INTERNATIONAL PACIFIC

HALIBUT COMMISSION

2025-27 FISS Design Evaluation

Agenda item: 8.1

IPHC-2024-SRB024-06

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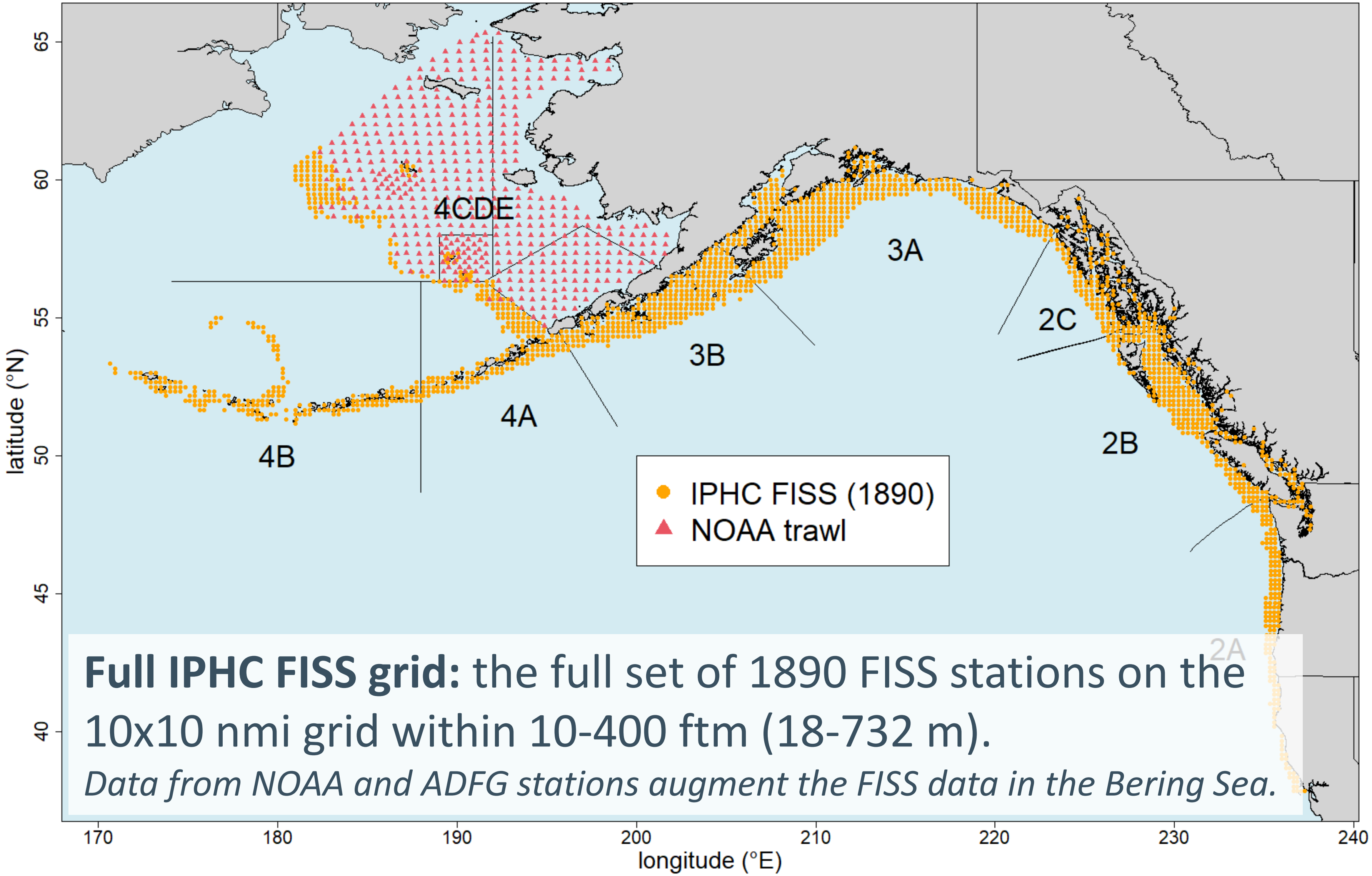
1. FISS Design Evaluation

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
- An annual FISS has been undertaken since 1993
  - Design expanded from 1993-2000 to include sampling in all IPHC Regulatory Areas
  - Further expansion into previously unsampled waters during 2011-2019 period

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 NOAA and ADFG stations augment the FISS data in the Bering Sea.

