2024 and 2025-28 FISS design evaluation

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PURPOSE

To present potential design options for the IPHC's Fishery-Independent Setline Survey (FISS) for the 2024-28 period and cost projections for 2024 design options considered during 2023.

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 81.3cm 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).

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 for use in the IPHC's management procedure. The priority of the current rationalized 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 1.1 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

Annual design review, endorsement, and finalisation process

Since completion of the FISS expansions in 2019, a review process has been developed for annual FISS designs created according to the above objectives:

- Step 1: The Secretariat presents preliminary design options based on the primary objective (Table 1) to the SRB for three subsequent years at the June meeting based on analysis of prior years' data. Commencing in 2024, this will include prior year fiscal details (revenue) and current year vessel contract cost updates;
- Step 2: Design options for the following year that account for both primary and secondary objectives (Table 1) are reviewed by Commissioners at the September work meeting, recognising that revenue and cost data from the current year's FISS are still preliminary at this time;
- Step 3: At their September meeting, the SRB reviews design options accounting for both primary and secondary objectives (Table 1) for comment and advice to the Commission (recommendation);
- Step 4: Designs are further modified to account for updates based on secondary and tertiary objectives before being finalized during the Interim and Annual meetings and the period prior to implementation:
    - Presentation of FISS designs for 'endorsement' by the Commission occurs at the November Interim Meeting;
    - Ad-hoc modifications to the design for the current year (due to unforeseen issues arising) are possible at the Annual Meeting of the Commission;
    - The endorsed design for current year is then modified (if necessary) to account for any additional tertiary objectives or revision to inputs into evaluation of secondary objectives prior (i.e., updated cost estimates) prior to summer implementation (February-April).

Consultation with industry and stakeholders occurs throughout the FISS planning process, at the Research Advisory Board meeting (late November) and particularly in finalizing design details as part of the FISS charter bid process, when stations can be added and other

adjustments made to provide for improved logistical efficiency. We also note the opportunities for stakeholder input during public meetings (Interim and Annual Meetings).

Note that while the review process examines designs for the next three years, revisions to designs for the second and third years are expected during subsequent review periods as additional data are collected. Having design proposals available for three years instead of the next year only assists the Secretariat with medium-term planning of the FISS, and allows reviewers (SRB, Commissioners) and stakeholders to see more clearly the planning process for sampling the entire FISS footprint over multiple years.

POTENTIAL DESIGNS FOR 2024-26

IPHC Secretariat began the design process in early 2023 with the development of design options based on the Primary Objective (Table 1) for 2024-26 (Figures 2 to 4). These designs were presented to the Scientific Review board at their June meeting (IPHC-2023-SRB022-06).

During the operation of the 2023 FISS, it became apparent that low prices for Pacific halibut and lower than expected catches in some charter regions were likely to result in a substantial net operating loss for the FISS in 2023. Preliminary estimates of net revenue for the 2024 design in Figure 2 projected a net operating loss of over $3 million. Optimizing the design for revenue by adding stations in revenue-positive charter regions and adjusting the number of skates still led to a projected loss of almost $3 million. For this reason, neither version of the design was considered feasible (IPHC-2023-SRB023-09).

Projected revenue-positive design for 2024

The IPHC Secretariat developed a series of designs that improved revenue and reduced cost to different degrees. These were presented to the SRB in September 2023 (IPHC-2023-SRB023-09) as well as at the Commissioner Work Meeting that same month. Included in these potential designs was a design that was projected to be slightly revenue-positive. This design has since been revised based on improved cost projections, and includes sampling only in IPHC Regulatory Areas 2B, 2C and one charter region in IPHC Regulatory 3A (Figure 5).

In order to achieve a revenue-positive design, several aspects of the standard FISS procedures were removed:

- No oceanographic monitoring will take place;
- NOAA Fisheries trawl surveys are not staffed by IPHC;
- All FISS training will be conducted virtually;
- Reduce field staff on each vessel from two to one in two charter regions; only basic biological information (length, weight and sex) would be collected.

Additional changes were required to the standard FISS design in sampled areas:

- 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. It is assumed pending further evaluation these stations will achieve 120% of the average catch rate of the usual fixed-station design stations

Further, the following assumptions regarding FISS bait were made:

- That the price of chum salmon is projected to be US$2.00/lb in 2024 and pink salmon US$1.30/lb.

With these modifications and assumptions, this design (Figure 5) has **a projected net operating profit of $3,000**.

Base HQ staff costs (incurred even if no FISS is conducted) are projected to be US$490,000 for 2024. These costs are fully offset, along with all variable costs, in the revenue-positive design (Table 2 and Figure 5).

Variable FISS costs

Due to concerns about the implications of the reduced sampling in the revenue-positive design (see below), IPHC Secretariat also projected costs of additional sampling and monitoring effort should supplementary funding become available. These are presented as a series of modular options that can be added to the revenue positive design (Table 2). All modular options (Table 2, options 2-6, 9) were designed to include an entire charter region or comprise at least 60 stations to increase the likelihood of obtaining one or more competitive bids.

Individual charter regions were added to the revenue neutral design one at a time, selecting the charter region that was closest to net revenue neutrality for each IPHC Regulatory Area (Table 2). The exceptions to this were:

- IPHC Regulatory Area 2A, where 60 stations were selected to encompass higher catch-rate areas in both Washington and Oregon
- IPHC Regulatory Areas 4A/4B where 60 adjacent stations were clustered around the boundary between these areas. The choice of 60 stations was motivated by the lack of bids for the 32 stations proposed in 2023 and intended to provide sufficient work to make the travel required for most vessels to reach 4A/4B worthwhile.

The net cost projected for each of these additional charter regions ranged from $47,000 for IPHC Regulatory Area 3A (Shelikof), to $245,000 for the 60 stations IPHC Regulatory Areas 4A/4B.

Staffing of the NOAA Fisheries trawl survey allows for much more extensive biological sampling (age, length, and weight) of Pacific halibut than is possible otherwise, and also provides a platform for wire-tagging of juvenile halibut in this area to provide long-term monitoring of migratory pathways. These data are used in the annual stock assessment to inform weight-at-age for young Pacific halibut (up to approximately age 6) that are not captured in large numbers by the FISS. As there is not considerable variability in weight-at-age, missing a year of this sampling (as was the case when the NOAA Fisheries trawl survey was cancelled in 2020) would not be a critical problem for subsequent analyses.

Oceanographic monitoring during FISS operations provides a valuable long-term monitoring data set that is used by both IPHC and external fisheries scientists. In some years (e.g., 2017) it has provided valuable supporting information for better interpreting anomalous catch-rates due to hypoxic events (observed periodically, primarily off the coasts of Oregon and Washington). Missing a single year of this time series, although unfortunate for long-term monitoring, would not be problematic for standard stock assessment and management supporting analyses provided for the Commission unless unexpected oceanographic conditions were encountered.

Regarding oceanographic monitoring and trawl survey staffing, we note the following paragraphs from the 2023 reports of the Research Advisory Board (RAB) meeting and IM099:

> IPHC-2023-RAB024-R, para. 32: *The RAB **RECOMMENDED** maintaining the oceanographic sampling program to provide a continuous source of data on environmental conditions experienced by Pacific halibut.*

IPHC-2023-IM099-R, para. 54: *The Commission **AGREED** to consider whether to maintain the oceanographic sampling program to provide a continuous source of data on environmental conditions experienced by Pacific halibut, and whether to staff the NOAA trawl surveys, in January 2024.*

Table 2. Comparison of design alternative costs for the 2024 FISS; see text for additional details on each design. Each of Options 2-9 can be added in any combination by summing the additional costs for each option selected.

