Adjusting IPHC setline survey WPUE for survey timing and hook competition

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Abstract

We review methods for adjusting survey WPUE for time of the survey relative to timing of all removals, and for competition for baits on the survey sets. The effect on survey WPUE of changes in set length among years is discussed, and the possibility of a set length adjustment is proposed for detailed examination in 2011.

Survey timing adjustment (review)

The amount of commercial catch taken prior to the IPHC setline survey varies with both regulatory area and time (Webster 2009). It is plausible that survey WPUE is affected by the proportion of removals taken prior to the survey, as exploitable biomass is decreased by commercial and sport fishing and other forms of removals, leaving fewer fish for the survey to catch. In areas where removals are greater early in the season, we might expect survey WPUE to be lower on average than in areas where removals are spread evenly across the fishing season. Concern about the effect of commercial catch in particular on survey WPUE is strong in Area 2A, where typically over 80% of the catch is taken prior to the mean survey date, much higher than all other areas (Webster 2009, Webster and Hare 2010).

Our approach, detailed in Webster and Hare (2010) is to estimate what WPUE would have been for each area had 50% of removals been taken prior to the mean date of the setline survey in that area. The current survey design began in 1998, which is where we begin our survey timing adjustment calculations. No survey was done in Area 2A in 1998 and 2000, nor in Area 4CDE in 1998 and 1999, and in those cases we assign a value of 0.5 to the proportion of removals prior to the survey. There is no annual setline survey in Area 4E, so the timing adjustment for combined Area 4CDE is based on the dates of the survey sets in Areas 4C and 4D only.

Information on sport catch taken prior to the survey was previously available for Areas 2A, 2C, and 3A. At present, we only use data from 2006-10, and use the 2006-10 mean of the proportion of catch taken prior to the mean survey data for earlier years. This year DFO has supplied us with monthly sport totals for Area 2B, and we use these to estimate the proportion of sport removals in Area 2B taken prior to the mean survey date. As we did last year, wastage of O32 fish (those at least 32 inches in length) is assumed to have the same temporal distribution as commercial catch, and O32 bycatch is assumed to be distributed evenly throughout the year.

Hook adjustment (review)

An analytical method for determining the level of hook competition and an adjustment factor were developed by Clark (2008), and shown by Webster et al. (2011) to be essentially identical to a method proposed by Etienne et al. (2011). The fraction of baits returned on the survey in each regulatory area is used to compute an adjustment factor. If a smaller than average

proportion of baits are returned, an area's WPUE index is adjusted upwards because higher competition for baits in that area would have had a negative effective on the halibut catch and therefore on that area's WPUE. Conversely, an area with more than the average rate of baits returned will have its WPUE index adjusted downwards. Figure 1 shows the average percentage of hooks on which bait, halibut, or other species are returned for 2008-10.

Calculation of the hook adjustment is done in the same manner as previous years (Clark, 2008, Webster and Hare 2010). One minor change from last year is that for the partitioning of Area 4CDE. Previously, Area 4CDE was divided into Area 4D edge, Area 4 islands (Area 4I) and Areas 4S and 4N (Hare et al. 2010), and a combined hook adjustment for Area 4CDE was computed by combining the data from all four subareas. This year we divide the island stations into 4ID (St. Matthew) and 4IC (Pribilof Islands): survey station density is greater in 4IC, and therefore these stations must be given less weight when combining data from 4IC with those from other subareas in 4CDE. As we did in 2009, a 4CDE hook adjustment factor is computed by calculating the weighted average of the subarea adjustment factors, where the weights are the bottom areas multiplied by the setline WPUEs. This combined adjustment is then applied to the combined Area 4CDE setline WPUE, computed as the weighted average of the subarea WPUEs, where this time the weights are simply the bottom areas. Hook adjustments are only available when a setline survey is conducted, and in our calculations we assume an adjustment factor of 1 (no adjustment) when no survey was conducted.

