INTERNATIONAL PACIFIC HALIBUT COMMISSION

Space-time modelling of survey data and FISS designs for 2021-23

Agenda item 5.2

IPHC-2021-AM097-07

Summary

- IPHC history of FISS, 1993-2010
- FISS expansions 2011-19
- Space-time modelling
  - Results for 2020
- FISS design objectives
- Review process and timeline
- FISS designs for 2021-23
- Consideration of cost

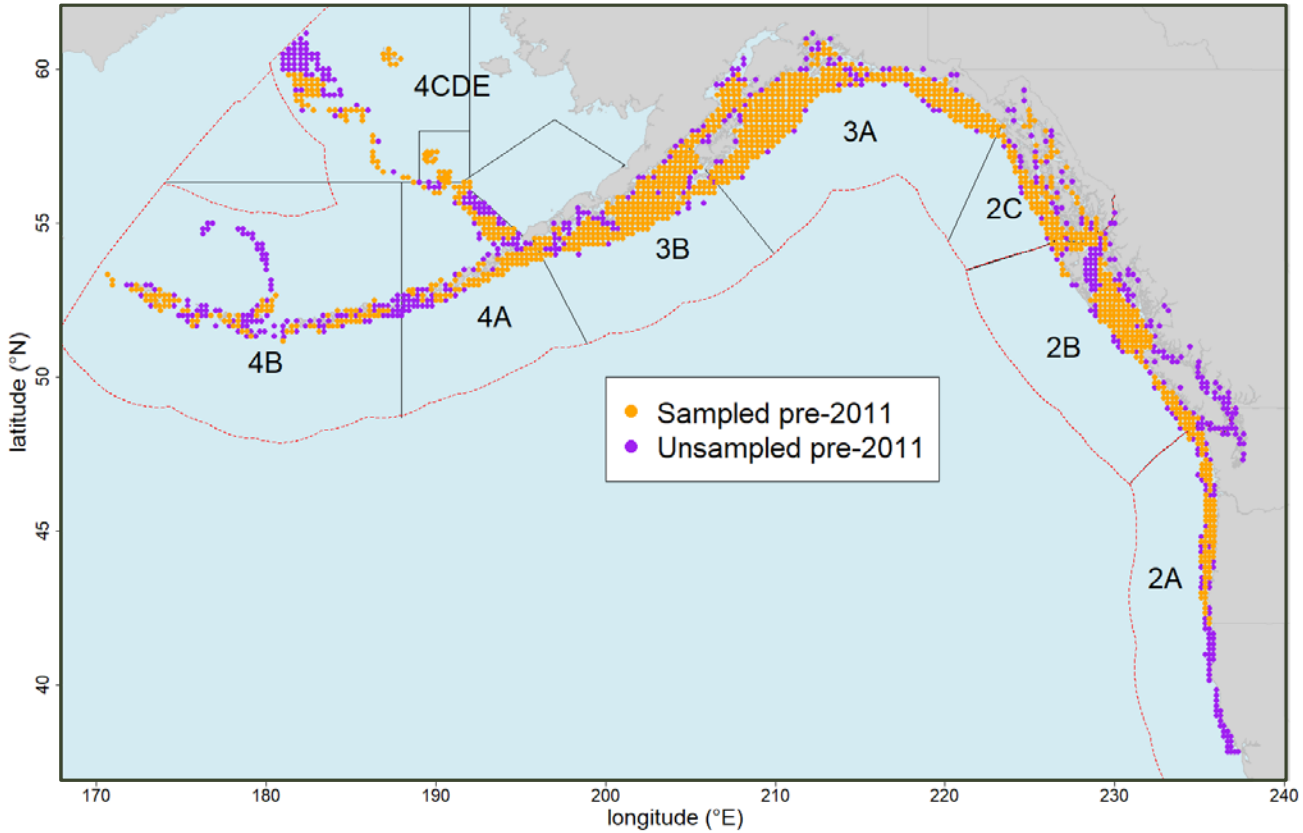
IPHC FISS

- 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 1993-2010

- 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

Pre-2011 FISS design



Expanding the FISS

- The unsampled habitat meant there was the potential for bias in estimates derived from FISS data
- This led the IPHC Secretariat to propose expanding FISS coverage to include the unsurveyed habitat
- Pilot FISS expansions were undertaken in IPHC Regulatory Area 2A in 2011 (deep, shallow waters, other “missing” stations) and 2013 (northern California)
  - The 2011 pilot demonstrated the ability of FISS gear and vessels to sample deep and shallow waters
  - In California, observer and recreational catch data implied the need for a FISS expansion south of the OR/CA border

