied to the estimated total number of fishing households to estimate total fishing trips by mode and area. The total number of fish caught by recreational fishermen is calculated by multiplying the estimated total number of fishing trips times the average catch per trip from the intercept survey. The estimated total catch is reported in three categories, depending on the nature of the sample catch from which it was derived. Catch type A is estimated from catch available for identification and measurement of length and weight. Catch type B1 is estimated from catch not available for identification, because the fish were either used for bait, cleaned, or discarded dead. Catch type B2 is estimated from catch released alive.

More detailed information on the procedures used to estimate total catch and effort from telephone and intercept survey samples is available from MRFSS publications (USDOC 1986).

Current use of the MRFSS data base

The following five issues concerning the use of the MRFSS data were addressed as part of the Northeast Fisheries Center (NEFC) stock assessment of Atlantic coast bluefish (Terceiro 1987).

I) Calculation of total catch in weight

MRFSS publications report the weight of fish caught for catch type A only, since no data are available on the length and weight of type B catch. However, there is a need to estimate the weight of all fish caught (e.g., in order to monitor trends in catch per unit effort). The National Marine Fisheries Service (NMFS) Fishery Statistics Program in Washington, D.C. has advised the NEFC on an appropriate procedure for this calculation (pers. comm., R. J. Essig).

A catch cell in the MRFSS database is defined at its finest level of resolution as a strata with dimensions of coastal subregion (North Atlantic, Middle Atlantic South Atlantic) and state of catches, area (inland, territorial sea, EEZ waters), fishing mode (man-made structure, beach/bank, party/charter boat, private/rental boat), and wave (two month time intervals: e.g., May/June). At this level of resolution, however, there may be instances when a cell contains type B catch, but no corresponding type A catch to provide weight per fish information. This problem can usually be avoided if annual data is sorted by coastal subregion, area, and fishing mode. Total catch in weight may then be calculated by assigning the annual mean weight per type A fish to annual total numbers of fish in the subregion/area/mode catch cell:

$$(\text{wgt A} / \text{num A}) * (\text{num A} + \text{B1} + \text{B2}) = \text{wgt} (\text{A} + \text{B1} + \text{B2}).$$

Total weight in these catch cells may be summed at whatever higher level of aggregation (e.g., annual subregion/mode) is appropriate for the fishery of interest.

II) Treatment of catch type B2

The literature dealing with hooking mortality in recreational fisheries mainly concerns salmonids and freshwater species; little work has been done to estimate the hooking mortality of saltwater gamefish. In salmonids, hooking mortality of released fish caught on bait varied from 5 to 50%; mortality of lure caught fish varied from 1 to 40% (Wydoski 1977). Given this high variability in survival rate and the paucity of data for many marine species, type B2 catch was included in the estimation of total recreational catch of bluefish in order to avoid underestimating the number of fish removed from the stock, and subsequent underestimation of fishing mortality. For bluefish, type B2 catch averaged 15% of total catch numbers during the 1979 - 1985 period.

The inclusion of all type B2 catch in the estimation of total catch implies a 100% hooking mortality, which in turn has implications for the justification of length and/or creel limits. For species such as striped bass, a large proportion of the catch is currently released in accordance with management regulations. Inclusion of all type B2 catch in the estimation of landings in this instance would obviously bias any subsequent estimation of mortality from catch data. The treatment of type B2 catch must be addressed on a species/stock basis, incorporating considerations of the hardiness of the species and the estimated proportion of catch released.

III) Length frequency of estimated catch

Assignment of length frequency to estimates of catch types A and B is made by merging intercept data type A records with catch estimates. Initially,

this merging procedure may be attempted with the catch sorted at a subregion/state/mode/area/wave cell level. At this fine cell level, there may occasionally be instances when no type A samples are present in a cell with type B catch; thus no length characteristics may be assigned and the merged cell catch cannot be included in catch-at-length totals. Thus, the summation of the merged catch may be underestimated relative to estimated total catch. One solution to this problem is to use the merged catch-at-length aggregated to an annual subregion/mode/area cell level as a proportional key to assign length frequency to the annual estimated catch. This procedure was used to assign length frequency to estimated catch totals for bluefish, and insures that totals of catch-at-length match previously published totals of catch in numbers.

