Space-time modelling of survey data

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PURPOSE

To provide results of the space time modelling of Pacific halibut survey data for the period 1993-2021.

INTRODUCTION

As described in Webster (2021a), since 2016 space-time modelling has been used by the IPHC to produce estimates of mean O32 WPUE (weight per unit effort), all sizes WPUE and all sizes NPUE (numbers per unit effort) indices of Pacific halibut density and abundance. The modelling depends primarily on data from the IPHC's fishery-independent setline survey (FISS, Ualesi et al, 2021), but in the Bering Sea also integrates data from the National Marine Fisheries Service annual trawl survey and the Alaska Department of Fish and Game's annual Norton Sound trawl survey. Both surveys are fishery-independent data sources.

Since 2019, weighing of Pacific halibut onboard FISS charter vessels has meant that the vast majority of the weight data used to compute WPUE has come from observed weights of fish rather than estimates from a length-net weight relationship. For fish without directly measured weights, weights are predicted from a year- and IPHC Regulatory Area-specific length-net weight relationship estimated from the FISS length and weight data. For U32 fish with round weight recorded, net weights are estimated from a round-net weight relationship estimated from coastwide sample data from the 2019 FISS (Webster 2021b).

In 2021, a comparison of snap gear to fixed gear on the FISS was conducted in the Seward charter region (IPHC Regulatory Area 3A) to expand on data collected in 2019 and 2020 in IPHC Regulatory Areas 2B and 2C. The design featured each station being fished twice, once with fixed gear and once with snap gear, with randomisation of the order of the two gear types for each station. It was hoped that results of this comparison would contribute to our overall understanding of gear differences and whether such differences were consistent across geographic regions or not.

Results of space-time modelling in 2021

Figures 1 and 2 show time series estimates of O32 WPUE (most comparable to fishery catch-rates) and all sizes NPUE over the 1993-2021 period included in the 2021 space-time modelling. Overall, there was an estimated increase of 4% in the coastwide O32 WPUE index from 2020, due largely to a 11% increase in Region 3 (Figure 1). The estimated increase in coastwide all sizes NPUE was greater, with a 17% estimated increase (Figure 2), driven by increases in both Regions 2 and 3. Estimated 1993-21 time series by IPHC Regulatory Area are in Appendix A.

