INTERNATIONAL PACIFIC HALIBUT COMMISSION

Space-time modelling of survey data

Agenda item 6.2

IPHC-2019-AM095-07

D. Griffay

Overview

1. Review of survey data sources and space-time modelling
2. Space-time model estimates of WPUE and NPUE
3. 2018 Fishery-Independent Setline Survey (FISS) expansions
   - IPHC Regulatory Areas 2A, 2B and 2C
4. Other space-time modelling work

Review of survey data sources

- IPHC fishery-independent setline survey (FISS):
  - Primary data source for space-time modelling of WPUE and NPUE indices
  - 10 nmi grid design since 1998, with fixed FISS (“setline survey”) stations and standardised fishing methods
    - Grid design ensures all habitat is sampled in proportion to its occurrence (on average)
    - Fixed FISS stations reduces variance in trend estimates
  - Gaps in annual coverage
    - Accounted for using data from other surveys, FISS expansions, and space-time model predictions into unsurveyed habitat

Review of survey data sources

- NMFS fisheries-independent Bering Sea trawl survey:
  - Important data source for WPUE and NPUE indices in the Bering Sea (Regulatory Areas 4A and 4CDE)
  - 20 nmi grid design since 1982, with higher station density in some regions
  - Northern expansions fished in 2010, 2017 and 2018
  - Data are calibrated with IPHC Bering Sea setline survey expansion data from 2006 and 2015
    - Provides WPUE and NPUE indices consistent with those from the IPHC setline survey

Review of survey data sources

- ADFG fisheries-independent Norton Sound trawl survey:
  - Data source for WPUE and NPUE indices in the northern Bering Sea (Regulatory 4CDE)
  - Fished triennially until 2014, and annually from 2017
- NOAA-fisheries (NMFS) fisheries-independent sablefish longline survey
  - Provides information on Pacific halibut density in deeper waters in Regulatory Areas 3A and 3B

Review of space-time modelling

- Space-time modelling of survey data has been used since 2016 to produce WPUE and NPUE estimates
- The modelling has two key purposes:
  - It smooths the data in time and space
    - Makes use of information on spatial and temporal relationships among survey stations to “sort the signal from the noise”
  - It fills in gaps in survey coverage using model predictions, while accounting for uncertainty

Review of space-time modelling

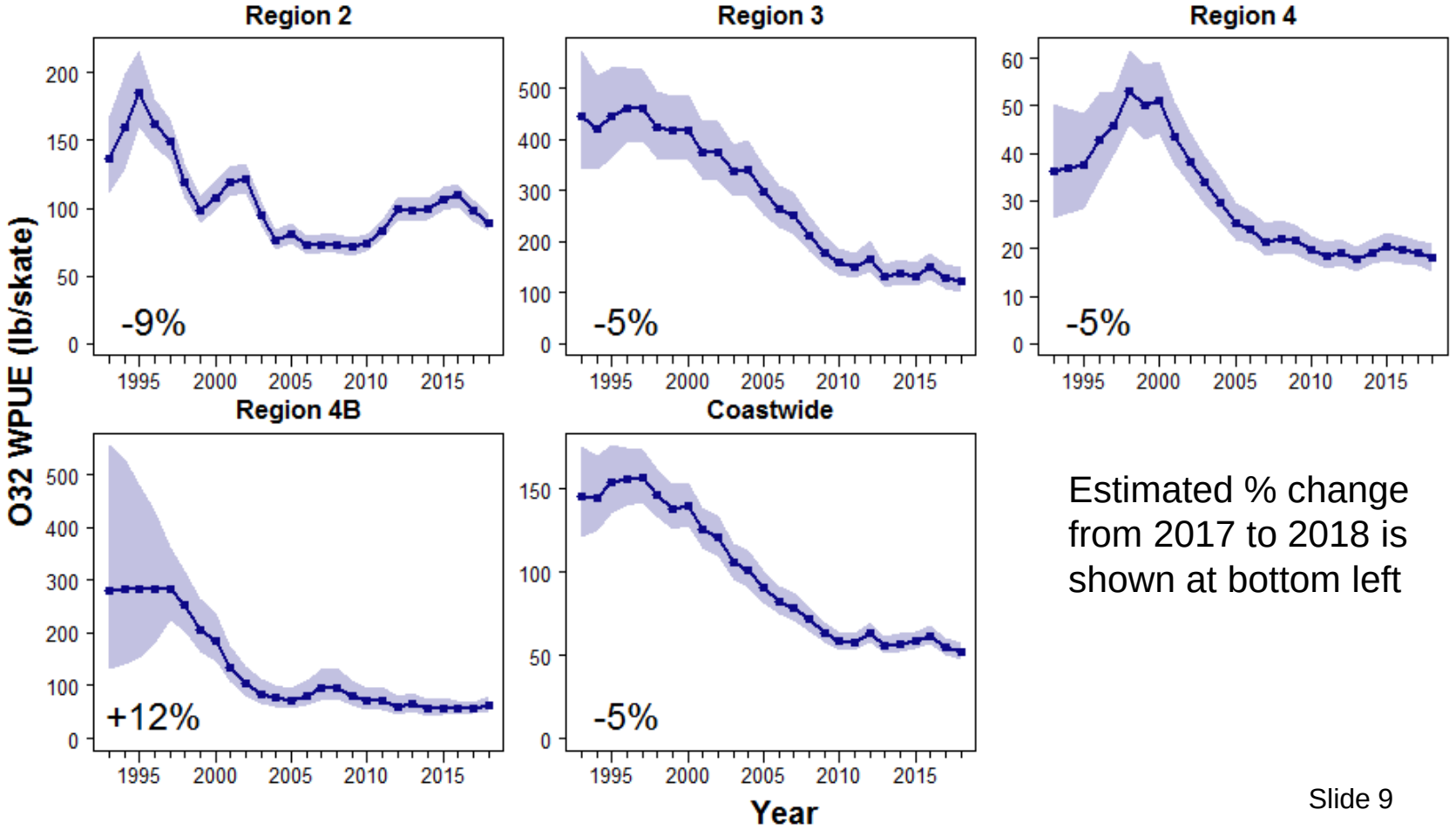
- The IPHC's Scientific Review Board (SRB) again endorsed the space-time modelling approach in 2018:

  IPHC-2018-SRB013-R, Para. 10. *"NOTING that this is the sixth review of the space-time modelling approach, the SRB reiterated its ENDORSEMENT of the approach as cutting-edge and could be widely used.*