Option	Design	IPHC Regulatory Areas sampled (charter regions)	Additional net cost (approximate)
1	Revenue positive with efficiencies	2B (2), 2C (3), 3A (1)	--
2	Add additional 3A to Option 1	2B (2), 2C (3), 3A (**2**)	($47,000)
3	Add 3B to Option 1	2B (2), 2C (3), 3A (1), **3B (1)**	($62,000)
4	Add 4A/4B to Option 1	2B (2), 2C (3), 3A (1), **4A+4B (1)**	($245,000)
5	Add 2A to Option 1	2B (2), 2C (3), 3A (1), **2A (1)**	($134,000)
6	Add additional 2B to Option 1	2B (**3**), 2C (3), 3A (1)	($68,000)
7	Add oceanographic monitoring to Option 1	2B (2), 2C (3), 3A (1)	($55,000)[1]
8	Add trawl survey staffing to Option 1	2B (2), 2C (3), 3A (1)	($120,000)
9	Add 4CDE to Option 1	2B (2), 2C (3), 3A (1), **4CDE (1)**	($205,000)

[1] The estimated expense for adding oceanographic monitoring would scale according to the number of regions included in the design. It is projected that with each additional region, expenses would increase by approximately $10,000.

At IM099, the Commission agreed on an optimized version of the revenue positive design:

IPHC-2023-IM099-R, para. 51: *The Commission **AGREED** on an optimized design for the 2024 FISS as provided at Appendix IV, that balances the Commission's primary and secondary objectives for the FISS. Specifically, the 2024 design shall include Options 1, 2, and 3 from Table 2. In addition, Option 4 shall be included in the RFT process but is not yet endorsed. Once bids are received and evaluated in February 2024, the Commission will make a final decision on whether to proceed or not with Option 4, based on bids and logistical constraints at that time and potentially a new option* [Option 9] *for IPHC Regulatory Area 4CDE.*

The design that adds Options 2-4 and Option 9 from Table 2 to the revenue positive design is shown in Figure 6.

Implications of the optimized revenue neutral design in 2024

In IPHC-2023-IM099-13 Rev_1 we discussed the implications of the reduced sampling in the revenue positive design (Figure 5) for data quality that affect estimates of stock trends and distribution together with biological inputs into the stock assessment. The optimized design in Figure 6 offers a significant improvement over the revenue positive design, with sampling over

a greater spatial extent leading to data from all IPHC Biological Regions and all IPHC Regulatory Areas except 2A.

The proposed sampling in IPHC Regulatory Areas 3A and 3B should lead to coefficients of variation for WPUE and NPUE indices in the range of 10-20%. Sampling some stations in the highest density parts of IPHC Regulatory Areas 4A and 4B (Option 4) should be sufficient to maintain CVs around 20% for these areas. In all four areas there remains a risk of bias due to stock trends in unsampled habitat differing from those in sampled charter regions, but this risk is reduced relative to Option 1 alone.

With a NOAA Fisheries trawl survey expected to take place in the Bering Sea in 2024, the CV for IPHC Regulatory Area 4CDE is not expected to increase much above 10% even without Option 9, but the additional sampling from Option 9 will reduce the risk of bias in estimates calculated for that area.

We anticipate the coastwide WPUE and NPUE indices to have CVs that remain in the target range of ≤10%. Estimates of stock distribution will have higher levels of uncertainty and bias risk than in past years for the optimized design (Figure 6), but with samples from all IPHC Biological Regions, the risks are lower than for the revenue positive design.

This 2024 spatial design will result in less information available for the annual stock assessment and management supporting calculations such as stock distribution than in recent years. 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. Given current spatial variability and uncertainty in the magnitude of younger year classes (2012 and younger), the limited biological information from the core of the stock distribution (Biological Region 3) makes it unclear whether the stock assessment will detect a major change in year class abundance, either up or down. Although the basic stock assessment methods can remain unchanged, a greater portion of the actual uncertainty in stock trend and demographics will not be able to be quantified due to missing FISS data from a large fraction of the Pacific halibut stock's geographic range.

FUTURE FISS DESIGNS

At IM099, Secretariat staff also presented options for 2024 and subsequent years based on rotational block designs (IPHC-2023-IM099-13 Rev_1, Part 2). For these designs, the random selection of FISS stations in IPHC Regulatory Areas 2B, 2C, 3A and 3B would be replaced with sampling complete charter regions in each area, with sampled regions rotated over a two-three year period depending on area. This type of design was first proposed in 2019 (IPHC-2019-IM095-07 Rev_1, Figure 4) to complement the similar subarea design proposed and adopted for areas at the ends of the stock (2A, 4A and 4B).

Block designs are potentially more efficient from an operational perspective than a randomized design, as they involve less running time between stations, possibly leading to cost reductions on a per station basis.

The block designs shown in Figures 7 to 11 for 2024-28 (called the "base block design") were presented to Commissioners at IM099. These 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 minimizing the potential for bias and maintaining CVs below 25% for each IPHC Regulatory Area. We note that paragraph 52 of the IM099 report (IPHC-2023-IM099-R) states:

> *The Commission **AGREED** that the base block design (Figs. 2.1 to 2.5 of paper IPHC-2023-IM099-13 Rev_1) or a block design with similar sampling effort looks promising for*

implementation as an alternative to FISS designs based on random sampling in the core of the stock.

For the core areas, projected CVs were generally higher than in recent years (IPHC-2023-IM099-13 Rev_1, Part 2) for the base block design, but remain below 15% for IPHC Regulatory Areas 2B, 2C and 3A while reaching 16% for IPHC Regulatory Area 3B. Even with reduced spatial coverage, sampling all stations in the core over a three-year period is projected to provide sufficient information to the space-time model to ensure precise estimates of the O32 WPUE index. At the ends of the stock, CVs for IPHC Regulatory Areas 2A, 4A and 4B were projected to be between 15 and 20%, similar to recent years in which not all planned sampling was able to be undertaken. Biological Region CVs are projected to be 5-9% (with 4B at 16%), with a 5% CV for the coastwide mean.

The base block design maintains good spatial coverage each year and complete spatial coverage in the core of the stock over a three-year period. While CVs are generally higher than recent values, estimates of O32 WPUE indices remain precise in the core and have acceptable precision elsewhere. Estimates of stock distribution computed from these indices would be expected to have similar levels of precision, sufficient for management decision making. Biological data used as input to the IPHC stock assessment will come from throughout the stock's range over a relatively short time frame, reducing the likelihood that the relative strength of important cohorts is estimated imprecisely or inaccurately. The indices of abundance by Biological Region and coastwide that are used in the stock assessment would continue to provide a reliable estimate of stock trend.

Revenue projections beyond one year are highly speculative. Therefore, base block design cost projections have been made as if each design were to be applied in 2024. Even modest changes in costs, price, or catch-rates can have a large effect on the net revenue of future FISS activity, as observed in the rapid changes from 2021 to 2023. The base block designs reported here reduce sampling in some high-cost areas, but also in some revenue positive areas. Therefore, **the Secretariat recommends that consistent supplementary funding of approximately $1.5 million per year would be needed to allow implementation of the base block designs reported here over 2024-2028.**

RECOMMENDATIONS

That the Commission:

1) **NOTE** paper IPHC-2024-AM100-13 that presents potential design options for the IPHC's Fishery-Independent Setline Survey (FISS) for the 2024-28 period and cost projections for 2024 design options considered during 2023;
2) **ENDORSE** proceeding with the revenue neutral design for 2024 proposed here in order to cover all fixed headquarters costs, and to provide data for basic trend estimation and biological data for use in the 2024 stock assessment. Specifically, the Secretariat recommends fishing two charter regions in IPHC Regulatory Area 2B, three regions in IPHC Regulatory Area 2C and one region in IPHC Regulatory Area 3A (Option 1, Table 2; Figure 5), with added efficiencies as described above.
3) **ENDORSE** sampling additional charter regions in IPHC Regulatory Areas 3A (1) and 3B (1) (Options 2 and 3, Table 2) as agreed by the Commission at IM099, and prioritize the addition of Option 4 to the 2024 FISS design so that data are obtained from all four biological regions and the potential for bias in trend estimates is further reduced.

