An Evaluation of Alternative Estimators of Ocean Boat Fishing Effort and Catch in Oregon

Prepared by

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August 8, 2000

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Abstract

The RecFIN Statistics Subcommittee was charged with examining differences in catch and effort estimates between the Oregon Ocean Boat Survey (OBS) and the Marine Recreational Fishery Statistics Survey (MRFSS) during periods when the two surveys overlapped from 1993-1999. The subcommittee extensively examined the designs and estimation methods of both surveys. Although the overall strategies of both surveys were deemed appropriate, some problems with each were identified. Most of the issues for OBS related to undercoverage of effort. The OBS did not sample or account for trips that occurred at all ports, time periods, and times of day. The subcommittee estimated adjustments to the OBS estimates that would account for these missed trips. The major problems with the MRFSS involved the possible reporting of some freshwater trips as saltwater trips, and non-representative sampling distributions that skewed estimated ocean:inland trip ratios. The subcommittee removed questionable trips from the MRFSS effort data and produced revised MRFSS estimates after implementing a geographic stratification of the Oregon coast that alleviated the impact of the non-representative sampling. Many other potential issues for both surveys were identified but the subcommittee was not able to quantify their effect, if any, on survey estimates.

The subcommittee was also charged with providing advice on the appropriate use of estimates from both surveys to the Groundfish Management Team (GMT). Previously, the GMT used unadjusted estimates from the OBS during periods when they were available and scaled MRFSS estimates by a factor calculated from the period of overlap. It was the opinion of the subcommittee that the use of adjusted estimates from both surveys would be more appropriate. The adjustments made to both surveys greatly reduced the differences in their effort estimates. We recommend the use of the adjusted OBS estimates during the May-August time period, based on the higher sampling level, hence greater precision, of that survey. During the other periods of the year, we recommend the use of geographically stratified MRFSS effort estimates. We also recommend the use of OBS estimates of catch per unit effort (CPUE) to calculate catch estimates for the May-August period because the OBS is more appropriately designed for accurate representation of the restricted fishing seasons for salmon and halibut that occur during that time period. For other time periods, we recommend the use of MRFSS CPUE estimates.

1. Introduction

Marine recreational fishing effort and catch by Oregon boats in ocean areas has been covered in recent years by two different surveys. The Oregon Department of Fish and Wildlife's Ocean Boat Survey (OBS) was originally developed to cover recreational ocean salmon fishing, but recently the survey has been modified to cover all ocean boat fishing from mid-May through the end of August. The National Marine Fisheries Service's Marine Recreational Fishery Statistics Survey (MRFSS), which also covers shore fishing and boat fishing in marine inland waters, has been conducted year-round in most years from 1979 through 1989 and from 1993 through the present.

1.1 Background on Pacific RecFIN surveys

Since 1993, the MRFSS and the OBS have been important components of a coast-wide strategy developed by the Pacific Recreational Fisheries Information Network (Pacific RecFIN) to monitor effort and catch for all marine recreational fisheries of the Pacific states. Pacific RecFIN is a NMFS-funded, state-federal cooperative program involving the NMFS, the Pacific States Marine Fisheries Commission (PSMFC) and the state marine fishery agencies of California, Oregon, and Washington. The state agencies contribute to RecFIN by continuing to conduct specialized sampling programs for salmon and/or ocean boat fishing. NMFS funds PSMFC's conduct of the intercept survey component of the MRFSS in all three states, conducts the telephone survey component through a contract, and estimates the MRFSS catch and effort statistics. The PSMFC maintains the RecFIN databases and reports combined Pacific marine recreational catch and effort statistics to federal and state fishery managers.

Starting in 1993, the Pacific RecFIN strategy was to report OBS estimates of ocean boat effort and catch for the July-August period and MRFSS estimates of ocean fishing effort on charter and private boats in all other time periods. This strategy was based on an understanding that ODFW's OBS would not be covering the entire May-June period. The intent was to avoid unnecessary overlap between the general (MRFSS) and specialized (OBS) RecFIN surveys while providing complete coverage of the ocean boat fishery throughout the year.

In 1997, the RecFIN Committee became aware that ODFW had extended the OBS to include coverage of most of the May-June period in 1993 through 1996 and that OBS May-June estimates of ocean boat fishing effort and catches of lingcod and rockfishes were considerably lower than MRFSS estimates in those years. This overlap between surveys provided RecFIN with an opportunity to study potential biases in its component surveys which could be corrected to improve their compatibility and integration into one coast-wide survey program. Additional overlap resulted when July-August MRFSS sampling of ocean boats was begun in 1998 for the purpose of collecting correlated angler economic variables. The RecFIN committee decided to continue MRFSS coverage of the July-August period in 1999 and 2000 to allow further side-by-side comparisons of the OBS and the MRFSS.

1.2 Goals of this report

In 1999, the RecFIN Committee formed a Statistics Subcommittee consisting of statisticians from NMFS, PSMFC, and each of the three state agencies to investigate possible causes for the differences between OBS and MRFSS estimates, and to recommend changes to both surveys which would improve the accuracy and comparability of their estimates. The Committee also charged the subcommittee with providing advice to the Pacific Fishery Management Council on how OBS and MRFSS 1993-1999 Oregon recreational ocean boat effort and catch statistics should be used for management.

This report summarizes the findings to date on the differences between OBS and MRFSS estimates of fishing effort and catch. The report describes factors contributing to the differences between the estimates and recommends adjustments which would correct for known biases in both surveys.

In addition, the report provides advice on the most appropriate use of adjusted OBS and MRFSS estimates by fishery managers, and recommends possible methodological improvements to both surveys. It is the understanding of the subcommittee that the Council's Groundfish Management Team (GMT) recently chose to use unadjusted Oregon estimates for the periods of overlap and to scale MRFSS estimates downward for other time periods. This report argues that the use of adjusted estimates from both surveys would be more appropriate.

The first section of the report briefly reviews how the two surveys operate and how they estimate fishing effort and catch on party/charter and private/rental boats fishing in ocean areas. The next section describes the observed differences between OBS and MRFSS estimates during the time periods when they have overlapped. The third section of the report describes the factors which we have identified that explain most of the observed differences. The fourth section presents estimated adjustments which would correct for most of the known biases. Finally, we present alternative strategies for combining estimators, our recommendations for appropriate uses of OBS and MRFSS estimates, and our recommendations for improvements to both surveys.

2. Brief overviews of the two surveys

2.1 The Oregon Ocean Boat Survey

The OBS samples ocean recreational fisheries to determine the amount of effort and catch of marine fish species. The objectives of the program are: 1) collect information on ocean recreational fishing effort, 2) estimate ocean recreational catch by species, 3) recover coded-wire tagged (CWT) fish, and 4) collect biological data from landed fish. Coho and chinook salmon were the primary recreational target species until the recent (1993) moratorium on coho fishing south of Cape Falcon. Marine species other than salmon are now the dominant species in the recreational fishery, including a short halibut quota season.

The original intent of the OBS was to estimate the catch of Pacific salmon and also estimate the percent of CWT present in the harvest. To be most efficient, both financially and logistically, the OBS intent was to cover 95 percent of all salmon landings. Sampling targeted the major coastal ports during the part of the year (mid-May – September) when most salmon were harvested. However, with the curtailed salmon fishery over the last decade, the non-salmonid marine fisheries have become more important both recreationally and economically for Oregon. The OBS has adjusted to the fishery change and by the early 1990's the main objectives of the program were adjusted to estimate the harvest of all fish species. Accordingly, ODFW has been continually expanding the OBS to cover more ports and harvest periods to account for the marine catch of non-salmonid fisheries since the mid-1990's.

The OBS collects data which is used to estimate total effort and catches by species, or species group, for charter boats (including partyboats) and private boats (including rental boats) fishing in ocean waters. The details of the OBS design can be found in the *Oregon Sampling Project 2000 Procedures Manual*. It uses different sampling methods to estimate numbers of boat trips and the catches per boat trip. Fishing effort estimates for private boats are based primarily on counts of the number of boats exiting inlets or on counts of boat trailers at ports with less restricted access to the ocean. To estimate charter boat effort, ODFW staff calls the offices of all registered charter boats to get daily accounts of all trips completed. All charter offices or companies are assumed to be known and the number of trips tallied is considered a census of charter boat effort. Estimates of mean catch per boat trip for both private and charter boats are based on dockside sampling of boats that have just completed a fishing trip. Catches are estimated by expanding the mean catch per boat trip by the estimated effort.

The effort estimation method used for private boats attempts to account for trips missed by boat counts through the application of an adjustment factor. Prior to 1999, boat counts conducted from dawn to mid-morning were expanded by a fixed, historical adjustment factor specific to each port. ODFW conducted a small study that estimated the adjustment factors for different ports by counting the boats that had left by 1:00 P.M. and then calculating the adjustment factor needed to expand the count at every ½ hour from 9:00 A.M. until noon. The least variable adjustment value at each port was then used to determine the appropriate stop time for boat counts and the necessary expansion factor to account for later trips. Only high use days when more than 50 boats left the port were used to calculate the adjustment factor. Counts have been conducted up to10:00 A.M. at all major ports, except at Garibaldi, where counts have been conducted until11:00 A.M.. The expansion factors are not used to expand counts on low effort or bad weather days. Typically, most recreational fishing boats have left a port by 1:00 pm.

In recent years, historical adjustment factors have been replaced by adjustments estimated from sampled data. Depending on the day type, the project leader will use the intercept data to determine the number of boats that left after 10:00 A.M. and use this value to expand the effort data. However, for the 1993-1996 sampling period, most effort was calculated using the fixed expansion factors. Effort estimates for bad weather days are calculated differently. If bad weather (high winds, large swell, or fog) does not allow boats to leave a port, the expansion

factor will not be used and either a zero is used or data from the intercept sampling will be used.

One or two samplers in each port attempt to intercept a random sample of boats that have completed fishing to collect the catch data which is used to calculate the mean catch per boat trip. Data collected include the number of anglers fishing, total number of fish caught on the boat by species, the target species of the trip (or trip-type), the number of hours that the anglers fished, and the time the boat left the port. Most samplers are scheduled to work eight-hour days. A day begins at dawn counting all boats leaving the port until the scheduled end time (10:00 or 11:00 am). At that time the interviewers switch to dockside sampling where they intercept all returning boats to gather catch data until their shifts has been completed. The number of samplers conducting interviews depends on the size of the port and the amount of effort.

Effort and catch estimates for charter and private boats are each stratified by port area. However, the directed fisheries that occur during the halibut season in May and the July ocean coho season are surveyed independently as separate seasonal strata (halibut season, salmon season) in each port. Outside of the restricted seasons, effort and catch per unit effort are estimated on a weekly basis in each port. In addition, dockside intercept data is used to partition weekly boat trip estimates for each port between fishing and non-fishing trip types, as well as among different fishing trip types defined by the target species. Trips that targeted salmon trips are separated from other fishing trips, and trips that targeted other species but caught salmon are considered to be "combination trips". Trips that did not catch salmon are classified by the types of species targeted (bottomfish, halibut, or tuna). Sampling for the seasonal halibut and salmon fisheries always covers every day of the season. For weekly estimates at other times, the larger ports are sampled seven days per week and the smaller ports are sampled five days per week (both weekend days and three week days). If a day is missed or is not scheduled to be sampled, the effort is imputed by taking an average of the two surrounding days, as long as they are similar day types. For example, a halibut day will not be used to estimate effort for a non-halibut day. Accordingly, effort for a normal weather day will not be estimated from a bad weather day.

2.2 The Marine Recreational Fishery Statistics Survey

The Marine Recreational Fishery Statistics Survey (MRFSS) was established by the National Marine Fisheries Service (NMFS) in 1979 to provide a reliable database for estimating the impact of recreational fishing on marine resources. Standardized and comparable estimates of catch, effort, and participation of recreational anglers in the marine waters of the United States are produced. The MRFSS is designed to produce precise estimates of catch and effort for common target species on a relatively large temporal (annual or seasonal) and geographic (regional) scale - for example, black rockfish landings for the Oregon and Washington region for 1996. The survey is not designed to produce precise estimates on a small temporal and geographic scale - for example, charter boat landings of lingcod for Oregon for the May-June time period. A strength of the MRFSS is the development of a consistent time series that allows fisheries managers to monitor and evaluate trends over time in the recreational fishery. There is a gap in the time series from 1990 to 1992 when the MRFSS was not conducted on the Pacific

coast due to budgetary constraints.

The MRFSS is designed as two independent and complementary surveys. A telephone survey of coastal resident households is conducted to estimate effort, measured as angler trips. An access-point intercept survey of anglers is conducted to estimate catch per unit of effort (angler trip). These estimates are combined to produce catch estimates. MRFSS sampling and estimates are stratified by state, wave (2-month sampling period, e.g., January-February), mode of fishing (e.g., charter boat, private boat, shore), and area of fishing (inland waters, state territorial seas, U.S. exclusive economic zone).