Space-time model estimates of WPUE and NPUE

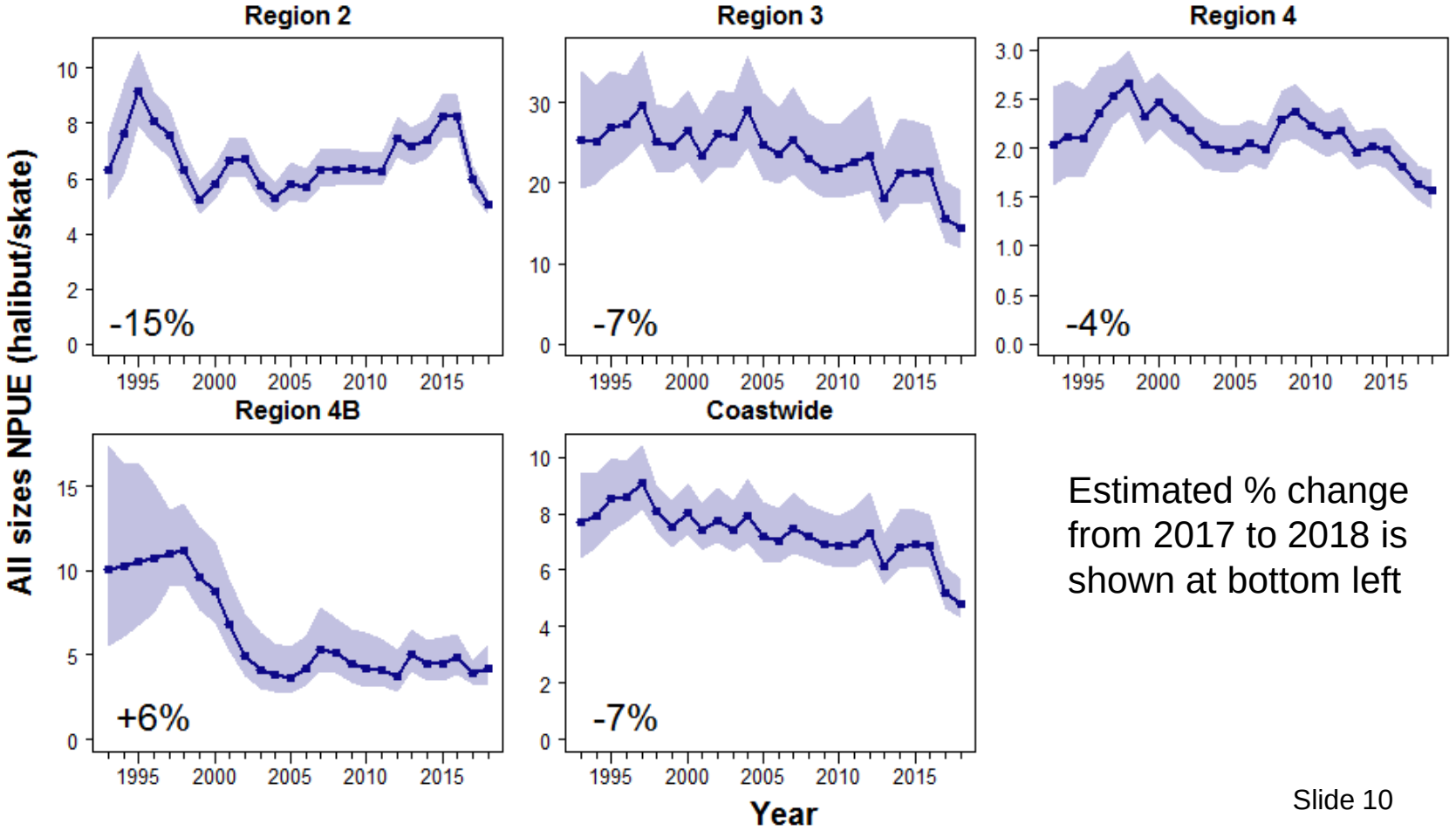
- As in 2016 and 2017, the space-time modelling was used to estimate O32 WPUE and all sizes NPUE indices. All sizes WPUE was also estimated from the modelling, as was the case in 2017.
- Estimates computed for:
  - Biological Regions
  - IPHC Regulatory Areas
  - Coastwide IPHC Convention waters, from San Francisco Bay to Bering Strait

O32 WPUE by biological region



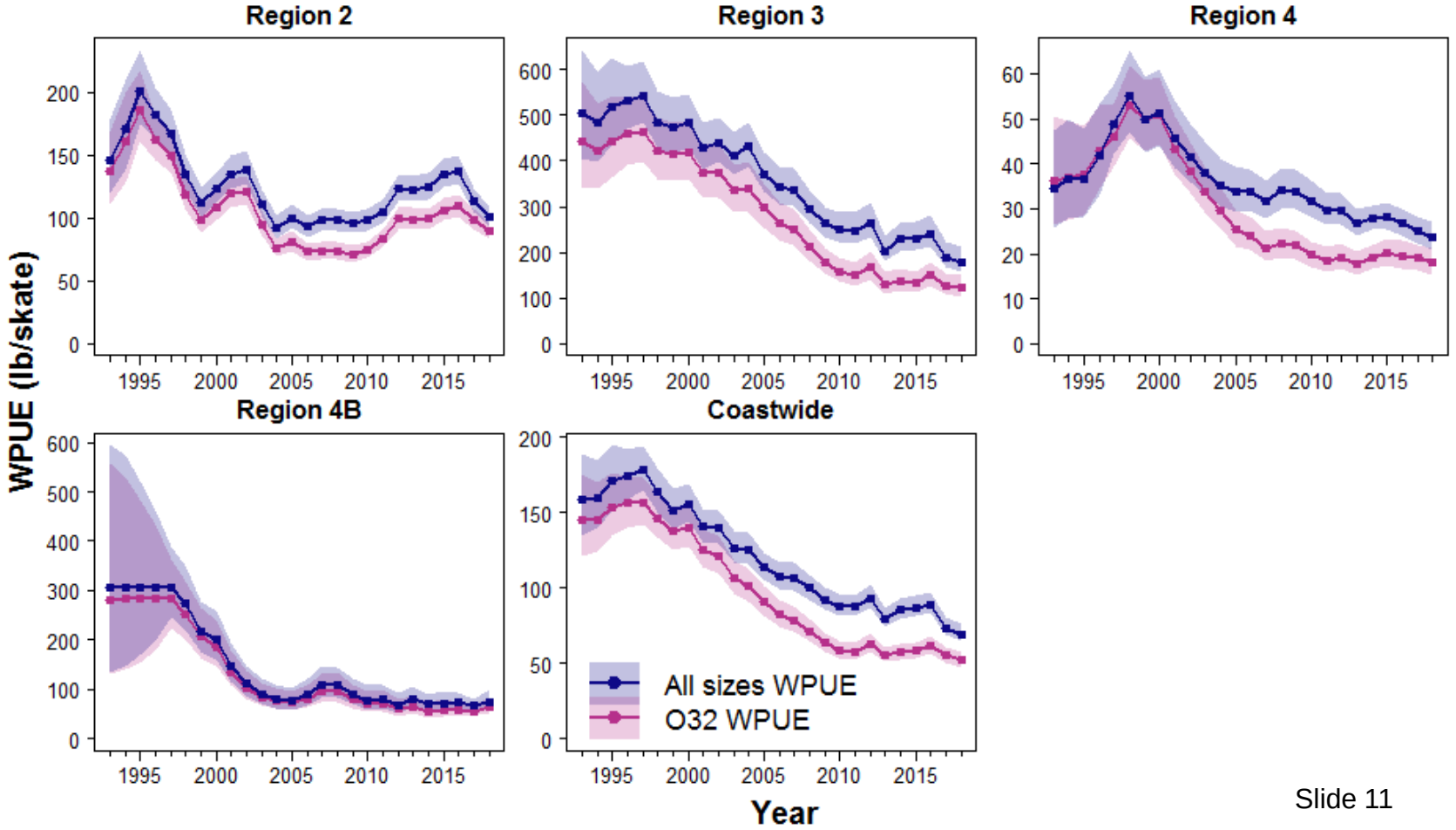
Estimated % change from 2017 to 2018 is shown at bottom left