Survey set length (for further study)

Standard survey sets have varied from 5 to 8 sets in length since the current setline survey station configuration was established in 1998. WPUE is computed as the weight of O32 halibut caught at each station divided by the number of sets. IPHC staff has found that skates at the end (first and last) of a set consistently catch more halibut than other skates, and so the ratio of WPUE of end skates to inside skates is greater than 1 (Table 5). The result is perhaps not difficult to explain: skates at either end of a set have, in theory, a greater area from which to catch halibut, because they are only competing with a single neighbouring skate. Less clear is why the difference varies so greatly from year to year and among areas.

The implication of these data is that WPUE in a year with a high number of skates per set could be expected to be lower than in a year with fewer skates per set, because the two end skates are a smaller fraction of the length of each set. It may therefore be appropriate to make some kind of adjustment to WPUE, possibly standardizing WPUE to what we would have expected had we fished five skates. However, IPHC staff will need to study this in greater detail before we are in a position to recommend an adjustment of this sort. We will need to feel confident that the end skates on an 8-skate set (for example) would have taken the same catch if the set had instead been five sets in length. For now, it is not clear to us if this would be the case.

Results

Table 1 presents the average fraction of baits returned on survey sets from 1998 onwards. These are the data we use to compute the hook adjustment. Tables 2-4 show, respectively, the proportions of commercial, sport, and total removals taken prior to the mean survey date. The latter values are used to compute the survey timing adjustment. The main effect of the timing adjustment is to increase WPUE in Area 2A due to the early removals relative to the survey in

that area. The hook adjustment also positively affects Area 2A this year, and as with past years, reduces WPUE in Area 4B in particular due to lower competition for baits in that area.

Estimated proportions of exploitable biomass (Ebio) in each area are given in Tables 6-9 under four different methods for computing WPUE. Tables 6 and 7 give biomass proportions for WPUE with both survey timing and hook competition applied. Two weighting scenarios are considered: an equal weighting of the three most recent years, used previously by IPHC staff, and a 75:20:5 reverse weighting, with the most weight give to the most recent data. This latter weighting follows from the statistical analysis detailed in Webster (2011). For comparison, Tables 8 and 9 give apportionment under the two weighting scenarios in the absence of any adjustments to the survey index. Figure 2 compares unadjusted (raw) WPUE with adjusted values using the two weighting scenarios.

References

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Table 1. Average fraction of baits returned on the setline survey and year and area. 4S refers to the south Bering Sea shelf, 4IC refers to the survey stations around the Pribilof Islands and 4ID to St. Matthew stations, 4D refers to the 4D edge survey stations. NS means no survey was done in that area in that year. Total refers to the coastwide average.

Area	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Total	0.117	0.149	0.126	0.136	0.156	0.14	0.152	0.145	0.114	0.112	0.146	0.118	0.117
4S	NS	NS	NS	NS	NS	NS	NS	NS	0.132	NS	NS	NS	NS
4IC	NS	NS	NS	NS	NS	NS	NS	NS	0.089	0.177	0.102	0.112	0.263
4ID	NS	NS	NS	NS	NS	NS	NS	NS	0.266	0.364	0.22	0.332	0.277
4D	NS	NS	0.161	0.24	0.441	0.359	0.413	0.476	0.206	0.516	0.283	0.25	0.397
4B	0.095	0.194	0.282	0.316	0.35	0.417	0.315	0.362	0.295	0.214	0.257	0.347	0.315
4A	0.097	0.171	0.104	0.196	0.182	0.188	0.182	0.222	0.129	0.142	0.078	0.096	0.170
3B	0.119	0.061	0.071	0.172	0.158	0.091	0.109	0.227	0.105	0.125	0.065	0.045	0.048
3A	0.129	0.167	0.125	0.083	0.111	0.058	0.087	0.12	0.128	0.08	0.116	0.118	0.076
2C	0.096	0.149	0.129	0.125	0.134	0.118	0.246	0.135	0.134	0.098	0.097	0.133	0.106
2B	0.124	0.223	0.12	0.101	0.059	0.148	0.137	0.095	0.077	0.082	0.22	0.113	0.117
2A	NS	0.068	NS	0.03	0.158	0.062	0.068	0.018	0.107	0.109	0.06	0.047	0.017

Table 2. Percentage of commercial catch and wastage taken prior to the mean setline survey date. NS means no survey was done in that area in that year.

