

2.2 Incidental mortality of Pacific halibut in the directed commercial halibut fishery (Wastage)

Jamie Goen, Lara M. Erikson, and Ian J. Stewart

Abstract

Incidental mortality of Pacific halibut (*Hippoglossus stenolepis*) in the commercial Pacific halibut fishery is the mortality of all halibut that do not become part of the landed catch. This mortality is termed wastage in many International Pacific Halibut Commission (IPHC) publications. The three main sources of this mortality estimate include: 1) fish that are captured and discarded because they are below the legal size limit of 32 inches (81.3 cm), 2) fish that are estimated to die on lost or abandoned fishing gear, and 3) fish that are discarded for regulatory reasons (e.g., the vessels trip limit has been exceeded). The methods that are applied to produce each of these estimates differ due to the amount and quality of information available. Information on lost gear and regulatory discards is collected through logbook interviews and fishing logs received by mail. The ratio of U32 to O32 Pacific halibut (≥ 32 inches in length) is determined from the IPHC fisheries-independent setline survey in most areas and by direct observation in the Area 2B fishery. Halibut wastage estimates from the commercial halibut fishery are presented, with 2016 data preliminary at time of publication.

Overview

The removals of Pacific halibut (*Hippoglossus stenolepis*) accounted for in the International Pacific Halibut Commission (IPHC) stock assessment include commercial and sport fisheries catch, incidental mortality from the commercial halibut fisheries (wastage), discard mortalities from the sport halibut fisheries, personal use, and incidental mortalities of halibut from the other commercial fisheries (bycatch). Commercial fishery wastage is 1) halibut that are smaller than the commercial minimum size of 32 inches (81.3 cm), known as U32s, that must be released by regulation and subsequently die, 2) fish of all sizes estimated to have been captured by fishing gear that were subsequently lost or abandoned during fishing operations, 3) fish that are discarded for regulatory reasons (e.g. the vessel's trip limit has been exceeded). Different mortality rates are applied to each category: released halibut have a 16% mortality rate and halibut mortality from lost gear is 100%. The methods applied to produce each of these estimates differ due to the amount and quality of the information available. The wastage mortality of halibut 26 inches and longer (O26), including O32 halibut (≥ 32 inches in length) and halibut between 26 and 32 inches (U32/O26), is directly deducted to determine the fishery constant exploitation yield (FCEY); and the mortality of U26 halibut is accounted for in the removals in the stock assessment and in the exploitation rates in the harvest policy. The intent of the division of U26/O26 is to standardize the treatment of removals, given that sport and personal use fishery removals are directly deducted when setting catch limits.

Wastage from discarded U32 halibut

In the directed commercial halibut fishery, direct observations by fisheries observers or electronic monitoring information are not available coastwide, so in most areas the weight of discarded U32 halibut must be estimated by indirect methods. In the Area 2B fishery (since 2006), fishers are required to record in their logbooks the number of U32 halibut discarded, which is verified for accuracy via analysis of electronic monitoring video from fishing activities. Therefore, for the Area 2B fishery, there exists a direct estimate of the total number of U32 halibut discarded. The percent of U32 fish (in numbers) in the IPHC setline surveys and the Area 2B logbooks is shown in [Figure 1](#). To convert this number for the Area 2B logbooks into a weight, the average observed weight of U32 halibut in the Area 2B setline survey is used.

In all other cases, since the setline survey uses similar fishing gear, it has been used as a proxy for the expected encounter rates by area and year. Previous analyses recognized that some survey stations produce a much lower catch rate of O32 halibut than observed for the average commercial set (Gilroy and Clark 2008). Therefore, to make them more comparable, the setline survey stations are filtered to stations with a higher catch rate (by weight) of O32 halibut. Following the previous analyses, the top 33% was used for Areas 3A-4CDE, and individually estimated percentages for Areas 2A, 2B, and 2C ([Fig. 2](#)). These percentages make the observed O32 halibut catch rates of filtered stations reasonably similar to those reported in commercial fishery logbooks. It is then inferred that the catch rate of U32 halibut would also be similar; however, this inference cannot be directly tested. Although the comparison is useful, there is considerable uncertainty with regard to the actual spatial and temporal patterns of the directed fishery, and direct estimates of U32 discards would be considerably better.

