INTERNATIONAL PACIFIC HALIBUT COMMISSION

2026-31 FISS design evaluation and modelling updates

Agenda item 4.2.2

IPHC-2026-SRB029-08

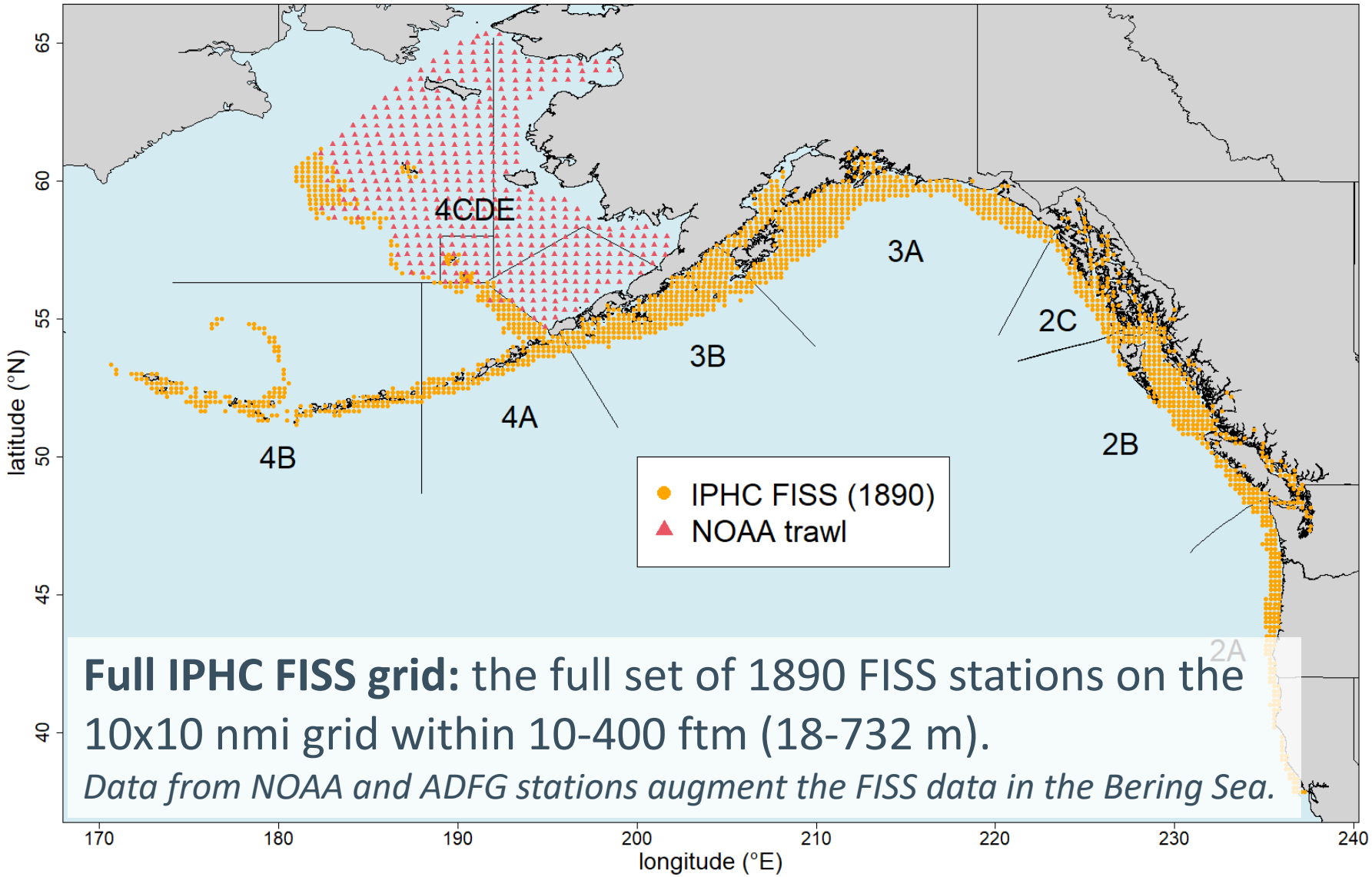
(R. Webster, I. Stewart, K. Ualesi, D. Wilson)



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

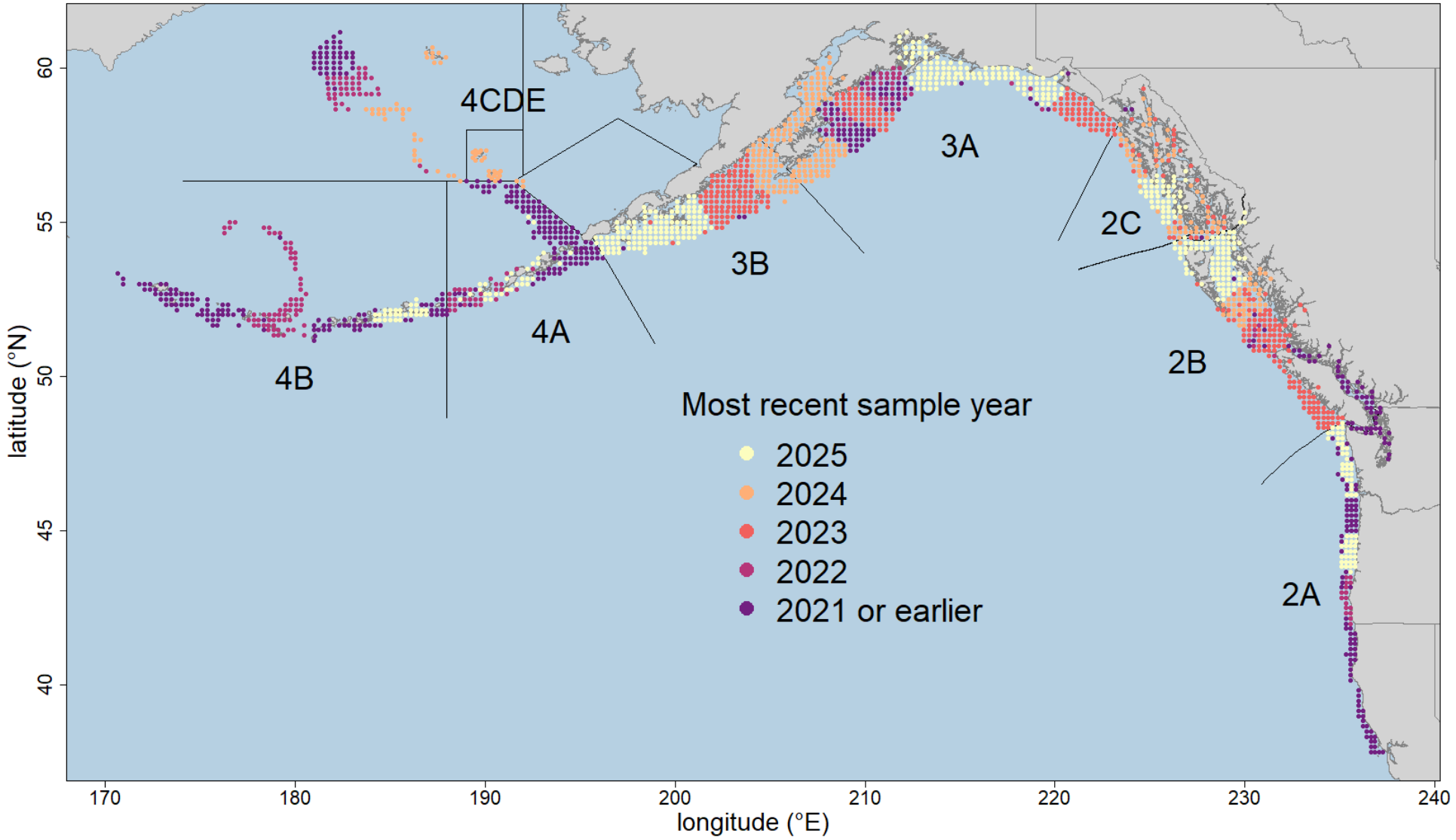
Full FISS grid



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.