Area	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
4CDE	NS	NS	22	14	19	22	15	6	16	23	26	24	60
4B	17	29	41	43	48	40	50	28	52	71	34	30	33
4A	40	70	46	21	42	33	28	40	32	44	18	18	35
3B	41	55	49	40	55	59	53	48	56	48	39	44	38
3A	52	67	63	64	68	62	63	61	61	54	56	52	64
2C	57	63	58	53	66	68	65	64	60	60	57	55	63
2B	50	59	54	51	52	49	50	45	53	54	51	43	67
2A	NS	62	NS	85	86	90	86	81	88	91	96	99	100

Table 3. Percentage of sport catch taken prior to the mean setline survey date.

Area	2006	2007	2008	2009	2010	Average
2A	83	67	74	84	90	80
2B	-	-	32	18	45	32
2C	37	36	23	16	20	27
3A	39	34	39	35	50	40

Table 4. Percentage of O32 halibut removals taken prior to the mean setline survey date.[1] NS means no survey was done in that area in that year.

Area	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
4CDE	NS	NS	33	28	33	33	29	22	31	34	35	33	60
4B	21	32	43	44	48	41	51	31	52	70	36	34	36
4A	45	68	48	24	44	35	31	42	36	47	23	25	38
3B	43	55	49	41	55	59	53	48	55	49	40	45	38
3A	51	63	57	59	63	57	58	56	56	50	53	49	60
2C	51	57	51	48	58	59	56	56	55	54	46	43	48
2B	49	57	52	50	50	48	48	43	50	51	48	40	63
2A	NS	60	NS	72	76	80	77	76	81	78	83	82	82

1. Includes commercial catch, wastage, sport catch in Areas 2A, 2B, 2C, and 3A, bycatch, personal use, and survey and research catch.

Table 5. WPUE on end skates (first and last) divided by WPUE on inside skates (second to second last).

Area	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
4D	NS	NS	0.95	1.13	1.06	1.29	1.10	0.75	1.10	1.34	1.39	1.43	1.37
4C	NS	NS	NS	NS	NS	NS	NS	NS	1.10	1.02	1.63	1.27	1.45
4B	1.28	1.09	1.24	1.21	1.33	1.22	0.99	1.11	1.28	1.27	1.18	1.20	1.69
4A	1.07	1.09	1.13	1.13	1.11	1.18	1.07	1.16	1.23	1.14	1.14	1.12	1.25
3B	1.10	1.15	1.17	1.20	1.24	1.19	1.19	1.20	1.14	1.16	1.07	1.13	1.17
3A	1.17	1.21	1.17	1.19	1.19	1.13	1.16	1.18	1.20	1.12	1.15	1.19	1.15
2C	1.19	1.17	1.18	1.21	1.27	1.34	1.24	1.26	1.18	1.22	1.19	1.28	1.30
2B	1.25	1.19	1.32	1.24	1.11	1.34	1.40	1.20	1.27	1.21	1.25	1.51	1.35
2A	NS	1.16	NS	1.43	0.84	1.31	1.10	1.36	1.03	1.10	1.25	1.46	1.02

Table 6. Percentage share of coastwide exploitable biomass based on an equal weighting of the three most recent WPUEs calculated by applying timing and hook competition adjustments. Values are for the beginning of each year.

