

Examination of the high Area 2B survey WPUE values of 1995-1997

Raymond A. Webster and Steven R. Hare

Abstract

Consideration is given to whether changes in the Area 2B survey design can explain the anomalously high survey index values of 1995-1997. We conclude that the high index values were not due to the design change and that it is likely the arrival of two strong year classes that produced the high index values.

Introduction

One of the primary indicators of exploitable biomass trends in IPHC regulatory areas is the annual setline survey index of over-32 inch halibut caught per standardized skate, termed weight per unit effort (WPUE). The 1995-97 setline surveys in Area 2B produced mean WPUE values that were markedly greater than those of both earlier and subsequent surveys (Fig. 1). Here we examine whether the design of the survey in those years could have had an effect on WPUE and any comparisons with survey WPUEs in subsequent years.

Area 2B survey design 1995-97

The 1995-97 surveys in Area 2B were a modification of earlier survey designs (Forsberg and Larsen 1996). A 1963 survey was designed with east-west orientated transects of stations 6 nmiles apart, with the transects themselves being separated by a distance of 12 nmiles. A 1976 modification involved removing every second transect so that the inter-transect spacing become 24 nmiles. This allowed the survey to be completed in a single year, something not achieved previously, but also left relatively large strips between transects with no survey coverage. In 1993, a new survey design was developed in which every second station on the 1963 12 nmile-spaced transects was removed. Adjacent transects had alternate stations removed from the 1963 design, so that a group of three stations in adjacent transects formed a triangular cluster that could be fished in a single day. An additional centre station was added to each cluster to improve efficiency, as there was also time to fish a fourth station in a fishing day. In 1997 a further modification was applied to the Area 2B survey grid: stations in each cluster were moved closer together by 1-2 nmiles to reduce vessel running time between stations (see IPHC Staff (1997) for details). Figs 2-4 compare the current survey station layout with those used in 1995-97 respectively. We note that while the layout of the survey stations changed between the 1995-1997 and post-1997 periods, the survey protocols, e.g., hook size, number of hooks per skate, size and type of bait, gear setting protocols, etc., have remained under the same standards since 1995. In addition, several different vessels were involved in the Area 2B survey over the 1995-2000 time frame (Table 1). The vessel most active in Area 2B during that period was the *F/V Cape Ball*, which was involved both in the high-WPUE period, as well as the lower-WPUE period. Thus, there appears to be little reason to suspect a “vessel” effect regarding the high WPUE values.

The portion of Area 2B covered by the 1995-97 survey was similar to the 1998 setline survey in which a 10 nmile grid was used for the first time: the only real difference was the inclusion of stations in the shallow waters of Dogfish Bank from 1995-97, an area with low survey WPUE (Forsberg and Larsen, 1996). The 1998 survey design did not include stations on Dogfish Bank because those waters were shallower than the 20-275 fathom depth range used in that design. The two clusters of stations (i.e., eight stations in total) in the shallow waters of Dogfish Bank (Figs 2-4) have been removed from the WPUE calculations for the purposes of this analysis in order that the 1995-97 and post-1997 surveys have similar geographic station distributions. In 1999 the survey was expanded to include stations off the west coast of Vancouver Island (WCVI). The area covered by the 41 stations off of west Vancouver Island has a consistently lower WPUE than the rest of Area 2B (Table 2). Beginning in 2006, earlier WPUE values for Area 2B have been scaled down by a factor of 0.89 to account for the lower halibut density in that part of the Area 2B survey region (Clark and Hare 2007). The scaling factor was computed by averaging the ratio of WPUEs with and without the WCVI stations from 1999 to 2006. Individual year ratios have ranged from a low of 0.84 (2002) to a high of 0.95 (2005). A rolling average of the individual year ratios has remained at 0.89 from 2006 to the present and we see no present need to adjust this value. A scaling factor is not necessary to account for the Dogfish Bank stations in 1995-97 when exclusion of those data is possible.