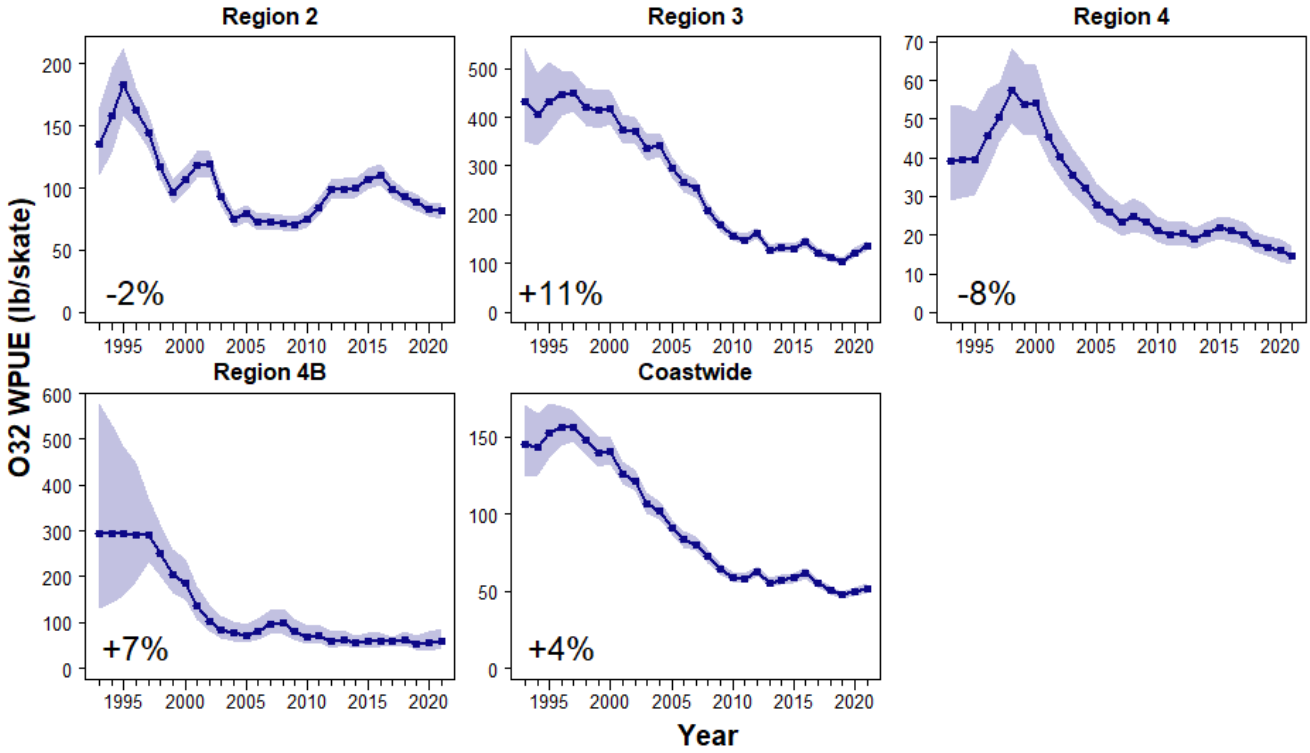

Figure 1. Space-time model output for O32 WPUE for 1993-2021 for Biological Regions. Filled circles denote the posterior means of O32 WPUE for each year. Shaded regions show posterior 95% credible intervals, which provide a measure of uncertainty: the wider the shaded interval, the greater the uncertainty in the estimate. Numeric values in the lower left-hand corners are estimates of the change in mean O32 WPUE from 2020 to 2021.