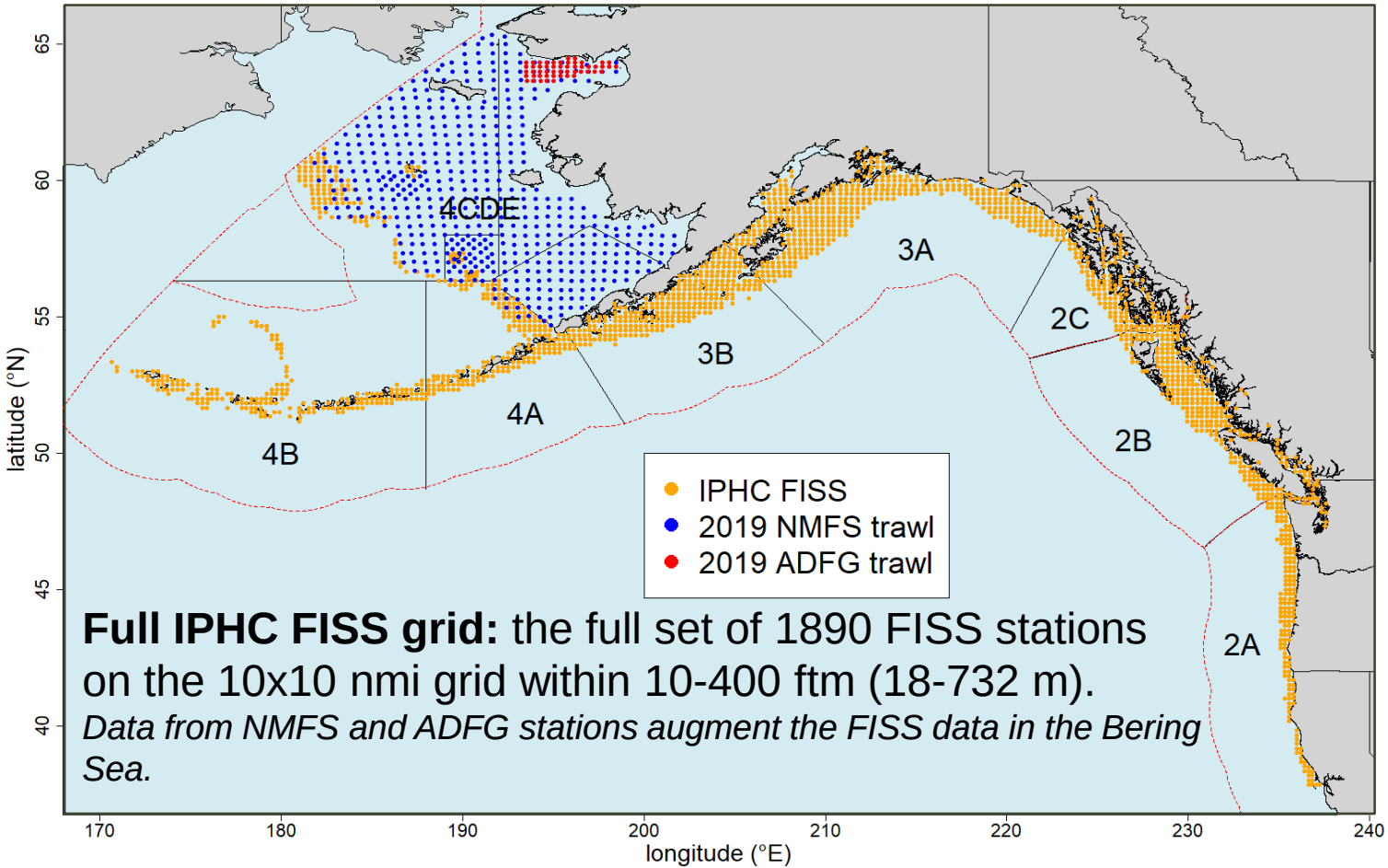
FISS history 2011-2019

- From 2014-19, a planned program of FISS expansions took place in all IPHC Regulatory Areas
- Areas were prioritized for expansion depending on the amount of unsurveyed habitat and the potential for bias in estimates of WPUE and NPUE
- Expansions proceeded as follows (with previously unsampled % of stations):
  - 2014: Regulatory Areas 2A and 4A (42%)
  - 2015: Regulatory Area 4CDE eastern Bering Sea flats
    - Repeat of 2006 FISS/trawl calibration study
  - 2016: Regulatory Area 4CDE shelf edge (62%)
  - 2017: Regulatory Areas 2A (46%) and 4B (55%)
  - 2018: Regulatory Areas 2B (42%) and 2C (25%)
  - 2019: Regulatory Areas 3A (18%) and 3B (19%)

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.

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
    - Gaps previously filled using ad hoc scaling factors based on ratio of averages in surveyed and unsurveyed habitat

Space-time modelling

- Estimates computed for:
  - Biological Regions
  - IPHC Regulatory Areas
  - Coastwide IPHC Convention waters, from San Francisco Bay to Bering Strait

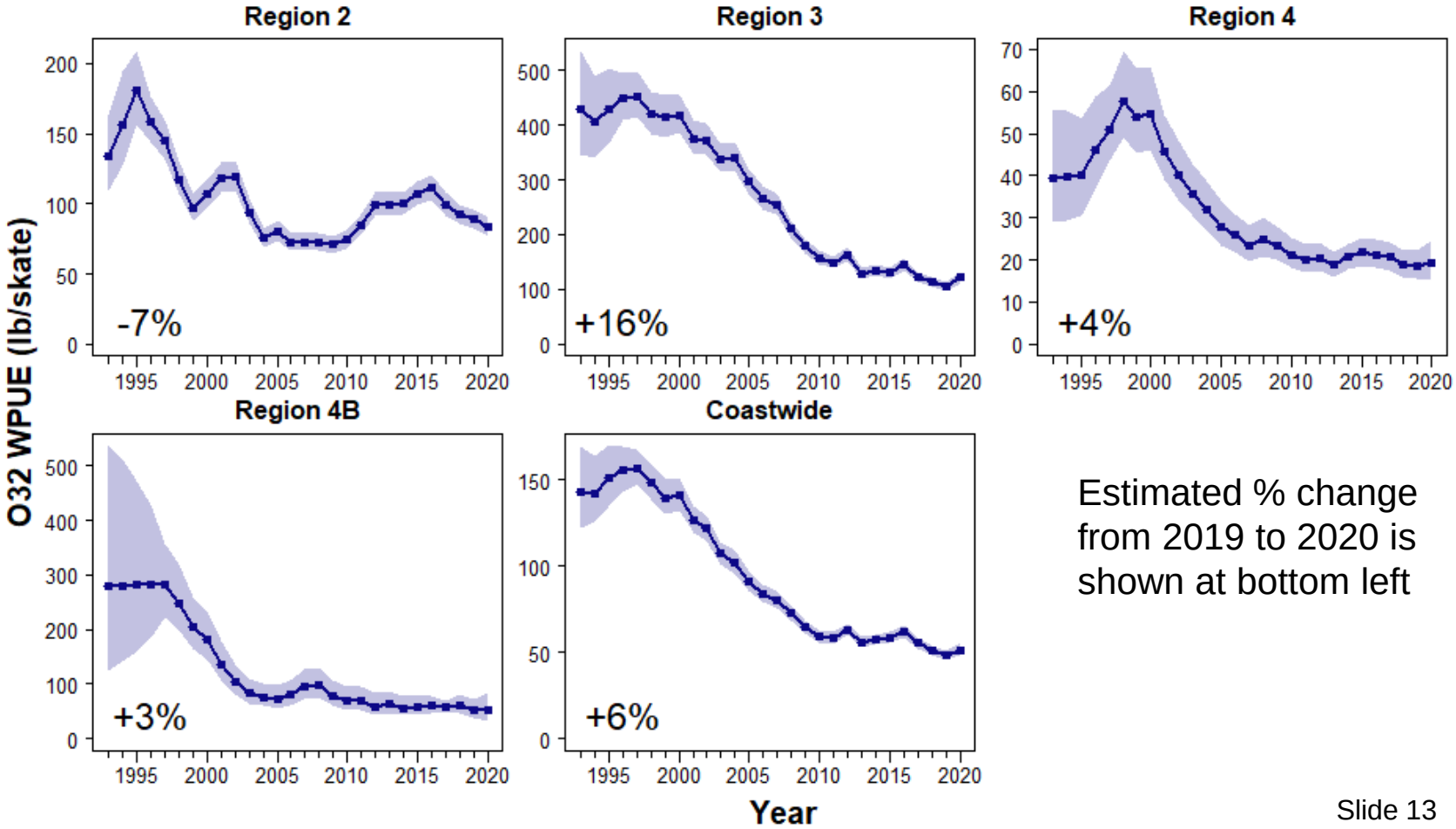
Reviews of space-time modelling methods

- The IPHC's Scientific Review Board (SRB) has repeatedly endorsed the space-time modelling approach, e.g. 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.*

