STATE OF ALASKA

DEPARTMENT OF FISH AND GAME

DIVISION OF SPORT FISH

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~~November 4, 2011~~
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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 IPHC in the fall of each year in support of the IPHC annual stock assessment. This year's letter provides (1) revised estimates of 2009 sport harvest for Area 2C, (2) final harvest estimates for 2010 for Areas 2C and 3A, (3) harvest projections for 2011 for Areas 2C and 3A, (4) estimates of sport harvest taken prior to the mean IPHC longline survey date in Areas 2C and 3A in 2011, and (5) final estimates of 2010 harvest and projections of 2011 harvest for IPHC Areas 3B and 4.

Area 2C - Revised Estimates of 2009 Sport Harvest

Earlier this summer we discovered some length data from creel surveys in Southeast that were inadvertently omitted in the calculation of average net weight ("average weight" hereafter) of charter and non-charter halibut harvest at some ports in Area 2C. Inclusion of these data resulted in small changes in the estimates of average weight as well as harvest biomass, but we felt that these revisions were worthwhile. The vast majority of missing data were from Ketchikan. Inclusion of these data raised the total Ketchikan sample size from 455 to 1,016 length measurements. The charter average weight for Ketchikan was revised from about 21.3 lb to 22.0 lb, and the non-charter average weight was revised from 14.3 lb to 15.1 lb. The effect of these revisions on the Area 2C estimate of harvest biomass was relatively small. Charter harvest biomass for all of Area 2C was revised from 1.245 million pounds to 1.249 million pounds, and non-charter harvest was revised from 1.123 M lb to 1.133 M lb. (Table 1).

The standard errors of the average weight estimates were calculated using bootstrapping last year. During the revision process, we discovered that there were a large number of length data that could not be assigned to a particular vessel trip. Because this gap compromised the accuracy of bootstrap estimates, the standard errors of average weight for each subarea were calculated using methods for simple random sampling even though data were collected through cluster sampling. As a result, the standard errors for average weight and harvest biomass for Area 2C are probably underestimated. This issue was corrected in the 2010 final estimates.

Areas 2C and 3A - Final Estimates of 2010 Sport Harvest

In November 2010 we provided projections of the 2010 sport harvest for Areas 2C and 3A. This letter provides updated estimates based on final statewide harvest survey (SWHS) estimates (in numbers of

fish) and final estimates of average weight. These final Area 2C and 3A estimates were also posted on the North Pacific Fishery Management Council's web site in October of this year.

Methods:

For Area 2C and Area 3A, sport fishery harvest (pounds net weight) was calculated separately for the charter and non-charter (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 ADF&G statewide harvest survey (SWHS). The SWHS is currently the preferred method for estimating charter harvest and the only method available for estimating non-charter harvest. Average net weight was estimated from length measurements of halibut harvested at representative ports in Areas 2C and 3A. Ports sampled in Area 2C in 2010 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. Bootstrapping was used to estimate standard errors of harvest (in number of fish) and average weight.

Results:

The Area 2C overall sport harvest biomass (yield) in 2010 was estimated at 1.971 million pounds (Table 2). The charter harvest estimate was 1.086 M lb and the non-charter harvest estimate was 0.885 M lb. Charter harvest accounted for 55% of the Area 2C sport harvest by weight. Average net weight was estimated at 26.4 lb in the charter harvest, 16.7 lb for the non-charter harvest, and 20.9 lb overall. Sample sizes for estimation of average weight were 3,291 for the charter fishery and 3,047 for the non-charter fishery.

The 2010 estimated charter yield in Area 2C was down 13 percent from 2009. Although the charter average weight increased 13%, the number of fish harvested decreased by 23%. The non-charter removal was down 22 percent, the result of a 3% drop in average weight combined with a 19% drop in the number of fish harvested. The reasons for the declines in harvest are unknown, but probably due mostly to the economic recession. There were no changes to fishery regulations in 2010; the bag limit was one halibut of any size for the charter fishery and two fish of any size for the non-charter fishery. Charter captains and crew were not allowed to retain fish in Area 2C.

The Area 3A sport harvest was estimated at 4.285 M lb. Charter harvest was estimated at 2.698 M lb and non-charter harvest at 1.587 M lb (Table 2). The charter fishery accounted for about 63% of the Area 3A sport harvest. Average net weight was estimated at 15.2 lb for the charter fishery, 12.8 lb for the non-charter fishery, and 14.2 lb overall. Average weight was estimated from samples of 3,391 charter halibut and 2,396 non-charter halibut.

The estimated Area 3A charter yield was down about 1% from 2009, the net result of a 1.1 lb decrease in average weight combined with a 6% increase in the number of fish harvested. The non-charter yield was down 22%. Average weight in the non-charter harvest declined only about 0.7 lb, but the number of fish harvested declined 17%. There were no regulation changes in 2010. The daily bag limit was two halibut of any size for all sport anglers.

The 2010 final harvest estimates were considerably lower than the projections made last year for the charter and non-charter fisheries in both areas. Last year's projections were too high by about 18% for the 2C charter fishery, 43% for the 2C non-charter fishery, 11% for the 3A charter fishery, and 31% for the 3A non-charter fishery. The discrepancies in charter projections are explained largely by variation in the relationship between SWHS estimates and reported logbook harvest. The magnitude of projection errors for the non-charter fisheries is not surprising given the high variation in harvest from year to year.

Areas 2C and 3A - 2011 Harvest Projections

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 of lengths. These preliminary estimates have been a focus of attention by the North Pacific Fishery Management Council (NPFMC) and have been incorporated in decisions regarding allocation of halibut between the sport charter and commercial sectors, despite their limited accuracy. 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 are suitable given current data limitations.

Charter harvest projections for 2011 were again based on relative changes in reported logbook harvest from the previous year to the current year. The relative changes were applied to the final 2010 SWHS estimates of charter harvest. This method has been used to project charter harvests since 2008. Logbook data for trips made through July 31 or 2010 and 2011 were used for this analysis. Charter harvest was projected separately for each SWHS area and summed to obtain the harvest projections for each regulatory area as follows:

$$\hat{H}_{proj} = \sum_i r_i \hat{H}_i \hat{w}_i$$

where:

$\hat{H}_{proj}$ = the projected 2011 charter harvest by weight (lb) for the IPHC regulatory area,

r_i = the ratio of reported 2011/2010 logbook harvest through July 31, for SWHS area *i*,

$\hat{H}_i$ = the final 2010 SWHS halibut harvest estimate, in numbers of fish, for SWHS area *i*, and

$\hat{w}_i$ = the estimated average net weight of halibut harvested in SWHS area *i* in 2011.

Because this projection method is based on relative changes from year to year in the logbook harvest taken through July, this method assumes that the proportion of overall harvest through July was the same as the previous year. Logbook harvest reported through July ranged from 62% to 66% of the yearly total for Area 2C during the years 2006-2010. In Area 3A, the fraction of harvest through July declined from about 75% in 2006 to 68% in 2010. In both areas, however, the percentage of harvest taken through July was practically unchanged from 2009 to 2010.

Non-charter harvest was estimated by multiplying a time series forecast of harvest (in numbers of fish) by the 2011 estimated average weight for each SWHS area and summing across areas. Several methods were evaluated retrospectively for the period 2001-2010: (1) using the previous year's harvest, (2) linear trend projections based on the previous 2-6 years, and (3) single and double exponential projections by SWHS area and by IPHC regulatory area. Single and double exponential projections were made with Minitab® software, using the default smoothing parameters. Performance of the various projection methods was evaluated using the mean squared deviations (MSD) from the final SWHS estimates. The single-exponential method had the lowest MSDs and was selected for projecting 2011 non-charter harvest in both areas.

For the first time, we projected charter harvest separately for the Area 2C and 3A portions of the Glacier Bay SWHS area (Area G). In past years, the entire Area G estimated harvest from the SWHS was

attributed to IPHC Area 2C. Fish from Area 3A made up less than 1% of the Area G charter harvest (in numbers) in 2006 and 2007, 3% in 2008 and 2009, and 2% in 2010. In 2011, however, the Area 3A share of harvest in Area G increased to nearly 12% for trips reported through July. Given that Area G charter operators were fishing in Area 3A to avoid the one fish bag limit and 37-inch maximum size limit, it was prudent to calculate the 2C and 3A harvests for this area separately.

There is no straightforward method for calculating confidence intervals for the charter projections because of differences in the SWHS and logbook harvests. The logbook numbers through July 2011 will undergo error checking and editing. In addition, it is possible that some logbook records will be submitted late for this period. The relationship between logbook data and SWHS estimates is stronger for Area 2C than for Area 3A. Despite these issues, the logbook data represent the best index of changes in charter harvest from year to year and are superior to time series methods for projecting harvest. Private harvest is highly variable from year to year, which is problematic for time series projections. We characterized uncertainty in the projections by describing the range of retrospective projection errors using the method selected for this year's projections.

Results:

The number of halibut reported harvested by charter anglers in Area 2C through July 31, 2011 was about 1% higher than for the same period in 2010. Average weight in the charter fishery was down 64% because of the 37-inch maximum size limit imposed in 2011. The projected Area 2C charter yield for 2011 was 0.388 M lb (Table 3), and the preliminary estimate of average net weight was 9.4 lb. Retrospective charter harvest projections for 2008-2010 ranged from -4% to +18% of the final SWHS estimates for those years, with an average projection error of +6% (Figure 1). The projected yield for the non-charter fleet was 0.925 M lb, up slightly from last year's harvest estimate. Average weight of the non-charter harvest was 16.4 lb. This fishery was not constrained by a maximum size limit. Retrospective non-charter harvest projections for 2001-2010 using the single exponential method ranged from -16% to +27% of the final SWHS estimates, and averaged +4%. The overall projected sport fishery yield for Area 2C (charter and non-charter) was 1.313 M lb.

The reported charter harvest through July 2011 in Area 3A was up about 5% from the same period in 2010, and average weight was practically unchanged. The projected charter yield for Area 3A was ~~2.810~~ **2.837** M lb, and the average net weight was estimated at ~~15.1~~ **15.3** lb (Table 3). The errors in similar projections of Area 3A charter harvest for 2008-2010 ranged from -6% to +11%, with an average of +4%. The projected non-charter yield was 1.704 M lb, with an estimated average weight of 12.6 lb. Errors in projected non-charter harvest for the period 2001-2010 ranged from -28% to +28%, with an average of +2%. The overall projected sport fishery yield for Area 3A was ~~4.514~~ **4.541** M lb.

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

This information is provided as part of the IPHC's adjustment to survey CPUE that is used to apportion estimated exploitable biomass among regulatory areas. The mean survey dates for 2011 were July 4 in Area 2C and June 24 in Area 3A.

Methods:

Charter logbook data are not yet complete for the 2011 season. Therefore, the proportion of charter harvest taken prior to the mean survey date was estimated from a logistic model fit to the cumulative charter harvest (logbook data) through the last day of each month, averaged over the previous three years. The proportion of non-charter harvest taken prior to the mean survey date was based on harvest reported in dockside interviews. These proportions were calculated separately for each SWHS area and weighted by the 2011 projected number of fish harvested to derive the overall proportion for the non-charter fishery. The total sport harvest biomass taken prior to the mean survey date was calculated by multiplying the charter and non-charter proportions by their respective projected harvest biomass and summing.

Results:

For Area 2C, about 30.0% of charter harvest and 38.6% of non-charter harvest was taken prior to the mean survey date (Table 4). This resulted in an estimated 0.473 M lb of sport harvest taken prior to the mean survey date. In Area 3A, an estimate 24.6% of charter harvest and 28.0% of non-charter harvest was taken prior to the mean survey date. The total sport harvest taken prior to the mean date of the Area 3A survey was estimated at ~~1.169~~ **1.175** M lb.

Areas 3B and 4 - Final 2010 Harvest Estimates and 2011 Projections

Methods:

For Area 3B and Area 4, the final SWHS estimates are provided in numbers of fish only. 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 reported in Area 3B has ranged from 0 to 728 fish (average = 133). These harvests are not large, and it is more convenient to continue reporting these Area 3A harvests in Area 3B because the number of survey responses are not sufficient to apportion the harvest precisely among the charter and non-charter sectors. This error has more impact on the Area 3B sport harvest estimate than the Area 3A estimate, but the Area 3B sport harvest represents less than 0.5% of the total removals in that area.

Several projection methods were evaluated for these areas using retrospective analyses. For each area we evaluated (1) using the previous year's harvest, (2) linear trend projections based on the previous 2, 3, 4, 5, and 6 years, (3) single and double exponential time series forecasts, and (4) moving averages of the previous 2, 3, 4, and-5 years. Retrospective projections were compared for the period 1998-2010 for Area 3B and 1997-2010 for Area 4. Two-year moving averages had the lowest MSD values for both areas. Harvest in both areas has been highly variable, with a sharp upward trend in recent years in Area 3B. This variability makes it difficult to fit time series projections with much accuracy, and the choice of best method has sometimes changed from year to year. Retrospective projection errors are described for the 2-year moving average as an indication of the uncertainty inherent in these projections.

Results:

The final 2010 harvest estimate for Area 3B was 1,416 fish, and the final estimate for Area 4 was 936 fish (Table 5). We were not able to assess the precision of estimates for areas 3B and 4. However, the coefficient of variation for the SWHS harvest estimate for Area R (areas 3B and 4 combined) was 18%.

Harvest projections for 2011 are 1,630 fish in Area 3B and 1,196 fish in Area 4 (Table 4). Retrospective projection errors for the years 1993-2010 ranged from -51% to +70% in Area 3B (average = +2%) and from -34% to +159% in Area 4 (average = +18%) (Figure 1).

It is our understanding that the IPHC typically applies the Kodiak average weight to estimate sport harvest biomass in Area 3B and Area 4. The estimated average weights of the overall Kodiak sport harvest (charter and non-charter) were 16.7 lb for 2010 and 15.2 lb for 2011. Anecdotal reports from Dutch Harbor/Unalaska suggest a higher average weight, but we cannot provide any data specific to that area.

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. Revised estimates of the 2009 sport halibut harvest (numbers of fish), average net weight (pounds), and yield (millions of pounds net weight) in Area 2C.

Area and Estimate	Charter	Non-Charter	Total
Area 2C			
No. Fish	53,602	65,549	119,151
Average Net Wt (lb)	23.3	17.3	20.0
Yield (M lb)	1.249	1.133	2.383
95% CI (M lb)	1.111–1.388	0.992–1.275	2.208–2.558

Table 2. Final estimates of the 2010 sport halibut harvest (numbers of fish), average net weight (pounds), and yield (millions of pounds net weight) in Areas 2C and 3A.