A mortality rate of 16% was applied to all commercial fishery halibut discards since the beginning of individual quota fisheries (1991 in Canada, 1995 in Alaska). During the era of the derby fishery and for all years in Area 2A a 25% rate was applied (Gilroy 2007). The Area 2A commercial catch numbers include the U32 estimates from the tribal and non-tribal commercial fisheries.

To estimate the pounds of U32 halibut captured in the commercial halibut fishery, the area-specific U32:O32 ratio was multiplied by the estimated commercial catch in each regulatory area for each year. The resulting poundage was then multiplied by the discard mortality rate to obtain the estimated poundage of U32 halibut killed in the commercial fishery ([Table 1](#)).

Wastage from lost or abandoned gear

Since the implementation of the quota share fisheries, lost gear is much less common. During the derby fishery of the 1980s and early 1990s in Alaska and B.C., extremely short fishing periods resulted in a competitive race to catch as many halibut as fast as possible, leading to a considerable quantity of longline gear being lost on the fishing grounds. Information on the amount of gear lost or abandoned by the halibut longline fishery was collected through logbook interviews or from fishing logs received via mail. Fishery-wide estimates were then extrapolated to total catch values using logbook catch and effort statistics.

Wastage for O32 halibut was calculated from the ratio of effective skates lost to effective skates hauled, multiplied by total landed catch. Effective skates are skates for which no data (skate length, hook spacing, number of hooks per skate) are missing and gear type meets the standardization criteria. The ratio was calculated using both fixed-hook and snap gear in all areas. The Area 2A

catch has always included the non-treaty directed commercial catch, treaty commercial catch, and, when open, incidental catch during the longline sablefish fishery. In addition, the quantity of U32 halibut captured by lost gear is also estimated using the method described above. All fish estimated to have been captured by lost gear are assumed to die. Wastage from lost gear was first calculated in 1985 and estimates are provided by IPHC regulatory area in [Table 2](#). The amount of gear lost varies by year and it is much lower since the inception of the quota share fisheries. In some instances, very few to no skates are reported lost, which was the case in Areas 4C and 4E in 2016 ([Table 2](#)). The 2016 data are preliminary and it is expected that some gear was lost in those areas and when final log data are available the numbers will be updated. We will be reviewing the procedure for determining the mortality of halibut from the lost gear in the future.

Wastage from discard mortality for regulatory reasons

The directed commercial fisheries in Area 2A are still managed using derby fishing seasons, in which the quantity of halibut for a vessel is limited by a fishing period limit. This results in catches that may exceed the vessel or trip limits, and therefore regulatory discards of O32 halibut, which are reported in the fishery logbooks. The ratio of discards to landings from the trips with logbook records available is used to estimate the O32 discards for all landings reported on fish tickets. In addition, the quantity of U32 halibut captured along with these discarded fish is estimated following the methods described above. The estimates for regulatory discards vary most likely due to the number of fishery openings, the number of vessels fishing, and the vessel trip limits. The Area 2A incidental halibut retention fisheries during the salmon and sablefish fisheries are not included as they are accounted for under bycatch mortality estimates.

Discards from the quota share fisheries in Alaska and B.C. are not included at present; however, they are under review with the intent to include them in the future.

Total wastage in the commercial fishery

Based on these methods, wastage in the commercial fishery is estimated to have been highest in the early 1980s, subsequently declined (particularly in Area 3A in 1995 when the derby fishery was converted to a quota system), and then increased from 1995 to 2010 as the size-at-age of halibut declined and more fish at older ages remained below the minimum size limit. The estimates of wastage cannot be delineated within Regulatory Area 4 prior to 1981 ([Table 3](#)), but there is very little wastage estimated prior to that time. In addition, there is currently no direct accounting for whale depredation in the wastage calculation.