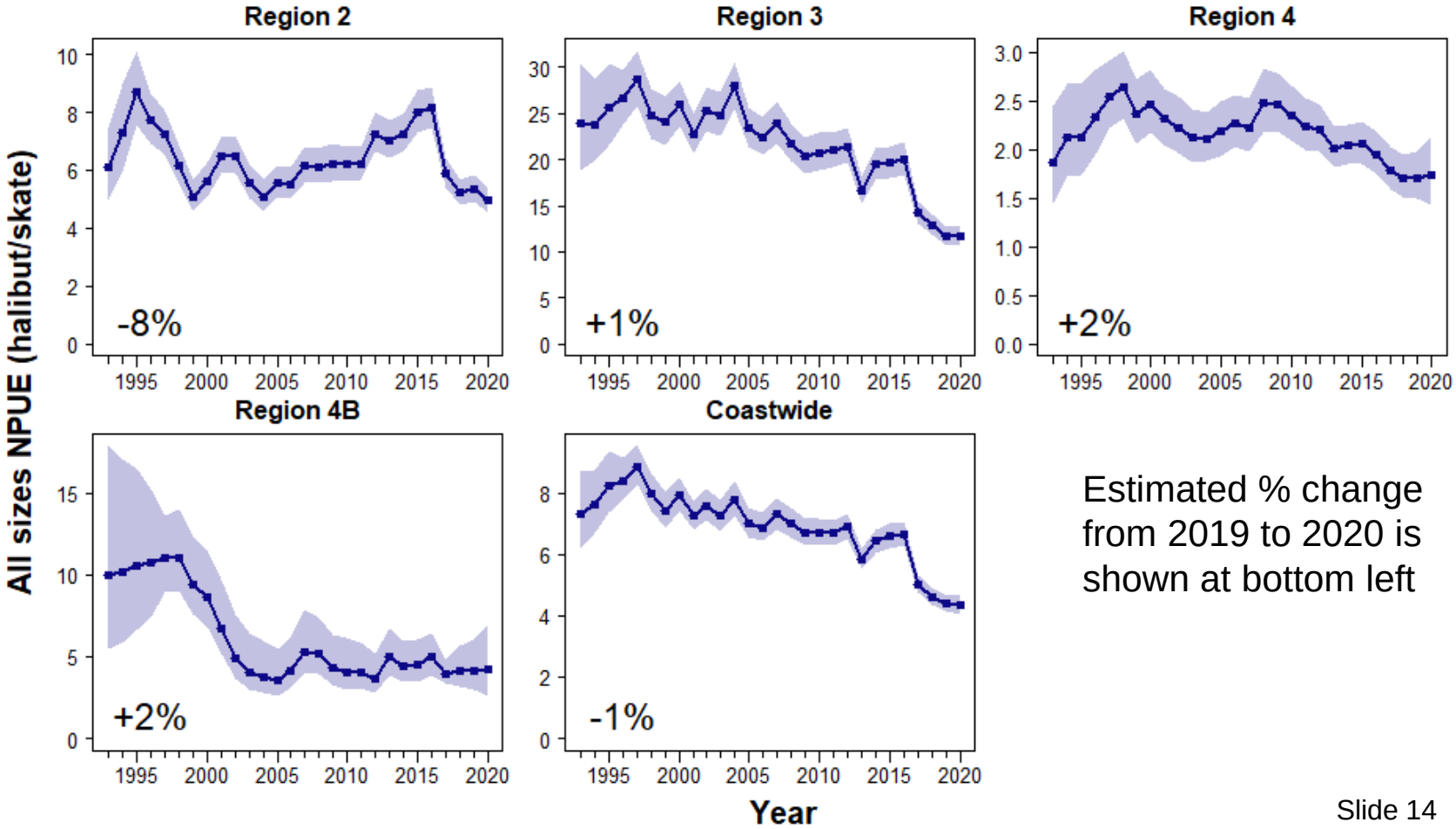
- The space-time modelling methods have been published in a peer-reviewed journal:
  - **Webster et al.** (2020) Monitoring change in a dynamic environment: spatio-temporal modelling of calibrated data from different types of fisheries surveys of Pacific halibut. Can. J. Fish. Aquat. Sci 77(8): 1421-1432

O32 WPUE by biological region



Estimated % change from 2019 to 2020 is shown at bottom left

All sizes NPUE by biological region



Estimated % change from 2019 to 2020 is shown at bottom left

Gear comparison in IPHC Regulatory Area 2B in 2020

- Space-time modelling included parameters allowing for gear differences in catch rates
- Results were generally consistent with the 2019 study in IPHC Regulatory Area 2C
  - Average WPUE and NPUE lower on snap gear (72-83% of fixed gear average; 86% in 2019)
  - Greater uncertainty in this smaller study: all 95% intervals included 100%, i.e. no gear difference in catch rate
- Further studies are being planned to collect additional data
  - to better understand the relative efficiency of the gears
  - to understand potential variability over time and space
- Future modelling will combine data across multiple Regulatory Areas

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

Review process

- Based on these objectives, the IPHC Secretariat developed methods for evaluating potential future FISS designs, and presented proposed designs for review:
  - Evaluation methods were reviewed at SRB014, SRB016 and SRB017
  - Design proposals for 2020-22 were presented at IM095 and AM096, and for 2021-23 at IM096
  - At AM096, Commissioners adopted an enhanced version of one of the proposed designs