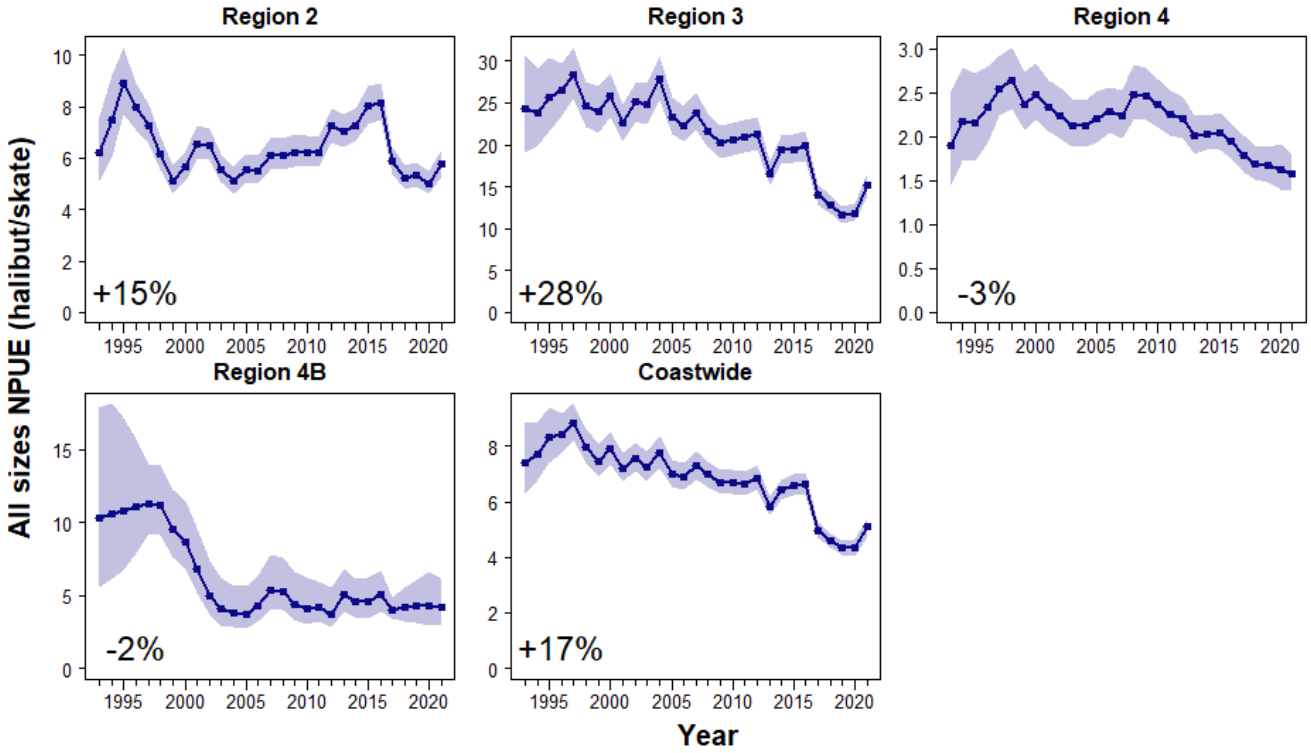

Figure 2. Space-time model output for all sizes NPUE for 1993-2021 for Biological Regions. Filled circles denote the posterior means of all sizes NPUE for each year. Shaded regions show posterior 95% credible intervals, which provide a measure of uncertainty: the wider the shaded interval, the greater the uncertainty in the estimate. Numeric values in the lower left-hand corners are estimates of the change in mean all sizes NPUE from 2020 to 2021.

In Regulatory Area 3A, data from both fixed and snap gears were used in the modelling. Parameters allowing for different catch rates of the two gears were included in the models, and estimates of WPUE and NPUE series were based on model predictions assuming fixed gear to ensure consistency with other Regulatory Areas. The design and analysis is consistent with the treatment of the data from both gears fished in IPHC Regulatory Areas 2C and 2B in 2019 and 2020 respectively. Parameter estimates of gear type differences all implied that snap gear catch rates were greater on average (Table 1), with estimated catch rate ratios of 1.18 to 1.43 for the three indices modelled in 2021 (i.e., we estimate snap gear had 125% to 143% of the catch rates of fixed gear, depending on the index). These results are at odds with those of the much larger gear comparison study in all of IPHC Regulatory Area 2C, which estimated a ratio of 0.86 for all three indices, and from the IPHC Regulatory Area 2B study in the St James charter region, which estimated ratios of 0.72-0.83. The 2021 study had two design limitations that make it impossible to draw conclusions regarding the cause of the differences: two vessels were used, each fishing a different gear; and there was almost no overlap in the time periods over which each gear was fished. In other words, gear differences were confounded with vessel effects and possible changes in underlying Pacific halibut density during the study period. These ambiguous and inconsistent results imply the need for a larger and more carefully designed comparison in this geographic region, one that controls as much as possible for factors such as vessel and temporal effects on catch rates of Pacific halibut, as was the case in the 2019 gear comparison study.

Table 1. Posterior estimates of the ratio of snap to fixed gear catch rates for O32 and all sizes WPUE, and all sizes NPUE, from space-time modelling of data from the Seward charter region in Regulatory Area 3A in 2021.

Variable	Ratio of snap to fixed catch rate	
	Posterior mean	95% credible interval
O32 WPUE	1.28	0.96 – 1.72
All sizes WPUE	1.18	0.89 – 1.56
All sizes NPUE	1.43	1.08 – 1.89

RECOMMENDATION

That the Commission **NOTE** paper IPHC-2021-IM097-08 which provides results of the space-time modelling of Pacific halibut survey data for 1993-2021.

REFERENCES

Ualesi, K., Wilson, D., Jones, C. & Rillera, R. IPHC Fishery-independent setline survey (FISS) design and implementation in 2021. IPHC-2021-IM097-07.

Webster R. 2021a. 2022-24 FISS design evaluation. IPHC-2021-IM097-09.

Webster R. 2021b. IPHC Fishery-Independent Setline Survey (FISS) and commercial data modelling. IPHC-2021-SRB019-05.