4) **ENDORSE** the use of the base block design (Figures 7 to 11) for future planning or a block design with similar sampling effort as an alternative to FISS designs based on random sampling in the core of the stock;

5) **ENDORSE** maintaining sufficient FISS sampling to ensure a maximum annual CV of 25% in each IPHC Regulatory Area, decreasing to 15% as financial considerations allow, and including FISS biological sampling in all Biological Regions each year;

6) **NOTE** that stock assessment and MSE simulation analyses will be conducted in 2024 to further explore the effect on annual tactical and strategic decision-making of reduced FISS designs in the future.

REFERENCES

IPHC 2019. Report of the 95th Session of the IPHC Interim Meeting (IM095) IPHC-2019-IM095-R. 30 p. 15 p.

IPHC 2023. Report of the 24th Session of the IPHC Research Advisory Board (RAB024) IPHC-2023-RAB024-R.

IPHC 2023. Report of the 99th Session of the IPHC Interim Meeting (IM099) IPHC-2023-IM099-R. 29 p.

Webster, R. A. 2022. 2023-25 FISS design evaluation. IPHC-2022-SRB021-06. 12 p.

Webster, R. A. 2023. 2024-26 FISS design evaluation. IPHC-2023-SRB022-06. 22 p.

Webster, R., Stewart, I., Ualesi, K. and Wilson, D. 2023. 2024-26 FISS design evaluation. IPHC-2023-SRB023-09. 24 p.

Webster, R., Stewart, I., Ualesi, K. and Wilson, D. 2023. 2024 and 2025-28 FISS design evaluation. IPHC-2023-IM099-13 Rev_1. 30 p.

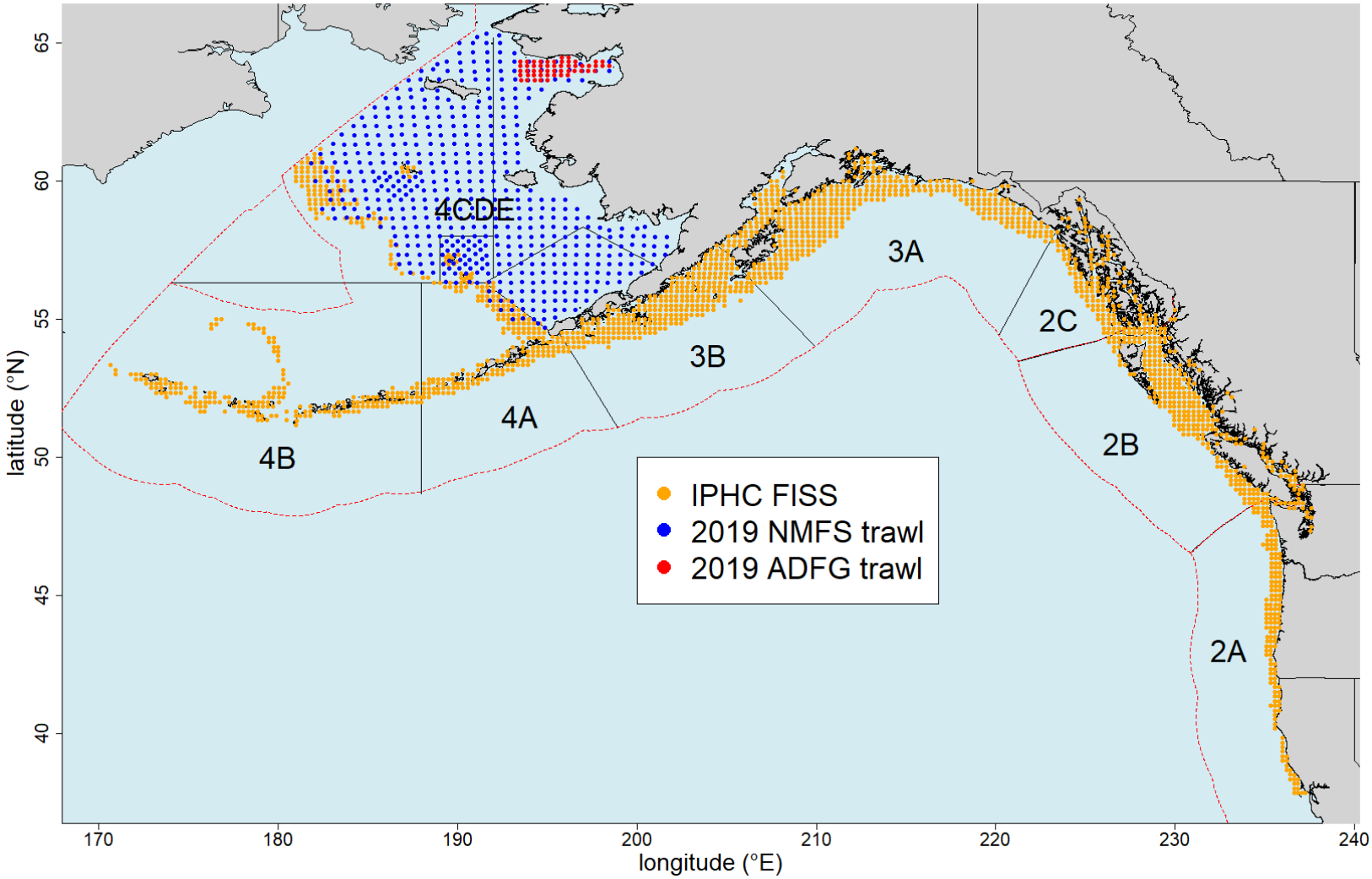

Figure 1. Map of the full 1890 station FISS design, with orange circles representing stations available for inclusion in annual sampling designs, and other colours representing trawl stations from 2019 NOAA and ADFG surveys used to provide complementary data for Bering Sea modelling.

