INTERNATIONAL PACIFIC HALIBUT COMMISSION

2023 FISS design evaluation

Agenda item: 4.1
IPHC-2022-SRB020-05
(R. Webster)

Summary

- Background
  - IPHC history of FISS, 1993-2019
  - Space-time modelling
  - FISS design objectives
  - Review process
- Proposed FISS designs for 2023-25
  - Evaluation and revision of designs
- Consideration of cost
- SRB requests

IPHC FISS

- Our most important source of data on Pacific halibut
- Provides data for estimating weight and numbers per unit effort (WPUE and NPUE) indices of density and abundance of Pacific halibut
  - Used to estimate stock trends
  - Used to estimate stock distribution
  - Important input in the IPHC stock assessment
- Provides biological data for use in the stock assessment

FISS history 1993-2019

- A standardised FISS has been conducted by the IPHC each year since 1993
  - Standardised for bait and fishing gear
- From 1993-97 coverage was limited and generally restricted to IPHC Regulatory Areas 2B, 2C, 3A and 3B
- The modern FISS design on a 10 nmi grid began in 1998
- By 2001, annual coverage occurred in all IPHC Regulatory Areas
  - Depth range 20-275 fathoms in Gulf of Alaska and Aleutian Islands
  - Depth range 75-275 fathoms along Bering Sea shelf edge

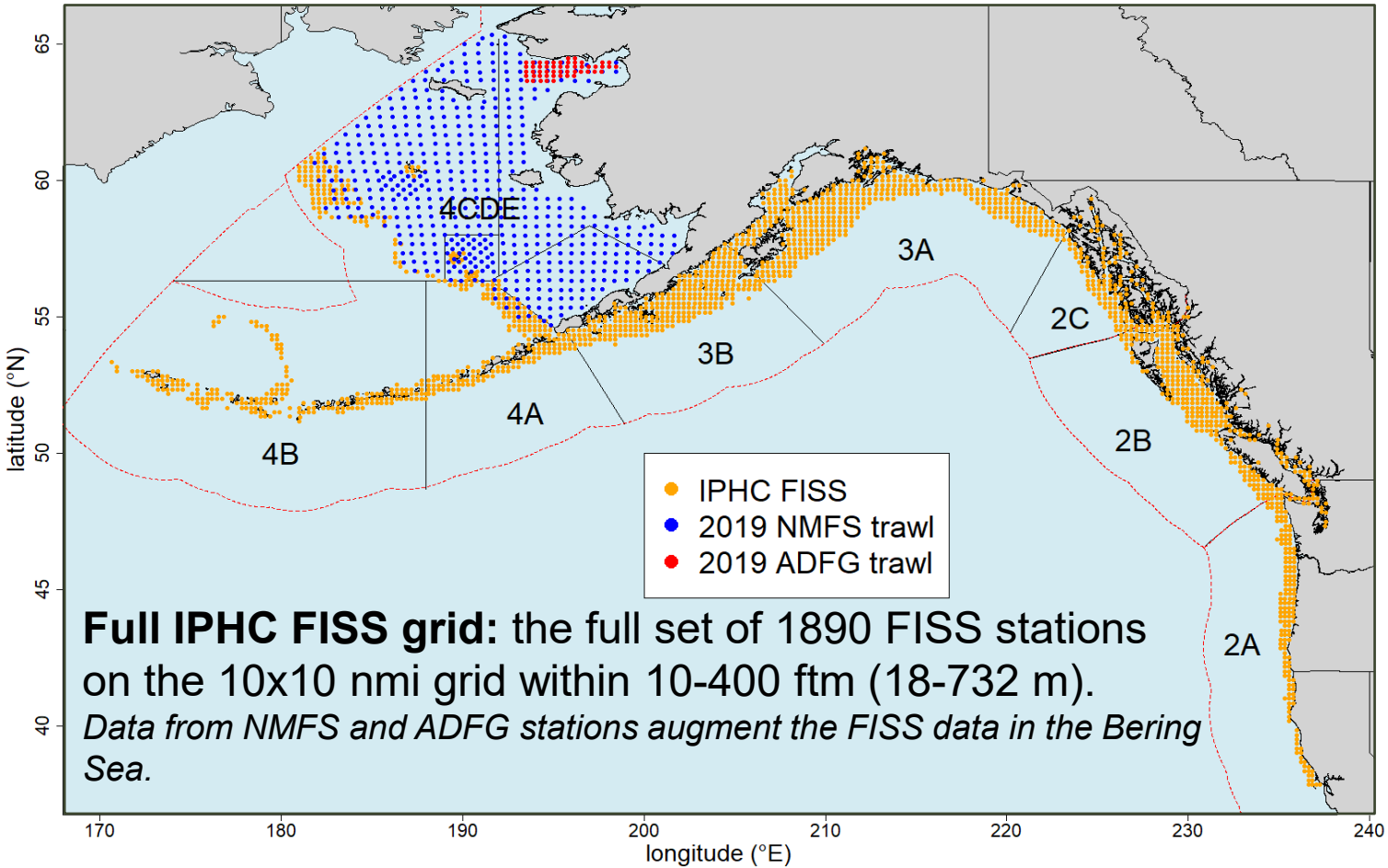
FISS history 1993-2019

- By 2010, data from other sources showed that not all Pacific halibut habitat was covered by the FISS
  - Pacific halibut were present outside the FISS depth range, in both deep and shallow waters
  - All IPHC Regulatory Areas had coverage gaps, even within the standard depth range
- Such unsampled habitat meant there was the potential for bias in estimates derived from FISS data
- Therefore, a series of FISS expansions from 2011 to 2019 were undertaken covering previously unsampled habitat in all IPHC Regulatory Areas

FISS history 2011-2019

- During the expansions, the FISS occupied for the first time 34% of the stations on the full 10 nmi FISS grid that had been previously unsampled
- The result was an improved understanding of Pacific halibut density and distribution
  - Bias was reduced, with indices for several Regulatory Areas being revised upwards or downwards
  - Uncertainty in estimates of WPUE and NPUE was reduced in most Regulatory Areas
  - These improvements were apparent throughout the time series, not only in the year of the expansion
- The resulting expanded grid of 1890 stations has provided a full FISS design from which stations can be selected for sampling in each annual FISS

Full FISS grid



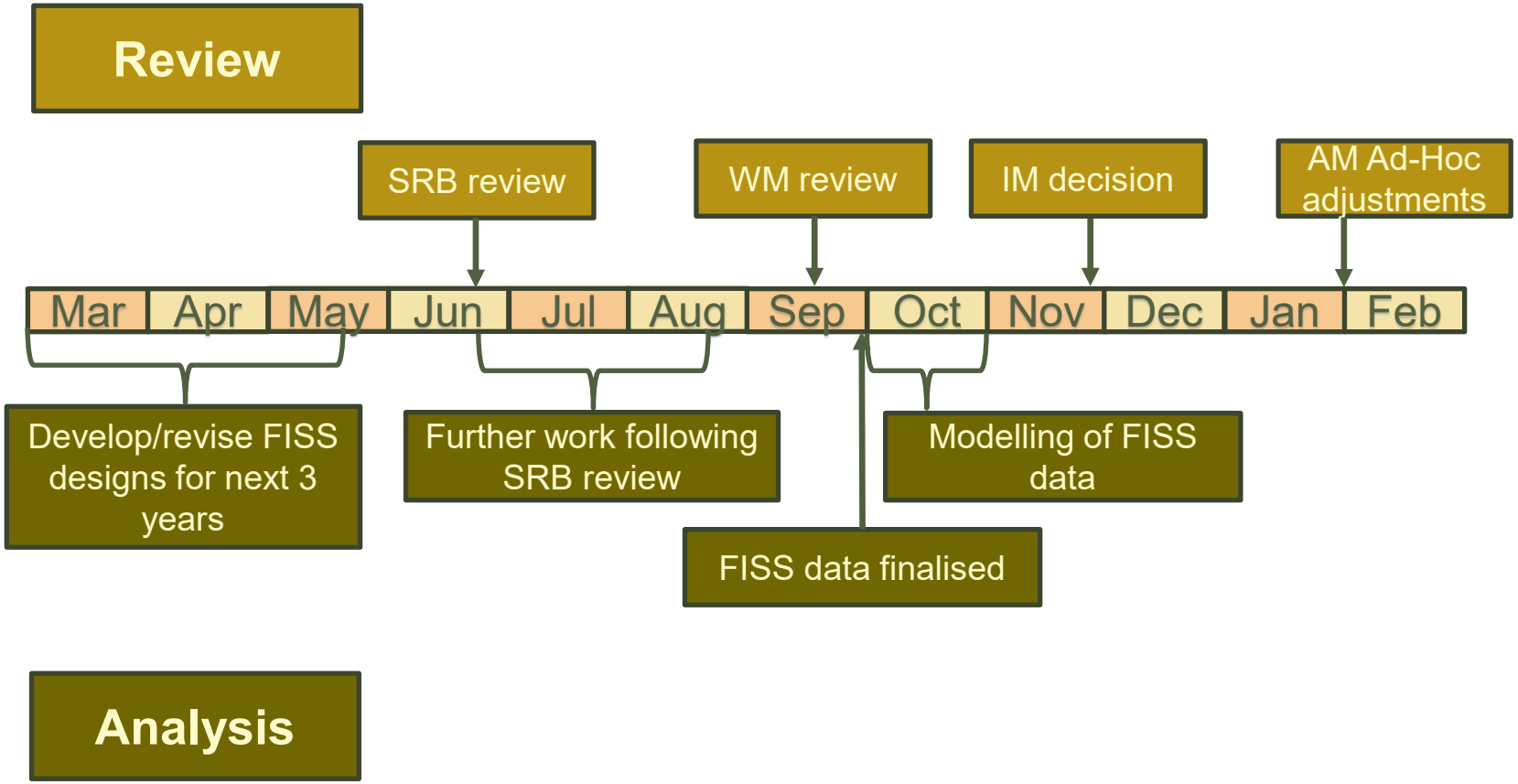
Full IPHC FISS grid: the full set of 1890 FISS stations on the 10x10 nmi grid within 10-400 ftm (18-732 m).