2.2.1 MRFSS telephone survey

The MRFSS telephone survey uses random-digit dialing to randomly select households in counties designated as coastal. The initial respondent in the household is asked whether or not anyone in the household participates in saltwater fishing. If not, the household is recorded as a non-fishing household and the call is terminated. If there are marine anglers, they are interviewed and asked to provide details on their trips in the last two months. For each trip, the angler provides the mode of fishing for the trip and the county where the trip was taken. From these data, the mean number of trips per household is calculated and an estimate of trips by county residents is made by expanding by the number of households in the county. These county trip estimates are summed across the coastal counties to produce a statewide estimate of effort by mode for residents of the coastal counties. A procedure called "hot deck imputation" is used to adjust the data to account for non-respondent anglers and households before effort estimates are calculated. Additionally, some outlier reduction is applied to households reporting more trips than the 95^{th} percentile of trips by households in the state.

To calculate an estimate of total effort, the effort from coastal residents must be expanded to account for out-of-frame anglers. This includes expansions for non-coastal residents of coastal states, residents of non-coastal states, and anglers who do not live in households with telephones. These expansion factors are determined based on the observed proportions of out-of-frame anglers encountered during the access-point intercept survey.

2.2.2 MRFSS intercept survey

Catch per trip, or CPUE, information is calculated from data collected in the access-point intercept survey. Access-point locations are randomly selected for interviewing from a list of all access sites for marine recreational angling. The probability of selection of a site is proportional to the expected effort at the site. At a site, anglers are interviewed at the conclusion of their fishing trip and asked about the trip and if their catch may be examined, enumerated, and measured. Also, information is collected from anglers on released fish. All catch information from intercept interviews is combined to produce estimates of catch per trip for a given mode and area of fishing for a state.

The proportions of fishing trips occurring in the different areas (i.e., inland or ocean) is determined by the responses of the anglers in the intercept survey, and these proportions are applied to the effort estimate calculated as described above. Note that this assumes that the distribution of trips by area in the intercept sample matches the area distribution of all trips taken by anglers. Equivalently, it requires that the trips sampled in the intercept survey are a representative sample of all trips by anglers.

3. Differences between OBS and MRFSS estimates

Estimates for ocean boat catch and effort in Oregon for the wave 3 period (May-June) were produced by both the MRFSS and the OBS programs for 1993 through 1999. Additionally, both programs produced estimates for the wave 4 period (July-August) in both 1998 and 1999.

3.1 Differences in effort estimates

A comparison of estimates produced by the two surveys shows the MRFSS ocean boat trip estimates are consistently higher than the Oregon OBS ocean boat trip estimates (Table 3.1). When the trip estimates are broken down by the mode of the trip, it is apparent the differences are most pronounced for the private/rental boat mode, but that substantial differences also exist in the party/charter boat effort estimates, with MRFSS estimating more trips in both modes for all years in wave 3 (May/June). In wave 4 (July/August), MRFSS estimates for charter boat trips are lower than OBS in 1998 and the same as OBS in 1999. MRFSS private boat trips were much higher than OBS trip estimates for the wave 4 period of both 1998 and 1999.

3.2 Differences in catch estimates

Large differences in the catch estimates for lingcod (Table 3.2) and the rockfish species group (Table 3.3) were also observed between the two studies for the wave 3 period, 1993-1999. For these species, catch estimates from the MRFSS are consistently higher than the estimates from the OBS. Much of this difference appears to be driven by the large differences in the effort estimates.

The CPUE estimates for lingcod (Table 3.4) and for rockfish (Table 3.5) have often differed between the two surveys. There appears to a trend for MRFSS to have larger CPUE estimates but the differences are not large and there are exceptions. Because of the dramatic differences in the effort estimates between the two surveys, especially in the private/rental mode, most of the analysis of the statistics subcommittee focused on the differences in effort estimates between the two surveys. The subcommittee found no strong evidence of a bias in the sampling for CPUE in either survey, although some of the problems in the estimation of effort to be discussed subsequently will also impact catch per trip estimation.

Table 3.1: Comparison of Oregon Ocean Sampling (OBS) and Marine Recreational Fishery Statistics Survey (MRFSS) estimates of angler trips during periods of overlap between the two surveys. All units are thousands of trips. PSE represents the proportional standard error (i.e. the estimated standard error divided by the trip estimate, expressed as a percentage).

WAVE 3: MAY-JUNE											
	Party / Charter mode				**Private / Rental boat mode**				**Combined ocean boats mode**		
			MRFSS				MRFSS				MRFSS
	OBS	MRFSS	PSE		OBS	MRFSS	PSE		OBS	MRFSS	PSE
	Angler Trips										
1993	13.9	22.7	15		17.6	52.0	15		31.5	74.7	12
1994	15.5	24.0	12		21.5	37.4	16		37.0	61.4	11
1995	15.1	23.6	10		19.4	32.9	14		34.5	56.5	9
1996	17.1	25.4	12		17.2	22.1	29		34.3	47.5	15
1997	17.7	32.2	12		16.7	46.0	18		34.4	78.2	12
1998	16.5	25.4	16		12.5	39.9	22		29.0	65.3	15
1999	15.8	17.1	16		13.9	39.5	21		29.7	56.6	15
WAVE 4: JULY-AUGUST											
	Party / Charter mode				**Private / Rental boat mode**				**Combined ocean boats mode**		
			MRFSS				MRFSS				MRFSS
	OBS	MRFSS	PSE		OBS	MRFSS	PSE		OBS	MRFSS	PSE
1998	27.5	11.5	17		28.9	105.9	18		56.4	117.4	16
1999	28.2	28.2	17		43.5	90.3	15		71.7	118.5	12

Table 3.2: Comparison of Oregon Ocean Sampling and Marine Recreational Fishery Statistical Sampling (MRFSS) estimates of lingcod catch during periods of overlap between the two surveys. All units are thousands of fish. PSE represents the proportional standard error (i.e. the estimated standard error divided by the catch estimate, expressed as a percentage).

WAVE 3: MAY-JUNE

	Party / Charter mode			Private / Rental boat mode			Combined ocean boats mode		
	OBS	MRFSS	MRFSS PSE	OBS	MRFSS	MRFSS PSE	OBS	MRFSS	MRFSS PSE
1993	7.3	11.1	19	5.5	19.9	19	12.8	31.0	14
1994	9.4	19.5	14	7.8	17.6	20	17.2	37.1	12
1995	3.9	8.2	14	3.3	6.5	19	7.2	14.7	11
1996	5.6	12.0	14	2.6	12.5	32	8.2	24.5	17
1997	4.5	9.9	15	3.2	16.1	24	7.7	26	16
1998	2.8	2.9	20	1.8	7.6	24	4.6	10.5	19
1999	3.8	4.2	17	2.5	3.6	24	6.3	7.8	14

Table 3.3: Comparison of Oregon Ocean Sampling and Marine Recreational Fishery Statistical Sampling (MRFSS) estimates of rockfish catch during periods of overlap between the two surveys. All units are thousands of fish. PSE represents the proportional standard error (i.e. the estimated standard error divided by the catch estimate, expressed as a percentage).

WAVE 3: MAY-JUNE

	Party / Charter mode			Private / Rental boat mode			Combined ocean boats mode		
	OBS	MRFSS	MRFSS PSE	OBS	MRFSS	MRFSS PSE	OBS	MRFSS	MRFSS PSE
1993	118.7	151.2	9	41.1	123.3	12	159.8	274.5	7
1994	60.6	138.7	10	38.2	81.3	15	98.8	220.0	8
1995	83.0	176.3	9	43.1	58.9	14	126.1	235.2	7
1996	121.9	238.0	9	30.7	85.0	27	152.6	323.0	10
1997	107.8	215.8	9	30.3	159.6	19	138.1	375.4	10
1998	133.7	215.5	13	25.8	147.4	18	159.5	362.9	11
1999	86.0	113.0	13	29.5	116.7	21	115.5	229.7	13

Table 3.4: Comparison of Oregon Ocean Sampling (OBS) and Marine Recreational Fishery Statistical Sampling (MRFSS) estimates of lingcod CPUE during periods of overlap between the two surveys. Units are catch per angler trip.

WAVE 3: MAY-JUNE

	Party / Charter mode			Private / Rental boat mode			Combined ocean boats mode		
	OBS	MRFSS	ratio	OBS	MRFSS	ratio	OBS	MRFSS	ratio
1993	0.53	0.49	0.93	0.31	0.38	1.22	0.41	0.41	1.02
1994	0.61	0.81	1.34	0.36	0.47	1.30	0.46	0.60	1.30
1995	0.26	0.35	1.35	0.17	0.20	1.16	0.21	0.26	1.25
1996	0.33	0.47	1.44	0.15	0.57	3.74	0.24	0.52	2.16
1997	0.25	0.31	1.21	0.19	0.35	1.83	0.22	0.33	1.49
1998	0.17	0.11	0.67	0.14	0.19	1.32	0.16	0.16	1.01
1999	0.24	0.25	1.02	0.18	0.09	0.51	0.21	0.14	0.65

Table 3.5: Comparison of Oregon Ocean Sampling (OBS) and Marine Recreational Fishery Statistical Sampling (MRFSS) estimates of rockfish CPUE during periods of overlap between the two surveys. Units are catch per angler trip.

WAVE 3: MAY-JUNE

	Party / Charter mode			Private / Rental boat mode			Combined ocean boats mode		
	OBS	MRFSS	ratio	OBS	MRFSS	ratio	OBS	MRFSS	ratio
1993	8.54	6.66	0.78	2.34	2.37	1.02	5.07	3.67	0.72
1994	3.91	5.78	1.48	1.78	2.17	1.22	2.67	3.58	1.34
1995	5.50	7.47	1.36	2.22	1.79	0.81	3.66	4.16	1.14
1996	7.13	9.37	1.31	1.78	3.85	2.15	4.45	6.80	1.53
1997	6.09	6.70	1.10	1.81	3.47	1.91	4.01	4.80	1.20
1998	8.10	8.48	1.05	2.06	3.69	1.79	5.50	5.56	1.01
1999	5.44	6.61	1.21	2.12	2.95	1.39	3.89	4.06	1.04

4. Factors causing the differences between estimates

For both surveys, OBS and MRFSS, the subcommittee inquired both into possible biases in the given estimates, and into potential underlying causes of such biases. This section reports on the major concerns and findings. The subcommittee was able to make adjustments (section 5) to the estimates of each survey to account for this set of concerns. Additional issues, either thought to be less important or not able to be quantified due to a lack of available data, are discussed in the later section (6), "Unexplained differences."

4.1 OBS issues

The OBS estimates of ocean boat fishing effort have been biased due to undercoverage. We identified a number of reasons why the OBS boat counts and associated adjustments do not include all of the ocean boat trips which occurred during the May-June and July-August periods of 1993-1999. Because of recent changes that ODFW has made to expand coverage of the OBS, we were able to evaluate the potential effects of not covering trips out of minor port areas, early May trips out of major port areas, and trips which departed later than 1:00 PM. It is important to note that an attempt at a census will generally undercount what it is trying to estimate. There may be other undercoverage factors that are not considered here.

4.1.1 Minor and minuscule ports

Since 1993, the OBS has sampled ocean boat fishing effort out of major port areas along the Oregon coast. The nine ports traditionally covered by the OBS are Astoria, Garibaldi, Pacific City, Depoe Bay, Newport, Florence, Winchester Bay, Coos Bay, and Brookings. Due to logistical and financial constraints, ODFW chose not to try to cover effort out of relatively minor port areas such as Bandon, Port Orford, and Gold Beach. In addition, there was no attempt made to cover the relatively small amount of ocean boat fishing effort leaving from small ocean beaches such as Cape Ocean Beach or from 10-15 smaller ports including Manzanita, Nehalem Bay, Nestucca Bay, Salmon Bay, Siletz Bay, Beaver Creek, and Sunset Bay.

Because the OBS has not attempted to cover all trips, ODFW has always considered OBS estimates of charter and private boat ocean fishing trips to be slightly lower than the true numbers. However, without expansion of survey coverage there had been no way to evaluate the proportions of charter and private boat trips missed. In 1999, ODFW started conducting boat counts for the so-called "minor" port areas of Bandon, Port Orford and Gold Beach (some sampling was done in Gold Beach in 1998).

The subcommittee used 1999 OBS private boat count data to estimate the amount of effort that would have been missed at the three minor ports. We assumed that the 1999 data would be representative of the missed effort during the 1993-1998 May/June and 1998 July-August sampling periods. In 1999, about 4.5% of the total private boat effort came from the three minor ports. Since 1999 census data on charter boats was not available at the time, we

assumed a similar proportion of effort would be missed by excluding the charter boats known to operate out of the minor ports.

To estimate the correction needed to account for boat trips missed by exclusion of the relatively "minuscule" ports and beaches, we relied on anecdotal information supplied by ODFW staff on the relative activity at such sites. We assumed that 15 such sites were missed. We assumed that one port, Nehalem Bay, would have as many as eight private boats departing on a given day and that the other 14 sites would each have as many as three private boats departing. Based on these assumptions, we estimated that as much as 3% of the total ocean private boat effort could have come from the uncovered minuscule sites. For charter boats we estimated about a 1 % adjustment to account for the effort of one uncensused charter boat known to operate out of Nehalem Bay.