Area and Estimate	Charter	Non-Charter	Total
Area 2C			
No. Fish	41,202	52,896	94,098
Average Net Wt (lb)	26.4	16.7	20.9
Yield (M lb)	1.086	0.885	1.971
95% CI (M lb)	0.935–1.237	0.769–1.000	1.796–2.145
Area 3A			
No. Fish	177,460	124,088	301,548
Average Net Wt (lb)	15.2	12.8	14.2
Yield (M lb)	2.698	1.587	4.285
95% CI (M lb)	2.470–2.925	1.395–1.779	3.987–4.582

Table 3. Preliminary estimates of the 2011 sport halibut harvest (numbers of fish), average net weight (pounds), and harvest biomass (millions of pounds net weight) in Areas 2C and 3A.

Area and Estimate	Charter	Non-Charter	Total
Area 2C			
No. Fish	41,209	56,354	97,563
Average Net Wt (lb)	9.4	16.4	13.5
Yield (M lb)	0.388	0.925	1.313
Projection Error Range	-4% to +18%	-16% to +27%	-4% to +22%
Area 3A			
No. Fish	185,691	134,724	320,415
Average Net Wt (lb)	~~15.1~~ **15.3**	12.6	~~14.1~~ **14.2**
Yield (M lb)	~~2.810~~ **2.837**	1.704	~~4.514~~ **4.541**
Projection Error Range	-6% to +11%	-28% to +28%	-5% to +14%

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

Area	Mean Survey Date	User group	Harvest Prior to mean Survey Date: Proportion of Harvest	Harvest Prior to mean Survey Date: Harvest (M lb)
Area 2C	July 4	Charter	30.0%	0.116
		Non-charter	38.6%	0.357
		Total	36.0%	0.473
Area 3A	June 24	Charter	24.6%	~~0.692~~ **0.698**
		Non-charter	28.0%	0.477
		Total	25.9%	~~1.169~~ **1.175**

Table 5. Final 2010 harvest estimates and 2011 projections for Areas 3B and 4 (numbers of fish).

Area	Number of Halibut Harvested: Final 2010	Number of Halibut Harvested: Projected 2011	Number of Halibut Harvested: Projection Error Range
Area 3B	1,416	1,630	-51% to +70%
Area 4	936	1,196	-34% to +159%

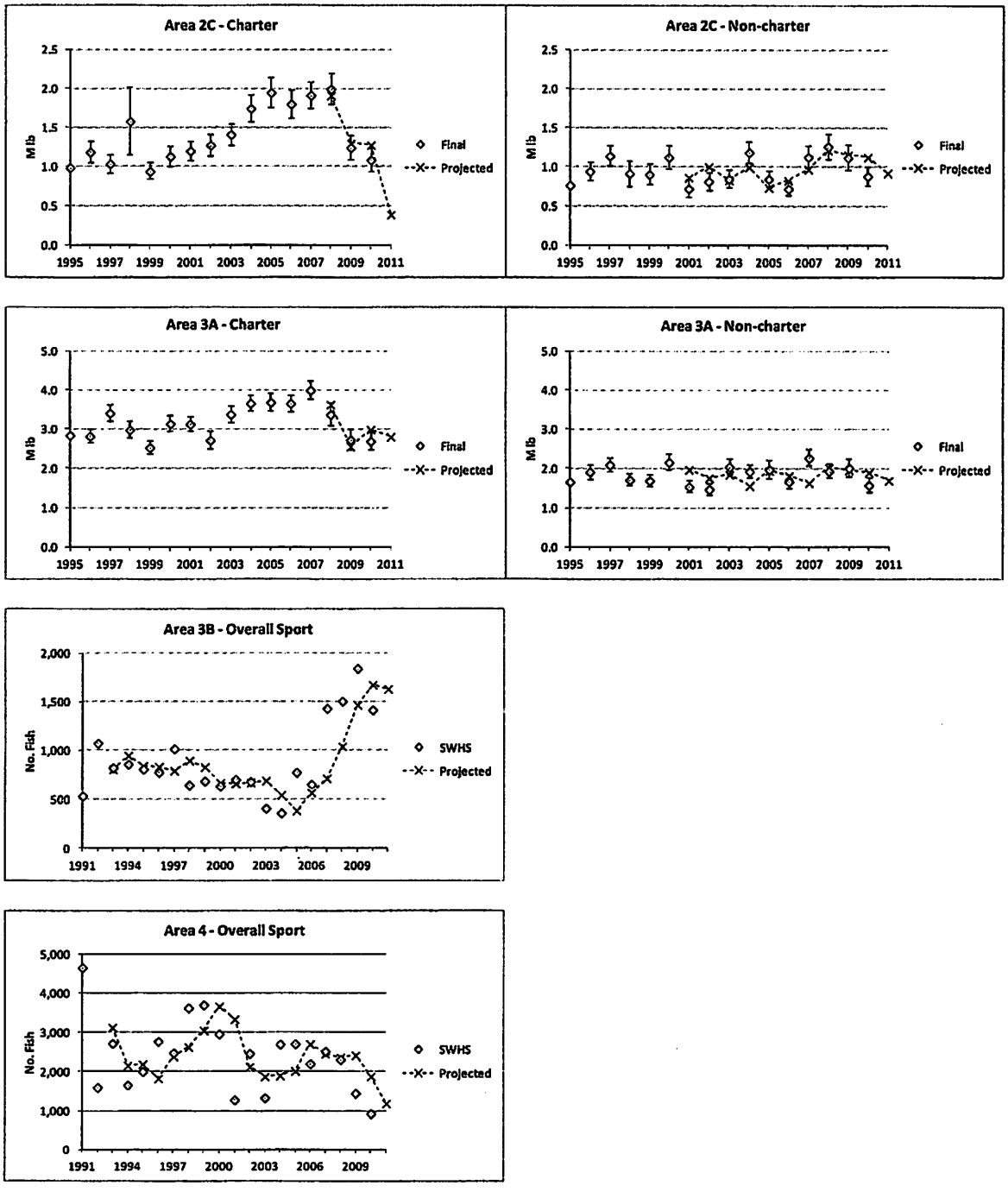


Figure 1. Comparison of final SWHS estimates and retrospective projections for IPHC Areas 2C, 3A, 3B, and 4 using the methods selected for projecting harvest in 2011. The Area 2C and 3A final harvest estimates include 95% confidence intervals. Estimates for Area 2C and 3A are presented by sector (charter, non-charter) and are in pounds net weight. Estimates for Areas 3B and 4 are for the overall sport fishery and are expressed in numbers of fish.

Final 2010 Sport Halibut Harvest Estimates
Alaska Department of Fish and Game

1. Area 2C Harvest:

Table 1.1. Area 2C sport halibut harvest estimates by harvest survey area, 2010.

	Charter			Non-Charter		
Area	Avg. Wt (lb)[a]	No. Fish	Yield (lb)	MeanWt (lb)	No. Fish	Yield (lb)
Ketchikan	22.1	3,174	70,164	13.5	7,254	97,933
Prince of Wales Island	14.8	9,480	140,415	11.7	11,933	140,040
Petersburg/Wrangell	34.6	3,731	129,276	21.2	7,920	167,865
Sitka	25.3	14,762	373,855	20.7	4,162	86,321
Juneau	16.2	3,302	53,518	15.0	11,993	180,378
Haines/Skagway	16.2	51	827	15.0	704	10,588
Glacier Bay	47.4	6,702	317,984	22.6	8,930	201,547
Area 2C	26.4	41,202	**1,086,038**	16.7	52,896	**884,672**

[a] – Average net weight, rounded to the nearest 0.1 lb.

Table 1.2. Approximate 95% confidence intervals for harvest estimates (million pounds).

User	Estimate	StdErr	Lower Limit	Upper Limit
Charter	1.086	0.077	0.935	1.237
Non-Charter	0.885	0.059	0.769	1.000
Overall	1.971	0.089	1.796	2.145

Table 1.3. Comparison of final estimates to October 2010 projections (million pounds).

User	Projection	Final	Projection Error (%)
Charter	1.279	1.086	+17.8%
Non-Charter	1.269	0.885	+43.4%
Overall	2.548	1.971	+29.3%

Table 1.4. Area 2C sport halibut harvest history.

	Charter				Non-Charter			Total Sport Harvest		
Year	No. Fish	Avg. Wt.	Yield (M lb)	GHL (M lb)	No. Fish	Avg. Wt.	Yield (M lb)	No. Fish	Avg. Wt.	Yield (M lb)
1995	49,615	19.9	0.986		39,707	19.3	0.765	89,322	19.6	1.751
1996	53,590	22.1	1.187		41,307	22.8	0.943	94,897	22.4	2.129
1997	51,181	20.2	1.034		53,205	21.4	1.139	104,386	20.8	2.172
1998	54,364	29.1	1.584	No GHL	42,580	21.5	0.917	96,944	25.8	2.501
1999	52,735	17.8	0.939		44,301	20.4	0.904	97,036	19.0	1.843
2000	57,208	19.7	1.130		54,432	20.6	1.121	111,640	20.2	2.251
2001	66,435	18.1	1.202		43,519	16.6	0.721	109,954	17.5	1.923
2002	64,614	19.7	1.275		40,199	20.3	0.814	104,813	19.9	2.090
2003	73,784	19.1	1.412	1.432	45,697	18.5	0.846	119,481	18.9	2.258
2004	84,327	20.7	1.750	1.432	62,989	18.8	1.187	147,316	19.9	2.937
2005	102,206	19.1	1.952	1.432	60,364	14.0	0.845	162,570	17.2	2.798
2006	90,471	19.9	1.804	1.432	50,520	14.3	0.723	140,991	17.9	2.526
2007	109,835	17.5	1.918	1.432	68,498	16.5	1.131	178,333	17.1	3.049
2008	102,965	19.4	1.999	0.931	66,296	19.1	1.265	169,261	19.3	3.264
2009	53,602	23.3	1.249	0.788	65,549	17.3	1.133	119,151	20.0	2.383
2010	41,202	26.4	1.086	0.788	52,896	16.7	0.885	94,098	20.9	1.971

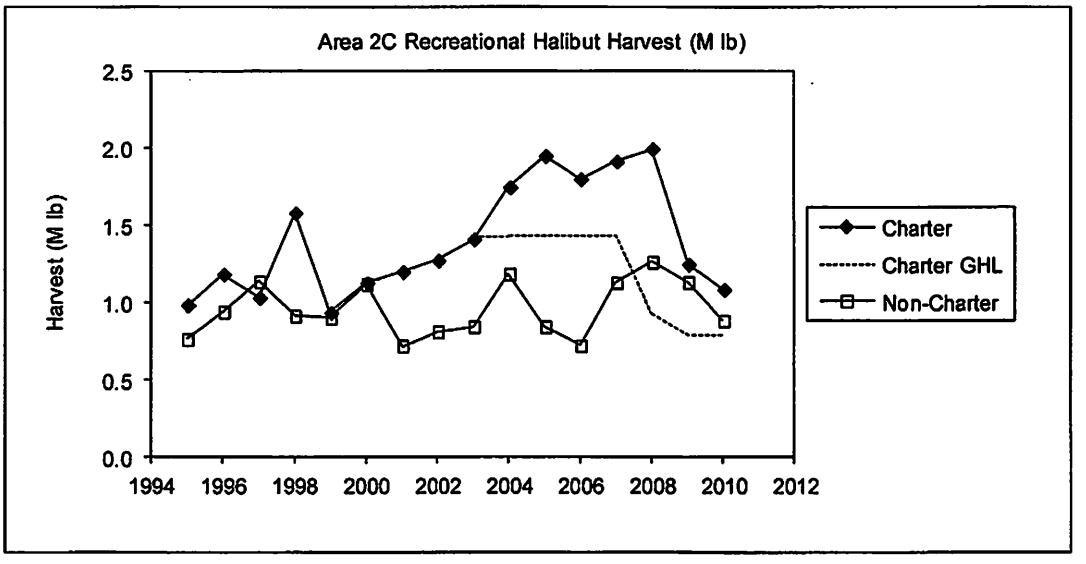


Table 1.5. Area 2C charter regulation history.

Year	Charter Regulations
1995-2005	Two-fish bag limit (no size restrictions), no limit on crew retention.
2006	Two-fish bag limit (no size limit), state EO prohibiting crew harvest 5/26-12/31.
2007	Two-fish bag limit (1 under 32" eff. 6/1), no crew retention 5/1-12/31 (State EO and Federal Rule).
2008	Two-fish bag limit (1 under 32"), except one-fish bag limit Jun 1-10 (halted by injunction).
2009	One fish (no size limit), no harvest by skipper & crew, line limit (effective June 5).
2010	One fish (no size limit), no harvest by skipper & crew, line limit.

2. Area 3A Harvest:

Table 2.1. Area 3A sport halibut harvest estimates by harvest survey area, 2010.

	Charter			Non-Charter		
Area	Avg. Wt (lb)[a]	No. Fish	Yield (lb)	MeanWt (lb)	No. Fish	Yield (lb)
Central Cook Inlet	15.5	45,781	708,126	12.5	29,022	363,626
Lower Cook Inlet	15.0	63,629	952,877	11.9	54,271	646,582
Kodiak	14.9	13,381	199,489	19.1	9,682	185,132
North Gulf Coast	12.0	33,359	401,486	10.8	16,618	179,244
Eastern PWS	24.4	8,843	216,121	12.2	5,503	67,294
Western PWS	12.0	8,511	102,160	16.3	6,468	105,452
Yakutat	29.7	3,956	117,523	15.6	2,524	39,442
Area 3A	15.2	177,460	**2,697,783**	12.8	124,088	**1,586,772**

[a] – Average net weight, rounded to the nearest 0.1 lb.

Table 2.2. Approximate 95% confidence intervals for harvest estimates (million pounds).

User	Estimate	StdErr	Lower Limit	Upper Limit
Charter	2.698	0.116	2.470	2.925
Non-Charter	1.587	0.098	1.395	1.779
Overall	4.285	0.152	3.987	4.582

Table 2.3. Comparison of final estimates to October 2010 projections (million pounds).

User	Projection	Final	Projection Error (%)
Charter	2.992	2.698	+10.9%
Non-Charter	2.077	1.587	+30.9%
Overall	5.068	4.285	+18.3%

Table 2.4. Area 3A sport halibut harvest history.