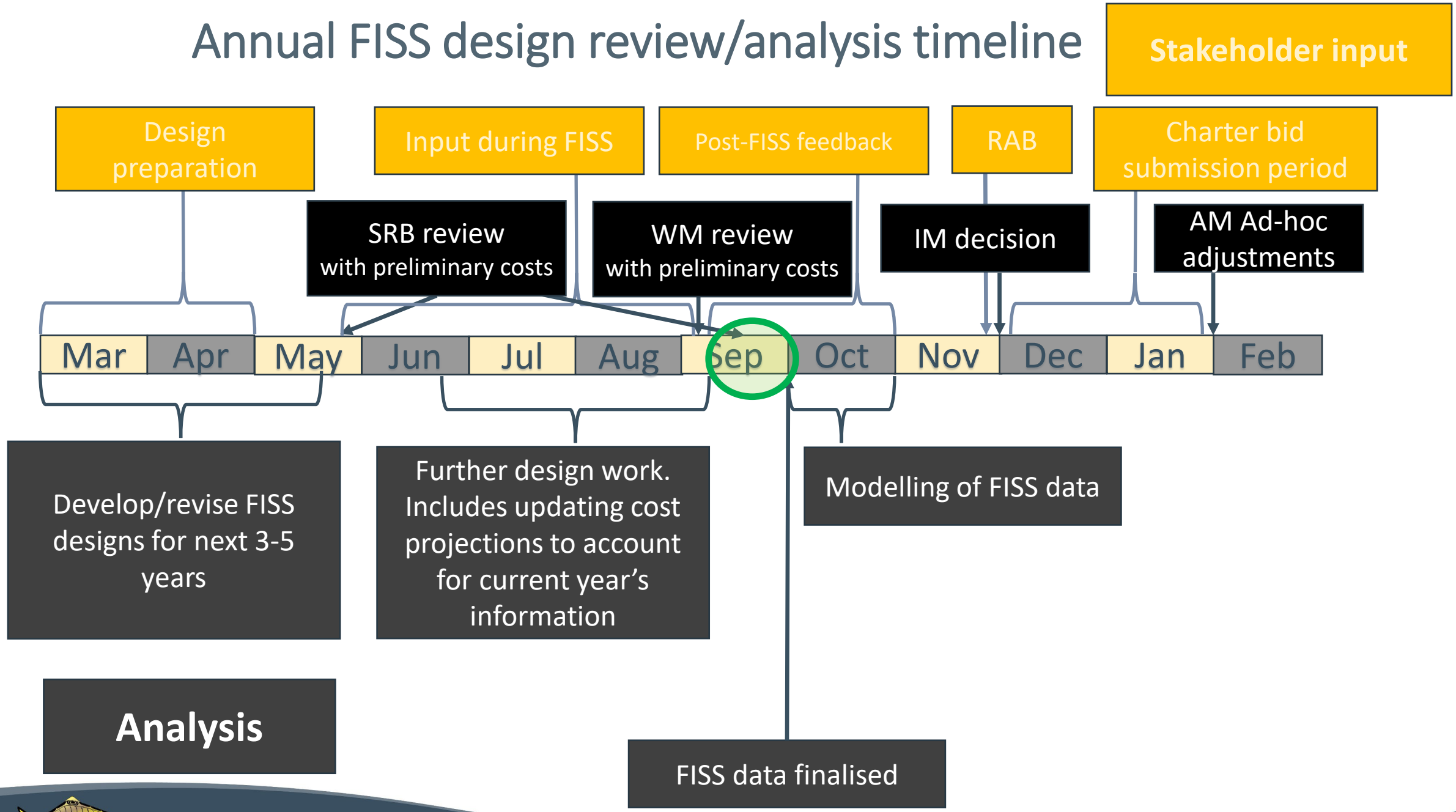
Most recent sampling year by station



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	Cost effectiveness without compromising the scientific integrity of the FISS design.	Balance operational feasibility/logistics, cost/revenue, and scientific needs. Includes an aspirational target reserve of US$4,000,000.
Tertiary	Minimize removals, assist others where feasible on a cost-recovery basis, address specific Commission informational needs.	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

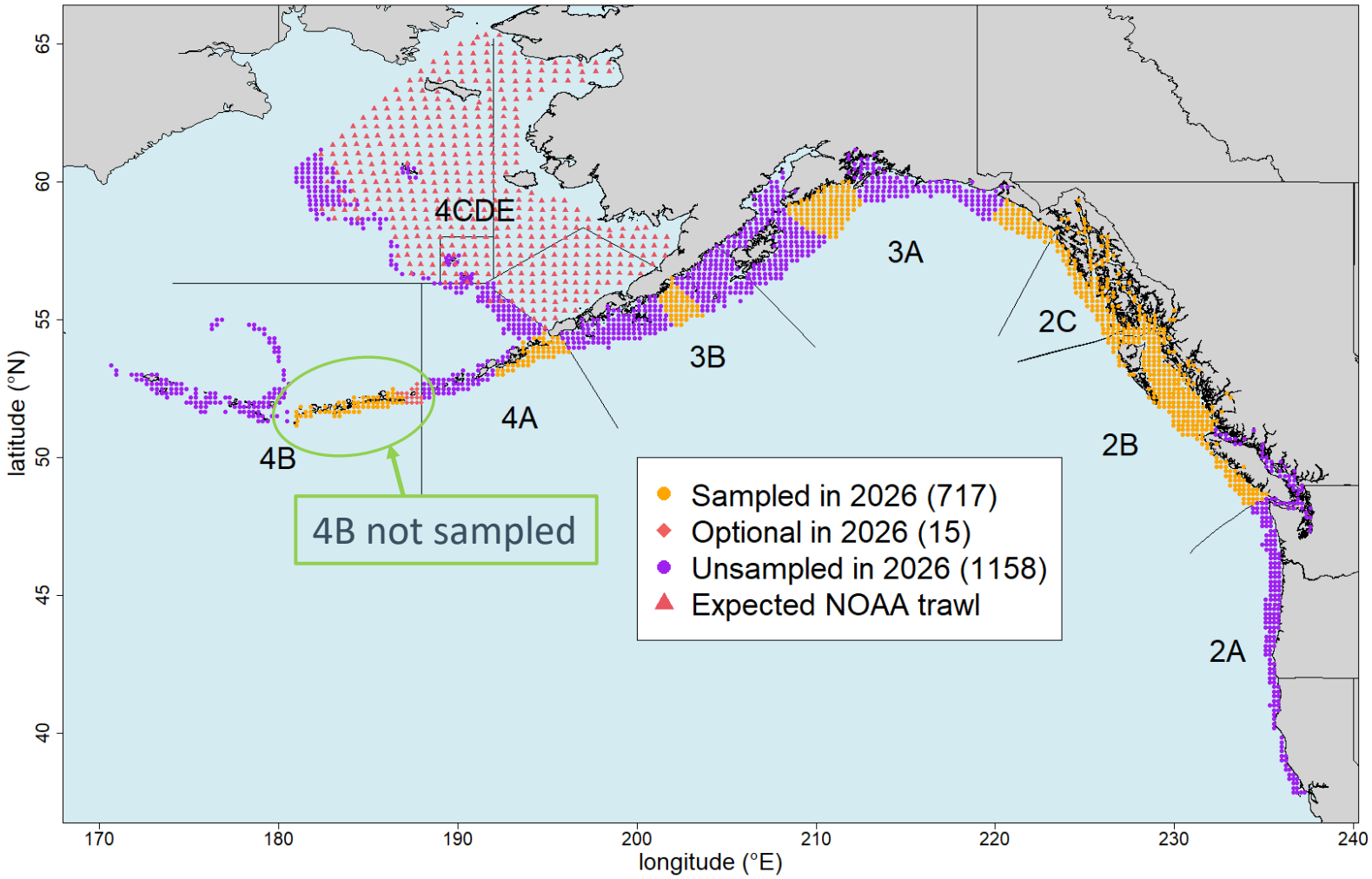


IPHC FISS 2020-25

- 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
- 2023-25: Reduced designs implemented due to financial constraints
  - 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
  - 2025 sampling in 3A and 3B to complement 2023-24 sampling; sampling higher density parts of 2A and 4A/4B for first time since 2022