Data from NMFS and ADFG stations augment the FISS data in the Bering Sea.

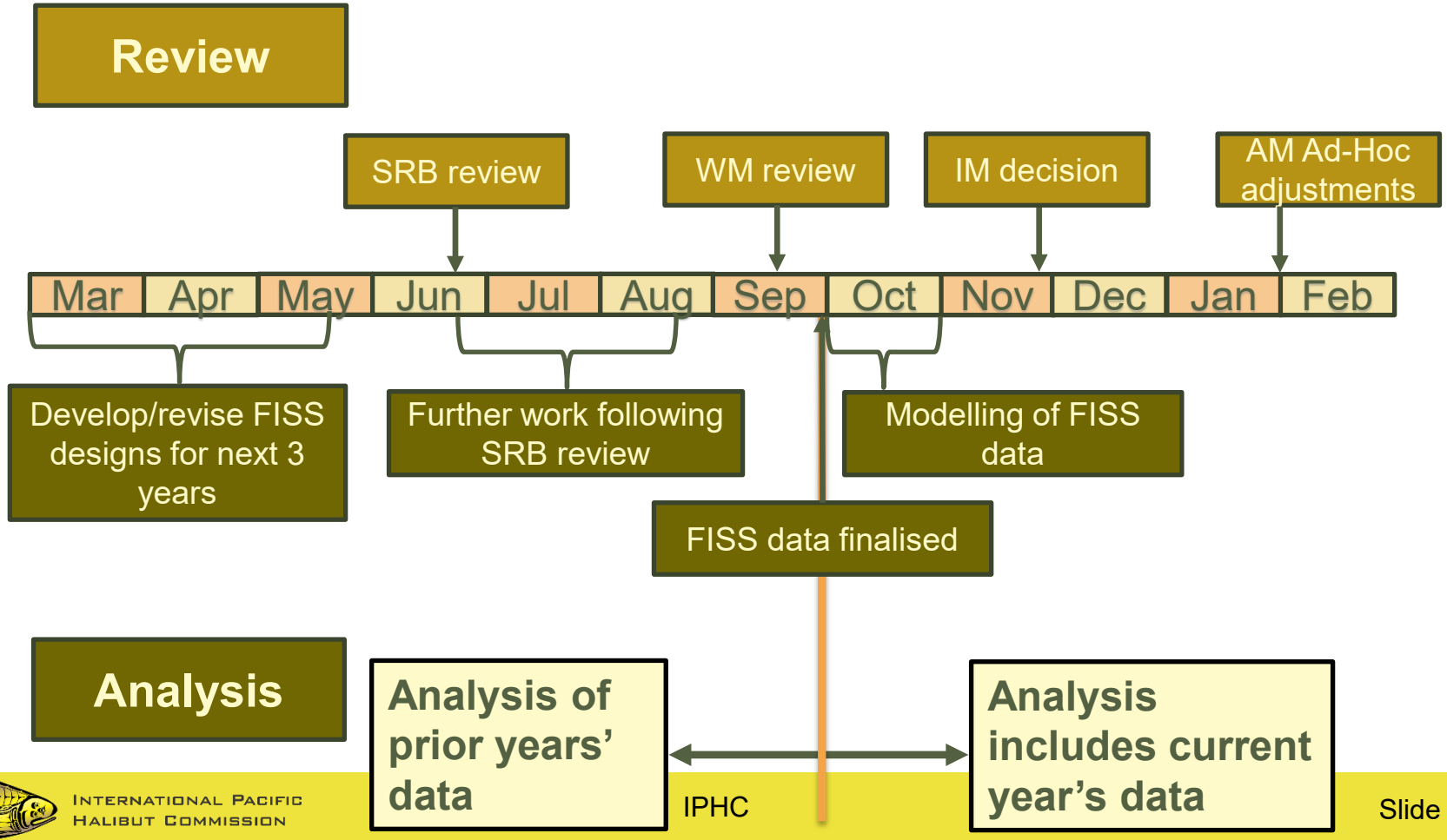
FISS objectives and design layers

Priority	Objective	Design Layer
Primary	Sample Pacific halibut for stock assessment and stock distribution estimation	Minimum sampling requirements in terms of: • Station distribution • Station count • Skates per station
Secondary	Long term revenue neutrality	Logistics and cost: operational feasibility and cost/revenue neutrality
Tertiary	Minimize removals, and assist others where feasible on a cost-recovery basis.	Removals: minimize impact on the stock while meeting primary priority Assist: assist others to collect data on a cost-recovery basis IPHC policies: ad-hoc decisions of the Commission regarding the FISS design

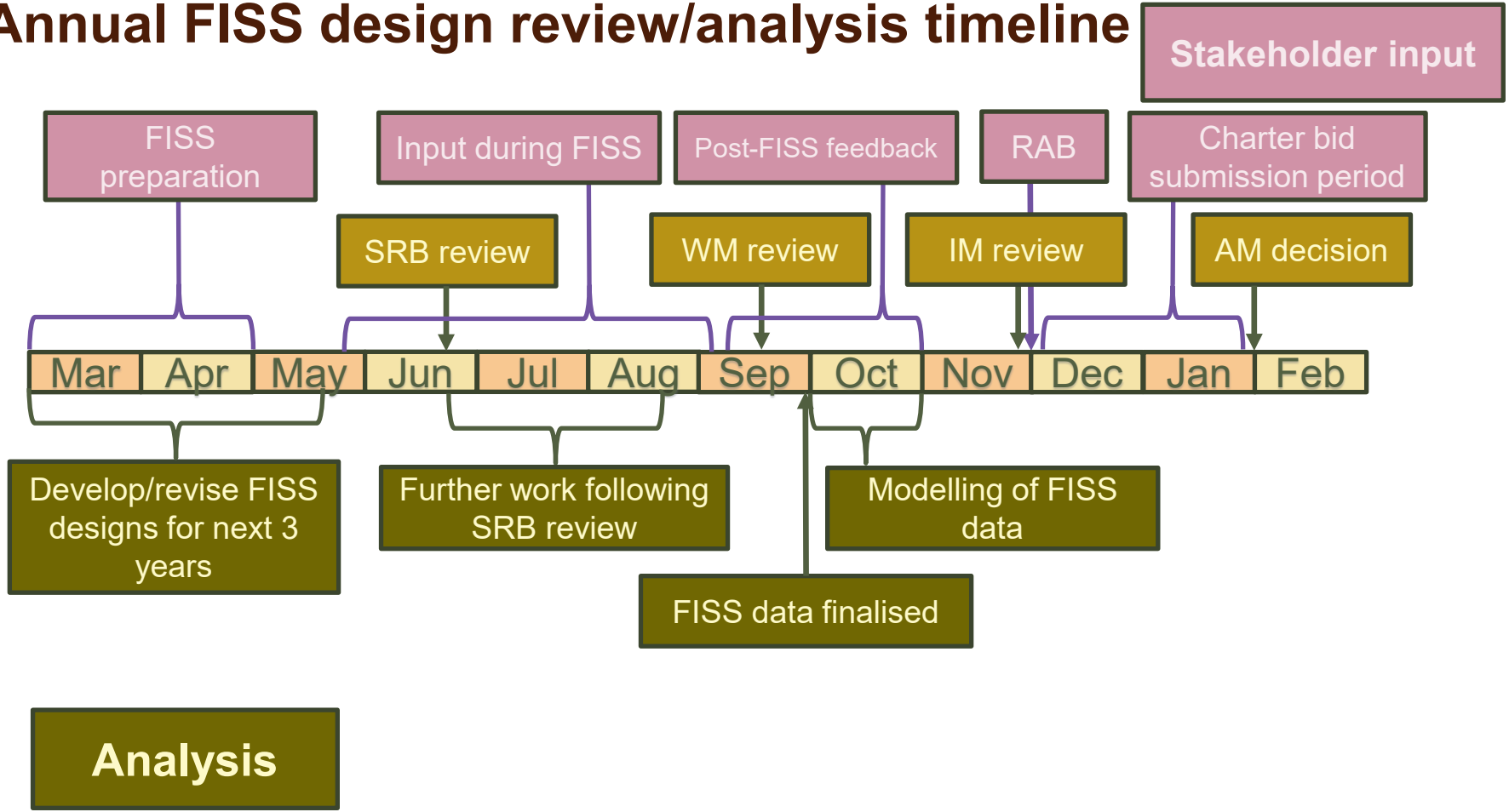
Annual FISS design review/analysis timeline