IV) Defining species-directed effort

The MRFSS does not provide an estimate of species-directed effort. Instead, the numbers of all fishing trips in catch cells are provided, which may serve as the basis for indices of directed effort. These data may be aggregated in several different ways to provide indices suitable for the species at hand. Option 1 is to use all fishing trips in the annual subregion/mode/area where fishing for the species of interest occurs. Option 2 is to use all fishing trips only in annual subregion/mode/area cells where catch of the species of interest is recorded. Options 3 and 4 are to multiply the above measures by the percentage of interviewed fisherman that indicate they were seeking a particular species. Employing this "target percentage" may introduce bias, however, if fisherman tend to report that they are fishing for the species they actually catch. For the bluefish assessment, options 1

and 2 were considered, and a high correlation (r = 0.99) found between these measures of effort on a subregional basis, with option 2 ultimately employed. This relationship may not be as strong for species that are less frequently encountered, however, and the definition of effort should probably be considered separately for each species or stock.

V) Precision of the catch estimates

Estimated standard errors of the catch estimates are provided in MRFSS publications for use in the calculation of confidence intervals at the subregional level. Coefficients of variation (CV), which express the standard error as a percentage of the estimate, are also provided as a measure of precision, and are useful for comparing the relative precision of estimates for different species. For U.S. Northwest Atlantic stocks with major recreational fisheries, the estimates of total catch in numbers for bluefish and summer flounder are the most precise (CV's of 10 - 20%, Table 2), and are among the most precise of all the species included in the MRFSS. Such low values of CV reflect the cosmopolitan distribution of these species along the coast and resulting wide availability to anglers, and hence large intercept sample sizes.

By contrast, the CV's of species such as Atlantic cod and Atlantic mackerel are generally higher (25-50%, Table 2), reflecting limited availability and/or exploitation coastwide, and thus a smaller available sample size from which to estimate catch. These catch estimates should be used with caution, with particular attention paid to the spatial and temporal properties of the sample data (intercept and telephone survey) from which they are derived, to insure that the estimates are valid. An understanding of the

manner in which the fishery is prosecuted would obviously be useful in these cases to properly evaluate annual changes in the catch estimates.

Variances of the estimates of the three catch types and total catch (numbers) by state/area/mode/wave catch cell are also provided in the MRFSS database. Again, these values may be used to construct confidence intervals and CV's for catch estimates at the catch cell level.

Future utilization of the MRFSS

I) Stock definition

Species with more than one unit stock along the Atlantic coast often do not conveniently fit the MRFSS subregional categories used for summarizing catch statistics. Atlantic cod is a prominent example, with one stock defined for the Gulf of Maine, and another for Georges Bank and areas south. One option in the utilization of recreational data is to assign catches to stock by state; for Atlantic cod, recreational catch in Maine and New Hampshire might be assigned to the Gulf of Maine stock, and recreational catch in states from Massachusetts and southward assigned to the Georges Bank stock. However, aggregation of MRFSS data by state may cause difficulties in the extrapolation of total weight, due to occasional missing type A catch data at the state level. A possible solution would be for users of the MRFSS database to aggregate state data into new "stock groups", different from current MRFSS subregions, which better conform to stock definitions, and perform aggregation and extrapolation using a "stock group"/area/mode catch cell. The MRFSS intercept data, which provides information at state, county, and specific landing site levels, will aid in determining the appropriate assignment of state recreational catch to stocks.

