2025 and 2026-29 FISS designs

PREPARED BY: IPHC SECRETARIAT (R. WEBSTER, I. STEWART, K. UALESI, T. JACK, D. WILSON; 12 DECEMBER 2024)

PURPOSE

To present an optimal long-term FISS design, the approved 2025 FISS design, and discuss the potential for biases that may result from non-optimal FISS designs.

BACKGROUND

The IPHC's Fishery-Independent Setline Survey (FISS) provides data used to compute indices of Pacific halibut density for use in monitoring stock trends, estimating stock distribution, and as an important input in the stock assessment. Stock distribution estimates are based on the annual mean weight per unit effort (WPUE) for each IPHC Regulatory Area, computed as the average of WPUE of all Pacific halibut and for O32 (greater than or equal to 32" or 81.3 cm in length) Pacific halibut estimated at each station in an area. Mean numbers per unit effort (NPUE) is used to index the trend in Pacific halibut density for use in the stock assessment models. Annual FISS designs are developed by selecting a subset of stations for sampling from the full 1890-station FISS footprint (Figure 1).

In recent years, financial constraints due to reduced catch rates, lower sales prices and higher costs have led to the implementation of FISS designs with reduced spatial footprints (IPHC-2024-SRB024-06). Effort has been concentrated in IPHC Regulatory Areas 2B, 2C, 3A and 3B, with limited sampling in other areas in 2023-24. In 2024, only a relatively small proportion of stations were fished in IPHC Regulatory Areas 3A and 3B.

The Base Block Design (described below) was presented to the Commission at the September 2024 Work Meeting and the 14th Special Session of the IPHC (SS014, IPHC-2024-SS014-03) as a more efficient approach to annual sampling in the core of the stock compared to recent designs based on random selection of FISS stations. For 2025, high projected financial costs for this design meant that it was not viable to undertake without substantial supplementary funding. Therefore, IPHC Secretariat staff developed a "fiscally viable" design for 2025 that would have reduced spatial coverage for the third year in a row but at a projected loss that could be covered by revenue, supplementary funding and (if necessary) IPHC reserve funds. Following SS014, the final 2025 FISS design was approved via inter-sessional agreement (IPHC-2024-CR-030, IPHC-2024-CR-031). This design included sampling of FISS charter regions in IPHC Regulatory Areas 3A and 3B that were unsampled in either 2023, 2024 or both, and were not part of the initial fiscally viable design. Both the Base Block Design and the Commission-approved 2025 FISS design are presented in this document.

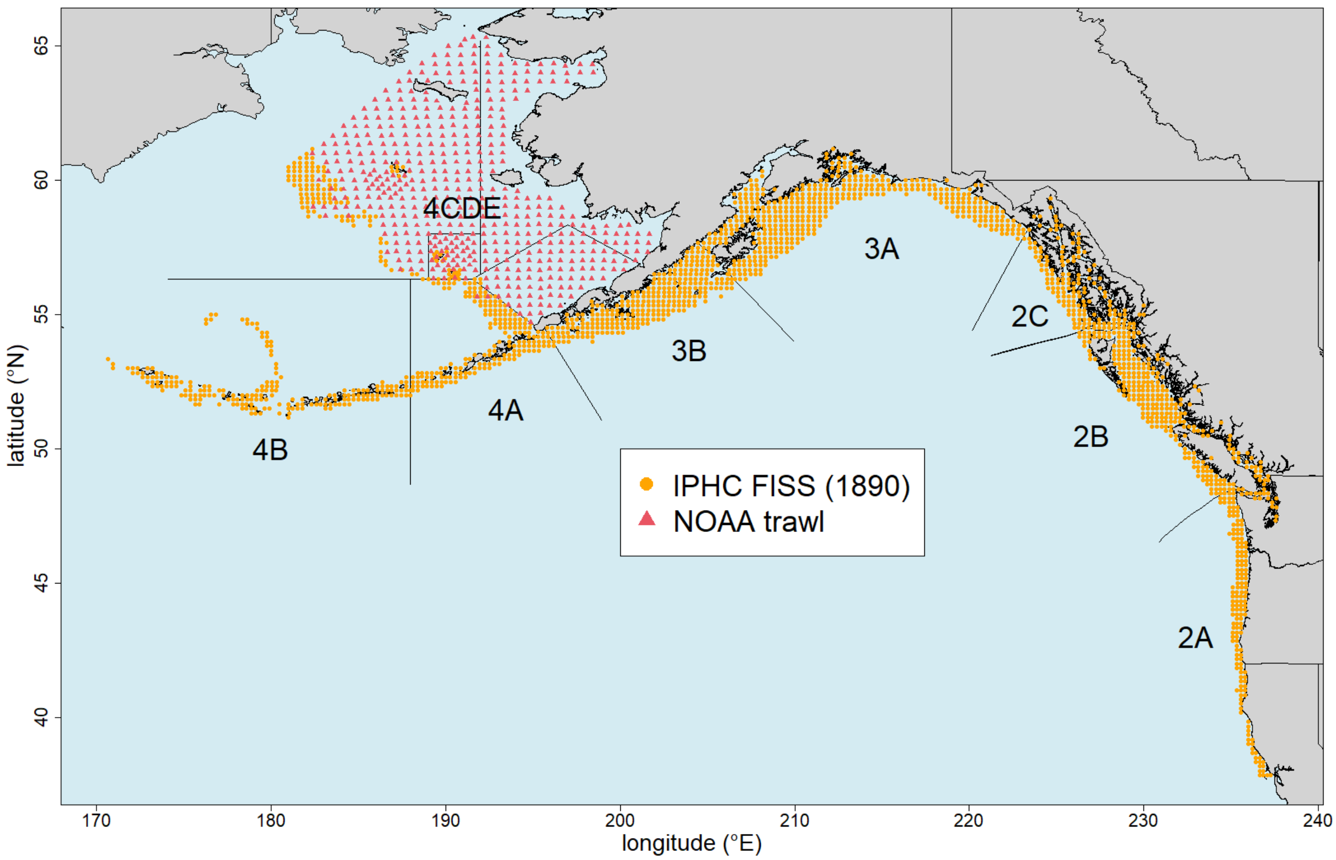

Figure 1. Map of the full 1890 station FISS design, with orange circles representing stations available for inclusion in annual sampling designs. Red triangles represent the locations of NOAA trawl stations used to provide complementary data for Bering Sea modelling (not all are sampled each year).

FISS DESIGN OBJECTIVES (Table 1)

Primary objective: *To sample Pacific halibut for stock assessment and stock distribution estimation.*

The primary purpose of the annual FISS is to sample Pacific halibut to provide data for the stock assessment (abundance indices, biological data) and estimates of stock distribution to inform spatial management decisions. The priority of the current rationalised FISS is therefore to maintain or enhance data quality (precision and bias) by establishing baseline sampling requirements in terms of station count, station distribution and skates per station.