All sizes NPUE by biological region



Estimated % change from 2017 to 2018 is shown at bottom left

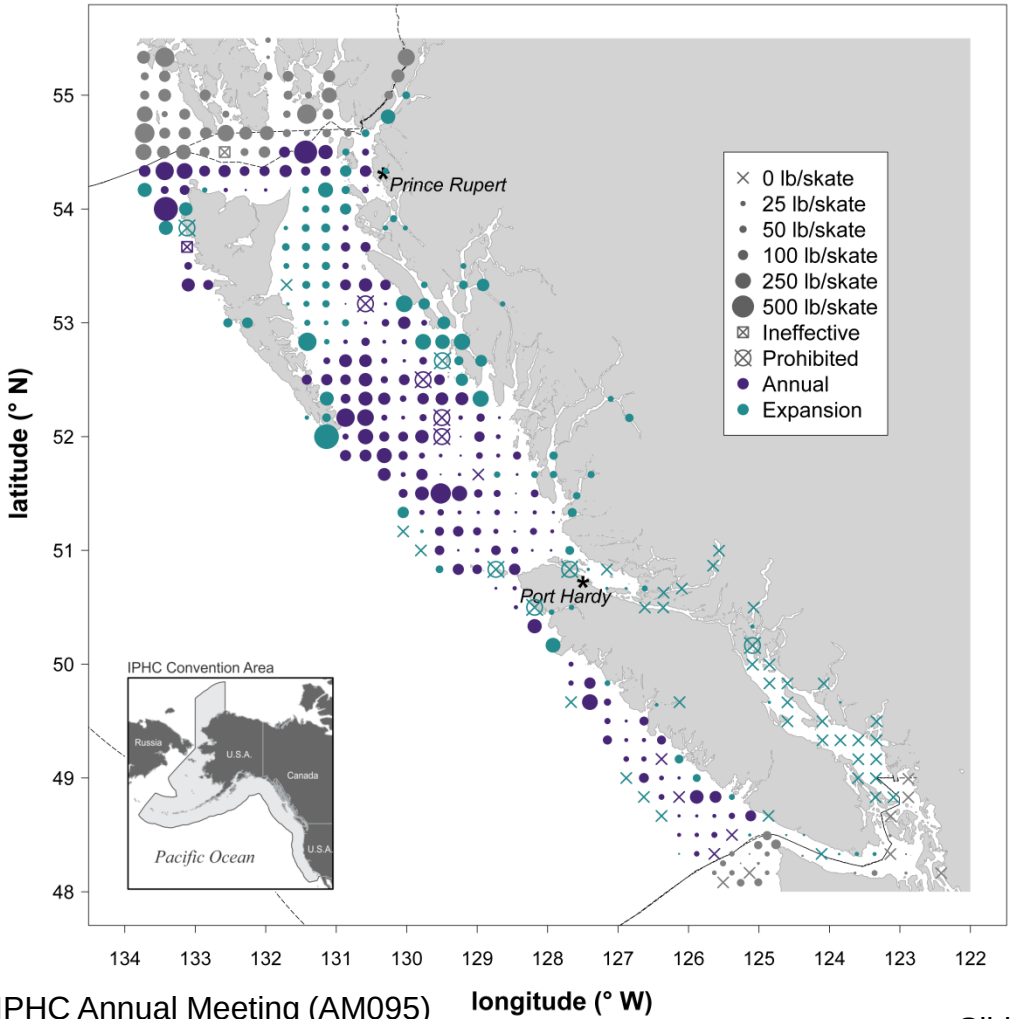
O32 and all sizes WPUE by biological region



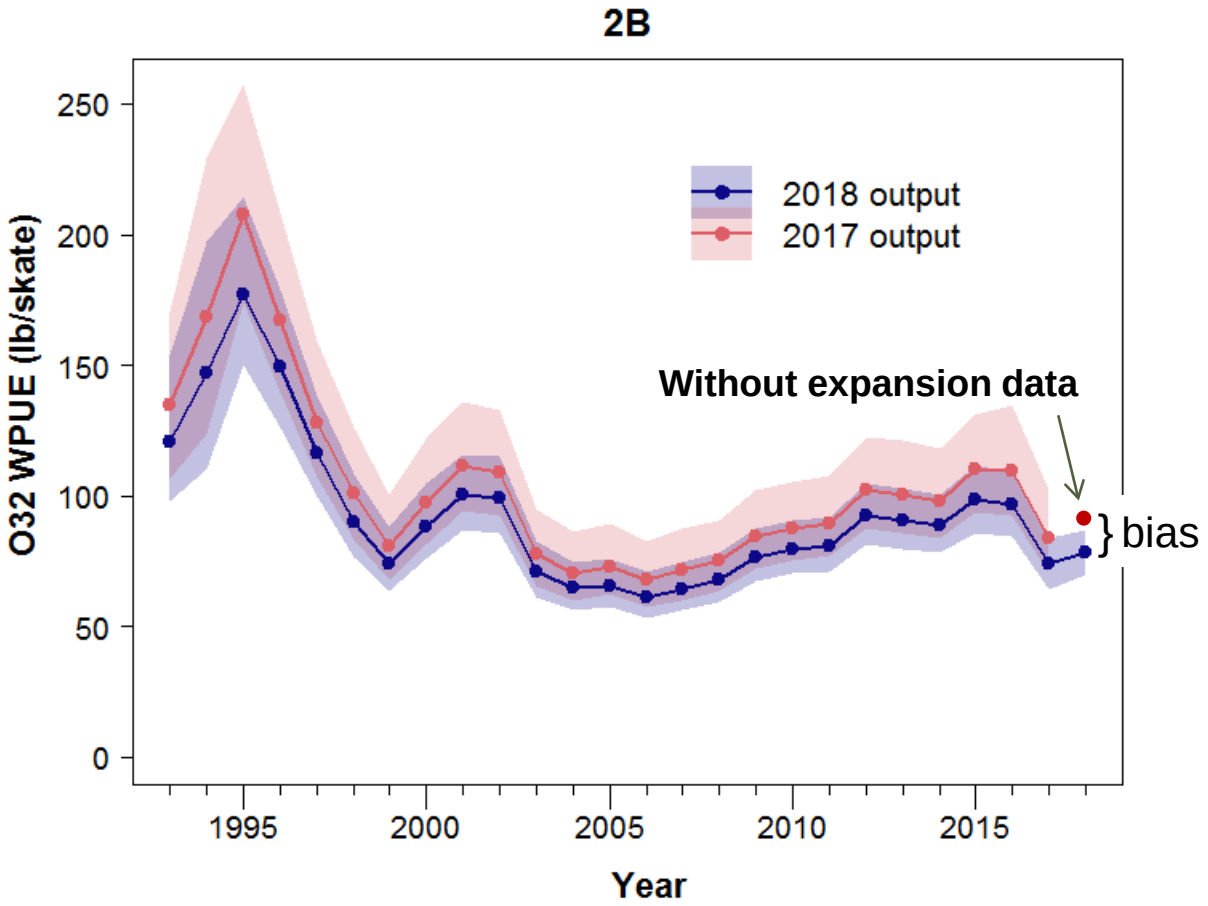
2018 FISS expansions

- 2018 was the 5th year of a program of setline survey expansions
- Setline survey expansions to date:
  - 2014: Regulatory Areas 2A and 4A
  - 2015: Regulatory Area 4CDE eastern Bering Sea flats
  - 2016: Regulatory Area 4CDE shelf edge
  - 2017: Regulatory Areas 2A and 4B; and
  - **2018: Regulatory Areas 2B and 2C**
- In 2018, we also repeated the ad hoc expansion off the north Washington coast first undertaken in 2017 (the “densified grid”)
- The result of these expansions is a cumulative update of the full WPUE and NPUE times series, using all available survey data to date.
  - Leads to reduced bias and uncertainty in WPUE and NPUE estimates