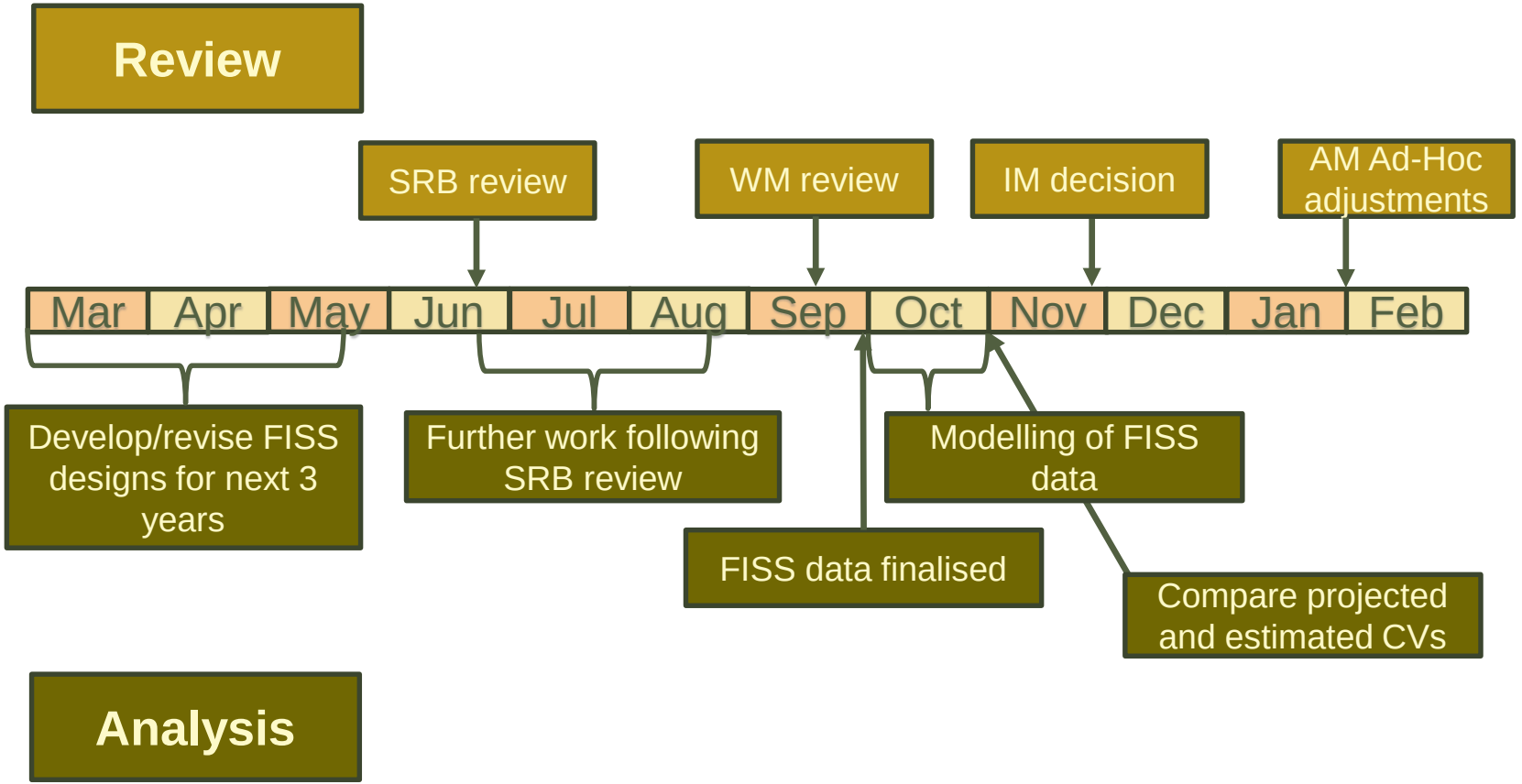
Review process

- Following the completion of the coastwide FISS expansion efforts, 2019/20 was the first year fully rationalised designs could be proposed
- Beginning in 2020, it is expected that the design proposal and review process going forward will be as follows:
  - IPHC Secretariat present design proposals to the SRB for three subsequent years at the June meeting (✓ completed for 2021-23 designs)
  - First review of design proposals by Commissioners at September work meeting, revised if necessary based on SRB input (✓ completed for 2021-23 designs)
  - Presentation of proposed design at the November Interim Meeting for approval (✓ completed for 2021-23 designs)
  - Ad-Hoc modifications possible at Annual Meeting (due to unforeseen issues arising).