Additional data sources

We do not currently utilize the North Pacific Observer Program's (NPOP) growing data set on discards (reference the NPOP's annual report) in the directed halibut fishery due to the very low coverage rates, the lack of coverage on vessels less than 40 feet, and the lack of a conversion from numbers to weight for discarded halibut. However, it is anticipated that stratification by depth, gear, and other fishing characteristics could improve the representativeness of these data for estimating halibut discard in the future, and we plan to explore using these data in the near future.

Ongoing and future research on discard mortality rates may be helpful to refine the current rates used in this analysis. (IPHC Staff 2017).

References

- Gilroy, H. L. 2007. Wastage in the 2006 Pacific halibut fishery. Int. Pac. Halibut Comm. Report of Assessment and Research Activities 2006: 55-58.
- Gilroy, H. L. and Clark, W. G. 2008. Re-estimation of sublegal discard mortality in the halibut fishery. Int. Pac. Halibut Comm. Report of Assessment and Research Activities 2007: 69-73.
- Planas, J. V. and IPHC Staff. 2017. 2017 IPHC Biological and Ecosystem Science Research Plan. Int. Pac. Halibut Comm. Report of Assessment and Research Activities 2016. IPHC-2016-RARA-26-R: 10-24

Table 1. Estimated U32 halibut discard mortality (in thousands of net pounds), in the commercial halibut fishery by IPHC regulatory area and year, since 1974.

Year	Regulatory Area											Total
	2A	2B	2C	3A	3B	4	4A	4B	4C	4D	4E	
1974	0.002	0.081	0.042	0.061	0.013	0.002	NA	NA	NA	NA	NA	0.201
1975	0.004	0.143	0.048	0.091	0.021	0.002	NA	NA	NA	NA	NA	0.309
1976	0.002	0.164	0.044	0.107	0.025	0.002	NA	NA	NA	NA	NA	0.344
1977	0.002	0.135	0.026	0.093	0.032	0.004	NA	NA	NA	NA	NA	0.292
1978	0.001	0.113	0.036	0.115	0.014	0.004	NA	NA	NA	NA	NA	0.283
1979	0.001	0.119	0.039	0.130	0.004	0.004	NA	NA	NA	NA	NA	0.297
1980	0.000	0.136	0.029	0.132	0.003	0.002	NA	NA	NA	NA	NA	0.302
1981	0.002	0.152	0.036	0.147	0.006	NA	0.004	0.002	0.002	0.000	0.000	0.351
1982	0.002	0.163	0.033	0.124	0.067	NA	0.010	0.000	0.002	0.000	0.000	0.401
1983	0.003	0.192	0.064	0.117	0.114	NA	0.023	0.009	0.004	0.000	0.000	0.526
1984	0.005	0.363	0.065	0.162	0.104	NA	0.010	0.008	0.006	0.001	0.000	0.724
1985	0.006	0.440	0.129	0.284	0.198	NA	0.021	0.012	0.009	0.004	0.000	1.101
