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 1993-2025.

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. 2025), but in the Bering Sea also integrates data from the National Oceanic and Atmospheric Administration (NOAA) - Fisheries annual trawl survey and the Alaska Department of Fish and Game's (ADFG) 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 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.

Data inputs to the space-time modelling were updated with 2025 data from the IPHC's FISS along with data from NOAA Bering Sea trawl survey data, which included sampling in the northern Bering Sea. The ADFG Norton Sound trawl survey was not undertaken in 2025. The FISS was implemented with reduced spatial coverage relative to years prior to 2023 (Figure 1), but with sampling in IPHC Regulatory Areas 4A and 4B for the first time since 2022. Fifteen stations in IPHC Regulatory Area 4B and six in IPHC Regulatory 4A were replaced with alternative stations largely due to challenging weather and tidal conditions. The sampling in IPHC Regulatory Area 2A was the most extensive since 2022, covering habitat with greatest historical density of Pacific halibut. Sampling for a catch protection gear study in IPHC Regulatory Area 4A (Planas 2025) included six sets that followed FISS sampling protocols, allowing the data from four of these sets that were fished effectively to be included in the modelling.
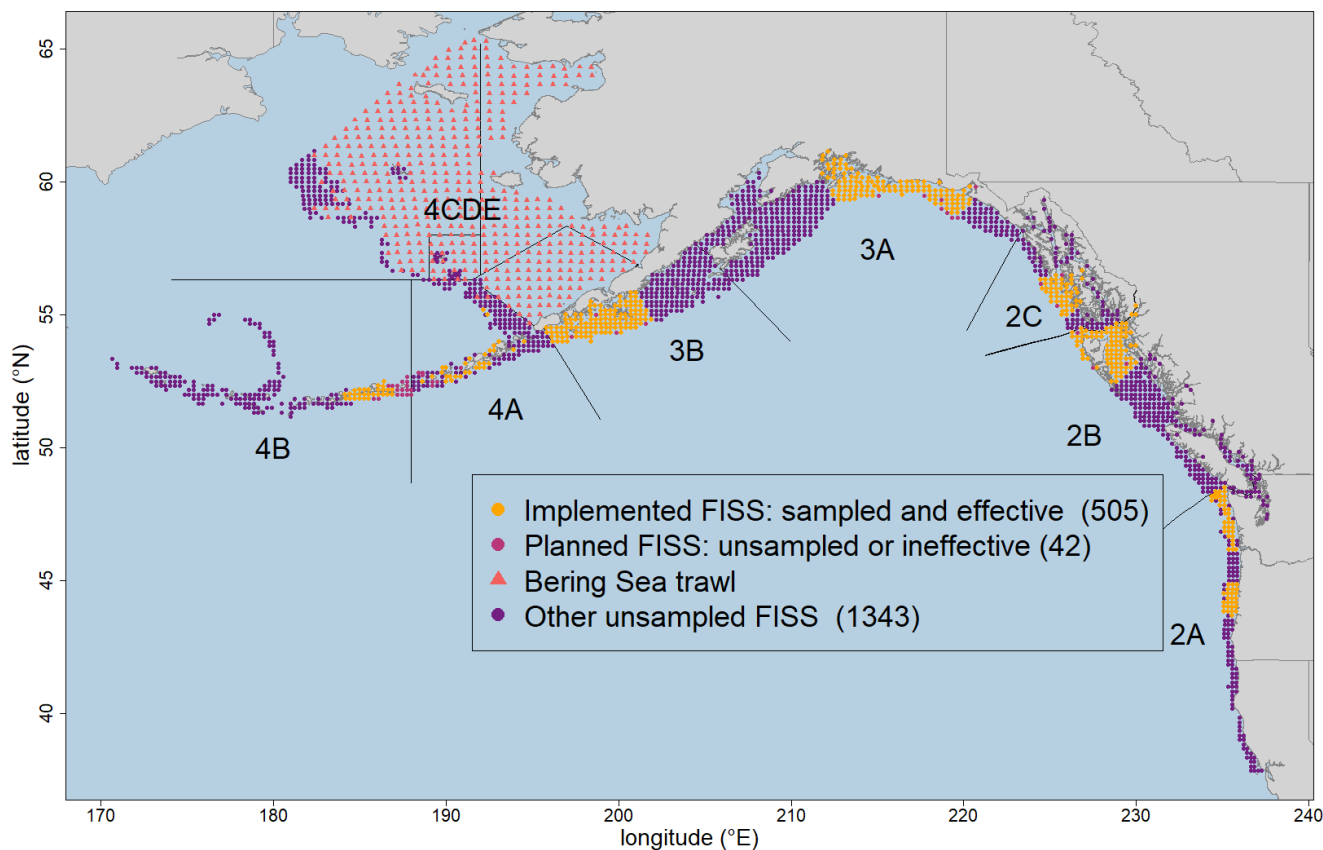
Figure 1. Map of 2025 sampled survey stations with data used in the space-time modelling (orange circles for FISS, red triangles for trawl), along with planned FISS stations that were either ineffective or not fished due to logistical reasons (lighter purple circles).