Annual FISS design review/analysis timeline



Annual FISS design review/analysis timeline



Annual revision of FISS design proposals

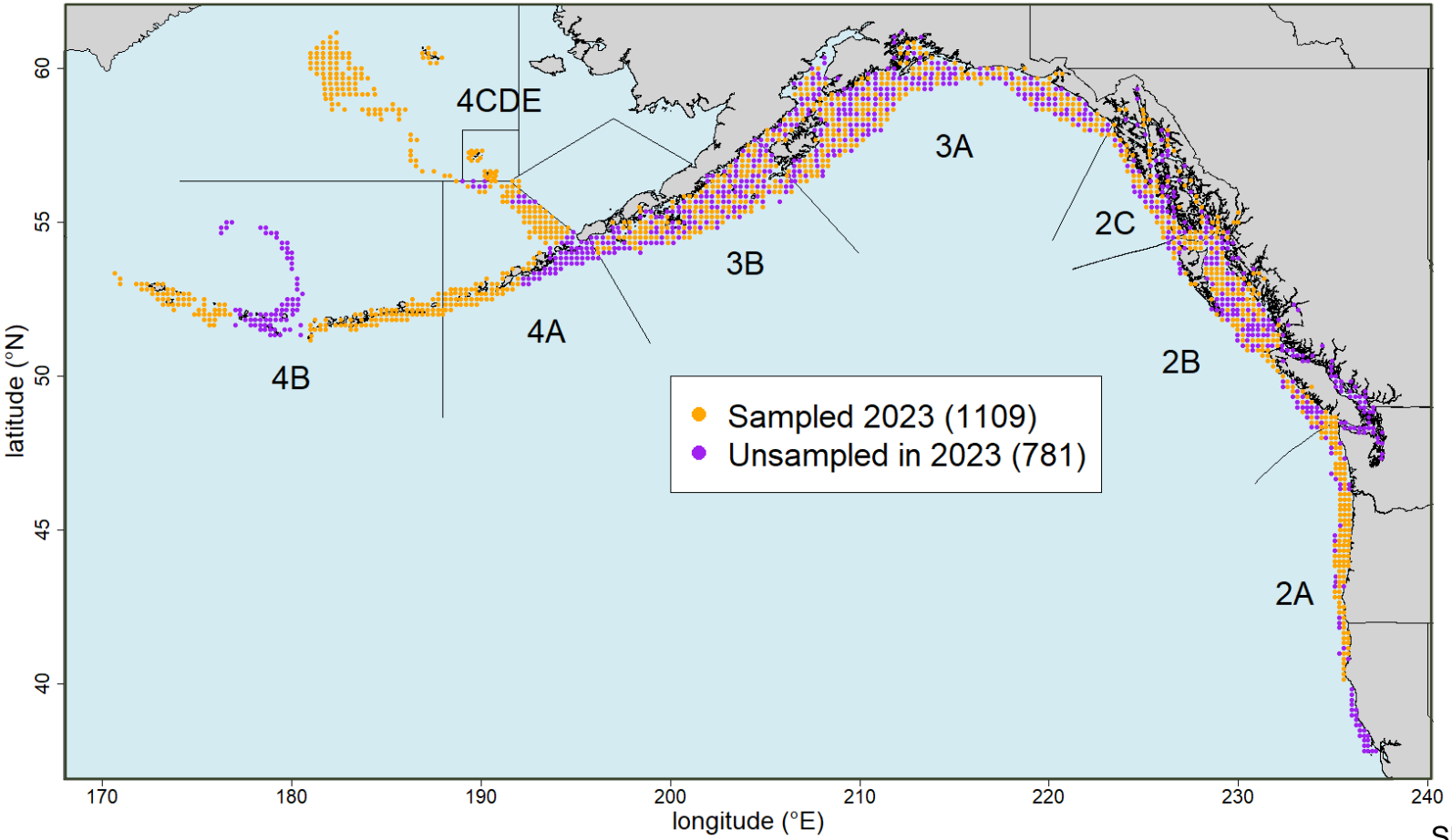
- As new FISS data come in each year, we revise our understanding of the spatial distribution of Pacific halibut.
- Local contraction or expansion of the distribution, or changes in inter-annual variability in subareas, can lead to revisions in the timing and frequency of FISS sampling in each subarea that will be incorporated into subsequent design proposals.
- Changes in the variability of Pacific halibut catch rates among stations can affect the number of stations proposed for sampling.