	Charter				Non-Charter			Total Sport Harvest		
Year	No. Fish	Avg. Wt.	Yield (M lb)	GHL (M lb)	No. Fish	Avg. Wt.	Yield (M lb)	No. Fish	Avg. Wt.	Yield (M lb)
1995	137,843	20.6	2.845		95,206	17.5	1.666	233,049	19.4	4.511
1996	142,957	19.7	2.822		108,812	17.6	1.918	251,769	18.8	4.740
1997	152,856	22.3	3.413		119,510	17.6	2.100	272,366	20.2	5.514
1998	143,368	20.8	2.985	No GHL	105,876	16.2	1.717	249,244	18.9	4.702
1999	131,726	19.2	2.533		99,498	17.0	1.695	231,224	18.3	4.228
2000	159,609	19.7	3.140		128,427	16.9	2.165	288,036	18.4	5.305
2001	163,349	19.2	3.132		90,249	17.1	1.543	253,598	18.4	4.675
2002	149,608	18.2	2.724		93,240	15.9	1.478	242,848	17.3	4.202
2003	163,629	20.7	3.382	3.650	118,004	17.3	2.046	281,633	19.3	5.427
2004	197,208	18.6	3.668	3.650	134,960	14.4	1.937	332,168	16.9	5.606
2005	206,902	17.8	3.689	3.650	127,086	15.6	1.984	333,988	17.0	5.672
2006	204,115	17.9	3.664	3.650	114,887	14.6	1.674	319,002	16.7	5.337
2007	236,133	16.9	4.002	3.650	166,338	13.7	2.281	402,471	15.6	6.283
2008	198,108	17.0	3.378	3.650	145,286	13.4	1.942	343,394	15.5	5.320
2009	167,599	16.3	2.734	3.650	150,205	13.5	2.023	317,804	15.0	4.758
2010	177,460	15.2	2.698	3.650	124,088	12.8	1.587	301,548	14.2	4.285

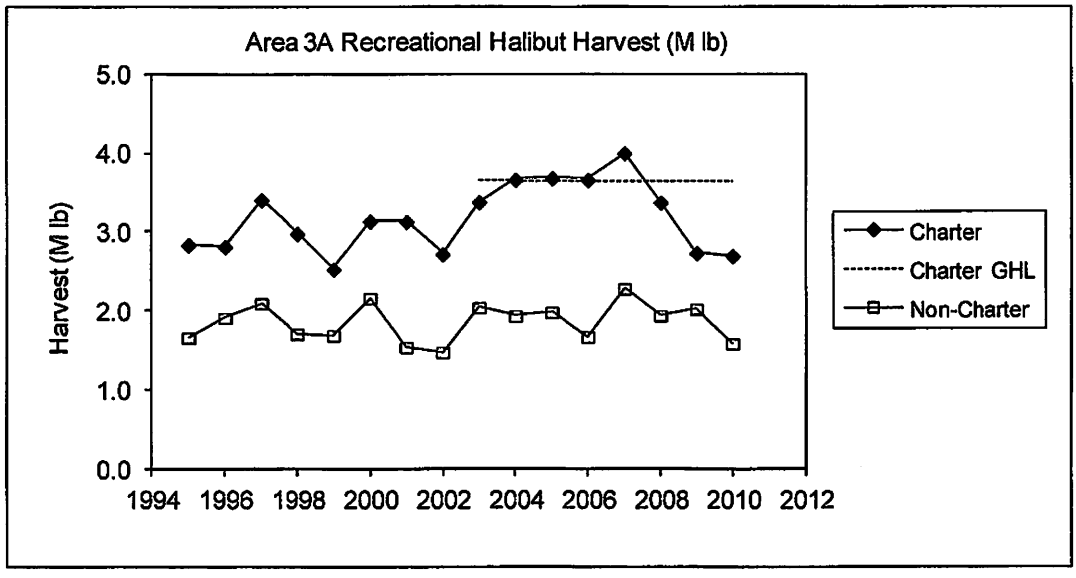


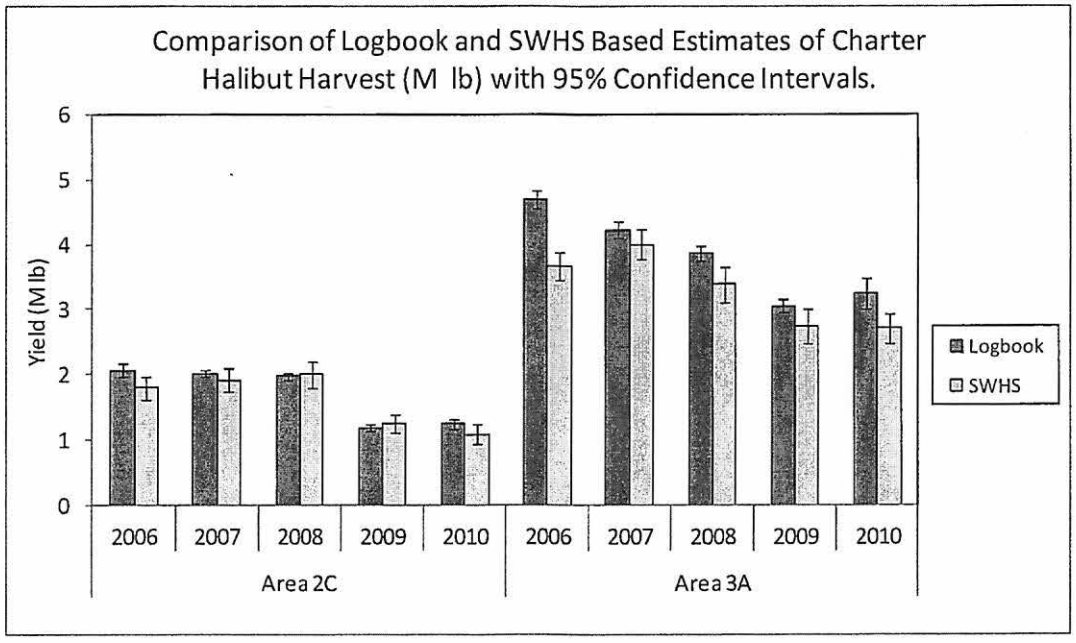
Table 2.5. Area 3A charter regulation history.

Year	Charter Regulations
1995-2006	Two-fish bag limit (no size restrictions), no limit on crew retention
2007	Two-fish bag limit (no size restrictions), state EO prohibiting crew harvest 5/1-12/31.
2008	Two-fish bag limit (no size restrictions), state EO prohibiting crew harvest 5/24-9/1.
2009	Two-fish bag limit (no size restrictions), state EO prohibiting crew harvest 5/23-9/1.
2010	Two-fish bag limit (no size restrictions), no limit on crew retention

3. Comparison of Logbook and Statewide Harvest Survey Estimates

Table 3.1. Comparison of estimates of charter halibut harvest biomass (yield) based on numbers of fish from logbooks and from Statewide Harvest Survey estimates, 2006-2010.

		Logbook		Statewide Harvest Survey	
Area	Year	Yield (M lb)	StdErr	Yield (M lb)	StdErr
2C	2006	2.063	0.052	1.804	0.089
	2007	2.015	0.028	1.918	0.085
	2008	1.974	0.025	1.999	0.099
	2009	1.187	0.022	1.249	0.071
	2010	1.249	0.040	1.086	0.077
3A	2006	4.689	0.072	3.664	0.108
	2007	4.229	0.059	4.002	0.120
	2008	3.865	0.063	3.378	0.142
	2009	3.044	0.055	2.734	0.133
	2010	3.238	0.123	2.698	0.116



Analysis of Management Options for the Area 2C Charter Halibut Fishery for 2012

A Report to the North Pacific Fishery Management Council, December 2012

Scott Meyer, Alaska Department of Fish and Game
November 28, 2011

Background

The North Pacific Fishery Management Council's Charter Implementation Committee met October 26, 2011 and requested that the Alaska Department of Fish and Game (ADF&G) analyze the following options for management measures for the Area 2C charter halibut fishery for 2012:

1. Maximum size limits,
2. Reverse slot limits, and
3. Closures on selected days of the week.

These management measures were analyzed with the goal of identifying choices under each option that would constrain the Area 2C charter harvest to within the guideline harvest level (GHL) defined in 50 CFR §300.65. Under this rule the GHL is specified based on the level of the Constant Exploitation Yield (CEY), which in turn is determined through the International Pacific Halibut Commission (IPHC) annual stock assessment. The CEY for 2012 is unknown at the time of this analysis. Because the Area 2C GHL is now set at its lowest possible level, viable options were identified for the current GHL of 788,000 lb as well as the next higher GHL of 931,000 lb. All analyses were done assuming a daily bag limit of one halibut.

Methods

2012 Harvest Forecast

The first step in the analysis was to forecast the number of halibut that will be harvested in each subarea of Area 2C in 2012, where the subareas are ADF&G Statewide Harvest Survey (SWHS) reporting areas. Harvest in Area 2C increased rather steadily through 2008 and then dropped abruptly in 2009 due to implementation of a one-fish bag limit and an economic slowdown (Figure 1). A suite of forecasting models were fit retrospectively to the time series of SWHS estimates for each subarea to see which method performed best over time. Two-year forecasts were initially done because the most recent final SWHS estimate was for 2010. No one method performed particularly well; all lagged about two years behind the trend and overshot the harvest substantially when it dropped in 2009. Given the recent dramatic shift in the charter harvest trajectory, it was decided instead to project 2012 harvest using simple methods that place more emphasis on the most recent years (since 2009). Two forecast options are provided for the 2012 charter harvest in each subarea of Area 2C: the first equals the 2011 projection, and the second is the average of the 2009-2010 final SWHS estimates and 2011 projection. Details of the 2011 charter harvest projection method are described in the November 11, 2011 ADF&G letter to the International Pacific Halibut Commission (IPHC). Logbook data indicate that harvest through July 2011 was similar to the same period in 2010, but there is a possibility that it might have been higher without the 37-inch maximum size limit. However, there is no way to know whether this is true, or how much higher it might have been. The 2011 projection is the most recent estimate of harvest and the three-year average reflects what appears to be relative stabilization at recent levels. These two forecasts were used as the basis of further calculations associated with size limits and closures on selected days of the week.

Maximum Size Limit

At the request of the committee, options for a maximum size limit were analyzed using the "hybrid method" described in a paper presented to the Council in June 2011 (Meyer 2011). At that meeting the Council approved a motion to recommend to the National Marine Fisheries Service that this method be used to set maximum size limits under the Catch Sharing Plan. This approach estimates the average weights associated with various maximum size limits using observed length frequency distributions of sport harvest. Length data for each subarea (Statewide Harvest Survey reporting area) from 2010 were used for this analysis. This is the most recent year in which there was no size limit in the charter halibut fishery. Use of 2010 data assumes that there has been no substantial change in the size structure of the population or charter fishery selectivity since then. The length frequency distributions of charter harvest were similar in 2009 and 2010, but substantially different in 2011 due to the imposition of a 37-inch maximum size limit (Figure 2).

The hybrid method assumes that the proportion of harvest below the size limit being analyzed will be the same as in the year upon which the data are based (2010), and that all fish above the maximum size limit will be replaced in the harvest with fish exactly at the maximum size limit. Because it is unlikely that such a large portion of the harvest will be exactly at the size limit, this method is conservative, i.e., it over-estimates the average weight. For example, the preliminary estimate of average length of the charter harvest in 2011 under the 37-inch size limit was only 30.5 inches (Figure 2). The hybrid method would have predicted an average net weight of 13.2 lb for the Area 2C harvest in 2011, but the preliminary estimate for 2011 was only 9.4 lb.

Once the average weights were determined for each subarea and size limit, they were multiplied by the projected harvest (in number) and summed to determine the Area 2C charter yield in pounds under each option. This approach assumed that the various maximum lengths considered will have no effect on the number of fish harvested. Although it is possible that size limits could affect effort and the number of fish harvested, there were insufficient data to attempt to model these relationships.

Reverse Slot Limit

A reverse slot limit is one in which harvest is allowed for fish under a relatively small maximum size limit and for fish over a relatively high minimum size limit. Analysis of reverse slot limits was also based on length-frequency data from the sport harvest in 2010. The average weight associated with each prospective length limit was calculated for each subarea of Area 2C as:

$$\hat{\bar{w}} = \left(\hat{p}_L \hat{\bar{w}}_L\right) + \left(\mathrm{h}\hat{p}_U \hat{\bar{w}}_U\right) + \left(\frac{\hat{p}_L}{\hat{p}_T}\hat{p}_C \hat{\bar{w}}_L\right) + \left(\frac{\mathrm{h}\hat{p}_U}{\hat{p}_T}\hat{p}_C \hat{\bar{w}}_U\right)$$

where

$\hat{p}_L$ = proportion of harvest (in numbers) ≤ the lower maximum length limit,

$\hat{\bar{w}}_L$ = the estimated average weight of fish ≤ the lower maximum length limit,

$\hat{p}_U$ = proportion of harvest (in numbers) ≥ the upper minimum length limit,

h = a multiplier to specify the degree of high-grading above the upper limit,

$\hat{\bar{w}}_U$ = the estimated average weight of fish ≥ the upper minimum length limit,

$\hat{p}_T$ = the total proportion of harvest ≤ the lower maximum length limit and ≥ the upper minimum length limit, or $\hat{p}_L + \mathrm{h}\hat{p}_U$, and

$\hat{p}_C$ = the proportion of harvest in the center of the distribution between the lower length limit and the upper length limit, or 1- $\hat{p}_T$.

Charter yield in pounds under each prospective slot limit was estimated by multiplying the average weight by the projected number of fish harvested in each subarea. This was done for both projected harvest levels described above.

This approach assumes that the proportions of harvest above or below the prospective upper and lower size limits will be the same as they were in 2010. It further assumes that there will be no decrease in harvest; all fish caught between the upper and lower size limits will be released and replaced in the harvest by fish above or below the size limits. With a high-grading multiplier of 1.0, the harvest between the limits is redistributed to the upper and lower tails proportional to their relative proportions of the harvest in 2010. It is possible that, under a reverse slot limit, anglers will have added incentive to harvest a large halibut that is above the upper minimum size limit. Therefore, results were also calculated with a high-grading multiplier of 1.2, which inflates the proportion of harvest in the upper tail, making it 20% higher than it was in 2010. The choice of 20% was arbitrary, chosen only to illustrate the sensitivity of the results to additional high-grading. There is no information to suggest that high-grading will occur specifically at this level. The high-grading multiplier could also be interpreted to reflect a change in the numbers of large fish available in the stock that might result in an increase in average weight in the harvest.