Without accounting for the trips missed in minor and minuscule ports, OBS estimates will always be biased. Therefore, we recommend adjusting the 1993-1998 OBS estimates of private boat effort in the May-June and July-August periods upward by about 7.5% to correct for these known undercoverage biases. We also recommend adjusting charter boat estimates for the same time period upward by about 5.5%.

4.1.2 Early May trips

Although the OBS has attempted to count all charter and private boat fishing trips out of nine major port areas in the May-August periods of 1993-1999, sampling in each port area has not always covered all of May. For various reasons sampling of each port area started at different times in each year. Table 4.1 shows the week during which OBS sampling started in each port area in each year. One major port area, Astoria, has almost no ocean boat fishing activity in the months of May and June, hence sampling has never been conducted there earlier than July. Astoria was not covered at all in 1994, and Winchester Bay was not covered in 1995. Although some coverage of Gold Beach occurred in 1998, coverage of all three of the minor port areas did not begin until 1999.

Table 4.1: Dates on which OBS sampling started for each port area in 1993-1999 (data provided by ODFW staff).

	1993	1994	1995	1996	1997	1998	1999
Major Ports:							
Astoria	7/5		7/16	7/23	7/15	8/3	7/19
Garibaldi	5/10	5/2	5/1	5/1	4/30	5/4	4/5
Pacific City	5/4	5/2	5/1	5/13	5/7	5/11	5/31
Depoe Bay	5/4	5/2	5/1	5/1	4/29	5/4	1/1
Newport	5/4	5/7	5/1	5/1	4/18	5/4	1/1
Florence	5/10	5/2	5/1	5/1	4/28	6/15	5/17
Winchester Bay	5/10	5/2		5/1	4/26	5/25	5/3
Coos Bay	5/5	5/2	5/1	5/1	4/15	5/4	5/3
Brookings	5/5	5/2	5/1	5/1	4/15	5/18	1/1
Minor Ports:							
Bandon							5/10
Port Orford							5/10
Gold Beach						6/22	5/10

Although fishing activity is usually relatively low in early May, the late starts of OBS sampling should have caused some underestimation of May-June charter and private boat trips. In 2000, ODFW started sampling by the beginning of May in all major port areas except Astoria. We used private boat count data collected by OBS in 2000 to estimate the relative amounts of charter and private boat trips missed by the late starts for each port area in prior years. Since charter boat census data was not available at the time, we assumed that the relative amounts of charter boat and private boat trips missed would be similar. This was supported by the knowledge that charter boats operated out of all of the major ports at which early May trips were missed. This approach provided us with maximum estimates of the percent of total May-June trips missed in each port area in each year which we show in Table 4.2.

Table 4.2: Estimated percentages of trips missed by late starts of OBS effort sampling in major port areas during the May/June period.

1993	1994	1995	1996	1997	1998	1999
4.0 %	2.5 %	2.5 %	3.0 %	1.0 %	6.0 %	4.0 %

Unless some adjustment is made to account for the early May trips missed in 1993-1999, the OBS estimates of charter and private boat trips will be lower than the true value. We recommend using the estimated percentages in Table 4.2 to help correct for known undercoverage biases in May-June OBS estimates for 1993-1999.

4.1.3 OBS boat count expansion factor

For the 1993-1996 effort estimates, OBS made exit counts of ocean boats until 10AM (11AM at Garibaldi) and then used a fixed expansion factor by port to account for boats that might have exited between 10AM and 1PM at that port. The expansion factor was applied by port on good weather days where there was fairly heavy traffic (> 50 boats exiting). If the expansion factor were biased, then the OBS effort counts would also be biased accordingly.

We examined this potential bias by comparing monthly estimated expansion values in 1999 to the fixed values used in 1999 and assumed that results from 1999 would be applicable in 1993-1996. In 1999, information on exit timing was collected during intercept sampling, allowing for this comparison. That information was used to estimate actual applicable expansion factors as follows:

Let D = # boats sampled that exited after the cut-off time in a port-month,
C = # boats sampled during intercept interviewing in a port-month, and
E = # exit counts before the cut-off time,

then (C-D)/C = proportion of boats that exited before the cut-off time and

E*C/(C-D) = estimated number of total exit counts to 1PM.

The expansion factors (C/(C-D)) were calculated by month for all major ports using intercept and exit count data collected in various months during 1999 and 2000. The total effort estimate was reduced by 0.4% when monthly port expansion factors were calculated instead of the accepted "used" value (shown in parentheses) in 1999. The 0.4% was calculated as the difference in total effort estimated using both methods relative to the accepted "used" method:

$$\frac{\text{(Old trip est. - new trip est.)}}{\text{new trip estimate}} = \frac{8866-8902}{8902} = -0.004$$

For OBS's effort estimators, the common fixed expansion value was used for all days, except on a few bad weather days when it was assumed that no effort went out after the cut-off time. Based on the analysis using 1999 data, application of the fixed expansion factor appeared to work well, and only a very slight adjustment was made to the OBS effort estimate. However, it is not clear if this comparison is valuable due to the different years of comparison, and the result here may not truly be applicable for 1993-1998.

4.1.4 Late day trips

Although we now feel comfortable with 1993-1999 OBS trip adjustments made to account for private boat trips departing after 10 AM and before 1 PM, we recognize that no adjustments have been made to account for trips which departed after 1 PM. In order to estimate the number of late day private boat fishing trips that have been missed by OBS trip adjustments, we used data collected by the 2000 MRFSS intercept survey on time of departure. One of the questions added to the MRFSS intercept survey interview for the 2000 add-on economic survey asks each intercepted angler for the time when his/her boat left the dock. We assumed that the time of dock departure would be a good approximation of the time when the angler's boat crossed the bar. In the data collected for May/June, about 4 % of sampled private boat angler trips to ocean areas had trip departure times of 1 PM or later. We recommend using this percentage to adjust the OBS May-June and July-August ocean boat effort estimates and account for the missed late day fishing trips.

4.2 MRFSS issues

There were two major sources of bias in the MRFSS that the subcommittee was able to quantify and account for in adjusted estimates. Discussion of these follows.

4.2.1 MRFSS telephone survey: possible freshwater trips

From the data obtained from the MRFSS telephone survey, there were trips that were

reported as having been to counties with no saltwater coastline. We speculate that anglers report this for two primary reasons:

(1) The angler may confuse a freshwater trip with a saltwater trip.
(2) It may be a valid trip, but the angler may report his residence county instead of the fishing county (some counties that are close to the coast, e.g. Multnomah, are in the coastal dialing zone even though they do not have saltwater coastline).

In recent years, the telephone contractor has added error checks to the data collection system to greatly reduce this problem. In addition, there were trips where no county of trip was identified. In section 6 of this report, we report the effects of removing such trips on the MRFSS effort estimates. Removal of all questionable trips from the data resulted in a reduction of the effort estimate. This will give an upper bound for the effect of possible errors in the distinction between freshwater and saltwater trips, as some number of these trips were probably valid saltwater trips.

4.2.2 Intercept survey: estimation of area fished

The MRFSS trip estimate is partitioned to the different fishing areas (ocean and inland) based on the observed distribution in the intercept survey. This assumes that the sampling of trips in the intercept survey is representative of the distribution of trips for all of Oregon. As an example, suppose one geographic area of the state tends to be under-sampled relative to the true distribution of effort, and suppose that geographic area has a significantly higher proportion of inland trips than is observed in other parts of the state. This situation would cause overestimation of the statewide proportion of ocean fishing trips.

A detailed study of the data by NMFS revealed that, in fact, this overestimation was occurring. The study stratified the entire Oregon coast into four coastal strata defined by blocks of counties, namely: North (Clatsop and Tillamook), North Central (Lincoln), South Central (Lane, Douglas and Coos), and South (Curry). This revealed that the northern portion of Oregon had been under-sampled relative to the rest of Oregon, and the proportion of inland trips was higher here than for the rest of Oregon. Thus, the proportion and number of ocean fishing trips was overestimated, also causing an overestimation of catch for ocean species. Accordingly, an adjusted Oregon-wide estimate based on this stratification resulted in a notably lower and more credible proportion and number of ocean trips.

Several possible causes of this under-sampling of Northern Oregon trips were identified. Note that the geographic stratification would correct these problems as they occurred *across* strata. They could remain an issue *within* a geographic stratum.

Oversampling of high activity sites. The intent of the MRFSS sampling design is to use limited staff resources as effectively as possible, in terms of sampling costs and likely information payoffs. The sampling procedure uses a PPS (probability proportional to size) strategy relative to the expected activity at the site, as determined by the assigned site

pressure. This means that high-pressure sites will have a higher probability of selection, and thus, a large percentage of interviews may come from a few high-activity sites. This reliance on high-pressure sites is not accounted for in the MRFSS estimation routines.

Difficulty in correctly estimating fishing pressure at sites. Estimated fishing pressure at sites are assigned based on historical effort at the site as determined from previous visits to the site. In a rapidly changing fishery with seasonal closures, and volatile, unpredictable weather, assigning these pressures is a daunting task. It appears that MRFSS fishing pressures assigned to sites in northern Oregon tended to consistently underestimate the true fishing effort.

Sampling departing from design. The subcommittee also noted several likely obstacles to faithful implementation of the sampling design. Site-selection software may be in error or not reflect all intentions of the design, notably for representative geographic coverage of the Oregon coast over sufficiently short time periods. Some samplers may be better than others at carrying out their full assignments. Vagaries of staff readiness and availability may conspire to modify the intended assigned list of sampled sites/times. Often, staff were not available for assignments in northern Oregon.

5. Adjustments to OBS and MRFSS estimates

Correctable problems with the effort estimation for both surveys were identified. The statistics subcommittee attempted to quantify the effect of these problems and adjust the estimates accordingly. Corrections were applied to OBS data to account for issues of undercoverage. MRFSS estimates were adjusted by eliminating all trips to the suspicious counties from the telephone data and by implementing new estimation methods that allowed for any arbitrary geographic stratification of the Oregon coast for producing estimates. This means that it was not necessary for the intercept sample for the state to be representative of the geographic distribution of effort. For Oregon, for the time periods examined, this correction almost always led to a reduction in the ocean boat effort. It is important to note that this situation is specific to Oregon and that the same reduction in ocean effort estimates should not be expected to result from further geographic stratification in other areas.

5.1 Effects of adjustments - wave 3, 1993-1999 period

The effects of the adjustments on the estimated effort were more dramatic for the MRFSS. The average effect of the adjustments is shown for the wave 3 (May/June) period, 1993-1999 for party/charter boats (Figure 5.1), and for private/rental boats (Figure 5.2). In Figures 5.1-5.17, "Stratified MRFSS" indicates geographically stratified MRFSS estimates based on unadjusted telephone survey data, and "Stratified MRFSS w/o FW" indicates geographically stratified estimates based on telephone survey data from which possible freshwater trips were removed. Error bars representing an approximate 95% confidence interval are indicated on the fully adjusted MRFSS estimates. Variance estimates for the Oregon survey were not available but they

can safely be assumed to be smaller than MRFSS variance estimates due to the larger sample size of the Oregon survey.

For the private/rental boat mode, the geographic stratification had a very large effect in reducing the MRFSS effort estimate. After the other adjustments were made, the mean estimates were much closer together, but there still were unexplained differences (MRFSS - 24.9 thousand trips, Oregon - 19.3 thousand trips). An examination of the data by year (Figure 5.3) showed that this remaining difference mostly resulted from very large MRFSS estimates for private boat trips in 1998 and 1999. For the 1993-1997 period, the mean adjusted estimates for the surveys fell within the MRFSS 95% confidence interval. The statistics subcommittee does not have an explanation for why MRFSS 1998 and 1999 estimates for private/rental trips remain higher after adjustments.

The mean charter boat estimates from the two surveys were nearly identical after the adjustments were made. Geographic stratification did not have much effect on the MRFSS charter mode trip estimate, as there were very few sampled inland charter trips for the state. Thus the area of trips distribution was not skewed. Elimination of trips with suspicious or missing counties had the larger affect on the MRFSS estimates. The yearly affect of the adjustments is shown in Figure 5.4. Note that in each year, the Oregon charter mode trip estimate falls within the bounds of the MRFSS 95% confidence interval.

5.2 Effects of adjustments - wave 4, 1998-1999 period

For the Wave 4 (July/August) period, we only had data from two years, 1998-1999 to compare. The mean adjustments for charter mode (Figure 5.5) and private mode (Figure 5.6) are provided, as are the yearly breakdowns for charter mode (Figure 5.7) and private mode (Figure 5.8). Stratification actually increased the mean MRFSS charter mode trip estimate for this time period. Oregon charter effort estimates were just above the upper 95% confidence limit of the MRFSS charter effort estimate. For private rental trips, MRFSS estimates were higher than the OBS estimates, however there is not enough comparable wave 4 data to make any conclusions as to the cause of these differences.

