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November 13, 2013

Gregg Williams
International Pacific Halibut Commission
P.O. Box 95009
Seattle, WA 98145

Dear Mr. Williams:

This letter presents Pacific halibut sport fishery information typically provided to the International Pacific Halibut Commission (IPHC) in the fall of each year in support of the annual stock assessment. This year's letter provides:

1. Final 2012 sport fishery harvest estimates for Areas 2C, 3A, 3B, and 4,
2. Preliminary 2013 estimates (projections) of harvest for Areas 2C, 3A, 3B, and 4,
3. Preliminary 2013 estimates (projections) of release mortality for Areas 2C and 3A, and
4. Estimates of 2013 sport harvest prior to the mean IPHC longline survey date in Areas 2C and 3A.

Final Estimates of 2012 Sport Harvest

In November 2012, we provided projections of the 2012 sport harvest for Areas 2C, 3A, 3B, and 4. This letter provides updated estimates based on final Alaska Department of Fish and Game (ADF&G) statewide harvest survey (SWHS) estimates, in numbers of fish, and final estimates of average net weight in pounds. The final Area 2C and 3A estimates were also posted on the North Pacific Fishery Management Council web site in mid-September of this year.

The Area 2C charter fishery regulations for 2012 included a one-fish daily bag limit and reverse slot (or "protected slot") limit that allowed harvest of halibut less than or equal to 45 inches and halibut greater than or equal to 68 inches. Charter captains and crew were not allowed to retain fish in Area 2C. In all other areas, the charter fishery was managed under a two-fish daily bag limit and charter captains and crew were allowed to retain halibut. Noncharter fisheries statewide were managed under a two-fish bag limit with no size limit.

Methods:

For Area 2C and Area 3A, sport fishery yield (pounds net weight) was calculated separately for the charter and noncharter (unguided) fisheries as the product of the number of fish and average weight of harvested halibut. Estimates of the number of fish harvested were provided by the SWHS. Standard errors of the SWHS estimates were obtained by bootstrapping. The SWHS estimates are the preferred method for estimating charter harvest under GHM management and the only method available for estimating noncharter harvest. Average net weight was estimated by applying the IPHC length-weight relationship to length measurements of halibut harvested at major ports in Areas 2C and 3A. Ports sampled in Area 2C in 2012 included Ketchikan, Craig, Klawock, Petersburg, Wrangell, Juneau, Sitka, Gustavus, and Elfin Cove. Ports sampled in Area 3A included Yakutat, Valdez, Whittier, Seward, Homer, Deep Creek, Anchor Point, and Kodiak. The

estimate of charter average weight for Homer was stratified to account for differences in sizes of halibut cleaned at sea versus cleaned onshore. Average weight was calculated separately for fish taken in Area 2C and Area 3A and landed at Elfin Cove.

Sampling at all ports followed a cluster design, where all fish from each cluster (vessel-trip) were measured. Two-stage bootstrapping was used to estimate the standard error of average weight for all Area 3A ports except Yakutat and Elfin Cove. Development is ongoing for a closed-form variance of average weight from cluster sampling in Southeast Alaska. In the interim, standard errors for average weight from simple random sampling equations were inflated by a factor of two to provide standard errors that are comparable to those from bootstrapping. The inflation factor was based on the comparison of standard errors from simple random sampling and two-stage bootstraps for each subarea of Area 2C using 2010 data. Inflation by a factor of two was felt to be conservative; the average inflation factor was about 1.6 for charter average weight and 1.5 for noncharter average weight.

For Area 3B and Area 4, we present only the final SWHS estimates of the number taken by charter and noncharter anglers combined. We do not conduct any sampling in these areas for average weight. As has been done historically, we included all harvest from SWHS Area R (Alaska Peninsula and Aleutian Islands south of Cape Douglas and the Naknek River) in the Area 3B estimate. In some years, Area R harvest estimates have included small harvests for sites that are actually in Area 3A. Since 1991, the estimated harvest of Area 3A halibut included in Area 3B estimates has ranged from 0 to 728 fish (average = 130). We continue to report these harvests in Area 3B because they are too small to apportion to the charter and noncharter sectors in Area 3A. This approach has more impact on the Area 3B sport harvest estimate than the Area 3A estimate, but the Area 3B sport harvest typically represents less than 0.5% of the total removals in that area.