II) Matching MRFSS catch with U.S. Statistical Areas

NEFC commercial catch data are compiled according to U.S. Statistical Reporting Areas (SA's; Figure 1). MRFSS recreational catch estimates are available at the state level; the intercept data are summarized at the county and landing site level. However, neither recreational data set provides information on the origin of fishery removals comparable with U.S. SA's, and so it is difficult to combine or compare recreational and commercial catches from the same stock. A non-standardized, stock-specific approach will be needed to reconcile existing recreational catch cells with commercial Statistical Areas (e.g., as would be necessary if SA-specific age/length keys were used to age recreational catch-at-length).

Because little recreational fishing occurs in waters hundreds of miles from the coast, SA's that are not proximal to the Atlantic coast may be eliminated from consideration for assignment of recreational catch. For the region from Maine to Cape Hatteras, for example, only 18 of 43 SA's (511-514, 521, 526, 537-539, 611-615, 621, 625, 631, and 635) are likely to be sources of recreational catch (Figure 1). Matching of state catch to SA can be made using the following criteria as guidelines 1) the proximity of the state to the SA, 2) the percentage of state commercial catch originating in various SA's, and 3) landing site information provided by the MRFSS intercept data.

As an example, consider the recreational catches of Atlantic cod in Maine, Massachusetts, and Connecticut during 1986. For the state of Maine, SA's 511, 512, 513 & 514 are adjacent to the coast, and so the recreational catch of cod from Maine might reasonably be assigned to these SA's. Maine 1986 commercial

landings (by weight) were apportioned among these areas as follows: 511 - 11%, 512 - 31%, 513 - 57%, 514 - 1%. The largest population centers in Maine (and thus likely areas of high recreational fishing activity) are adjacent to SA's 512 & 513, and the MRFSS intercept data indicate that 17% of recreational catch of cod was landed at sites that border SA 512 (Hancock and Washington counties), and 83% at sites bordering SA 513 (Cumberland and York counties). Assigning these latter proportions of Maine recreational catch to SA's 512 and 513 might thus be reasonable procedure.

The state of Massachusetts is adjacent to SA's 513, 514, 521, 537, 538, and 539. Proportions of 1986 Massachusetts commercial landings of cod in these areas were: 513 - 15%, 514 - 20%, 521 - 63%, 537 - 2%, 538 - <1%, 539 - <1%. SA 521 borders the outer coast of Cape Cod and includes Georges Bank, and thus currently is unlikely to be the source of a significant number of recreationally caught Atlantic cod (although this situation may change in the future, as increasing numbers of party/charter boats undertake extended trips to offshore grounds). The MRFSS intercept data indicate that 90% of samples with cod were landed in Essex county (mainly at Gloucester, MA), which borders SA 513 and 514, while the remaining 10% were landed at sites along the Massachusetts coast bordering SA 514 (Barnstable, Norfolk, and Plymouth counties; adjacent to Cape Cod Bay and Massachusetts Bay). Thus, SA's 513 and 514 are the most likely sources of recreational catch of Atlantic cod taken by Massachusetts anglers. However, because the MRFSS data base provides no information on the location of fishery removals, it is difficult to distribute the recreational catch of Atlantic cod between these two SA's using only the MRFSS data. However, assignment of Massachusetts recreational catch of Atlantic cod to SA's might be made based on the respective proportions of

Massachusetts commercial catch of Atlantic cod in only these two SA's, with 43% of the recreational catch assigned to SA 513, and 57% to SA 514.

The treatment of recreational catch of Atlantic cod in Connecticut (about 2% of the coastwide recreational total) presents a different set of problems. All Connecticut MRFSS intercepts with catch of Atlantic cod were made in New London county, bordering SA 611. Commercial landings (all states) of cod from SA 611 in 1986 were very small. In this instance, the most reasonable option would be to assign the recreational catch to the nearest SA with significant commercial landings of Atlantic cod, perhaps SA 539, 537, or 613. Over 92% of the commercial catch of cod (all states) removed from these three SA's was taken from SA 537, so it is reasonable to assign Connecticut recreational catch of cod to SA 537.