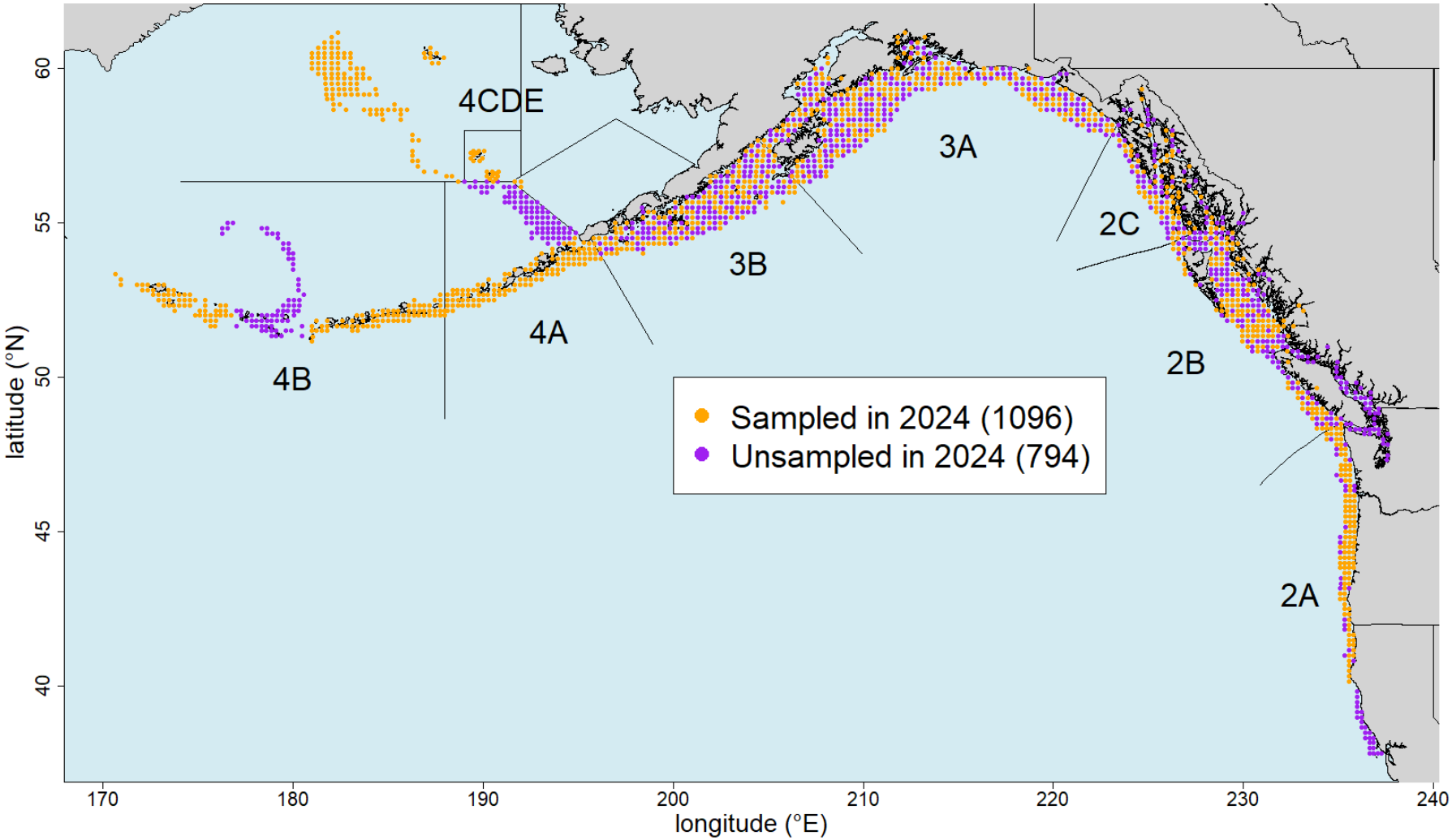

Figure 2. Potential FISS Design 1 in 2024 (orange circles) based on prioritization of the Primary Objective in Table 1. The design relies on randomized sampling in 2B-3B, and a subarea design elsewhere. Purple circles are optional for meeting data quality criteria.

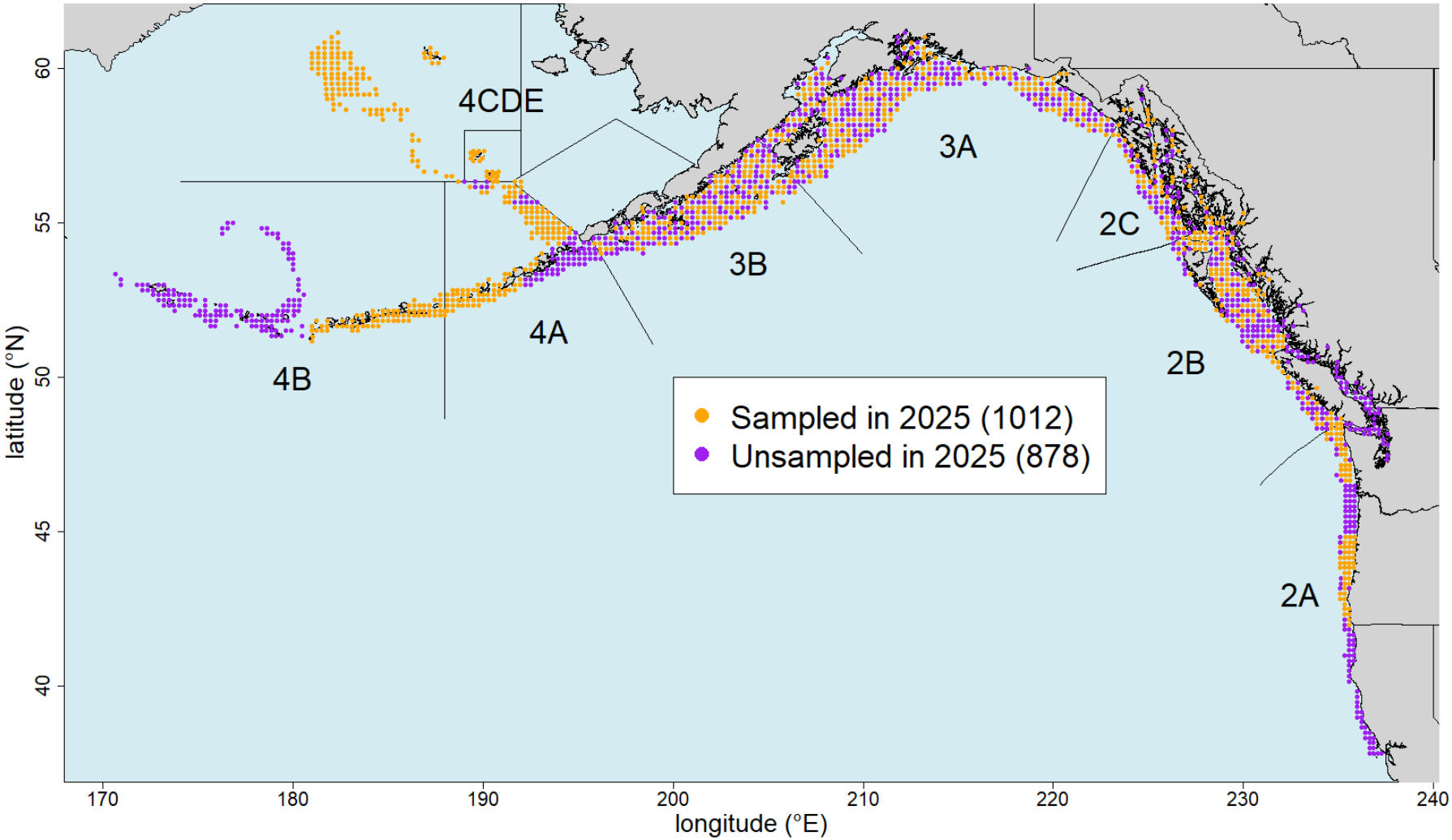

Figure 3. Potential FISS design in 2025 (orange circles) based on prioritization of the Primary Objective in Table 1. The design relies on randomized sampling in 2B-3B, and a subarea design elsewhere. Purple circles are optional for meeting data quality criteria.