Results:

The Area 2C overall sport yield (harvest biomass) in 2012 was estimated at 1.583 million pounds (Table 1). The charter yield estimate was 0.605 M lb and the noncharter yield was 0.977 M lb. The charter sector accounted for 38% of the Area 2C sport yield by weight. Average net weight was estimated at 14.3 lb in the charter harvest, 17.9 lb for the noncharter harvest, and 16.3 lb overall. Average weights were based on sample sizes of 5,134 charter fish and 4,606 noncharter fish.

The Area 3A overall sport yield was estimated at 3.626 M lb, with 2.284 M lb (63%) from the charter sector and 1.341 M lb (37%) from the noncharter sector (Table 1). Average net weight was estimated at 13.2 lb for the charter fishery, 11.8 lb for the noncharter fishery, and 12.6 lb overall. Average weight was estimated from length samples of 5,796 charter halibut and 2,752 noncharter halibut.

Charter harvest projections made last year were closer to the final estimates than noncharter projections. Last year's charter yield projections were high by 6.5% in Area 2C and by 4.0% in Area 3A. The noncharter projection was 22.2% lower than the final yield estimate in Area 2C, but the noncharter projection was 16.5% higher than the final estimated in Area 3A. Larger projection errors are to be expected for the noncharter fisheries because those projections are made using time series methods without any information from the current year, and because the forecasts are based on fairly short and highly variable harvests.

Area 3B overall sport harvest (charter and noncharter combined) was estimated at 1,579 halibut and Area 4 harvest was estimated at 2,061 halibut (Table 1). It is our understanding that the IPHC has typically applied the Kodiak average weight to estimate yield (harvest biomass) in Area 3B and Area 4. The estimated average net weight for sport harvest at Kodiak (charter and noncharter combined) was 13.8 pounds. Anecdotal reports from Dutch Harbor/Unalaska suggest a higher average weight, but we have no data specific to that area. The overall sport yields were estimated at 0.022 M lb in Area 3B and 0.028 M lb in Area 4.

Preliminary 2013 Estimates of Harvest (2C, 3A, 3B, 4)

Methods:

Final harvest estimates are typically not available from the SWHS until September of the year following harvest. Therefore, ADF&G provides preliminary estimates of the most recent season's harvest using projections of the number of fish harvested, multiplied by the recent season's estimates of average weight from dockside sampling for length measurements. These preliminary estimates are updated once the final SWHS estimates become available in September of the following year. The NPFMC Scientific and Statistical Committee (SSC) reviewed ADF&G's projection methods in October 2007 and February 2009 and concluded that the projection methods were suitable given current data limitations. The SSC again reviewed the time series forecasting methods in October 2012 and made several suggestions. These suggestions were incorporated in current projections.

Charter harvests (numbers of fish) for Areas 2C and 3A were projected using regression of final SWHS estimates on logbook data through July 31 for the years 2006-2012. Regressions and forecasts were done for each subarea and summed to obtain totals for each regulatory area. Regression through the origin was used because it was conceptually realistic and because regressions for subareas with good contrast (mostly in Area 2C) indicated that the intercept was close to or not significantly different from zero. This allowed forecasting for subareas in Area 3A with weak relationships due to little contrast. The harvest projections were multiplied by estimates of average weight from dockside sampling in 2013 to obtain projections in pounds.

The Glacier Bay subarea was split into two subareas corresponding to account for Area 2C and 3A harvest separately. This is necessary because average weight differs between these two subareas due to regulatory differences. Before 2011, the entire Area G estimated harvest from the SWHS was attributed to Area 2C. Logbook data indicate that halibut from Area 3A accounted for only 0.7% to 2.8% of the Area G charter halibut harvest (in numbers) from 2006 to 2010. However, the Area 3A portion jumped to 9.4% in 2011 and 13.9% in 2012. Logbook data through July 2013 suggest that the 3A portion may be closer to 19% in 2013. Therefore, historical SWHS estimates for Area G were apportioned between Areas 2C and 3A using logbook data prior to doing regressions and making projections.

