4.3 Setline survey-based apportionment estimates

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Abstract

Mean weight per unit effort (WPUE) of Pacific halibut from the IPHC fishery-independent setline survey is used to estimate how the coastwide stock is distributed among Regulatory Areas. In 2016, WPUE was estimated by fitting space-time models to the survey data. Apportionment estimates at the beginning of 2017 indicate that our understanding of the distribution of the stock has changed somewhat from last year, with more biomass in Area 3 and less in Area 2 than shown by last year's estimates.

Introduction

Since 2007, the IPHC has used the fishery-independent setline survey mean weight per unit effort (WPUE) index of population density for O32 (fish greater than 32 inches (81.3 cm) in length) Pacific halibut (hereafter referred to as "halibut") weighed by bottom area to estimate the distribution of the stock among regulatory areas, a process known as apportionment. This method was reviewed by the IPHC's Scientific Review Board (SRB) in 2013 (Cox et al. 2014). In 2016, the previous empirical method for WPUE estimation was replaced with space-time modelling of setline survey station WPUEs (Webster 2017). Previously, two adjustments to the raw WPUE index for each regulatory were made as part of the apportionment process in order to account for important factors known to influence survey catch rates of Pacific halibut. These adjustments, for survey timing and hook competition, are now applied at the station-level, with adjusted station WPUE used as data in the space-time modelling, and are no longer detailed in this report.

We present the apportionment estimates for the start of 2017, and comparisons of these with the estimates obtained last year for the start of 2016 are discussed in the context of changes in our understanding of the distribution of biomass among Regulatory Areas.

Revisions in 2016

The most important revision in 2016 was the change to using a space-time model for WPUE estimation, with the results of the modelling used to apportionment estimation. The methods are described in Webster (2017). With this change, the three-year reverse weighting used to smooth the WPUE time series was discontinued, as the space-time modelling now estimates the degree of temporal dependence in the data, which determines the smoothness of the time series. All data were updated with 2016 observations, including new setline survey data from an expansion along the Regulatory Area 4CDE edge (Webster and Soderlund 2017).

The space-time modelling for Regulatory Area 2A covered only the region over which the IPHC has previously undertaken a setline survey, that is, to 39°N. Apportionment is based on the bottom area of Area 2A down to 37.75°N (Webster 2016), and we used data from the NMFS (National Marine Fisheries Service) West Coast trawl survey to estimate a scalar to account for the lower densities at the southern limit of the halibut range. For apportionment, we again use this scalar (which has a value of 0.916), applying it the WPUE estimates for Area 2A from the space-time modelling.

Apportionment results

Apportionment estimates from 1999 to 2017 are presented in Table 1, and Figure 1. Compared to the revised estimates for the start of 2016, the greatest change was in Area 3A, with an estimated O32 biomass share that is 1.3% higher in 2017. Area 3B's estimate increased by 0.8%, and the percentage in Areas 4A and 4CDE decreased by the same amount. Changes in Areas 2B and 2C were also 0.6%, with a decrease in the former area and an increase in the latter. Together, the changes represent an approximate 2% shift in distribution from Area 4 to Area 3, while Area 2's percentage of the biomass is practically unchanged.

Figure 2 compares the apportionment estimates calculated last year for the start of 2016 (so not revised using new data or methods from 2016) with this year's estimates from Table 1. Our understanding of the distribution of the stock has changed somewhat, and our new estimates show a greater proportion of biomass in Area 3 and a smaller proportion in Area 2 than we estimated a year ago. Nevertheless, our observation in previous reports (Webster and Stewart, 2015 and 2016) that the stock is divided approximately into thirds among Areas 2 (31.4%), 3A (32.2%) and 3B-4CDE (36.4%) still holds true, although our perception of where the centre of the stock is located has shifted slightly to the west. For comparison, last year's estimates were 33.8% in Area 2, 31.2% in Area 3A, and 34.5% in Areas 3B-4CDE (Webster and Stewart 2016).

This year is the first time we have estimated the uncertainty in the apportionment estimates. Table 2 shows 95% posterior credible intervals for the mean WPUE in each regulatory area. These intervals also appear as error bars in Figure 2. Potentially, these intervals could be used by managers to inform decisions on setting actual apportionment values for 2017 by showing how much the apportionment values can depart from the model estimates while remaining generally consistent with the estimated stock distribution, noting that the total must still sum to 100%.