Secondary objective: *Long-term revenue neutrality.*

The FISS is intended to have long-term revenue neutrality, and therefore any implemented design must consider both logistical and cost considerations.

Tertiary objective: *Minimize removals and assist others where feasible on a cost-recovery basis.*

Consideration is also given to the total expected FISS removals (impact on the stock), data collection assistance for other agencies, and IPHC policies.

Table 1 Prioritization of FISS objectives and corresponding 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

OPTIMAL FIVE-YEAR ROTATIONAL FISS DESIGN (BASE BLOCK DESIGN)

The **Base Block design** when undertaken on an annual basis ensures that all charter regions in the core areas are sampled over a three-year period, while prioritizing coverage in other areas based on minimising the potential for bias and maintaining CVs below 25% for each IPHC Regulatory Area. The **Base Block design** also includes some sampling in all IPHC Biological Regions in each year, ensuring that both trend and biological data from across the spatial range of Pacific halibut in Convention waters are available to the stock assessment and for stock distribution estimation. From the perspective of meeting the Primary Objective of the FISS (Table 1), the **Base Block design** can be considered the optimal rotational design.

Using samples generated from the fitted 2023 space-time models as simulated data for 2024-27, we projected the coefficient of variation (CV, a relative measure of precision) for mean O32 WPUE for each year of the design by IPHC Regulatory Area and Biological Region. As CVs are generally greater in the terminal year of the time series and that year is the most relevant for informing management, the CV values in Table 2 are for the final year of the modelled time series. For example, the values for 2026 were found by fitting the model to the data for 1993-2026 (with simulated data used for 2024-26).

With uncertainty in future designs, it is expected that by 2027 implemented designs will vary significantly from those in the Base Block design and the other designs (Core Block and Reduced Core) presented at WM2024. Nevertheless, to compare potential levels of uncertainty five years from now under designs with similar sampling coverage, we also projected CVs for IPHC Regulatory Areas 2A, 3B and 4B for 2029. The Base Block design would lead to CVs of 21%, 14% and 14% for 2A, 3B and 4B respectively in 2029.

Table 2. Projected coefficients of variation (CVs, %) for mean O32 WPUE for the FISS **Base Block design**, terminal year of time series, and IPHC Regulatory Area or Biological Region.

Regulatory Area	Base Block		
	2025	2026	2027
2A	17	22	23
2B	8	10	7
2C	6	6	6
3A	9	7	7
3B	13	12	15
4A	19	13	20
4B	15	20	18
4CDE	8	8	8
Biological Region			
Region 2	5	6	5
Region 3	7	7	8
Region 4	8	7	9
Region 4B	15	20	18
Coastwide	4	4	4

Projected terminal year CVs for the Base Block design for 2025-27 are all 25% or less for all IPHC Regulatory Areas. In the core areas (2B, 2C, 3A and 3B), CVs are at 15% or less (Table 2). All Biological Region CVs except Region 4B are below 10% while the coastwide CV is projected to be 4% in all years. The Base Block design is therefore projected to maintain precise estimates of indices of Pacific halibut density and abundance across the range of the stock, and to provide a strong basis for estimating trends, demographics, and the distribution of the stock. At the same time, the rotating nature of the sampled blocks means that almost all FISS stations are sampled within a 5-year period (2-3 years within the core areas) resulting in low risk of missing important stock trends and therefore a low risk of large bias in estimates of trend and stock distribution. The consistent nature of the sampling design means that CVs will be maintained at comparable values beyond 2027.

For context, average research survey CVs[1] have been estimated to be approximately ~20%; however, this value includes both estimated observation and process error (based on lack of fit in the stock assessments), and so is larger than the survey-only observation CVs projected in this report (Francis et al. 2003). In NOAA Fisheries trawl survey results in the Bering Sea (roughly analogous to one Biological Region for Pacific halibut), commercially important species showed a range of average annual model-based CVs, including: Pacific cod (5%), Walleye pollock (7%), Northern rock sole (6%), and yellowfin sole (5%) over 1982-2019 (DeFilippo et al. 2023). These values are comparable to the projected 5-9% CVs for IPHC Biological Regions that would be expected from the **Base Block design** (with the exception of Biological Region 4B), but lower than corresponding values for the Core Block and Reduced Core designs.

The **Base Block design** shown in Figures 2 to 6 for 2025-29 were presented to the Commission at IM099 as potential designs for 2024-28, although the **Base Block design** was not considered for adoption for 2024 due to high projected costs and low catch rates. These block designs ensure that all charter regions in the core areas are sampled over a three-year period, while prioritizing coverage in other areas based on minimising the potential for bias and maintaining CVs below 25% for each IPHC Regulatory Area. The **Base Block design** also include some sampling in all IPHC Biological Regions in each year, ensuring that data from across the spatial

[1] Based on a meta-analysis of 18 trawl survey and species combinations.

range of Pacific halibut are available to the stock assessment and for stock distribution estimation. We note that paragraph 72 of the AM100 report (IPHC-2024-AM100-R) states:

> *The Commission NOTED that the use of the base block design (Figures 7 to 11 of paper IPHC-2024-AM100-13) will be the focus of future planning and annual FISS proposals from the Secretariat.*

The Base Block design for the 2025 FISS (Figure 2) was projected to result in a net loss of around US$2 million and was therefore not considered fiscally viable (IPHC-2024-SS014-03).