Finite survey resources

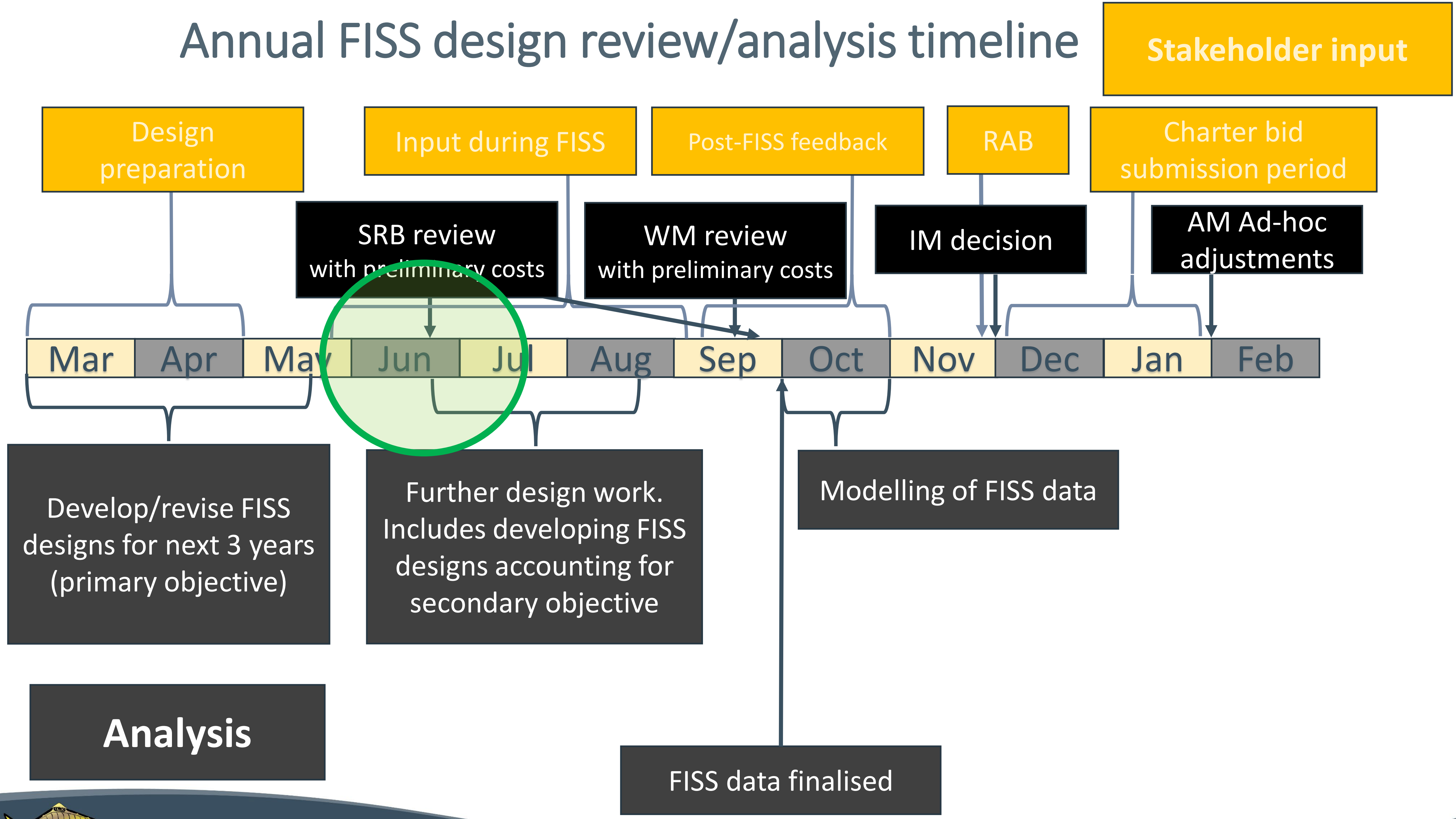
- The full FISS grid cannot be sampled each year
    - Logistically challenging and cost prohibitive
- We prioritize sampling effort based on:

1. **Scientific needs:**
    - Precise estimates of indices of abundance and stock distribution with low potential for bias
    - Requires more frequent sampling in areas with higher variability
2. **Long-term revenue neutrality:**
    - Increase effort in revenue-positive areas to offset cost of sampling low-density habitat
    - Potentially reduce effort in high-cost areas to avoid large deficits