Noncharter harvest in Areas 2C and 3A, and overall sport harvests for Areas 3B and 4 were projected in numbers of fish using time series methods. Following a suggestion from the SSC, appropriate time series models were identified using the Box and Jenkins¹ procedure for auto-regressive integrated moving average (ARIMA) models. Models were chosen for each subarea based on examination of residuals and Akaike's Information Criteria corrected for small sample sizes.

Noncharter yield was estimated for Areas 2C and 3A by multiplying the forecasts for each subarea by average weights from dockside sampling, and summing over all subareas. Unlike the Glacier Bay charter harvest that was apportioned to Areas 2C and 3A, all Glacier Bay noncharter harvest was assumed to be taken in Area 2C. Unguided anglers interviewed at Gustavus and Elfin Cove in 2013 reported a harvest of 1,055 halibut, but only three of those fish were taken in Area 3A.

For Areas 3B and 4, yield was estimated for the overall sport fishery (charter and noncharter) by multiplying time series harvest projections by the average weight for the Kodiak subarea. There are no sampling programs to estimate average weight in either of these areas.

Results:

The preliminary 2013 halibut yield projections for Area 2C were 0.723 M lb for the charter sector and 0.904 M lb for the noncharter sector, for a total sport harvest of 1.627 M lb (Table 2, Figure 1). Average weights were 14.1 lb for the charter sector, 17.4 lb for the noncharter sector, and 15.8 lb overall. Compared with 2012,

¹ Box, G. E. P. and G. M. Jenkins. 1976. Time series analysis: forecasting and control. Holden-Day, San Francisco.

charter average weight was down 0.2 lb and noncharter average weight was down 0.5 lb. The projected charter yield was up about 118,000 pounds from 2012, but projected noncharter harvest was down slightly.

Projected halibut yields in Area 3A were 2.271 M lb for the charter sector, 1.444 M lb for the noncharter sector, and 3.715 M lb overall (Table 2, Figure 1). Average weights in Area 3A were 12.8 lb for the charter harvest and 12.0 lb for the noncharter harvest, and 12.4 lb overall. The charter average weight is the lowest estimated average weight for Area 3A since ADF&G began monitoring charter harvests in the early 1990s.

The 2013 projected harvest for Area 3B was 1,695 halibut, with a 95% confidence interval (CI) of 755-3,301 (Table 2, Figure 1). The projected harvest for Area 4 was 2,061 halibut, with 95% CI of 0-4,161. Applying the overall (charter and noncharter) average weight of 11.9 lb for Kodiak resulted in yield projections of 0.020 M lb in Area 3B and 0.025 M lb in Area 4.

A variety of ARIMA models were chosen for forecasting noncharter harvest in each subarea of Area 2C or 3A, most with autoregressive or moving average parameters. The naïve forecast (equal to last year's harvest) was the best fitting model in only two subareas, compared with seven last year. The time series' for three subareas were log-transformed to stabilize the variance prior to fitting a model. For all but two subareas, the time series' were differenced to remove a trend prior to fitting.

Preliminary 2013 Estimates of Release Mortality (2C, 3A)

Methods:

There are no data available on the lengths of released halibut in sport fisheries in Alaska. In addition, the mortality rate for halibut released in the sport fishery is unknown. However, estimates of the number of released halibut are available from charter logbooks, from creel survey interviews, and from the SWHS. The SWHS estimates are derived by subtracting the estimates of harvest from estimates of total catch. Creel survey interviews have provided data on the relative numbers of halibut released from circle hooks versus other hook types. These data, combined with information from the literature, can be used to provide working estimates of the discard mortality rate.