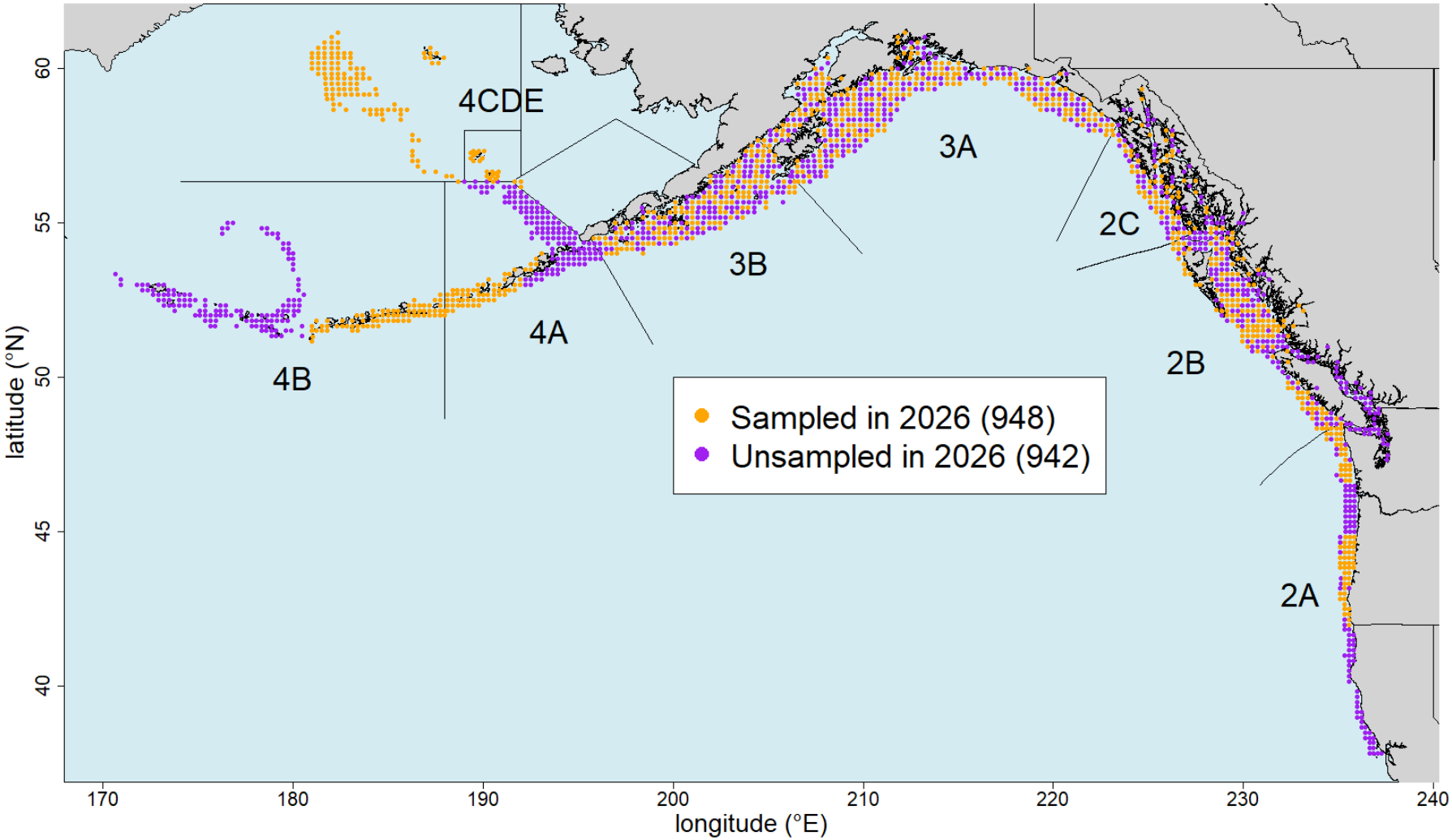

Figure 4. Potential FISS design in 2026 (orange circles) based on prioritization of the Primary Objective in Table 1. The design relies on randomized sampling in 2B-3B, and a subarea design elsewhere. Purple circles are optional for meeting data quality criteria.

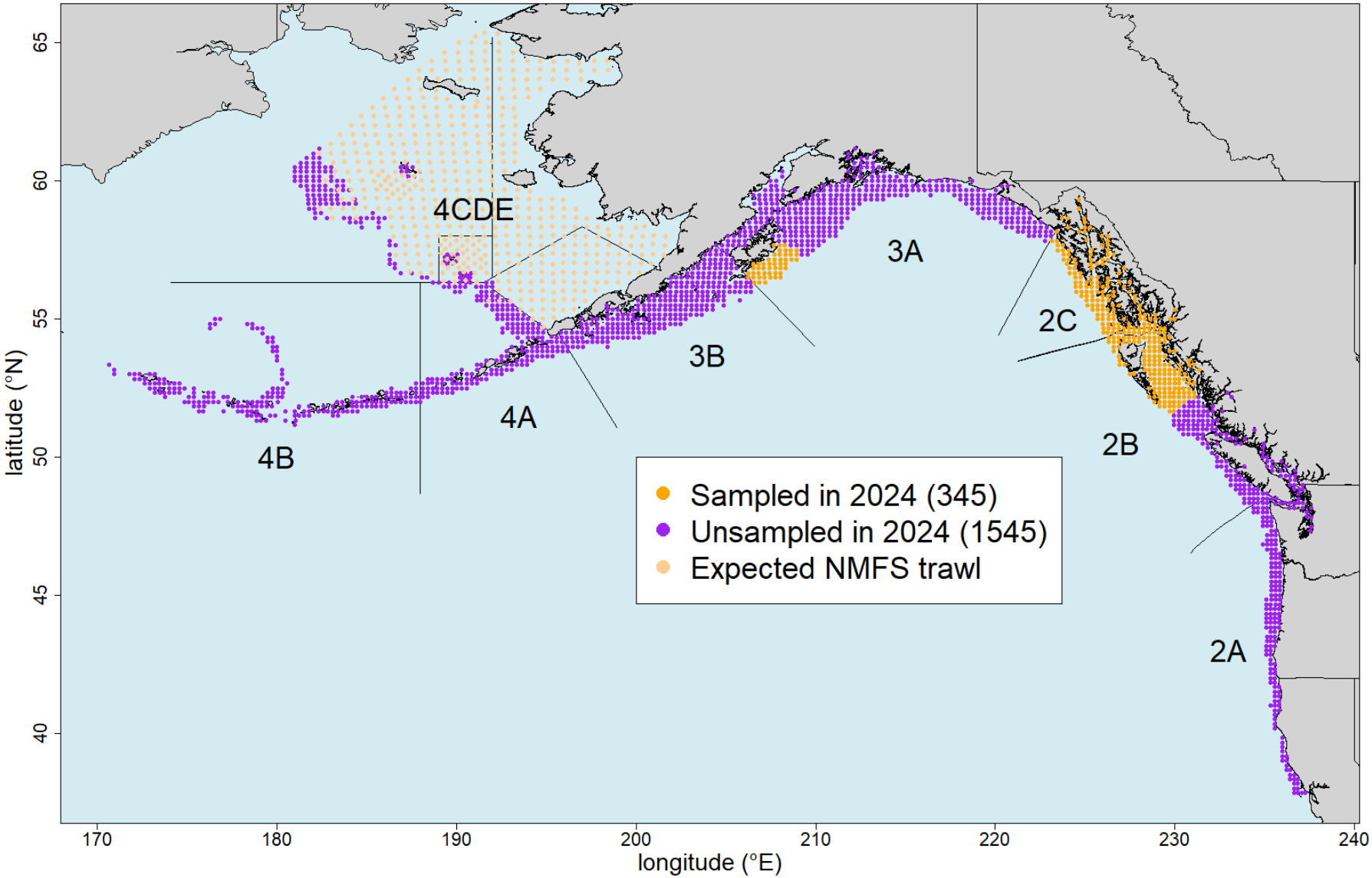

Figure 5. FISS design in 2024 (orange circles) based on prioritization of the Secondary Objective in Table 1. See text for more information.