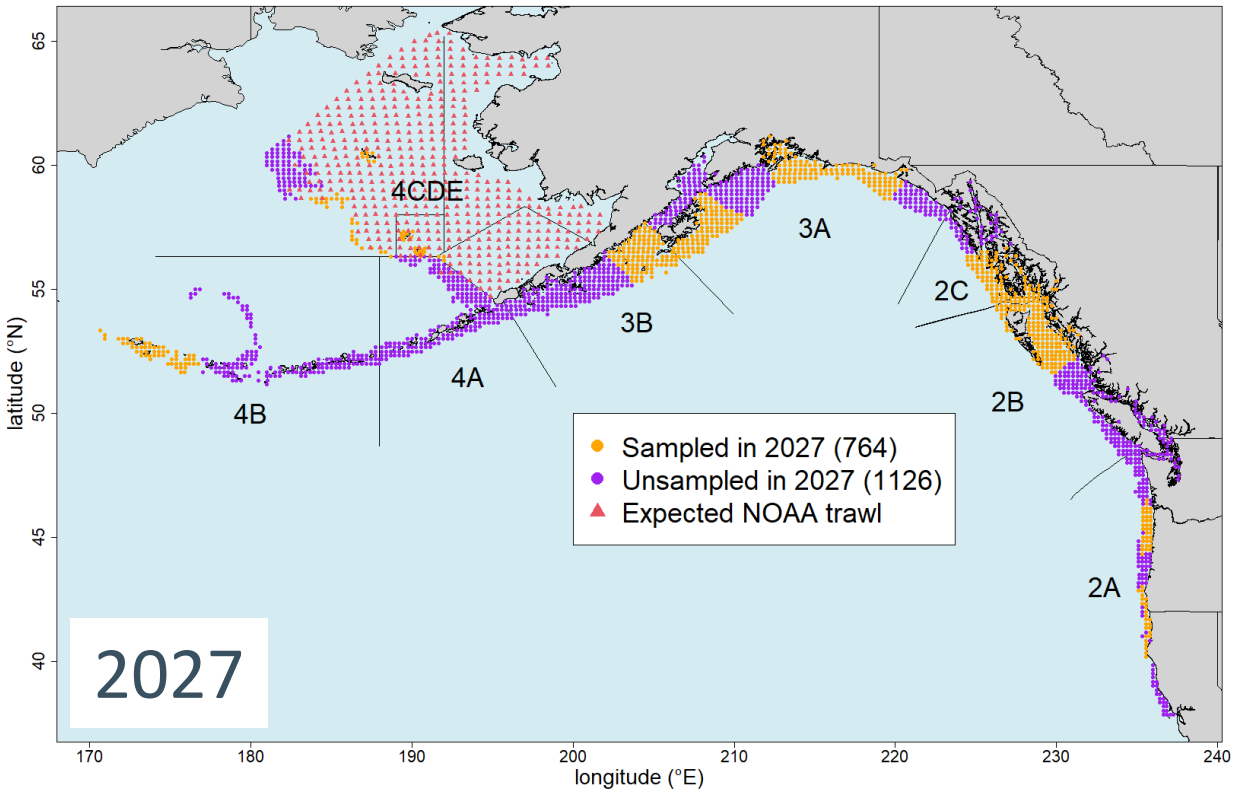
Adopted 2026 FISS design

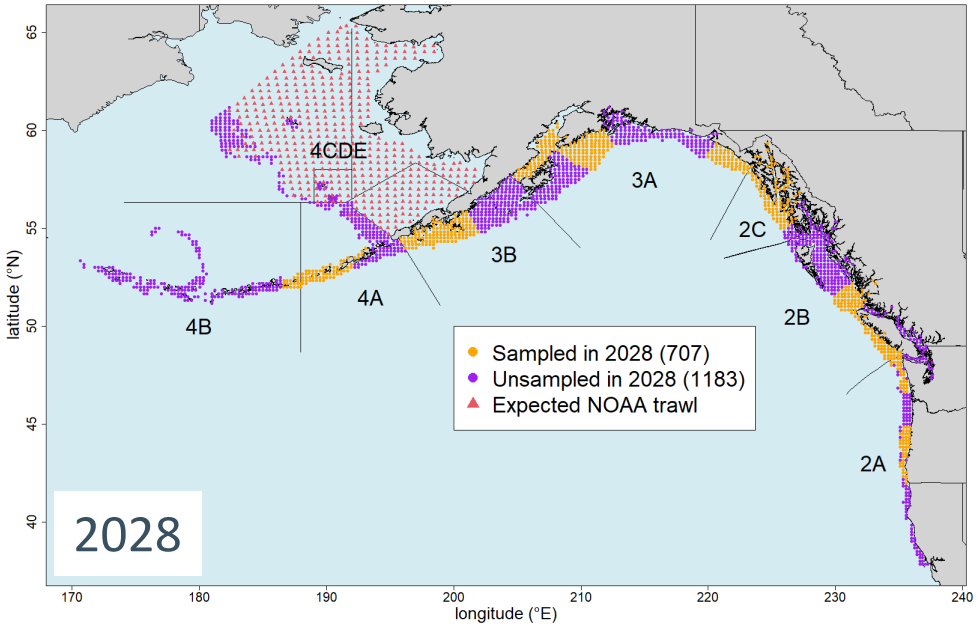
- Increased spatial coverage relative to 2023-25
- Complemented the 2025 design by including ten charter regions not sampled last year
- 4B stations not sampled due to lack of charter bids



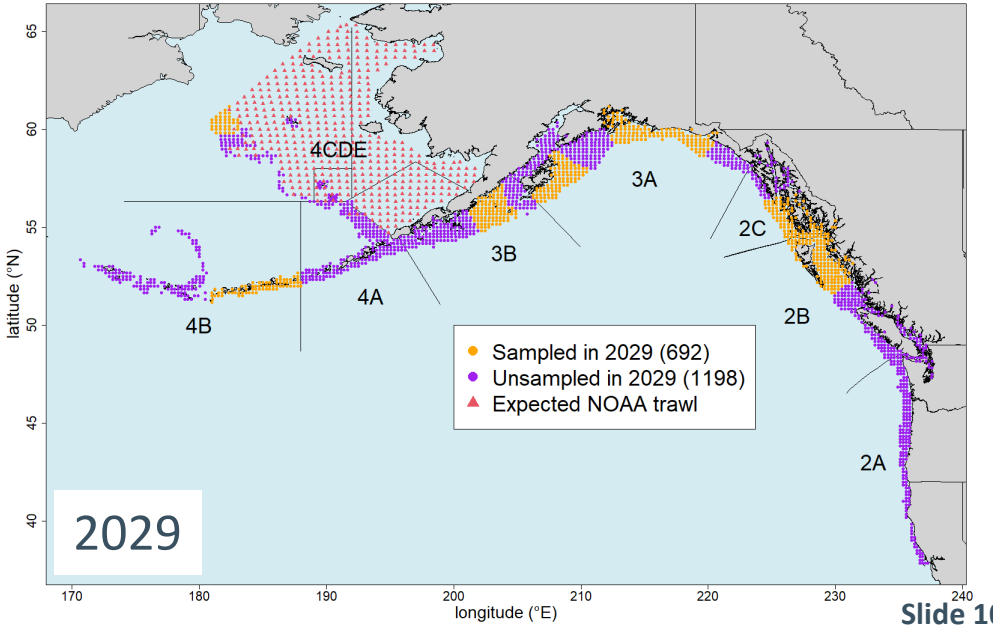
The Base Block design

- The **Base Block design** is considered the **optimal long-term FISS design** in terms of balancing scientific needs and cost-effectiveness:
  - 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 relatively precise estimates
- The sampled blocks (charter regions) are rotated over time.
- The Commission has noted that “the use of the Base Block Design will be the focus of future planning and annual FISS proposals from the Secretariat” (e.g., IPHC-2026-AM102-R, para. 72)