Meyer (2007)² provided estimates of release mortality in the sport fishery by combining SWHS-derived estimates of the numbers of released fish, assumed mortality rates based on hook type data, and modeling of length distributions to derive estimates of the average weight of released fish. This effort expands on that approach. Release mortality (R) was calculated for each subarea for 2013 using the basic equation:

$$R(lb) = \hat{N} \cdot DMR \cdot \hat{w}$$

where

\hat{N} = the projected number of fish released (scaled to SWHS estimates),

DMR = the assumed mortality rate due to capture, handling, and release, and

\hat{w} = the estimated average net weight (in pounds) of released fish.

Two methods were used to project the number of released fish (N). For the charter fishery, the number of halibut released was projected for each subarea using a regression of numbers of fish released (derived from the SWHS) on the numbers of halibut reported released in charter logbooks through July 31 of each year (similar to charter harvest projections). For the noncharter fishery, the number of fish released in each subarea was projected using ARIMA time series forecasts based on SWHS-derived estimates of released halibut.

² Meyer 2007. Halibut discard mortality in recreational fisheries in IPHC Areas 2C and 3A. Unpublished discussion paper for North Pacific Fishery Management Council, September 2007. Alaska Department of Fish and Game, Homer.

Assumed mortality rates were 5% for Area 3A charter-caught halibut, 6% for Area 2C charter and Area 3A noncharter, and 7% for Area 2C noncharter halibut. These were the same rates used by Meyer (2007). They were derived by assuming a 3.5% mortality rate for halibut released on circle hooks and a 10% mortality rate for halibut released on all other hook types. These rates were applied to the reported number of fish released on each hook type to calculate a weighted mean mortality rate for each user group in each subarea. These weighted mean rates were then subjectively inflated to account for uncertainty in the assumed rates and for possible cumulative effects of multiple recaptures. The available data on numbers of fish released on each hook type was examined for 2008-2013 data. Data were available for 2008 only in Area 2C and for 2008-2013 in Area 3A. Although there has been annual variation in the release mortality rates, there has been no systematic change large enough to warrant new rates.

The average weight of released fish in each subarea was arrived at using different approaches, depending on whether the subarea had a size limit or not:

1. Fisheries without size limits included charter fisheries in Area 3A and noncharter fisheries in 2C and 3A. For these fisheries, average weight was derived using a modeling approach similar to the one described in Meyer (2007)². This approach constructs a logistic selectivity curve representing the probability of retaining a halibut that is caught as a function of its length³. This probability is applied to the estimated harvest at length to predict the catch at length, and from that the number of released fish at length, and the average weight of released fish. Data from several other fisheries where both retained and released fish were measured (or lengths were estimated) suggest that about 20% of the catch was retained at the 10th percentile for length in the harvest. Additionally, about 80% of the catch was retained at the 90th percentile for length of retained fish. The 10th and 90th percentiles for length were used as targets to fit selectivity curves to halibut length data for each subarea. The selectivity parameters were chosen using Excel Solver by minimizing the absolute relative difference between the predicted and target selectivity proportions at the 10th and 90th percentiles, and at the same time imposing a constraint that the predicted number of released fish matches the projected number of released fish (R).
2. In 2013 the Southeast creel survey interviews recorded the number of charter-caught fish released in three length classes corresponding with the reverse slot limit: (1) ≤ 45 inches, (2) >45 and <68 inches, and (3) ≥ 68 inches. These data were used to apportion the projected number of fish released R and average weight was calculated separately for each length class. The average weight of fish ≤ 45 inches was determined using the modeling approach described above. This was possible because the selectivity function (probability of retaining a fish based on length) approaches the maximum of 0.95 around 45 inches. For the other two length classes, the average weight was assumed to equal the average weight of harvested fish in those length classes in 2010 when there was no size limit.

Because the logistic modeling is done as a function of length, it allows for calculations of release mortality for fish less than 26 inches (U26) and fish ≥ 26 inches (O26). This will allow for equal treatment of these components in the sport, commercial, and bycatch sectors.