1986	0.007	0.492	0.173	0.517	0.190	NA	0.048	0.002	0.011	0.011	0.000	1.452
1987	0.007	0.513	0.175	0.525	0.172	NA	0.050	0.015	0.014	0.005	0.001	1.479
1988	0.005	0.508	0.179	0.652	0.145	NA	0.024	0.016	0.009	0.002	0.000	1.540
1989	0.004	0.397	0.160	0.644	0.172	NA	0.014	0.028	0.009	0.004	0.000	1.432
1990	0.004	0.320	0.182	0.583	0.198	NA	0.038	0.015	0.010	0.008	0.001	1.359
1991	0.003	0.166	0.173	0.523	0.293	NA	0.035	0.018	0.012	0.011	0.001	1.237
1992	0.004	0.167	0.191	0.587	0.207	NA	0.039	0.028	0.013	0.004	0.001	1.241
1993	0.006	0.224	0.219	0.513	0.185	NA	0.038	0.024	0.013	0.004	0.001	1.227
1994	0.002	0.202	0.215	0.632	0.095	NA	0.028	0.025	0.012	0.004	0.002	1.217
1995	0.002	0.189	0.102	0.292	0.049	NA	0.016	0.013	0.006	0.001	0.001	0.672
1996	0.004	0.182	0.133	0.358	0.061	NA	0.019	0.013	0.014	0.015	0.003	0.800
1997	0.005	0.254	0.148	0.455	0.192	NA	0.031	0.019	0.023	0.023	0.005	1.157
1998	0.006	0.276	0.189	0.522	0.233	NA	0.048	0.035	0.018	0.018	0.003	1.347
1999	0.006	0.281	0.170	0.429	0.251	NA	0.033	0.046	0.015	0.016	0.002	1.249
2000	0.007	0.162	0.160	0.416	0.326	NA	0.066	0.036	0.004	0.004	0.001	1.183
2001	0.011	0.199	0.193	0.391	0.449	NA	0.099	0.047	0.007	0.008	0.002	1.407
2002	0.009	0.168	0.146	0.507	0.481	NA	0.083	0.020	0.003	0.004	0.001	1.423
2003	0.027	0.309	0.171	0.608	0.611	NA	0.085	0.026	0.004	0.008	0.002	1.851
2004	0.009	0.275	0.331	0.682	0.701	NA	0.063	0.022	0.005	0.009	0.002	2.100
2005	0.034	0.298	0.309	0.568	0.546	NA	0.127	0.011	0.005	0.025	0.004	1.927
2006	0.043	0.569	0.404	0.690	0.465	NA	0.095	0.009	0.006	0.031	0.005	2.318
2007	0.030	0.500	0.338	0.913	0.436	NA	0.127	0.019	0.009	0.045	0.010	2.427
2008	0.036	0.432	0.288	0.943	0.672	NA	0.138	0.018	0.018	0.063	0.015	2.622
2009	0.051	0.334	0.292	1.131	0.775	NA	0.145	0.011	0.015	0.050	0.010	2.813
2010	0.026	0.275	0.246	1.429	0.883	NA	0.130	0.030	0.020	0.053	0.010	3.102
2011	0.020	0.256	0.074	0.901	0.763	NA	0.134	0.035	0.041	0.112	0.024	2.359
2012	0.018	0.208	0.082	0.581	0.516	NA	0.090	0.035	0.017	0.044	0.011	1.602
2013	0.014	0.198	0.084	0.498	0.403	NA	0.062	0.032	0.015	0.029	0.009	1.346
2014	0.012	0.231	0.110	0.431	0.324	NA	0.034	0.047	0.016	0.028	0.006	1.238
2015	0.024	0.229	0.112	05.08	0.211	NA	0.074	0.035	0.013	0.022	0.003	1.233
2016	0.031	0.211	0.115	0.371	0.233	NA	0.050	0.058	0.017	0.040	0.005	1.131