Potential Base Block designs 2027-29

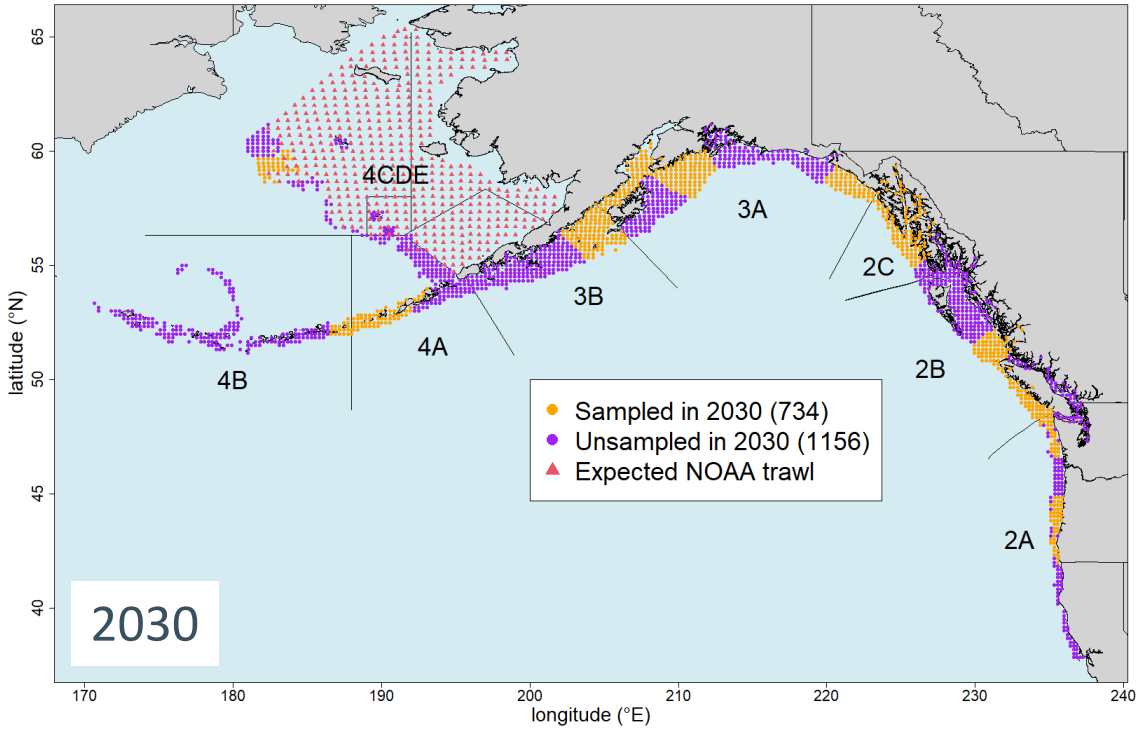


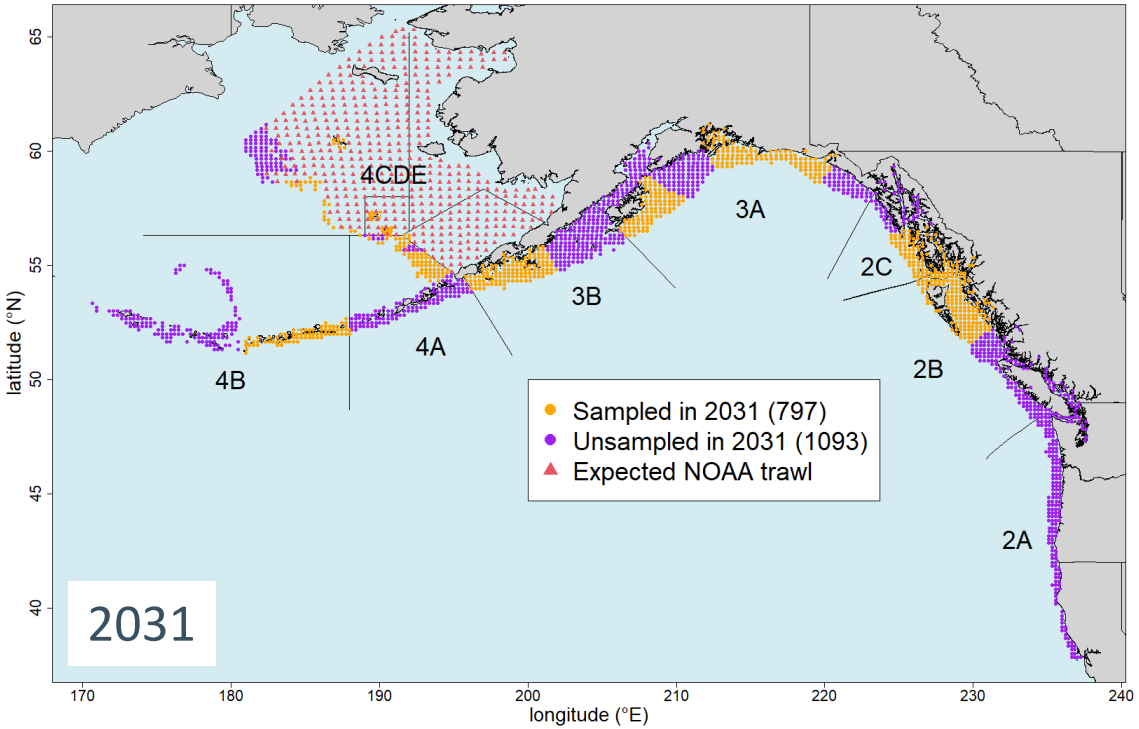
Projected coefficients of variation* (CVs)

Regulatory Area	Base Block		
	2027	2028	2029
2A	26	16	22
2B	5	10	7
2C	6	6	6
3A	8	7	7
3B	14	12	9
4A	24	12	19
4B	16	17	14
4CDE	9	9	8
Biological Region			
Region 2	5	5	4
Region 3	7	6	6
Region 4	11	7	9
Region 4B	16	17	14
Coastwide	4	4	4