Area	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
4CDE	16.4	14.9	13.1	13.1	12.4	11.9	11.3	10.5	10.2	10.3	11.6
4B	7.2	6.2	5.3	4.2	3.4	3.2	3.7	4.5	5.5	6.0	5.9
4A	11.4	10.0	8.9	7.1	6.8	6.3	6.0	5.3	5.9	6.5	7.2
3B	27.8	27.2	22.9	21.4	21.2	20.4	19.3	19.0	20.0	19.9	18.9
3A	24.8	27.5	33.1	36.7	39.8	42.3	43.6	43.7	41.7	39.5	36.3
2C	6.4	6.8	8.0	8.7	8.1	7.8	7.2	8.2	7.6	7.5	7.4
2B	4.9	5.8	7.2	7.1	6.9	6.4	7.1	7.2	7.7	9.0	11.1
2A	1.1	1.5	1.5	1.5	1.3	1.7	1.7	1.6	1.3	1.3	1.6

Table 7. Percentage share of coastwide exploitable biomass based on a 75:20:5 reverse weighting of the three most recent WPUEs calculated by applying timing and hook competition adjustments. Values are for the beginning of each year.

Area	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
4CDE	14.5	13.9	12.5	13.2	12.1	10.8	11.6	9.8	9.5	11.8	12.7
4B	6.5	5.7	4.3	3.5	3.1	3.4	4.5	5.1	6.1	6.3	5.1
4A	11.6	8.6	7.4	6.8	6.7	5.9	5.7	4.9	6.8	7.6	6.7
3B	27.9	23.3	20.6	22.2	21.4	17.9	19.6	20.3	19.3	20.0	18.1
3A	26.3	31.9	36.8	37.9	42.1	44.9	42.3	43.3	41.1	35.6	34.5
2C	6.6	7.6	8.9	9.0	6.7	8.0	7.7	8.2	7.3	7.2	7.9
2B	5.4	6.9	8.1	6.1	6.6	7.0	7.2	7.1	8.4	10.5	12.9
2A	1.2	2.0	1.3	1.2	1.4	2.2	1.3	1.3	1.5	1.0	2.2

Table 8. Percentage share of coastwide exploitable biomass based on an equal weighting of the three most recent WPUEs calculated by applying no adjustments. Values are for the beginning of each year.

Area	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
4CDE	17.2	16.2	15.3	16.3	16.1	14.8	13.2	12.1	12.0	12.4	13.7
4B	8.3	8.2	7.4	6.3	5.1	5.0	5.3	6.1	7.2	8.2	8.5
4A	11.4	10.7	9.5	8.4	8.0	7.6	6.8	5.9	6.0	6.5	7.4
3B	24.5	24.3	22.5	21.9	20.6	20.2	19.5	19.9	18.9	17.7	15.2
3A	25.9	26.6	30.1	31.2	34.4	36.7	40.0	40.9	39.9	37.5	34.7
2C	6.5	6.9	7.9	8.5	8.4	8.0	7.4	7.6	7.3	7.4	7.5
2B	5.2	5.9	6.3	6.4	6.5	6.6	6.7	6.4	7.7	9.5	12.1
2A	1.1	1.2	1.2	1.1	1.0	1.0	1.1	1.0	1.0	0.9	0.9

Table 9. Percentage share of coastwide exploitable biomass based on a 75:20:5 reverse weighting of the three most recent WPUEs calculated by applying no adjustments. Values are for the beginning of each year.

Area	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
4CDE	15.5	15.6	15.7	17.1	15.3	12.7	12.9	11.7	11.5	13.8	15.0
4B	8.7	7.9	6.1	5.7	4.5	5.0	6.2	6.5	8.0	9.2	7.9
4A	11.5	9.6	8.2	8.3	7.9	6.9	6.2	5.4	6.5	7.3	7.7
3B	23.8	23.7	21.2	21.3	20.3	19.5	19.2	21.0	17.1	15.7	14.8
3A	27.0	28.0	32.7	31.7	36.3	40.4	40.7	40.2	39.1	34.8	32.0
2C	6.8	7.5	8.5	8.9	7.6	7.6	7.5	7.7	6.9	7.4	8.3
2B	5.6	6.5	6.4	6.1	6.9	6.7	6.3	6.4	9.7	11.1	13.3
2A	1.1	1.3	1.1	0.9	1.0	1.2	0.9	1.0	1.1	0.7	1.1