Table 2. Estimates of Pacific halibut (in millions of net pounds) killed by lost or abandoned longline gear in the commercial halibut fishery, by IPHC regulatory area, since 1974.

Year	Regulatory Area										Total
	2A	2B	2C	3A	3B	4A	4B	4C	4D	4E	
1974	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1975	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1976	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1977	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1978	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1979	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1980	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1981	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1982	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1983	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1984	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1985	0.002	0.111	0.236	1.019	0.219	0.065	0.046	0.025	0.027	0.001	1.751
1986	0.004	0.221	0.472	2.036	0.439	0.195	0.014	0.041	0.074	0.002	3.498
1987	0.003	0.188	0.401	1.732	0.373	0.147	0.058	0.037	0.029	0.004	2.972
1988	0.001	0.053	0.225	1.651	0.134	0.030	0.024	0.011	0.008	0.000	2.137
1989	0.007	0.050	0.211	1.599	0.212	0.029	0.072	0.017	0.020	0.000	2.217
1990	0.016	0.127	0.357	1.217	0.237	0.117	0.060	0.026	0.049	0.003	2.209
1991	0.002	0.078	0.378	1.253	0.458	0.098	0.064	0.031	0.066	0.004	2.432
1992	0.007	0.058	0.267	0.705	0.198	0.054	0.046	0.017	0.016	0.001	1.369
1993	0.009	0.104	0.209	0.374	0.069	0.049	0.036	0.017	0.017	0.001	0.885
1994	0.001	0.075	0.249	0.918	0.043	0.038	0.041	0.016	0.016	0.002	1.399
1995	0.003	0.042	0.059	0.138	0.009	0.009	0.009	0.003	0.003	0.001	0.276
1996	0.001	0.032	0.048	0.196	0.024	0.026	0.030	0.011	0.011	0.002	0.381
1997	0.006	0.042	0.044	0.082	0.061	0.028	0.031	0.011	0.011	0.002	0.318
1998	0.001	0.060	0.046	0.173	0.063	0.022	0.018	0.008	0.009	0.001	0.401
1999	0.007	0.045	0.074	0.129	0.079	0.036	0.030	0.015	0.016	0.002	0.433
2000	0.007	0.031	0.042	0.067	0.065	0.028	0.024	0.009	0.010	0.002	0.285
2001	0.003	0.051	0.042	0.072	0.037	0.037	0.031	0.011	0.012	0.003	0.299
2002	0.005	0.039	0.029	0.157	0.040	0.022	0.016	0.005	0.007	0.002	0.322
2003	0.002	0.041	0.028	0.079	0.043	0.022	0.017	0.004	0.008	0.002	0.246
2004	0.000	0.041	0.037	0.089	0.019	0.017	0.013	0.004	0.007	0.001	0.228
2005	0.006	0.042	0.038	0.177	0.033	0.015	0.007	0.002	0.010	0.001	0.331
2006	0.002	0.044	0.026	0.059	0.014	0.008	0.004	0.001	0.005	0.001	0.164
2007	0.003	0.036	0.036	0.064	0.023	0.010	0.004	0.002	0.009	0.002	0.189
2008	0.001	0.026	0.015	0.075	0.006	0.014	0.007	0.003	0.011	0.002	0.160
2009	0.001	0.024	0.014	0.058	0.030	0.016	0.007	0.003	0.011	0.002	0.166
2010	0.001	0.033	0.012	0.030	0.031	0.011	0.008	0.003	0.009	0.001	0.139
2011	0.005	0.031	0.006	0.040	0.012	0.013	0.009	0.004	0.012	0.003	0.135
2012	0.004	0.014	0.013	0.016	0.016	0.007	0.003	0.001	0.001	0.001	0.076
2013	0.002	0.015	0.027	0.027	0.002	0.010	0.003	0.001	0.001	0.001	0.089
2014	0.003	0.022	0.007	0.016	0.003	0.005	0.011	0.000	0.002	0.000	0.069
2015	0.005	0.011	0.008	0.018	0.003	0.007	0.001	0.001	0.004	0.000	0.058
2016	0.004	0.019	0.006	0.005	0.002	0.005	0.003	0.000	0.009	0.000	0.053

Table 3. Wastage (millions of pounds net weight) in the commercial halibut fishery since 1974.

