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 1993-2023.

INTRODUCTION

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, 2023), but in the Bering Sea also integrates data from the National Oceanic and Atmospheric Administration - Fisheries 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 weight data used to compute WPUE now comes almost entirely 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.

RESULTS OF SPACE-TIME MODELLING IN 2023

Figures 1-3 show the time series estimates of O32 WPUE (most comparable to fishery catch-rates), all sizes WPUE and all sizes NPUE by IPHC Biological Region over the 1993-2023 period included in the 2023 space-time modelling. Coastwide, we estimate small declines in the indices since 2022 of 2-4%, largely due to 6-8% declines in IPHC Biological Region 3.

Estimated 1993-23 time series by IPHC Regulatory Area are in Appendix A. We note the high uncertainty for estimates in IPHC Regulatory Areas 2A, 4A and 4B in 2023 (Figures A.1 to A.3). Little sampling (minimal 2A FISS, Bering Sea trawl on 4A edge only) or no sampling (4B) took place in these areas in 2023, and caution should be taken when interpreting estimates of change from 2022, as these are not well informed by data.

In 2023, bids for FISS charter regions were opened to vessels fishing snap gear and one vessel fished snap gear in two charter regions in IPHC Regulatory 3A. In 2021, a snap-fixed gear comparison study was conducted in a single charter region in this area, but the limited scope of the study made it impossible to distinguish gear differences from differences in catch rates due to vessel and temporal effects (Webster 2021). The additional 2023 data from snap gear in IPHC Regulatory Area 3A means the space-time modelling now includes snap data from two vessels that fished in three charter regions, leading to revised estimates of gear differences that are likely to be more representative of gear differences in general (Table 1).

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 2021 study, and the 2023 modelling/

Variable	Ratio of snap to fixed catch rate			
	2021 study		2023 modelling	
	Posterior mean	95% credible interval	Posterior mean	95% credible interval
O32 WPUE	1.28	0.96 – 1.72	0.97	0.81 – 1.17
All sizes WPUE	1.18	0.89 – 1.56	1.08	0.90 – 1.30
All sizes NPUE	1.43	1.08 – 1.89	1.15	0.95 – 1.39

Tables of model output (time series, stock distribution estimates) are updated annually on the IPHC website at https://www.iphc.int/data/time-series-datasets.

FISS model output may also be explored interactively using the link on this page of the IPHC website: https://www.iphc.int/data/datatest/fishery-independent-setline-survey-fiss.

RECOMMENDATION

That the Commission **NOTE** paper IPHC-2023-IM099-09 Rev_1 which provides results of the space-time modelling of Pacific halibut survey data for 1993-2023.

REFERENCE

Ualesi, K., Rillera, R., Jack, T. and Coll, K. (2023) IPHC Fishery-independent setline survey (FISS) design and implementation in 2023. IPHC-2023-IM099-08.

Webster, R. A. (2021). Space-time modelling of survey data. IPHC-2021-IM097-08 Rev_1.