RESULTS OF SPACE-TIME MODELLING IN 2025

Figure 2 shows the time series estimates of O32 WPUE (most comparable to fishery catch-rates) over the 1993-2025 period included in the 2025 space-time modelling. Coastwide, we estimate a stable index, with 0% estimated change since 2024. The index increased in IPHC Biological Regions 3 and 4 but declined in Region 2. Coastwide indices of all sizes WPUE (Figure 3) and all sizes NPUE (Figure 4) were also estimated to be relatively stable, with changes of −2% since 2024. Declines in IPHC Biological Region 2 were largely offset by increases elsewhere. Results for IPHC Regulatory Areas are shown in Appendix A.

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-2025-IM101-09 Rev_1 which provides results of the space-time modelling of Pacific halibut survey data for 1993-2025.

REFERENCE

Planas, J. 2025. Report on current and future biological and ecosystem science research activities. IPHC-2025-IM101-14.

Ualesi, K., Jack, T., Rillera, R. and Coll, K. 2025. IPHC Fishery-independent setline survey (FISS) design and implementation in 2025. IPHC-2025-IM101-08.
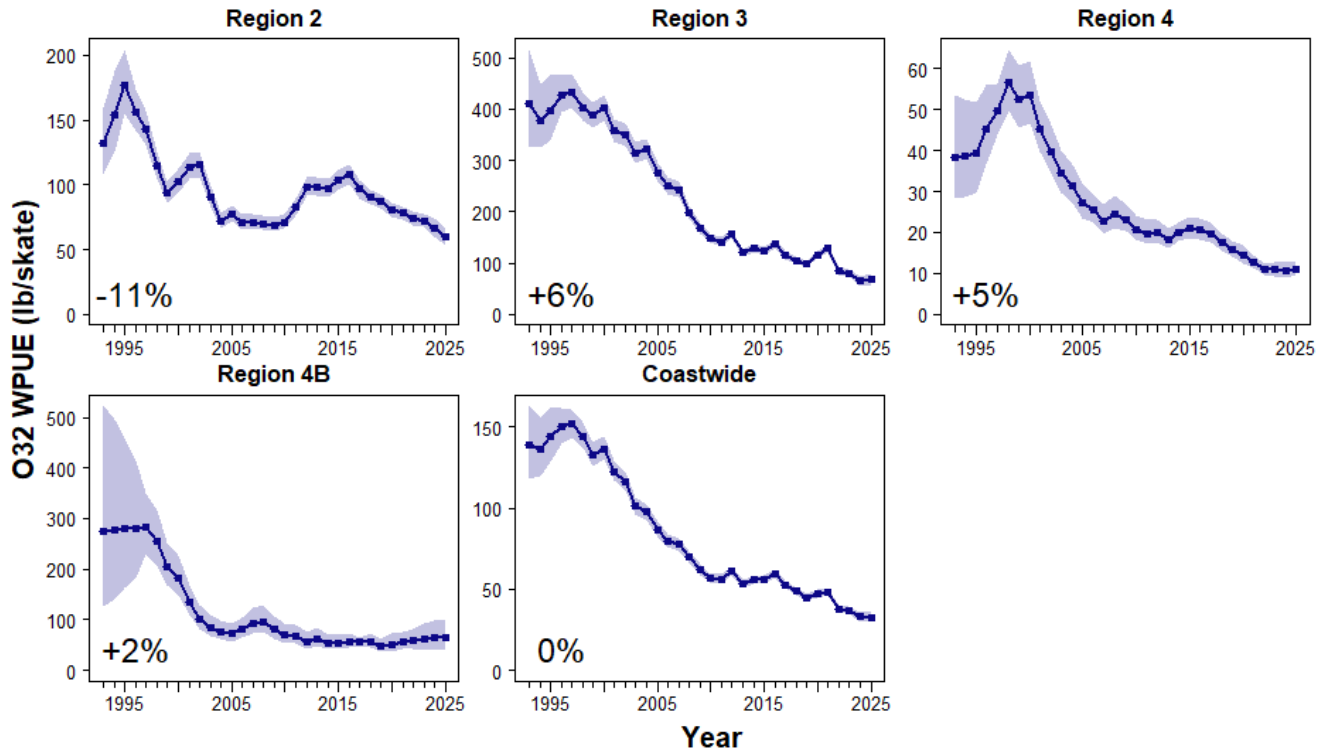

Figure 2. Space-time model output for O32 WPUE for 1993-2025 for Biological Regions. Filled circles denote the posterior means of O32 WPUE for each year. Shaded regions show posterior 95% credible intervals, which provide a measure of uncertainty: the wider the shaded interval, the greater the uncertainty in the estimate. Numeric values in the lower left-hand corners are estimates of the change in mean O32 WPUE from 2024 to 2025.
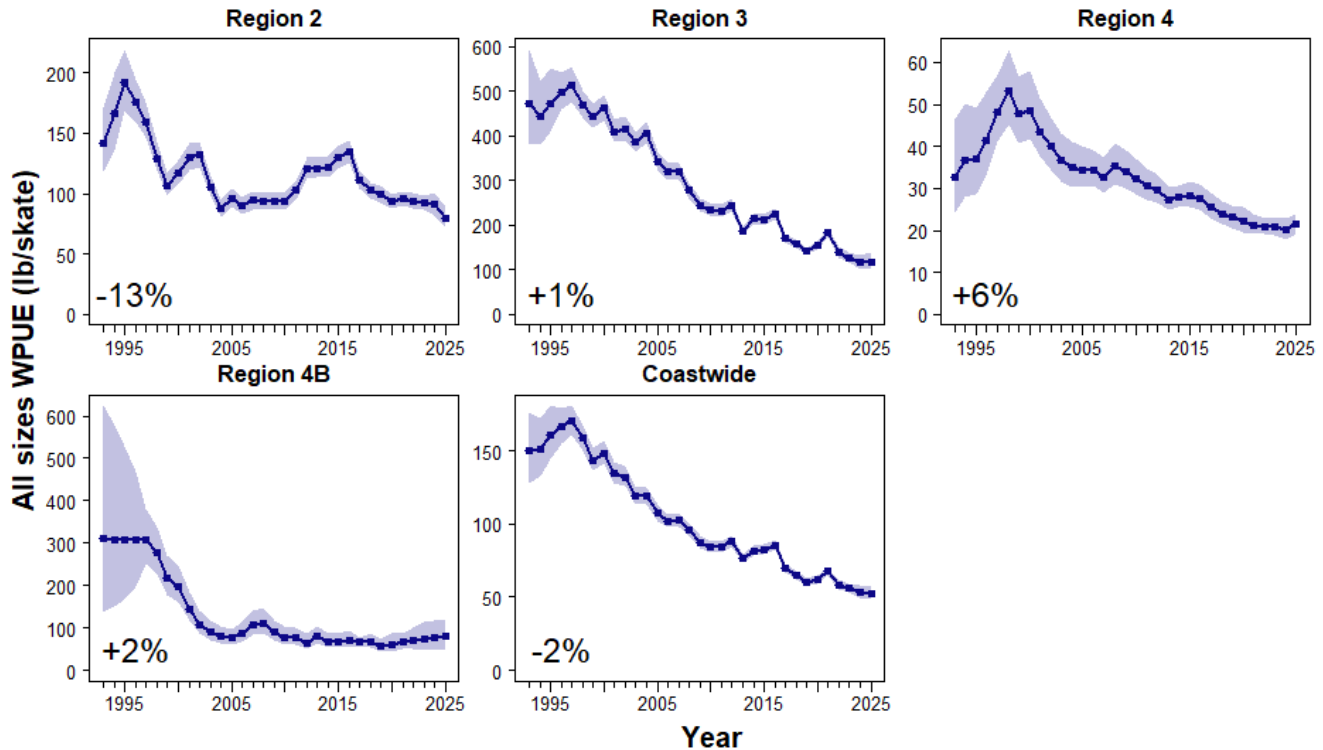
Figure 3. Space-time model output for all sizes WPUE for 1993-2025 for Biological Regions. Filled circles denote the posterior means of all sizes WPUE for each year. Shaded regions show posterior 95% credible intervals, which provide a measure of uncertainty: the wider the shaded interval, the greater the uncertainty in the estimate. Numeric values in the lower left-hand corners are estimates of the change in mean all sizes WPUE from 2024 to 2025.