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

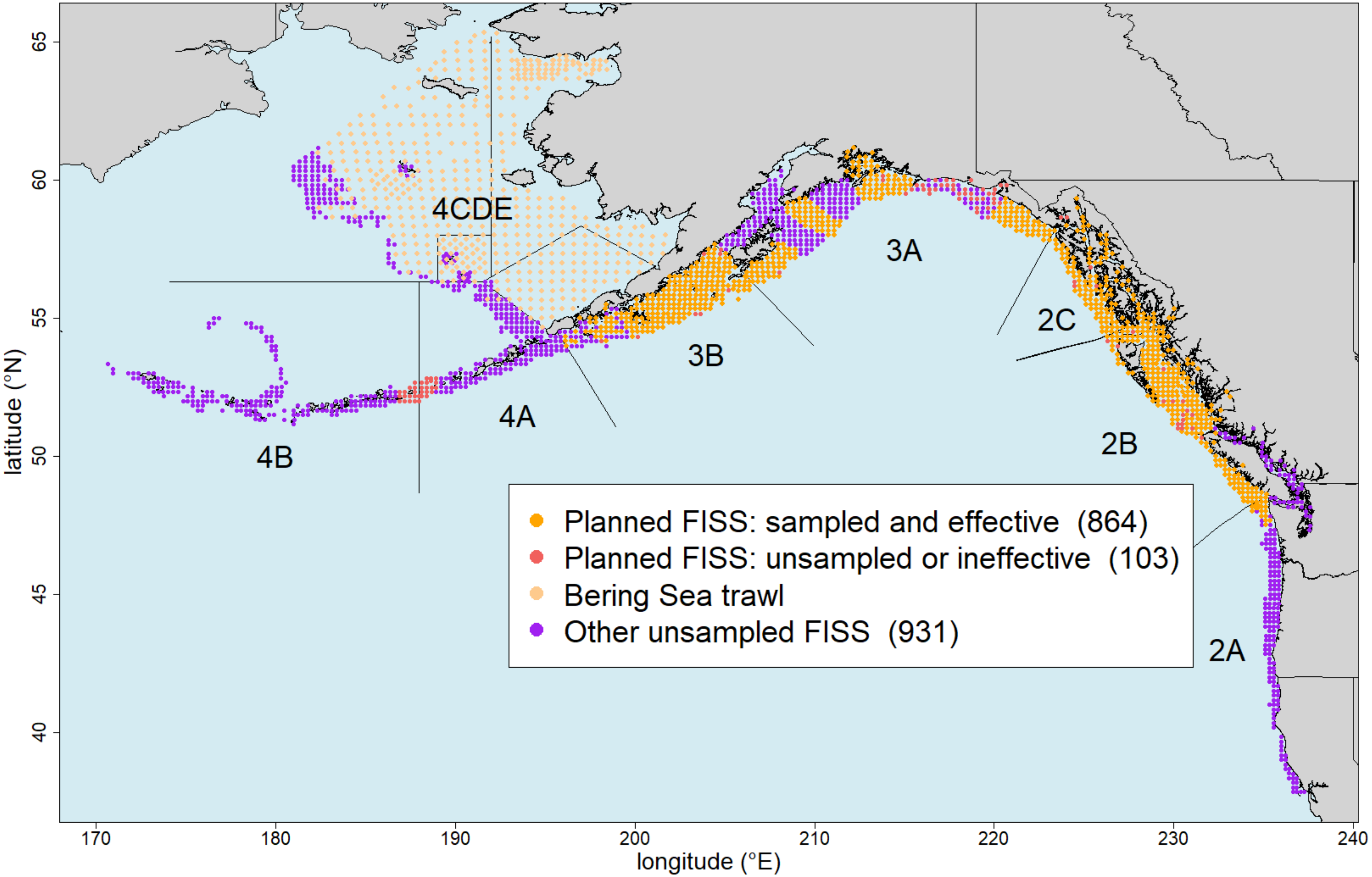
Annual FISS design review/analysis timeline