WPUE has previously been computed for the years 1995-97 by using a simple arithmetic mean of the WPUE of the individual stations. Given that the stations are sampled in clusters of four, an alternative estimate could be calculated by first computing a mean for each cluster and then averaging those. In each year, there were some stations that were not considered effective or were not fished, and excluded from WPUE calculations, and so we would expect this method to yield slightly different WPUE estimates than the overall mean. A third approach is to omit the centre stations, which are departures from the grid design, and were added to make full use of survey resources rather than for scientific reasons. Without these stations, the design is similar to the 10 nmile grid currently in use, with stations close to uniformly distributed throughout the region.

In 1996 an Area 2C grid survey was initiated. For the purpose of computing mean WPUE, stations that were part of that survey and were located south of 54.5 degrees N are included in Area 2B. This resulted in an additional cluster of four stations and two other individual stations being added to the Area 2B WPUE estimation (Figs. 3 and 4). For the cluster approach to computing mean WPUE, the two individual stations are omitted.

Figure 5 compares the estimates from the three methods for computing mean WPUE. There is little difference between the three values for 1995-97. The 1995 mean computed without centre stations is somewhat lower than the other values due to some centre stations having high catches. Nevertheless, all estimates are much higher than those obtained in subsequent years (Table 2), even allowing for the 0.89 scaling factor described above. Given these results and the similar spatial coverage north of Vancouver Island, there is no evidence that the survey design in 1995-97 was a factor in the higher WPUE values estimated in those years compared with values from 1998 onwards.

Discussion

Mean WPUE for Area 2B is well estimated, with coefficients of variation (CVs) generally less than 10% (Hare 2011). This arises in large measure both due to the relatively even distribution of halibut within Area 2B (the WCVI area excepted) as well as the large number of stations – approximately 130, then approximately 170 for the periods before and after addition of the WCVI stations, respectively. The 1995-1997 surveys, which did not include the WCVI stations, have even larger WPUE values than are published in the annual RARA due to the exclusion of data from eight stations on Dogfish Bank. Those values are scaled down by a factor of 0.89. Depending on the years used to compute the scaling factor, it is possible to argue that the scaling factor could be somewhat lower (or higher). However, even using the single lowest scaling factor (0.84 in 2002), the gap between the WPUEs of 1995-1997 and those since 1998 is still very large and highly significant statistically. In summary, given the large number of broadly distributed stations, and the results of the comparisons presented in Fig. 5, there is no reason to suspect that the 1995-97 survey design contributed to higher WPUE in those years

The question arises then as to what might be the explanation for the significantly high WPUE values of 1995-1997. Random sampling variation is a potential cause, but given the low CVs and the fact that three consecutive years showed the same trend, this is unlikely. We believe that the large WPUE values are directly the result of the very large 1987 and 1988 year classes moving into Area 2B. The annual stock assessments for the past decade have consistently estimated that the 1987 and 1988 year classes were among the largest in modern time (Hare 2011). Further, in the late 1980s size-at-age was considerably greater than it is in the 2000s and halibut from those two year classes, which were ages 8-10 during the 1995-1997 surveys, were on average much larger than the commercial size limit. The dominance of the 1987 and 1988 year classes can be seen by examining both the survey and commercial age distributions (Table 3). We conclude that the arrival of these large year classes is the main explanation for the seemingly anomalous high WPUE values in the 1995-1997 Area 2B surveys.