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

Base Block Designs 2030-31

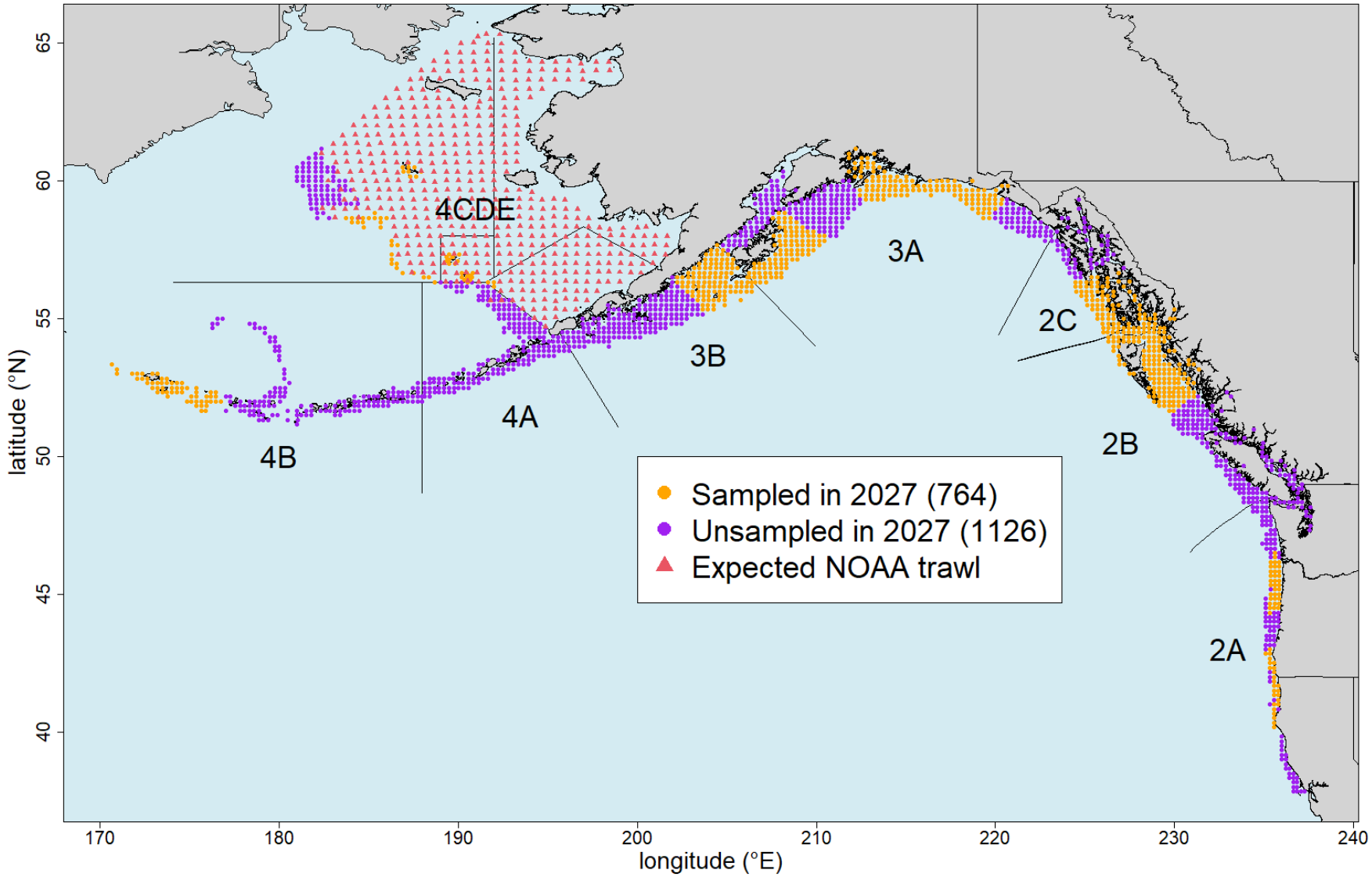




Cost evaluation for 2027

- Projected costs for 2027 design options were estimated assuming:
  - Designs are optimised for numbers of skates, with sets of 4, 6 or 8 100-hook skates used, depending on projected catch rates and bait costs.
  - Projected Pacific halibut average sales price for 2027 in each charter region is unchanged from our current best estimate of 2026 FISS values (based on both 2025 data and 2026 data received to date)
  - Projected Pacific halibut average landings per station remain unchanged in each charter region from 2026 FISS values (based on both 2025 data and 2026 data received to date).
  - The price of chum salmon bait remains at the average 2026 price of US$2.40/lb.

2027 Base Block design



Projected net revenue (US$):
($131,000)

Income: $3,977,000
Expenses: ($4,108,000)

Projected income and expenses

Design		2027 Base Block design
Income (US$)	Pacific halibut sales	3,874,000
	Byproduct sales	103,000
	Total	**3,977,000**
Expenses (US$)	Base HQ (staff salary and wages, and benefits x 4)	(547,000)
	Vessel contracts	(1,545,000)
	Field staff (salary and wages, and benefits)	(475,000)
	Bait	(509,000)
	Non-IPHC fish sales@	(432,000)
	Other expenses*	(601,000)
	Total	**(4,108,000)**
Net revenue		**(US$131,000)**

Cost estimates are preliminary and do not fully account for 2026 realized costs. Therefore, it is important to note there is considerable uncertainty in the catch and cost projections for 2027.

Projected income and expenses for the 2027 design will be updated once FY2026 has been reconciled (expected late October 2026) and will be used to refine the projections at that time.

@Sales revenue from both byproduct and Pacific halibut that are paid to a third party (e.g. vessel share, ADF&G)

*Other costs include staff training, personnel expenses, mailing and shipping, travel, technology, gear replacement, customs fees, bait storage fees, field supplies and equipment, equipment maintenance fees, facility rental fees, and communication fees.

Modular add-ons

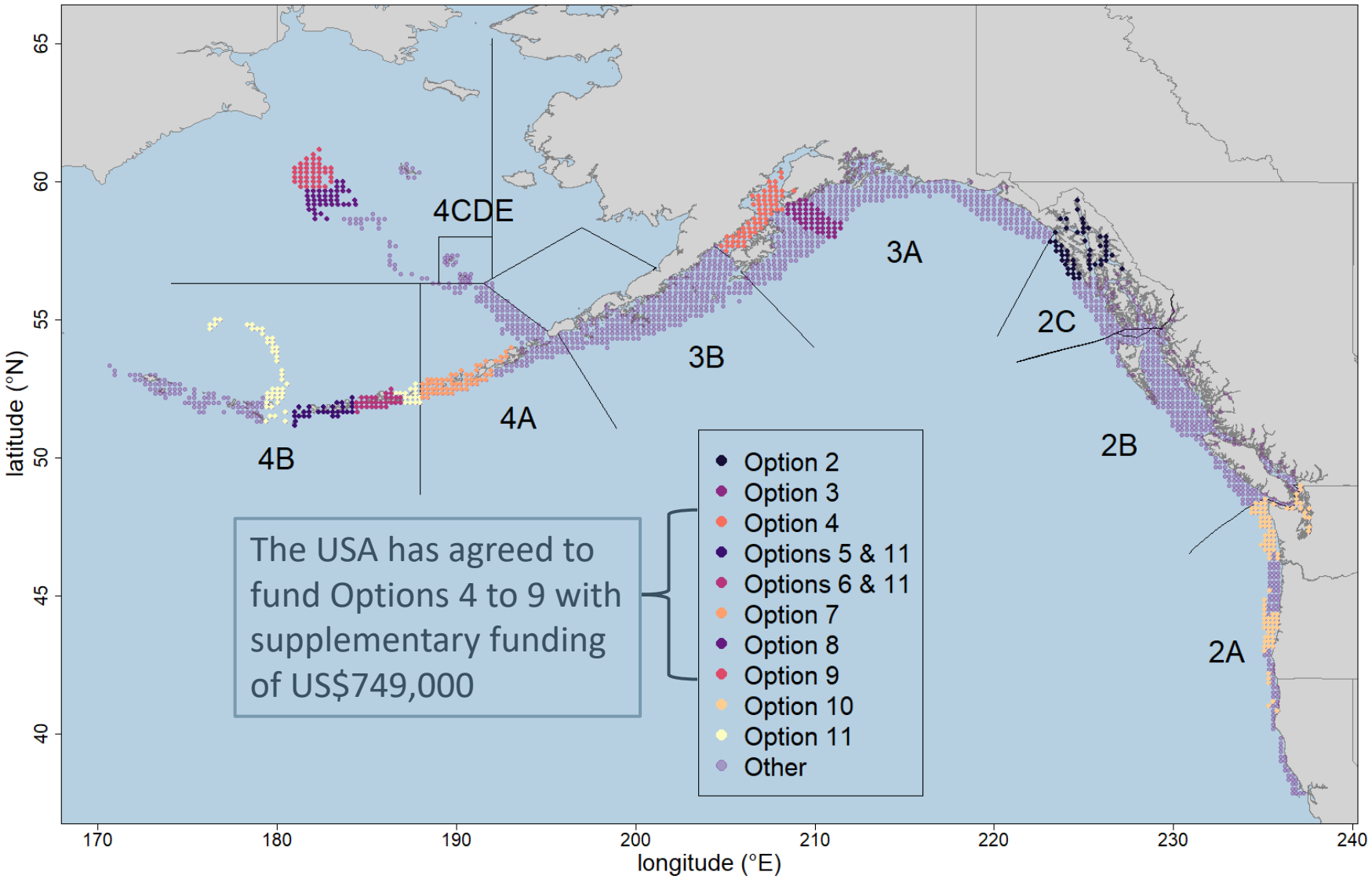
The Secretariat prepared ten modular add-ons to the proposed 2027 Base Block design with the following goals:

- Reduce the projected net loss of the FISS in 2027;
- ‘Catch up’ on FISS regions that were part of the 2026 **Base Block design** but were not fished;
- Reduce the heterogeneity in net revenue among future years by sampling in 2027 some of the more costly regions planned in future years;
- Set the FISS station charter rate at a higher value to increase the chance of receiving bids for challenging charter regions (i.e., Adak in IPHC Regulatory Area 4B);
- Fully clear the ‘backlog’ of uncertainty created by the reduced designs implemented in 2023-2026 to provide the most informative data in 2027 for the stock assessment and management decisions.