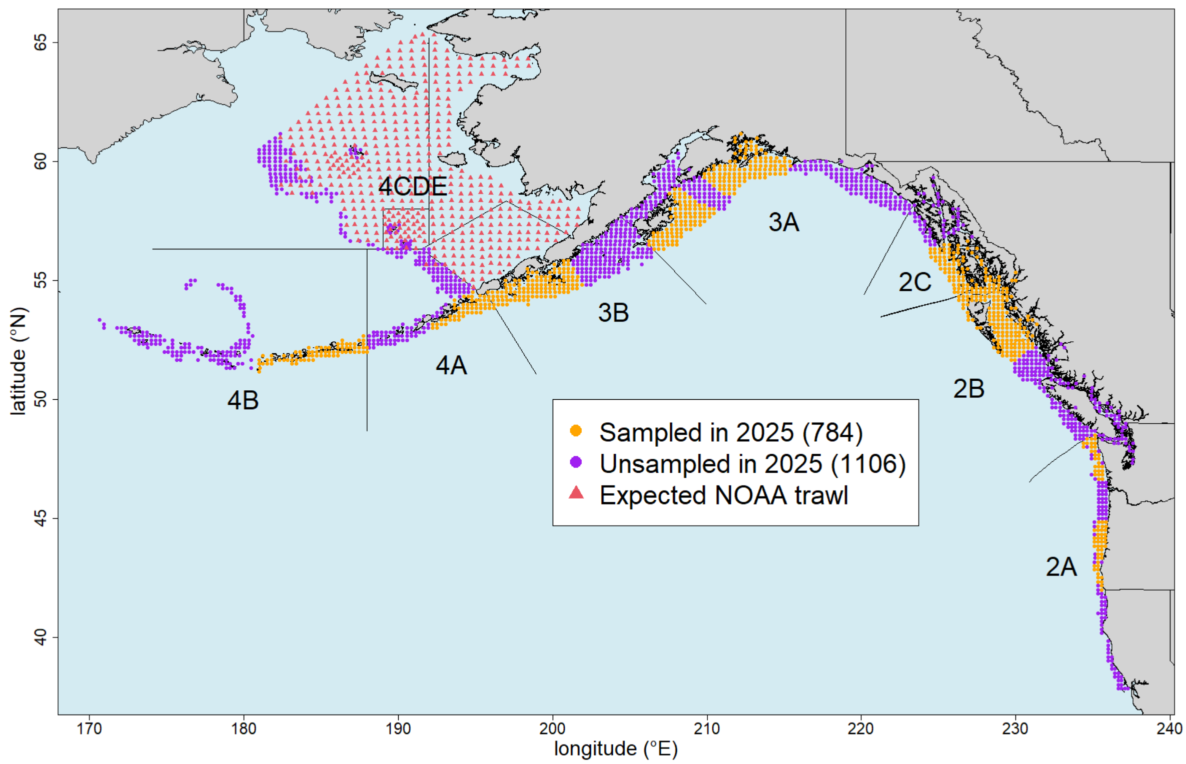

Figure 2. Base Block design for 2025 (orange circles). Design is based on fishing 2-4 complete blocks of stations (charter regions) in the core areas (2B, 2C, 3A and 3B) and previously implemented subareas elsewhere.

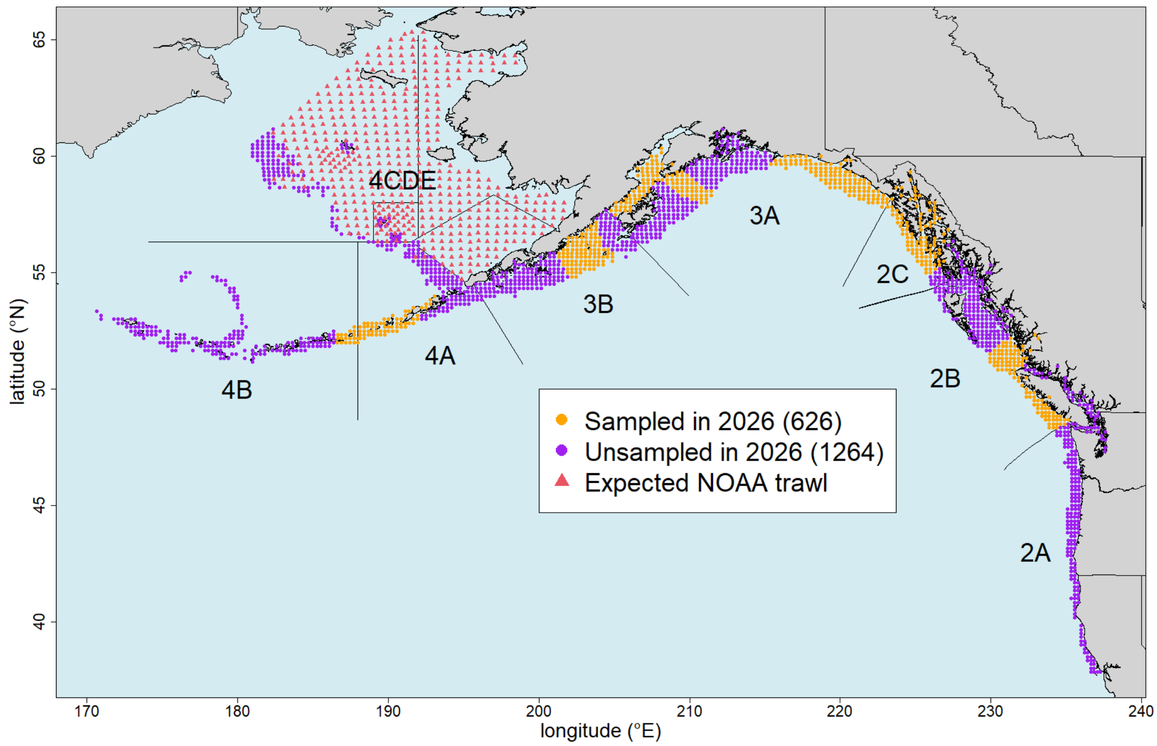

Figure 3. Base Block design for 2026 (orange circles) – indicative only. Design is based on fishing 2-4 complete blocks of stations (charter regions) in the core areas (2B, 2C, 3A and 3B) and previously implemented subareas elsewhere.

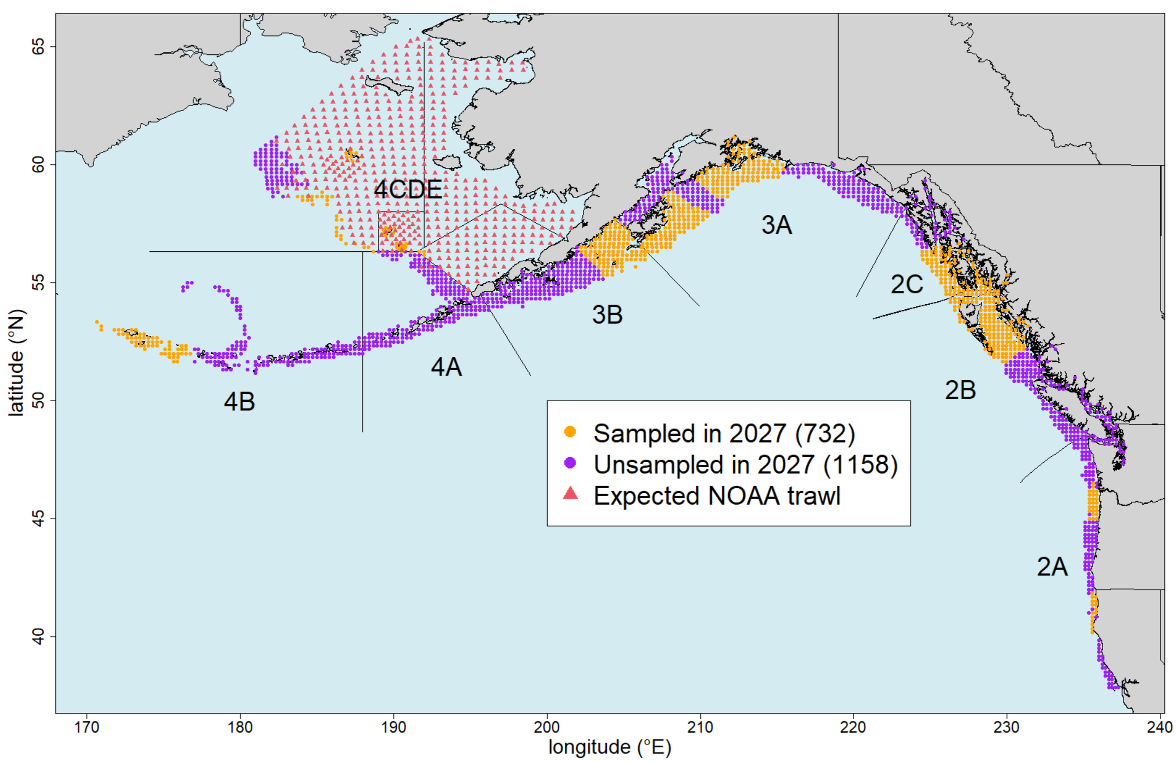

Figure 4. Base Block design for 2027 (orange circles) – indicative only. Design is based on fishing 2-4 complete blocks of stations (charter regions) in the core areas (2B, 2C, 3A and 3B) and previously implemented subareas elsewhere.