5.3 Effects of adjustments - CPUE

Geographic stratification of MRFSS effort estimates resulted in small changes in angler CPUE estimates. On the average, state level MRFSS estimates of CPUE for lingcod and rockfishes increased slightly with stratification. For the May/June period, the 7-year (1993-1999) average of charter boat angler CPUE increased by about 10 % for lingcod and by about 15% for rockfishes. The two-year (1998-1999) average of charter boat CPUE increased by about 15% for lingcod and by about 5% for rockfishes for the July/August period. Mean private boat angler CPUE for lingcod and rockfishes increased by no more than 5% for the May/June period. For the July/August period, mean private boat CPUE increased by about 5% for lingcod and by about 10% for rockfishes. The CPUE increases occurred because undersampled geographic strata had

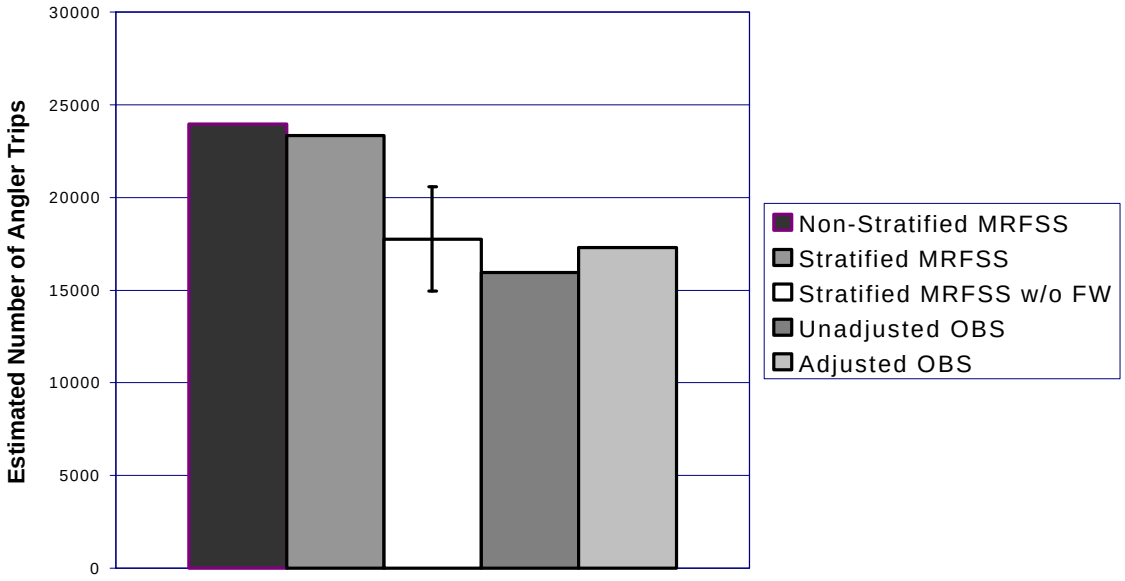
slightly higher sample CPUE and the stratification of effort estimates effectively gave more weight to CPUE data collected in those strata.

In general, OBS catch-per-trip (CPT) estimates for lingcod and the rockfish species group are lower than stratified MRFSS estimates. As shown in Figures 5.9 - 5.17, revised MRFSS estimates and OBS estimates of CPUE for the same time period are similar in some years yet noticeably different in other years. The OBS CPUE estimate falls within the 95% confidence region around the MRFSS estimate in most cases, even when the estimates appear to be quite different. Because confidence regions have not been calculated for OBS CPUE estimates, we do not know if the differences are statistically significant even in those cases where the OBS estimate is not within the MRFSS 95% confidence region. Nevertheless, average MRFSS CPUE for the May/June and July/August time periods studied are always higher than OBS CPUE estimates.

5.4 Summary of the effects of adjustments

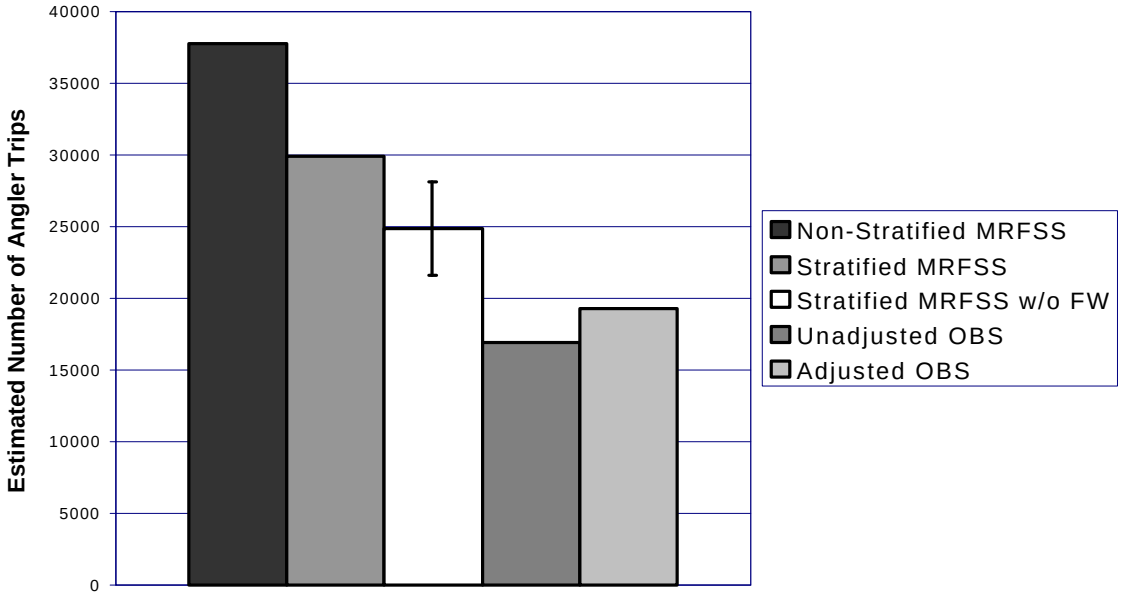
Adjustments were made to the OBS effort estimates to account for under-coverage issues identified and quantified by the subcommittee. These corrections resulted in increases to the OBS effort estimates. MRFSS estimates were adjusted to account for possible freshwater trips being included in the effort estimate and for a skewed distribution of trips by area of fishing. Both of these adjustments resulted in a reduction of the MRFSS effort estimates. After all of these adjustments, the charter method effort estimates were nearly identical, on average, for 1993-1999 May-June period. For the same time period in the private/rental boat mode, the adjustments resulted in trip estimates much closer together for the two surveys. However, differences still exist. Most of this difference appears to be caused by large remaining unexplained differences in the 1998 and 1999 numbers. Data for the May-June period for 2000 will be available for examination soon and we will investigate whether these large differences persist. Adjustments to MRFSS estimates made slight changes in CPUE estimates. No adjustments were made to OBS CPUE estimates. The next section discusses some of the other factors that may be contributing to the observed differences in the estimates.

Figure 5.1: Mean Oregon Charter Boat Ocean Fishing Effort in May/June (1993-1999)



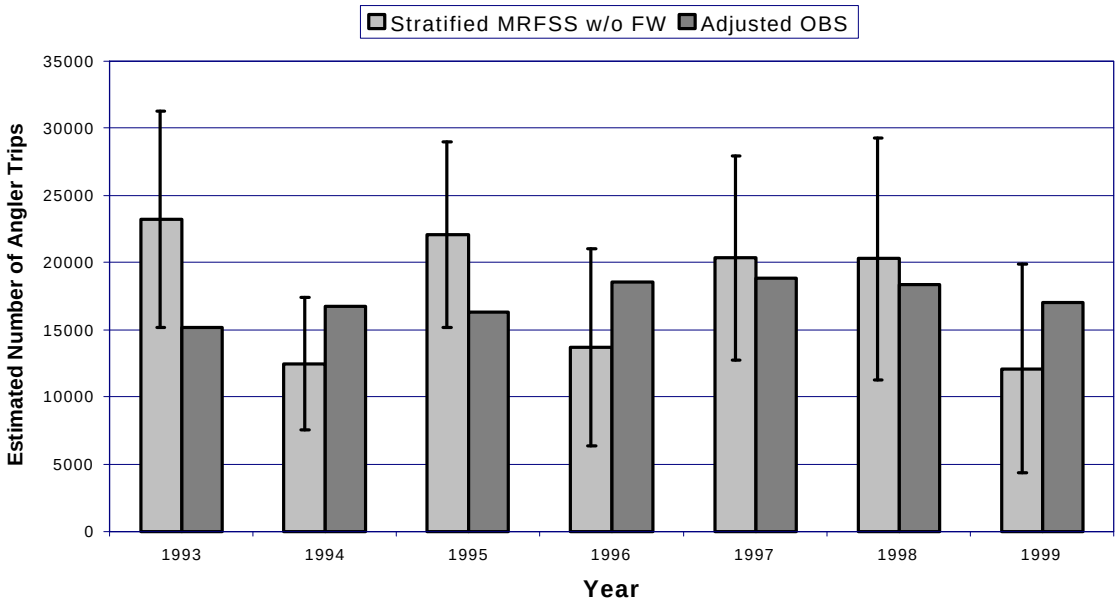
* Bars indicate 95% confidence region around MRFSS point estimate.

Figure 5.2: Mean Oregon Private Boat Ocean Fishing Effort in May/June (1993-1999)



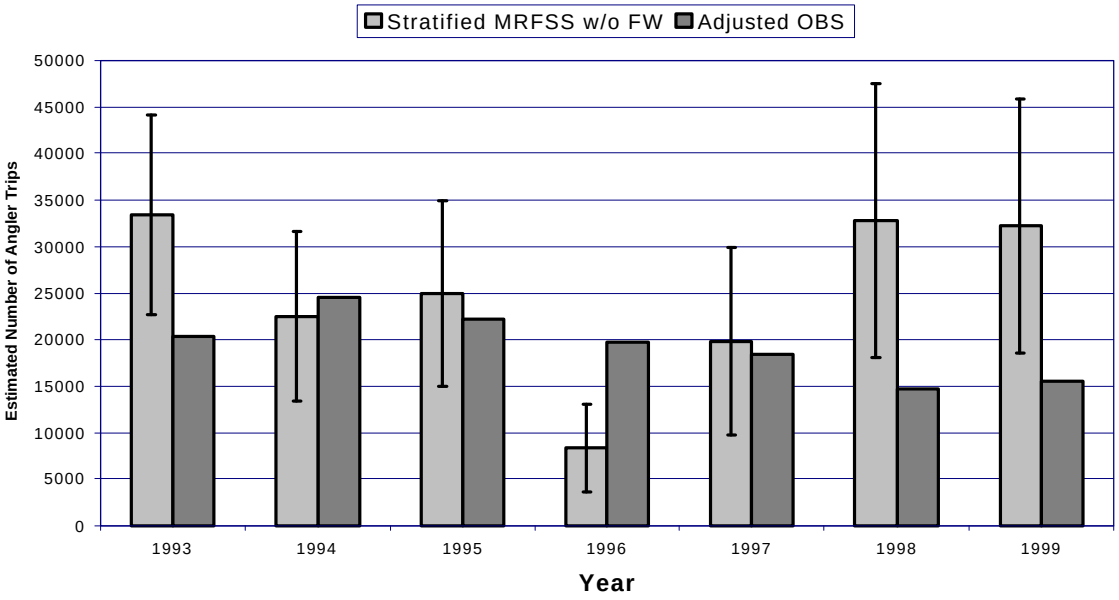
* Bars indicate 95% confidence region around MRFSS point estimate.

Figure 5.3: Oregon Charter Boat Ocean Fishing Effort May/June



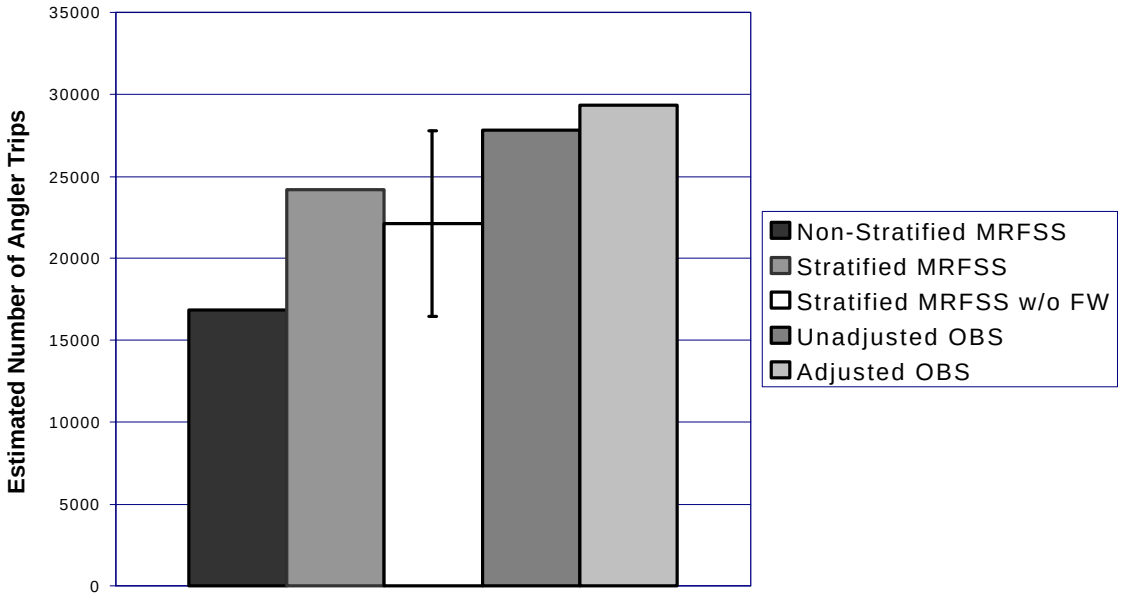
* Bars indicate 95% confidence regions around MRFSS point estimates.