Further support for the hypothesis that the rise in Area 2B WPUE in the mid-1990s was due to the arrival of a couple of strong year classes can be found by considering WPUE trends in the neighboring regulatory areas 2C and 3A. We computed the mean annual WPUE for the periods 1995-1997 and 1998-2000 (Table 4). There was no survey in Area 2C in 1995, thus the mean WPUE is computed from 1996 and 1997 values in that area. All three areas show a similar pattern of decline, though the decrease in mean WPUE is greatest for Area 2B. The decline in WPUE for the three areas was roughly 43%, 37%, and 19% for Areas 2B, 2C and 3A, respectively. Comparison of trends in the years just prior to 1995 is thwarted by the lack of surveys in most of the areas: between 1990 and 1994, Area 2B was surveyed just once (1993), Area 2C not at all, and Area 3A was surveyed twice (1993 and 1994). However, even these limited surveys paint a consistent picture: both Areas 2B and 3A had WPUEs comparable to those of the post-1997 period, reflecting a rise and fall of WPUEs that would be expected as two strong year classes enter and exit the survey catches.

References

- Forsberg, J. E. and Larsen, M. J. 1996. 1995 Area 2B setline survey grid. Int. Pac. Halibut Comm. Report of Assessment and Research Activities 1995: 225-236.

Hare, S.R. 2011. Assessment of the Pacific halibut stock at the end of 2010. Int. Pac. Halibut Comm. Report of Assessment and Research Activities 2010: 85-175.

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Table 1. Vessls chartered to survey Area 2B from 1995 to 2000. Values in parentheses are number of stations surveyed by each vessel.

Year	Vessel 1	Vessel 2	Vessel 3
1995	Kristiana (107)		
1996	Cape Ball (110)	Ocean Viking (6)	
1997	Cape Ball (60)	Bold Pursuit (51)	Ocean Viking (5)
1998	Venturous (82)	Western Sunrise (46)	
1999	Pender Isle (124)	Cape Ball (44)	
2000	Pender Isle (84)	Star Wars II (44)	

Table 2. Summary of Area 2B survey station data. Three sets of WPUE values are listed: without the west coast of Vancouver Island (non-WCVI), only the WCVI (WCVI) and all stations (All). The annual ratio is computed from the quotient of All to non-WCVI WPUEs; the running ratio is the mean of all annual ratios up until the indicated year. Note that the eight Dogfish Bank stations surveyed in 1995-1997 are excluded from the WPUE calculations.

Year	No. of stations	WPUEs			Ratios	
		non-WCVI	WCVI	ALL	Annual	Running
1995	107	178.8		159.1		
1996	116	186.4		165.9		
1997	116	161.9		144.1		
1998	128	93.6		83.3		
1999	168	96.9	60.1	88.1	0.91	0.91
2000	128	102.5		91.2		
2001	170	119.3	43.9	101.1	0.85	0.88
2002	170	109.3	36.8	91.8	0.84	0.87
2003	169	85.2	32.4	72.7	0.85	0.86
2004	169	100.2	40.9	85.8	0.86	0.86
2005	170	75.9	59.2	71.9	0.95	0.88
2006	169	62.0	48.3	58.7	0.95	0.89
2007	170	61.0	45.4	57.2	0.94	0.89
2008	170	103.6	46.4	89.8	0.87	0.89
2009	170	95.2	58.2	86.3	0.91	0.89
2010	170	96.7	64.2	88.8	0.92	0.89
Average					0.89	0.89

Table 3. Age distributions in survey and commercial catches for the years 1995 to 1997 in Area 2B. The 1987 and 1988 year classes are highlighted.

Survey catch age distribution				Commercial catch age distribution			
	Year				Year		
Age	1995	1996	1997	Age	1995	1996	1997
4		1		4	1		
5	12	26	4	5	7	1	
6	88	85	43	6	38	21	37
7	215	133	118	7	91	91	118
8	325	309	199	8	238	235	254
9	246	352	343	9	216	498	450
10	246	152	478	10	247	329	591
11	246	151	184	11	350	351	297
12	210	185	146	12	299	398	260
13	175	139	140	13	221	306	231
14	153	110	116	14	211	202	191
15	117	74	59	15	174	170	98
16	89	70	46	16	113	130	96
17	66	58	36	17	81	99	77
18	41	31	38	18	60	42	34
19	22	23	27	19	37	35	32
20+	46	28	63	20+	52	37	64
Total	2,297	1,927	2,040	Total	2,436	2,945	2,830

Table 4. Comparison of mean WPUE values for two time periods, 1995-1997 and 1998-2000.