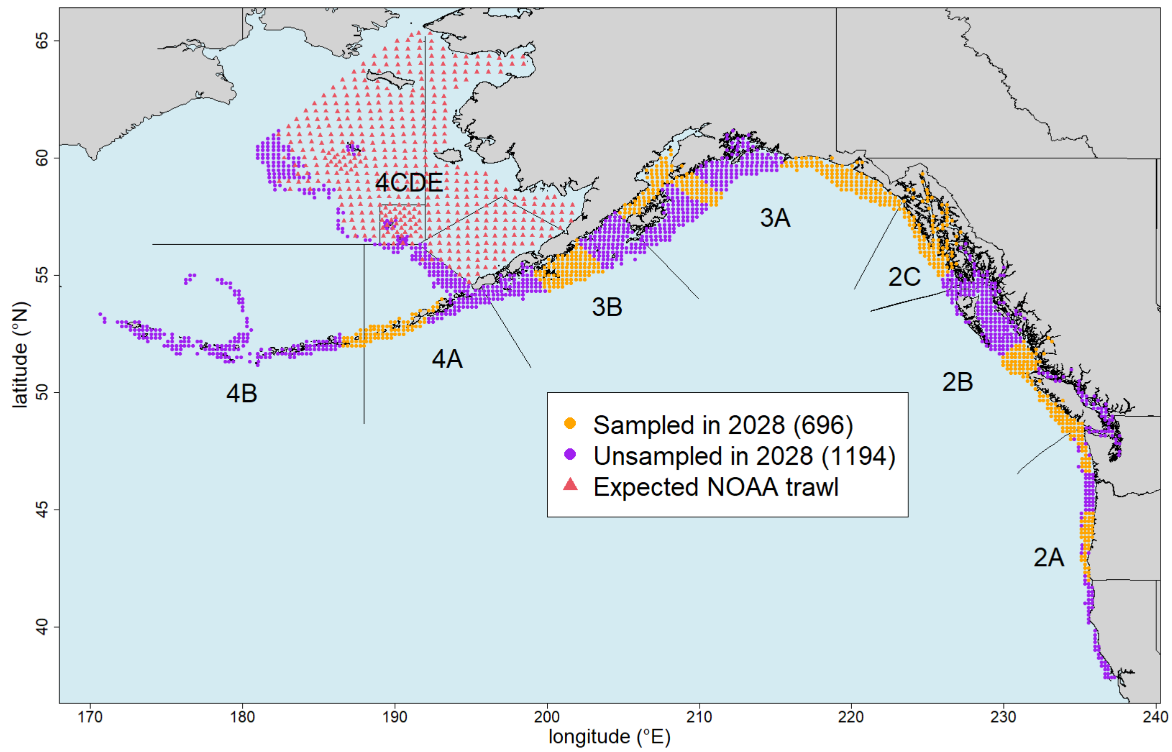

Figure 5. Base Block design for 2028 (orange circles) – indicative only. Design is based on fishing 2-4 complete blocks of stations (charter regions) in the core areas (2B, 2C, 3A and 3B) and previously implemented subareas elsewhere.

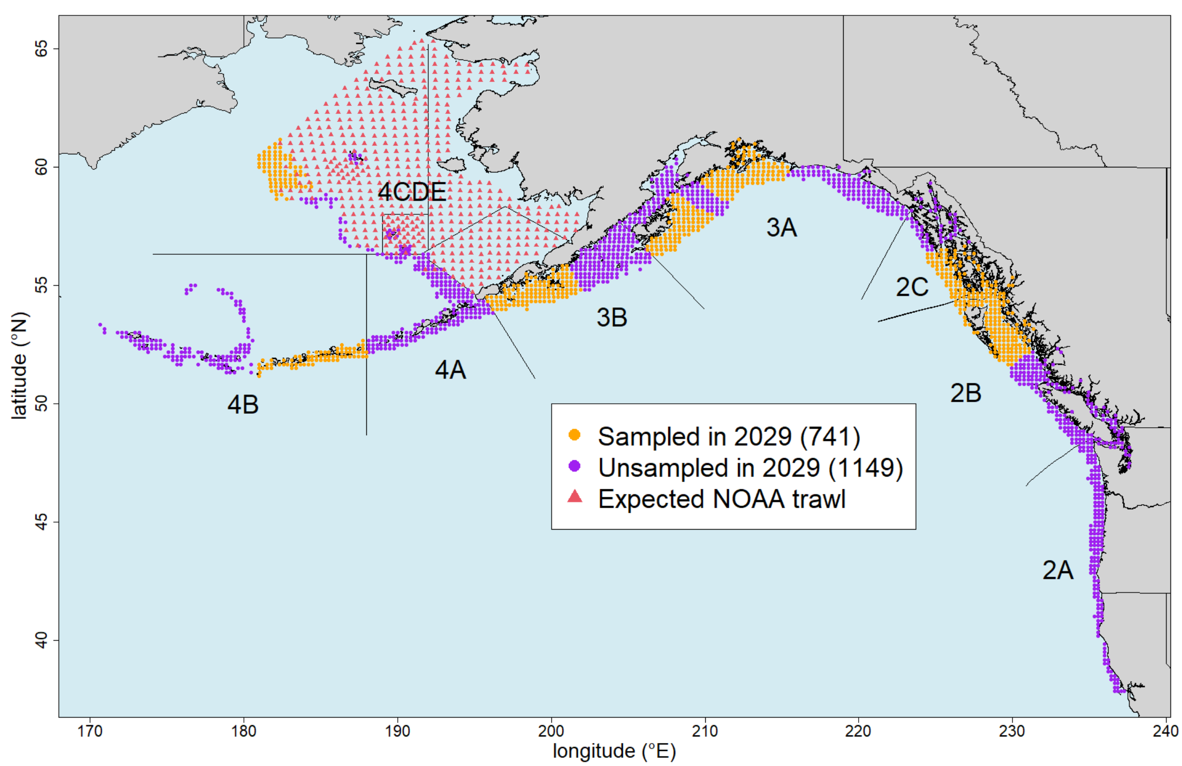

Figure 6. Base Block design for 2029 (orange circles) – indicative only. Design is based on fishing 2-4 complete blocks of stations (charter regions) in the core areas (2B, 2C, 3A and 3B) and previously implemented subareas elsewhere.