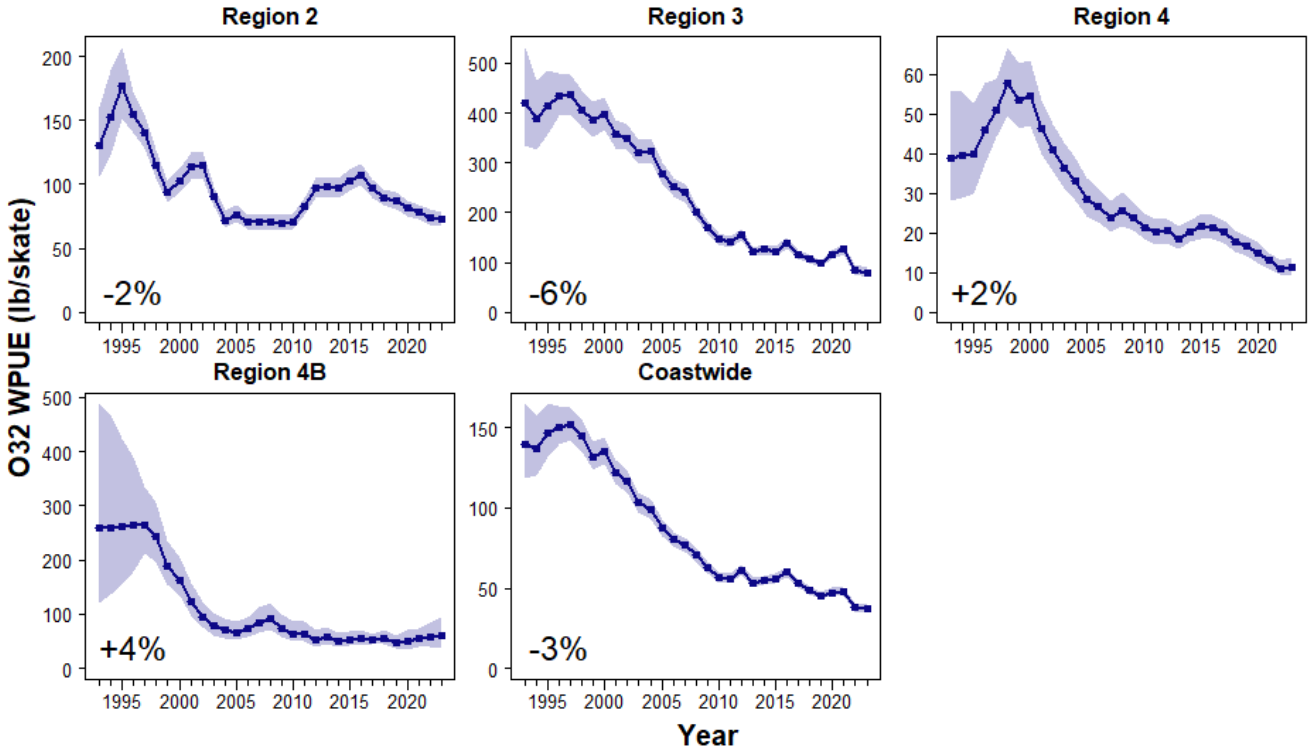

Figure 1. Space-time model output for O32 WPUE for 1993-2023 for Biological Regions. Filled circles denote the posterior means of O32 WPUE for each year. Shaded regions show posterior 95% credible intervals, which provide a measure of uncertainty: the wider the shaded interval, the greater the uncertainty in the estimate. Numeric values in the lower left-hand corners are estimates of the change in mean O32 WPUE from 2022 to 2023.