Proposed FISS designs for 2023-25

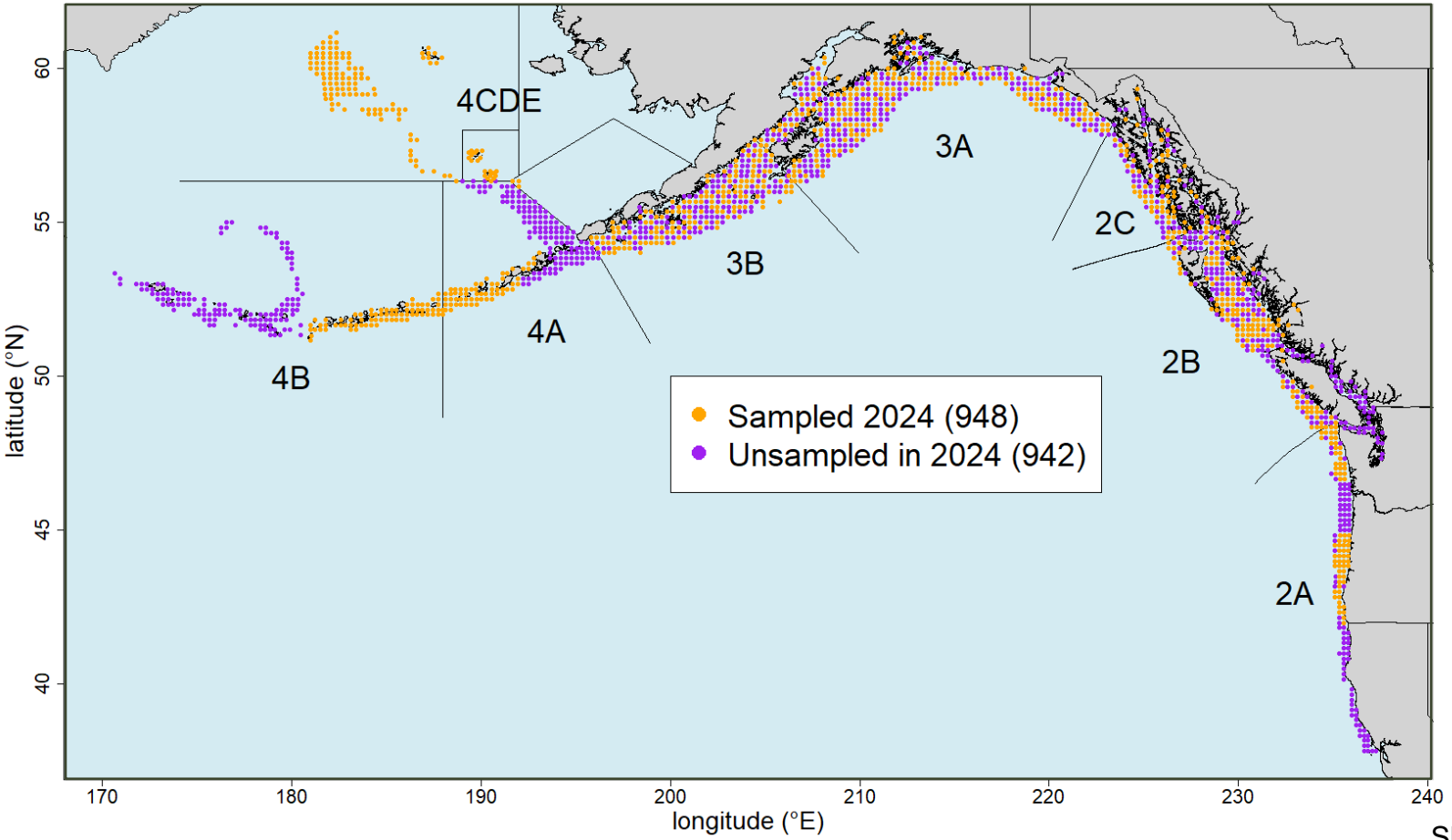
- The proposed designs again use efficient subarea sampling in IPHC Regulatory Areas 2A, 4A and 4B, but incorporate a randomized design in IPHC Regulatory Areas 2B, 2C, 3A and 3B
- We continue to propose sampling all standard FISS stations in IPHC Regulatory Area 4CDE
  - A highly dynamic area with apparently northward-shifting distribution, and uncertainty regarding connectivity with populations near to and within in Russian waters
  - We note that complete sampling did not take place in 2021 (north only) and in 2022, only the southern portion will be sampled
  - We also note the following recommendation from SRB019:

SRB019–Rec.02 (para. 14) **NOTING** the presentation of three alternative 2022 sampling designs (Figs. 1, 2, and 3) that optimize the SRB018-endorsed proposed 2022 design for cost, thereby meeting the goals of long-term revenue neutrality (Secondary Objective), without compromising the scientific goals of the FISS (Primary Objective), the SRB **RECOMMENDED** that the Secretariat prioritize 2022 sampling designs that include IPHC Regulatory Area 4CDE despite the relatively low contribution of this area to overall biomass and variance. This region is an important area to monitor for future range shifts and biological samples collected here are likely to be important for understanding the biology of Pacific halibut at their leading range edge.

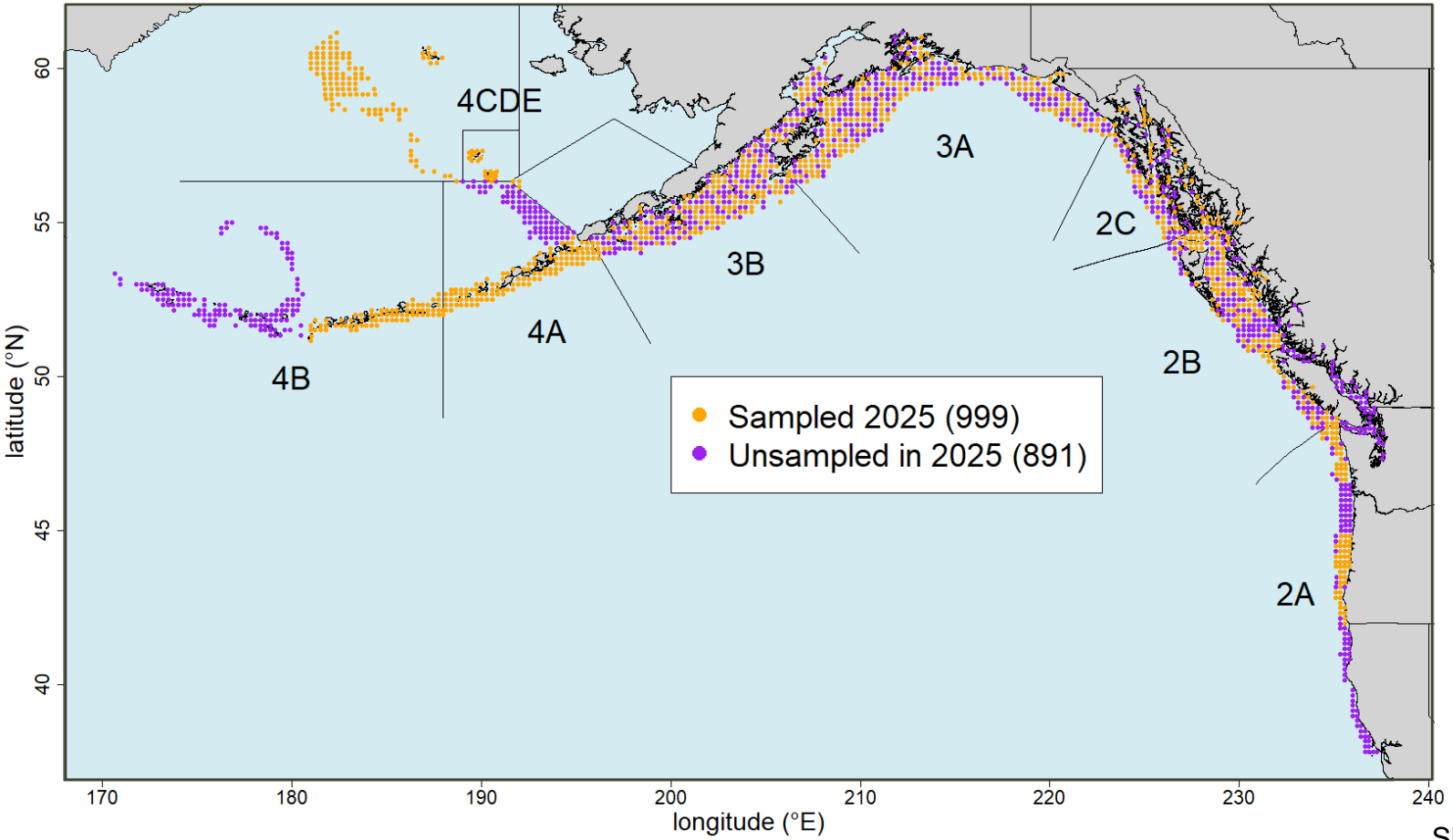
Proposed 2023 FISS design



Proposed 2024 FISS design



Proposed 2025 FISS design



Changes from preliminary 2023-24 proposals presented in 2021

- In IPHC Regulatory Area 2A, we added the moderate density waters of southern Washington/northern Oregon and northern California (2023 only)
  - Previously not proposed before 2025
- In IPHC Regulatory Area 4B, we added the western subarea (2023 only)
  - Previously proposed for 2022 but lacked a suitable charter bid

Projected CVs

- The proposed designs have high sampling rates in Regulatory Areas 2B, 2C, 3A, 3B and 4CDE
  - CVs will remain well within the target range (<15% per Reg. Area)
- Randomised or full sampling designs in these areas will result in unbiased estimation
- In other Reg. Areas we project the following CVs (%) after completion of the 2024 FISS:

Area	2022	2023	2024	2025
2A	13	12	13	15
4A	10	9	10	10
4B	12	9	10	12

Minimizing bias

- To minimize bias due to not sampling one or more subareas each year, we selected a sampling frequency that aims to keep the change in biomass proportion of each subarea within 10% between successive sampling years.
  - This is based on estimated changes in WPUE over the 1993-2021 period
- For example, if a subarea's % of its Reg. Area's biomass changed by no more than 8% over 1 or 2 years but by up to 12% over 3 years, we should sample it at least every three years.