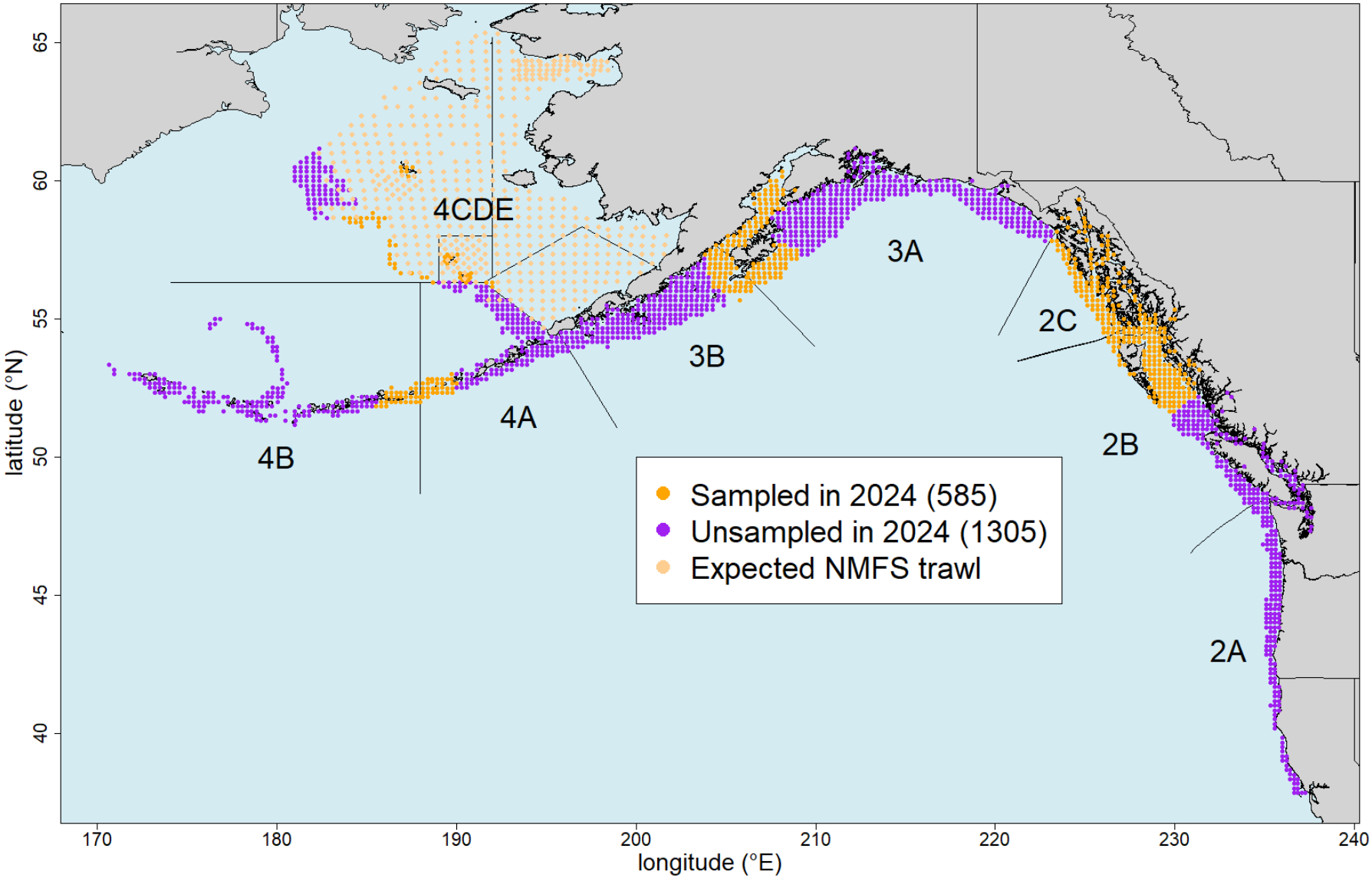

Figure 6. FISS design in 2024 (orange circles) based on the revenue positive design (Figure 5) plus options 2-4 and option 9 from Table 2. See text for more information.

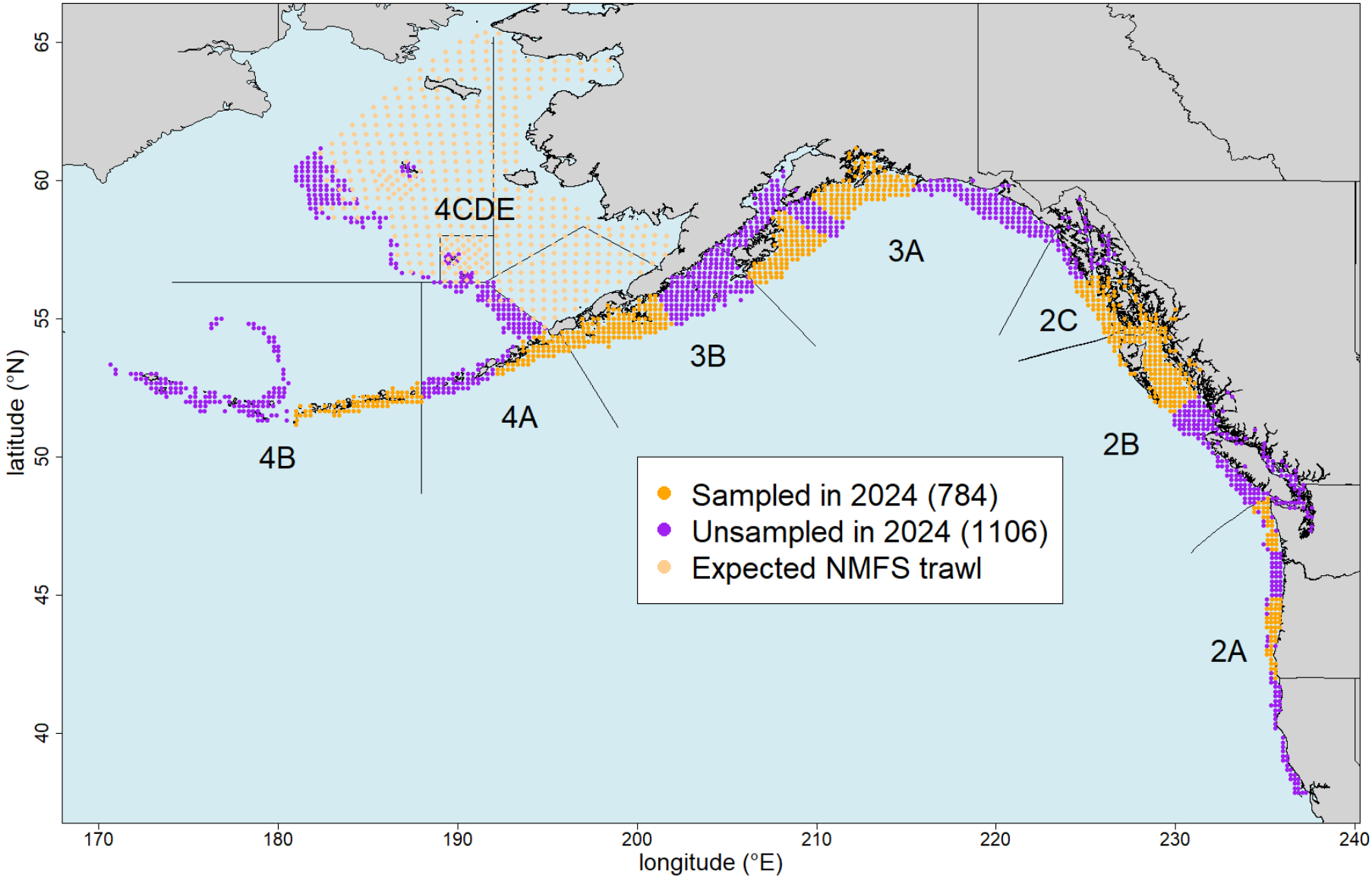

Figure 7. Base block design in 2024 (orange circles). Design is based on fishing 2-4 complete blocks of stations (charter regions) in the core areas (2B, 2C, 3A and 3B) and previously implemented subareas elsewhere.