The North Pacific Fishery Management Council's Scientific and Statistical Committee reviewed the logistic modeling approach and stated that it provided "reasonable" estimates of average weight given the lack of data. One problem inherent in this method is that the size distribution of released fish is truncated at the size of the smallest fish measured in the harvest sample. Undoubtedly, some halibut are released that are smaller than the smallest halibut retained and measured. Therefore, the method may in effect underestimate the numbers of U26 fish released and overestimate their average weight. It may also overestimate the numbers of O26 fish released, but probably has little effect on their average weight. The net effect is unknown, but likely is a minor source of error given all the other uncertainties in this approach.

³ The selectivity function was $s = 0.95 / (1 + \exp(-k(L - g)))$ where k is a slope parameter, L is the length in inches, and g is the inflection point. The theoretical maximum retention is 0.95, i.e., at least 5% of the largest fish captured were assumed to be released.

Results:

The regression approach produced charter release estimates of 47,279 fish in Area 2C and 102,311 fish in Area 3A. Time series forecasts of noncharter releases were 21,349 fish in Area 2C and 99,130 fish in Area 3A. The total sport releases were 68,628 fish in Area 2C and 201,441 fish in Area 3A.

Estimated average weights of the U26 portion of harvest were about 3.8 lb for Area 2C charter releases, 3.6 lb for 2C noncharter releases, 4.1 lb for 3A charter releases, and 3.9 lb for 3A noncharter releases. Average weights for the O26 releases in Area 2C were about 18.0 lb for charter releases and 10.2 lb for noncharter releases. By comparison, average weights of O26 fish in Area 3A were about 8.4 lb for charter releases and 7.9 lb for noncharter releases. The higher average weights in Area 2C are due to the reverse slot limit that requires release of charter-caught fish between 45 and 68 inches, and the presence of larger fish in general.

The preliminary estimates of sport fishery release mortality were 0.052 M lb in Area 2C and 0.074 M lb in Area 3A (Table 3). The charter sector accounted for 0.041 M lb, or about 79% of the Area 2C total, and 0.036 M lb, or 49% of the Area 3A total release mortality.

Adding preliminary estimates of total sport harvest (Table 2) and release mortality results in total sport fishery removals of 1.679 M lb in Area 2C and 3.789 M lb in Area 3A. Therefore, release mortality accounted for about 3% of total sport removals in Area 2C and about 2% in Area 3A.

Sport Harvest Prior to the Mean IPHC Survey Date: Areas 2C and 3A

This information is provided to aid the IPHC's adjustment to survey CPUE that is used to apportion estimated exploitable biomass among regulatory areas. The mean survey dates for 2013 were June 21 in Area 2C and July 3 in Area 3A.

Methods:

Separate methods were used to estimate charter and noncharter harvest prior to the mean survey date. The proportion of charter harvest taken prior to the mean survey date was averaged using logbook harvest data from the previous three years. The proportion of noncharter harvest taken prior to the mean survey date was based on harvest reported in dockside interviews. These proportions were calculated separately for each subarea of Area 2C and 3A and weighted by the 2013 projected harvest in each subarea to derive the overall proportion for the noncharter fishery. The total sport yield taken prior to the mean survey date was calculated by multiplying the charter and noncharter proportions by their respective projected yields for 2012 and summing.

Results:

An estimated 0.286 M lb of halibut were taken by the sport fishery in Area 2C prior to June 21, and about 1.551 M lb of halibut were taken in Area 3A prior to July 3 (Table 3). About 17.6% of the overall sport harvest was projected to have been taken prior to the mean survey date in Area 2C, compared with about 41.7% in Area 3A. These preliminary estimates will be updated next year once logbook and SWHS data are finalized.

We hope this information satisfies the IPHC's needs. Please feel free to contact us if you require clarification or additional information.

Sincerely;

(sent via email)

Scott Meyer, Mike Jaenicke, Diana Tersteeg, Barbi Failor

Fishery Biologists

Table 1. Final estimates of the 2012 sport halibut harvest (numbers of fish), average net weight (pounds), and yield (millions of pounds net weight) in Areas 2C, 3A, 3B, and 4. NA indicates no estimate is available.