Maximum expected unobserved change in biomass % across all subareas since previous sampling, based on proposed 2023-25 designs and the implemented 2022 design

Area	2022	2023	2024	2025
2A	9	9	9	9
4A	10	7	6	8
4B	13	5	8	10

Projected CVs

- As part of our evaluation of the FISS design process, we compared projected CVs for O32 WPUE for IPHC Regulatory Areas that use these as part of the annual design evaluation
  - CVs in other areas are well within the <15% target range

Area	2021 projected CV(%)	2021 estimated CV (%)
2A	15	18
4A	11	15
4B	14	18

- 2A: Spatial variability appears to have increased relative to prior years
- 4A, 4B: Not all planned sampling stations were completed due to logistical issues
- We note that the CVs for Biological Regions 2 and 4, along with the coastwide CV, remained low in 2021 (4% in Biological Region 2, 9% in Region 4, 3% coastwide).

Consideration of cost

- The proposed FISS designs for 2022-24 incorporate some consideration of cost
  - Logistically efficient subarea designs are proposed in lower-density IPHC Regulatory Areas.
- The goal here was to provide statistically efficient and logistically feasible designs for consideration by the Commission
- The FISS is funded by sales of captured fish and is intended to have long-term revenue neutrality, meaning that any design must also be evaluated in terms of the following factors:
  - Expected catch of Pacific halibut
  - Expected Pacific halibut sale price
  - Charter vessel costs, including relative costs per skate and per station
  - Bait costs
  - IPHC Secretariat costs

Consideration of cost

- Balancing these factors may result in modifications to the design proposals:
  - e.g., may need to increase sampling effort in high-density regions and decrease effort in low density regions
- Optimized designs accounting for cost are presented to Commissioners at the Interim and Annual Meetings

SRB Requests

At SRB018 (IPHC-2021-SRB018-R), the SRB made the following requests:

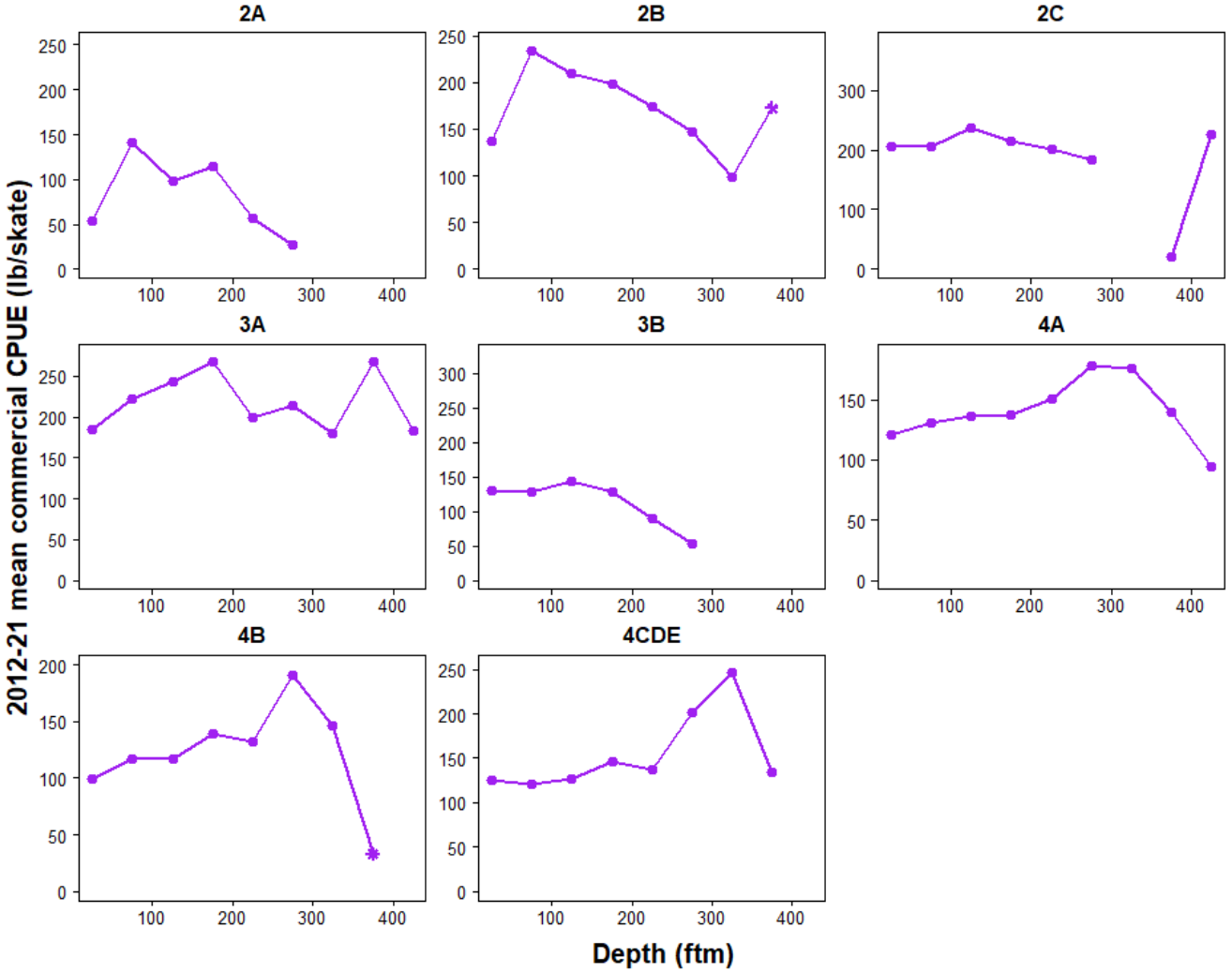
- SRB018–Req.1 (para. 13) The SRB **REQUESTED** plots by survey area of WPUE vs. depth from both FISS and commercial fisheries to help understand if there is part of the Pacific halibut stock in deeper waters not covered by the FISS.
- SRB018–Req.2 (para. 14) The SRB **REQUESTED** that the IPHC Secretariat conduct a preliminary comparison, to be presented at SRB020, between male, female, and sex-aggregated analysis of the FISS data using the spatial-temporal model.

Req. 1: Catch rates in deeper waters

- Examined commercial CPUE for 2012-2021 during summer FISS sampling period (May-Sep)
- Just 36 commercial sets in waters deeper than 732 m (400 ftm, FISS depth limit)
  - Several in 2C and 3A in waters within the current 10 nmi grid: no coverage gap
  - Largest cluster of sets (15) in western 4A
- Proportion of commercial catch in waters deeper than 732 m is at or near 0% in almost all areas and years

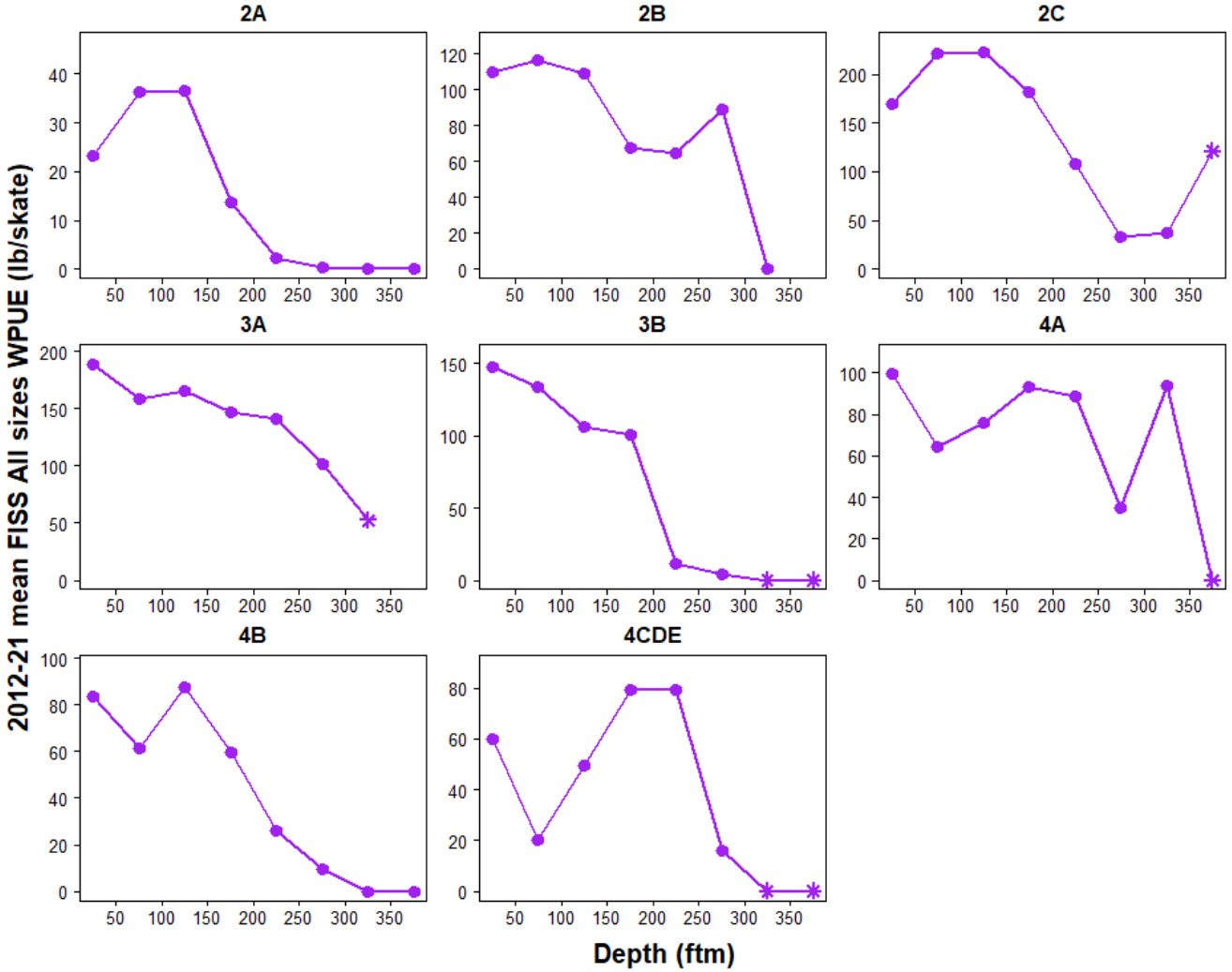
Mean commercial CPUE by area for 2012-21 (binned into 50 ftm depth bins).