Figure 5.4: Oregon Private Boat Ocean Fishing Effort in May/June



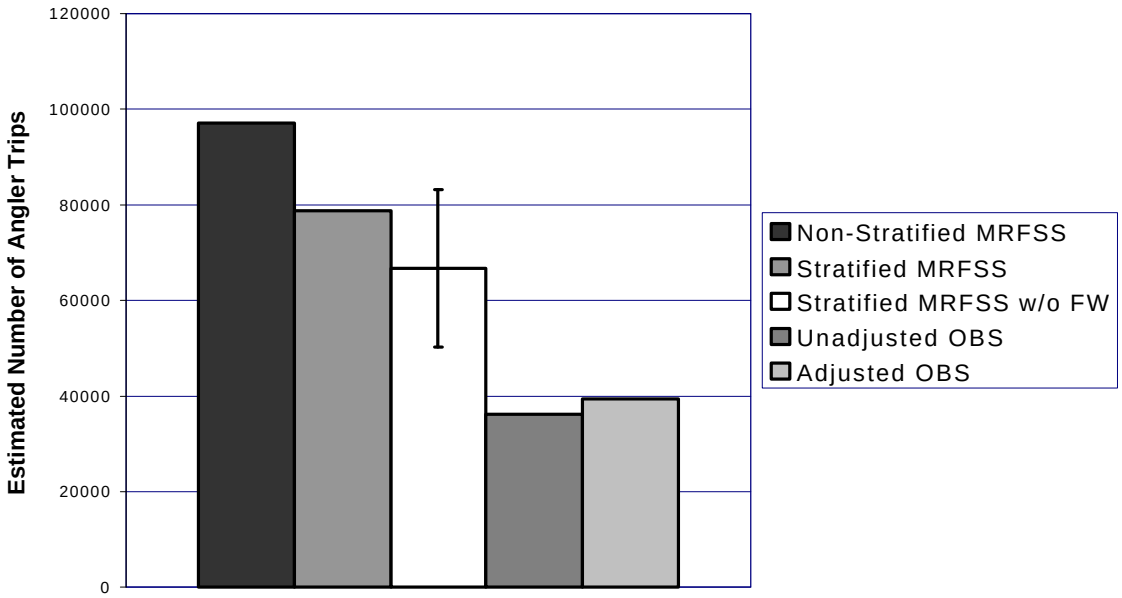
* Bars indicate 95% confidence regions around MRFSS point estimates.

Figure 5.5: Mean Oregon Charter Boat Ocean Fishing Effort in July/August (1993-1999)



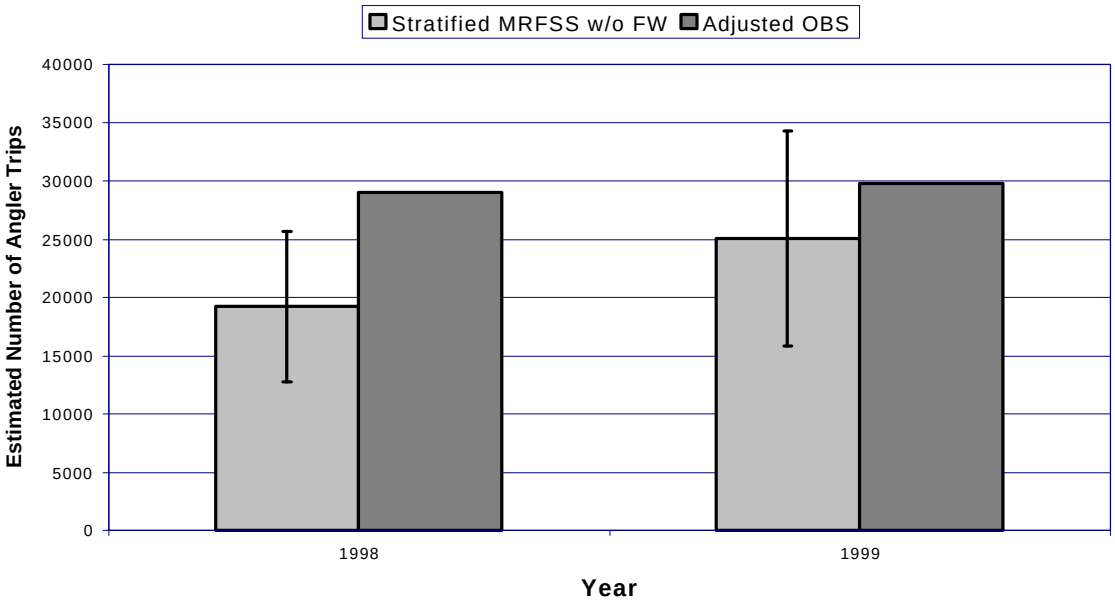
* Bars indicate 95% confidence region around MRFSS point estimate.

Figure 5.6: Mean Oregon Private Boat Ocean Fishing Effort in July-August (1998-1999)



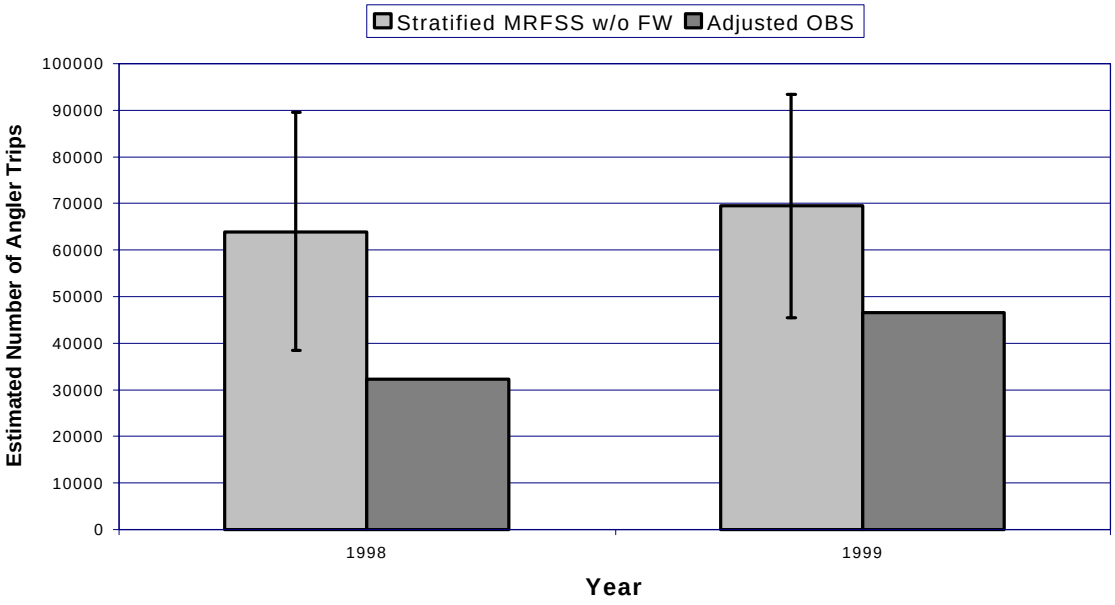
* Bars indicate 95% confidence region around MRFSS point estimate.

Figure 5.7: Oregon Charter Boat Ocean Fishing Effort in July/August



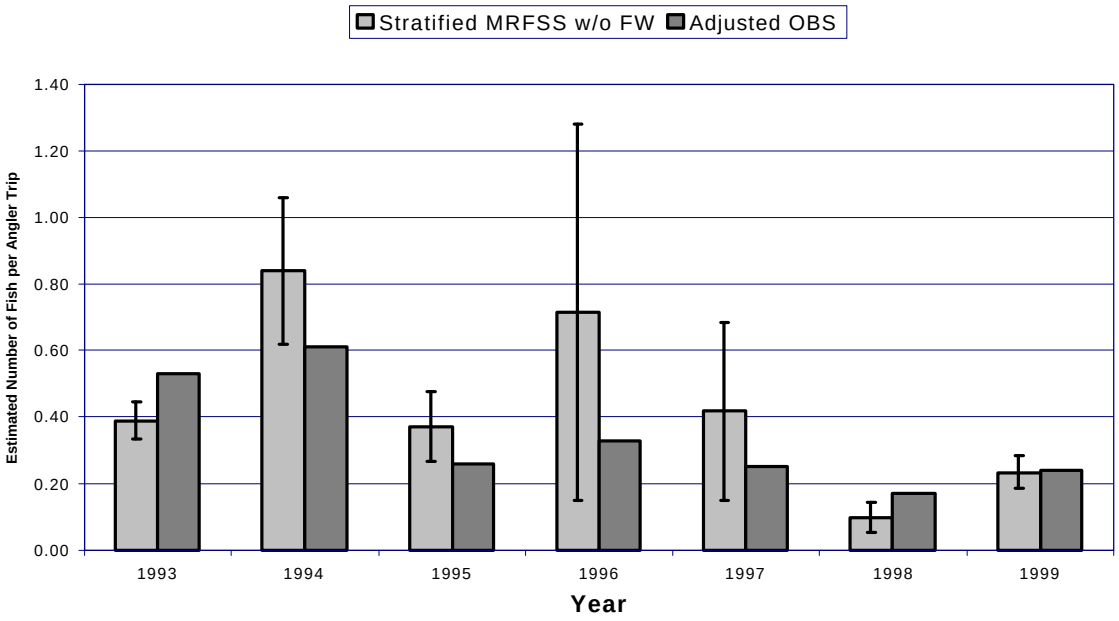
* Bars indicate 95% confidence regions around MRFSS point estimates.

Figure 5.8: Oregon Private Boat Ocean Fishing Effort in July/August



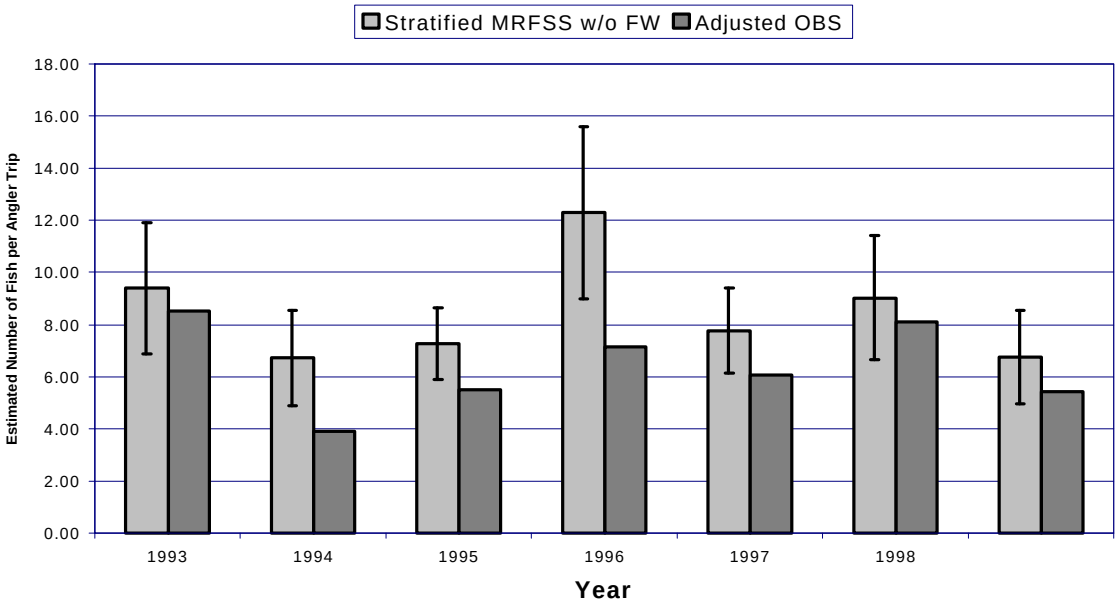
* Bars indicate 95% confidence regions around MRFSS point estimates.