Option	Design	Sampled IPHC Regulatory Areas (with number of FISS charter regions)	Projected expenses (US$)	Projected income (US$)	Projected net revenue	Benefit/rationale
1	Base Block	2A(3), 2B(2), 2C(2), 3A(4), 3B(2), 4B(1), 4CDE(1)	($4,108,000)	$3,977,000	($131,000)	Optimal long-term design
	Design change	**Change in sampling**	**Projected change in expenses ($US)**	**Projected change in income ($US)**	**Projected change in net revenue**	
2	Add Sitka	2C(+1)	($208,000)	$253,000	$45,000	Revenue positive: reduces overall net loss.
3	Add Gore Pt	3A(+1)	($221,000)	$238,000	$17,000	Revenue positive: reduces overall net loss.
4	Add Shelikof	3A(+1)	($245,000)	$226,000	($19,000)	3A catch-up. Last sampled 2024.
5	Add Adak West	4B(+1)	($196,000)	$103,000	($93,000)	4B catch-up. Last sampled 2021.
6	Add Adak East	4B(+1)	($196,000)	$103,000	($93,000)	4B catch-up. Last sampled 2025.
7	Add Unalaska	4A(+1)	($367,000)	$99,000	($268,000)	Reduces costs in 2028.
8	Add 4CDE North	4CDE(+1)	($168,000)	$12,000	($155,000)	Reduces costs in 2029. Last sampled 2021.
9	Add 4CDE Central	4CDE(+1)	($188,000)	$67,000	($121,000)	Potential to reduce costs in 2030. Last sampled 2022.
10	Expand 2A sampling to include all stations north of 40°N	2A(+2)	($239,000)	$89,000	($150,000)	Reduces costs in 2028. Includes deep, shallow, and Salish Sea stations not sampled since 2018.
11	Fixed Contract rate[1] for expanded Adak (alternative to Options	4B(+2)	($937,000)	$419,000	($519,000)	Reduces probability of receiving no bids for this region (as occurred in 2023 and 2026)

The USA has agreed to fund Options 4 to 9 with supplementary funding of US$749,000

Modular add-ons



Discussion

- The **Base Block design** has a preliminary projected net loss of US$131,000 for 2027 and therefore can be implemented using FISS reserves without the need for supplementary funding.
- It is projected that adding two revenue-positive charter regions from IPHC Regulatory Areas 2C and 3A would reduce this net loss by US$62,000.
- With supplementary funding, the design is able to:
  - add charter regions in IPHC Regulatory Areas 3A and 4B that were part of the approved 2026 Base Block design but were not fished this year
  - bring forward one or more revenue-negative regions to reduce projected costs in 2028.

Recommendation

That the Scientific Review Board **NOTE** paper IPHC-2026-SRB029-08 (Part 1), which presents potential Base Block designs for 2027-31, including a preliminary projection of revenue and expenses for the 2027 design and potential modular add-ons to this design.

Modelling updates

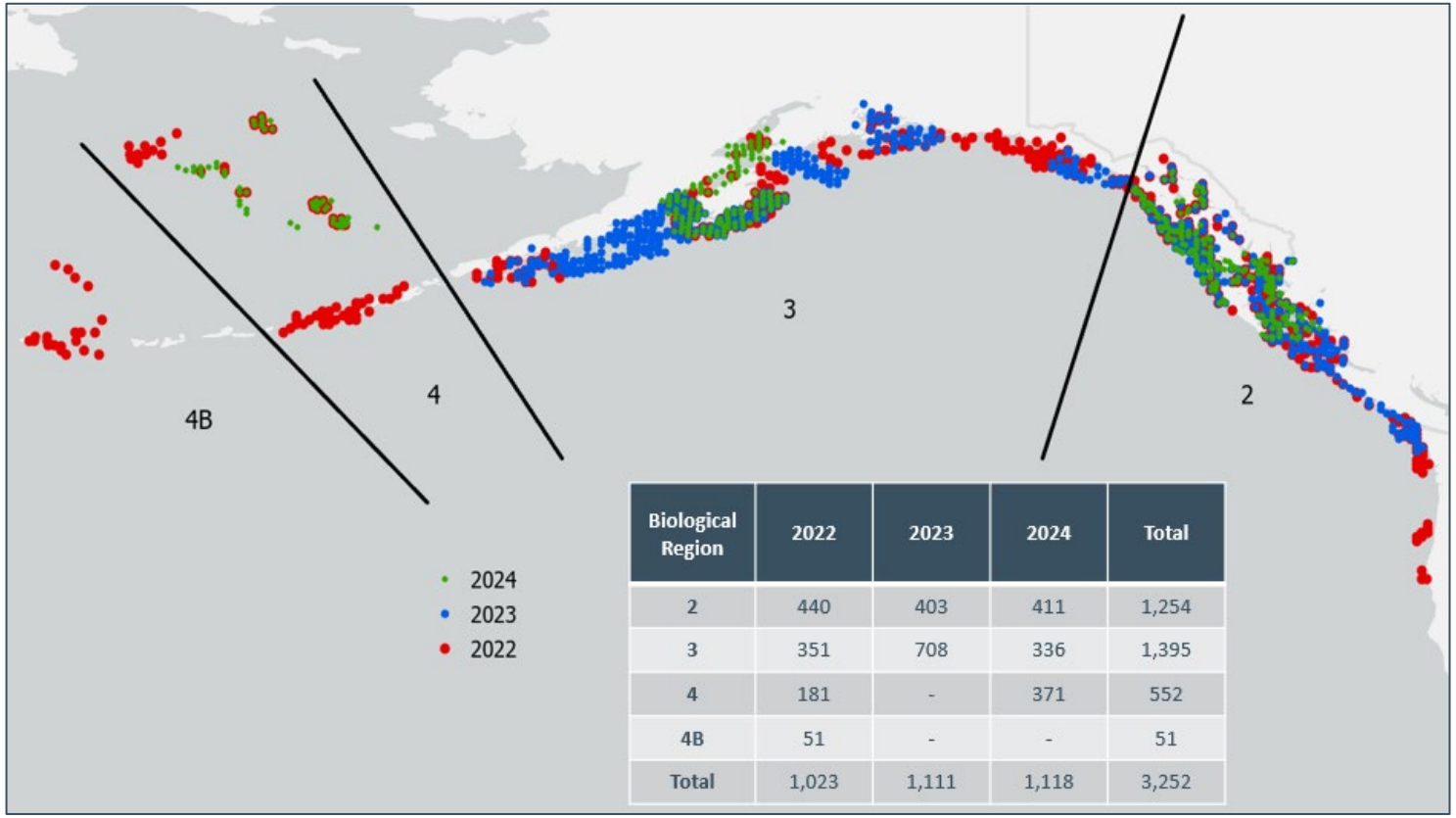
- At present, the IPHC models Pacific halibut survey data by fitting a spatio-temporal model to data from each individual IPHC Regulatory Area
- Model output is aggregated to produce estimates for larger geographical units (Biological Regions, coastwide waters).
- Fitting models to coastwide data sets has become more feasible due to substantial reductions in the runtime (due to both software and hardware improvements)
- Potential applications of coastwide models:
  - Modelling of FISS WPUE and NPUE data as a single data set, with parameters that vary across space
  - Modelling of biological data on individual fish, which may have shorter time series or larger spatial gaps than FISS catch rate data
  - Modelling of environmental data collected on FISS water column profilers

Application to histological maturity data

- The IPHC has collected histological data on Pacific halibut maturity on the FISS since 2022 (see Planas et al, 2025, for details).
- Maturity is assessed on individual female Pacific halibut, and each fish has an approximate capture location given by the midpoint of the location of the FISS set on which it was captured.
- Recent modelling of the relationship of maturity probability and age has used generalized additive models (GAMs) to estimate the relationship between maturity probability and age by IPHC biological region.
- At SRB027, we presented results of preliminary coastwide spatial modelling of maturity data.