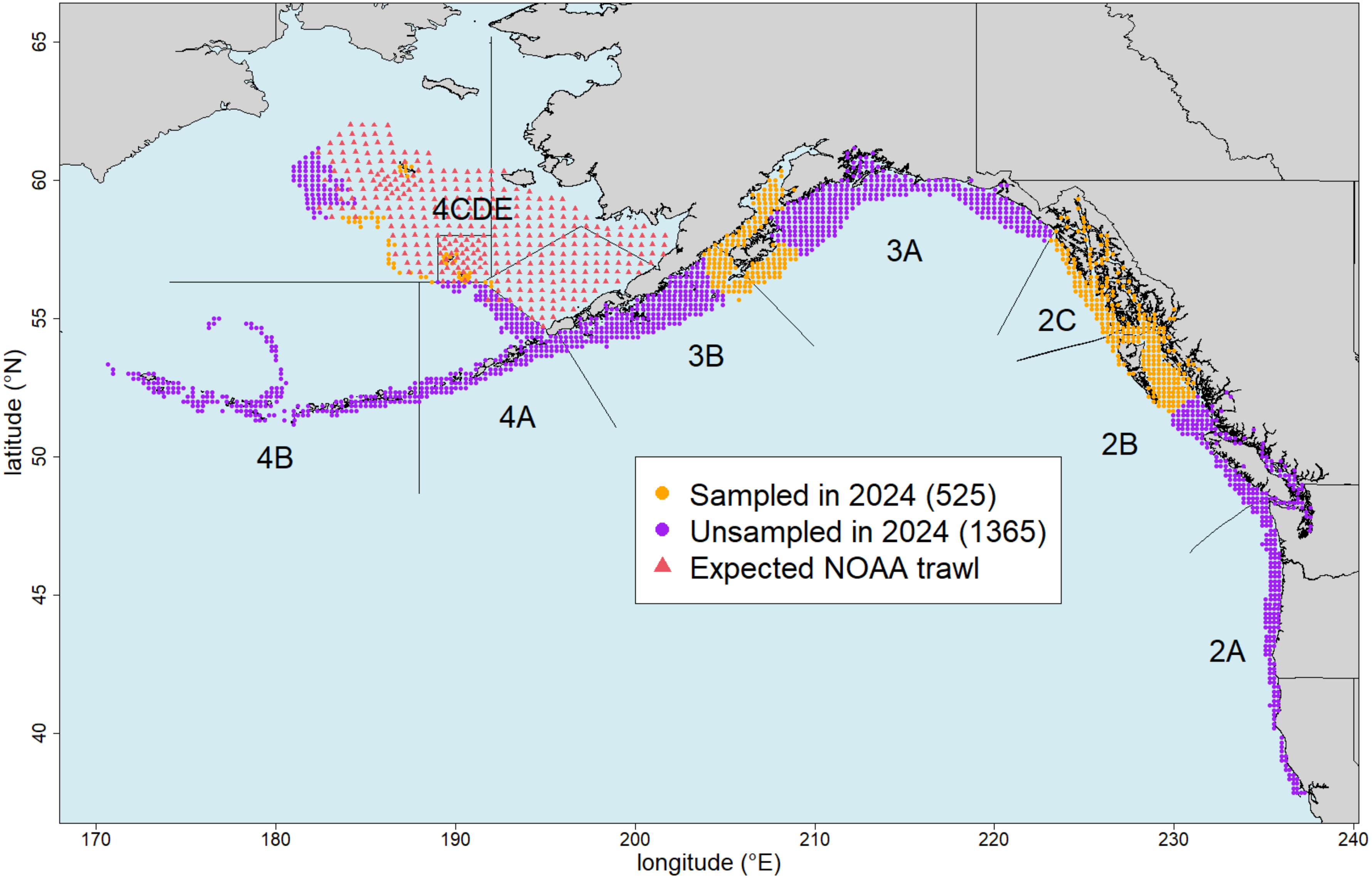
IPHC FISS 2020-24

- 2020: Rationalized FISS design approved
  - Random sampling in core areas (2B, 2C, 3A, 3B)
  - Sampling of blocks of stations elsewhere prioritized to maintain precise estimates with low bias
  - FISS reduced to core areas only due to COVID19
- 2021-22: Proposed design largely implemented
  - Western 4B not sampled in 2022 due to lack of viable bids
- 2023-24: Reduced designs implemented to lower costs
  - Little sampling outside core areas in 2023, with no FISS sampling in 4A, 4B or 4CDE
  - Further reductions in 3A and 3B in 2024, but some sampling in 4CDE

Implemented 2023 design



Adopted 2024 design (with added efficiencies)



Added efficiencies

Aspects of the standard FISS procedures were removed to achieve a revenue-positive design:

- No oceanographic monitoring;
- NOAA Fisheries trawl surveys will not be staffed by the IPHC

Additional changes were made to the standard FISS design in sampled areas with the goal of improving revenue:

- Allow for “vessel captain stations”, in which vessel captains can choose to fish up to one third of their sets at a location that is optimal in terms of catch rates or revenue.
  - We will compare space-time model estimates with and without data from these sets to determine if their inclusion introduces bias
- Use less expensive pink salmon baits on 50% of sets

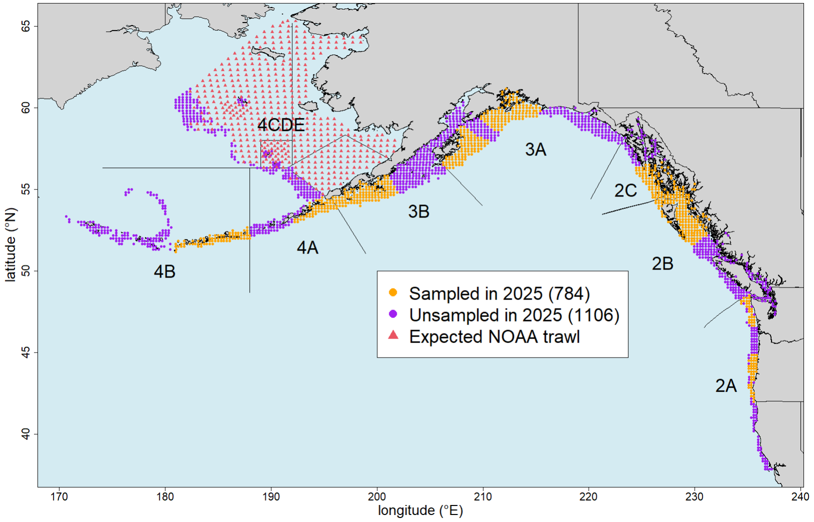
Potential designs for 2025-27

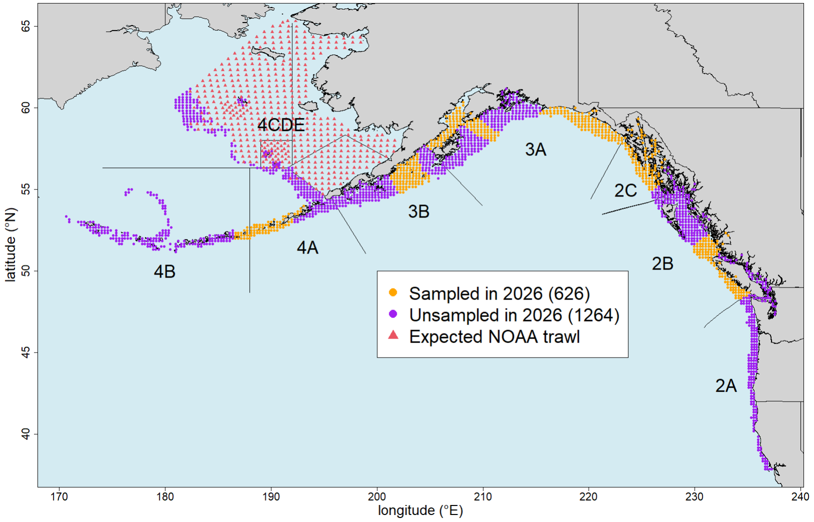
- In recent years, the FISS has fished a random selection of stations in the core IPHC Regulatory Areas (2B, 2C, 3A and 3B).
- This method for station selection was chosen in 2019 over a proposal to instead fish a selection of charter regions as blocks of stations.
- In September 2023, the Commission directed IPHC Secretariat to evaluate potential block designs for future FISS sampling
  - Reduced running time between stations in a block design leads to greater operational efficiency, an important consideration in bringing these designs forward.