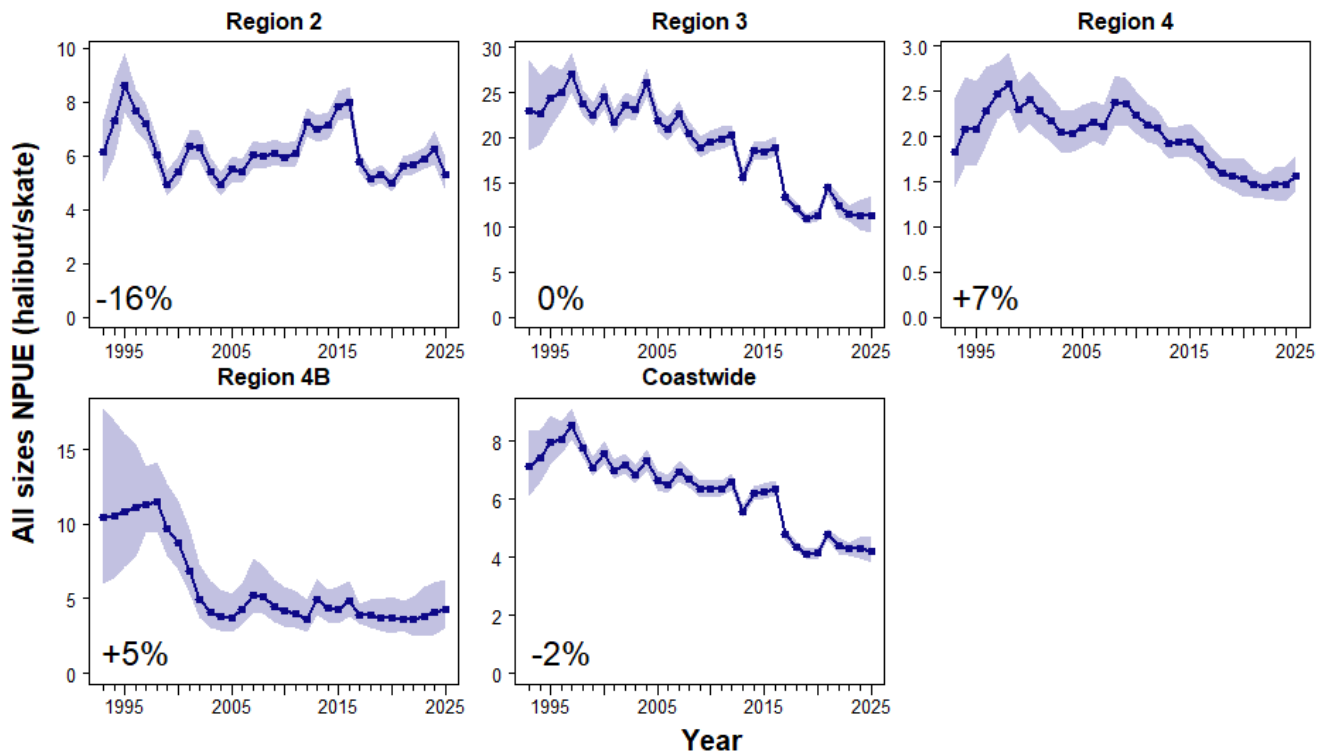
Figure 4. Space-time model output for all sizes NPUE for 1993-2025 for Biological Regions. Filled circles denote the posterior means of all sizes NPUE for each year. Shaded regions show posterior 95% credible intervals, which provide a measure of uncertainty: the wider the shaded interval, the greater the uncertainty in the estimate. Numeric values in the lower left-hand corners are estimates of the change in mean all sizes NPUE from 2024 to 2025.