Day of the Week Closures

The effect of closing selected days of the week was examined using charter logbook data from the entire years 2008-2010. The average proportion of the harvest (numbers of fish) was calculated for each day of the week, and these proportions were added to estimate the harvest reductions associated with various combinations of two or three days closed per week. On the suggestion of Charter Implementation Committee members, the combinations of closed days were chosen to be non-consecutive to minimize rescheduling of charter trips to avoid the harvest restriction.

Results and Discussion

Harvest Projections

The Area 2C charter harvest projections for 2012 are 41,209 fish (equal to the 2011 projection) and 45,338 fish based on the recent 3-year average (Table 1). The Sitka area made up the highest percentage of harvest, followed by Prince of Wales and then Glacier Bay. The percentage of harvest in the Sitka area is about 6.5% higher in the 2011 projection than in the recent three year average, while the percentages in all other areas are slightly lower.

The harvest projection for 2011 was practically identical to the final SWHS estimate for 2010, due to the fact that there was no significant change in harvest reported in logbooks through July of 2011 compared to the same period in 2010. There is no way to know whether harvest in 2011 would have been higher without the 37-inch size limit.

Maximum Size Limit

The hybrid method predicts that if harvest in 2012 was similar in magnitude and distribution to 2011, the highest maximum size limit that would constrain charter harvest to the 788,000 lb GHL would be 47 inches (Table 2). At this harvest level, the highest size limit that would keep the harvest below the 931,000 lb GHL would be 55 inches. Under the higher harvest projection, the maximum size limits would have to be lowered to 44 inches for the 788,000 lb GHL and 49 inches for the 931,000 lb GHL.

As noted previously, the method used here is conservative in that it is likely to overestimate the average weight under each maximum size limit. Uncertainty in the choice of a size limit is therefore mainly a

function of the assumed level of harvest in each area and whether the 2010 length compositions are representative of harvest in 2012.

Potential effects of a maximum size limit are as follows:

- A maximum size limit is a fairly simple regulation and is effective at constraining the average weight. It requires a companion regulation to require that halibut are either landed whole or the carcass (frame) is retained as proof of size.
- Under a maximum size limit, anglers that catch trophy fish, including state or world records, are not legally able to retain those fish. This was the case in Area 2C in 2011.
- Anglers are not allowed to keep the larger fish, which may reduce angler demand in areas where large halibut are more abundant (e.g., Glacier Bay, Petersburg). A maximum size limit would be expected to have a relatively small effect on harvest in areas where a small fraction of the harvest was over the maximum size limit (e.g., Prince of Wales, Juneau).
- There may be additional incentive to target larger fish under higher maximum size limits due to the larger difference in weight for a given difference in length. Therefore, there may be additional handling and release mortality associated with higher size limits. At higher maximum sizes, it may become more difficult for anglers to measure fish to determine if they are legal. For example, a 49-inch halibut has an average round weight of over 56 lb. Fish near this size may experience rough handling in an attempt to bring them aboard a small boat to be measured precisely.

Reverse Slot Limit

Average weights and yield were calculated for a combination of prospective lower limits ranging from 35 inches to 45 inches (U35-U45), and upper limits in 2-inch increments ranging from 50 to 76 inches (O50-O76). The lower length limits of 35-45 inches correspond to round weights of 19-43 lb, and the upper limits of 50-76 inches correspond to round weights of 60-234 lb (Table 3).

In the first scenario with no additional high-grading, and using the lower harvest projection, a wide range of reverse slot limits with upper minimums ranging from 64 to 66 inches would constrain the harvest to less than a 788,000 lb GHL (Table 4). The upper minimums could be lowered to a range of 58 to 64 inches to stay within a 931,000 lb GHL. Using the higher harvest projection, acceptable upper limits range from 70 to 72 inches for a 788,000 lb GHL and 64 to 68 inches for a 931,000 lb GHL.

In the second scenario, where anglers would harvest 20% more fish above the upper limit, and under the lower harvest projection, viable upper minimum size limits range from 66 to 70 inches for a 788,000 lb GHL and 62 to 66 inches for a 931,000 lb GHL (Table 4). At the higher harvest projection, viable upper limits range from 72 to 74 inches for a 788,000 lb GHL and 64 to 70 inches for a 931,000 lb GHL.

Potential effects of a reverse slot limit include:

- Reverse slot limits allow anglers the opportunity to harvest exceptionally large fish. It is generally believed that this improves the charter industry's ability to market some types of charter trips, such as lodge stays or multi-day trips with an emphasis on larger fish. This regulation would also require retention of whole fish or carcasses to verify length.
- Because reverse slot limits provide opportunity to harvest exceptionally large fish, there may be some increase in the numbers of fish released that are below the upper minimum size limit. This could result in increased handling and release mortality.
- It may be challenging for charter operators to determine whether large fish near the upper size limit can be legally retained. Operators may need to buy or manufacture measuring devices that work outboard of the vessel in order to identify legal fish and release sublegal-size fish with

minimal handling. Fish that are very close to the upper minimum size limit may need to be brought aboard for a precise length measurement.

Day of the Week Closures

Without a size limit, the average weight in the charter harvest could be about 26.4 lb (net weight), based on the 2010 length distribution. This translates to a charter yield of 1.088 M lb under the lower harvest projection and 1.197 M lb under the higher harvest projection. Therefore, using the lower harvest projection, harvest would have to be reduced 28% percent to stay within a 788,000 lb GHL and 14% to stay within a 931,000 b GHL. Using the higher harvest projection, harvest would have to be reduced 34% percent to stay within a 788,000 lb GHL and 22% to stay within a 931,000 b GHL.

The average percentage of harvest on any day of the week during the years 2008-2010 ranged from 12.5% to 15.2% (Table 5). The lowest percentages tended to fall on weekends. Using the lower harvest projection, a single weekday (Mon-Fri) closure could potentially achieve the 14% reduction needed for a 931,000 lb GHL (Table 5). A two-day closure could potentially achieve the 28% reduction needed to stay within the 788,000 lb GHL (Table 6). Using the higher harvest projection, a two-day closure could potentially reduce harvest by at least 22% in order to stay within the 931,000 lb GHL, but a three-day closure would be required to reduce harvest by at least 34% to stay within a 788,000 lb GHL. (Table 6).

Potential effects of daily closures include:

- The regulation is straightforward and easy to understand. It would not be expected to result in additional high-grading. The lack of a size limit may encourage more cleaning at sea, which increases the potential for bias in estimates of average weight.
- Daily closures may be difficult to enforce. Boats in the Glacier Bay, Juneau, or Sitka areas that hold Area 3A permits would continue to fish that area. In this instance it may be difficult for enforcement personnel to verify the area of capture. It may also be difficult to verify the date of capture for fish taken on multi-day charters.
- The projected effect of daily closures may be overestimated to the degree that charter anglers can rebook to avoid the closures. If multiple day closures are needed, it may be more difficult for charter businesses to avoid closures if the closures are implemented on non-consecutive days.

Summary

Two alternative charter harvest projections were provided for Area 2C for 2012. The lower level projection of 41,209 fish was equal to the preliminary harvest projection for 2011. The higher projection of 45,338 fish was the average of the 2009, 2010, and projected 2011 harvest.

Three management measures were analyzed for the Area 2C charter fishery at the request of the Council's Charter Implementation Committee: (1) maximum size limits, (2) reverse slot limits, and (3) closures on selected days of the week. These options were analyzed assuming the length-frequency distributions from the 2010 charter harvest would be representative of the harvest distributions in 2012 in the absence of a size limit. All options were analyzed assuming a charter daily bag limit of one halibut. A further assumption in analysis of size limits was that the number of fish harvested was independent of the management measure, or that fish of a prohibited length would be replaced in the harvest by fish of a legal size.

For each management measure, a wide range of options restricted the charter yield to a level that was less than or equal to a GHL of either 788,000 lb or 931,000 lb. The least restrictive size limits or daily closures that achieved that objective are listed in Table 7. Viable measures are listed for both projected harvest levels and for both potential GHLs.

Maximum size limits were calculated with a method that assumes that all fish of a prohibited length will be replaced by fish equal to the lower size limit. Therefore, the maximum size limits corresponding to each harvest level are felt to be conservative. Reverse slot limits were calculated by replacing harvest between the upper and lower limits with legal-size fish above the upper limit and below the lower limit, in proportion to their occurrence in the harvest. Reverse slot limits were also calculated assuming 20% more fish would be harvested in the upper legal size range. The 20% figure was chosen arbitrarily to show the effect on the results, rather than to suggest that this specific level of high-grading might occur.

References

Meyer, S. C. 2011. Methods for establishing maximum size limits for the charter fishery under the halibut catch sharing plan. A report to the North Pacific Fishery Management Council, June 2011. Alaska Department of Fish and Game, Anchorage.

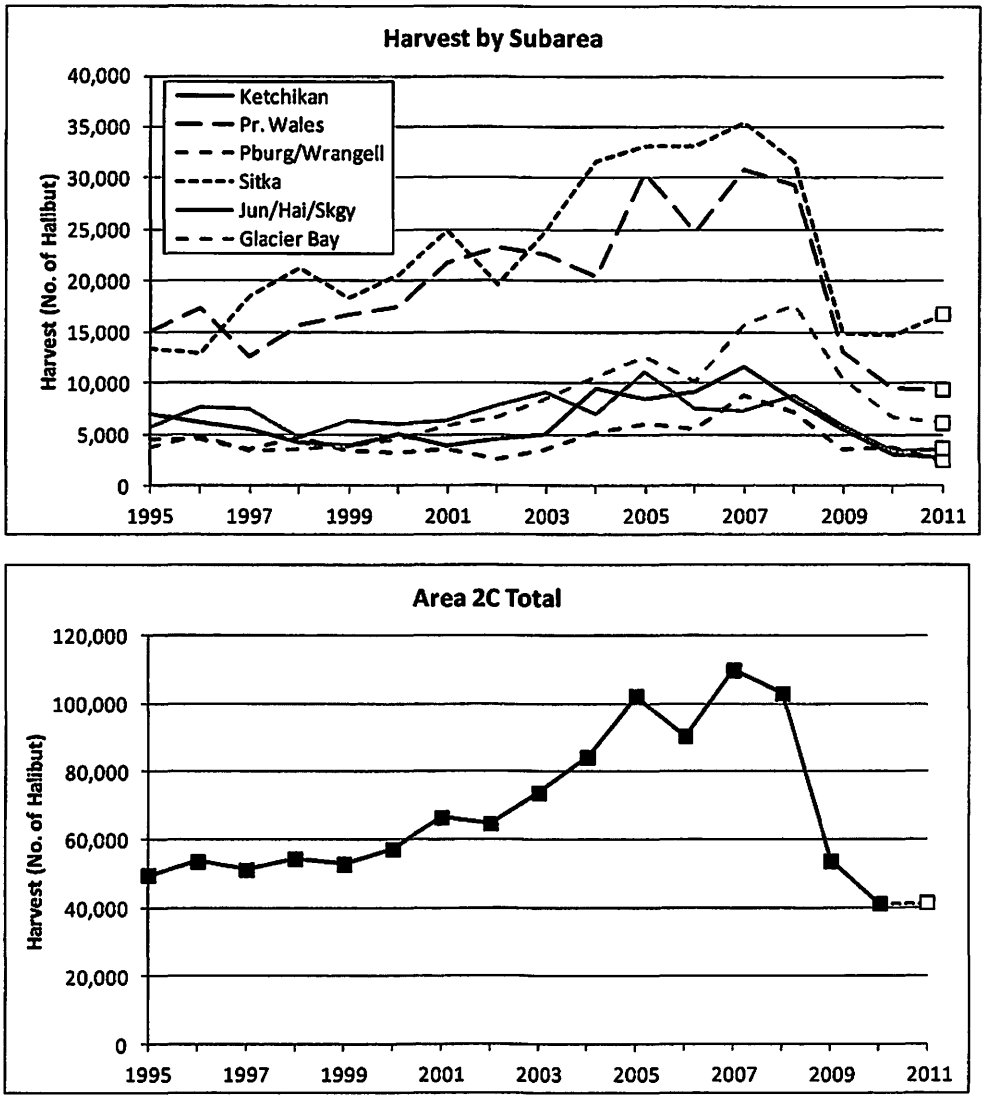


Figure 1. Estimated number of halibut harvested by charter anglers in Area 2C, 1995-2011. All estimates are final estimates from the ADF&G Statewide Harvest Survey except 2011, which are projections based on the change in charter harvest reported in logbooks through July from 2010 to 2011 (open squares).

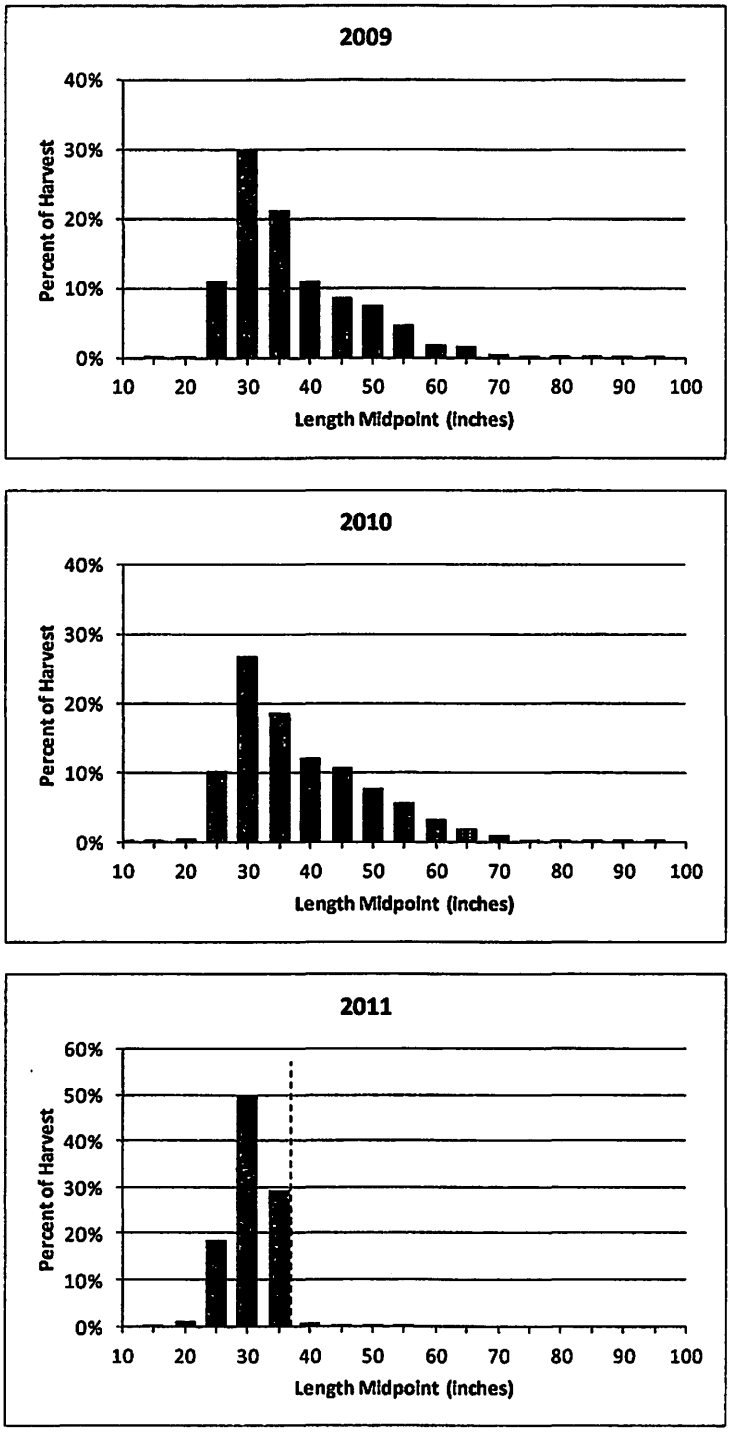


Figure 2. Comparison of estimated length-frequency distributions of charter halibut harvest in Area 2C, 2009-2011. The vertical dashed line references the 37-inch maximum size limit in place in 2011.