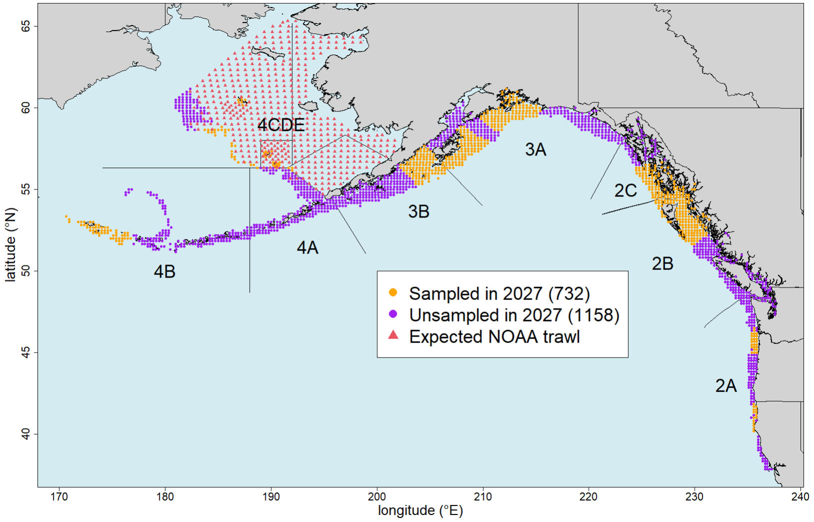
Potential designs for 2025-27

- In 2023, a **Base Block design** was evaluated for the Commission's consideration for 2024-26, and is presented here for 2025-27
  - Prioritizes some annual sampling in each Biological Region for stock assessment purposes.
  - Ensures all charter regions in the core of the stock (2B, 2C, 3A and 3B) are sampled over a three-year period
  - Coverage in other areas is prioritized to minimize bias potential and maintain CVs below 25%
- The sampled blocks (charter regions) are rotated over time.