THE APPROVED 2025 FISS DESIGN

At SS014 (IPHC-2024-SS014-03), the Commission tentatively decided on a 2025 FISS design (Figure 7) that included the following:

- One charter region in each of 2B and 2C
- 60 stations in each of 2A and 4A/4B, covered by supplementary funding
- Two charter regions in each of 3A and 3B, each last sampled in 2022-23, and selected to reduce the bias risk over the short term

Implementation of this design is projected to result in a net loss to the FISS, with the projected deficit to be covered by a transfer from the IPHC Reserve Fund of $1,000,000. This design was approved via inter-sessional agreement (IPHC-2024-CR-030, IPHC-2024-CR-031).

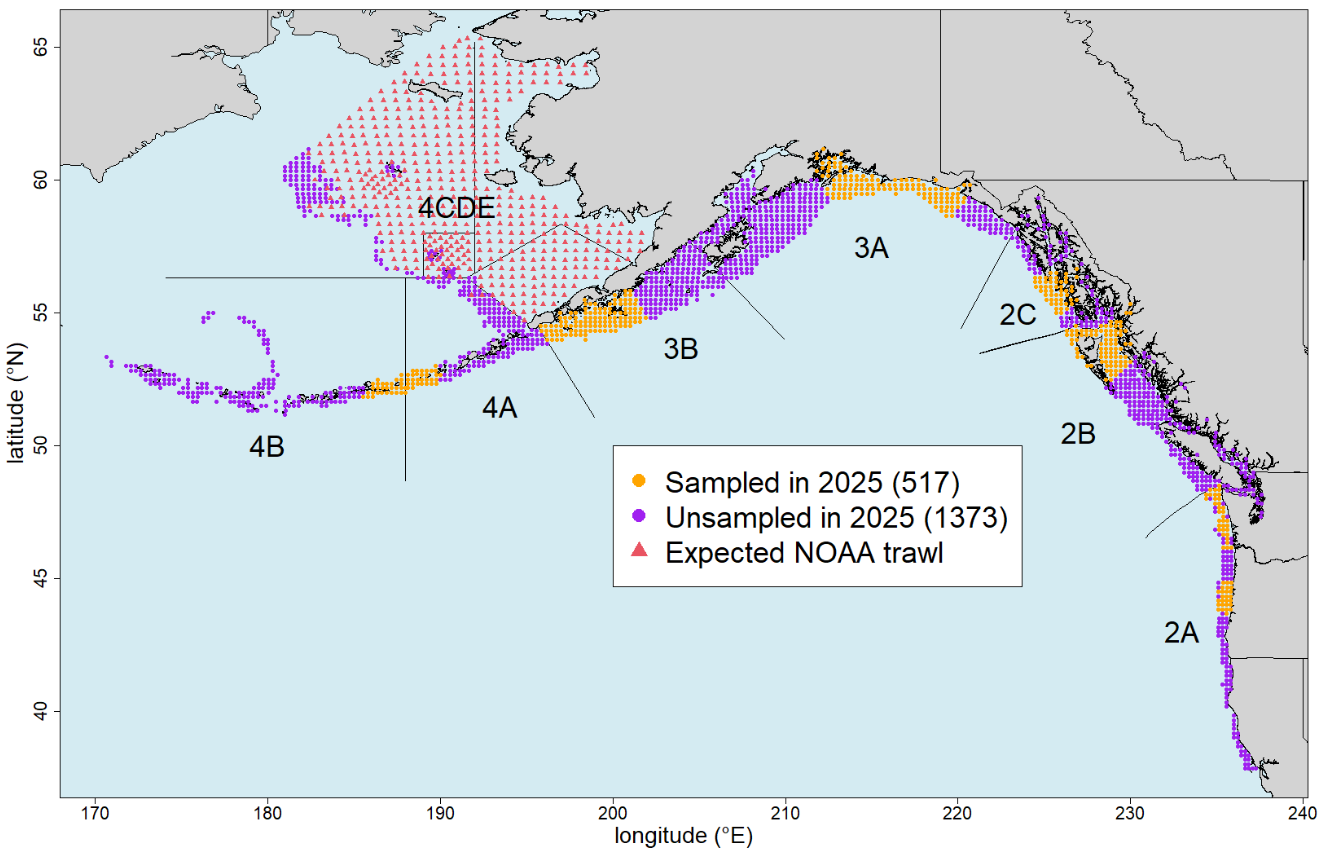

Figure 7. The approved 2025 FISS design (orange circles).

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THE POTENTIAL FOR BIAS RESULTING FROM REDUCED FISS DESIGNS

Indices of Pacific halibut density can change by large amounts over short periods, with annual changes of 15% or more regularly observed at the level of Biological Region (Figure 8) and Regulatory Area (Figure 9). Over a three-year period, large changes in indices of density are the norm (Figures 10 and 11), including at the coastwide level. Lack of sampling or low spatial coverage in an area or region means such changes are fully or largely unobserved, leading to biased estimates of indices, stock trends, and stock distribution. The greater the unobserved change, the greater the bias. Designs such as that implemented in 2024 and the approved 2025 FISS design (Figure 7) therefore have high potential for bias in area, regional and coastwide estimates, particularly as 2025 would be the second or third year with reduced coverage for much of the stock.

The risk of bias is lowest in Biological Region 2, which has had good spatial coverage over the last three years (2022-24; Figure 12). The planned 2025 sampling in the highest density habitat in IPHC Regulatory 2A means that bias risk in 2025 will be low throughout this region. While some sampling in Biological Regions 3, 4 and 4B mitigates the bias potential, persistent large coverage gaps means that 73% of habitat covered by the full FISS design will be unsampled next year and the risk of not observing the large changes that often occur in much of the stock remains high.

Including the habitat covered by the NOAA trawl survey in the Bering Sea, implementation of approved 2025 FISS design means that either FISS or trawl sampling covers 51% and 63% of habitat in each of 2024 and 2025 respectively. Based on this level of sampling coverage and observed levels of change shown in Figures 8 to 11, we would expect coastwide indices of abundance to have bias of up to +/-13% following the 2025 FISS. However, bias could be much higher in Biological Regions 3 and 4B, which would have had lower levels of sampling than the coast as a whole for two or more years following completion of the 2025 FISS.