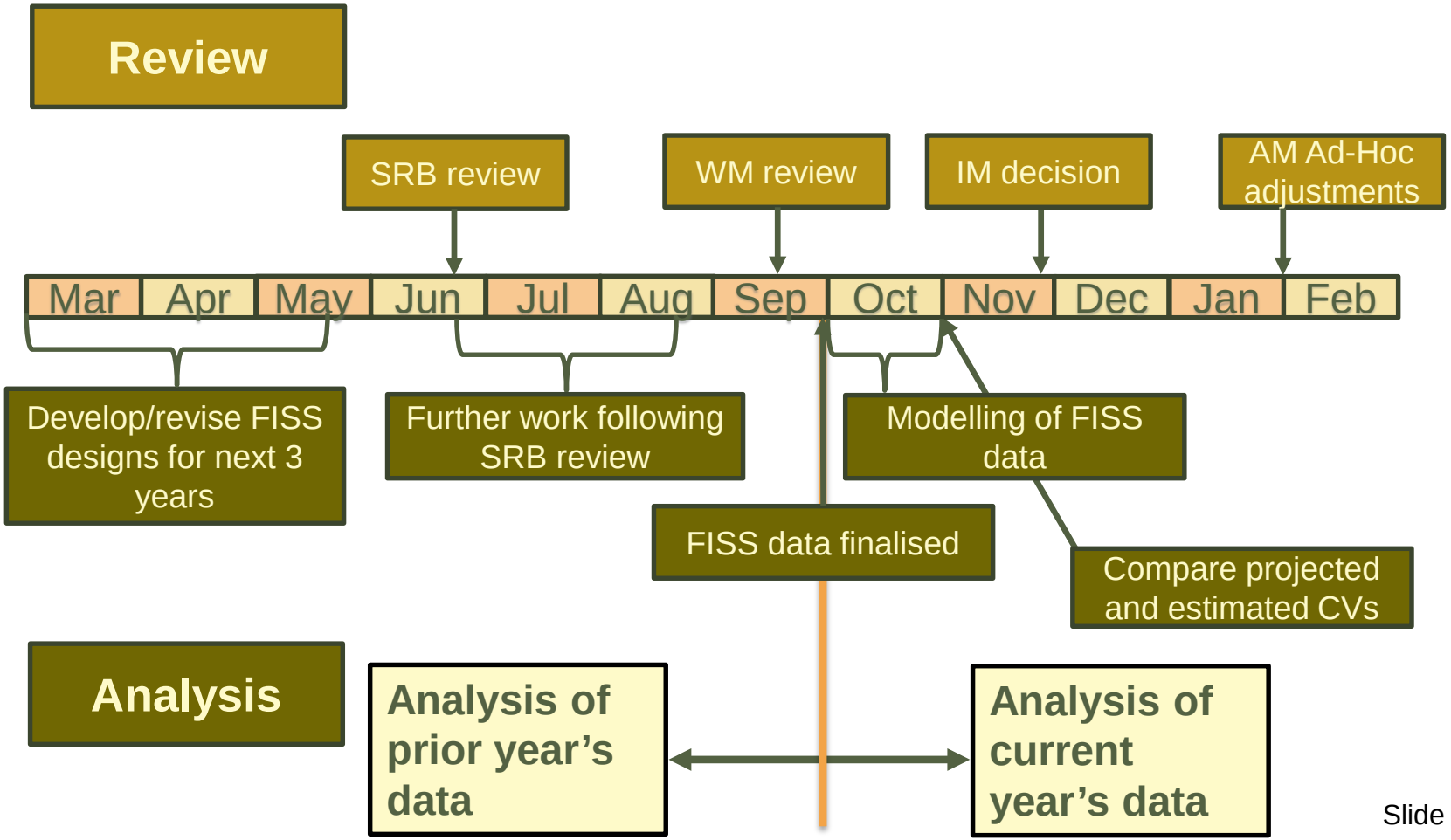
Stakeholder input

- Consultation with industry and stakeholders occurs throughout the FISS planning process
  - Input is particularly valuable in finalizing design details as part of the FISS charter bid process, when stations can be added to provide for improved logistical efficiency.
- We also note the opportunities for stakeholder input during public meetings (Interim and Annual Meetings) and through the IPHC's Research Advisory Board.

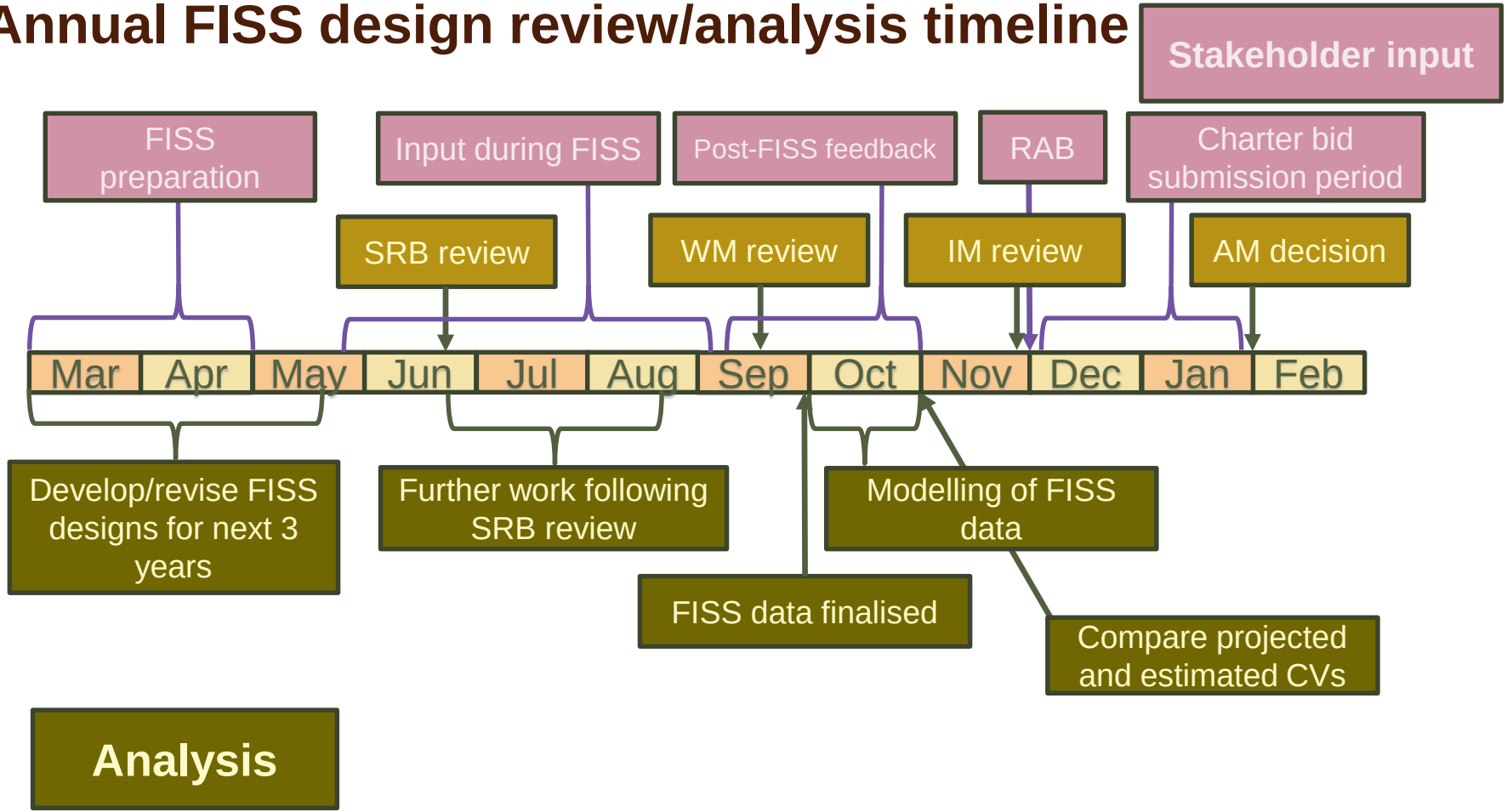
Annual FISS design review/analysis timeline