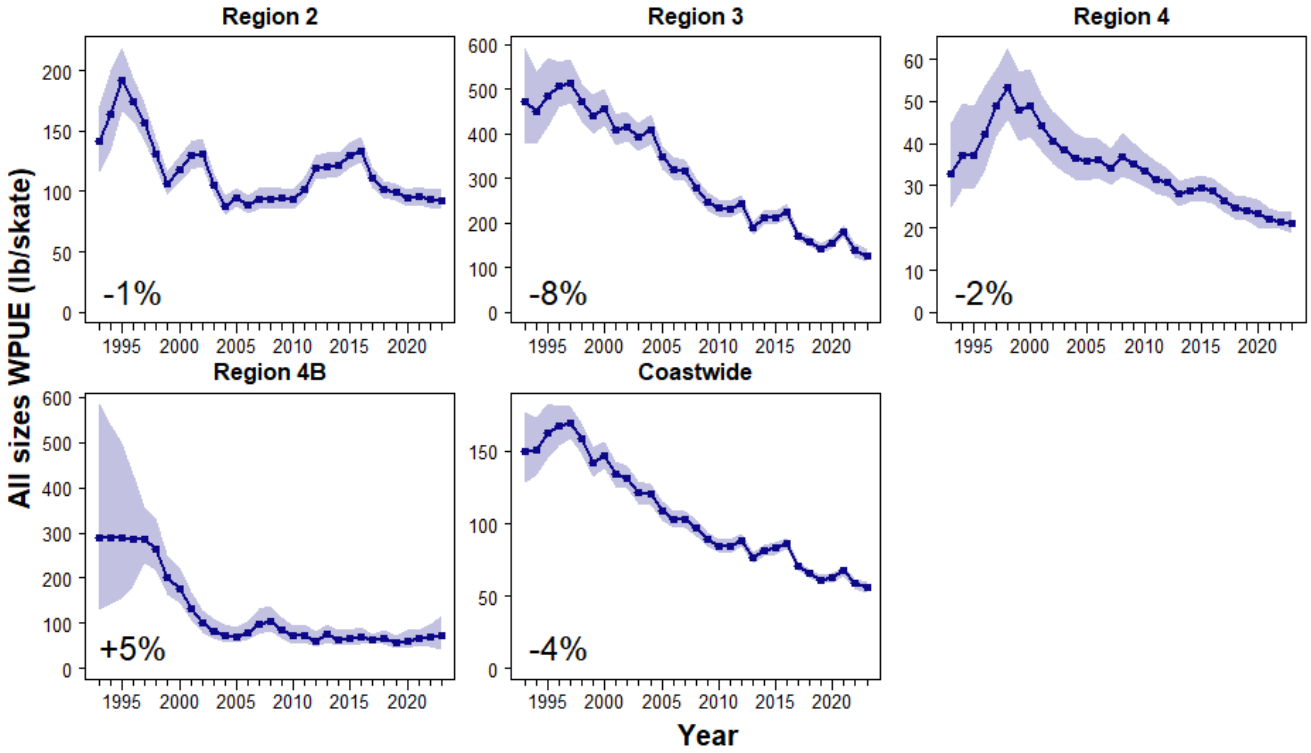

Figure 2. Space-time model output for all sizes WPUE for 1993-2023 for Biological Regions. Filled circles denote the posterior means of all sizes WPUE for each year. Shaded regions show posterior 95% credible intervals, which provide a measure of uncertainty: the wider the shaded interval, the greater the uncertainty in the estimate. Numeric values in the lower left-hand corners are estimates of the change in mean all sizes WPUE from 2022 to 2023.

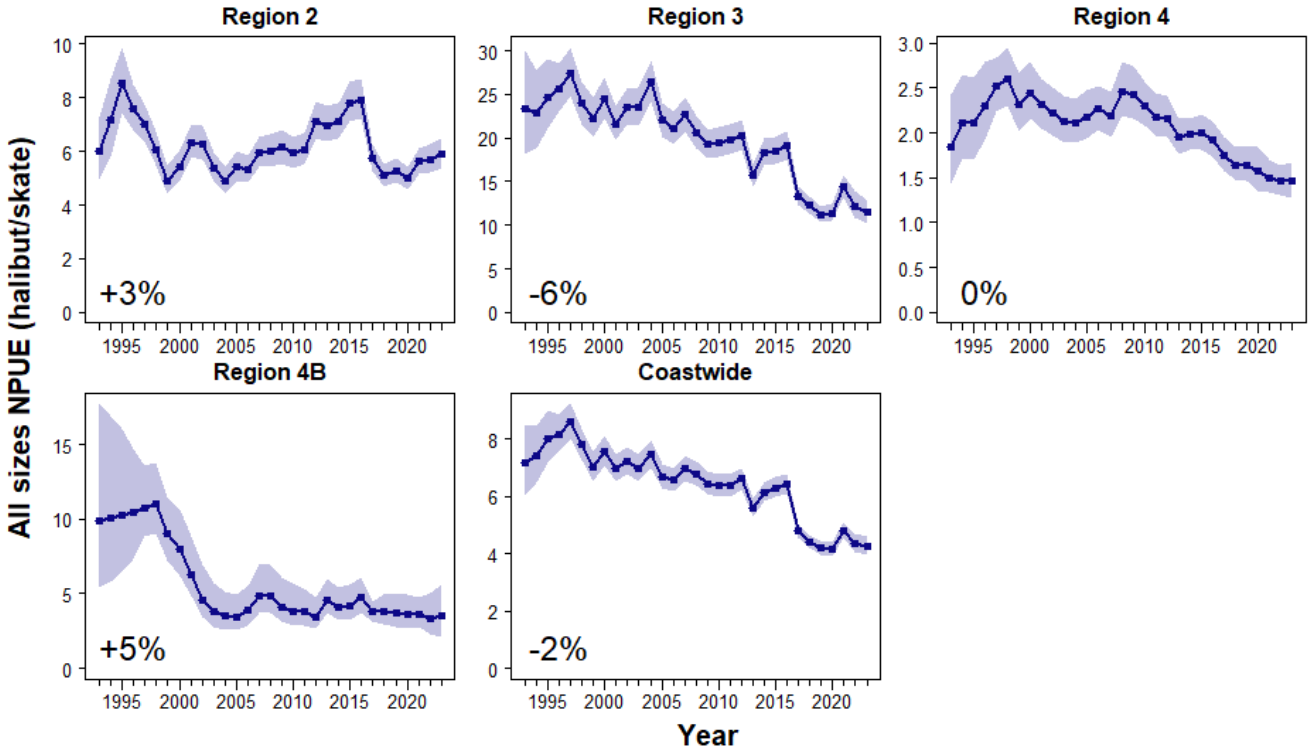

Figure 3. Space-time model output for all sizes NPUE for 1993-2023 for Biological Regions. Filled circles denote the posterior means of all sizes NPUE for each year. Shaded regions show posterior 95% credible intervals, which provide a measure of uncertainty: the wider the shaded interval, the greater the uncertainty in the estimate. Numeric values in the lower left-hand corners are estimates of the change in mean all sizes NPUE from 2022 to 2023.