Period	2B	2C	3A
1995-1997	156.4	358.4	316.0
1998-2000	90.1	227.5	264.6
Percent decline	43.4	36.5	16.3

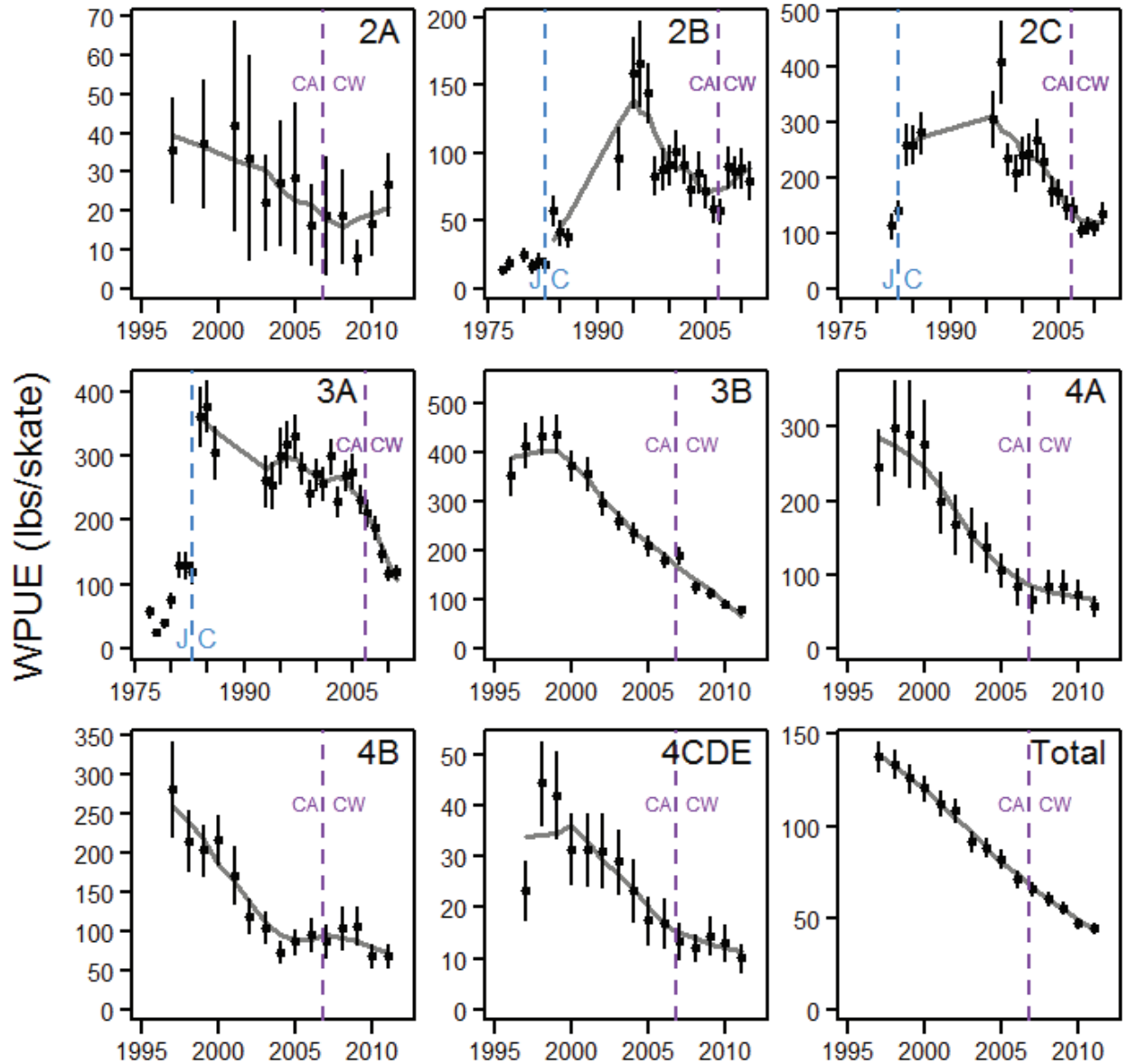


Figure 1. Survey WPUE (weight of O32 halibut per standardized skate of gear) by regulatory area. The dots indicate the area-wide average; the vertical bars represent ± 2 standard errors of the mean. The thick line is a smoother to illustrate trend; it is not an assessment model fitted to the WPUE data. The total is computed by area-weighting the individual area WPUE time series. Note that the timeline for Areas 2B, 2C, and 3A differs from the other areas and extends back to 1975. The data points prior to 1984 are from the “J” hook era; points after 1984 are from the “C” hook era.