Year	Regulatory Area											Total
	2A ^a	2B	2C	3A	3B	4	4A	4B	4C	4D	4E	
1974	0.002	0.081	0.042	0.061	0.013	0.002	NA	NA	NA	NA	NA	0.201
1975	0.004	0.143	0.048	0.091	0.021	0.002	NA	NA	NA	NA	NA	0.309
1976	0.002	0.164	0.044	0.107	0.025	0.002	NA	NA	NA	NA	NA	0.344
1977	0.002	0.135	0.026	0.093	0.032	0.004	NA	NA	NA	NA	NA	0.292
1978	0.001	0.113	0.036	0.115	0.014	0.004	NA	NA	NA	NA	NA	0.283
1979	0.001	0.119	0.039	0.130	0.004	0.004	NA	NA	NA	NA	NA	0.297
1980	0.000	0.136	0.029	0.132	0.003	0.002	NA	NA	NA	NA	NA	0.302
1981	0.002	0.152	0.036	0.147	0.006	NA	0.004	0.002	0.002	0.000	0.000	0.351
1982	0.002	0.163	0.033	0.124	0.067	NA	0.010	0.000	0.002	0.000	0.000	0.401
1983	0.003	0.192	0.064	0.117	0.114	NA	0.023	0.009	0.004	0.000	0.000	0.526
1984	0.005	0.363	0.065	0.162	0.104	NA	0.010	0.008	0.006	0.001	0.000	0.724
1985	0.008	0.542	0.345	1.213	0.398	NA	0.082	0.056	0.031	0.028	0.001	2.702
1986	0.011	0.695	0.606	2.374	0.591	NA	0.231	0.016	0.048	0.077	0.002	4.652
1987	0.010	0.686	0.543	2.105	0.513	NA	0.188	0.071	0.047	0.031	0.005	4.201
1988	0.006	0.557	0.385	2.158	0.267	NA	0.052	0.039	0.019	0.009	0.000	3.492
1989	0.011	0.443	0.353	2.102	0.366	NA	0.041	0.098	0.024	0.022	0.000	3.460
1990	0.019	0.437	0.509	1.693	0.414	NA	0.148	0.073	0.033	0.052	0.004	3.382
1991	0.005	0.238	0.520	1.666	0.711	NA	0.127	0.080	0.040	0.070	0.005	3.464
1992	0.011	0.220	0.436	1.230	0.388	NA	0.090	0.072	0.028	0.018	0.002	2.495
1993	0.021	0.320	0.411	0.854	0.248	NA	0.084	0.059	0.028	0.019	0.002	2.047
1994	0.009	0.271	0.443	1.477	0.134	NA	0.064	0.065	0.026	0.018	0.004	2.511
1995	0.008	0.228	0.156	0.420	0.058	NA	0.024	0.022	0.009	0.004	0.002	0.932
1996	0.010	0.211	0.177	0.535	0.083	NA	0.043	0.042	0.024	0.025	0.005	1.154
1997	0.013	0.291	0.188	0.529	0.246	NA	0.057	0.049	0.033	0.033	0.007	1.448
1998	0.019	0.329	0.230	0.676	0.289	NA	0.068	0.052	0.025	0.026	0.004	1.717
1999	0.018	0.321	0.237	0.546	0.322	NA	0.067	0.074	0.029	0.031	0.004	1.649
2000	0.024	0.190	0.198	0.475	0.384	NA	0.092	0.059	0.013	0.014	0.003	1.453
2001	0.024	0.245	0.230	0.456	0.481	NA	0.132	0.076	0.018	0.020	0.005	1.689
2002	0.022	0.204	0.172	0.646	0.515	NA	0.103	0.036	0.008	0.011	0.003	1.721
2003	0.043	0.344	0.196	0.676	0.646	NA	0.105	0.042	0.008	0.016	0.004	2.080
2004	0.016	0.311	0.362	0.758	0.716	NA	0.078	0.034	0.009	0.016	0.003	2.304
2005	0.039	0.335	0.341	0.724	0.572	NA	0.139	0.018	0.007	0.034	0.005	2.215
2006	0.050	0.605	0.425	0.741	0.476	NA	0.102	0.013	0.007	0.036	0.006	2.462
2007	0.040	0.529	0.367	0.966	0.454	NA	0.135	0.023	0.011	0.053	0.012	2.589
2008	0.044	0.454	0.300	1.004	0.676	NA	0.149	0.025	0.021	0.073	0.017	2.763
2009	0.052	0.354	0.302	1.175	0.796	NA	0.157	0.018	0.018	0.060	0.012	2.944
2010	0.027	0.302	0.255	1.450	0.903	NA	0.138	0.037	0.023	0.061	0.011	3.207
2011	0.025	0.283	0.079	0.930	0.770	NA	0.144	0.043	0.044	0.121	0.026	2.464
2012	0.025	0.220	0.093	0.593	0.526	NA	0.095	0.038	0.018	0.045	0.012	1.665
2013	0.025	0.211	0.107	0.519	0.404	NA	0.070	0.035	0.016	0.030	0.010	1.429
2014	0.021	0.250	0.116	0.443	0.326	NA	0.038	0.056	0.016	0.030	0.006	1.300
2015	0.031	0.238	0.119	0.521	0.213	NA	0.079	0.036	0.014	0.025	0.003	1.281
2016	0.039	0.227	0.120	0.375	0.234	NA	0.054	0.060	0.017	0.047	0.005	1.178

^a Area 2A includes O32 regulatory discards.