- Star symbol indicates fewer than five sets
- Values based on fewer than three vessels omitted



Mean FISS all sizes WPUE by area for 2012-21 (binned into 50 ftm depth bins).

- Star symbol indicates fewer than five sets

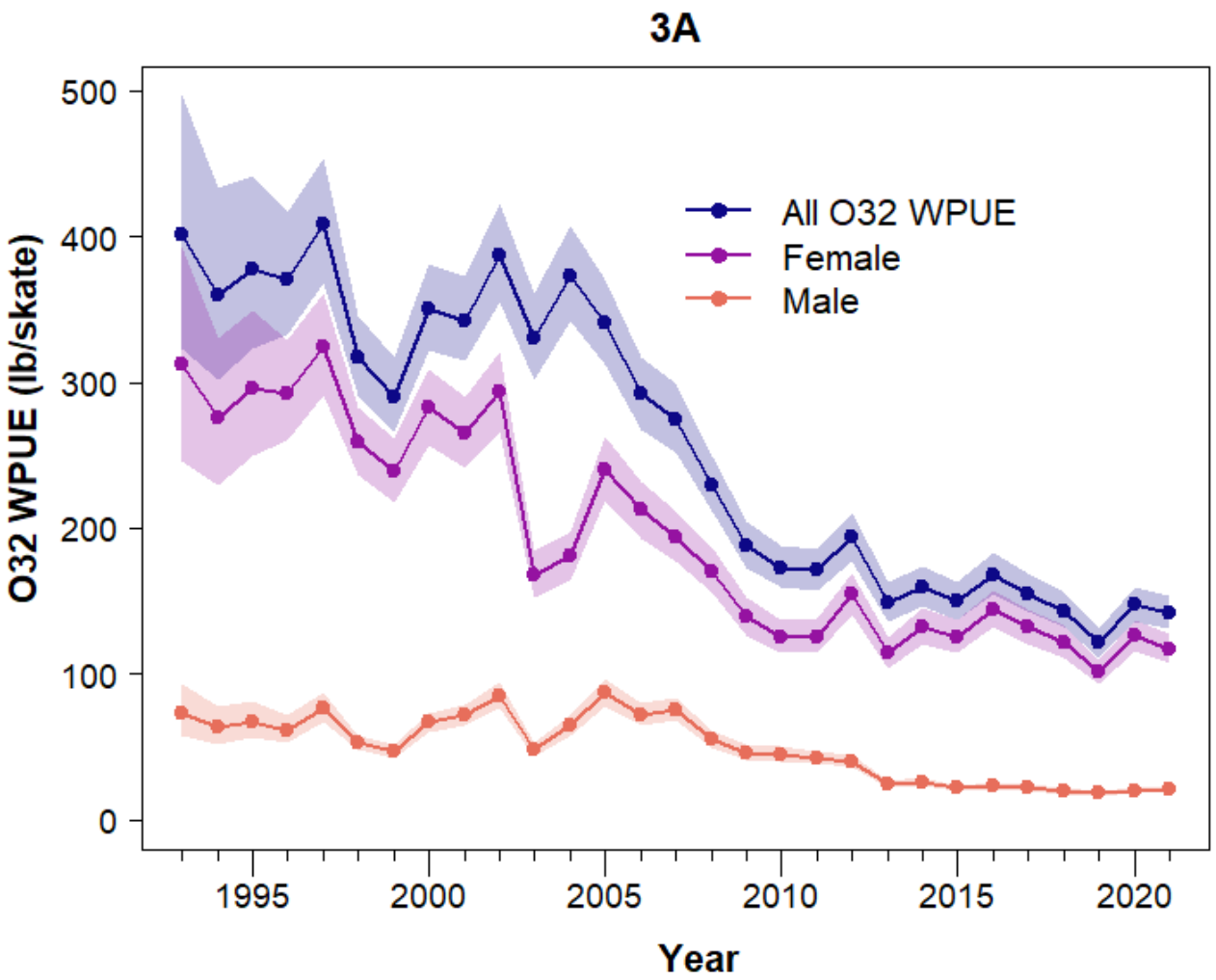


Req. 1: Catch rates in deeper waters

- Some evidence of Pacific halibut presence in deeper waters from commercial data in IPHC Regulatory Areas 2C, 3A and 4A
  - Only in 4A were fish captured outside the current FISS footprint
- We note the following:
  - Commercial fishers may be targeting known, isolated locations that may be missed by an expanded FISS
  - They may be targeting the easiest fishing locations
    - Data do not exclude the possibility of P. halibut in deeper waters elsewhere
  - Some sets cross the 732 m contour and catch may have been taken in waters shallower than 732 m
  - These depths comprise a narrow band on the shelf edge: any FISS expansion is likely to involve few stations with low impact on overall mean WPUE
  - High cost and logistical difficulty will be a factor in any potential expansion into deeper waters

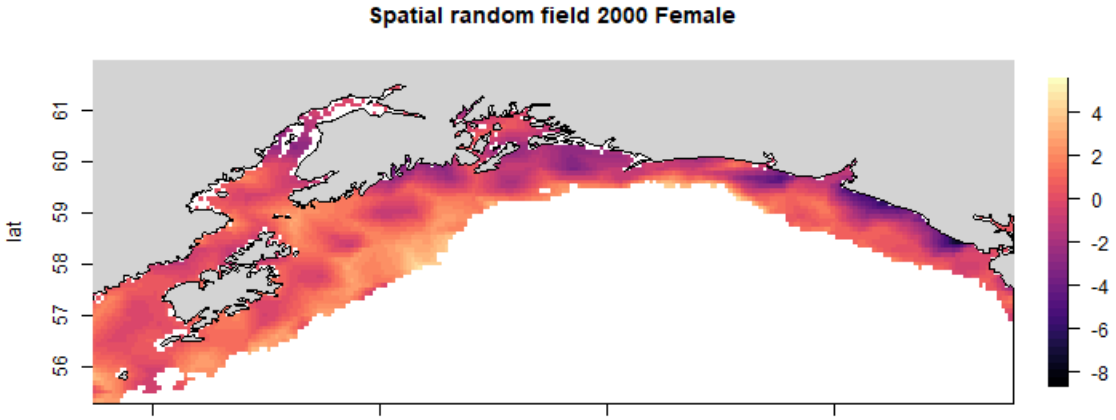
Req. 2: Sex-specific modelling

- Notes on IPHC sex data:
  - Small fish (under 32” in length) are subsampled, and only a small proportion have sex information
  - Sex is missing from 5% of larger fish, with high proportions missing in 2003-04 (up to 40% depending on area)
- Preliminary analysis looked at O32 WPUE in IPHC Regulatory Area 3A
  - Separate space-time models were fitted to female and male catch rates and compared with output from model fitted to combined data