Annual FISS design review/analysis timeline



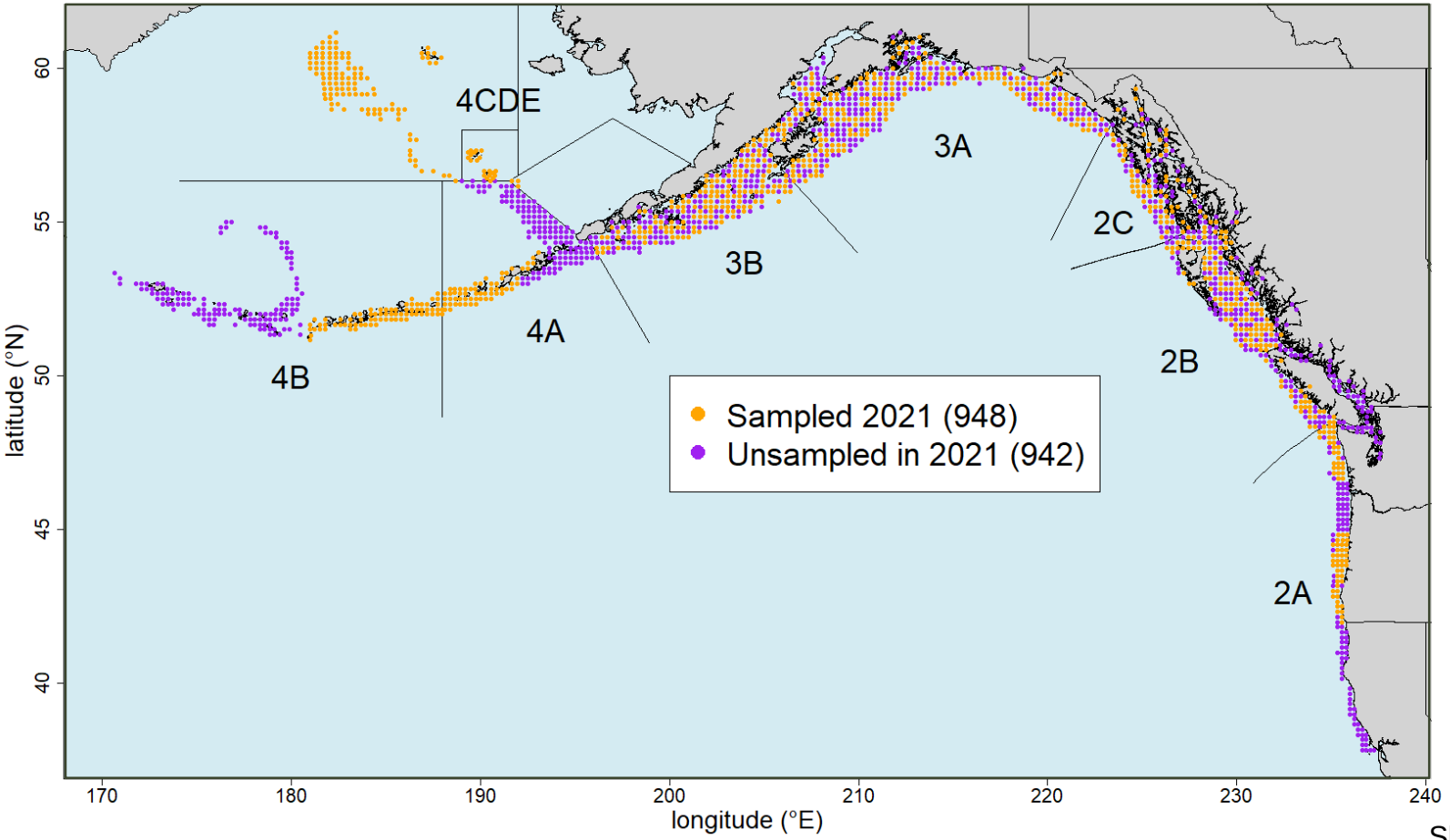
Annual FISS design review/analysis timeline



