

3.2 Area 4CDE edge IPHC survey expansion

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Abstract

The third year of the International Pacific Halibut Commission's fishery-independent setline survey expansion was carried out along the Regulatory Area 4CDE continental shelf edge, with 84 additional stations fished in 2016 in this region. The weight per unit effort (WPUE) of O32 Pacific halibut at these new stations averaged 14.0 lb/skate (6.4 kg/skate), compared with 18.7 lb/skate (8.5 kg/skate) at the 51 standard stations successfully fished in 2016. Mean WPUE over all Regulatory Area 4CDE continental shelf edge stations fished in 2016 was 84.5% of that computed from the standard stations that are fished annually, implying that previous estimates of WPUE in this region were positively biased. Several of the new stations close to the USA/Russia EEZ border had average or above the average catch rate, indicating that Pacific halibut density does not strongly taper off approaching the border.

Introduction

The third year of the International Pacific Halibut Commission's (IPHC) fishery-independent setline survey expansion was carried out in 2016 along the Area 4CDE continental shelf edge. In other Regulatory Areas, the IPHC undertakes an annual setline survey of Pacific halibut on a 10 nmi (18.5 km) grid in the depth range of 20-275 fm (37-503 m). A high proportion of the bottom area in Area 4CDE is low-density habitat shallower than 275 fm (503 m), which is impractical to survey at standard station densities and on an annual basis. Instead, only the area from 75-275 fm (137-503 m) is surveyed annually, along with clusters of stations around St Matthew and the Pribilof Islands (surveyed since 2006), while the eastern Bering Sea has been surveyed twice using a low station-density design (Webster 2016). In this region, even within the 75-275 fm (137-503 m) depth range, there were substantial gaps in coverage prior to 2016: the area north of 60°N had never been surveyed by the IPHC, and recent bathymetry data (Becker et al 2009; data updated in 2014) showed other potential coverage gaps south of 60°N. The IPHC survey expansions in other regions have included new stations in the 10-20 fm (18-37 m) and 275-400 fm (503-732 m) ranges; the 2016 survey expansion in Area 4CDE include five stations in the 275-400 fm (503-732 m) range, but the 75 fm (137 m) lower depth limit was maintained when planning new stations in this region.

Area 4CDE setline survey expansion

Since 2000, 52 IPHC setline survey stations have been fished annually along the Area 4CDE shelf edge, including three stations in the Closed Area (managed as part of Area 4CDE). The 2016 expansion added 84 new stations in this region. Prior to surveying these stations, most (77) were expected to be in the standard 75-275 fm (137-503 m) depth range, with seven from 275-400 fm (503-732 m). Close to half of the new stations were located at 60°N or above (Fig. 1).

Two vessels accustomed to working in the Bering Sea, the *F/V Saint Peter* and *F/V Sunward*, completed the sampling at the expansion stations. Both vessels were effective platforms for the

work and the IPHC survey team rated their performance as excellent. In addition to standard survey sampling, several special projects were conducted, including wire-tagging of U32 Pacific halibut, deploying pop-up satellite transmitting archival tags on Pacific halibut along the northern 4CDE edge (Loher 2017), collecting Pacific halibut flesh samples for analysis of heavy metals and persistent organic pollutants, and collecting lengths and genetic samples from incidentally captured Pacific cod. All stations were successfully surveyed; however, one station was ineffective for use in weight per unit effort (WPUE) calculations and the stock assessment because of gear issues (see [Fig. 1](#)).

Actual depth soundings taken from the charter vessel were not always consistent with the estimates computed prior to fishing from bathymetry data (Becker et al. 2009). Twenty-five stations had mean depth (average of minimum and maximum depth soundings) of less than 75 fm (137 m), including two existing stations. Most of these (14 stations) had mean depth in the 70-75 fm (128-137 m) range, but the others were shallower, including six stations in water shallower than 65 fm (119 m). Three stations had mean depth greater than 400 fm (732 m), although mean depths were in the range of 406-412 fm (742-753 m), and so relatively close to 400 fm (732 m), and their minimum station depths were shallower than the limit at 287-362 fm (525-662 m). Two of the new “deep” stations had mean depths shallower than 275 fm (503 m), including one with mean depth of just 120 fm (219 m). How data from these stations are incorporated into WPUE estimation is discussed below.