Table 1. Two alternative projections of charter halibut harvest (number of fish) by subarea for Area 2C in 2012.

	2011 Logbook Projection		Average of 2009-2011 Harvest	
Subarea	Harvest	Percent	Harvest	Percent
Ketchikan	2,832	6.9%	3,858	8.5%
Prince of Wales Island	9,356	22.7%	10,658	23.5%
Petersburg/Wrangell	2,459	6.0%	3,266	7.2%
Sitka	16,723	40.6%	15,468	34.1%
Juneau/Haines/Skagway	3,665	8.9%	4,304	9.5%
Glacier Bay	6,174	15.0%	7,784	17.2%
Total	41,209		45,338	

Table 2. Projected charter yield of halibut in Area 2C under various maximum size limits, calculated using the "hybrid" method applied to the length composition of the charter halibut harvest in 2010. Yield was calculated for harvest levels of 41,209 fish (2011 logbook-based projection) and 45,338 fish (2009-2011 average). Shaded cells indicate the largest maximum size limit for which the yield is less than a 788,000 lb GHL (shading) or less than a 931,000 lb GHL (boxes).

	Yield (M lb) when Harvest is:	
Maximum Size Limit (in)	41,209 fish	45,338 fish
37	0.530	0.586
38	0.557	0.616
39	0.583	0.645
40	0.609	0.675
41	0.634	0.703
42	0.660	0.731
43	0.684	0.759
44	0.709	0.787
45	0.732	0.813
46	0.755	0.838
47	0.777	0.863
48	0.798	0.887
49	0.818	0.910
50	0.838	0.932
51	0.857	0.953
52	0.875	0.972
53	0.891	0.991
54	0.907	1.008
55	0.921	1.025
56	0.935	1.040
57	0.947	1.054
58	0.959	1.067

Table 3. Average net weight (headed and gutted) and round weight associated with various lengths of Pacific halibut, based on the IPHC length-weight relationship.

Length (in)	Net Weight (lb)	Round weight (lb)
35	14	19
36	16	21
37	17	23
38	19	25
39	20	27
40	22	29
41	24	32
42	26	34
43	28	37
44	30	40
45	32	43
46	35	46
47	37	49
48	40	53
49	42	56
50	45	60
51	48	64
52	51	68
53	55	73
54	58	77
55	62	82
56	65	87
57	69	92
58	73	98
59	78	103
60	82	109
61	86	115
62	91	121
63	96	128
64	101	134
65	106	141
66	111	148
67	117	156
68	123	163
69	129	171
70	135	179
71	141	188
72	148	197
73	155	206
74	161	215
75	169	224
76	176	234

Table 4. Projected charter yield of halibut in Area 2C under various reverse slot length limits. Results are shown for two scenarios: one in which there is no additional high-grading, or targeting of halibut above the upper size limit, and one in which high-grading results in a 20% increase in harvest above the upper size limit. Results are also shown for harvest levels of 45,338 fish (2009-2011 average) and 41,209 fish (2011 logbook-based projection). Shaded cells indicate the largest maximum size limit for which the yield is less than a 788,000 lb GHL (shading) or less than a 931,000 lb GHL (boxes).

Scenario – No high-grading

Harvest Level = 41,209

Upper (minimum) Size Limit (in)	Lower (maximum) Size Limit (in)										
	35	36	37	38	39	40	41	42	43	44	45
50	1.200	1.156	1.132	1.104	1.092	1.074	1.061	1.051	1.045	1.042	1.044
52	1.186	1.137	1.111	1.081	1.067	1.048	1.033	1.022	1.016	1.015	1.017
54	1.159	1.108	1.080	1.049	1.035	1.016	1.002	0.991	0.986	0.985	0.989
56	1.113	1.061	1.035	1.004	0.991	0.972	0.959	0.949	0.945	0.946	0.951
58	1.073	1.021	0.994	0.963	0.952	0.934	0.922	0.913	0.910	0.912	0.918
60	1.035	0.982	0.955	0.925	0.915	0.898	0.887	0.880	0.877	0.881	0.888
62	0.971	0.923	0.897	0.869	0.861	0.847	0.837	0.831	0.831	0.836	0.845
64	0.882	0.840	0.818	0.795	0.790	0.781	0.775	0.773	0.775	0.782	0.794
66	0.826	0.790	0.771	0.752	0.750	0.743	0.739	0.739	0.742	0.751	0.765
68	0.763	0.737	0.721	0.707	0.709	0.706	0.706	0.707	0.713	0.724	0.739
70	0.706	0.687	0.675	0.666	0.669	0.670	0.672	0.676	0.683	0.696	0.711
72	0.663	0.652	0.642	0.637	0.643	0.646	0.650	0.655	0.663	0.677	0.693
74	0.602	0.603	0.597	0.598	0.607	0.613	0.620	0.627	0.637	0.652	0.670
76	0.573	0.576	0.573	0.576	0.586	0.594	0.602	0.610	0.621	0.636	0.655

Harvest Level = 45,338

Upper (minimum) Size Limit (in)	Lower (maximum) Size Limit (in)										
	35	36	37	38	39	40	41	42	43	44	45
50	1.361	1.310	1.282	1.249	1.233	1.211	1.194	1.181	1.173	1.169	1.170
52	1.351	1.294	1.262	1.225	1.208	1.184	1.165	1.151	1.143	1.140	1.141
54	1.326	1.265	1.232	1.193	1.176	1.151	1.132	1.118	1.110	1.108	1.111
56	1.281	1.219	1.186	1.146	1.130	1.106	1.088	1.075	1.068	1.067	1.071
58	1.241	1.177	1.143	1.103	1.088	1.065	1.048	1.036	1.030	1.031	1.037
60	1.198	1.133	1.099	1.060	1.045	1.024	1.008	0.998	0.993	0.996	1.003
62	1.129	1.067	1.034	0.998	0.985	0.966	0.953	0.944	0.942	0.946	0.955
64	1.027	0.973	0.944	0.913	0.905	0.892	0.883	0.878	0.879	0.886	0.898
66	0.966	0.918	0.892	0.865	0.861	0.850	0.844	0.841	0.844	0.853	0.866
68	0.888	0.852	0.830	0.811	0.810	0.805	0.803	0.803	0.808	0.820	0.835
70	0.818	0.791	0.774	0.760	0.763	0.762	0.763	0.765	0.773	0.786	0.802
72	0.769	0.752	0.737	0.728	0.733	0.735	0.738	0.742	0.751	0.765	0.783
74	0.696	0.694	0.684	0.682	0.691	0.697	0.704	0.710	0.721	0.737	0.756
76	0.660	0.661	0.654	0.655	0.665	0.673	0.682	0.689	0.701	0.718	0.738

(continued)

Table 4. Continued (2 of 2).

Scenario – 20% high-grading

Harvest Level = 41209

Upper (minimum) Size Limit (in)	Lower (maximum) Size Limit (in)										
	35	36	37	38	39	40	41	42	43	44	45
50	1.280	1.234	1.208	1.179	1.165	1.147	1.132	1.120	1.113	1.109	1.109
52	1.269	1.218	1.190	1.158	1.142	1.121	1.105	1.093	1.085	1.081	1.082
54	1.244	1.189	1.160	1.126	1.110	1.089	1.072	1.060	1.052	1.050	1.051
56	1.196	1.141	1.112	1.078	1.063	1.042	1.026	1.014	1.008	1.006	1.009
58	1.156	1.100	1.070	1.036	1.022	1.001	0.986	0.975	0.969	0.969	0.974
60	1.118	1.060	1.030	0.996	0.982	0.963	0.948	0.938	0.934	0.935	0.941
62	1.050	0.996	0.967	0.934	0.923	0.905	0.892	0.884	0.881	0.884	0.892
64	0.955	0.906	0.880	0.852	0.845	0.832	0.823	0.817	0.817	0.823	0.833
66	0.893	0.850	0.827	0.803	0.798	0.788	0.781	0.778	0.780	0.787	0.799
68	0.824	0.791	0.771	0.753	0.752	0.746	0.743	0.742	0.746	0.755	0.769
70	0.760	0.735	0.719	0.705	0.707	0.705	0.704	0.706	0.711	0.722	0.737
72	0.711	0.695	0.682	0.672	0.676	0.676	0.678	0.681	0.688	0.700	0.716
74	0.640	0.637	0.629	0.626	0.633	0.638	0.643	0.648	0.657	0.671	0.688
76	0.607	0.607	0.601	0.600	0.609	0.615	0.622	0.628	0.638	0.653	0.670

Harvest Level = 45,338

Upper (minimum) Size Limit (in)	Lower (maximum) Size Limit (in)										
	35	36	37	38	39	40	41	42	43	44	45
50	1.447	1.395	1.366	1.331	1.314	1.291	1.273	1.258	1.249	1.243	1.242
52	1.442	1.383	1.350	1.311	1.292	1.266	1.245	1.229	1.219	1.214	1.213
54	1.420	1.356	1.321	1.279	1.260	1.233	1.211	1.195	1.185	1.181	1.181
56	1.374	1.308	1.273	1.231	1.212	1.184	1.163	1.148	1.139	1.136	1.138
58	1.336	1.267	1.230	1.187	1.168	1.141	1.121	1.106	1.098	1.097	1.100
60	1.294	1.223	1.185	1.141	1.123	1.098	1.079	1.065	1.058	1.058	1.063
62	1.221	1.152	1.116	1.073	1.058	1.034	1.017	1.005	1.000	1.002	1.009
64	1.114	1.051	1.018	0.981	0.969	0.951	0.938	0.930	0.929	0.934	0.944
66	1.046	0.990	0.959	0.927	0.918	0.904	0.894	0.888	0.888	0.895	0.907
68	0.961	0.917	0.891	0.865	0.862	0.853	0.847	0.844	0.847	0.857	0.871
70	0.884	0.850	0.827	0.808	0.808	0.803	0.801	0.801	0.806	0.818	0.833
72	0.827	0.804	0.785	0.771	0.773	0.772	0.772	0.774	0.781	0.793	0.810
74	0.743	0.736	0.723	0.717	0.724	0.728	0.732	0.736	0.746	0.760	0.779
76	0.702	0.699	0.688	0.685	0.694	0.700	0.706	0.712	0.722	0.738	0.757

Table 5. Proportion of Area 2C charter halibut harvest by day of the week, 2008-2010 (ADF&G charter logbook data).

	Percent of the Number of Fish Harvested						
Year	Mon	Tue	Wed	Thu	Fri	Sat	Sun
2008	14.7%	14.5%	15.4%	14.9%	13.8%	13.0%	13.8%
2009	14.4%	15.7%	15.5%	14.5%	14.7%	12.6%	12.6%
2010	15.3%	15.3%	14.2%	15.2%	15.1%	11.9%	13.1%
Average	14.8%	15.2%	15.1%	14.9%	14.5%	12.5%	13.1%

Table 6. Harvest reductions associated with closures of the Area 2C charter halibut fishery for two days per week (A), and for all possible combinations of three days per week in which no two days are consecutive (B).

A. Reductions associated with combinations of two days.

	Mon	Tue	Wed	Thu	Fri	Sat
Mon	--	--	--	--	--	--
Tue	30%	--	--	--	--	--
Wed	30%	30%	--	--	--	--
Thu	30%	30%	30%	--	--	--
Fri	29%	30%	30%	29%	--	--
Sat	27%	28%	28%	27%	27%	--
Sun	28%	28%	28%	28%	28%	26%

B. Reductions associated with all possible combinations of 3 days (without consecutive days).

Closure	Harvest Reduction
Mon-Wed-Fri	44%
Mon-Wed-Sat	42%
Mon-Thu-Sat	42%
Tue-Thu-Sat	42%
Tue-Thu-Sun	43%
Tue-Fri-Sun	43%
Wed-Fri-Sun	43%

Table 7. Summary of the least restrictive size limits and daily closures that are projected to result in charter harvests that are under the Area 2C guideline harvest level (GHL) for two projected levels of harvest.