In an effort to better reflect biological, rather than management units, Table 3 shows the results from Table 1 aggregated into four geographical regions: Area 2, Area 3, Area 4 (including Areas 4A and 4CDE), and Area 4B. The broad trends are easier to see in these results, namely that Area 3 is estimated to contain the largest portion of the stock (45.8%), followed by Area 2 (31.4%), Area 4 (18.3%), and only a small proportion (4.5%) is estimated to be in Area 4B. These aggregated apportionments may be useful for future harvest policy calculations or for management considerations.

The changes from 2016 to 2017 in apportionment percentages are due to a combination of changes in survey catch rates, and the change to a modelling approach for estimating WPUE (with the latter affected the use of station-level hook competition adjustments, Webster 2017). Figure 3 compares how the apportionment estimates changed from 2016 to 2017 using the previous empirical methods in both years. For most areas, the differences between Figures 2 and 3 are small, showing that most of the changes were driven by changes in observed WPUE from the setline survey between 2015 and 2016. The notable exceptions are Areas 2A, 2B and 4B. Webster (2017) notes that changes to the application of the hook competition adjustment factors led to lower WPUE in Area 2A and higher WPUE in Area 4B relative to other areas. For the former area, competition was higher at stations with below average WPUE, and lower at stations with above average WPUE. This was not true to the same degree in any other area, leading to lower WPUE in Area 2A relative to other areas, and therefore a reduced estimate of the coastwide biomass share. The reverse was the case in Area 4B, which had higher competition in stations with above average WPUE. The difference in Area 2B is at least in part due to the model estimating WPUE

in unsurveyed regions such as Dogfish Bank and the Strait of Georgia, which is informed by the WPUE relationship with depth and the influence of nearby low-WPUE stations (such as those in the Salish Sea in Area 2A). These regions were previously assumed to have WPUE equal to the mean of the surveyed part of Area 2B. Changes in the application of the hook adjustment factor may have also contributed to the change in Area 2B's apportionment estimate (Webster 2017).

References

Cox, S. and others. 2014. Report of the SRB's review of Apportionment. Int. Pac. Halibut Comm. Report of Assessment and Research Activities 2013: 217-237.

Webster, R. A. and Stewart, I. J. 2015. Setline survey-based apportionment estimates. Int. Pac. Halibut Comm. Report of Assessment and Research Activities 2014: 181-194.

Webster, R. A. and Stewart, I. J. 2016. Setline survey-based apportionment estimates. Int. Pac. Halibut Comm. Report of Assessment and Research Activities 2014: 181-194.

Webster, R. A. 2016. Indexing density in southern Area 2A using West Coast trawl survey data. Int. Pac. Halibut Comm. Report of Assessment and Research Activities 2015: 544-551.

Webster, R. A. 2017. Results of space-time modelling of IPHC fishery-independent setline survey WPUE and NPUE data. Int. Pac. Halibut Comm. Report of Assessment and Research Activities 2016. IPHC-2016-RARA-26-R: 241-257.

Webster, R. A. and Soderlund, E. 2017. Area 4CDE edge IPHC survey expansion. Int. Pac. Halibut Comm. Report of Assessment and Research Activities 2016. IPHC-2016-RARA-26-R: 216-219.

Table 1. Estimated percentages of the coastwide stock in each regulatory area by year. Values were calculated using the posterior means of average O32 WPUE from the space-time modelling. In some years, row totals do not sum exactly to 100% because of rounding.