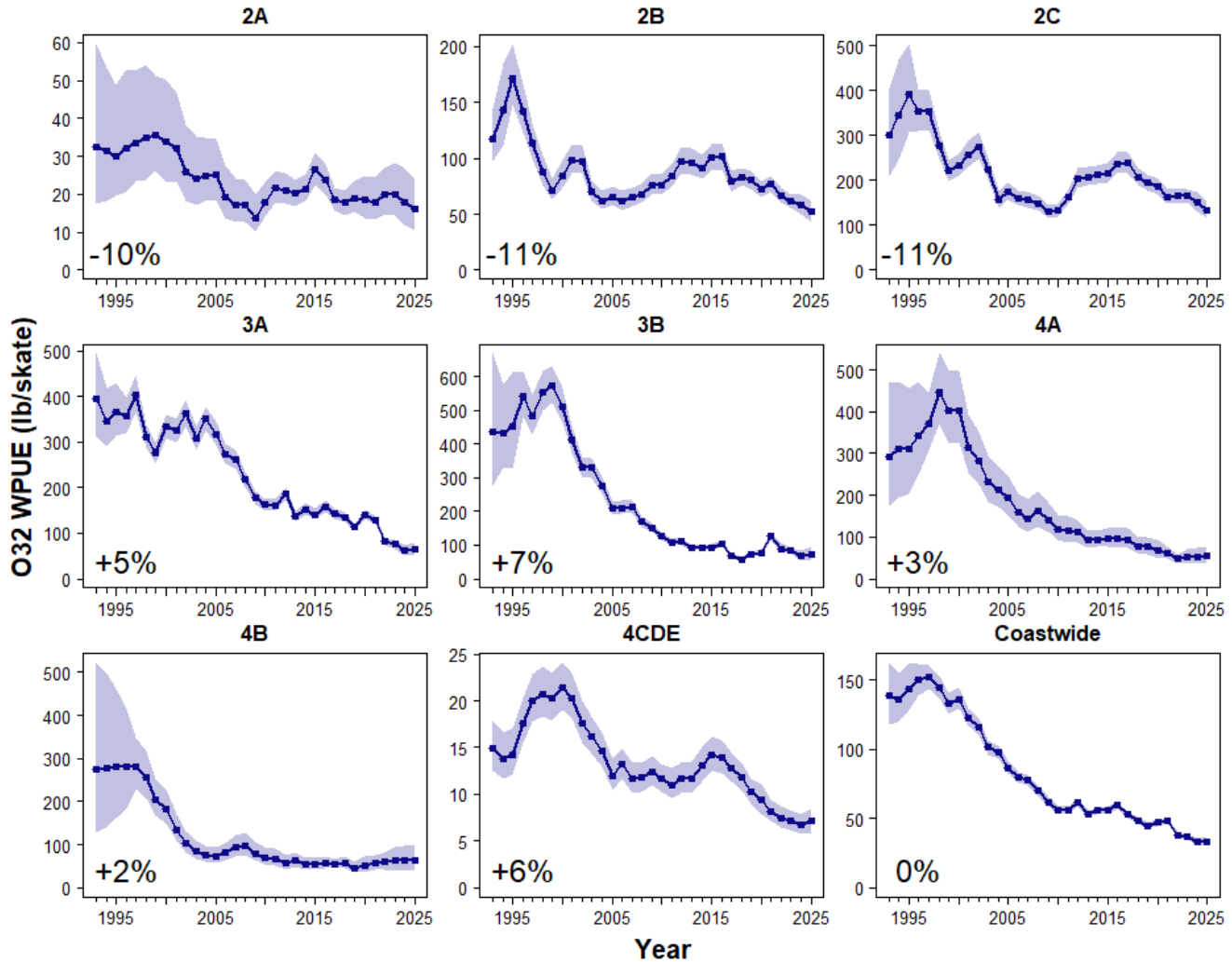
APPENDIX A
Space-time modelling results by IPHC Regulatory Area

Figure A.1. Space-time model output for O32 WPUE for 1993-2025. 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 2024 to 2025.