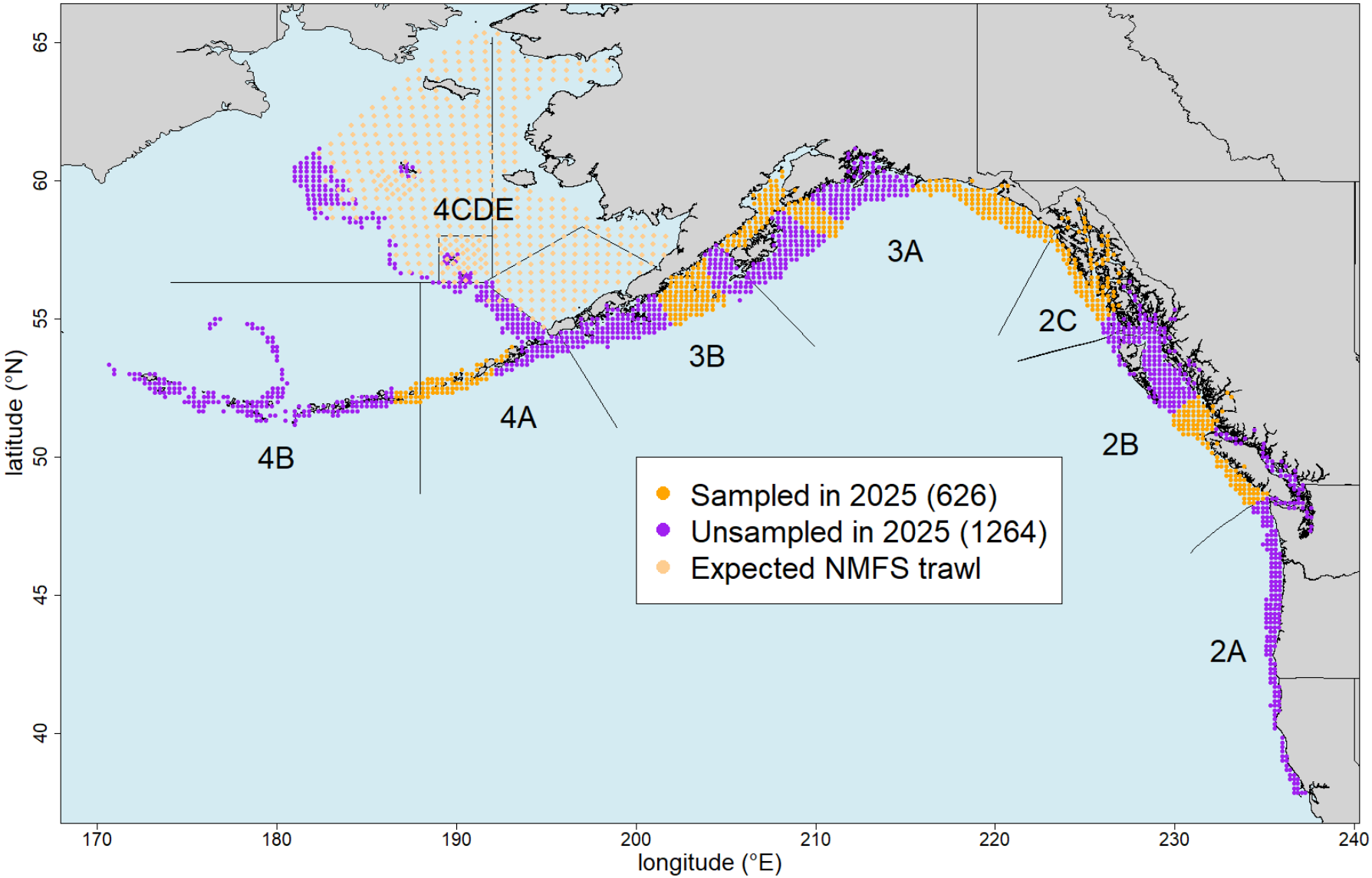

Figure 8. Base block design in 2025 (orange circles). Design is based on fishing 2-4 complete blocks of stations (charter regions) in the core areas (2B, 2C, 3A and 3B) and previously implemented subareas elsewhere.

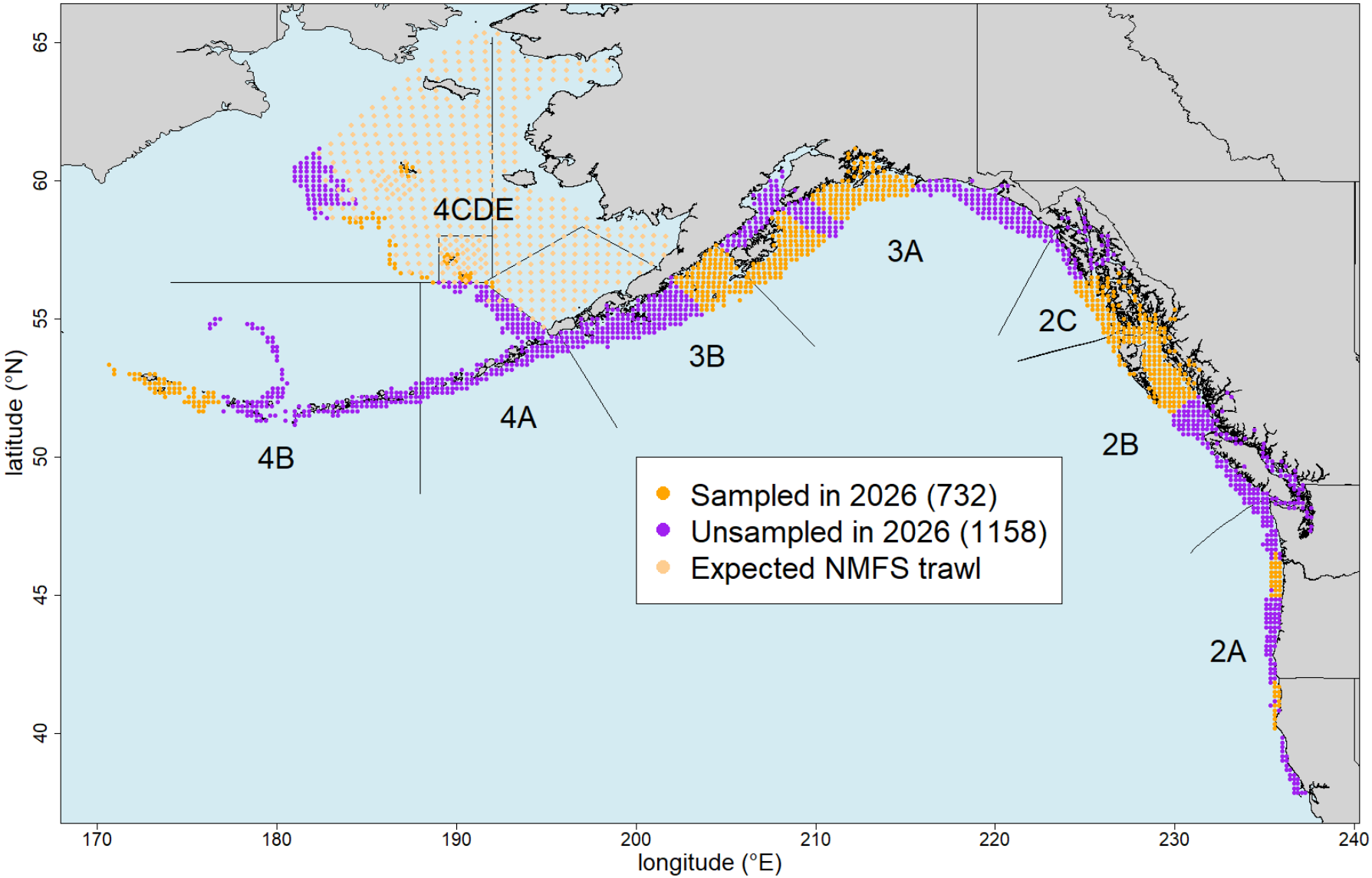

Figure 9. Base block design in 2026 (orange circles). Design is based on fishing 2-4 complete blocks of stations (charter regions) in the core areas (2B, 2C, 3A and 3B) and previously implemented subareas elsewhere.