Projected Harvest (number of fish)	Management Measure Combined with 1-Fish Daily Bag Limit	Potential Area 2C Charter GHL (depends on outcome of IPHC stock assessment)	
		GHL = 788,000 lb	GHL = 931,000 lb
41,209 (2011 projection)	Maximum Size Limit	47 inches	55 inches
	Reverse Slot Limit (no additional high-grading)	U35-36/O68 U37-39/O66 U40-44/O64 U45/O66	U35/O64 U36-37/O62 U38-40/O60 U41-45/O58
	Reverse Slot Limit (with20% additional high-grading)	U35-36/O70 U37-39/O68 U40-44/O66 U45/O68	U35/O66 U36-38/O64 U39-45/O62
	Day of the Week Closure (no size limit)	Close 2 days	Close 1 weekday
45,338 (2009-2011 average)	Maximum Size Limit	44 inches	49 inches
	Reverse Slot Limit (no additional high-grading)	U35-36/O72 U37-44/O70 U45/O72	U35/O68 U36-37/O66 U38-45/O64
	Reverse Slot Limit (with 20% additional high-grading)	U35-36/O74 U37-43/O72 U44-45/O74	U35/O70 U36-37/O68 U38-41/O66 U42-43/O64 U44-45/O66
	Day of the Week Closure (no size limit)	Close 3 days	Close 2 days

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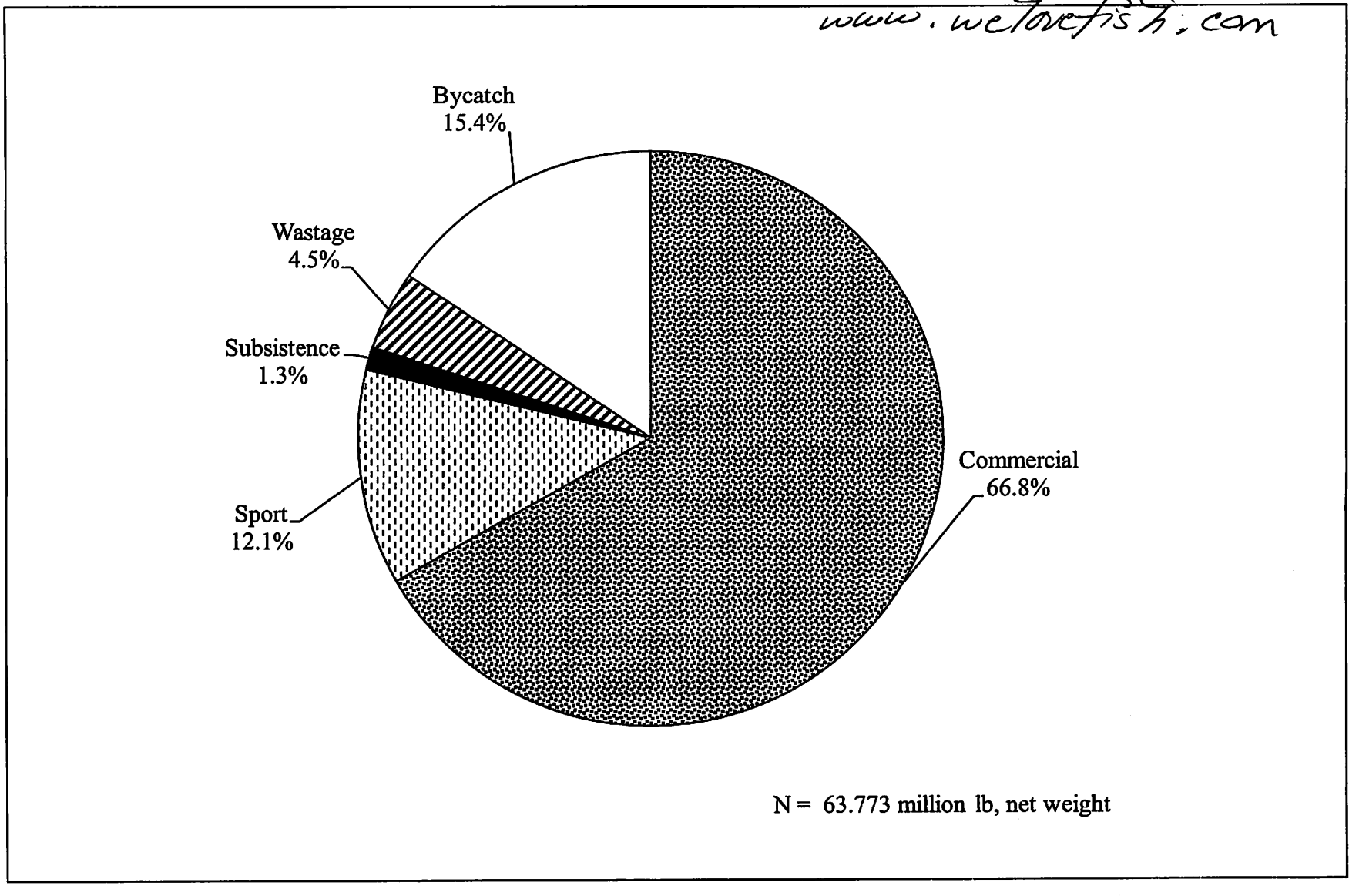


Figure 33.–Halibut removals, Alaska, 2010.

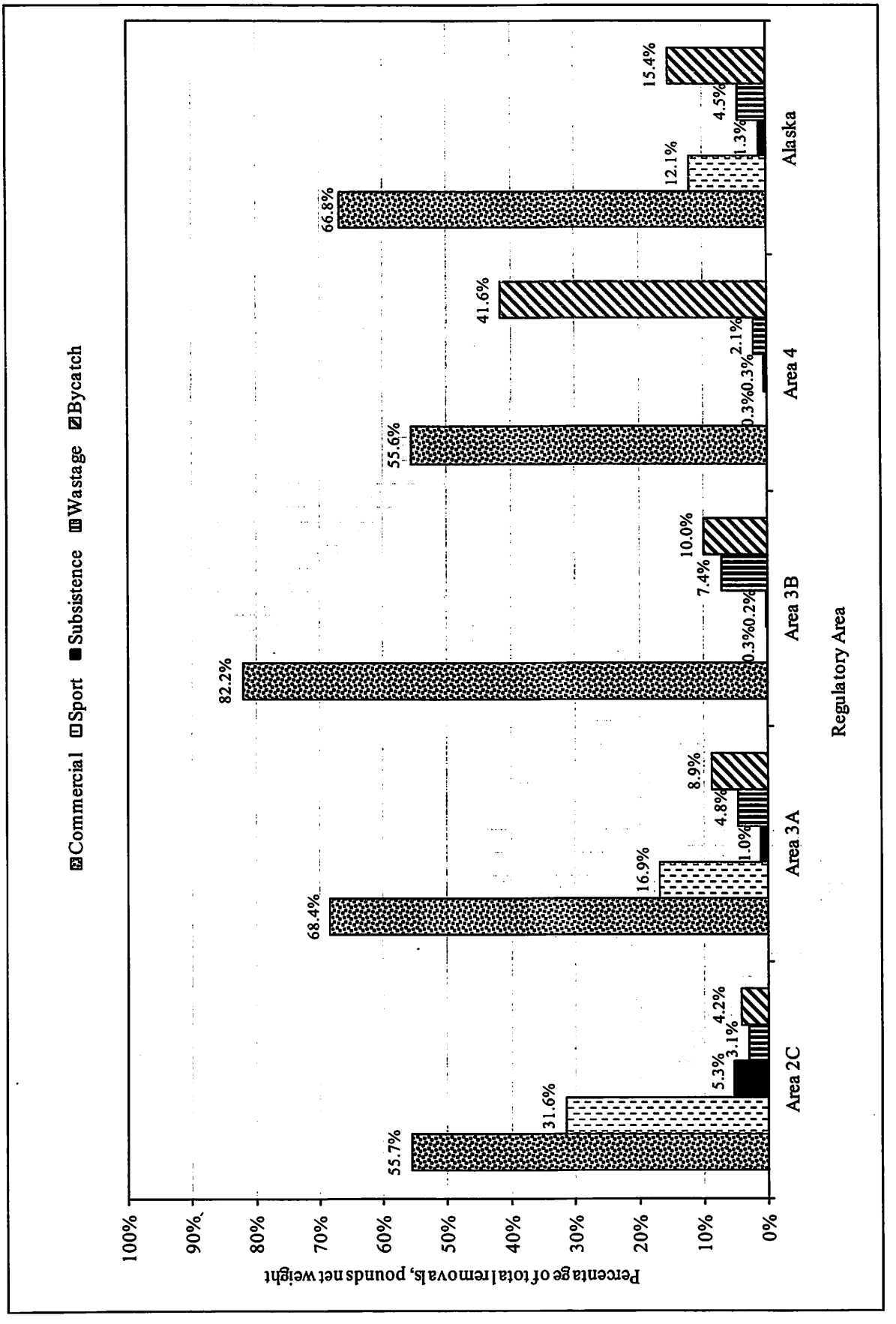


Figure 34.–Halibut removals in Alaska by regulatory area and removal category, 2010.

IPHC REPORT ON THE 2011 HALIBUT ASSESSMENT AND 2012 STAFF RECOMMENDATIONS

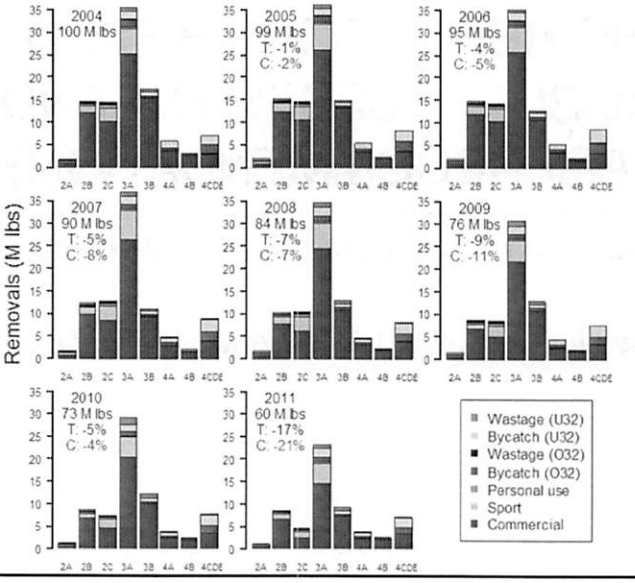
Steven R. Hare, with contributions by IPHC Staff

(Edited for December 2012 NPFMC presentation)

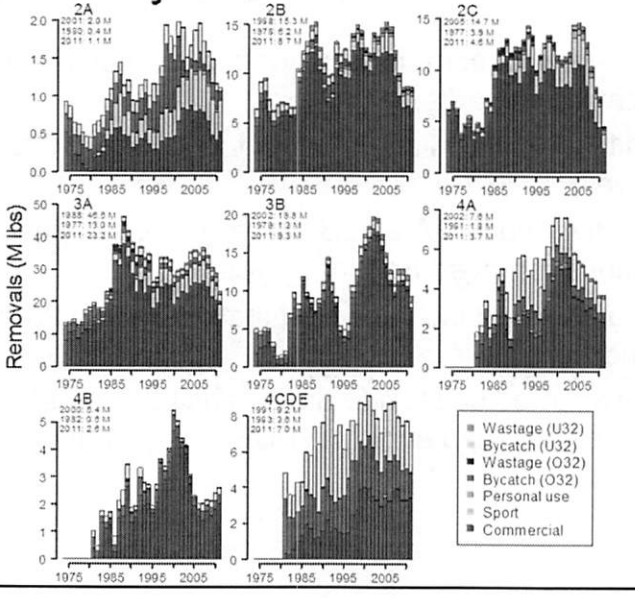
Assessment changes/updates for 2011

1. 2011 survey, commercial, sport, personal use and bycatch data added
2. 2011 NMFS trawl survey data for BS and GOA (no AI survey)
3. Slightly modified Area 2B survey index (Dogfish Bank stations removed from early years)
4. Area 2A index includes new stations within 20-275 fathoms
5. Re-weighted coastwide dataset using two definitions of bottom area and survey WPUE adjustments