Recently completed simulation analyses explored the effect on stock assessment results of a cumulative bias in the FISS index of 15% over the upcoming period from 2025-2027 (IPHC-2024-SRB025-06). If the true FISS trend were going down by 15%, but due to a reduced design the FISS index was estimated to be flat over this same period, the estimates of spawning biomass, fishing intensity (SPR) and probability of stock decline in 2028 at the same harvest level would be biased. The simulation results indicated that this bias correspond to a 2-3% overestimate of spawning biomass, a 1% overestimate of SPR (underestimate of fishing intensity) and a 9% underestimate of the probability of stock decline in 2028. Based on recent harvest decision tables, to account for a 9% underestimate of the probability of stock decline the coastwide TCEY would need to be reduced by approximately 4 million pounds, equating to approximately US$24 million in landed catch. Thus, under significantly reduced FISS designs accounting for potential bias in management decisions could have a significant impact on short-term fishery yields and revenue. While the true degree of bias would be unknown (at least until the next comprehensive FISS design was completed), this level of bias (15%) is possible in the reduced designs evaluated here.

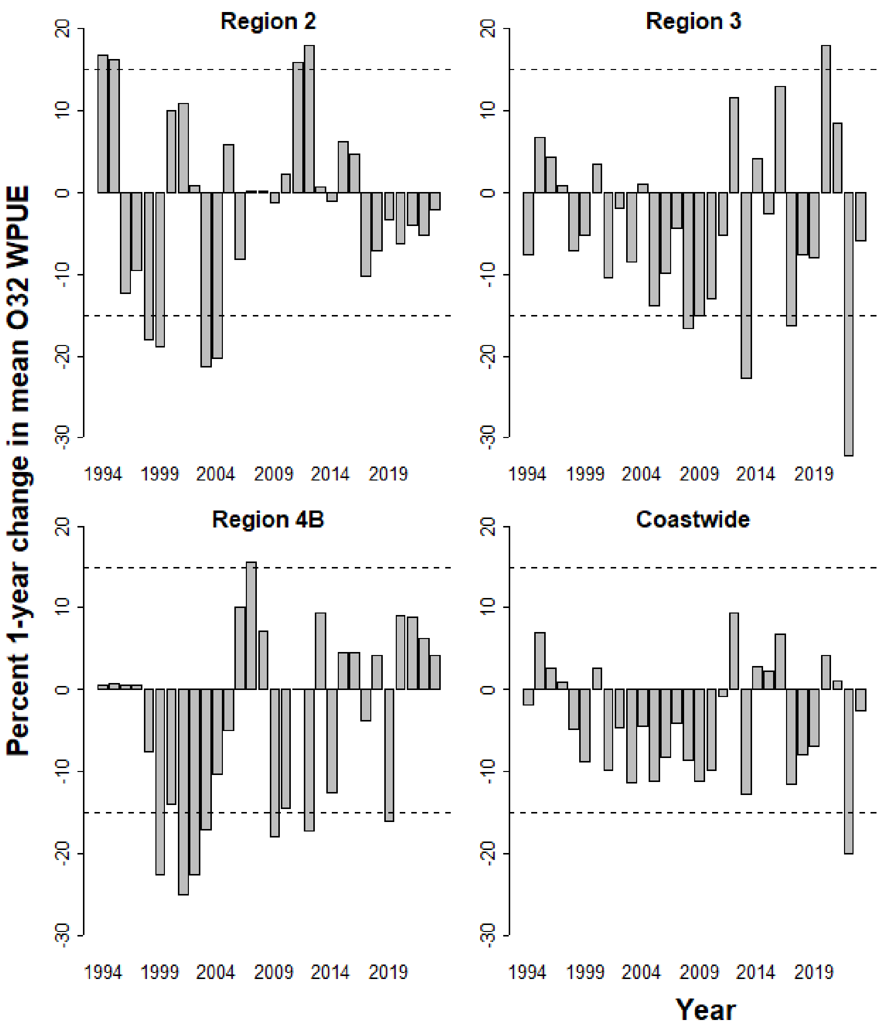

Figure 8. Estimated 1-year changes in mean O32 WPUE by IPHC Biological Region. Dashed lines mark changes of +/-15%.

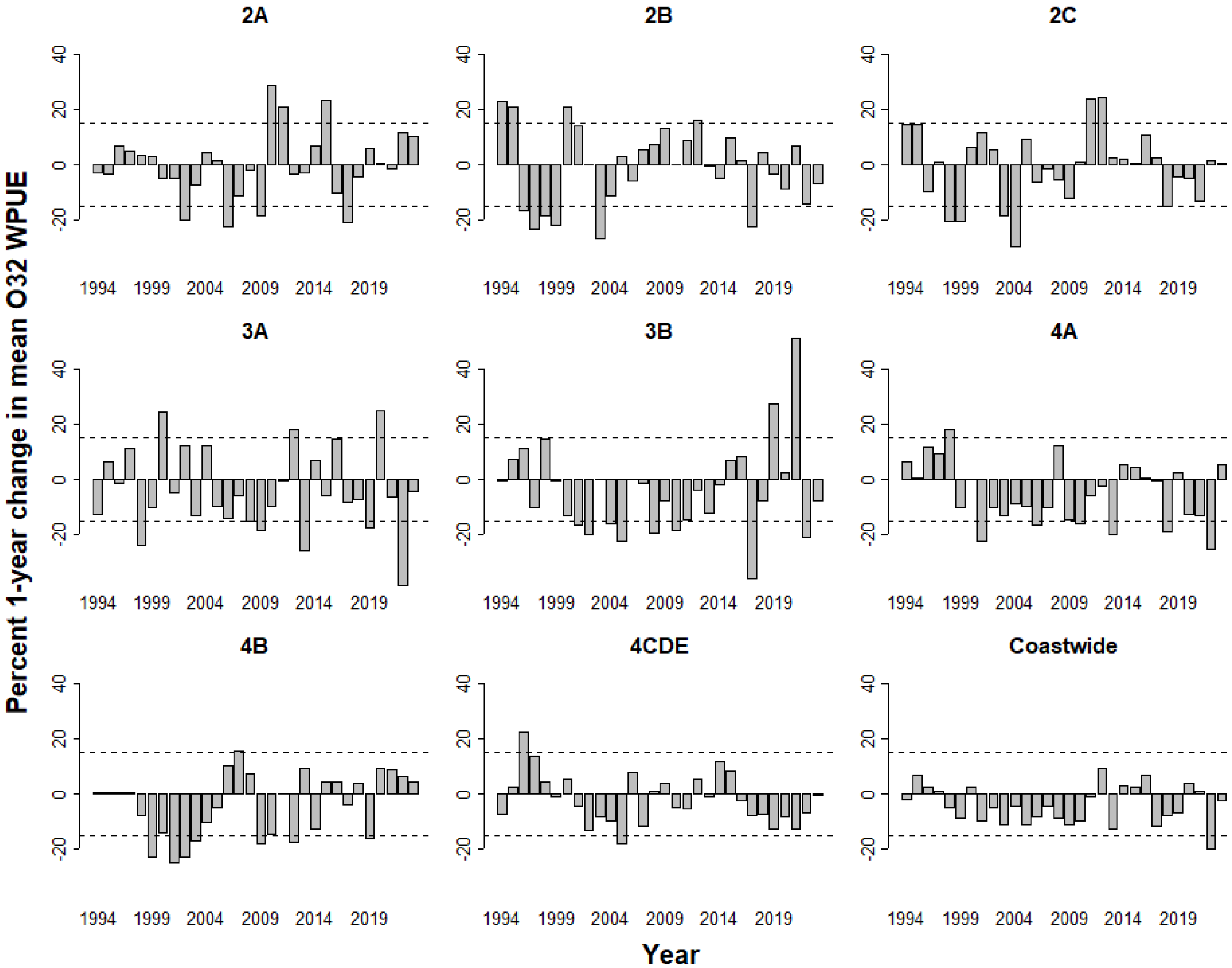

Figure 9. Estimated 1-year changes in mean O32 WPUE by IPHC Regulatory Area. Dashed lines mark changes of +/-15%.

