2026-28 FISS design evaluation

PREPARED BY: IPHC SECRETARIAT (R. WEBSTER, I. STEWART, K. UALESI, T. JACK & D. WILSON; 09 MAY 2025)

PURPOSE

To present the SRB with potential FISS designs for 2026-28, including a preliminary cost evaluation of the 2026 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 81.3cm 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).

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. Effort has been concentrated in IPHC Regulatory Areas 2B, 2C, 3A and 3B, with limited sampling in other areas (Figures 2 and 3). 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 IPHC reserve funds. Following SS014, the final 2025 FISS design was approved via inter-sessional agreement (IPHC-2024-CR-030, IPHC-2024-CR-031; Figure 3). This design included sampling of FISS charter regions in IPHC Regulatory Areas 3A, 3B, 4A and 4B that were unsampled in either 2023, 2024 or both.

FISS history 1993-2019

The IPHC has undertaken FISS activity since the 1960s. However, methods were not standardized to a degree (e.g., the bait and gear used) that allows for simple combined analyses until 1993. From 1993 to 1997, the annual design was a modification of a design developed and implemented in the 1960s, and involved fishing triangular clusters of stations, with clusters located on a grid (IPHC 2012). Coverage was limited in most years and was generally restricted to IPHC Regulatory Areas 2B through 3B. The modern FISS design, based on a grid with 10 nmi (18.5 km) spacing, was introduced in 1998, and over the subsequent two years was expanded to include annual coverage in parts of all IPHC Regulatory Areas within the depth ranges of 20-

275 fathoms (37-503 m) in the Gulf of Alaska and Aleutian Islands, and 75-275 fathoms (137-503 m) in the Bering Sea (IPHC 2012). Annually-fished stations were added around islands in the Bering Sea in 2006, and in the same year, a less dense grid of paired stations was fished in shallower waters of the southeastern Bering Sea, providing data for a calibration with data from the annual National Marine Fishery Service (NMFS) bottom trawl survey (Webster et al. 2020).

Through examination of commercial logbook data and information from other sources, it became clear by 2010 that the historical FISS design had gaps in coverage of Pacific halibut habitat that had the potential to lead to bias in estimates derived from its data. These gaps included deep and shallow waters outside the FISS depth range (0-20 fathoms and 275-400 fathoms), and unsurveyed stations on the 10 nmi grid within the 20-275 fathom depth range within each IPHC Regulatory Area. This led the IPHC Secretariat to propose expanding the FISS to provide coverage of the unsurveyed habitat with United States and Canadian waters. In 2011 a pilot expansion was undertaken in IPHC Regulatory Area 2A, with stations on the 10 nmi grid added to deep (275-400 fathoms) and shallow (10-20 fathoms) waters, the Salish Sea, and other, smaller gaps in coverage. The 10-fathom limit in shallow waters was due to logistical difficulties in standardized fishing of longline gear in shallower waters. A second expansion in IPHC Regulatory Area 2A was completed in 2013, with a pilot survey in California waters between the latitudes of 40 and 42°N.

The full expansion program began in 2014 and continued through 2019, resulting in the sampling of the entire FISS design of 1890 stations in the shortest time logistically possible. The FISS expansion program allowed us to build a consistent and complete picture of Pacific halibut density throughout its range in Convention waters. Sampling the full FISS design has reduced bias as noted above, and, in conjunction with space-time modelling of survey data (see below), has improved precision and fully quantified the uncertainty associated with estimates based on partial annual sampling of the species range. It has also provided us with a complete set of observations over the full FISS design (Figure 1) from which an optimal subset of stations can be selected when devising annual FISS designs. This station selection process began in 2019 for the 2020 FISS and continues with the current review of design proposals for 2024-26. Note that in the Bering Sea, the full FISS design does not provide complete spatial coverage, and FISS data are augmented with calibrated data from National Marine Fisheries Service (NMFS) and Alaska Department of Fish and Game (ADFG) trawl surveys (stations can vary by year – 2019 designs are shown in Figure 1). Both supplementary surveys have been conducted approximately annually in recent years.

Rationalized FISS, 2020-25

Following the 2011-2019 program of FISS expansions, rationalized FISS designs were approved for 2020 based on random selection of over 50% of stations in the core of the stock (IPHC Regulatory Areas 2B, 2C, 3A and 3B) and sampling of all stations in selected subareas of the remaining IPHC Regulatory Areas. For the latter areas, sampling priorities were determined based on maintaining precise estimates of area-specific indices of density and ensuring low bias in index estimators. That year, the COVID19 pandemic led to a reduced FISS with sampling only in the core areas. The 2021-22 FISS sampling proceeded largely as designed, although with planned stations in western IPHC Regulatory 4B in 2022 unsampled due to a lack of viable charter bids. In some charter regions in the core areas, 100% of stations were sampled in order to achieve revenue goals (see below). The 2023 FISS design had more limited spatial coverage, with almost no FISS sampling outside of the core areas due to large projected revenue losses from designs that included extensive sampling in IPHC Regulatory Areas 2A, 4A, 4B and 4CDE.

Limited sampling was carried out in northern IPHC Regulatory 2A, while planned stations around the IPHC Regulatory Area 4A/4B boundary were not sampled due to a lack of charter bids. The adopted 2024 FISS design (IPHC-2024-AM100-R) included high sampling rates in IPHC Regulatory Areas 2B and 2C, a small number of charter regions in IPHC Regulatory Areas 3A and 3B, and sampling of the southern shelf edge and Bering Sea islands in IPHC Regulatory Area 4CDE (Figure 2). The 2025 design includes stations in IPHC Regulatory Areas 3A and 3B that complement coverage in recent years (Figure 3), along with stations in IPHC Regulatory Areas 2A, 4A and 4B that have not been sampled for three or more years and is therefore expected to reduce the potential for bias in most IPHC Regulatory Areas relative to recent years.