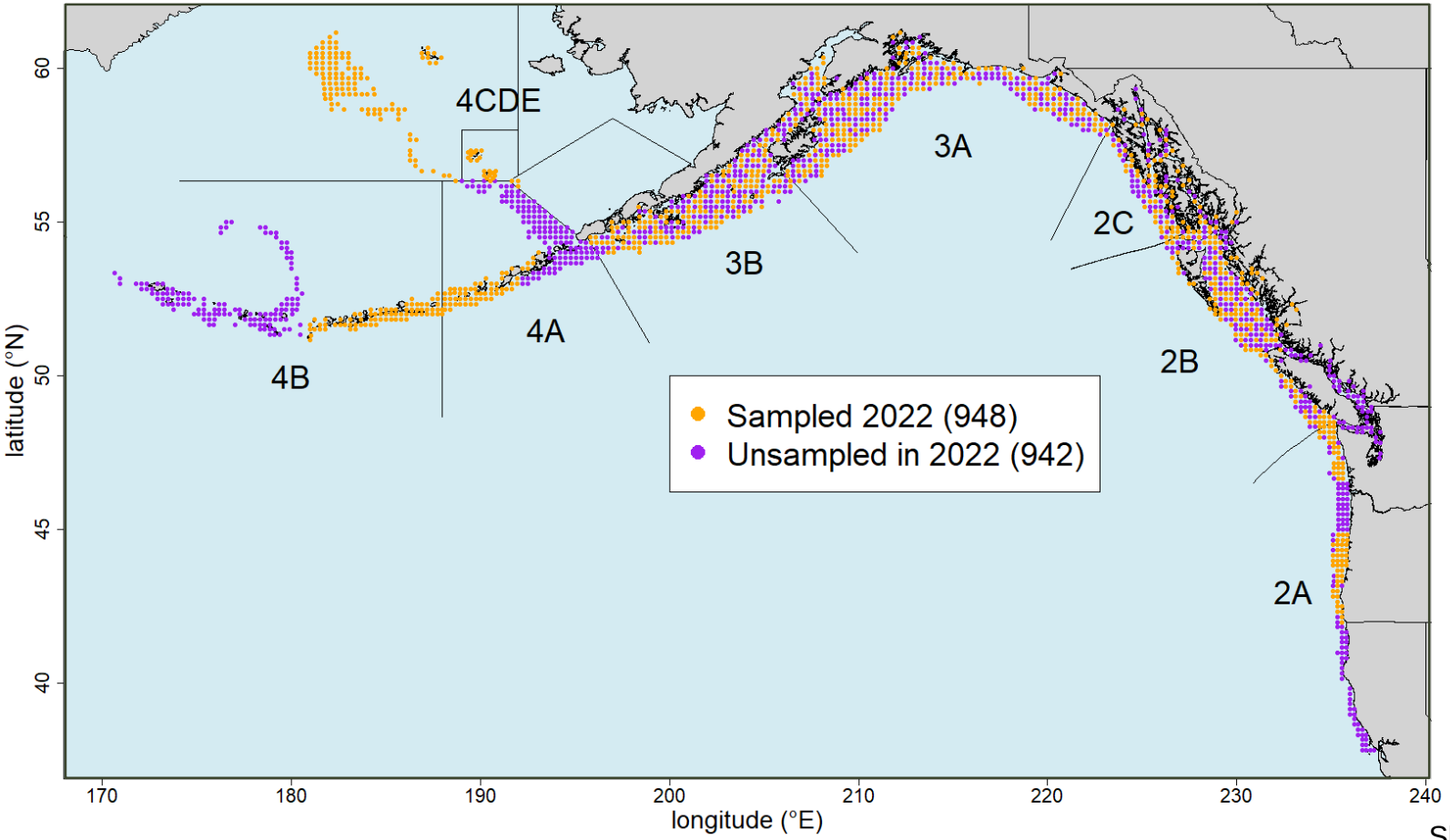
FISS designs for 2021-23

- Due to budgetary constraints and the impact of COVID-19, neither the proposed nor adopted AM096 designs were implemented in 2020
- Instead, sampling was only conducted within the core areas (2B, 2C, 3A and 3B) for the 2020 FISS
- Because of this, our proposal for 2021-23 was to shift the 2020-22 Secretariat-preferred compromise proposal presented at AM096 to instead be implemented in 2021-23
- This design uses efficient subarea sampling in IPHC Regulatory Areas 2A, 4A and 4B, but incorporates a randomized design in IPHC Regulatory Areas 2B, 2C, 3A; and
- It is likely that this design represents the maximum effort that can be deployed outside the core areas in coming years, while still meeting the Secondary Objective.

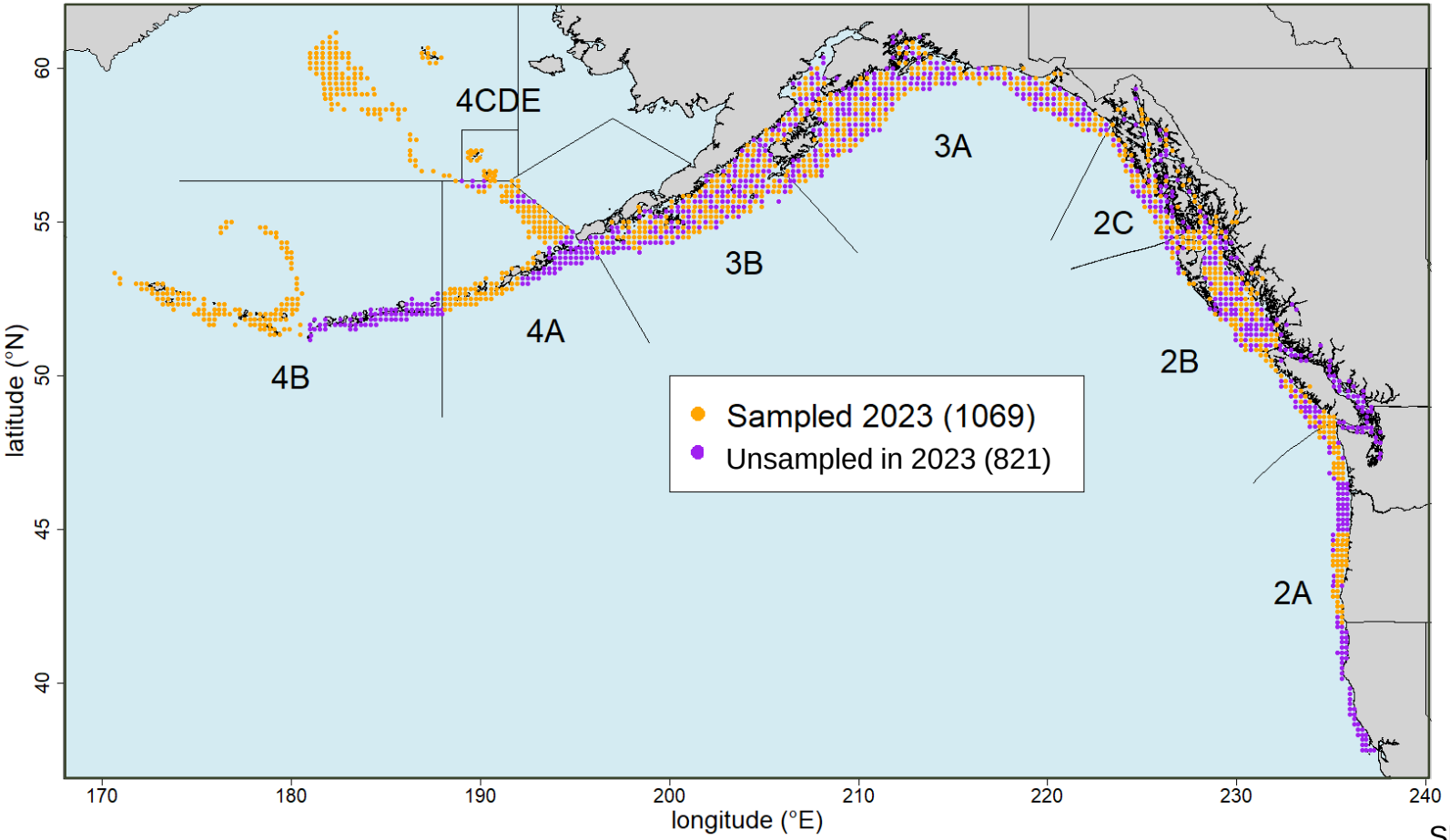
Proposed 2021 FISS design



Proposed 2022 FISS design



Proposed 2023 FISS design



Projected CVs

- The proposed designs have high sampling rates in Regulatory Areas 2B, 2C, 3A, 3B and 4CDE
  - CVs will remain well within limits (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 (%) following completion of the 2023 FISS:

Reg. Area	2020	2021	2022	2023
2A	22	13	13	15
4A	16	9	9	10
4B	16	11	10	13

Scientific Review Board comments

- In its report for SRB017, the SRB stated:

“The SRB RECOMMENDED that the Commission endorse the final 2021 FISS design as proposed by IPHC Secretariat, and provided at Appendix IVa.”;

and

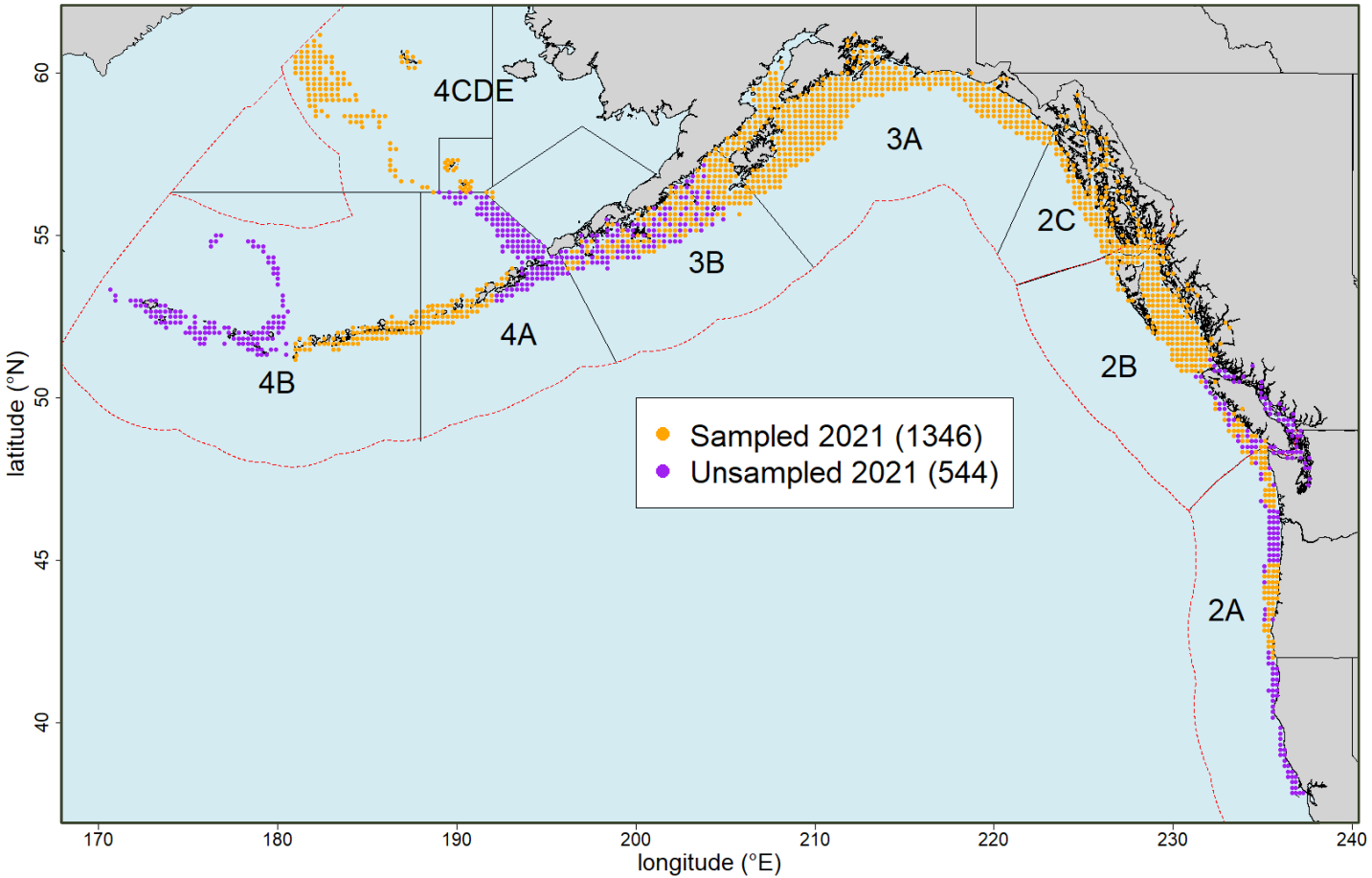
“The SRB provisionally ENDORSED the 2022 and 2023 FISS design proposals provided at Appendix IVb and IVc, recognizing that these will be reviewed again at subsequent SRB meetings.”

Commission decision

- In its Intersessional Decision on Dec 8 2020, the Commission stated:

“IPHC-2020-ID016 (para. 8) The Commission RECOMMENDED that the IPHC Secretariat proceed with an ‘optimised’ version of the ‘minimum 2021 FISS design’, involving adding an additional ~398 stations within the areas covered by the ‘minimum 2021 FISS design’ and where feasible, adding additional skates on each station (Fig. 2). The Commission reserved the right to make ad-hoc adjustments to the 2021 FISS at the 97th Session of the IPHC Annual Meeting (AM097), based on updated information to be provided by the IPHC Secretariat on IPHC Regulatory Areas 4B and 2A.”

Commission-approved design for 2021



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 future frequency of FISS sampling in each subarea that will be incorporated into subsequent design proposals.

Consideration of cost

- The proposed FISS designs for 2021-23 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
- At present, with stocks near historic lows and low prices for fish sales, the current funding model may require that some low-density habitat be omitted from the design entirely, as occurred in 2020
- This will have implications for data quality, particularly if such reductions in effort relative to proposed designs continue over multiple years.

Recommendations

That the Commission:

1) **NOTE** paper IPHC-2021-AM097-07 that proposes FISS designs for 2021-23 for endorsement

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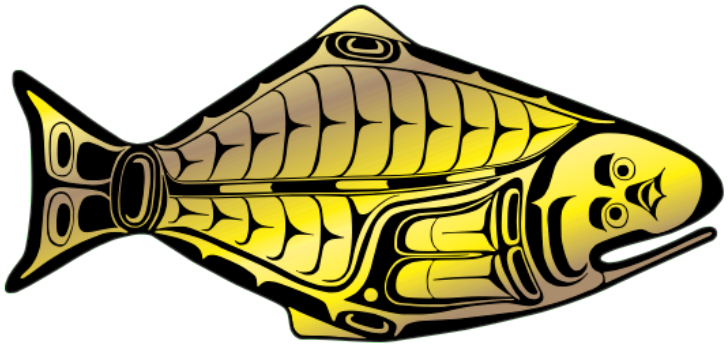

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