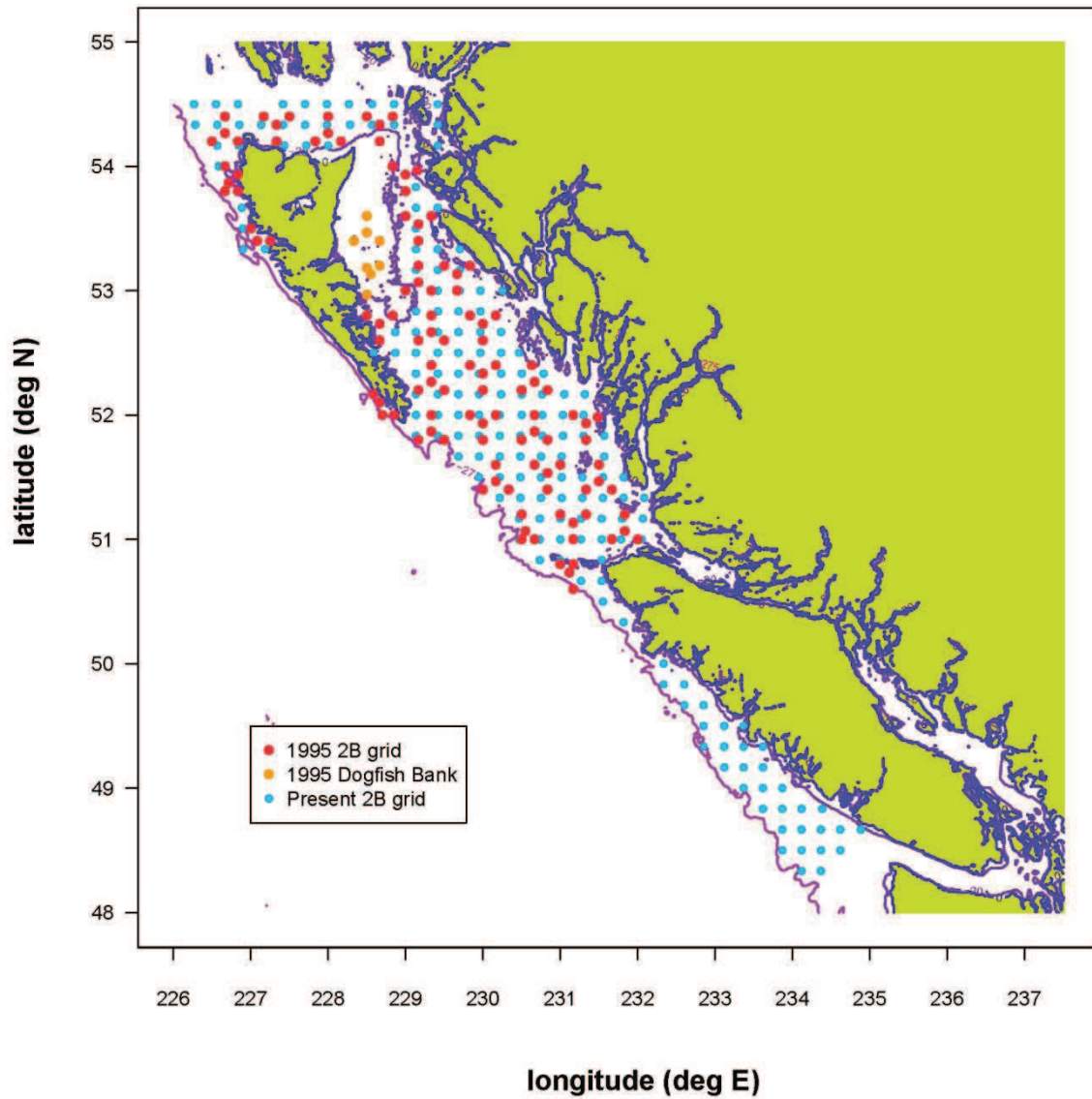


Figure 2. Comparison of 1995 survey grid with present-day survey grid.