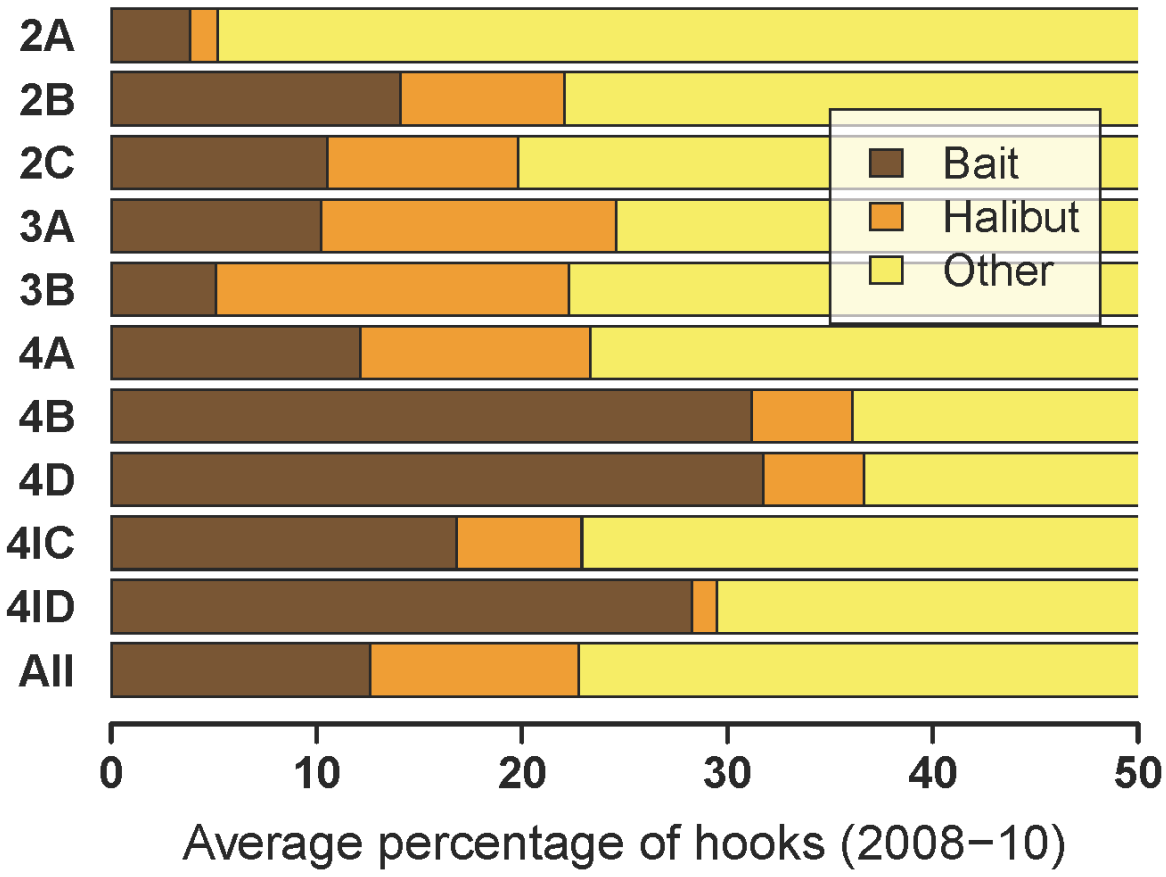

Figure 1. Hook occupancy by regulatory area, 2008-2010 data combined.