Year	2A	2B	2C	3A	3B	4A	4B	4CDE
1999	1.3	5.5	6.9	25.8	30.1	14.1	8.7	7.9
2000	1.3	4.7	6.0	25.5	33.2	13.5	7.7	8.2
2001	1.3	5.5	6.4	30.2	28.1	13.3	6.8	8.5
2002	1.4	6.9	7.7	32.7	25.3	11.4	5.6	9.0
2003	1.1	7.0	8.7	38.6	21.3	10.6	4.4	8.2
2004	1.2	5.9	8.0	37.6	24.4	10.2	4.2	8.6
2005	1.3	5.6	6.0	44.5	21.3	9.3	3.9	8.1
2006	1.5	6.4	7.3	45.4	18.6	9.1	4.2	7.4
2007	1.3	6.5	7.2	42.6	20.3	8.2	5.1	8.9
2008	1.2	7.1	7.3	41.8	20.7	7.6	6.2	8.1
2009	1.3	8.3	7.7	39.2	18.2	9.2	7.1	9.0
2010	1.2	10.2	7.7	35.5	19.0	9.3	6.6	10.6
2011	1.6	11.4	8.6	36.0	16.7	8.3	6.2	11.0
2012	2.0	11.9	10.7	35.9	14.6	8.0	6.3	10.5
2013	1.8	12.5	12.5	37.5	13.3	7.4	4.9	10.3
2014	1.9	13.9	14.4	32.9	12.7	6.7	5.8	11.6
2015	2.0	13.3	14.3	33.9	12.1	6.9	4.9	12.6
2016	2.5	14.7	14.4	30.9	12.8	6.5	4.8	13.4
2017	2.2	14.1	15.0	32.2	13.6	5.7	4.5	12.6

Table 2. 95% posterior credible intervals for the 2017 apportionment proportions.

Area	Estimate	95% interval
2A	2.2	1.8 - 2.8
2B	14.1	12.0 - 16.8
2C	15.0	12.9 - 17.9
3A	32.2	27.9 - 36.7
3B	13.6	11.1 - 16.7
4A	5.7	4.4 - 7.2
4B	4.5	3.1 - 6.7
4CDE	12.6	10.3 - 15.1

Table 3. Estimated percentages of the coastwide stock in each regulatory area by year. Values were calculated using the posterior means of average O32 WPUE from the space-time modelling. In some years, row totals do not sum exactly to 100% because of rounding.

Year	2	3	4ACDE	4B
1999	13.3	56.0	22.1	8.7
2000	12.0	58.7	21.7	7.7
2001	13.1	58.3	21.8	6.8
2002	15.9	58.1	20.4	5.6
2003	16.9	60.0	18.8	4.4
2004	15.0	62.0	18.8	4.2
2005	12.9	65.8	17.4	3.9
2006	15.2	64.0	16.6	4.2
2007	15.0	62.9	17.1	5.1
2008	15.6	62.4	15.7	6.2
2009	17.4	57.4	18.1	7.1
2010	19.1	54.5	19.8	6.6
2011	21.6	52.7	19.4	6.2
2012	24.6	50.6	18.5	6.3
2013	26.7	50.8	17.6	4.9
2014	30.3	45.6	18.3	5.8
2015	29.6	46.0	19.5	4.9
2016	31.5	43.7	19.9	4.8
2017	31.4	45.8	18.3	4.5