Figure 5.9: Oregon Charter Boat Ocean CPUE for Lingcod in May/June



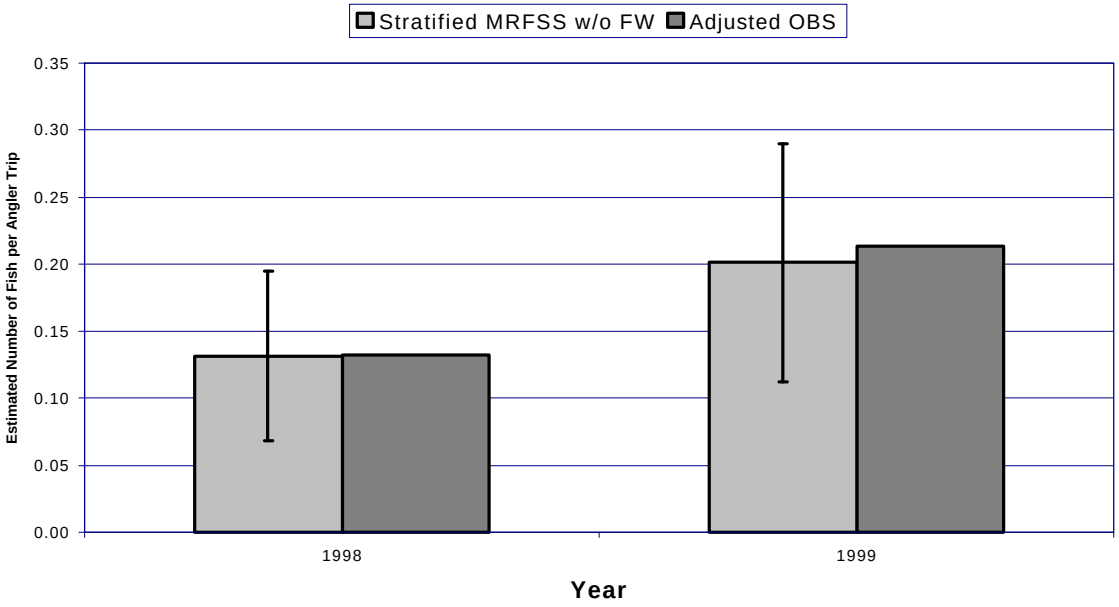
* Bars indicate 95% confidence regions around MRFSS point estimates.

Figure 5.10: Oregon Charter Boat Ocean CPUE for Rockfishes in May/June



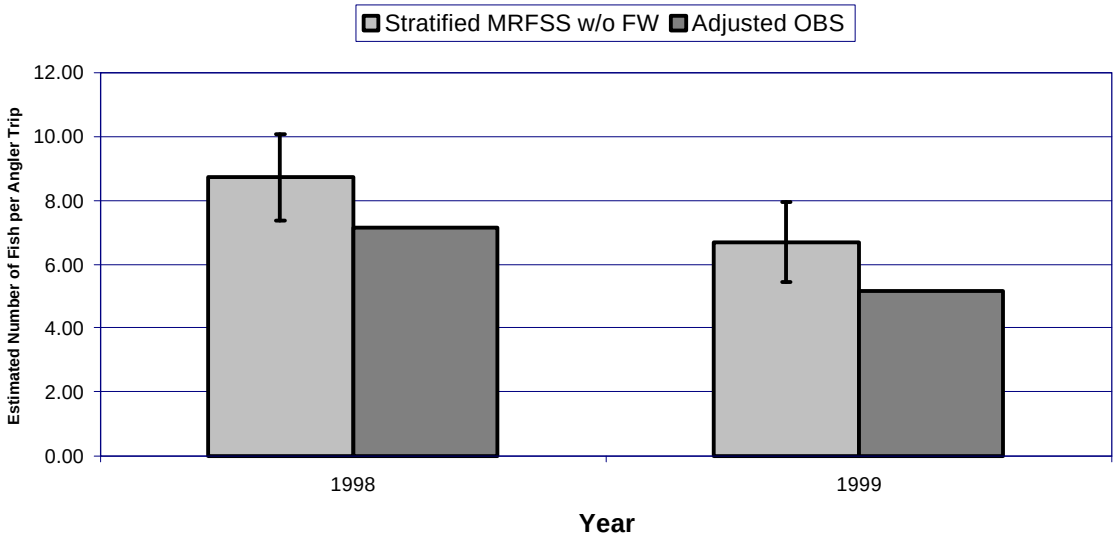
* Bars indicate 95% confidence regions around MRFSS point estimates.

Figure 5.11: Oregon Charter Boat Ocean CPUE for Lingcod in July/August



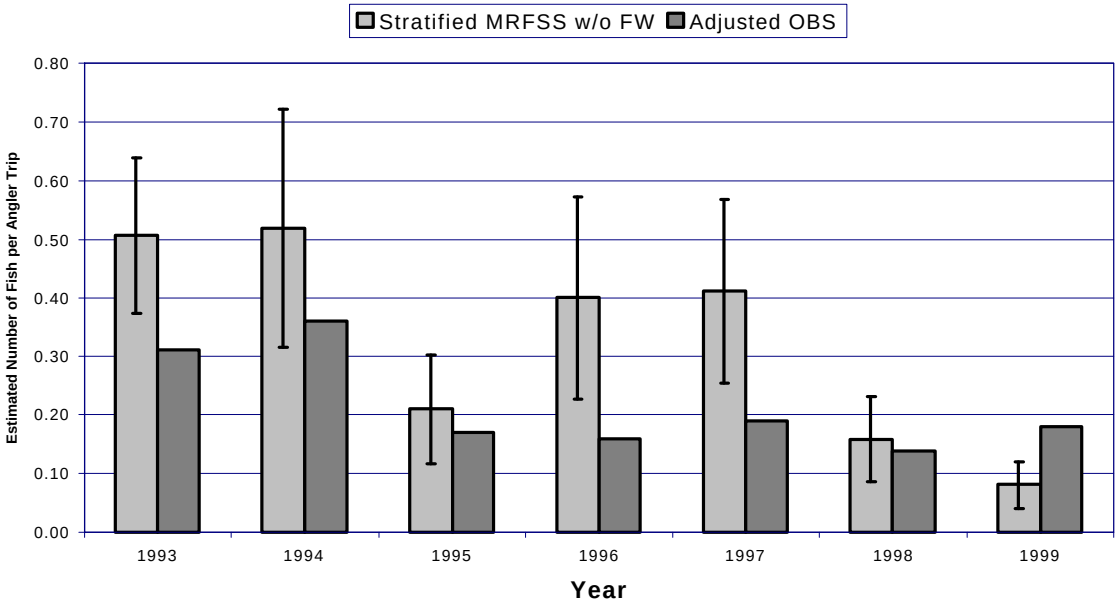
* Bars indicate 95% confidence regions around MRFSS point estimates.

Figure 5.12: Oregon Charter Boat Ocean CPUE for Rockfishes in July/August



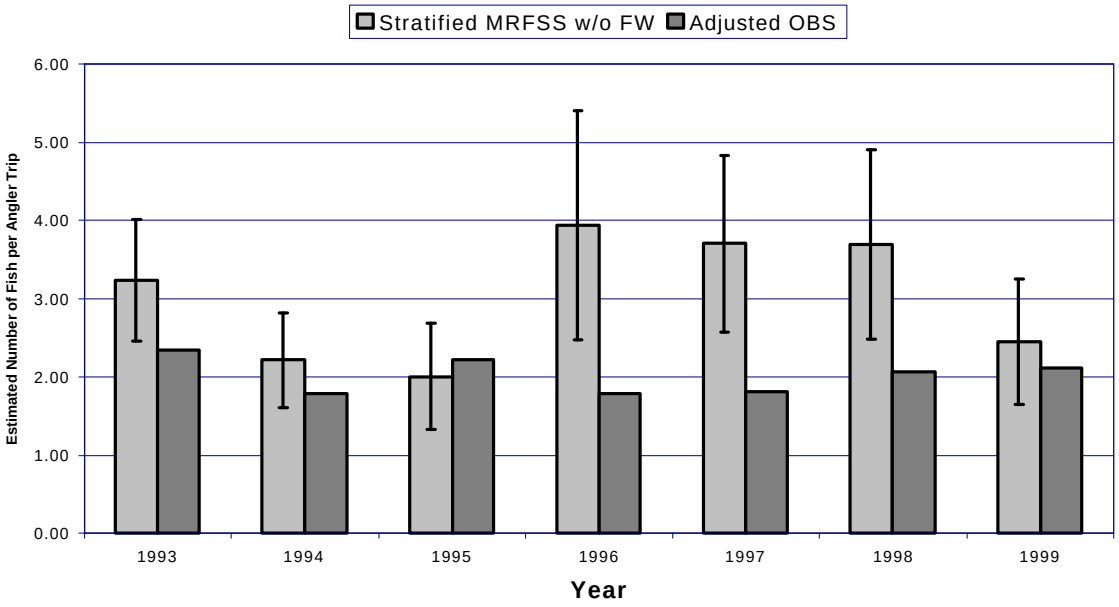
* Bars indicate 95% confidence regions around MRFSS point estimates.

Figure 5.13: Oregon Private Boat Ocean CPUE for Lingcod in May/June



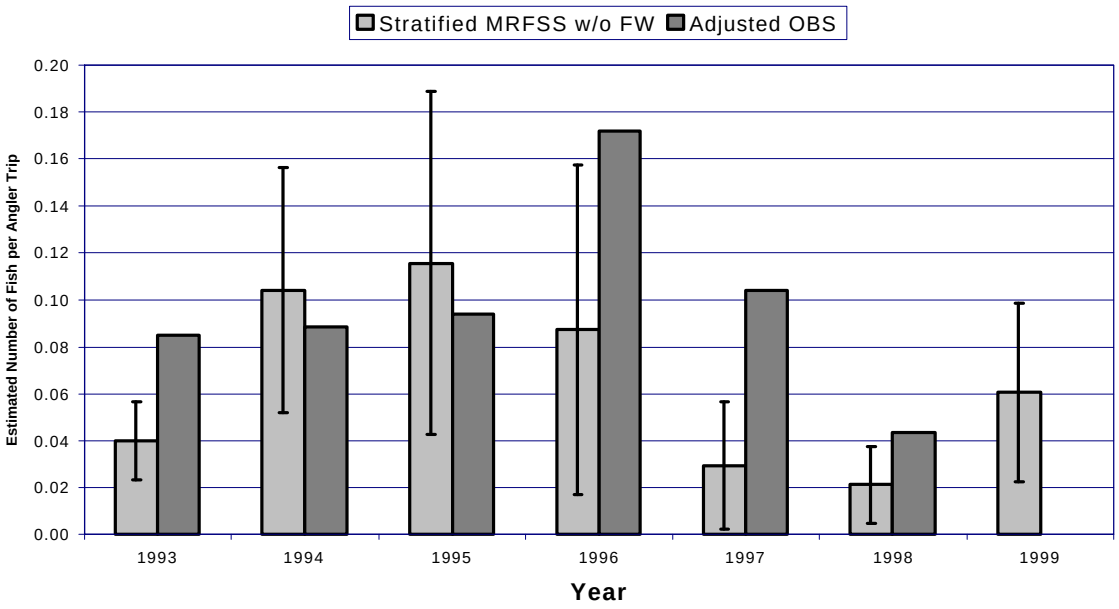
* Bars indicate 95% confidence regions around MRFSS point estimates.

Figure 5.14: Oregon Private Boat Ocean CPUE for Rockfishes in May/June



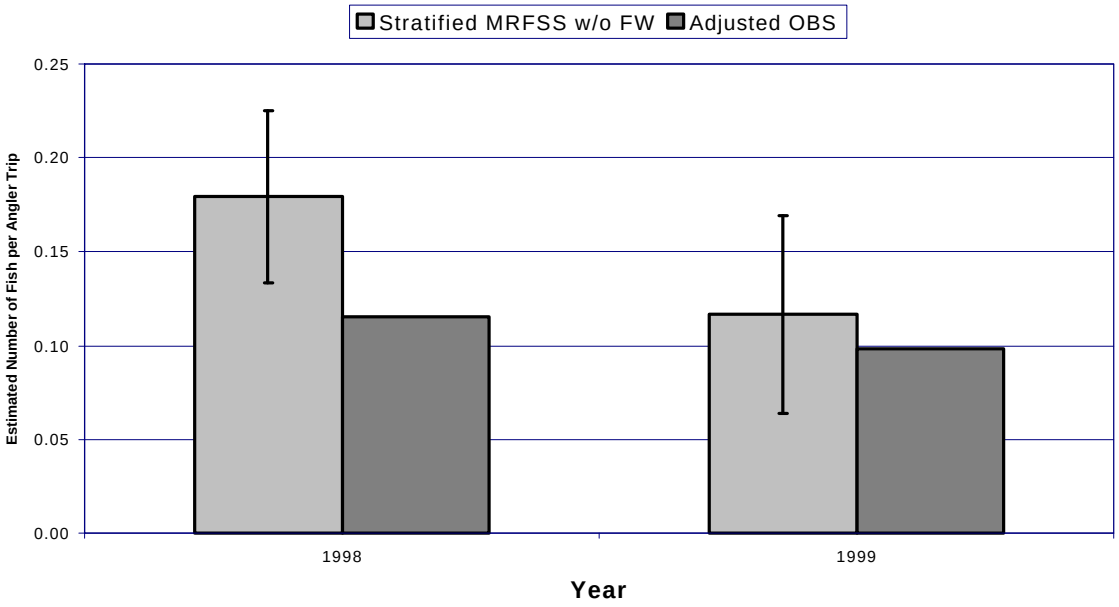
* Bars indicate 95% confidence regions around MRFSS point estimates.