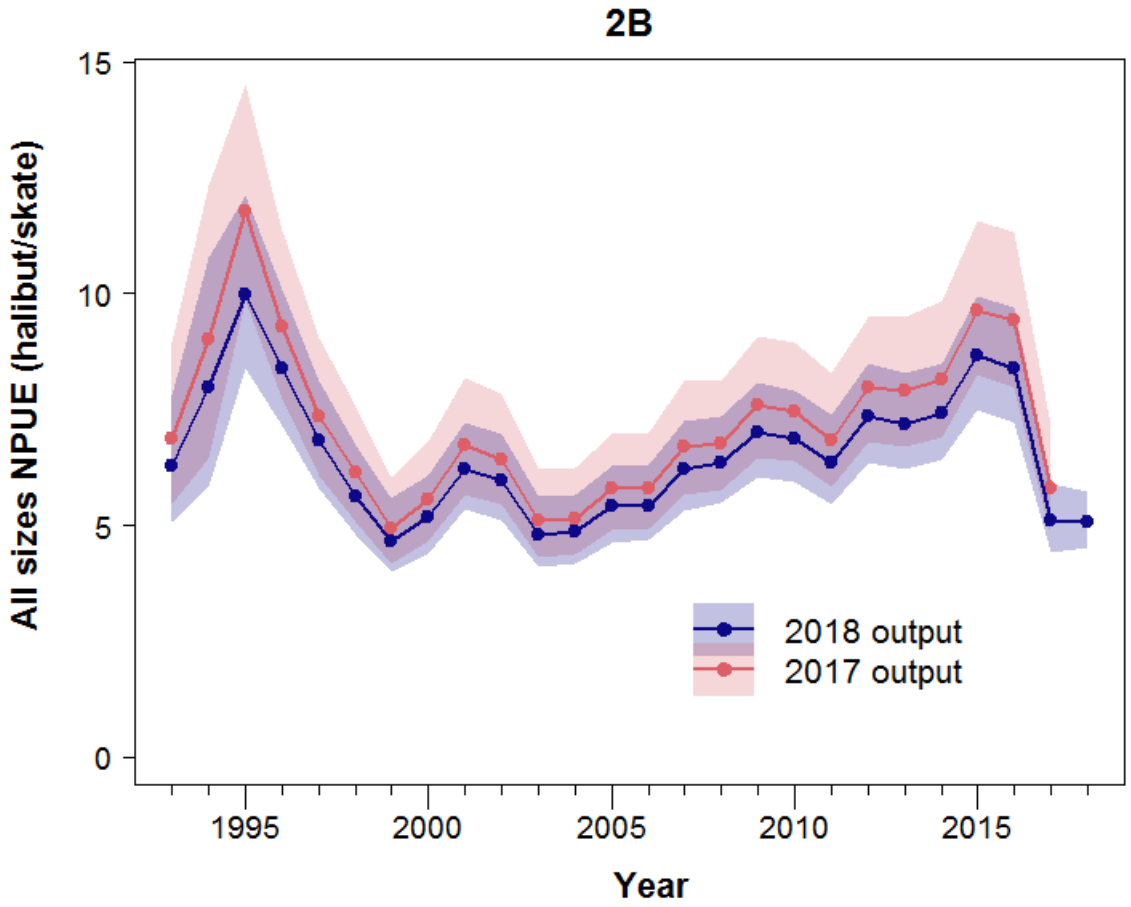
2018 setline survey design and O32 WPUE in Regulatory Area 2B.



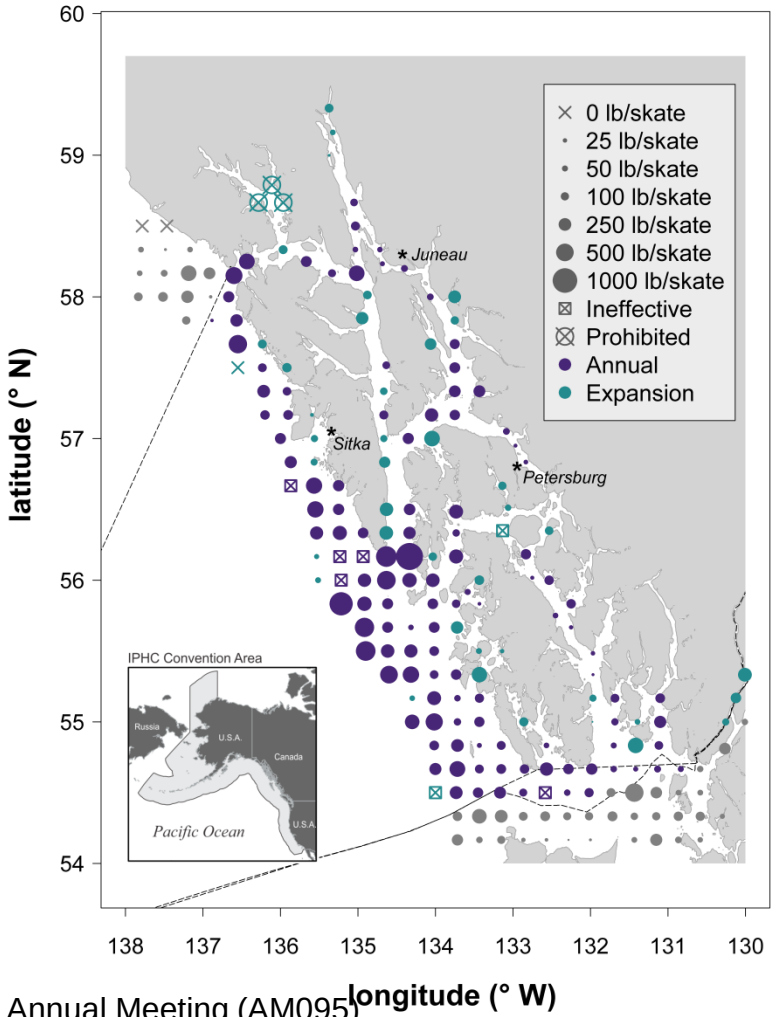
O32 WPUE time series: comparison of 2017 and 2018 model for Regulatory Area 2B