Application to histological maturity data

Spatial models can also account for uncertainty due to gaps in coverage when estimating relationships for Biological Regions or coastwide.



Biological Region	2022	2023	2024	Total
2	440	403	411	1,254
3	351	708	336	1,395
4	181	-	371	552
4B	51	-	-	51
Total	1,023	1,111	1,118	3,252

Spatio-temporal maturity modelling

- At SRB027, we presented results of preliminary coastwide spatial modelling of maturity data.
- The preliminary modelling was based on only three years of data from a sampling design with partial and inconsistent spatial coverage across the three years.
  - Models used combined data across years and did not account for temporal dependence
- The IPHC has visual assessments of maturity data for Pacific halibut from 2002 onwards, including for the individual sampled fish with histological data from 2022-24
- This allows us to:
  - Estimate a calibration between visual and histological maturity curves using the paired data from 2022-24
  - Model the entire 2002-24 time series of maturity curves, including modelling of both spatial and temporal correlation in model parameters
  - Predict histology-based maturity curves across space and time

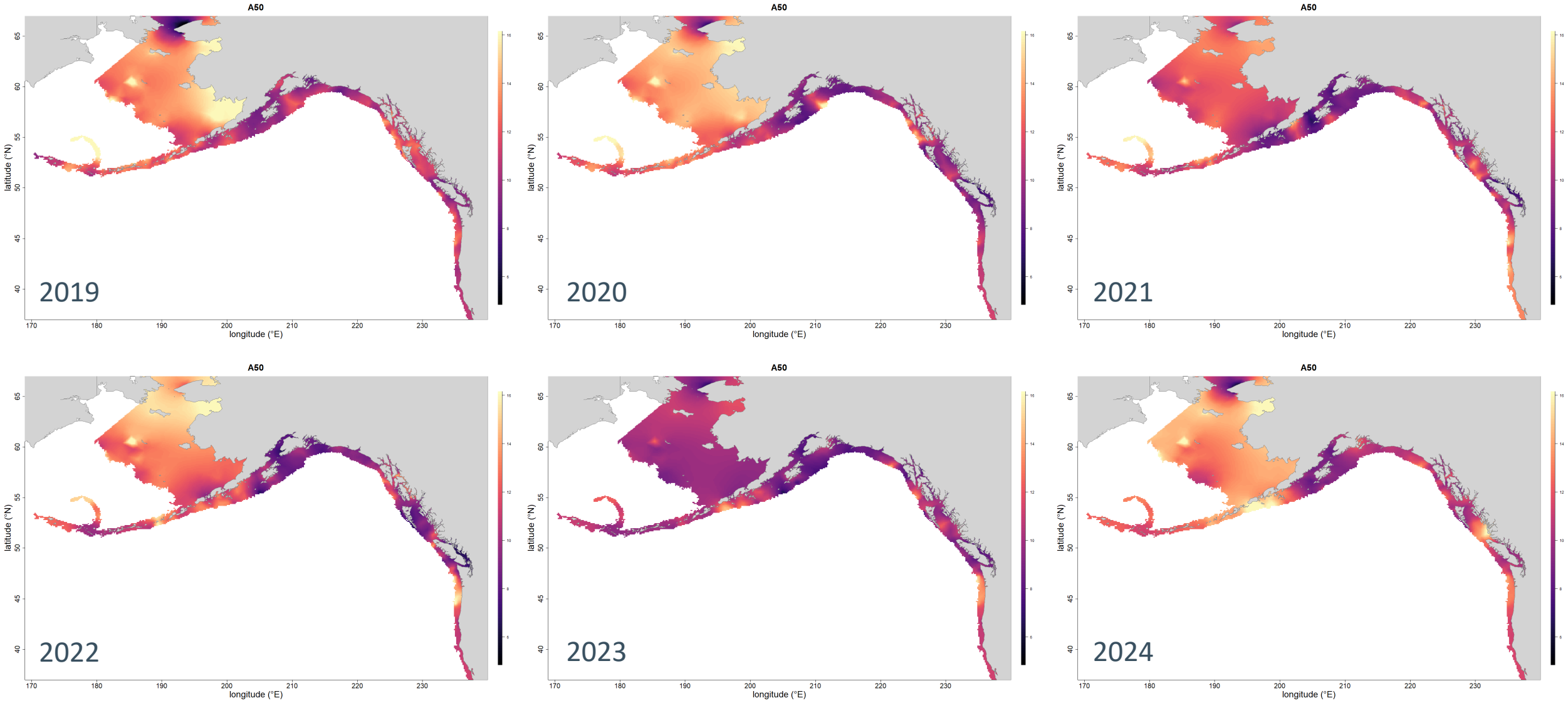
Preliminary spatial modelling

- As with the 2025 work, our models are based on a logistic model relating P(Mature) to age, with spatially-varying intercept and slope, and added “GAM-like” flexibility through a random walk term in the age relationships
- In 2026, these models were extended to include:
  - Temporal dependence in the logistic parameters (AR(1) models)
  - Slope and intercept fixed effects that differ for visual and histological maturity data (calibration of maturity assessment methods)
- While the full 2002-24 visual dataset is available, to date we have trialed models with shortened timeseries (2018-24) in order to reduce runtimes while setting up and troubleshooting model fitting

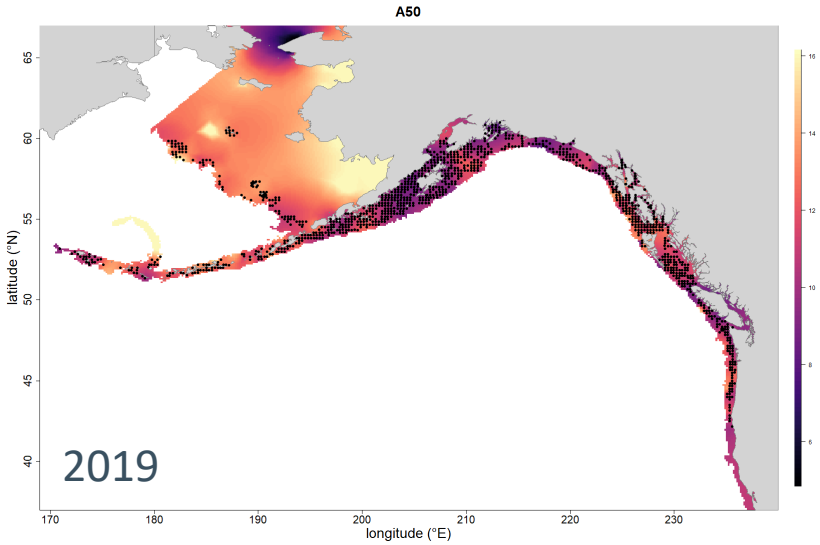
Summary of early results

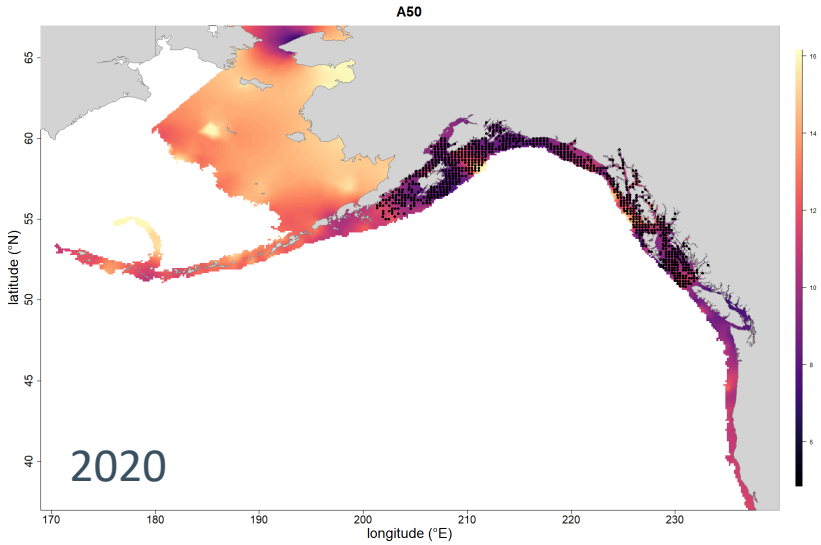
- Spatial dependence is strong, as was the case in the 2025 modelling
- Temporal dependence is moderate, with correlation parameters ≈0.5, much less than the 0.9-0.95 values typical of FISS catch rate modelling
- The calibration fixed effects estimate that curves based on visual assessments result in lower maturity probabilities at age than those derived from histological assessments