In summary, the problem of assigning recreational catch to stocks might be handled by employing user defined state groupings, forming "stock groups." Extrapolation of total catch in weight may then be performed at a "stock group"/area/mode cell level. The more complex problem of reconciling existing recreational catch reporting categories with commercial SA's may be approached on a state to SA basis, making accommodations akin to those often necessary to best aggregate commercial catch data. Procedures such as those described above will allow recreational catch to be combined with commercial catches, so that assessments will better account for total removals.

Discussion

The most extensive use of the MRFSS data base has occurred in developing the stock assessments of Atlantic coast bluefish and summer flounder. Methods of data compilation and extrapolation used in those assessments and

presented here will likely need to be altered to address the characteristics of fisheries of other species with multiple stocks and/or different recreational/commercial balance.

Further examination of the variance associated with MRFSS catch estimates will allow inclusion of confidence intervals with recreational catch statistics. These parameters will be especially important for stocks with catch constrained by management measures (e.g., striped bass), stocks with spatially or temporally limited fisheries (e.g., Atlantic cod), and stocks with expanding recreational fisheries (e.g., scup and black sea bass), to accurately interpret trends in the recreational catch.

The difficulty in matching the reporting categories of NMFS commercial and recreational data sets will become a significant issue as recreational fisheries for commercially important species expand. Currently, emphasis in the MRFSS database is placed on landing sites of recreational catches, with little information (other than distance from shore) available on location of removals. In the future, inclusion of additional information on the origin of recreational catch (in terms of SA) in the MRFSS database would require more questions to be asked of recreational fishermen during interviews, but would allow more accurate integration of recreational catch data in stock assessment analyses than is currently possible. The resulting increased compatibility between NMFS commercial and recreational data bases would facilitate a more comprehensive understanding of the effects of fishing on stock status of species which are taken in both recreational and commercial fisheries.

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Table 1. U.S. Northwest Atlantic stocks with important recreational fisheries (>10% total catch in weight).

Recreational catch: percent of total U.S. (commercial & recreational)

SPECIES	1979	1980	1981	1982	1983	1984	1985	1986
BLUEFISH	92	91	89	87	90	88	88	91
SUMMER FLOUNDER	33	60	26	27	50	42	37	42
SCUP	22	33	17	26	33	19	30	52
STRIPED BASS	55	20	18	60	56	14	57	82
ATLANTIC MACKEREL	65	47	64	25	44	41	19	29
BLACK SEA BASS	55	20	18	60	56	14	56	78
WINTER FLOUNDER	46	30	33	36	34	40	47	31
ATLANTIC COD	8	11	16	13	14	11	19	NA

Source: Status of the Fishery Resources for 1987 (In prep.). NOAA TM NMFS-F/NEC.

Table 2. Precision of MRFSS expanded catch estimates, North and Middle Atlantic subregions: coefficient of variation of total numbers (A + B1 + B2).

NORTH (ME to CT)

	1979	1980	1981	1982	1983	1984	1985	1986
BLUEFISH	10	14	30	14	20	11	23	16
SUMMER FLOUNDER	19	24	22	16	20	17	38	18
SCUP	17	12	20	21	15	21	16	13
STRIPED BASS	30	21	26	46	35	33	37	41
ATLANTIC MACKEREL	19	21	27	31	18	30	62	25
BLACK SEA BASS	46	46	30	39	26	30	33	19
WINTER FLOUNDER	11	6	19	39	12	12	17	27
ATLANTIC COD	17	17	23	23	15	19	26	27

MIDDLE (NY to VA)

	1979	1980	1981	1982	1983	1984	1985	1986
BLUEFISH	5	6	19	14	8	12	10	7
SUMMER FLOUNDER	28	4	11	43	12	12	16	8
SCUP	17	13	28	16	24	34	23	16
STRIPED BASS	19	10	18	32	33	19	21	25
ATLANTIC MACKEREL	51	61	57	43	45	57	58	32
BLACK SEA BASS	14	8	15	42	22	18	13	24
WINTER FLOUNDER	14	9	13	12	21	12	25	10
ATLANTIC COD	--	9	13	12	21	12	25	10