APPENDIX A

Space-time modelling results by IPHC Regulatory Area

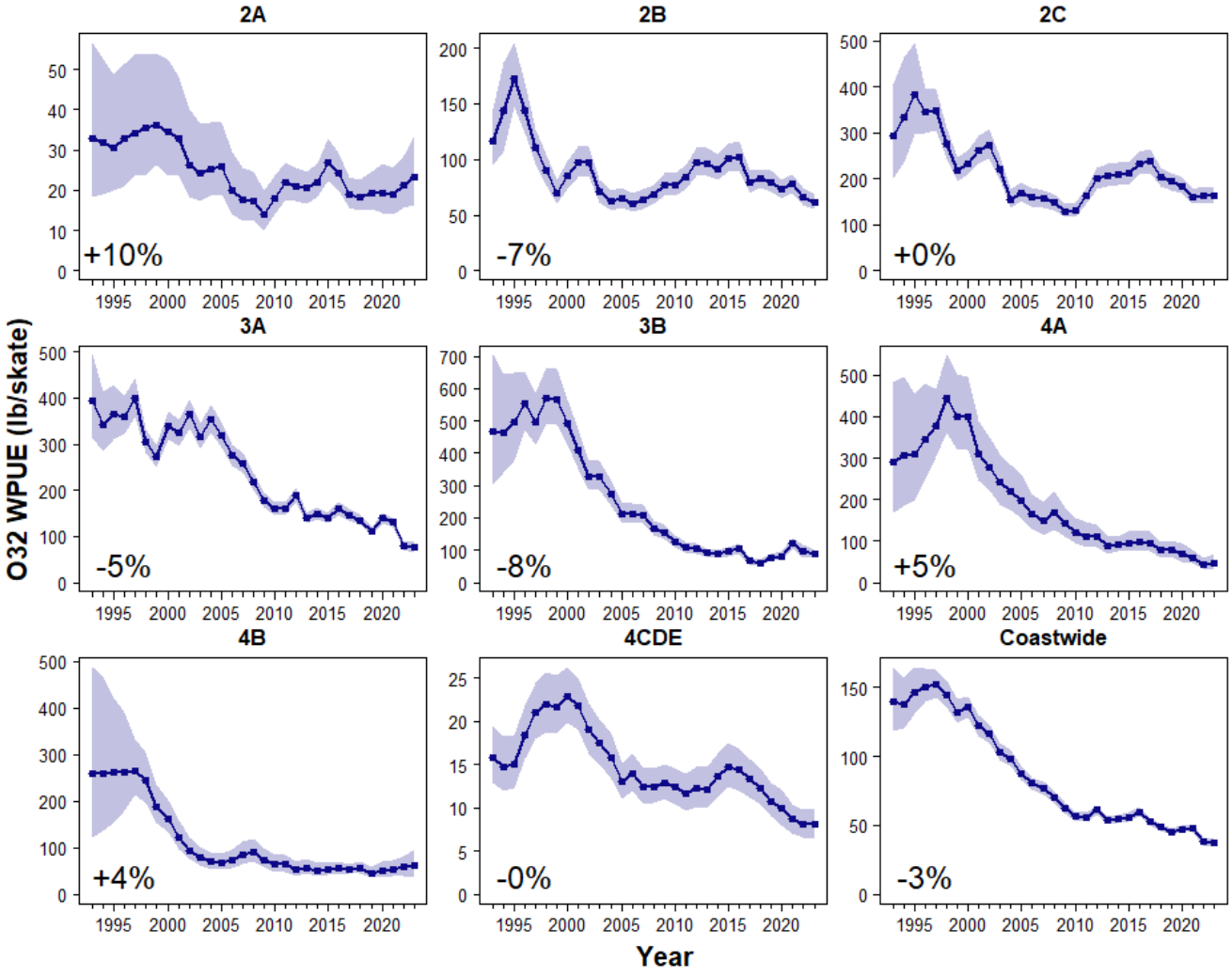

Figure A.1. Space-time model output for O32 WPUE for 1993-2023. Filled circles denote the posterior means of O32 WPUE for each year. Shaded regions show posterior 95% credible intervals, which provide a measure of uncertainty: the wider the shaded interval, the greater the uncertainty in the estimate. Numeric values in the lower left-hand corners are estimates of the change in mean O32 WPUE from 2022 to 2023.