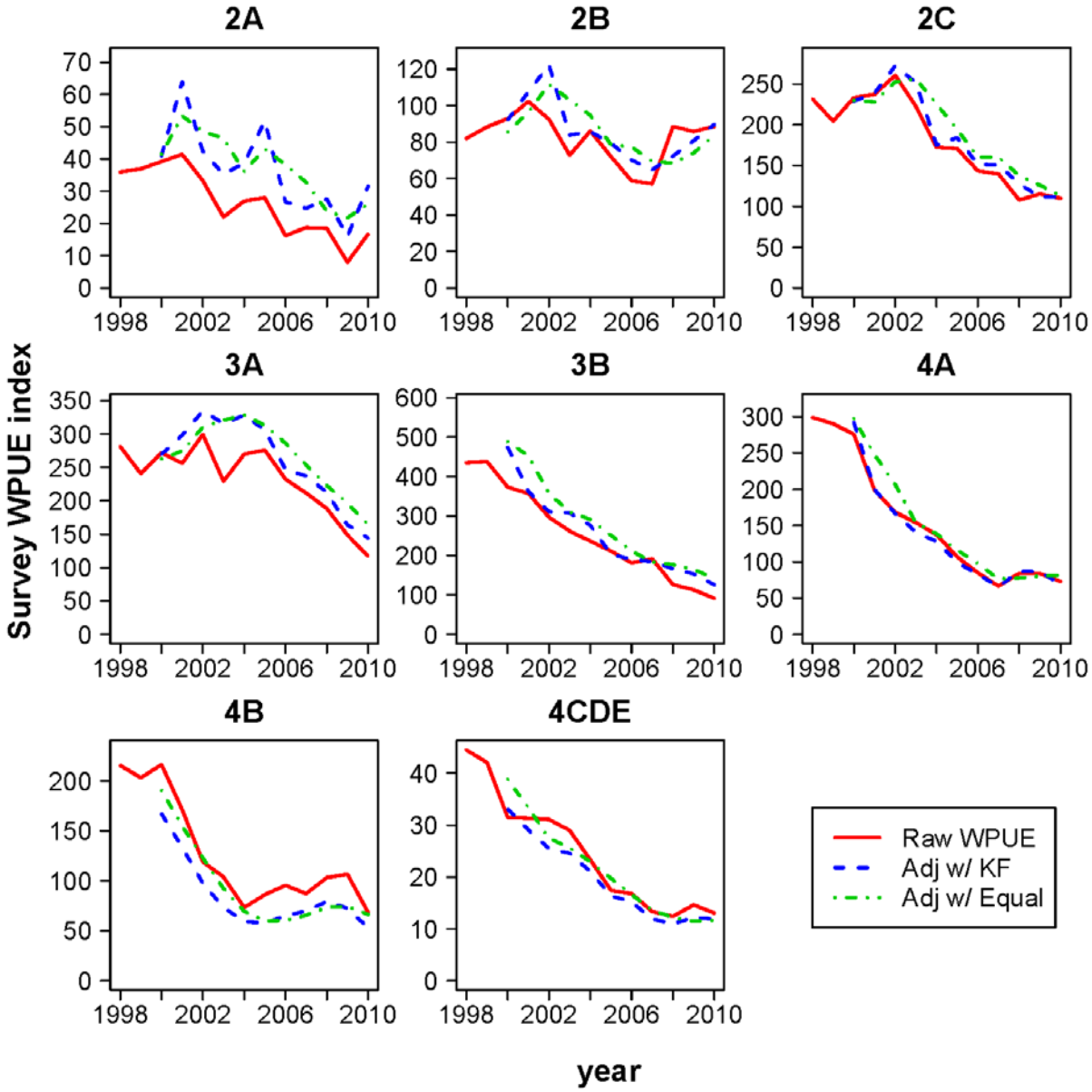

Figure 2. Comparison of survey WPUE without adjustments (Raw WPUE), and with both timing and hook competition adjustments applied, with 75:20:5 weighting (Adj w/ KF) and equal weighting (Adj w/ Equal) of the three most recent years' values.