APPENDIX A

Space-time modelling results by IPHC Regulatory Area

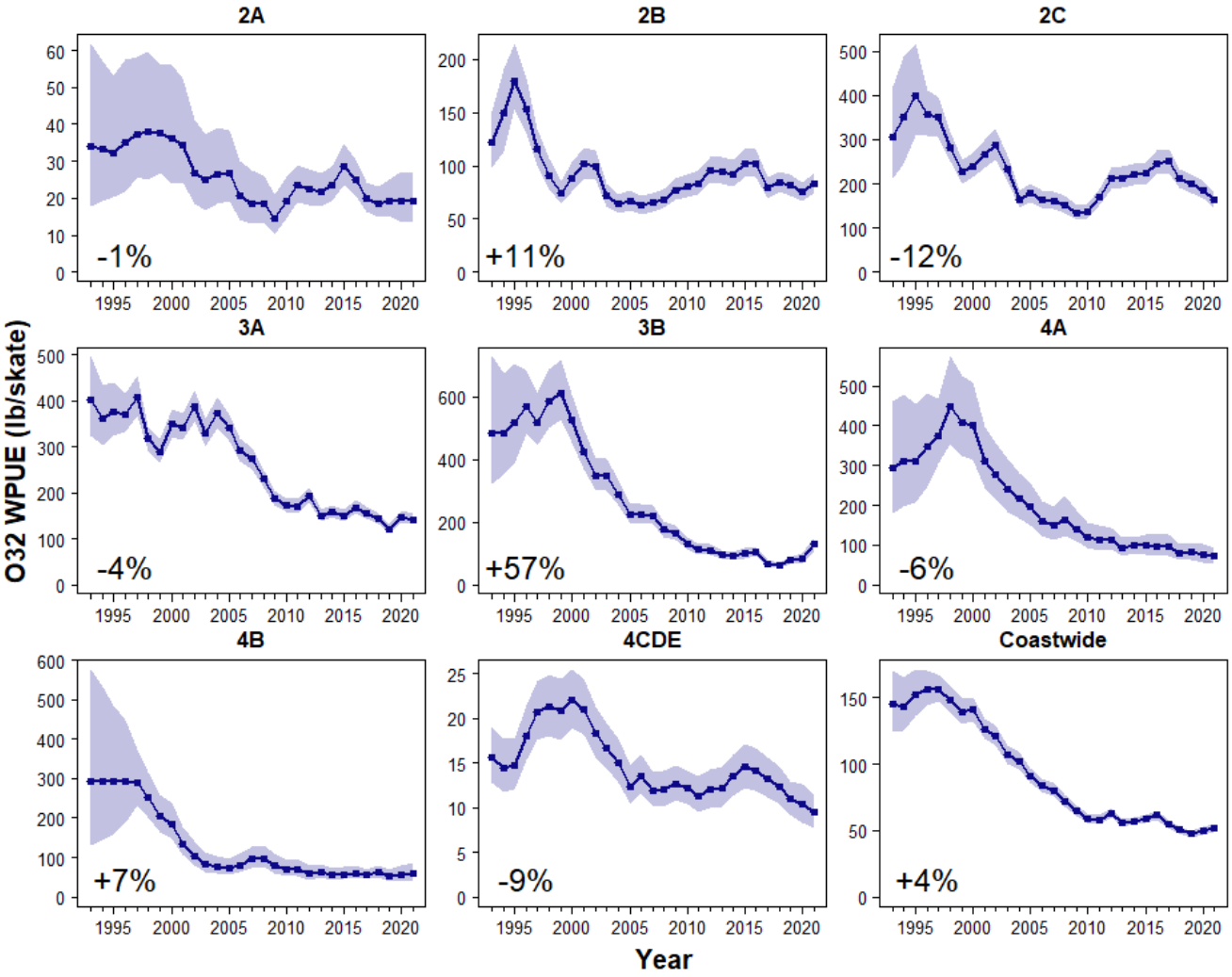

Figure A.1. Space-time model output for O32 WPUE for 1993-2021. Filled circles denote the posterior means of O32 WPUE for each year. Shaded regions show posterior 95% credible intervals, which provide a measure of uncertainty: the wider the shaded interval, the greater the uncertainty in the estimate. Numeric values in the lower left-hand corners are estimates of the change in mean O32 WPUE from 2019 to 2021.