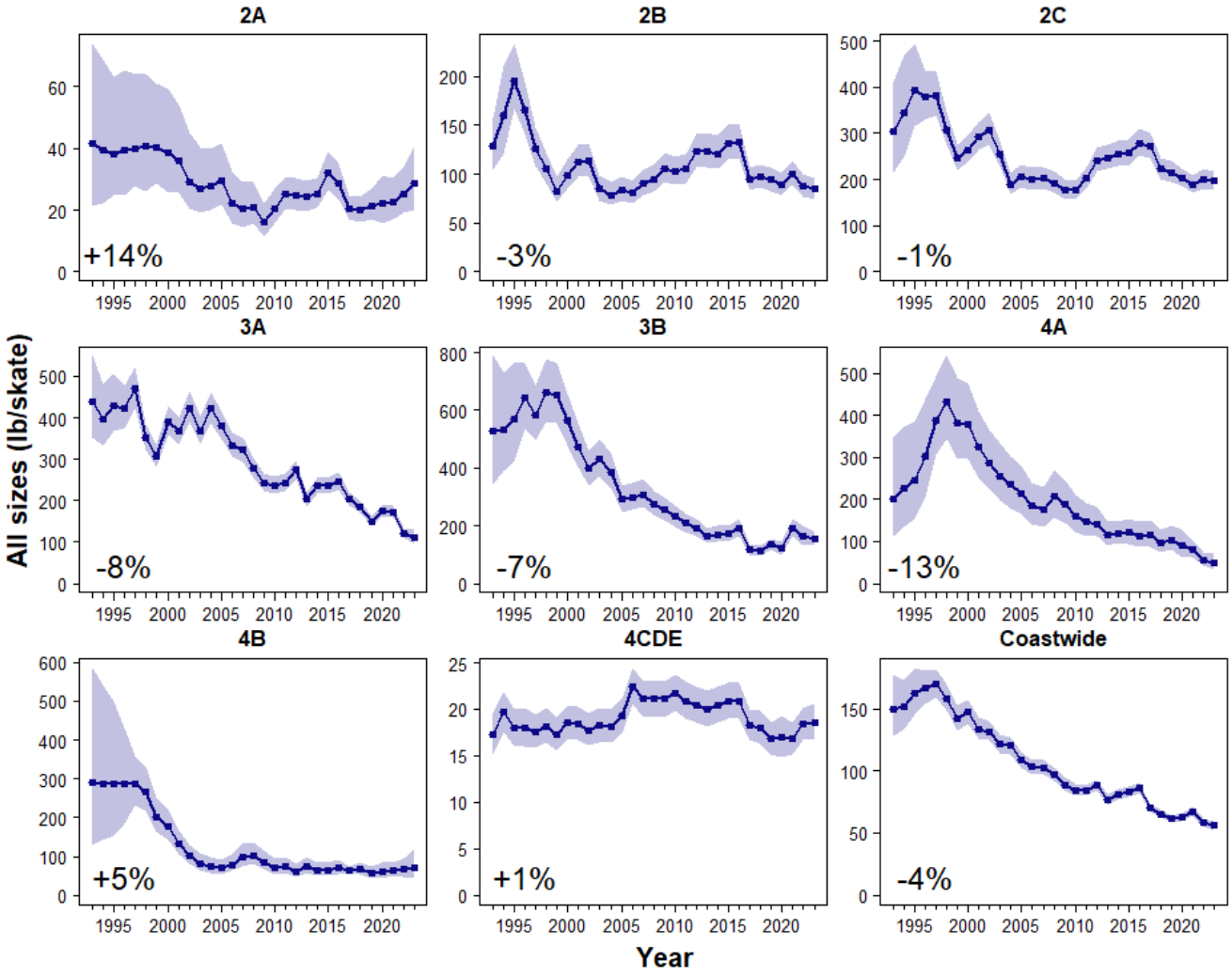

Figure A.2. Space-time model output for all sizes WPUE for 1993-2023. Filled circles denote the posterior means of all sizes WPUE for each year. Shaded regions show posterior 95% credible intervals, which provide a measure of uncertainty: the wider the shaded interval, the greater the uncertainty in the estimate. Numeric values in the lower left-hand corners are estimates of the change in mean all sizes WPUE from 2022 to 2023.