Figure 5.15: Oregon Private Boat Ocean CPUE for Salmons in May/June



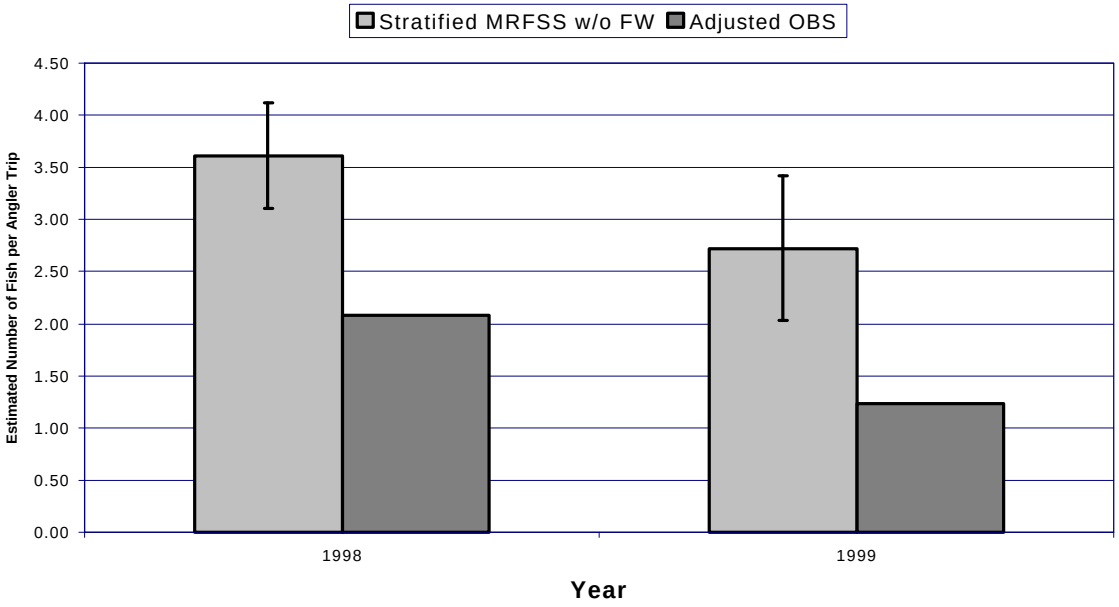
* Bars indicate 95% confidence regions around MRFSS point estimates.

Figure 5.16: Oregon Private Boat Ocean CPUE for Lingcod in July/August



* Bars indicate 95% confidence regions around MRFSS point estimates.

Figure 15.17: Oregon Private Boat Ocean CPUE for Rockfishes in July/August



* Bars indicate 95% confidence regions around MRFSS point estimates

6. Unexplained differences

6.1 Unexplained differences in effort estimates

After estimating adjustments to correct for known biases, we find that there are still unexplained differences between the adjusted OBS and MRFSS ocean fishing effort estimates for private boats in the May/June and July/August periods of 1998 and 1999. Also, in estimating maximum adjustments we may have over-estimated the effects of known biases in both surveys. Therefore, there may be additional differences to explain even in the case of the OBS and MRFSS for-hire boat effort estimates which appear to be very similar after adjustments. In addition, because we based our estimated corrections of known biases in 1993-1998 on analyses of more complete data collected in 1999, it is possible that we may have either over- or under-estimated some of these adjustments and the unexplained differences that remain may be either smaller or larger than what we have estimated.

The Statistics Subcommittee recognizes that there are several additional factors which may possibly cause differences between OBS and MRFSS estimates of for-hire and private boat ocean fishing effort. Although the possible impacts of such factors were not measurable with existing data, we recommend that future data collections attempt to collect the information needed to evaluate these factors. The following is a list of such factors with our assessment of their potential impact and our recommendations about how those impacts could be measured:

OBS omission of late fishing trips from adjustments of trip counts? – Our estimate of the proportion of trips missed by the OBS boat count adjustment factor is a minimum estimate. It is based on time of departure data collected by 2000 MRFSS dockside intercepts of boats which usually occurred before 5 PM. We have not attempted to account for private boat trips which departed after 1 PM and returned after 5 PM. With the addition of a "time of departure" question to the MRFSS telephone survey we can get a record of the proportions of trips departing between 8 and 10 AM, between 10 AM and 1 PM, and after 1 PM. With this data we could better estimate the number of late trips missed by the OBS boat count procedures.

Possible reporting errors by party/charter boat offices? – The OBS assumes that trip counts reported by party/charter boat operations are accurate. A 1997-1999 NMFS pilot survey of Gulf of Mexico charter boat fishing effort showed that at least some charter boat representatives tend to under-report the number of their fishing trips when interviewed by telephone. For-hire boat operators may be motivated to under-report their effort in an attempt to minimize possible regulations on their fishing. In 2001, RecFIN hopes to conduct a new telephone directory survey of for-hire boats on the Pacific coast which will measure possible reporting errors by independently validating self-reported effort data through field observations. This information could be used to estimate any necessary corrections to OBS and MRFSS estimates.

Private boat trips missed by OBS imputation methods? – Trips taken on foggy days and

days on which no exit counts were attempted are imputed by ODFW. Such imputation masks the fact that some weekly port area estimates are actually based on a sample of days. For some days designated as "bad-weather" days, ODFW assumes that no trips were made and does not impute. Although attempts are made to substitute information for similar days on which counts were made, we suspect that some trips may be missed by ODFW's current procedures. We recommend that ODFW conduct counts on at least a sample of "bad-weather" days to confirm that there is no private boat fishing activity on those days. We also recommend that ODFW consider the alternative approach of estimating activity for each week in a given port area based on trip counts obtained on a random sample of days within the week. This approach would more appropriately allow estimation of the variance, or uncertainty, in the total trip estimate for each week in a given port area.

Possible reporting biases on MRFSS telephone survey? – It was suggested that anglers contacted by the MRFSS telephone survey might tend to report more fishing trips than they actually took. Prestige may be a factor, or anglers who have trouble remembering their trips may tend to round up to a higher number. If so, this could be causing an over-estimation of total trips. At the moment there is no evidence to support such a hypothesis. Possibly, anglers may tend to do the opposite – report fewer trips than they actually took – if they recognize that this would shorten the interview. NMFS has added questions to the end of the MRFSS telephone survey interview which attempt to confirm whether the number of trips reported at the beginning of an interview or the number of trips actually profiled, is the true number of trips made for the given two-month period. Analysis of this data may shed some light on whether or not reporting errors in either direction could have occurred in the past.

Effect of MRFSS over-sampling of households with multiple telephone lines? – It has been suggested that households with multiple phone lines might be likely to take more fishing trips than households with only one phone. If this hypothesis were correct, then the MRFSS telephone survey might tend to slightly over-estimate trips. At this time there is no data to support or refute this hypothesis. NMFS hopes to start collecting data on the number of phone lines in each household surveyed by the MRFSS telephone survey so that this hypothesis can be tested.

Matching of "saltwater trip" definitions on MRFSS phone and intercept surveys? – It has been suggested that some inland fishing trips classified as "saltwater" trips on the MRFSS telephone survey might actually be classified as "freshwater" trips on the MRFSS intercept survey. If this were true, then this could result in an over-estimation of the proportion of boat angler trips taken in ocean areas. We believe that there are probably sufficient checks in both surveys to ensure that telephone and intercept survey "saltwater trip" definitions match. The surveys have been using the same landmarks to establish cut-off points separating saltwater and freshwater stretches of rivers since 1993. In 2000, NMFS added telephone and intercept survey cut-off points for inland bays in an attempt to facilitate accurate and consistent distinctions between freshwater and saltwater trips.

Effect of MRFSS emphasis on high-activity sites on ocean:inland ratios? – Because the MRFSS does not currently attempt to weight site-specific intercept survey data to account for differences in site selection probabilities and/or site fishing pressures, angler boat trips from high-activity sites are over-represented in the sample relative to trips from low-activity sites. Both the OBS and the MRFSS emphasize high-activity sites in their dockside sampling surveys. For the MRFSS this could possibly cause errors in the estimation of the ocean:inland ratio for boat trips if high-activity and low-activity sites within a given geographic stratum tend to differ in this ratio. Analyses of existing data have been initiated by NMFS and PSMFC staff to look for the possible existence of such a bias.

The subcommittee also examined two additional issues which had been raised by the RecFIN Committee regarding the procedures used by the MRFSS:

MRFSS imputation procedures – We reviewed the imputation methods used by the MRFSS to substitute trip information where it was missing due to partial non-response by households or anglers within households. Imputation is necessary to avoid the under-estimation of trips which would result if incomplete data were used. The hot-deck re-sampling method which is used assumes that substituted data obtained by random sampling of comparable households, anglers, or trips with complete reports is representative. The majority of the imputation which is done substitutes a value for the mode of the fishing trip (shore, party/charter boat, or private/rental boat) where no mode was given. This is done by randomly selecting mode information from among other trips fully profiled by the same angler. Our review revealed no inherent biases in the imputation which should cause either over- or under-estimation of trips.

MRFSS "proxy" interviews – We also reviewed the inclusion of effort data obtained by proxy in the MRFSS telephone survey data. In some cases when an angler in a given household is difficult to reach, the MRFSS telephone survey allows collection of that angler's fishing effort data from another member of the household who claims to be able to accurately report that information. There was some concern that inclusion of "proxy" data might cause an over-estimation of effort. However, the subcommittee did not feel that there was any basis for assuming that errors in proxy data would be greater in one direction than in the other. On the other hand, exclusion of proxy data might cause an under-estimation of effort if the most avid anglers are the hardest to contact for non-proxy interviews.

6.2 Unexplained differences in CPUE estimates

The subcommittee is aware that there have been relatively consistent differences between OBS and MRFSS CPUE estimates for lingcod, rockfishes as a group, salmon species, and Pacific

halibut. Although we have been able to document the CPUE differences, we are unable to definitively explain what is causing them. Although salmon catches are not nearly as common as catches of lingcod and rockfishes, it is interesting to note that OBS private boat CPUE estimates for the salmon species group tended to be higher than MRFSS estimates in the same years when the OBS estimates for lingcod and rockfishes were lower (Figure 5.15). It is possible that differences in the historical emphases of the two surveys may have caused subtle sampling biases toward or against trips targeting salmon. We have no support at this time for such biases but we recommend that training of samplers for both surveys be coordinated in the future to ensure that similar procedures are followed for random sampling of trip types (salmon, halibut, bottomfish, or tuna) and random sampling of boat and angler CPUE data within each trip type.

It is likely that the differences in CPUE for the May-August time period are simply attributable to differences between the surveys in their capacities for representative sampling of restricted pulse fisheries for salmon and halibut. Changes in the location and timing of open salmon and halibut seasons from year to year make it difficult to reliably match MRFSS intercept survey sampling with the true geographic and temporal distributions of fishing. ODFW's ocean fishing seasons for salmon and halibut have traditionally been scheduled for short time periods in specific port areas within the May-August period. Many fishing access sites which become very active during these restricted seasons are much less active at other times. MRFSS intercept survey sampling is designed to match average historical distributions of fishing effort within a two-month time frame. This level of temporal stratification is not conducive to accurate representation of specialized pulse fisheries in small areas with durations that are hard to predict. Therefore, it would not be surprising if restricted season salmon and halibut trips were under-represented in the MRFSS samples of trips for the May/June and July/August periods. Although geographic stratification of MRFSS estimates can reduce CPUE estimation errors resulting from gross errors in the geographic distribution of sampling, it can not sufficiently correct for failures to sample trips at sites with very short-lived periods of specialized fishing.

The OBS is more appropriately designed to accurately represent predictable pulses of specialized fishing activity in small areas during the May-August period. Dockside CPUE sampling is stratified into shorter time periods (usually one week) and smaller geographic areas (9 major port areas). For this reason, it is probably much less likely that OBS CPUE sampling would under-represent restricted season trips directed at salmon and halibut. Therefore, we should expect that May-August OBS CPUE would tend to be higher than MRFSS CPUE for salmon species and halibut, but lower for other species, such as lingcod and the rockfishes.

We are currently comparing 1993-1999 CPUE data collected by the OBS and MRFSS samplers in the same ODFW port areas and time periods to look for differences in the proportions of different trip types (salmon, bottomfish, halibut, etc.) and CPUE for the same trip types. This analysis should provide further insight into the possible causes of the differences in CPUE estimates. Further comparisons of OBS and MRFSS CPUE sampling would be greatly facilitated if both surveys were modified to record the same kind of information on the location, date, and time of each intercept. Currently the OBS samplers do not record the actual site (marina, boat ramp, etc.) where each boat intercept occurs within a given port area. It would be helpful if OBS

would record the actual MRFSS site code and time of day of each boat intercept. This would allow better comparisons of geographic and temporal sampling distributions between surveys, as well as direct comparisons of CPUE data collected by OBS and MRFSS samplers at the same marina or boat ramp and, whenever possible, on the same day.

7. Strategies for combining OBS and MRFSS data and estimators

The subcommittee considered how best to use and combine data and estimates from the two surveys, both for periods when both surveys were conducted and for periods when only the MRFSS was conducted. This section provides a general description of the statistical strategy that might be employed when two estimators are available for some time periods.

For the discussion that follows, the term "biased" refers to the tendency of an estimator to consistently over- or under-estimate the quantity that it is estimating. The average amount of the over- or under-estimate is termed the "bias" of the estimator. The term "unbiased" means the same as "bias equals zero". Thus an unbiased estimator, in the long run, neither consistently under- nor over-estimates that quantity. The term "precision" refers to the degree of certainty in the estimate, as reflected by the estimated variance of the estimator. Less uncertainty is reflected in greater precision and smaller estimated variances. Generally, increasing the sample size is the best way to increase precision.