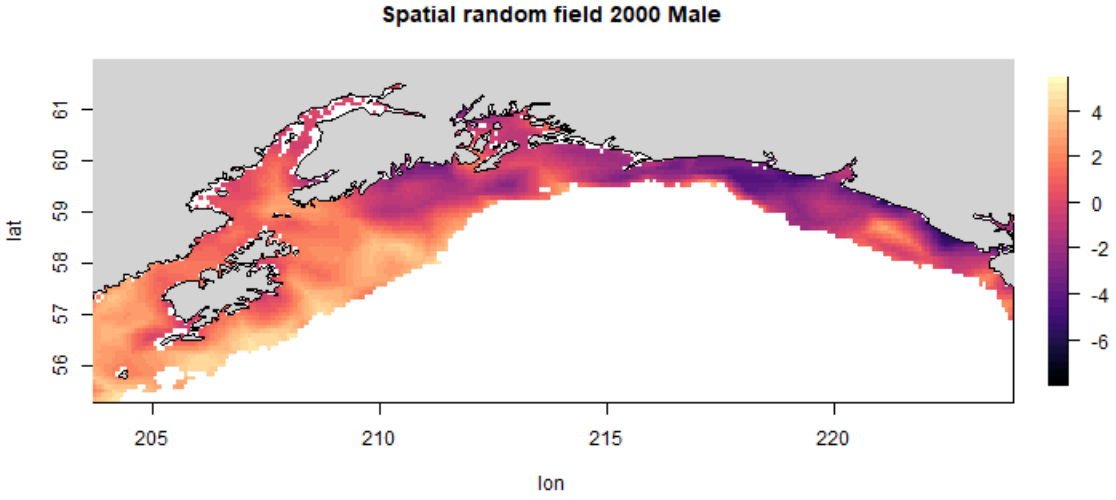

3A
O32 WPUE (lb/skate)
500
400
300
200
100
0
1995
2000
2005
2010
2015
2020
Year
All O32 WPUE
Female
Male