Base block designs 2025-27



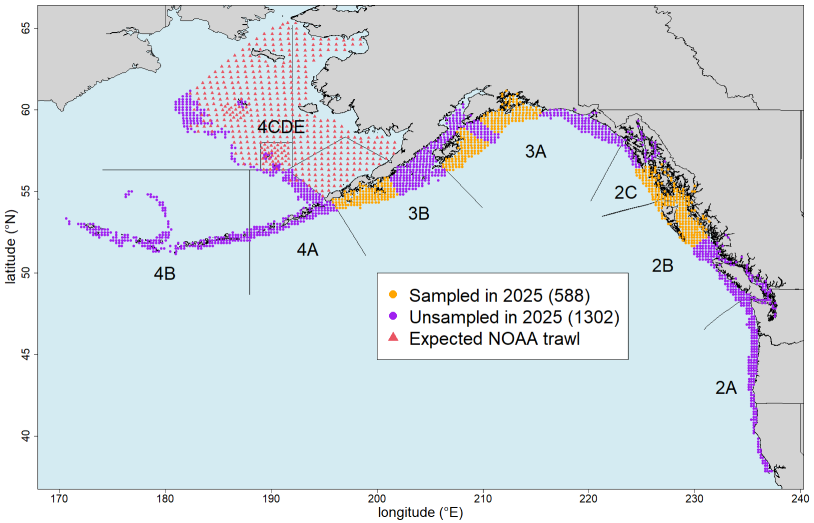


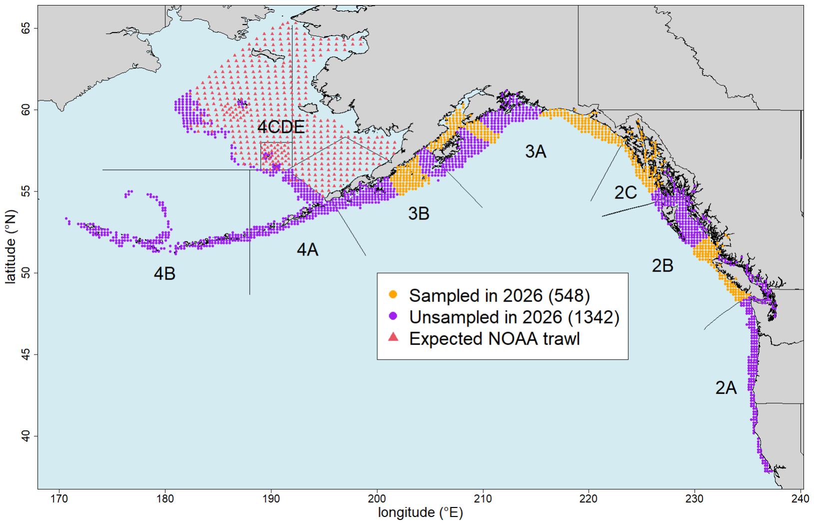


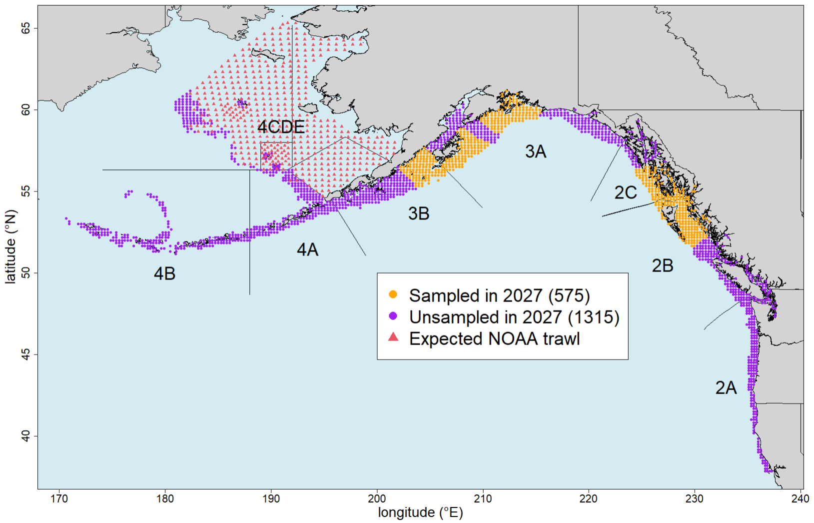
Designs that reduce net losses

- The Base Block design is projected to result in a substantial operating loss for the FISS and would require supplementary funding
- Therefore, we compare this design with two others that would achieve lower net costs through reduced spatial coverage:
  - **Core Block design:** Maintain the same rotating block coverage in the core IPHC Regulatory as the Base Block design but remove sampling outside of the core areas.
  - **Reduced Core design:** Sample only the FISS charter regions in the core areas that are planned for 2024 as these are likely to result in relatively low net losses for the FISS overall.
    - While the more profitable charter regions will vary over time, this design is intended to be representative of similar low-coverage designs.

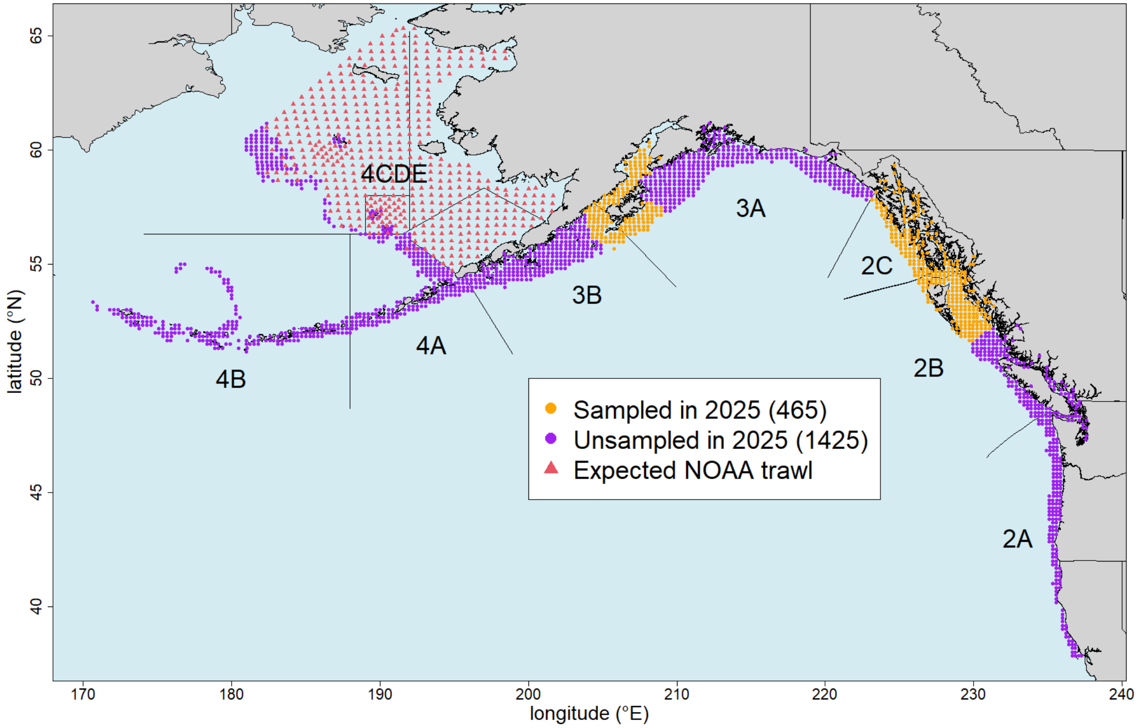
Core Block designs 2025-27







Reduced Core design: same design 2025-27



Projected coefficients of variation* (CVs)

Regulatory Area	Base Block			Core Block			Reduced Core		
	2025	2026	2027	2025	2026	2027	2025	2026	2027
2A	17	22	23	29	29	31	29	31	34
2B	8	10	7	8	10	7	9	9	9
2C	6	6	6	6	6	6	5	5	5
3A	9	7	7	9	7	7	11	13	15
3B	13	12	15	13	12	15	19	21	26
4A	19	13	20	26	29	33	28	31	33
4B	15	20	18	35	39	44	35	39	44
4CDE	8	8	8	8	9	9	8	9	9
Biological Region									
Region 2	5	6	5	5	6	5	5	5	6
Region 3	7	7	8	7	7	8	10	12	14
Region 4	8	7	9	11	12	14	11	14	15
Region 4B	15	20	18	35	39	44	35	39	44
Coastwide	4	4	4	5	5	6	6	7	8

* For terminal year of time series. Projected using IPHC's space-time modelling.