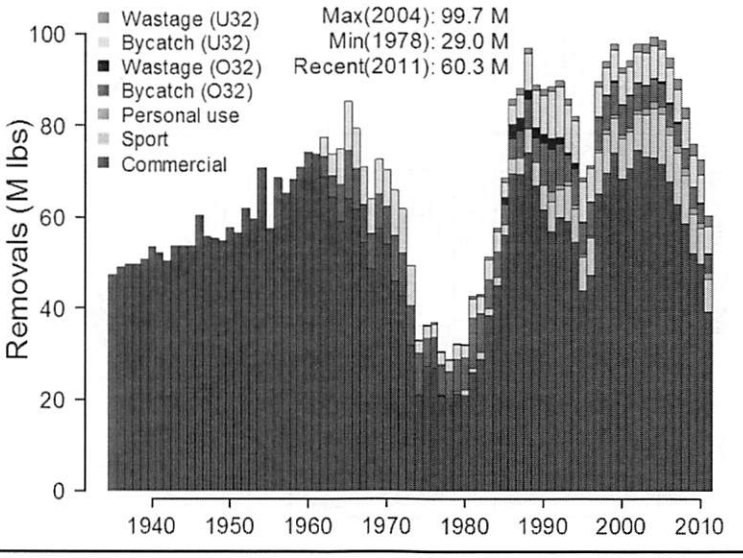
Recent removals and trends



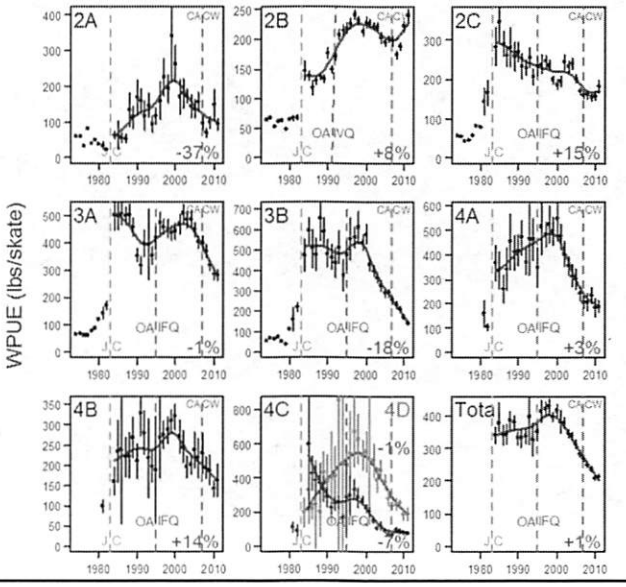
Removals by area



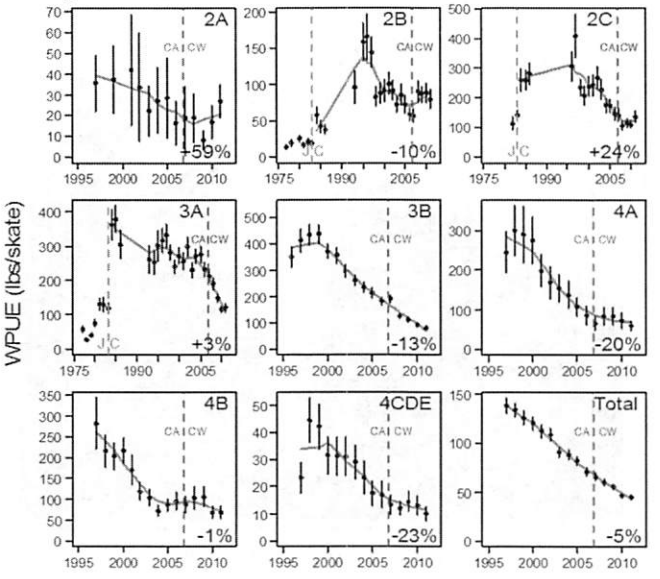
Coastwide removals history

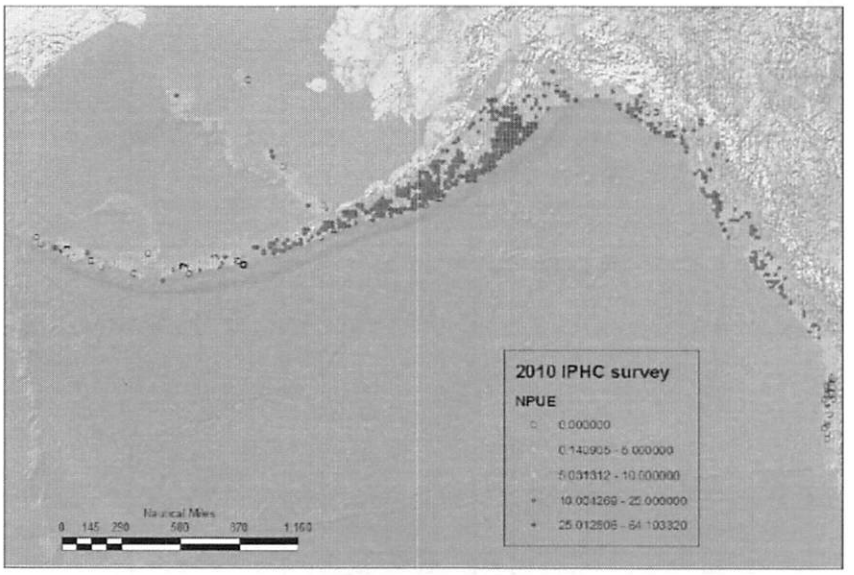


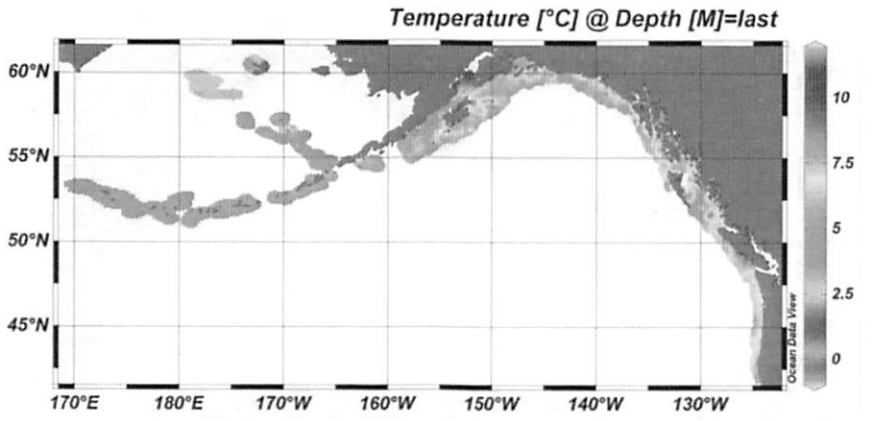
Commercial WPUE



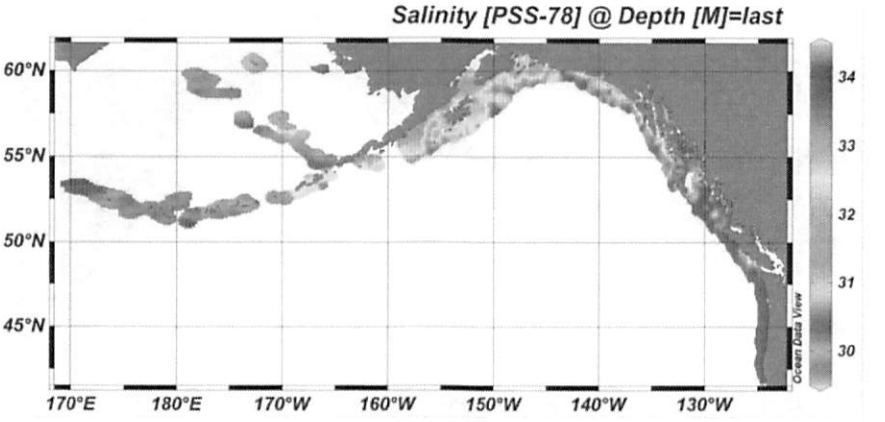
Survey O32 WPUE



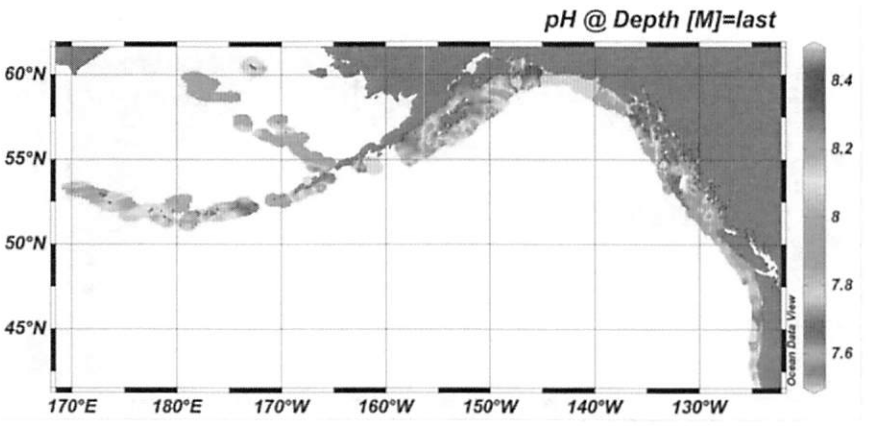




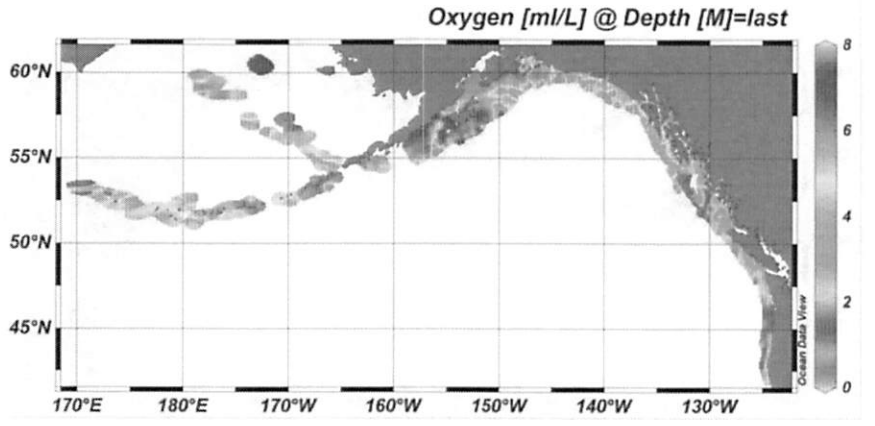
2010 Results



2010 Results

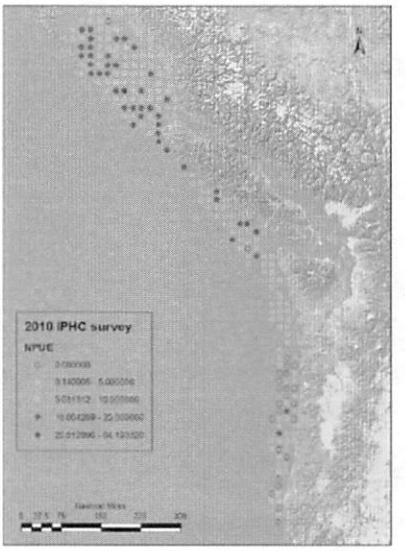


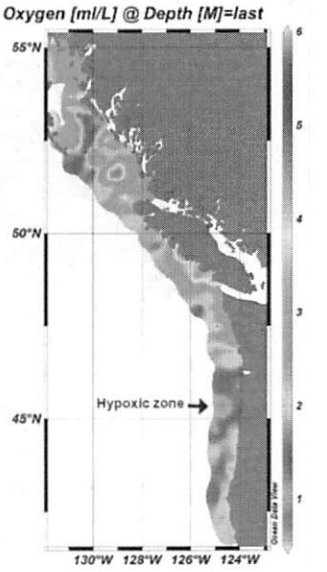
2010 Results



2010 Results

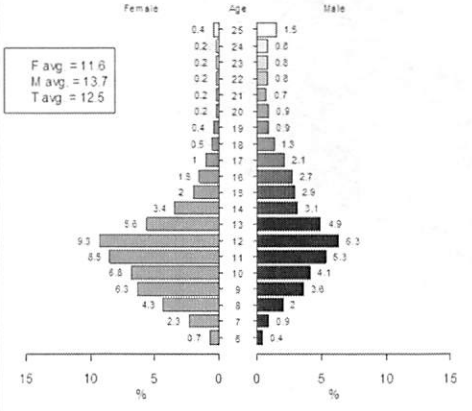
2010 West Coast Hypoxic Zone



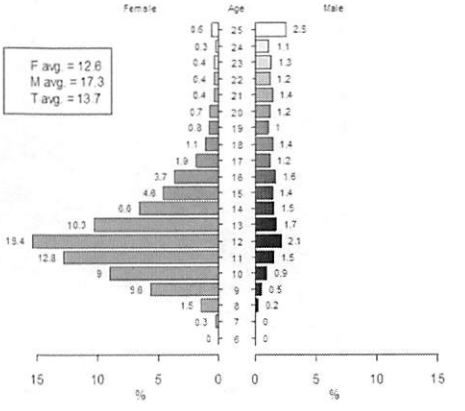


Comparison of survey and commercial catch age compositions

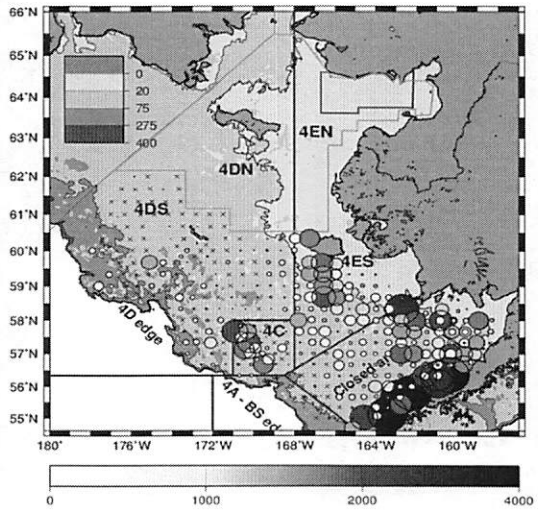
2011 Area Total Survey catch age composition



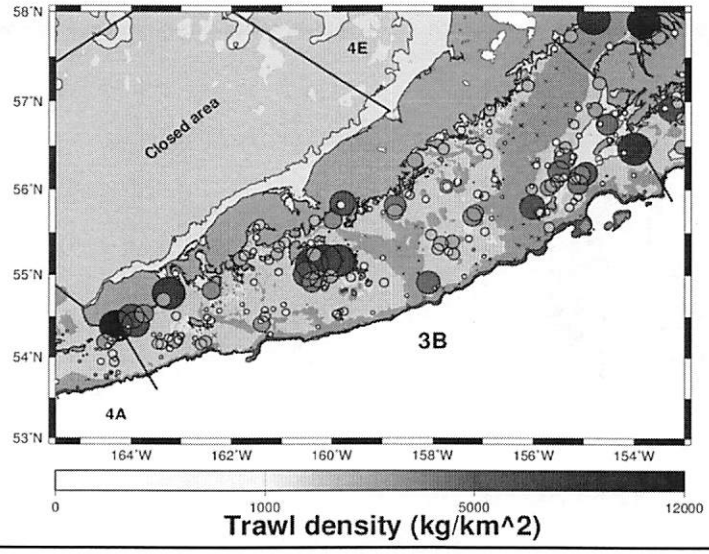
2011 Area Total Comm. catch age composition