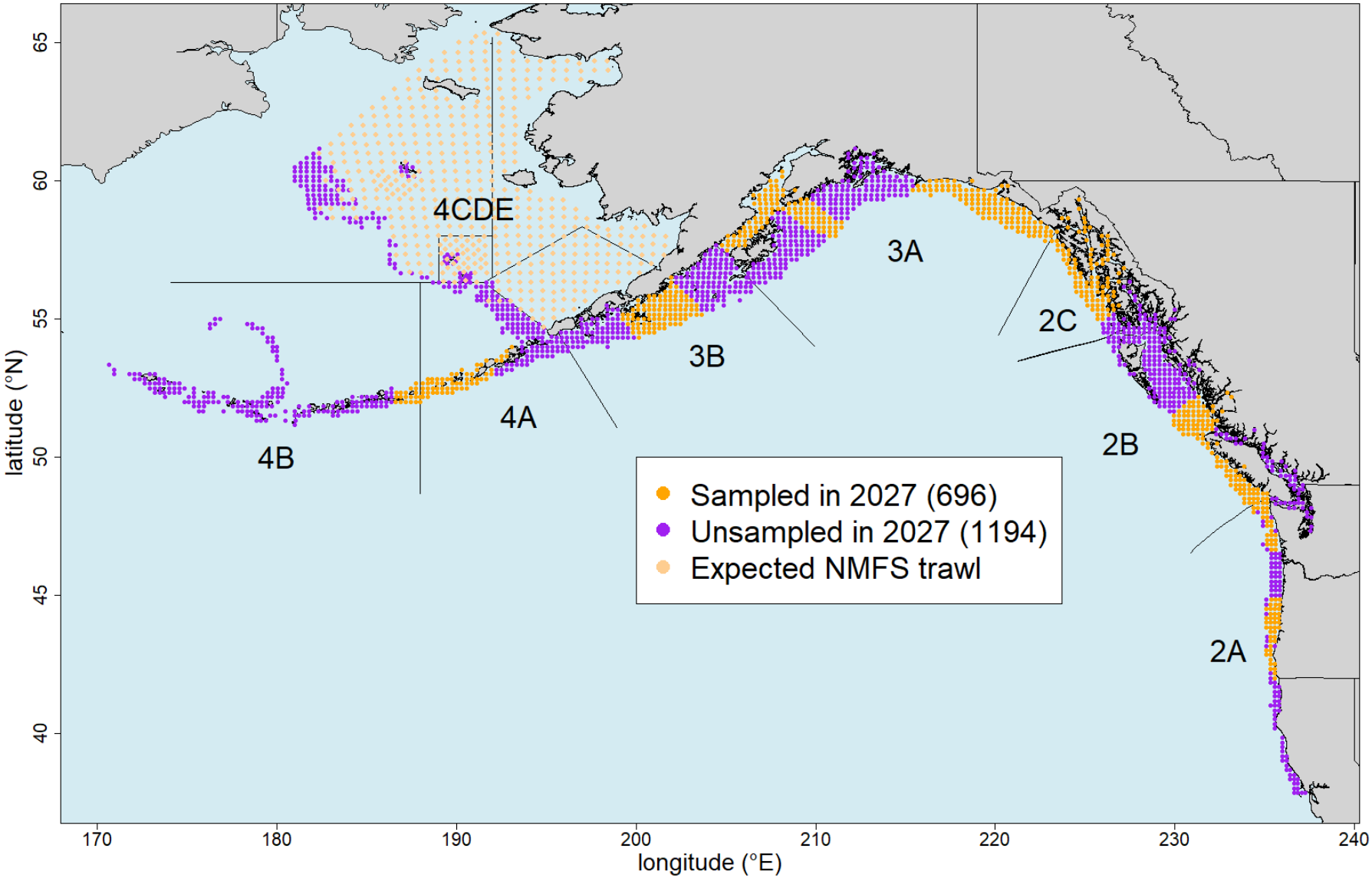

Figure 10. Base block design in 2027 (orange circles). Design is based on fishing 2-4 complete blocks of stations (charter regions) in the core areas (2B, 2C, 3A and 3B) and previously implemented subareas elsewhere.

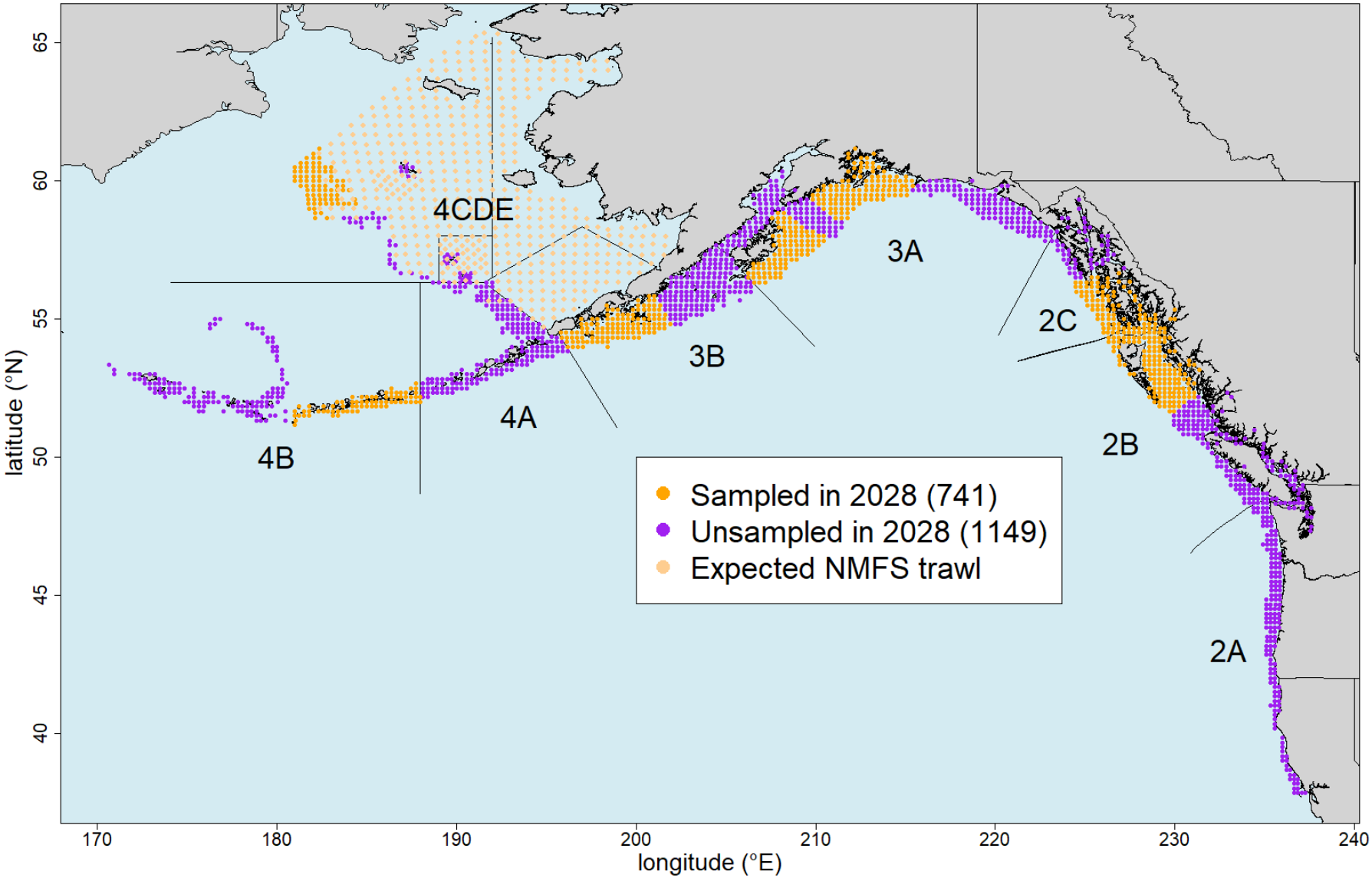

Figure 11. Base block design in 2028 (orange circles). Design is based on fishing 2-4 complete blocks of stations (charter regions) in the core areas (2B, 2C, 3A and 3B) and previously implemented subareas elsewhere.