Evaluation of potential designs

- **Base Block design**:
  - Projected terminal year CVs 25% or less for all IPHC Regulatory Areas; 15% or less for core areas (2B, 2C, 3A and 3B).
  - All Biological Region CVs except Region 4B projected below 10%.
  - Coastwide CV is projected to be 4% in all years.
  - Therefore, this design is **projected to maintain precise estimates** of indices of Pacific halibut density and abundance across the range of the stock.
  - By rotating the sampled blocks, almost all FISS stations are sampled within a 5-year period (2-3 years within the core areas) resulting in **a low risk of large bias** in estimates of trend and stock distribution.

Evaluation of potential designs

- **Core Block design**:
  - Projected terminal year CVs of 15% or less for core areas (2B, 2C, 3A and 3B).
  - CVs rapidly increasing to 31-44% by 2027 for 2A, 4A and 4B.
  - This also leads to increasing CVs in Biological Regions 4 and 4B.
  - This design is **not projected to maintain precise estimates** of indices of Pacific halibut density and abundance outside the core of the stock.
  - With a large proportion of the stock unsampled for 2025-27, **the risk of bias also increases over time** in unsampled areas and regions, as well as coastwide.
    - Bias expected in age composition information, as well as stock trend and distribution estimation

Evaluation of potential designs

- **Reduced Core design**:
  - Projected terminal year CVs of 10% or less in 2B and 2C
    - These are the only areas with spatially extensive sampling
  - CVs increasing annually to 15 and 26% by 2027 in 3A and 3B due to limited sampling.
  - CVs rapidly increasing to 33-44% by 2027 for 2A, 4A and 4B.
  - Leads to steadily increasing coastwide CVs and for all IPHC Biological Regions except Region 2.
  - This design is **not projected to maintain precise estimates** of indices of Pacific halibut density and abundance outside of Region 2.
  - **Very high risk of bias** in coastwide and regional estimates of density and distribution due to very large unsampled proportion of the stock.
    - Bias also expected in age composition information

Preliminary net revenue projections for 2025

Assumptions:

1. Designs are optimized for numbers of skates, with 4, 6 or 8 skate-sets used, depending on projected catch rates and bait costs.
2. 2025 Pacific halibut price and catch rates decline by 5% per year from those used to develop the 2024 design.
3. Chum and pink salmon bait each continue to be used on approximately 50% of the stations and prices remain similar to those for 2024.

Design	With Seacat*	Without Seacat
Base Block	$1,542,000	−$1,407,000
Core Block	−$900,000	−$805,000
Reduced Core	−$644,000	−$569,000

* For oceanographic monitoring

Discussion

- Depending on the level of available supplementary funding and Commission priorities during Interim and Annual meeting decision making process, we can anticipate the adopted FISS design for 2025 to differ in spatial scope from the **Base Block design**.
- Like the adopted 2024 FISS design, the **Core Block and Reduced Core designs** will result in less information available for the annual stock assessment and management supporting calculations such as stock distribution than in years prior to 2024:
  - The increased uncertainty in the index of abundance is likely to cause the assessment model to rely more heavily on the commercial fishery catch-per-unit-effort index.
  - Limited biological information from Biological Region 3 makes it unclear whether the stock assessment will detect a major change in year class abundance.
  - Basic stock assessment methods can remain unchanged, but a greater portion of the uncertainty in stock trend and demographics will not be quantified due to missing FISS data from a large fraction of the Pacific halibut stock's geographic range.
  - The implications for the assessment would be of increasing concern if Core Block or Reduced Core designs were implemented beyond 2025 due to increasing uncertainty and risk of bias in stock trend estimates and the unrepresentativeness of the biological samples.
  - Reduced stakeholder confidence in the FISS results and in the aggregate scientific information from the stock assessment (as was already evident at AM100) will result from FISS designs that do not fully inform stock distribution with annual sampling in all IPHC Regulatory areas.

Recommendation

That the Scientific Review Board:

1. **NOTE** paper IPHC-2024-SRB024-06, which presented an evaluation of design options for 2025-27, including options accounting for the secondary FISS objective of long-term revenue neutrality;
2. **ENDORSE** the Base Block design for 2025 (Figure 1.4 of IPHC-2024-SRB024-06) provided that sufficient supplementary funding is available to cover the projected net revenue loss.

2. Modelling Updates

Background

- At SRB021, the Scientific Review Board recommended that the Secretariat explore other parameterizations of the space-time model used for modelling Pacific halibut survey catch rates. From paragraph 20 in IPHC-2022-SRB021-R:
  - *“**NOTING** that the ‘hurdle’ model structure (separate modeling of presence/absence and abundance conditional on presence) of the space-time model used to analyze the FISS may not be the most efficient approach, the SRB **RECOMMENDED** that the Secretariat explore other approaches such as the use of mixture models or the ‘Tweedie’ distribution.”*

Background

- The current 'delta-gamma' model accounts for the probability of zero catch and the distribution of non-zero catch rates through two model components, linked by a common spatio-temporal correlation structure:
    - A Bernoulli process for probability of zero
    - A gamma process for non-zero values
- Covariates are included in both model components, increasing model complexity relative to alternative parameterisations
- The Tweedie model as implemented in R-INLA is a compound Poisson-gamma model
- Zeros and non-zeros are modelled together, and it therefore requires fewer parameters when covariates are included

Background

- At SRB023, we presented promising results from fitting the Tweedie model to all sizes WPUE data from three IPHC Regulatory Areas
- Here we compare common model parameter estimates, the DIC measure of model fit, and estimated time series for O32 WPUE data for all IPHC Regulatory Areas.