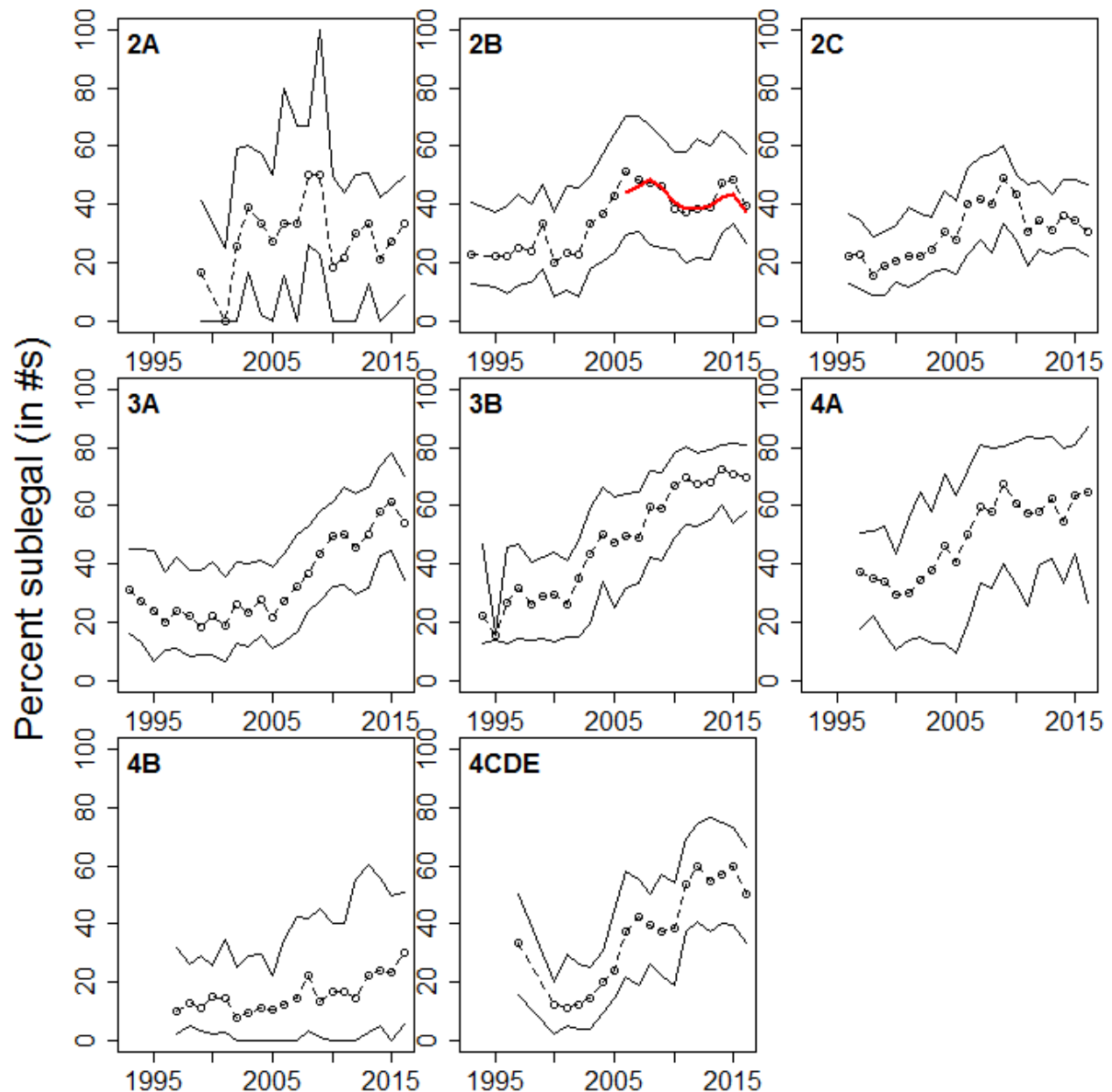


Figure 1. Setline survey percentage U32 by number, 1996-2016. Circles represent the median station observed each year in the setline survey and the lines indicate the 25th and 75th percentiles. The thick solid line in Area 2B since 2006 represents the percent U32 reported in the logbooks.