IPHC Area	Sector	Harvest (no. fish)	Average Net Wt. (lb)	Yield (M lb)	95% CI for Yield (M lb)
Area 2C	Charter	42,436	14.3	0.605	0.540 - 0.672
	Noncharter	54,696	17.9	0.977	0.855 - 1.104
	Total	97,132	16.3	1.583	1.442 - 1.724
Area 3A	Charter	173,582	13.2	2.284	2.117 - 2.457
	Noncharter	113,359	11.8	1.341	1.212 - 1.475
	Total	286,941	12.6	3.626	3.411 - 3.841
Area 3B	Total	1,579	13.8 ^a	0.022	NA
Area 4	Total	2,061	13.8 ^a	0.028	NA

^a - No size data available from Areas 3B and 4; substituted average weight from Kodiak.

Table 2. Preliminary estimates of the 2013 sport halibut harvest (numbers of fish), average net weight (pounds), and harvest biomass (millions of pounds net weight) in Areas 2C, 3A, 3B, and 4. NA indicates no estimate is available.

IPHC Area	Sector	Harvest (no. fish)	Average Net Wt. (lb)	Yield (M lb)	95% CI for Yield (M lb)
Area 2C	Charter	51,196	14.1	0.723	0.583 - 0.863
	Noncharter	51,900	17.4	0.904	0.660 - 1.149
	Total	103,096	15.8	1.627	1.346 - 1.909
Area 3A	Charter	177,646	12.8	2.271	1.993 - 2.548
	Noncharter	120,819	12.0	1.444	1.165 - 1.724
	Total	298,465	12.4	3.715	3.322 - 4.109
Area 3B	Total	1,695	11.9 ^a	0.020	NA
Area 4	Total	2,061	11.9 ^a	0.025	NA

^a - No size data available from Areas 3B and 4; substituted average weight from Kodiak.

Table 3. Preliminary estimates of release mortality in sport fisheries in Areas 2C and 3A in 2013. Some columns may not add to the published totals due to rounding.

IPHC Area	Sector	Size Class	Estimated No. Halibut Released	Assumed Mortality Rate	Number Released that Died	Estimated Average Weight (lb)	Release Mortality (M lb)	
Area 2C	Charter	U26	11,926	6.0%	716	3.81	0.003	
		O26-U45	29,846	6.0%	1,791	8.94	0.016	
		O45-U68	4,984	6.0%	299	57.85	0.017	
		O68	522	6.0%	31	156.76	0.005	
	Noncharter	U26	8,417	7.0%	589	3.61	0.002	
		O26	12,932	7.0%	905	10.15	0.009	
	Total	U26	20,343	6.4%	1,305	3.72	0.005	
		O26	48,285	6.3%	3,026	15.67	0.047	
	Area 3A	Charter	U26	29,429	5.0%	1,471	4.11	0.006
			O26	72,881	5.0%	3,644	8.36	0.030
Noncharter		U26	38,193	6.0%	2,292	3.86	0.009	
		O26	60,937	6.0%	3,656	7.85	0.029	
Total		U26	67,621	5.6%	3,763	3.96	0.015	
		O26	133,818	5.5%	7,300	8.10	0.059	

Table 4. Estimated sport harvest prior to the mean IPHC survey date in 2013 in Areas 2C and 3A.

Area	Mean Survey Date	User group	Harvest Prior to mean Survey Date	
			Percent of Harvest	Harvest (M lb)
Area 2C	June 21	Charter	15.3%	0.111
		Noncharter	19.4%	0.175
		Total	17.6%	0.286
Area 3A	July 3	Charter	33.6%	0.764
		Noncharter	54.5%	0.787
		Total	41.7%	1.551