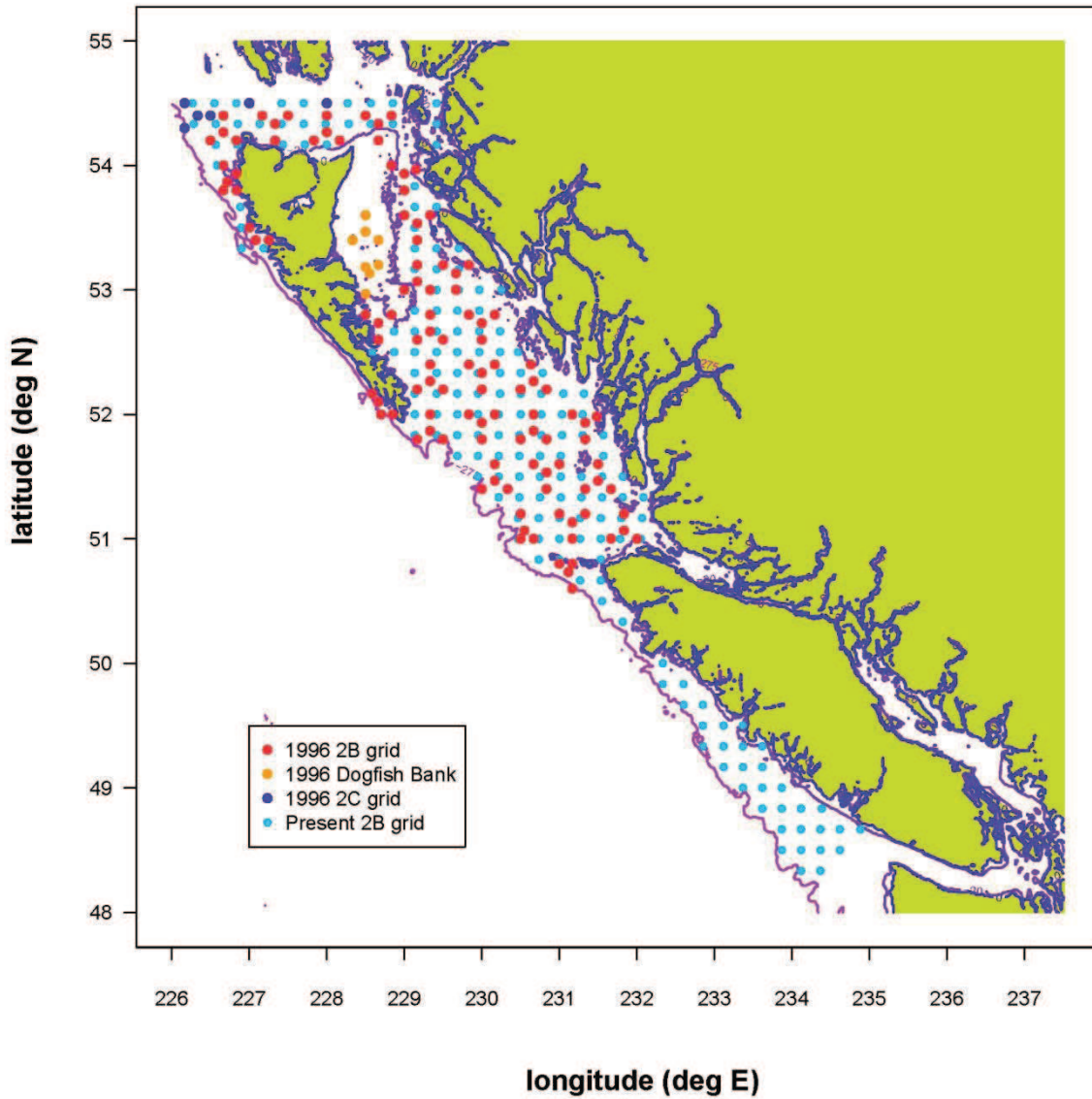


Figure 3. Comparison of 1996 survey grid with present-day survey grid. Stations that were part of the Area 2C survey grid in 1996 and were not north of 54.5 N are included in WPUE calculation for Area 2B.