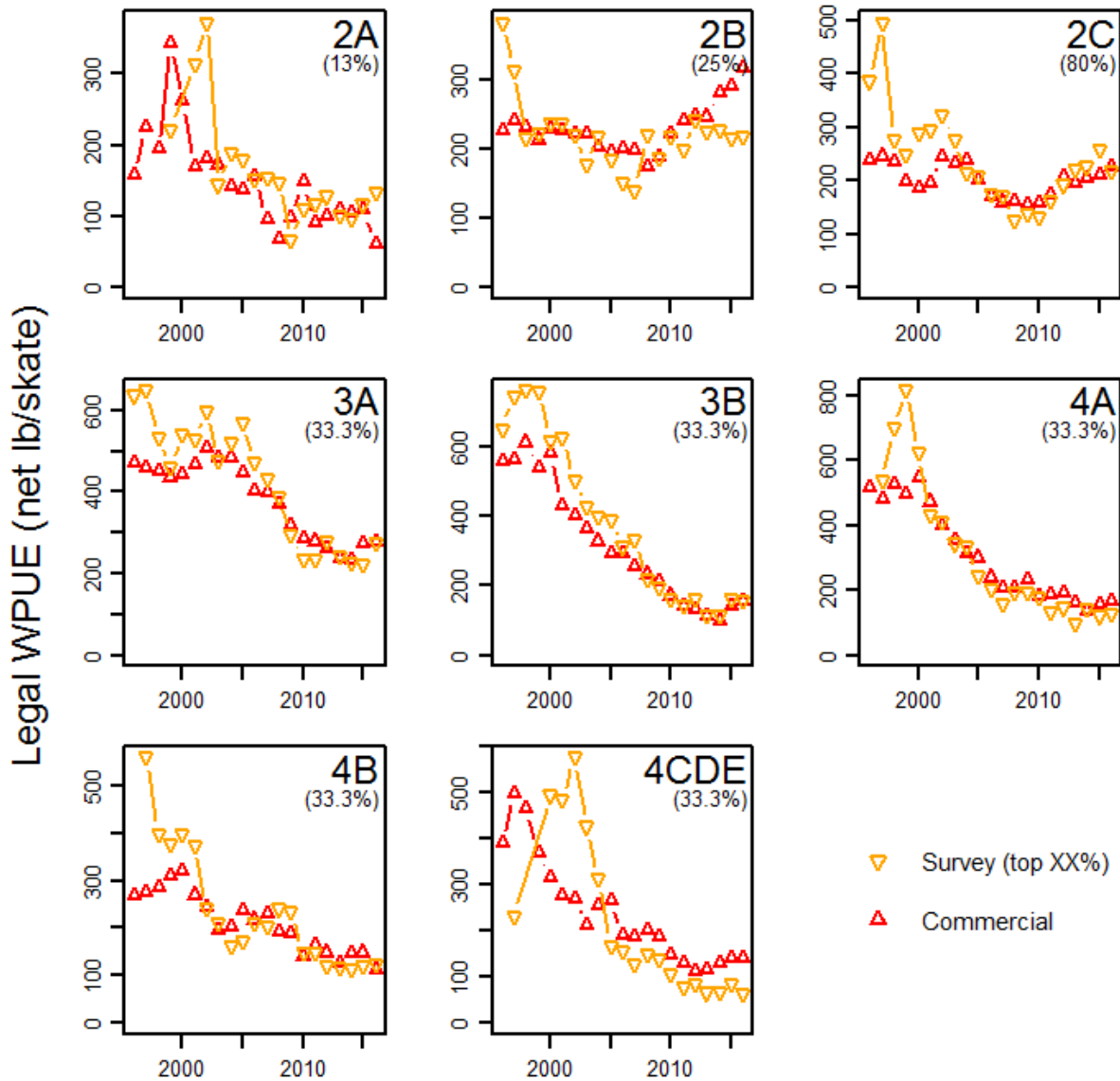


Figure 2. O32 WPUE for the commercial fishery versus setline survey filtered to the top XX%, 1997-2016.