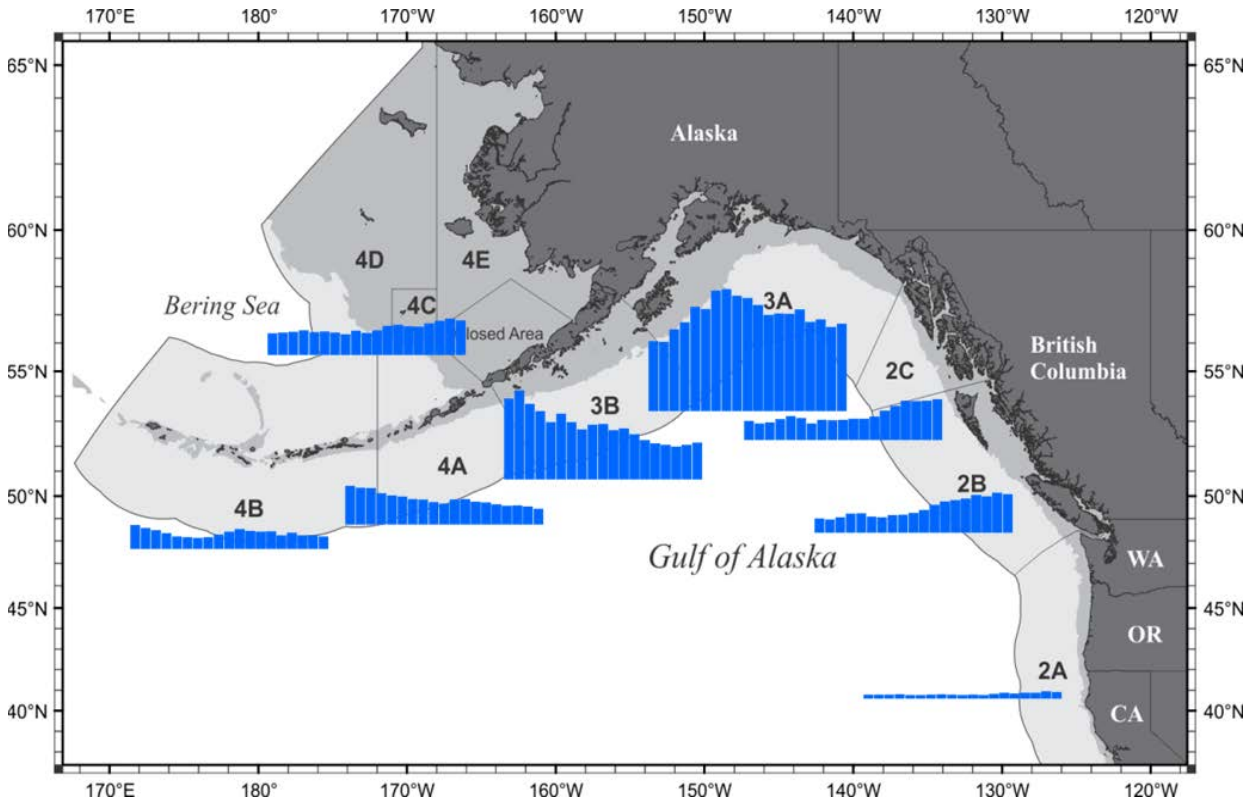

Figure 1. Estimated O32 halibut apportionment from 1999-2017 based on space-time modelling of setline survey WPUE.