7.1 Periods when only one survey was conducted

During periods when only one survey was conducted, there were two basic strategies considered for developing an estimate. The first, more simple, approach is to use the single estimate that is available. This strategy would be appropriate if the one survey conducted is shown to be relatively unbiased, even if the precision on that estimate is not great.

The second approach is to apply a fixed scaling factor to the estimate. This would be appropriate if there is a consistent and verifiable bias in the one survey conducted. This scaling factor might be calculated based on the estimates from a second survey that is known to be unbiased. This type of scaling correction would also require that the relationship between the two survey estimates remains constant over time. Thus, the mathematical relationship between the two surveys would need to be the same for periods when the two surveys overlap, and for periods when only the one survey is conducted. The derivation of such an adjustment is given next under two assumptions concerning the nature of the known bias.

Suppose there are two statistical estimators T_{1i} and T_{2i} of a parameter of interest, q_i for time period i. Let T_{1i} be unbiased, i.e. the expected value of T_{1i}, $E(T_{1i}) = q_i$ and the other T_{2i} be biased, i.e. the expected value of T_{2i}, $E(T_{2i}) = Bq_i$. In this particular formulation the bias, B, is assumed to be constant and multiplicative. Then an estimate of an adjustment factor could be calculated as the ratio of T_{1i} and T_{2i} where i indicates a period of overlap. This adjustment factor, R_i, can then be applied to time periods where there is no overlap. That is, an adjusted estimator

for method 2 is given by:

$$\hat{T}_{2j}^{adj} = \frac{\hat{T}_{1i}}{\hat{T}_{2i}} \hat{T}_{2j} = \hat{R}_i \hat{T}_{2j}, \quad \text{for} \quad j \neq i.$$

If the bias cannot be assumed to be multiplicative, but is instead additive, then the adjustment is the difference, D_i, during the overlap period rather than the ratio:

$$\hat{T}_{2j}^{adj} = (\hat{T}_{1i} - \hat{T}_{2i}) + \hat{T}_{2j} = \hat{D}_i + \hat{T}_{2j}, \quad \text{for} \quad j \neq i.$$

If the bias cannot be assumed to be constant but is suspected of varying over time, then this type of adjustment method is not appropriate.

7.2 Periods when both surveys were conducted

Suppose that two survey methods both produce relatively unbiased estimates for some quantity of interest. Then, the simplest strategy would be to choose the estimate with greater precision. Alternatively, if possible, one could combine the information in a meaningful way to effectively increase the sampling power of both.

Combination of estimators can occur at various levels. At the estimator level, a weighted average could be used. Let $C_1(\mathbf{X_1})$ and $C_2(\mathbf{X_2})$ be two unbiased estimators of total catch, where the $\mathbf{X_i}$ are the data vectors. Then the weighted average estimator is

$$C(X,Y) = W_1 C_1(\mathbf{X_1}) + W_2 C_2(\mathbf{X_2}),$$

where $W_1 + W_2 = 1.0$ and are chosen to represent the relative precision in each estimator.

In some cases it may be possible to combine the data at a lower level where the units are similar. This is analogous to increasing the effective sampling effort. For example, both the OBS and the MRFSS estimate fishing effort, but use different lowest sampling units. The MRFSS estimator is based on the angler trip and the OBS estimator is based on the boat trip. Although the units of measurement vary, information on numbers of anglers per boat could be used to convert the measures in to like units for combinatorial purposes. If the units of measurement are dissimilar and cannot be converted to similar units until the overall estimate level, then it may be that the lowest level is the estimate itself.

8. Recommendations for improvements and use of estimates

8.1 Use of effort estimates

Because the OBS charter boat effort estimator was likely to have been more precise due to the size of the OBS sampling program, it was the recommendation of this committee to use adjusted OBS charter effort estimates for the overlapping period. It was seen that the adjustments made to the MRFSS charter mode estimates resulted in estimates quite close to the OBS effort estimates, but likely with less precision. Thus, it is reasonable to use the MRFSS charter mode effort estimates during the other periods.

Based on the criterion of smaller bias, we could not determine that one estimator should be used over the other for estimating private boat effort. Based on the criterion of greater precision, the OBS estimator is preferable. Because there is no logical means of combining the data (fishing households and numbers of boats), a combination at the estimate level (a weighted average combination) would be unreasonable. If precision information were available for the OBS estimator, our recommendation would be a weighted average where the weights were equal to the inverse of the variance estimates normalized to sum to 1.0. Because these variance estimates are not available, we recommend using the OBS estimate for the overlap period based on the precision criteria alone, and using the MRFSS estimator during the other periods.

8.2 Use of CPUE estimates

The MRFSS CPUE sampling unit is the individual angler trip, while the OBS sampling unit is the boat trip. The MRFSS program attempts to sample approximately in proportion to angler effort using their pressure site index. The greater amount of sampling in the OBS program was likely to yield more precise estimates. Again, it was difficult to draw a conclusion that one program was more suitable than the other. However, the temporal and geographic stratification of the OBS appears to be better suited for accurate representation of short-lived, localized pulse fisheries for salmon and halibut which occur in the May-August time period. Therefore, it is the recommendation of the subcommittee that CPUE data should be chosen to match the effort data used. That is, the OBS CPUE data should be used for the May-June and July-August time periods. For other periods, the MRFSS CPUE data should be used. In the future it may be advantageous to combine CPUE data from both surveys. The catch per angler from the MRFSS interviews could be converted to catch per boat by multiplying by the number of anglers on board, if available, or, if not, the average number of anglers per boat.

8.3 Improvements to the OBS

Based on the extensive analysis of both survey methods, the RecFIN statistics subcommittee makes the following recommendations for the OBS program:

Continue the expansion of sampling to the minor and minuscule ports. The sampling would not need to be as intensive as at major ports, but some sampling would allow for estimation of what fishing activity may be being missed.

Begin sampling on May 1 at all ports to insure that data is collected for the entire year.

Originally, MRFSS data was used for this period because all of May was not sampled by OBS. In order for OBS data to be used for the May-June period, all of the period should be sampled. This would not need to be a census. A well designed sampling program can be developed to ensure coverage during less busy periods in early May.

Continue to use data collected dockside to estimate the proportion of trips missed by the exit counts. It would be useful to conduct occasional sampling (either dockside or exit count) later in the day to estimate the amount of late afternoon and evening fishing effort.

Record the specific site within the port area where the intercept sample occurs. This would allow for better future comparisons with MRFSS catch per trip data.

Implement validation of reports given by charter offices. Charter operators may be motivated to under-report effort in an attempt to minimize impacts on the fishery. A small validation study could show if this is relevant or not.

8.4 Improvements to the MRFSS

Based on extensive analysis of both survey methods, the RecFIN statistics subcommittee makes the following recommendations for the MRFSS program:

Continue to stratify Oregon into sub-regions. This helps to correct for non-representative sampling of trips with respect to the area of fishing distribution across geographic regions. To do this properly, sample sizes should be increased to acceptable levels for each region. If adequate funding is not available, the estimates can continue to be post-stratified as was done for this analysis. In this case, estimates should not be reported at the geographic stratum level but should be aggregated up to the state level. It is important to note that further geographic stratification in other states would not necessarily lead to an increase or a decrease in the effort estimates.

Examine the implementation of the sample draw and correct any problems that are found to occur. In the past many assignments have not been completed in particular parts of the state leading to unbalanced CPUE sampling and area distributions. Obviously, with a coastline as large as that of Oregon, it is difficult to sample sites in such a way to obtain a near-random sample of trips from the state. Because many of the fisheries in Oregon are short-term pulse fisheries, it is difficult for the MRFSS to properly sample them. If the sample size for intercept sampling was much larger, these pulse fisheries would be more likely to be observed in the intercept sample.

Further investigate license-based sampling frames for effort estimation. A pilot study was conducted in 1993 to investigate using the Oregon saltwater license as a dialing frame for estimating effort. This resulted in a much more efficient sampling frame and allowed more precise effort estimates for the same cost. The MRFSS is a national program, however, and it would not be practical to change methods in one state. A national, or perhaps

coastwide, consistent saltwater angling license (without exceptions) could greatly improve estimation of angler trips taken.

Add checks to the telephone data collection system to insure that the county given for a trip is indeed a valid fishing county. The telephone contractor has already made improvements in this area and the number of trips to inland counties has been greatly reduced. There is probably still room for improvement here, especially concerning trips where the county is given as "not known".

Increase funding and sample sizes. It is important to emphasize that the MRFSS is designed to produce regional catch and effort estimates on an annual basis. Funding of the MRFSS is such that specific, narrow cell estimates may have a great deal of uncertainty associated with them. This can be corrected by very large increases in funding and sample sizes, and by appropriate, realistic use of MRFSS data.

8.5 Coordination of OBS and MRFSS surveys

The two surveys have overlapping objectives. Both attempt to estimate catch and effort for ocean boat fishing. The subcommittee considered how, in the future, the two surveys might more effectively collaborate to the benefit of both programs.

8.5.1 Different survey objectives and capabilities

Inevitably, the saltwater fishing surveys by states and by MRFSS differ somewhat in their respective objectives and strengths. MRFSS is an ongoing nationwide program, with attendant uniformity requirements, over time and space, for the nature of data collected and for their manner of collection. The strength and payoff of such uniformity is potential for historical comparisons and for learning in one state from experiences in others. Each state, on the other hand, has regionally important objectives which tend to focus on tracking of key seasons, species and gear. For the covered seasons and data, the state surveys typically can involve much larger sampling effort, with attendant potential for precision of estimates.

8.5.2 Basic future goal: a single consistent methodology

A basic goal for the future is not to alter the respective objectives but rather to arrive at a situation where, thanks to evolution and improvements, the surveys may be viewed as complementary aspects of a single consistent estimation methodology which nonetheless addresses both sets of objectives. For each coverage time and area, this methodology would use both data sources to arrive at just one consistent set of estimates. Presumably, high-season estimates will mostly reflect data from the state's larger sampling effort, and low-season estimates will mainly reflect the year-round MRFSS effort.

8.5.3 Mutual assistance

In the near future, each survey could attempt to generate data for use by the other, and to exploit data taken by the other. For example, MRFSS phone and intercept survey data concerning ports and times of trip departures might be exploited by the Oregon survey to make adjustments which account for undersampled times and places, e.g., daytime departures after 1 PM, night trips, and small ports. Ideally, both intercept surveys could be modified to work with a common sampling frame of sampling sites and time windows.

9. Concluding summary of recommendations for use of survey data

This RecFIN Statistics Subcommittee, as well as previous subcommittees, has spent a great deal of time examining the Oregon OBS survey and the MRFSS and examining the many issues that may be causing the observed differences in the two surveys. Many issues with each survey are detailed in this report and, when possible, corrections were applied to the effort estimates of each. This section provides a brief reiteration of the recommendations for the use of the estimates.

9.1 Charter boat effort and catch

For charter boat effort, it was shown that the mean effort estimates between the two surveys were nearly identical for the time periods examined. Because of the nature of its design, it can be assumed the OBS has greater precision than the MRFSS. Therefore, we recommend the use of the adjusted OBS estimates for charter boat effort during periods when those data are available. For other time periods, the adjusted MRFSS estimates of charter mode effort should be used.

As was stated previously, there were observed differences in catch per trip estimates between the two surveys. However, the subcommittee was not able to identify definitive reasons for this. Some possible explanations were discussed in section 6 of this report. Therefore, the subcommittee recommends that charter mode catch per trip estimates from the OBS survey be used when available, due to the larger sample size involved. This means that OBS charter boat catch should be scaled upwards by the same adjustment factor as the OBS charter mode effort. For other time periods, catch estimates from the adjusted MRFSS should be used. In this case, the modified estimation programs will incorporate the geographic stratification of the Oregon coast for both effort and catch per effort.

9.2 Private boat effort and catch

For private boat effort, for the reasons discussed in section 7, the subcommittee recommends the use of the adjusted OBS estimates when the data are available. In periods where data are not available, the subcommittee recommends the use of the adjusted MRFSS effort estimates. It was seen that the mean May-June adjusted MRFSS estimate for 1993-1997 was close to the mean OBS estimate. The final two years of overlapping data are more problematic.

However, it is the recommendation of the subcommittee that it would not be prudent to apply widespread scaling factors to the estimates from all other time periods based on two waves worth of data.

For the reasons stated above, the subcommittee recommends that private boat mode catch per trip estimates from the OBS survey be used when available, due to the larger sample size involved. Also, as was discussed, the OBS is better suited for sampling short term pulse fisheries as they occur in the May-August period. Thus, for these periods, OBS private boat total catch should be scaled upwards by the same adjustment factor as the OBS private mode effort. For other time periods, catch estimates from the adjusted MRFSS should be used. For these periods, the effect of missing pulse fisheries will be unimportant. Again, the modified estimation programs will incorporate the geographic stratification of the Oregon coast for both effort and catch per unit effort.

The RecFIN Statistics Subcommittee plans to continue comparing the estimates of the MRFSS and OBS surveys as more data are available. The adjustments used in this analysis may change as we learn more from the overlap between the two surveys. In addition, similar comparisons and examinations are planned for the Washington and California state sampling programs and estimates.