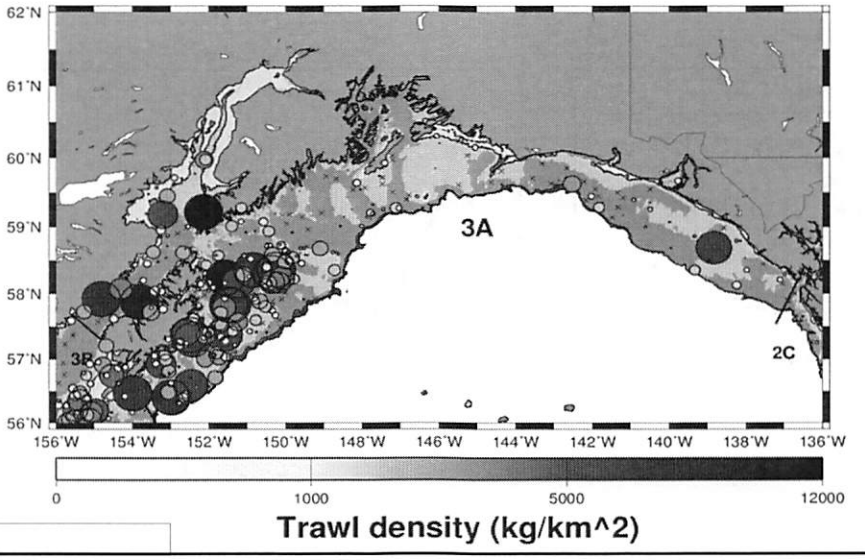
NMFS trawl survey – EBS



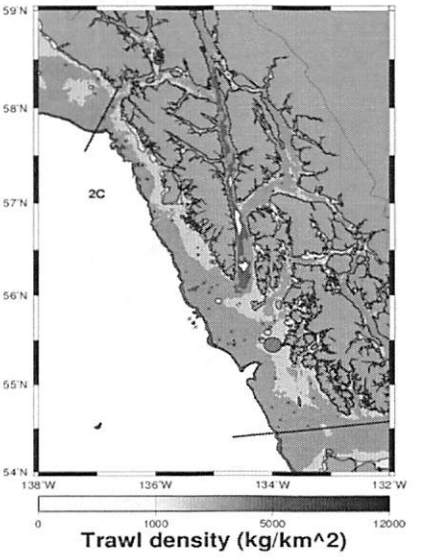
NMFS trawl survey – western GOA



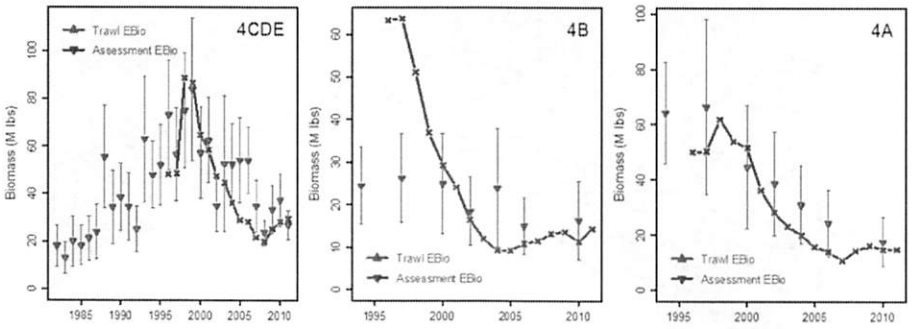
NMFS trawl survey – western GOA



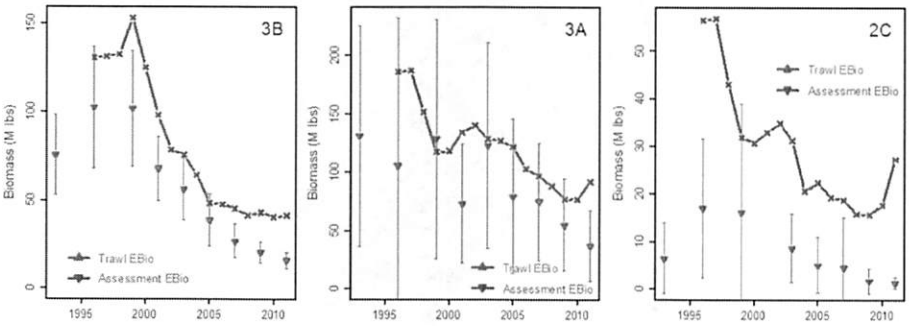
NMFS trawl survey – eastern GOA



Comparison of assessment and trawl EBio estimates – Bering Sea



Comparison of assessment and trawl EBio estimates – Gulf of Alaska



Measures of Uncertainty

- Commission asked staff to provide some explicit measures of uncertainty in the assessment and catch limit process.
- Primary sources are structural (model formulation), followed by retrospective mis-estimation, parameter estimation and harvest projections.
  - Survey WPUE adjustments: 5-15% (~ symmetric)
  - Weighting the input data: 3% (~ symmetric)
  - Chosen model and parameterization: 15% (~ symmetric)
  - Alt. parameterizations of chosen model: 30% (~ symmetric)
  - Between Alternative models: 25% (both)
  - Revision/Retrospective: 10-30% (asymmetric)
  - Apportionment by area: 5-15% (~ symmetric)

Measures of Uncertainty

- The staff had previously presented a conceptual review of sources of uncertainty (Clark et al. 2004) but we do not yet have a comprehensive framework for presenting all sources of uncertainty that might be considered in setting Catch Limits.
- Uncertainty exists at all stages of every assessment and set of harvest recommendations, including those for halibut.
- Apportionment also introduces a subsequent suite of uncertainties.
- Staff will be working more in 2012 on how to best present this.

Model fitted to coastwide dataset

- Model developed and used since 2006, relatively flexible
  1. **Trendless (2010 Base): Survey q has no trend**
  2. Vanilla: Survey q is constant
  3. **WobbleSQ: Survey q allowed to drift over time**
  4. NMFS: Model not fitted to commercial WPUE
  5. NMFS2: Model also not fitted commercial catch
  6. Cagean: Model not fit to survey data

What is "q", exactly?

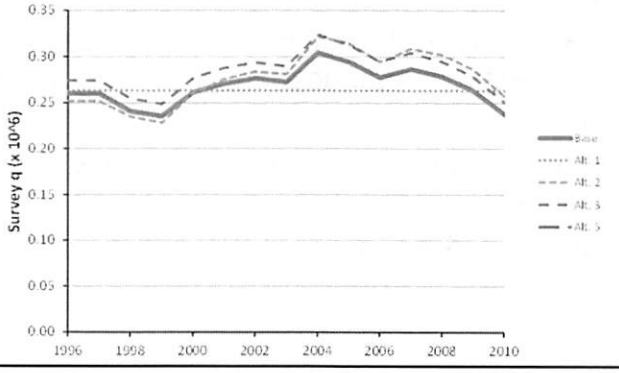
- It is a scalar between NPUE and numbers in the population

$$CPUE = q * Sel * N \text{ therefore } \frac{CPUE}{q*Sel} = N$$

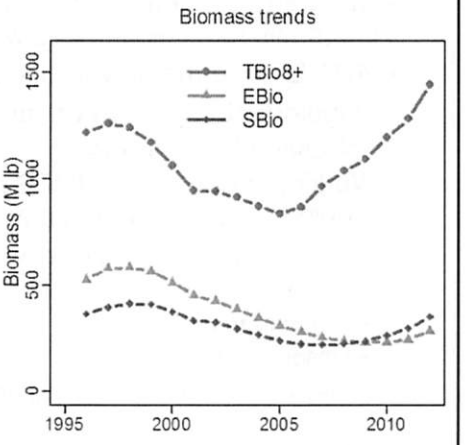
- A higher q leads to a smaller estimate of N

Statistical comparison of models

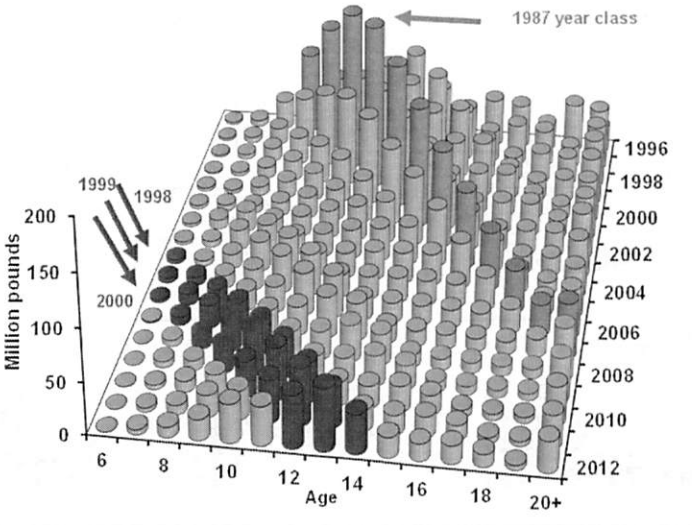
	Model	RSS	n	K	Delta AIC	$EBio_{MLE}$	$SBio_{MLE}$
Base	trendless	2699	3340	188	20	288	352
Alt. 1	vanilla	2990	3340	174	334	262	315
Alt. 2	wobblesq	2683	3340	188	0	260	319
Alt. 3	nmfs	2025	2534	171	129	289	358
Alt. 4	cagean	1283	1760	159	117	218	271



Model output from WobbleSQ



Age composition of the EBio

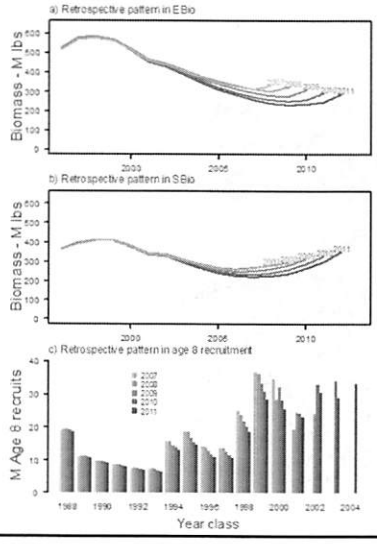


Revision and retrospection

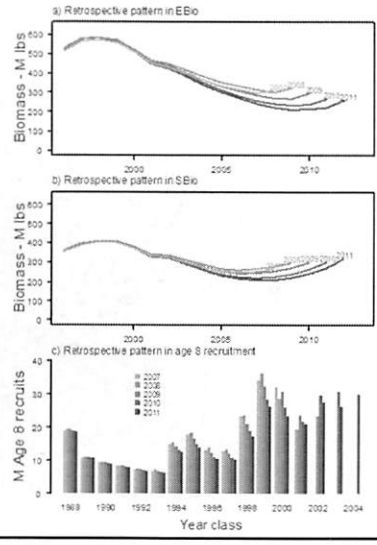
- Updated commercial data for 2010 lowered EBio from 318 M lbs (basis for CLRs) to 292 M lbs (revision)
- 2011 EBio further lowered to 245 from retrospective behavior
- Ongoing retrospective behavior of all model fits to halibut data – ongoing for 20 years
- Working group out of NMFS has not solved retrospective problem despite forming and meeting since 1991
- Unknown if it will continue; work continues on identifying…
  - Model mis-specification, e.g., trend in some parameter
  - Contrary trends in data
  - Unspecified mortality
  - May be indicative of ongoing decline in size at age and reverses with increase
- One potential solution: lowering the applied HR to achieve target HR

Retrospective behavior in 2 models

Trendless (Base 2010)



WobbleSQ (Alt. 2)



Onward to apportionment

- Apportionment based on assessment survey catch rates
- O32 WPUE forms basis
- Adjustments made to raw WPUE values
  - Survey timing
  - Competition for baited hooks
- Survey values for last 3 years weighted
  - 75:20:5
- Adjusted and weighted WPUE values applied to amount of bottom area per reg area to estimate relative density across all areas

Apportionment and Ebio distribution

2012 Apportionment by Regulatory Area									
	2A	2B	2C	3A	3B	4A	4B	4CDE	Total
Relative Share	2.4%	13.4%	10.5%	35.4%	15.8%	5.7%	5.5%	11.3%	100.0%

Coastwide abundance (Ebio, Mlbs) based on survey apportionment									
Model	2A	2B	2C	3A	3B	4A	4B	4CDE	Total
Trendless (Base 2010)	6.810	38.663	30.216	101.905	45.601	16.456	15.786	32.563	288.000
WobbleSQ (Alt 2)	6.148	34.904	27.279	91.997	41.167	14.856	14.251	29.397	260.000

…ON TO 2012 RECOMMENDATIONS

2012 IPHC Staff Preliminary Catch Limit Recommendations

Catch Limit Considerations

- Commission's goal to achieve target harvest rates in all areas.
- Commission's request to staff to present uncertainty in the assessment, harvest rate determination and apportionment process.
- Continuing retrospective issues in biomass estimation, though partly accounted for in simulations supporting current harvest rates.
- Declining size at age and effect on Ebio
- Continued declines in coastwide Ebio

Staff Recommendations for Setting Catch Limits - I

- Staff recommended use of WobbleSQ (Alt 2) assessment model, both because it is statistically the best model fit and because the trend in several alternative models indicates Ebio is nearer the 260 Mlb level than the 280 Mlb level estimated with the 2010 Base Model.
- Staff notes that retrospective issues continue to be evident in biomass estimation. This is a common feature of catch at age models.
- As a result of the CIE assessment review in 2006, the staff modified the harvest policy to account for observed retrospective behavior of the assessment model. As such, current harvest rates do account for some persistent mis-estimation, either higher or lower, from the assessment, however the staff would prefer to solve the underlying problem.
- In addition, the assessment process has continually corrected historical estimates of Ebio and Staff has correctly recommended decreasing catch limits to account for decreases in Ebio estimates.

Staff Recommendations for Setting Catch Limits II

- Staff has not yet decided whether a change in approach is required and will continue examination of the issue during 2012. In particular, we need to determine to what extent the retrospective issue is mitigated by the current harvest policy, whether any peril to the stock over the long term exists because of the retrospective issue or whether current HRs are simply suboptimal, and whether a change in the applied (i.e., a modification of the target) harvest rate should be recommended.
- Other potential approaches to addressing the effect of this issue on harvest projections could be considered. The effect of these approaches is similar and they involve either reducing the estimated Ebio from the current assessment to account for the potential future reduction of this estimate, or reducing the target harvest rate (HR) on currently estimated Ebio.
- In addition, the eventual implementation of a management strategy evaluation framework will provide a vehicle to examine this question more comprehensively.

Apportionment Procedures

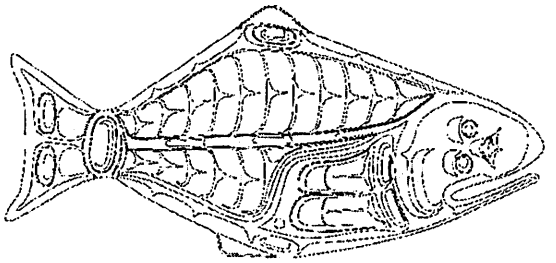
- As in 2010, staff continues the use of the 0-400 fm depth range as the basis for apportionment because it incorporates the active commercial fishing area, recognizing that both alternatives have potential for bias. Staff has proposed research to address these potential biases, subject to funding.
- As in 2010, the staff continues the use of the hook competition and survey timing adjustment factors to survey WPUE, and Kalman averaging of the adjusted WPUEs, when determining apportionment proportions.
- As in 2010, staff continues the use of the Slow Up – Full Down (SUFullD) harvest control rule.

Catch Limits Recommendations with Current Harvest Rates

Regulatory Area	EBio	2012 Total CEY	Other Removals*	2012 Fishery CEY	2011 Catch Limit	Recommended 2012 Catch Limit
2A	6.148	1.322	0.174	1.148	0.910	0.989
2B	34.904	7.504	0.871	6.633	7.650	6.633
2C	27.279	5.865	2.653	3.212	2.330	2.624
3A	91.997	19.779	7.861	11.918	14.360	11.918
3B	41.167	6.638	1.568	5.070	7.510	5.070
4A	14.856	2.395	0.828	1.567	2.410	1.567
4B	14.251	2.298	0.429	1.869	2.180	1.869
4CDE	29.397	4.740	2.275	2.465	3.720	2.465
Total	260.00	50.541	16.659	33.882	41.070	33.135

Harvest Rates: 0.215 (2A-3A); 0.161 (3B-4CDE)

* GHL in Area 2C = 0.931; GHL in Area 3A = 3.103

NPFMC GHL Schedule

	Area 2C		Area 3A	
Step #	Total CEY	GHL	Total CEY	GHL
1	9.027+	1.432	21.581+	3.650
2	7.965 - 9.026	1.217	19.042 - 21.580	3.103
3	6.903 - 7.964	1.074	16.504 - 19.041	2.734
4	5.841 - 6.902	0.931	13.964 - 16.503	2.373
5	4.799 - 5.840	0.788	11.425 - 13.963	2.008
2012 TCEY:	5.865 Mlbs		19.779 Mlbs