On average, O32 WPUE at the 84 expansion stations was 14.0 lb/skate (6.4 kg/skate), compared with 18.7 lb/skate (8.5 kg/skate) in 2016 at the 51 previously existing stations ([Table 1](#)). Overall WPUE at all 135 stations in 2016 was 15.8 lb/skate (7.2 kg/skate). No O32 Pacific halibut were captured at the five stations with observed mean depths greater than 275 fm. The ratio of mean WPUE at all stations to that at existing stations was $15.8/18.7 = 0.845$, or 84.5%. Compared to other recent years' WPUE, the mean of 18.7 lb/skate (8.5 kg/skate) at the existing stations was similar to the value from 2014, but somewhat lower than mean WPUE observed in 2013 and 2015 ([Table 1](#)).

Discussion

Prior to 2016, the WPUE from the 52 stations on the 4CDE edge fished on an annual basis was assumed to also apply in parts of this region not covered by the setline survey. The new data from 2016 imply that this assumption resulted in a positive bias in the WPUE for the Area 4CDE edge, as mean WPUE was only 84.5% of that on the full, expanded survey grid relative to the existing standard grid. In past years, this would have led us to scale down WPUE in years without an expansion, so that, for example, the mean WPUE in 2015 of 27.2 lb/skate (12.3 kg/skate) would be adjusted to $0.845 \times 27.2 = 23.0$ lb/skate (10.4 kg/skate). With the adoption of space-time modelling for estimation of WPUE, such an explicit adjustment is no longer necessary (see Webster 2016). Instead, the modelling allows us to predict WPUE at any station not fished in a given year, with the prediction informed by years with survey expansions, WPUE at nearby stations, nearby NMFS trawl survey data, and any covariate relationships used in the model (such as the relationship between WPUE and depth).

While the new data have revised downwards our estimates of mean WPUE across the Area 4CDE edge, this revision is modest compared to recent annual changes in mean WPUE estimated from the 52 stations fished annually: on those stations, mean WPUE declined from 27.2 lb/skate

(12.3 kg/skate) in 2015 (approximately a 1/3 decrease) to 18.7 lb/skate (8.5 kg/skate) in 2016 ([Table 1](#)), but is similar to the 19.6 lb/skate (8.9 kg/skate) observed in 2014.

In previous work, data from stations that were clearly outside of a region's depth range for Pacific halibut (0-400 fm, or 0-732 m, in most areas; 75-400 fm, or 137-732 m, in the Area 4CDE edge) would have been excluded from WPUE or numbers per unit effort (NPUE) calculations. With the change in 2016 to a model-based approach for estimating WPUE and NPUE, data from such stations are included in the modelling as they provide useful information on local density that informs both the estimates of model parameters and the estimates of WPUE at nearby stations (Webster 2017).

The 2016 expansion provided the northernmost setline survey data to date, with several stations north of 60°N along the US/Russia EEZ border. The northwestern extent of the Pacific halibut distribution managed by the IPHC is of interest because it provides information on the connectivity of Pacific halibut populations in US and Canadian waters with those in the waters of the western Pacific Ocean. Very low densities of Pacific halibut near the EEZ border might have been evidence of relatively little connectivity. Instead, we observed average to above average WPUE at several stations near the border ([Fig. 1](#)), indicating that density does not taper off strongly in this region. It is hoped that data from Pacific halibut released along the northern 4CDE edge with pop-up satellite transmitting archival tags further improve our understanding of the connectivity between eastern and western Pacific populations (Loher 2017).

References

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Table 1. Comparison of mean O32 WPUE (lb/skate) between existing and expansion stations in the Area 4CDE edge, and with WPUE at existing stations in recent years.