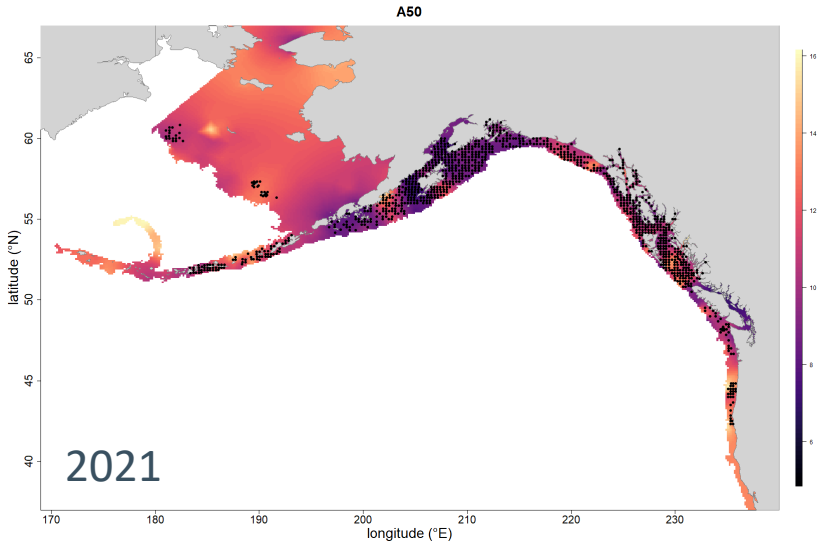
Estimated A50 values from space-time model

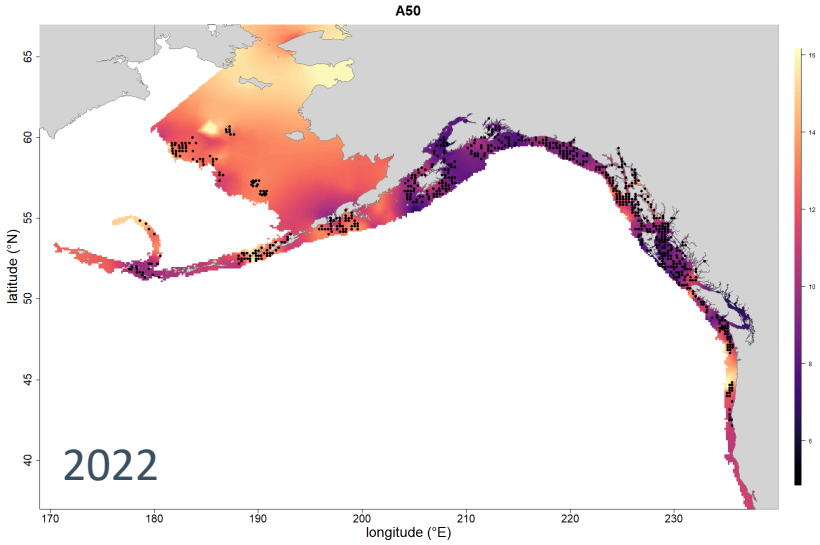


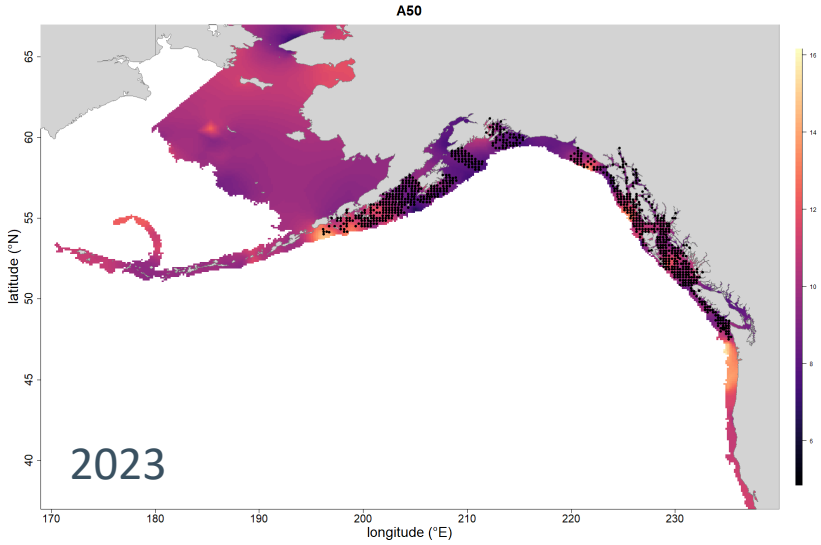
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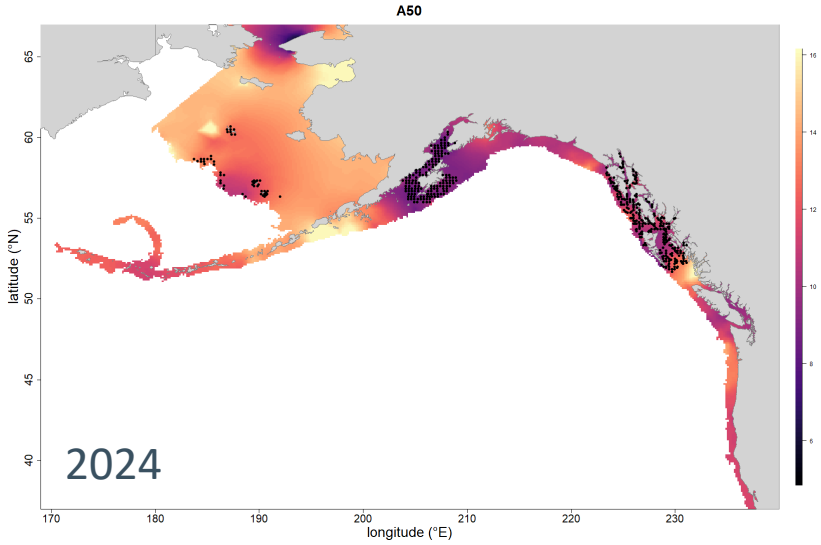












Discussion

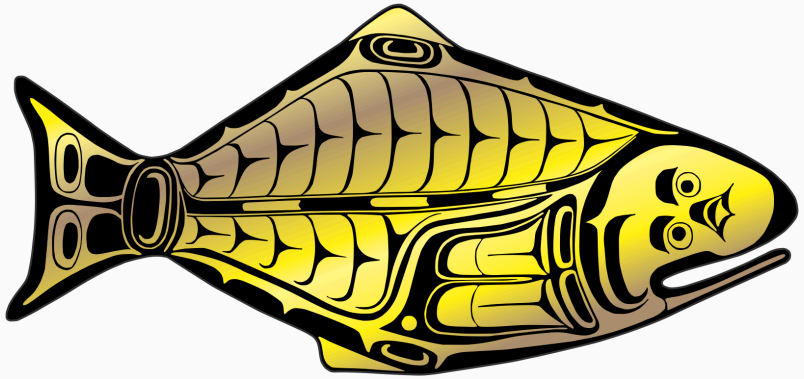
- Ongoing work includes:
  - Testing alternative model priors
  - Considering other options for GAM-like model flexibility
  - Computing cross-validation metrics for model comparisons

- Implications of output to date for computing coastwide maturity curves
  - How to deal with large, persistent coverage gaps when integrating predicted values across the coast

Recommendation

That the Scientific Review Board **NOTE** paper IPHC-2026-SRB029-08 (Part 2), which provides an update on recent work on coastwide modelling of Pacific halibut survey data, using histological maturity data as a test case.

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