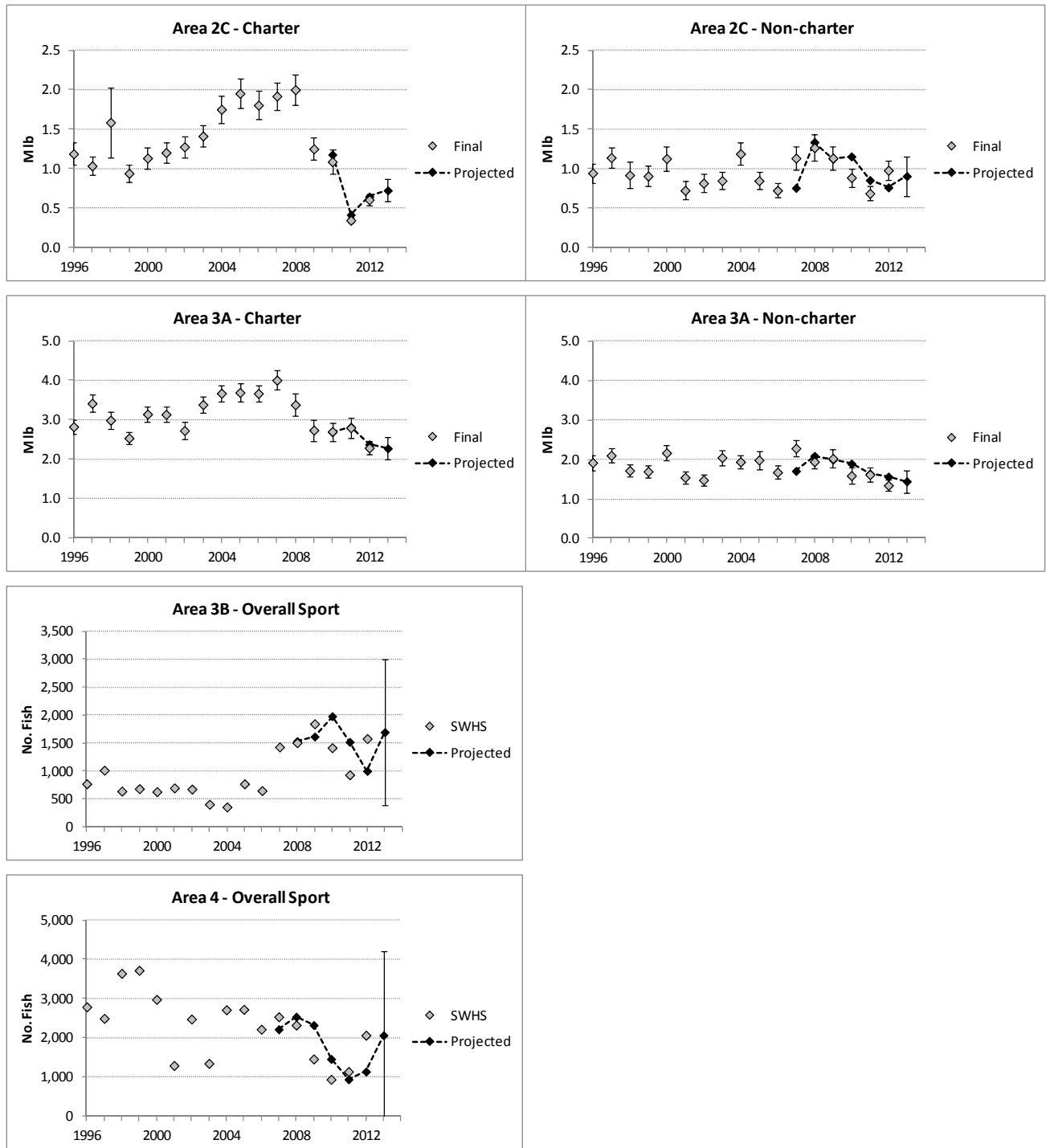


Figure 1. Comparison of final sport harvest estimates through 2012 for Areas 2C, 3A, 3B, and 4, and projections of sport harvest for recent years using the method selected for 2013 projections. The final estimates are from the ADF&G Statewide Harvest Survey (SWHS) and include 95% confidence intervals for Areas 2C and 3A. The 95% confidence intervals are also shown for 2013 projections.