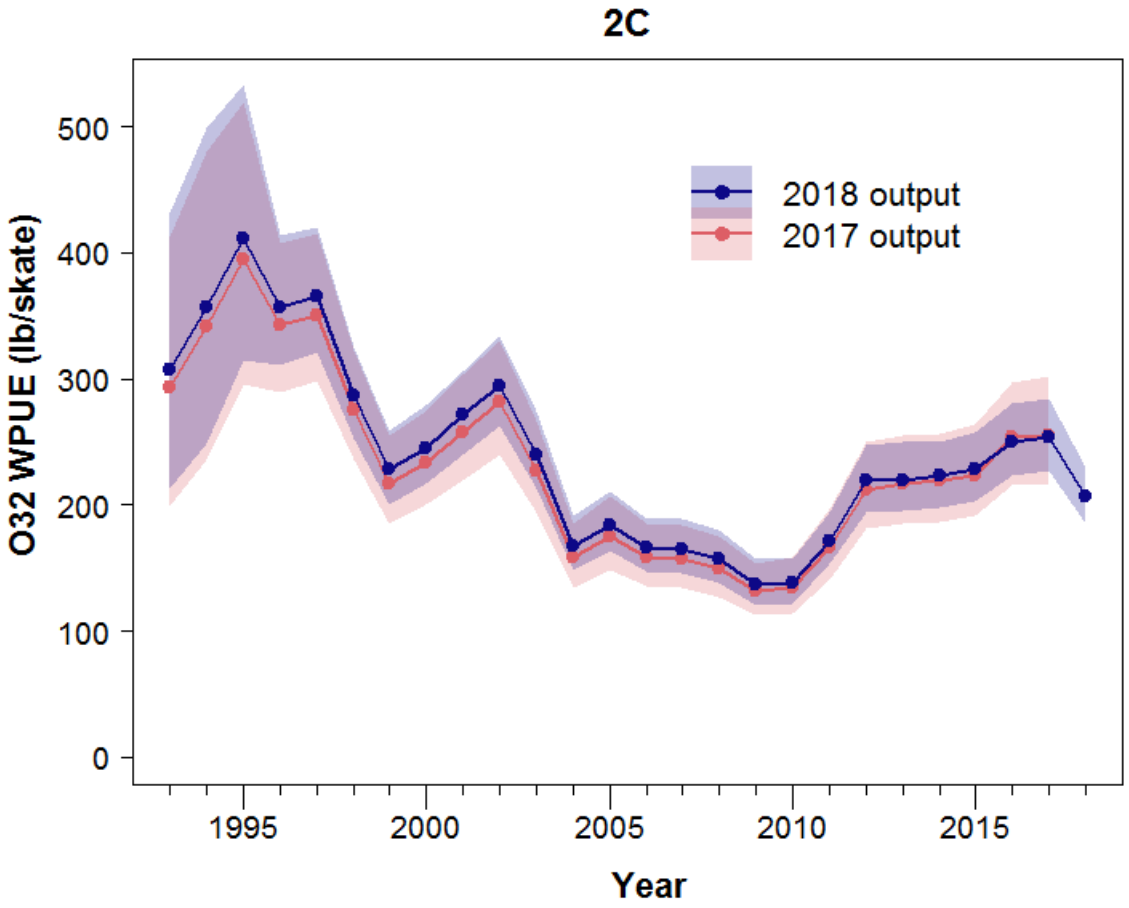
All sizes NPUE time series: comparison of 2017 and 2018 model for Regulatory Area 2B



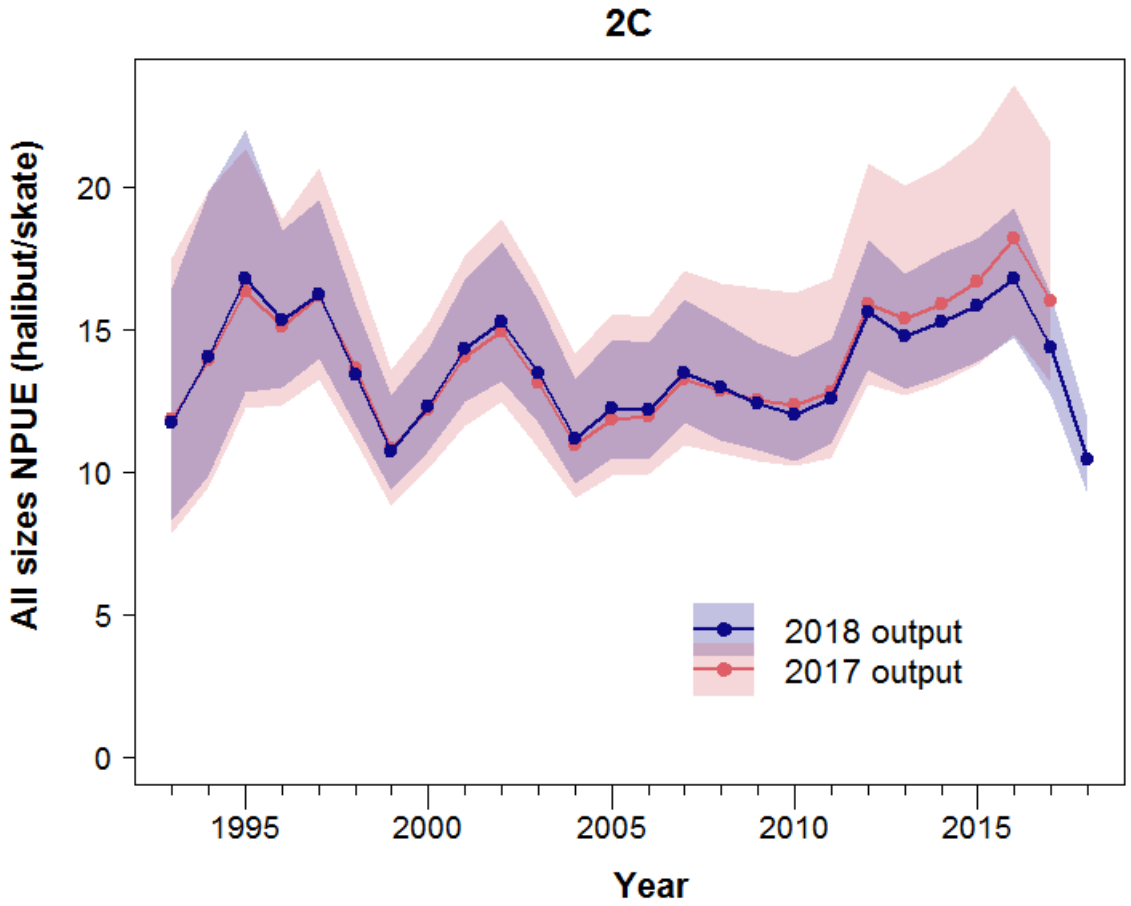
2018 setline survey design and O32 WPUE in Regulatory Area 2C.