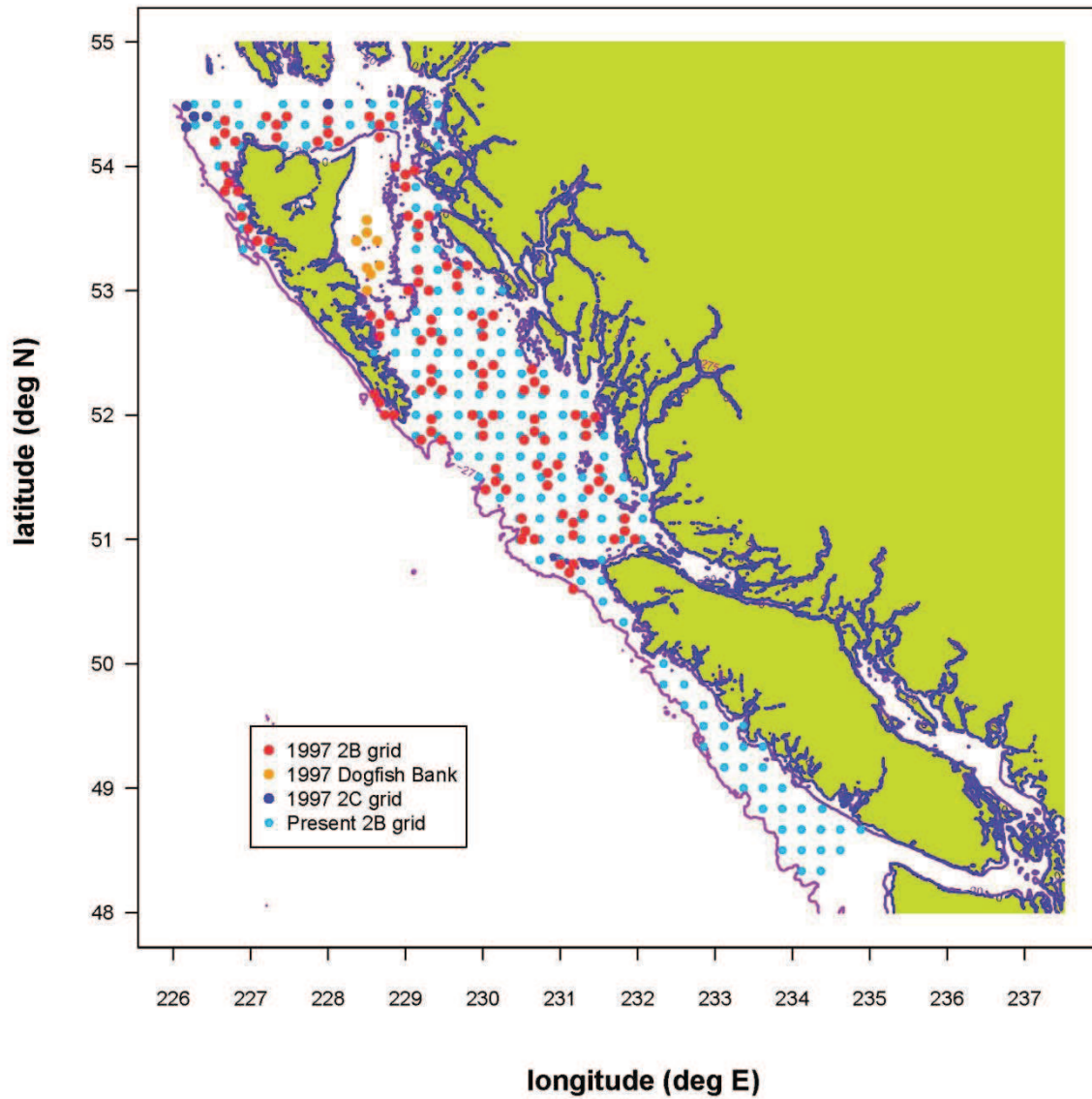


Figure 4. Comparison of 1997 survey grid with present-day survey grid. Stations that were part of the Area 2C survey grid in 1997 and were not north of 54.5 N are included