Year	Depth*	Existing		Expansion		Total	
		WPUE	N	WPUE	N	WPUE	N
2016	Standard (≤ 275 fm)	18.7	51	15.1	79	16.5	130
	Deep (>275 fm)			0.0	5	0.0	5
	Total	18.7	51	14.0	84	15.8	135
2015	Standard (≤ 275 fm)	27.2	52			27.2	52
2014	Standard (≤ 275 fm)	19.6	52			19.6	52
2013	Standard (≤ 275 fm)	24.2	52			24.2	52

* Observed mean depth

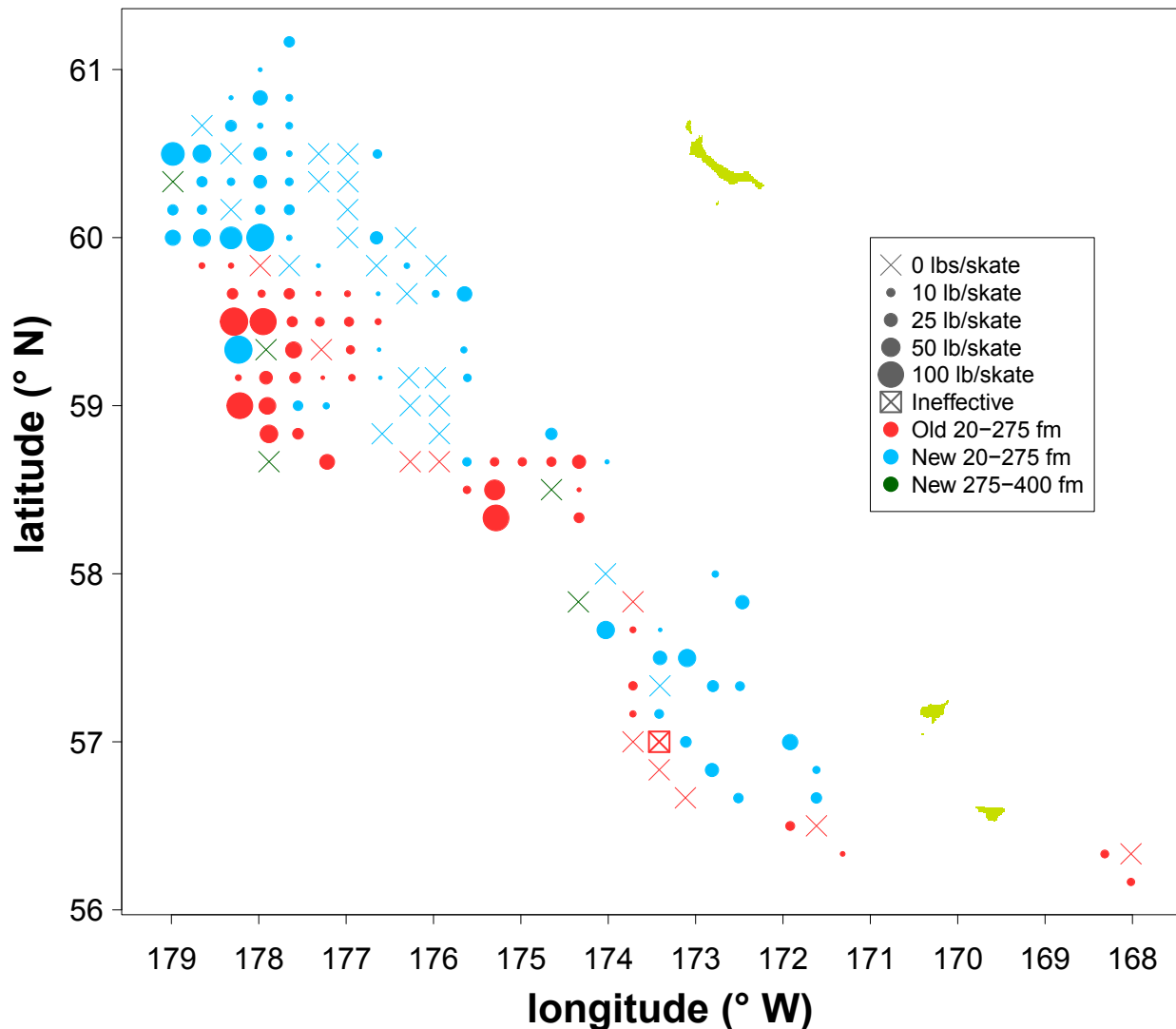


Figure 1. Map of O32 Pacific halibut WPUE by station along the 4CDE edge in 2016. Image best viewed electronically in colour.