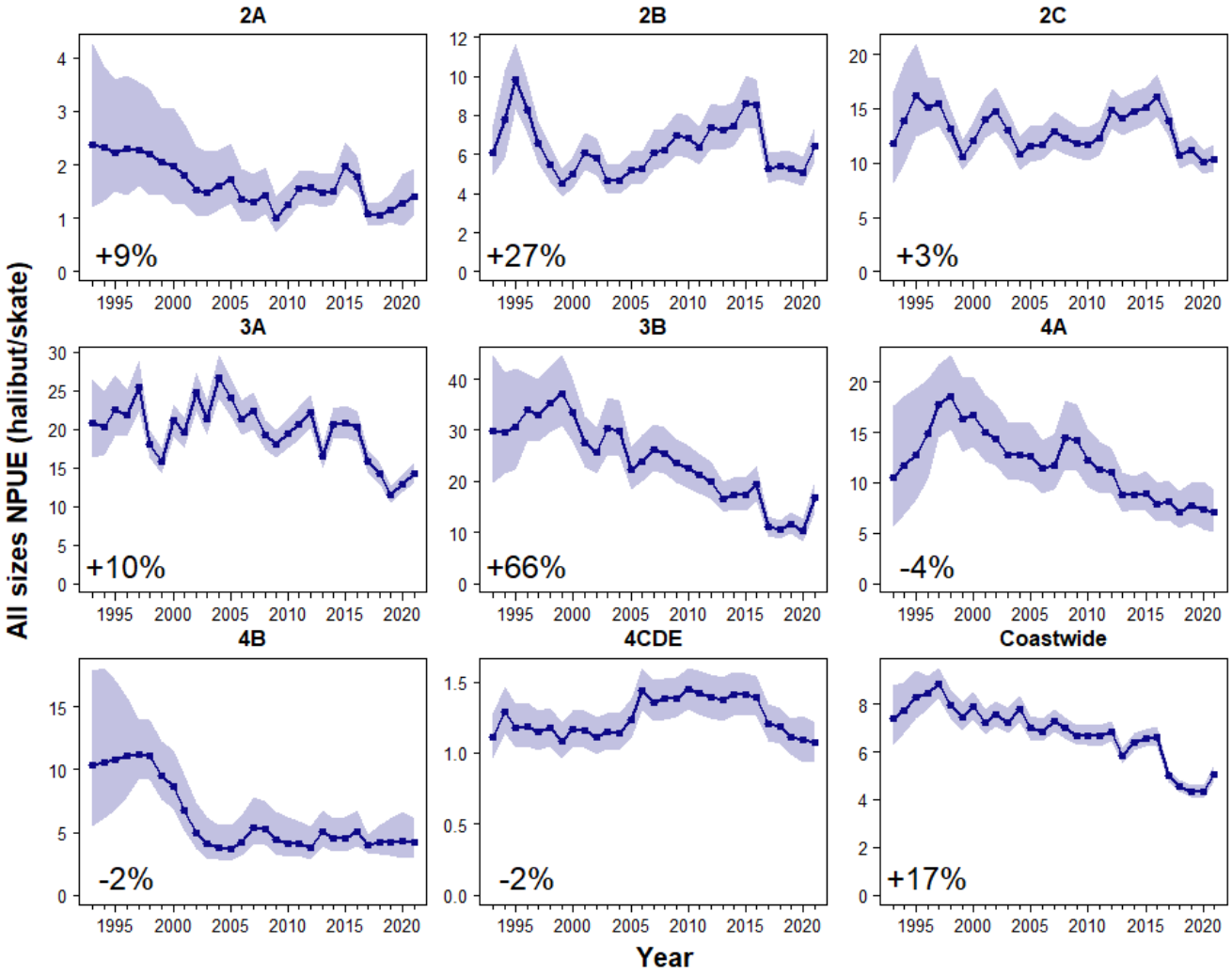

Figure A.2. Space-time model output for all sizes NPUE for 1993-2021. Filled circles denote the posterior means of all sizes NPUE for each year. Shaded regions show posterior 95% credible intervals, which provide a measure of uncertainty: the wider the shaded interval, the greater the uncertainty in the estimate. Numeric values in the lower left-hand corners are estimates of the change in mean total NPUE from 2019 to 2021.