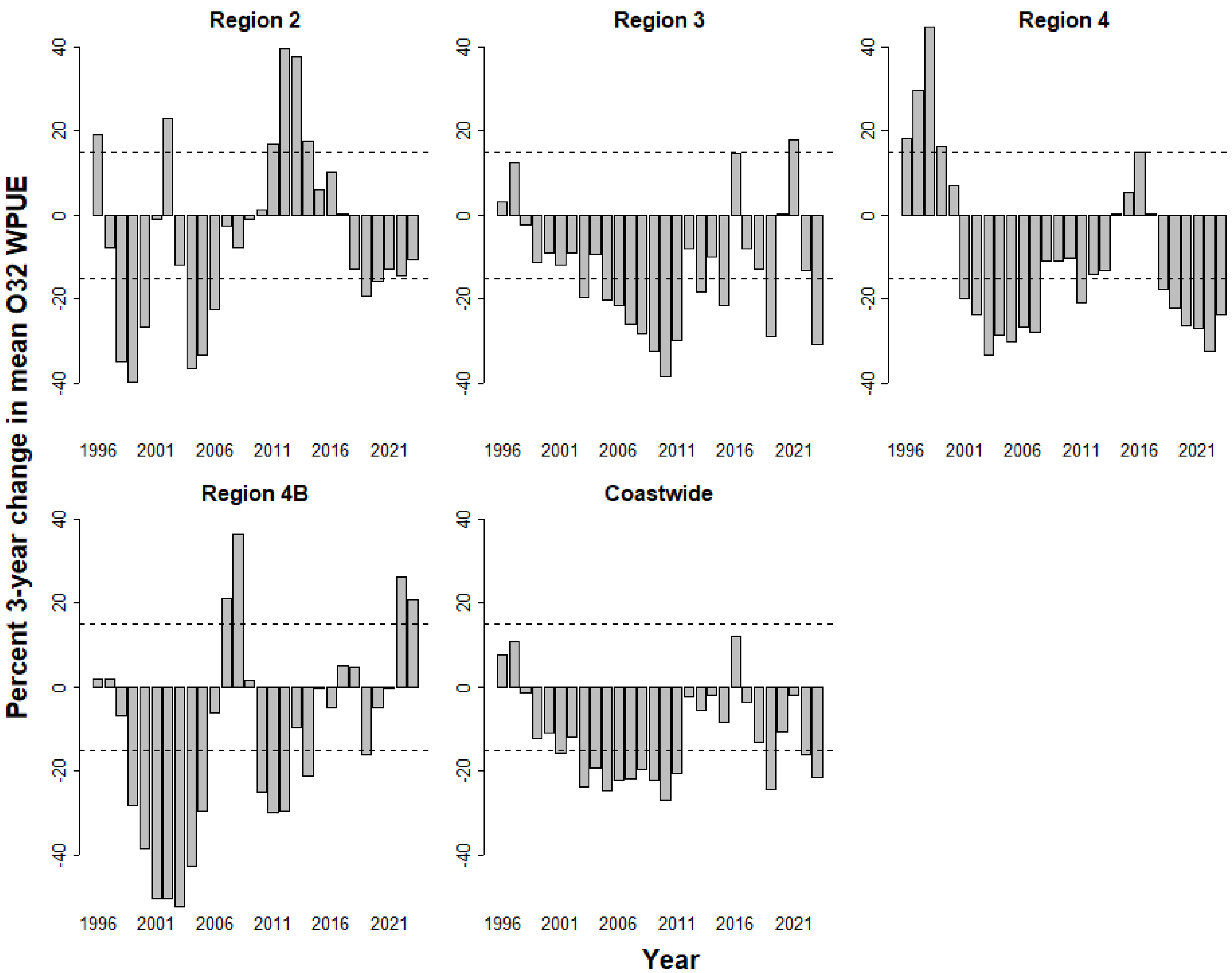

Figure 10. Estimated 3-year changes in mean O32 WPUE by IPHC Biological Region. Dashed lines mark changes of +/-15%.