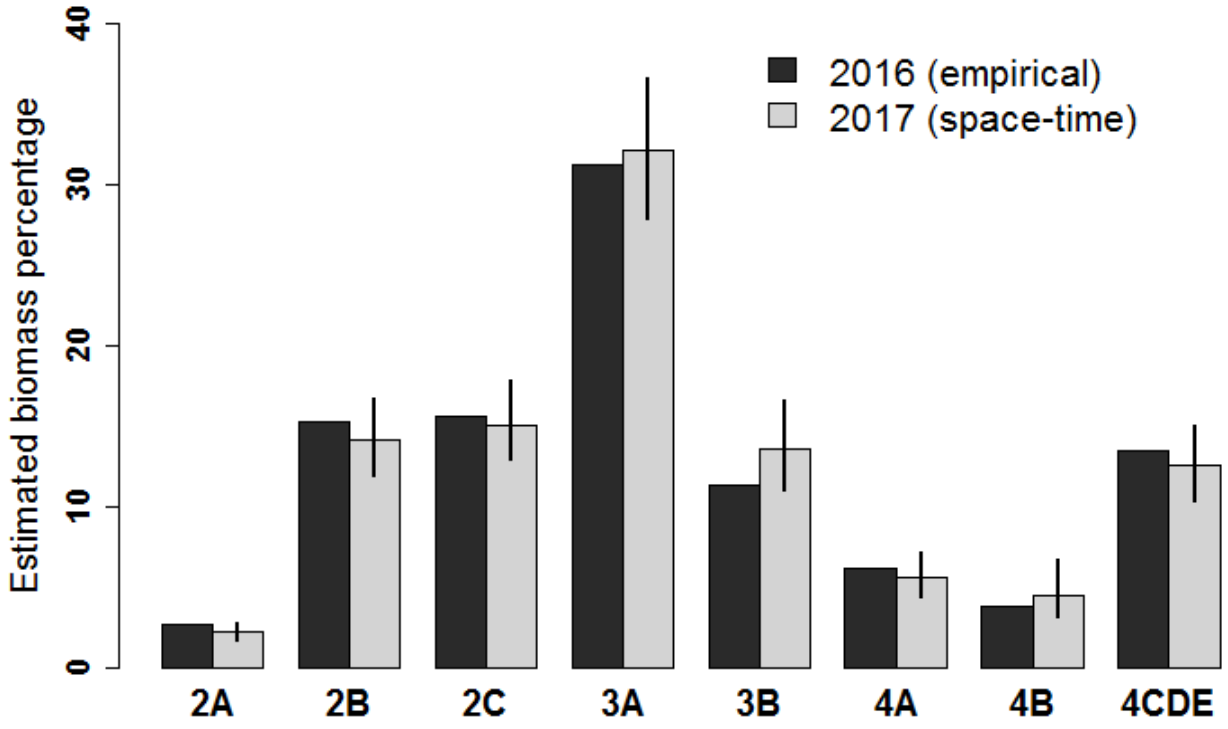

Figure 2. Comparison of apportionment estimates of halibut stock distribution calculated for the beginning of 2016 and 2017. The 2016 values are those estimated during the 2015 apportionment process using the previous empirical method for WPUE estimation, and differ from the revised values in Table 1 come from the space-time estimates of WPUE. Vertical bars represent 95% posterior credible intervals for the 2017 apportionment estimates, also presented in Table 2.

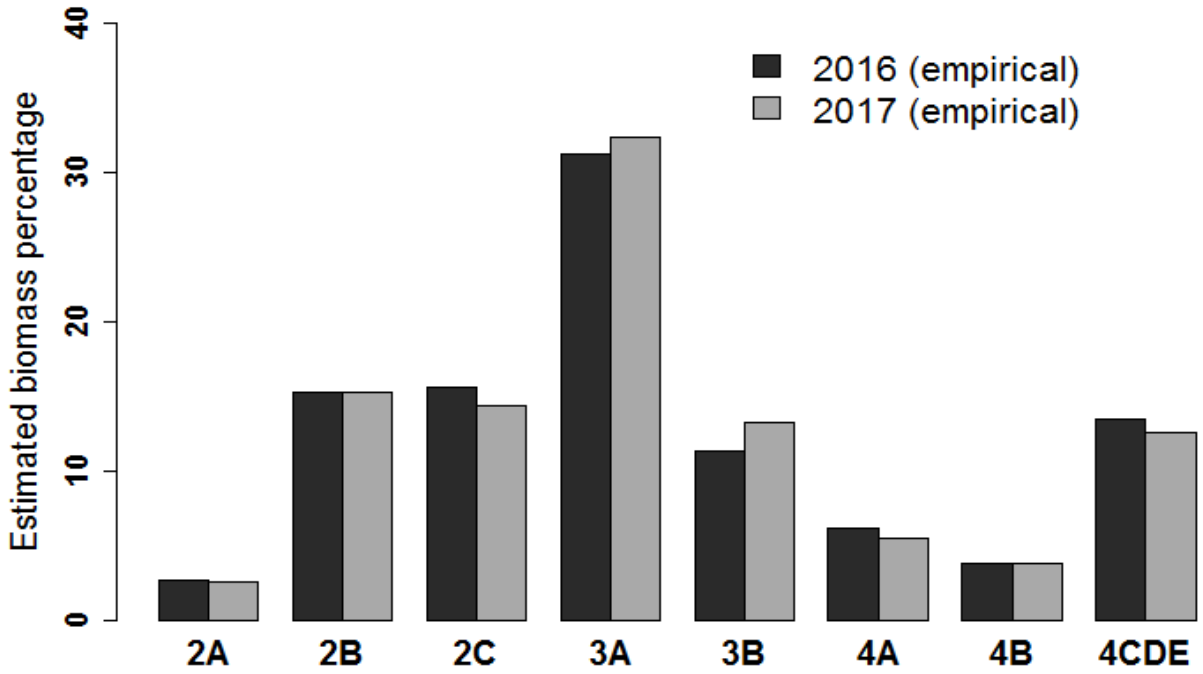

Figure 3. Comparison of apportionment estimates of halibut stock distribution calculated for the beginning of 2016 and for 2017, with both derived from WPUE estimated using the previous empirical method.