--: < 30 thousand fish reported

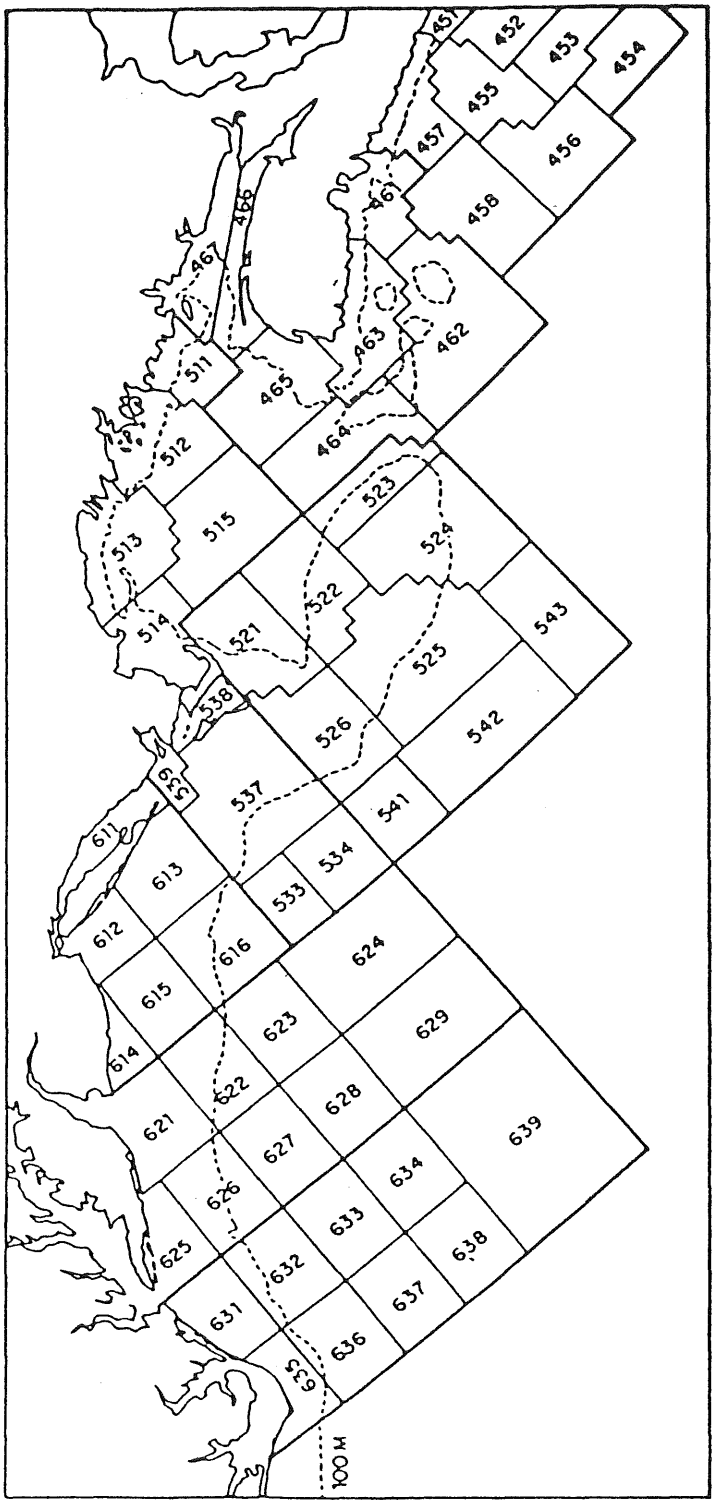

Figure 1. U.S. Statistical Areas used for reporting U.S. commercial fishery statistics.