O32 WPUE time series: comparison of 2017 and 2018 model for Regulatory Area 2C

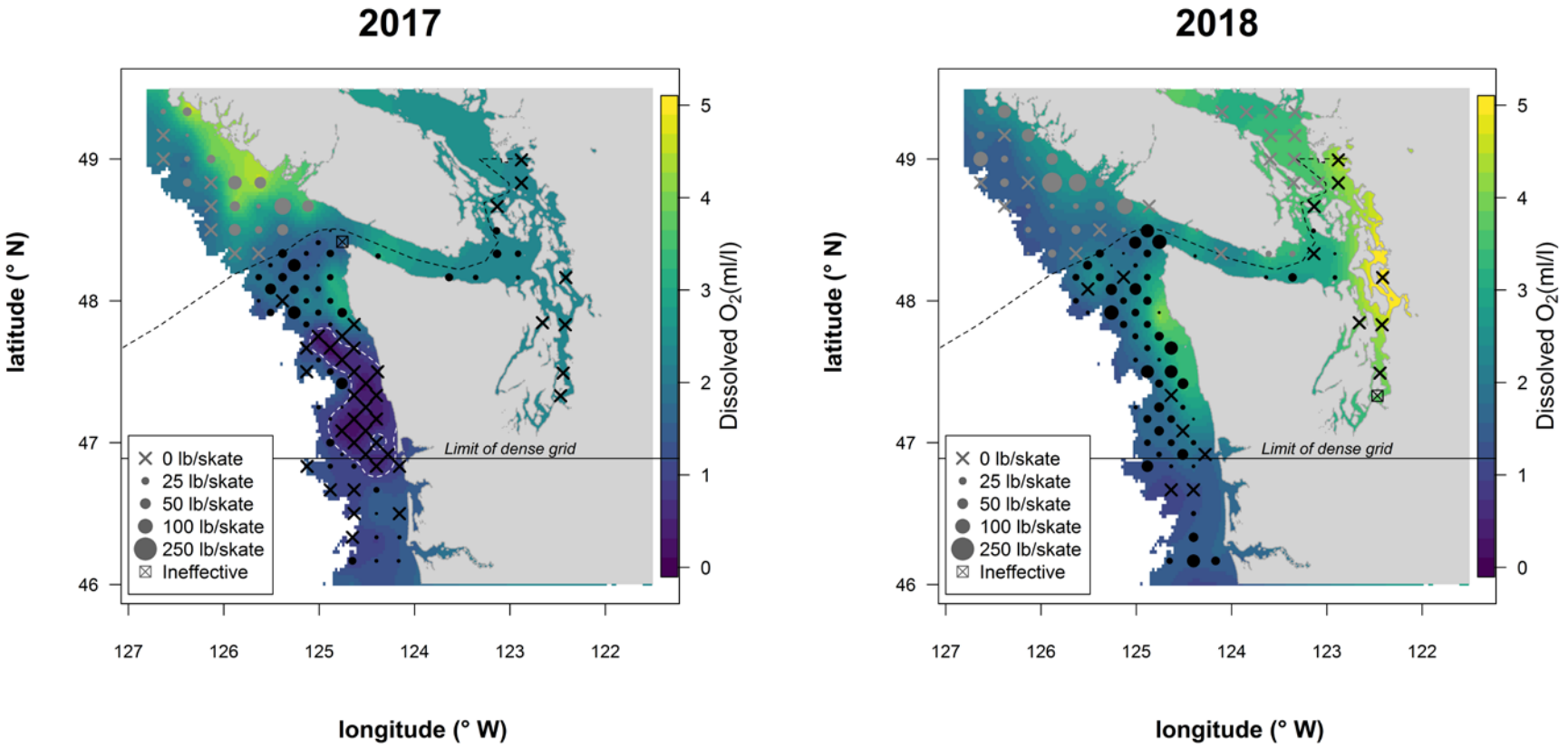


All sizes NPUE time series: comparison of 2017 and 2018 model for Regulatory Area 2C

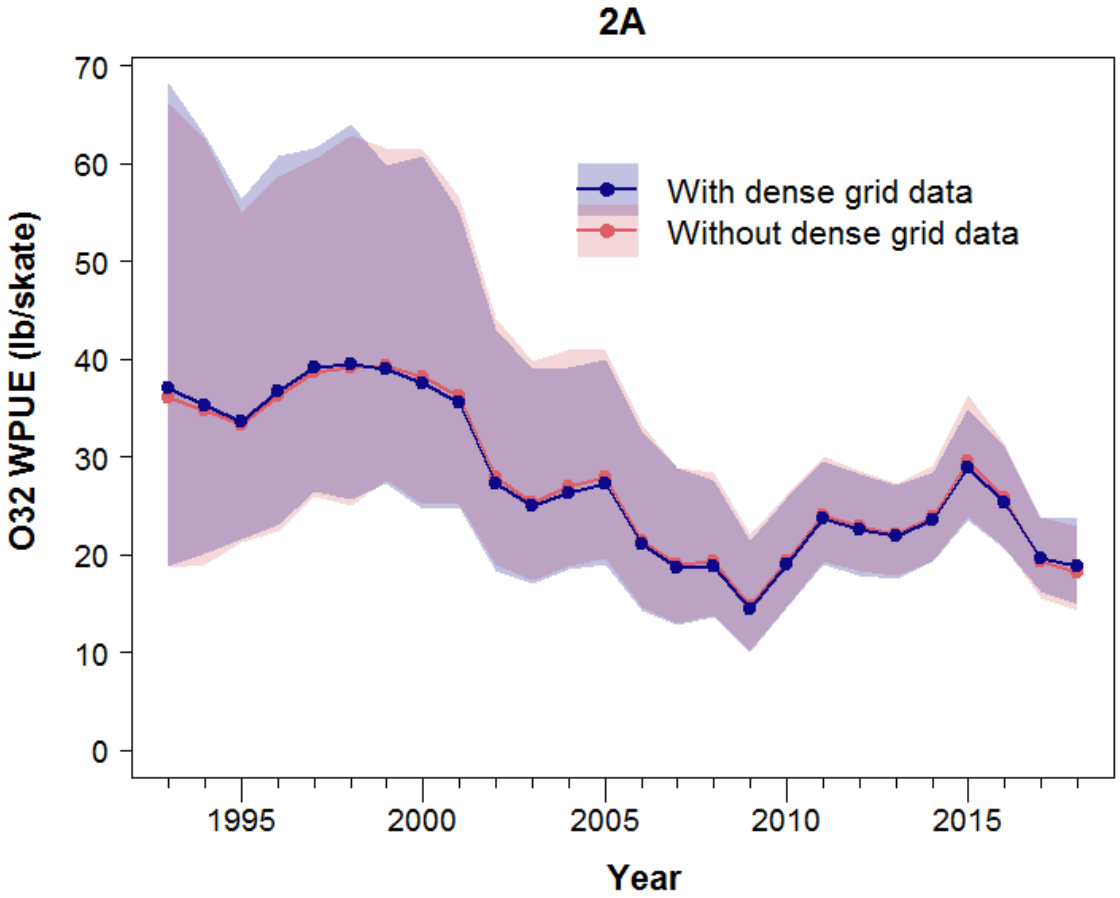


FISS expansions

- Data from the 2018 setline survey expansions in Regulatory Areas 2B and 2C:
  - Improved our understanding of the distribution of Pacific halibut within those areas
  - Reduced both bias and uncertainty in estimates of WPUE and NPUE indices
- Following completion of the planned expansions in 2019, we would not expect subsequent large revisions of the entire WPUE and NPUE time series
  - All previous gaps in the setline survey will have been sampled at least once, and future sampling of expansion stations will mainly affect the most recent years' estimates


2017
2018
latitude (° N)
longitude (° W)
Dissolved O2(ml/l)
Limit of dense grid
0 lb/skate
25 lb/skate
50 lb/skate
100 lb/skate
250 lb/skate
Ineffective
49
48
47
46
127
126
125
124
123
122
5
4
3
2
1
0

O32 WPUE comparison of space-time model output with and without data from the *ad hoc* dense grid stations off the north WA coast.