2000

Female

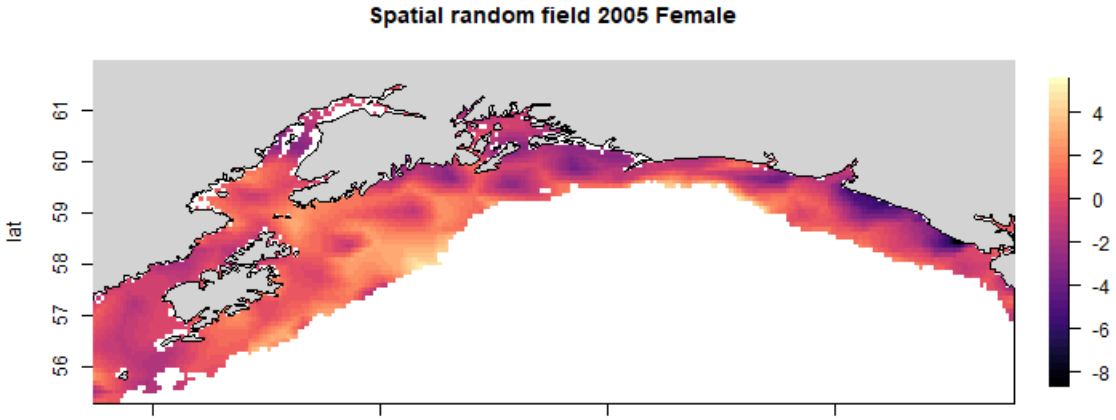


Male

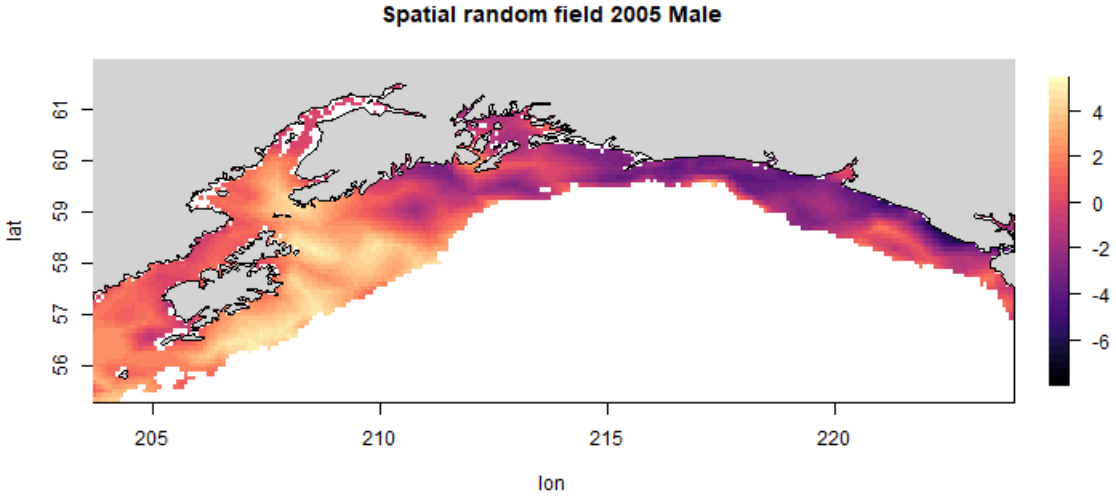


2005

Female

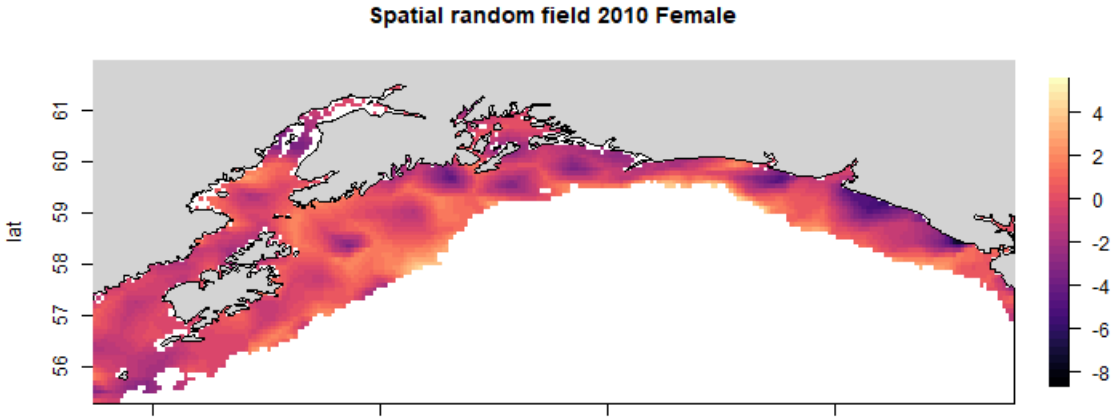


Male

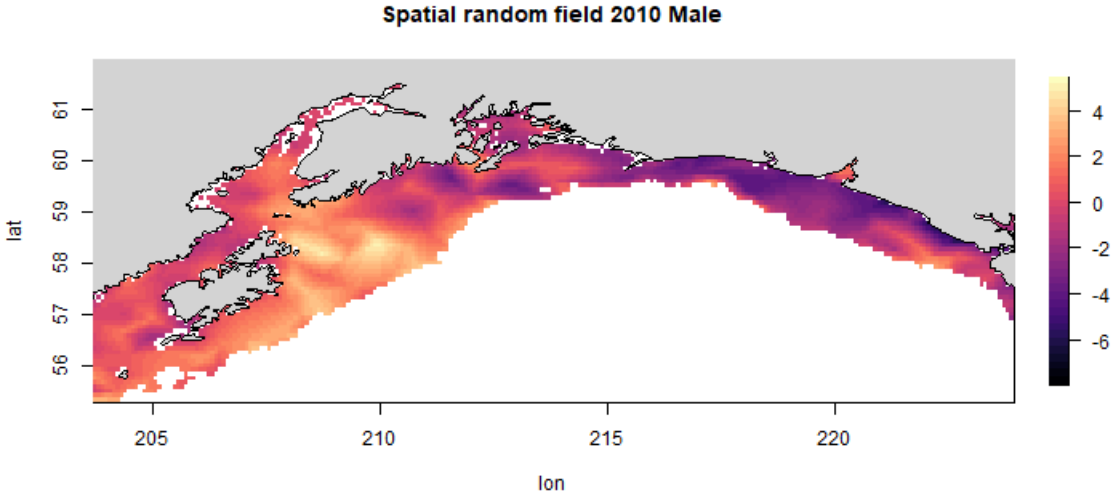


2010

Female

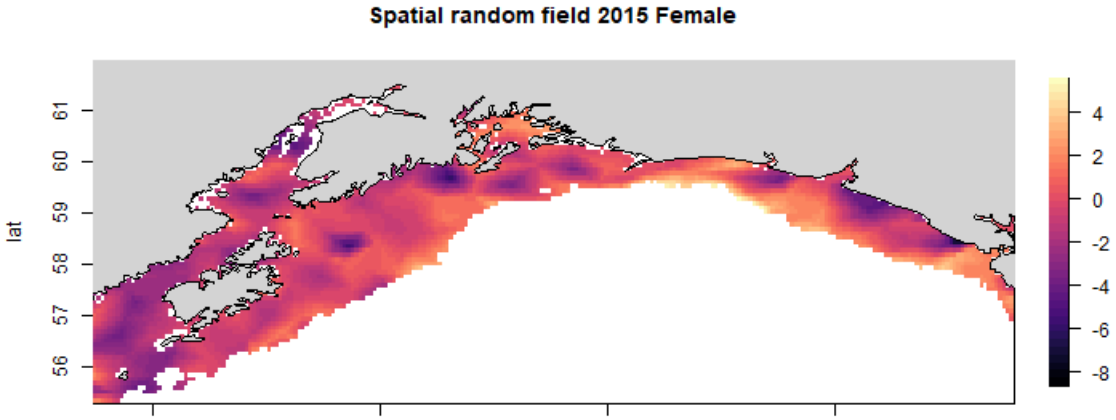


Male

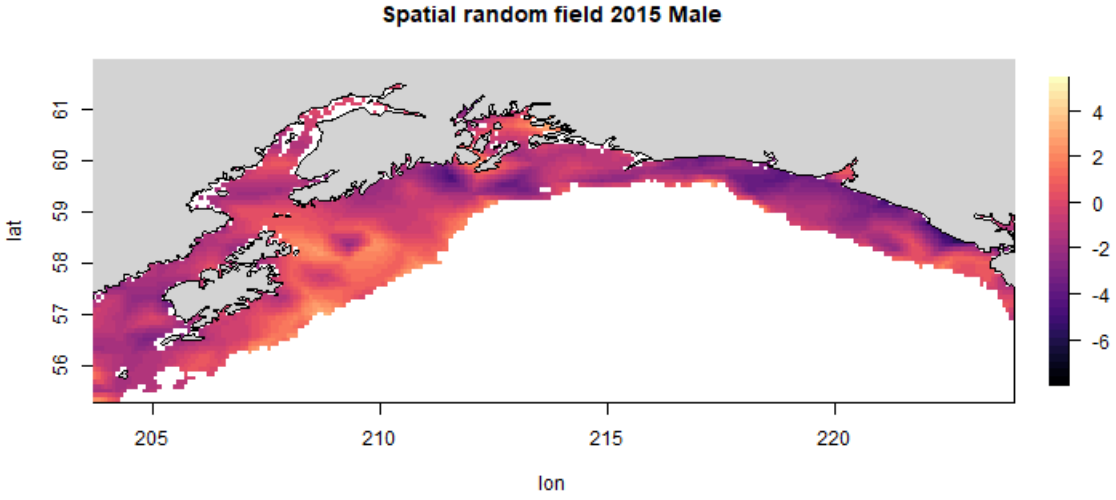


2015

Female

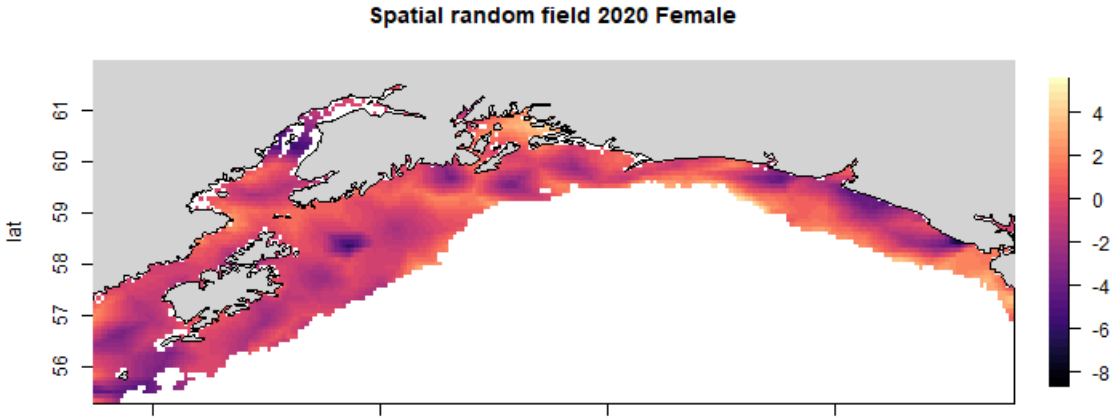


Male



2020

Female



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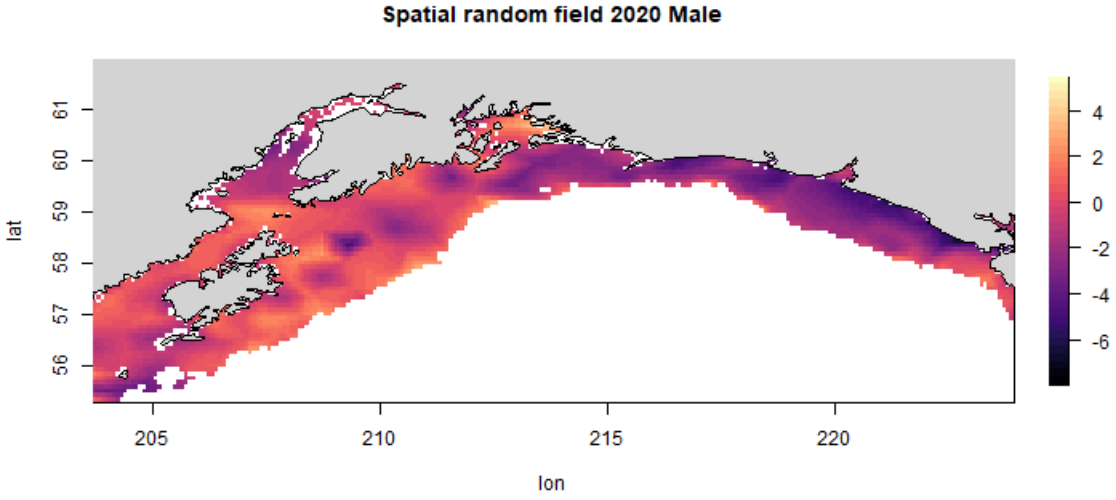

Recommendations

That the Scientific Review Board:

1) **NOTE** paper IPHC-2022-SRB020-05 that provides background on and a discussion of the IPHC fishery-independent setline survey design proposals for the 2023-25 period;

2) **ENDORSE** the final 2023 FISS design as presented in Figure 2 of IPHC-2022-SRB020-05, and

3) Provisionally **ENDORSE** the 2024-25 designs (Figures 3 and 4 of IPHC-2022-SRB020-05), recognizing that these will be reviewed again at subsequent SRB meetings.

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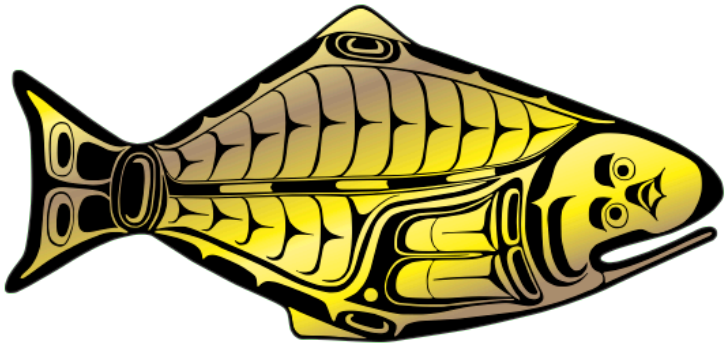

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