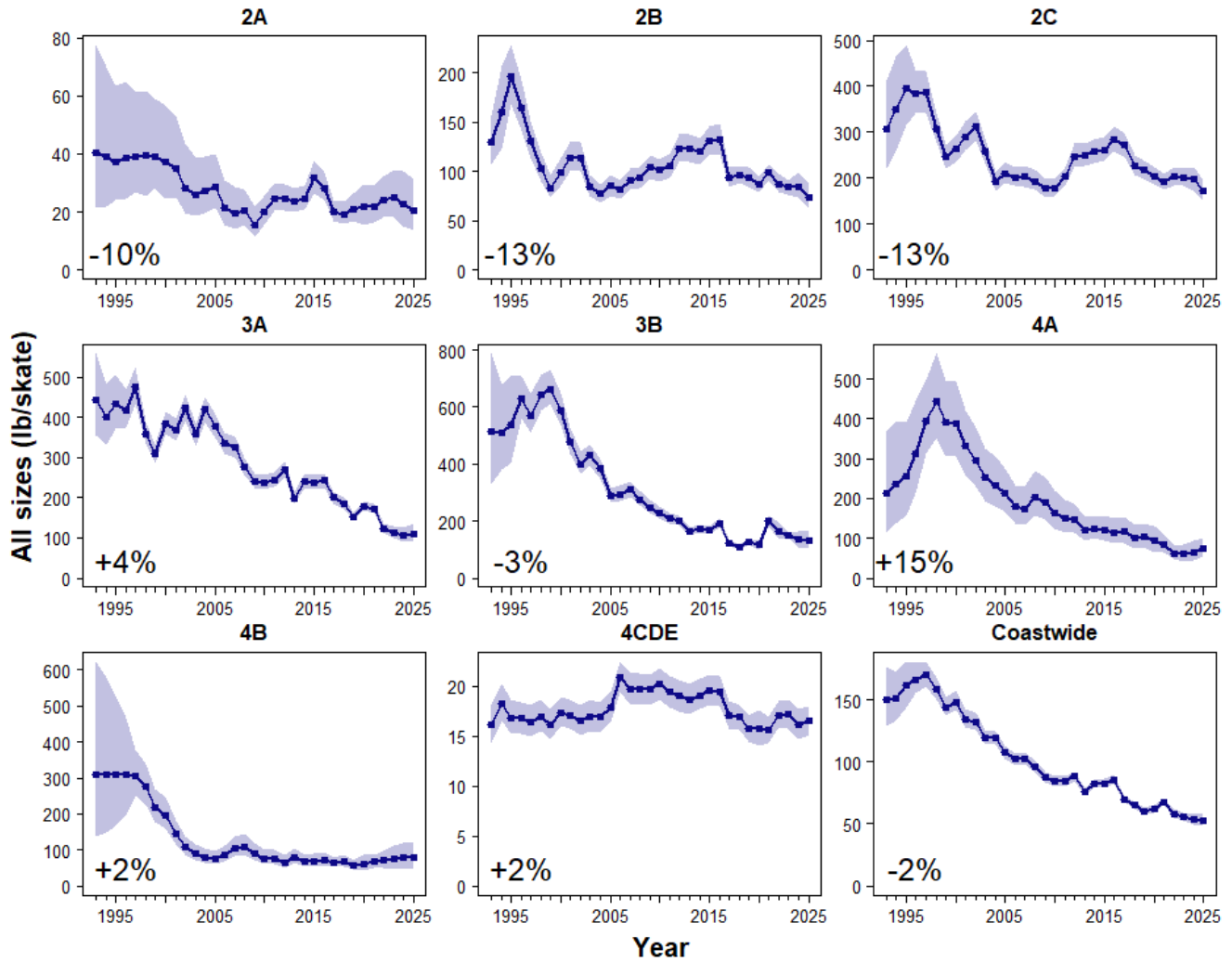
Figure A.2. Space-time model output for all sizes WPUE for 1993-2025. Filled circles denote the posterior means of all sizes WPUE for each year. Shaded regions show posterior 95% credible intervals, which provide a measure of uncertainty: the wider the shaded interval, the greater the uncertainty in the estimate. Numeric values in the lower left-hand corners are estimates of the change in mean all sizes WPUE from 2024 to 2025.