2018 FISS expansions

- The 2018 *ad hoc* setline survey expansion in Regulatory Area 2A:
  - Confirmed the 2017 conclusion that the increase in station density off the north Washington coast did not have a meaningful effect on estimates of WPUE and NPUE for Regulatory Area 2A
  - We find no scientific justification/benefit in repeating the *ad hoc* increase in station density in the future

Other space-time modelling work

- Setline survey 20-hook counts:
  - In most Regulatory Areas, all species are counted on the first 20 hooks per skate
  - Is this sufficient for accurate estimation of hook competition adjustment factors?
  - We compared space-time model output for Regulatory Area 2B using 20-hook counts and 100% hook counts
  - No meaningful differences were found in space-time model estimates: **the conclusion is that 20-hook counts are sufficient**

Other space-time modelling work

- Effect of including environmental covariate data on O32 WPUE estimates in Regulatory Area 2A
  - Fitted space-time models with bottom temperature and dissolved oxygen as covariates
  - Strong evidence of relationship between O32 WPUE and dissolved oxygen
  - However, inclusion of dissolved oxygen in the models had no meaningful effect on estimates of O32 WPUE or its uncertainty

Other space-time modelling work

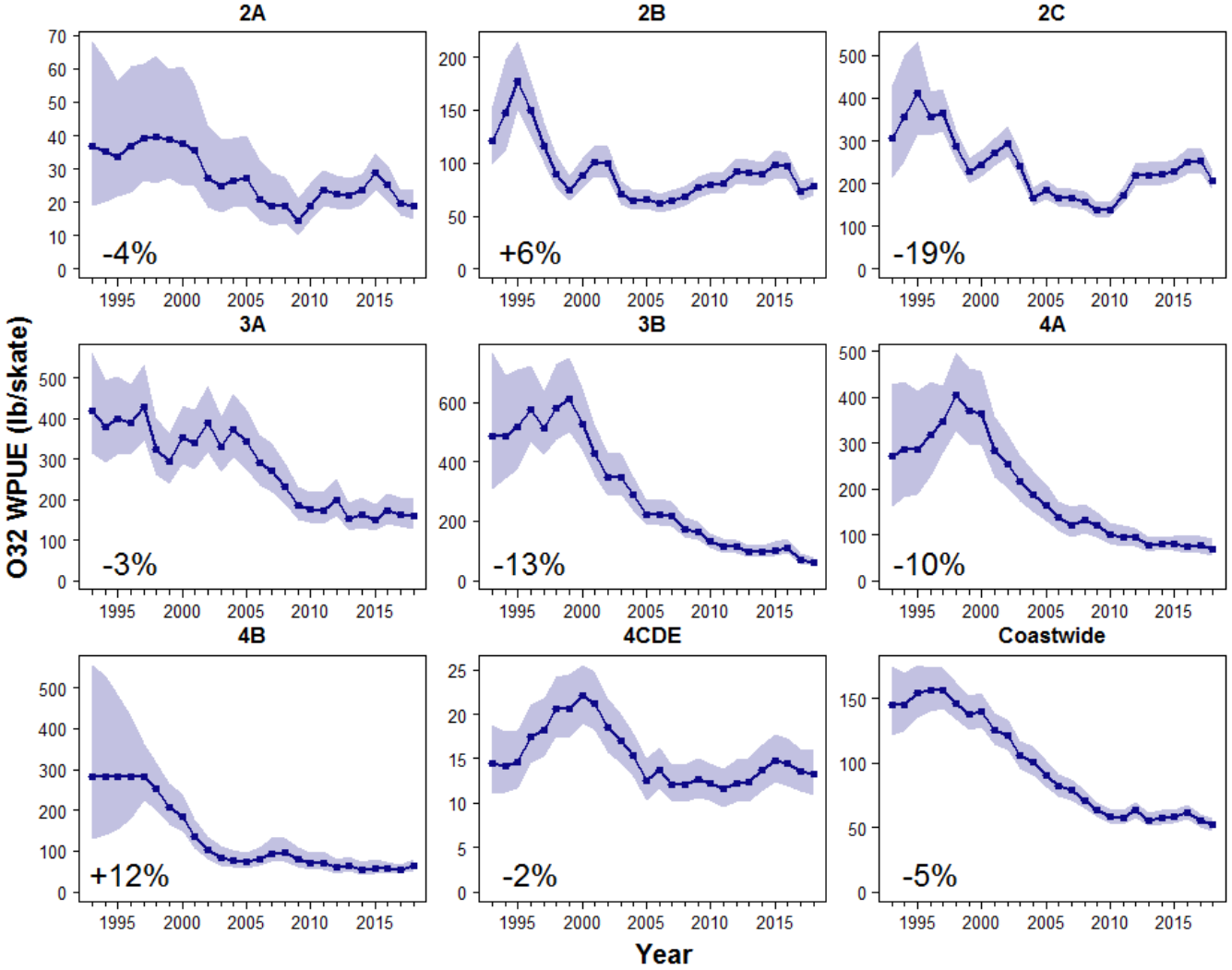
- The SRB stated the following in their June 2018 review:

  IPHC–2018–SRB012–R, Para 10. "*The SRB AGREED that, while dissolved oxygen (DO) levels improved space-time model fits to setline survey data, the results were not compelling or widespread enough (i.e. small effect size estimates) to warrant routine inclusion in the stock assessment process or WPUE/NPUE standardization. DO results could be reported at annual meetings*."

Extra slides (for publication)