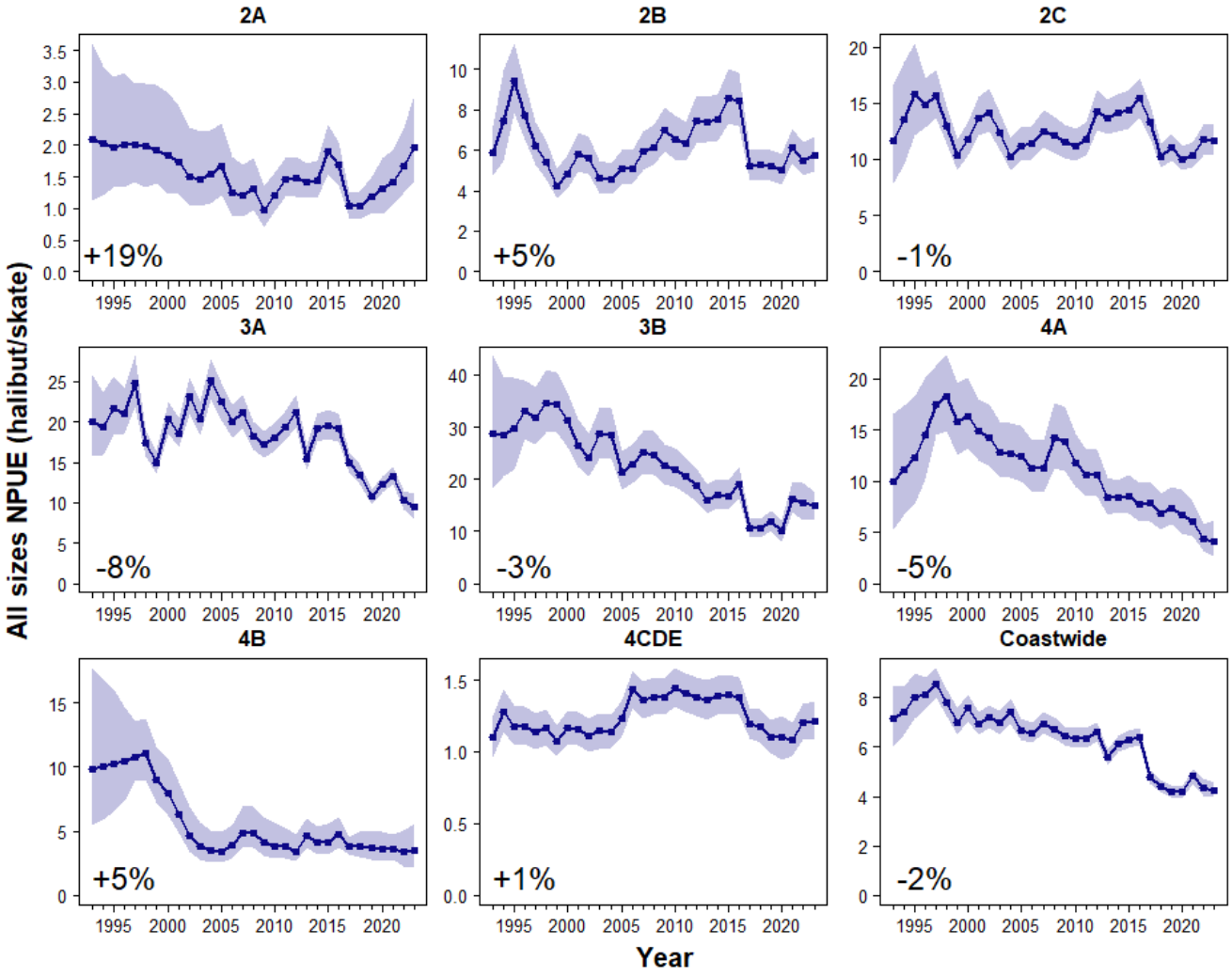

Figure A.3. Space-time model output for all sizes NPUE for 1993-2023. Filled circles denote the posterior means of all sizes NPUE for each year. Shaded regions show posterior 95% credible intervals, which provide a measure of uncertainty: the wider the shaded interval, the greater the uncertainty in the estimate. Numeric values in the lower left-hand corners are estimates of the change in mean all sizes NPUE from 2022 to 2023.