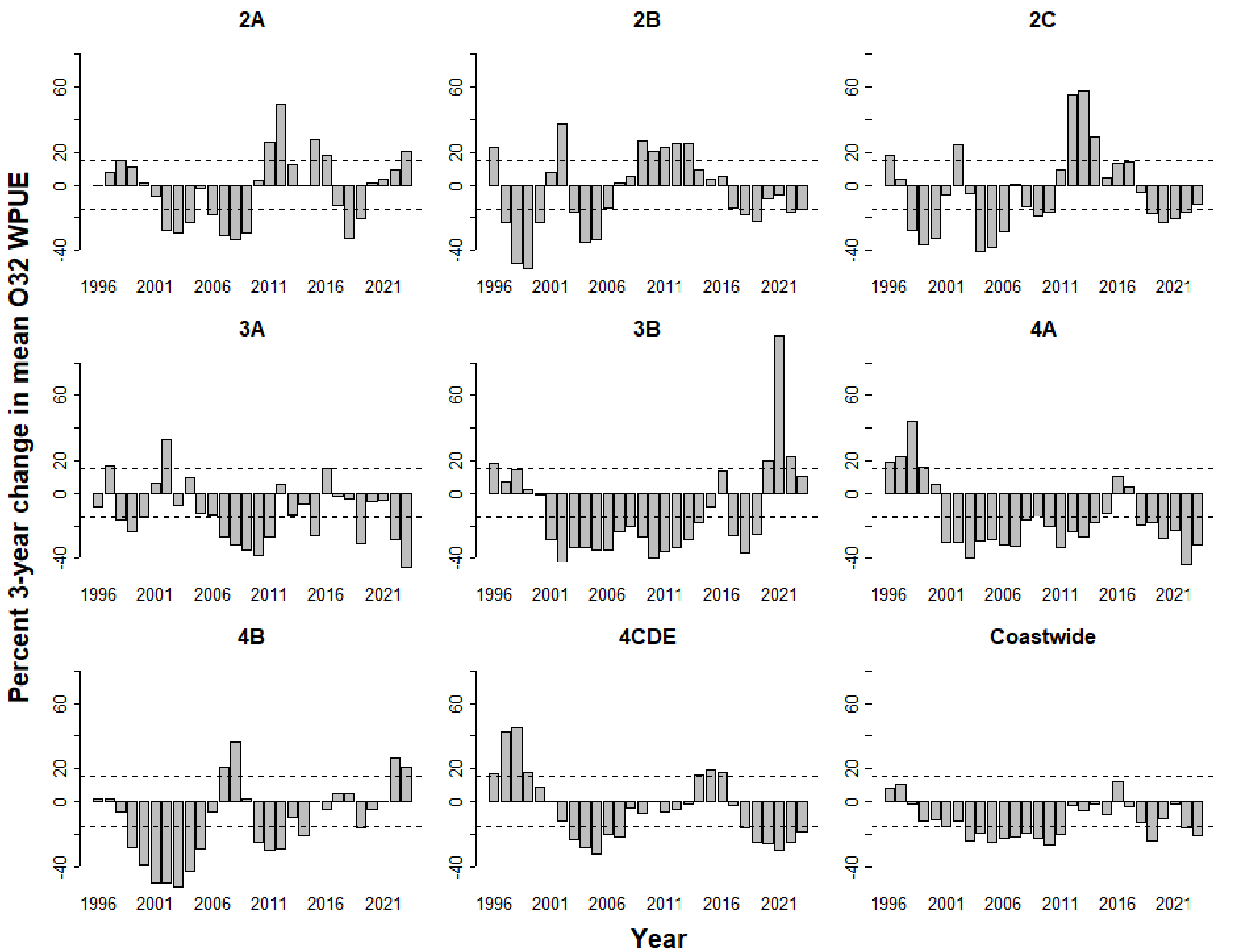

Figure 11. Estimated 3-year changes in mean O32 WPUE by IPHC Regulatory Area. Dashed lines mark changes of +/-15%.

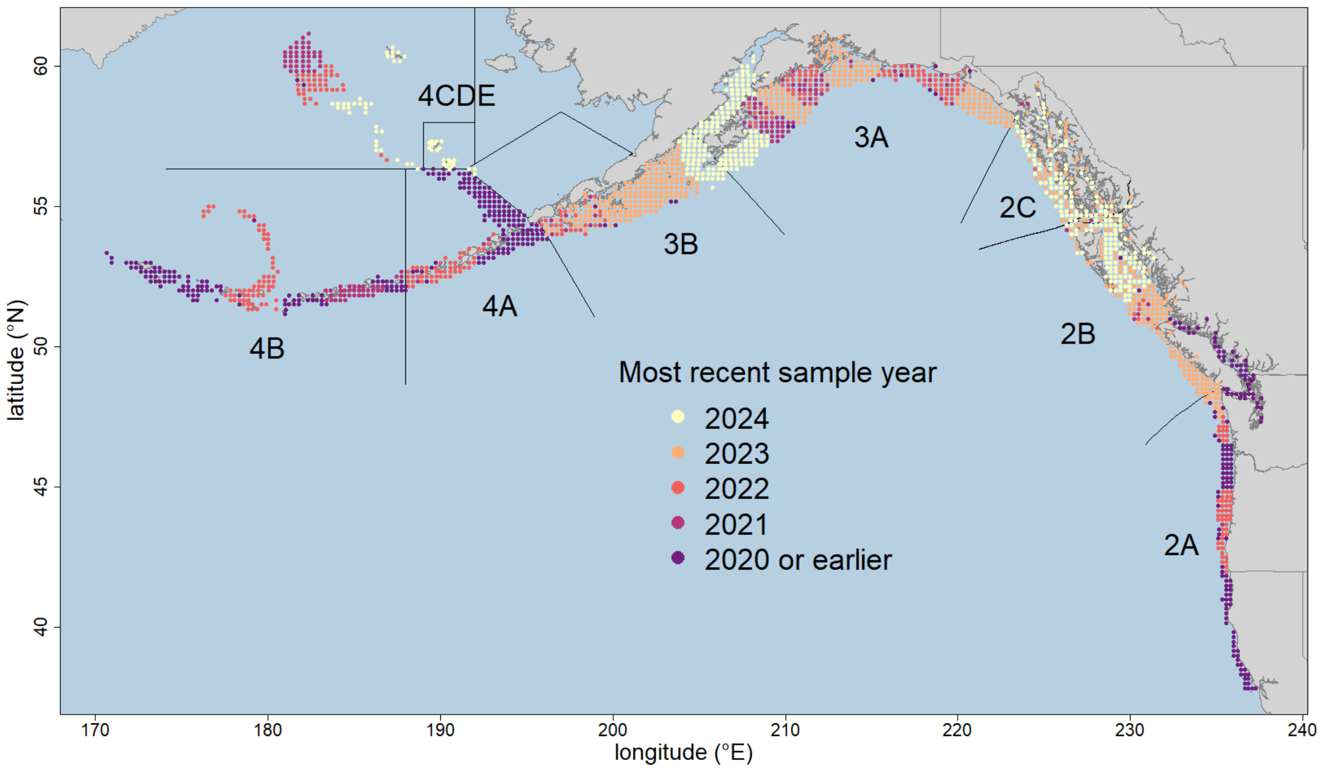

Figure 12. Map of FISS grid stations with coloured circles showing the most recent year each station was fished effectively.

Recommendation

That the Commission **NOTE** paper IPHC-2025-AM101-14 that reviews an optimal long-term FISS design, the approved 2025 FISS design, and discusses the potential for biases that may result from non-optimal designs.

References

DeFilippo, L., Kotwicki, S., Barnett, L., Richar, J., Litzow, M.A., Stockhausen, W.T., and Palof, K. 2023. Evaluating the impacts of reduced sampling density in a systematic fisheries-independent survey design. Frontiers in Marine Science **10**. doi:10.3389/fmars.2023.1219283.

Francis, R.I.C.C., Hurst, R.J., and Renwick, J.A. 2003. Quantifying annual variation in catchability for commercial and research fishing. Fishery Bulletin **101**: 293-304.

IPHC 2024. Report of the 100th session of the IPHC Annual Meeting (AM100). IPHC-2024-AM100-R. 55 p.

IPHC 2024. IPHC Circular 2024-030, Subject: For decision – FISS 2025 design. 4 p.

IPHC 2024. IPHC Circular 2024-031, Subject: For information – Intersessional decisions 2024-ID009 - ID010 FISS 2025 design. 1 p.

Stewart, I. and Hicks, A. 2024. Development of the 2024 Pacific halibut (*Hippoglossus stenolepis*) stock assessment. IPHC-2024-SRB025-06. 12 p.

Webster, R., Stewart, I., Ualesi, K. and Wilson, D. 2024. 2025-27 FISS design evaluation. IPHC-2024-SRB024-06. 26 p.

Webster, R., Stewart, I., Ualesi, K., Jack, T. and Wilson, D. 2024. 2025 and 2026-29 FISS designs. IPHC-2024-SS014-03. 21 p.