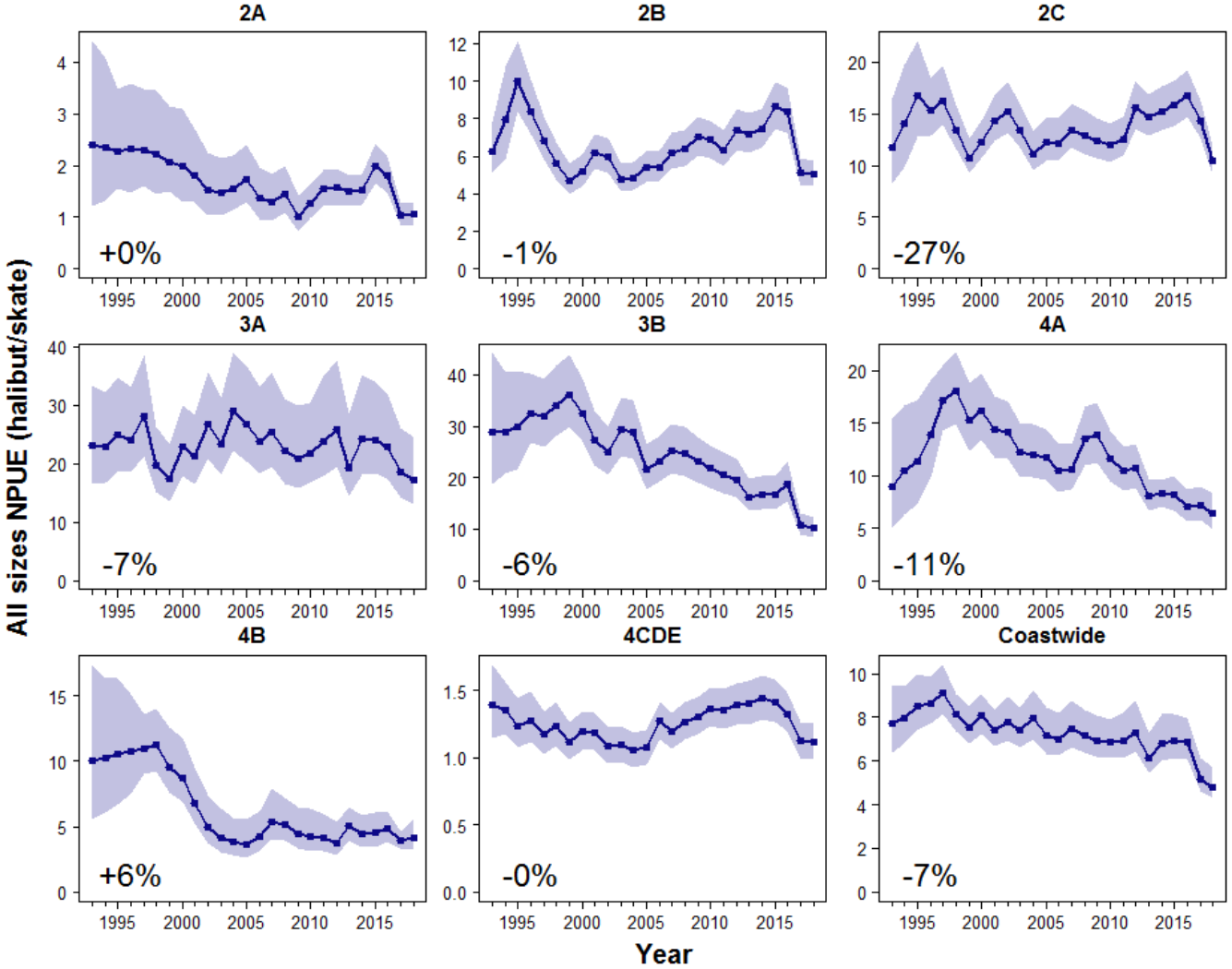
Space-time model estimates:

O32 WPUE by IPHC Regulatory Area. The estimated % change from 2017 to 2018 is shown at bottom left.



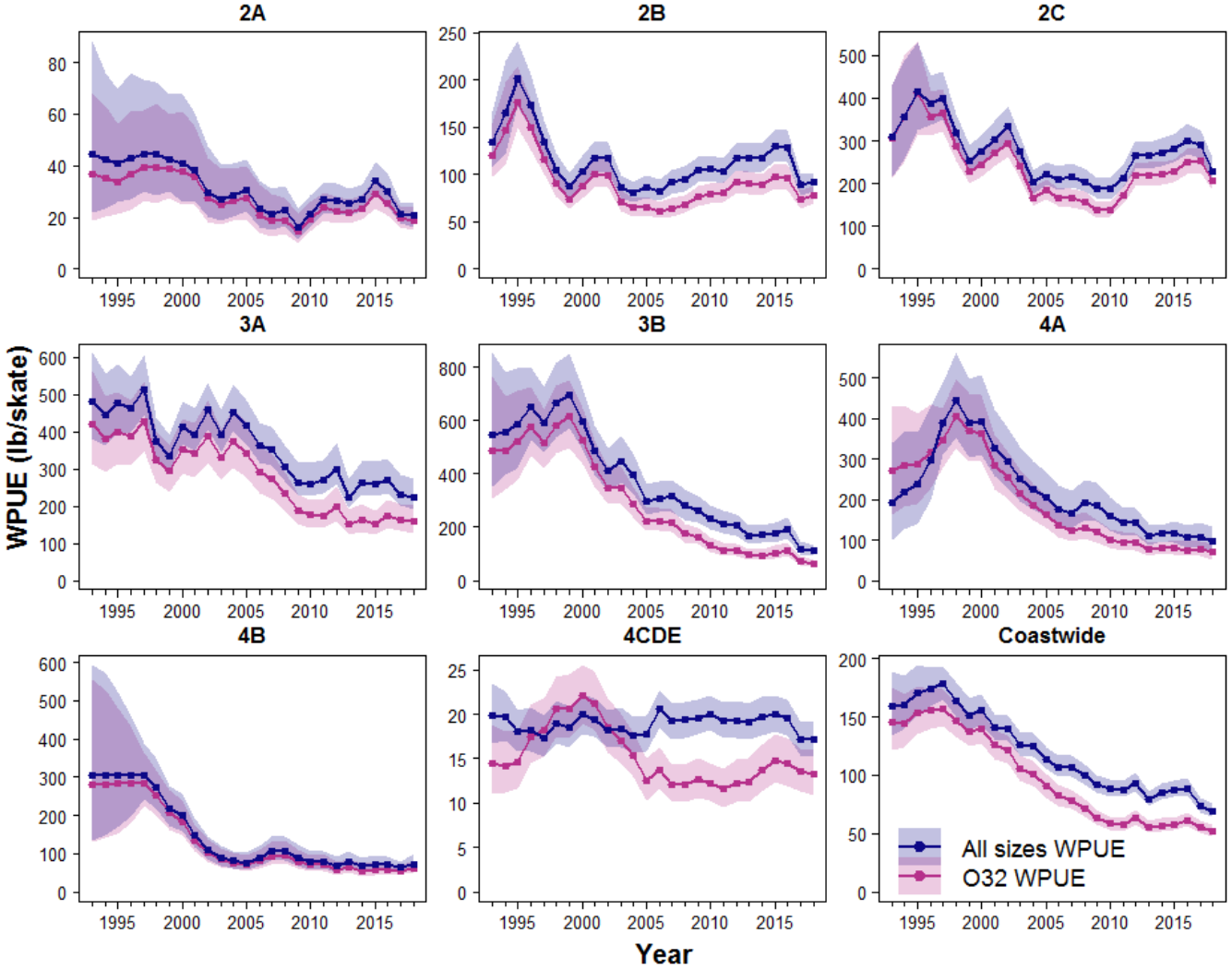
Space-time model estimates:

All sizes NPUE by IPHC Regulatory Area. The estimated % change from 2017 to 2018 is shown at bottom left.

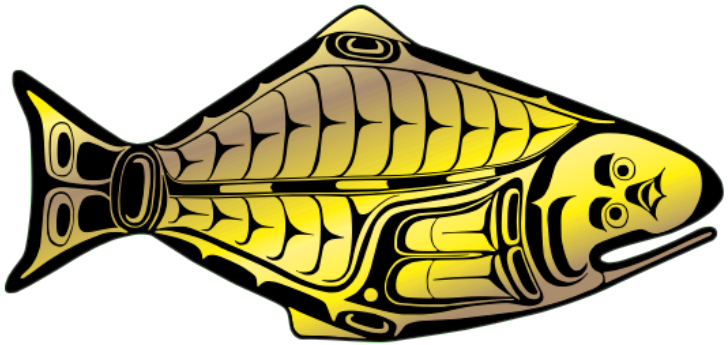


Space-time model estimates:

Comparison of O32 and all sizes WPUE by IPHC Regulatory Area



INTERNATIONAL PACIFIC



HALIBUT COMMISSION