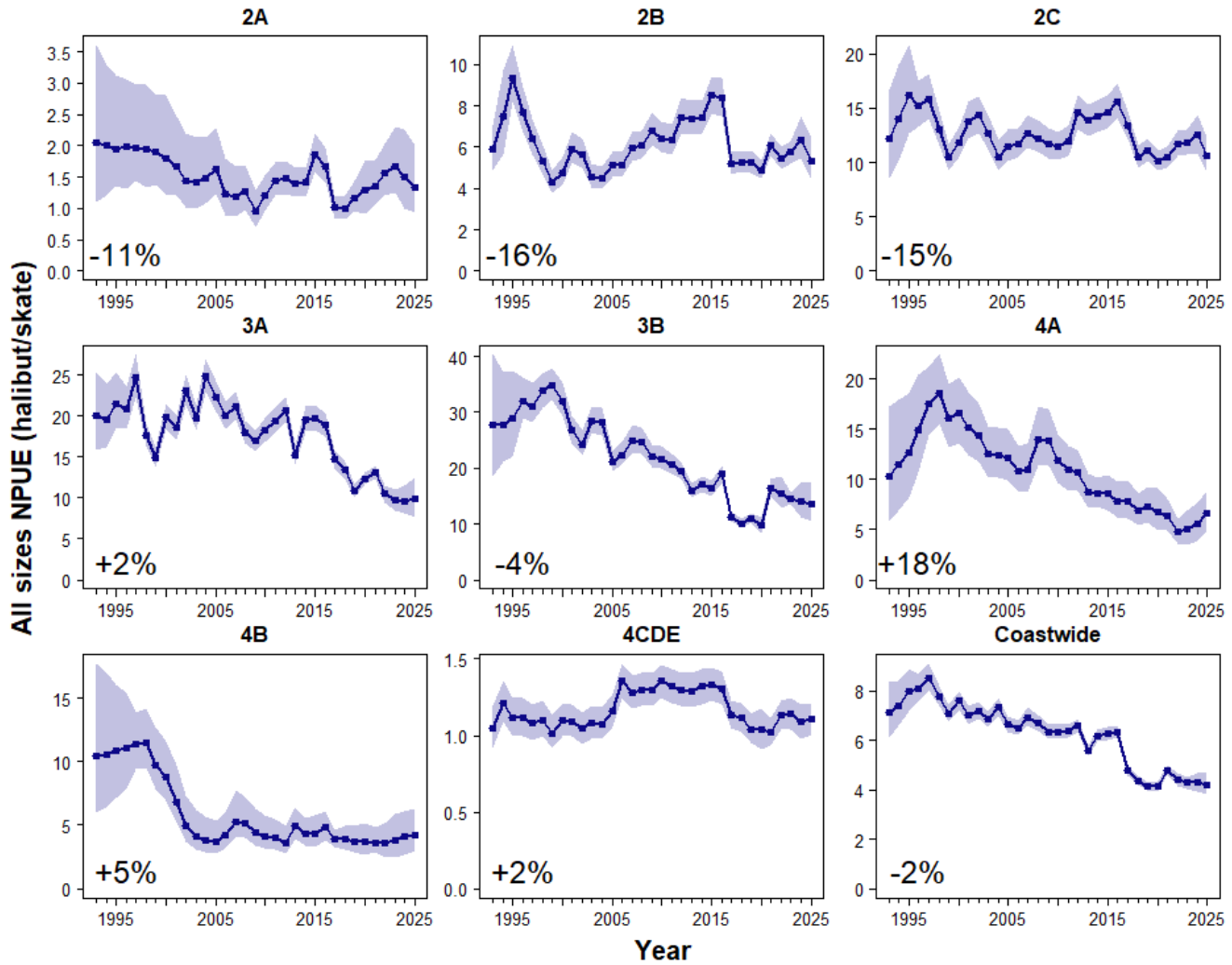
Figure A.3. Space-time model output for all sizes NPUE for 1993-2025. Filled circles denote the posterior means of all sizes NPUE for each year. Shaded regions show posterior 95% credible intervals, which provide a measure of uncertainty: the wider the shaded interval, the greater the uncertainty in the estimate. Numeric values in the lower left-hand corners are estimates of the change in mean all sizes NPUE from 2024 to 2025.