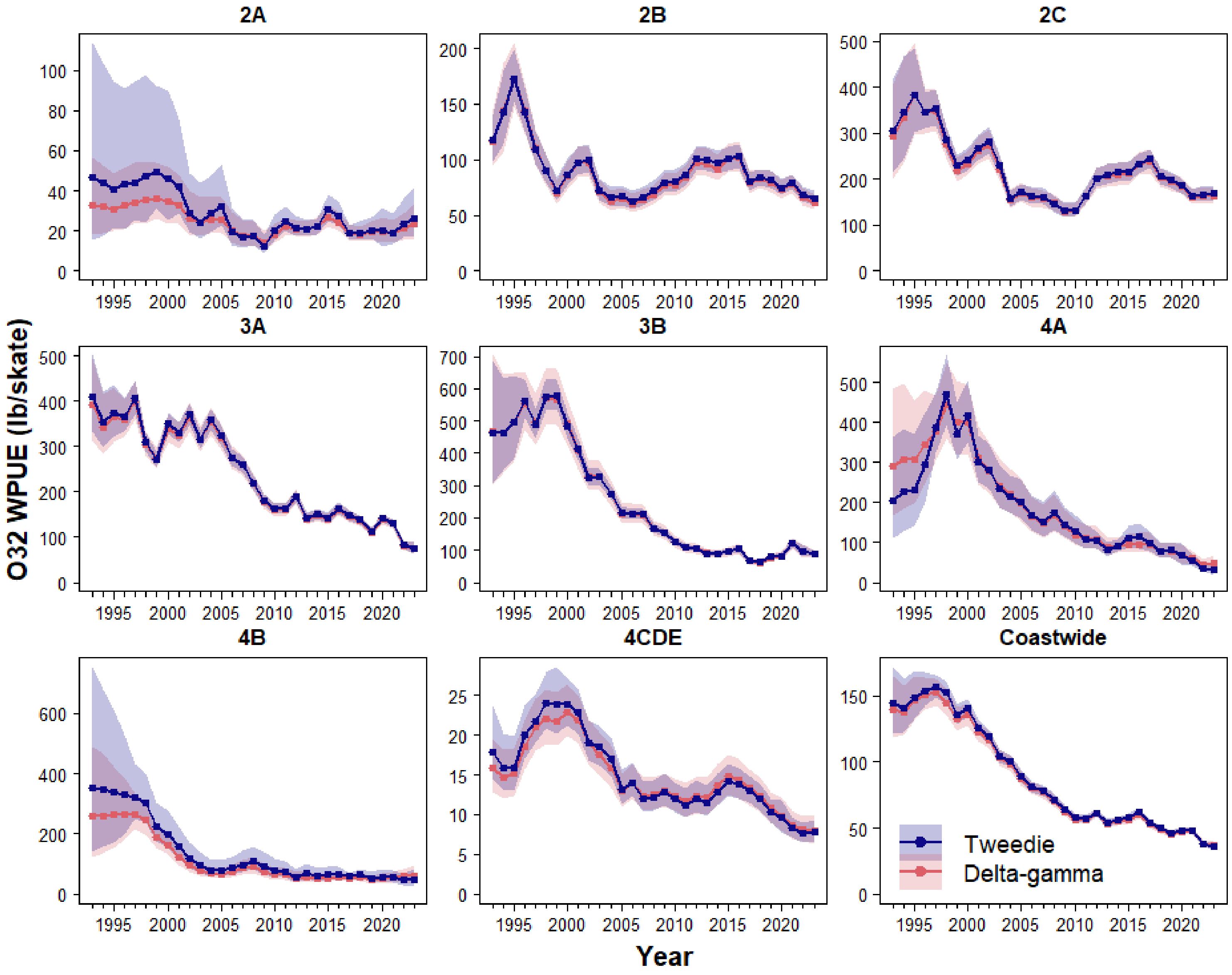
Results

- Model parameters:
  - Both Tweedie and delta-gamma models yielded similar estimates (posterior means and SDs) of parameters they had in common.
- Model fit:
  - DIC values were greater for the Tweedie model for almost all IPHC Regulatory Areas, implying poorer model fit to the data.

Reg. Area	DIC Delta-gamma	DIC Tweedie	Difference*
4CDE	72 091.8	74 157.6	-2 065.7
4B	21 878.2	21 927.8	-49.6
4A	41 672.5	42 188.2	-515.7
3B	86 994.3	86 979.7	14.6
3A	148 692.7	148 741.8	-49.1
2C	55 653.8	55 816.9	-163.2
2B	81 323.8	81 453.4	-129.7
2A	23 582.9	23 763.9	-181.0

* Negative value means Tweedie had poorer fit

Results


2A
2B
2C
3A
3B
4A
4B
4CDE
Coastwide
O32 WPUE (lb/skate)
Year
Tweedie
Delta-gamma

Discussion

- Current model results do not support changing to the Tweedie model for the production version of the IPHC's space-time model.
- We will continue to investigate the usefulness of the Tweedie and other model improvements in future work.

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