in WPUE calculation for Area 2B.

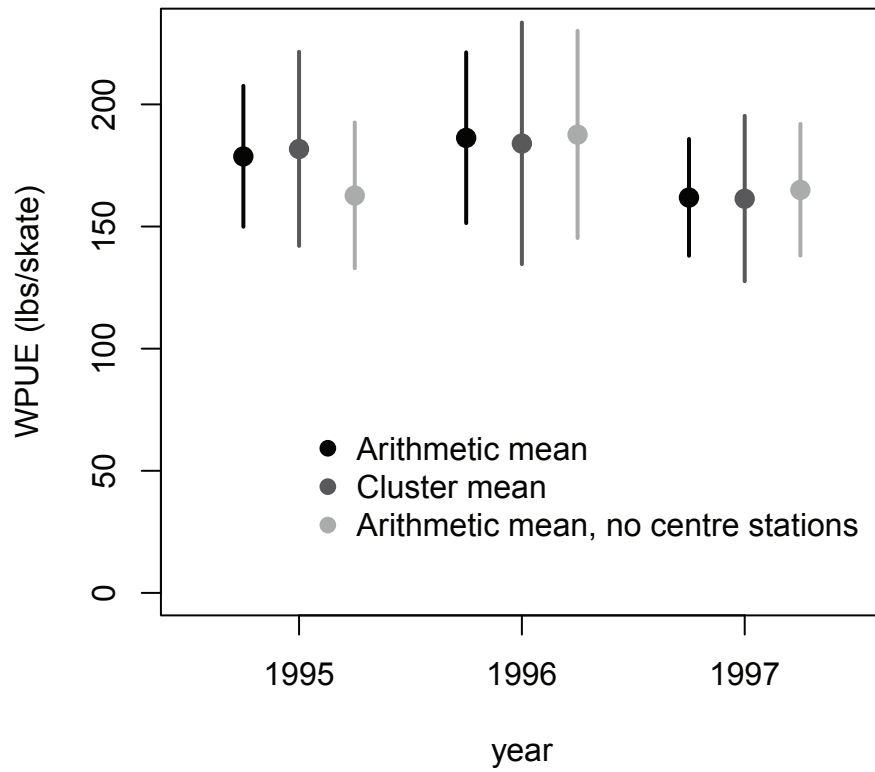


Figure 5. Mean WPUE with approximate 95% confidence intervals for 1995-97 calculated using the three methods described in the text.