Space-time modelling

In 2016, a space-time modelling approach was introduced to estimate time series of weight and numbers-per-unit-effort (WPUE and NPUE), and to estimate the stock distribution of Pacific halibut among IPHC Regulatory Areas. This represented an improvement over the largely empirical approach used previously, as it made use of additional information within the survey data regarding the degree of spatial and temporal correlation in Pacific halibut density, along with information from covariates such as depth (see Webster 2016, 2017). It also allowed a more complete accounting of uncertainty; for example, prior to the use of space-time modelling, uncertainty due to unsurveyed regions in each year was ignored in the estimation. Prior to the application of the space-time modelling, these unsampled regions were either filled in using independently estimated scalar calibrations (if fished at least once), or catch-rates at unsampled stations were assumed to be equal to the mean for the entire Regulatory Area. The IPHC's Scientific Review Board (SRB) has provided supportive reviews of the space-time modelling approach (e.g., IPHC-2018-SRB013-R), and the methods have been published in a peer-review journal (Webster et al. 2020). Similar geostatistical models are now routinely used to standardize fishery-independent trawl surveys for groundfish on the West Coast of the U.S. and in Alaskan waters (e.g., Thorson et al. 2015 and Thorson 2019). The IPHC space-time models are fitted through the R-INLA package in the R software (R Core Team, 2024).

FISS DESIGN OBJECTIVES (Table 1)

Note that the secondary objective was revised at AM101 (IPHC-2025-AM101-R, para. 61).

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: *Cost effectiveness.*

The FISS is intended to be cost-effective without compromising the scientific integrity of the design. Any implemented design must consider logistics and cost together with scientific integrity.

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	Cost effectiveness without compromising the scientific integrity of the FISS design.	Logistics, cost, scientific integrity: operational feasibility and cost/revenue, and scientific needs. With an aspirational target reserve of US$2,000,000
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 has included preliminary cost projections based on prior year fiscal details (revenue) and current year vessel contract cost updates;
- Step 2: Updated 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 annual November/December 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 the evaluation of secondary objectives prior (i.e. updated cost estimates) and logistical considerations raised by the operators of contracted vessels 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 direct 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 2026-28

BASE BLOCK DESIGN

At AM101, Secretariat staff presented the Base Block design for 2025 and subsequent years based a rotational block design (IPHC-2025-AM101-14). Instead of the random selection of FISS stations used in past designs for IPHC Regulatory Areas 2B, 2C, 3A and 3B, the design features the sampling of complete FISS charter regions in each area. Sampled regions are rotated over two or three years 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 Base Block designs shown in Figures 4 to 6 for 2026-28 were revised from the designs presented to Commissioners at AM101 to account for the Commission-approved 2025 design; in particular, charter regions not selected in IPHC Regulatory Areas 3A and 3B in 2025 were prioritized for sampling in 2026. The Base Block design ensures 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. The Base Block designs also include some sampling in all IPHC Biological Regions in each year, ensuring that trend and biological data from across the spatial range of Pacific halibut are available to the stock assessment and for stock distribution estimation.

Using samples generated from the fitted 2024 space-time models as simulated data for 2025-28, we projected the coefficient of variation (CV, a relative measure of precision) for mean O32 WPUE for each year of the design by area. As CVs are generally greater in the terminal year of the time series and that year is usually 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 2027 were found by fitting the model to the data for 1993-2027, with simulated data used for 2025-27.

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

Regulatory Area	2026	**Year** 2027	2028
2A	21	22	14
2B	11	7	10
2C	6	6	6
3A	8	7	8
3B	11	15	11
4A	18	22	13
4B	15	16	17
4CDE	9	9	8
Biological Region			
Region 2	6	5	5
Region 3	7	7	7
Region 4	9	10	7
Region 4B	15	16	17
Coastwide	4	4	4

Projected terminal year CVs for the Base Block design are 25% or less for all IPHC Regulatory Areas. In the core areas (2B, 2C, 3A and 3B), CVs are projected to be 15% or less (Table 2). All Biological Region CVs, except that of Region 4B, are at most 10%, while the coastwide CV is projected to be 4% in all years. The Base Block design is therefore expected to maintain precise estimates of indices of Pacific halibut density and abundance across the range 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 changes and therefore a low risk of large bias in estimates of trend and stock distribution.

The 'global average' research survey CVs has been estimated to be approximately ~20%; however, this value includes 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.

Reduced Loss Design

The Base Block design is projected to result in a substantial operating loss (Table 3) and would require supplementary funding to be viable. As an alternative, the Secretariat staff has developed a preliminary design that would result in a net operating loss of approximately $500,000 (Figure 7). This Reduced Loss design includes revenue positive charter regions in

IPHC Regulatory Areas 2B and 2C and maintains a subsample of 30 stations in each of three other revenue-negative charter regions from the Base Block design in IPHC Regulatory Areas 2B and 3A. The three regions with partial sampling were prioritized as they are among the regions not sampled in the last two to three years.

Table 3 gives preliminary net revenue projections for Base Block and Reduced Loss designs. Projections include the following 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. 2026 Pacific halibut price and landings do not change from values realized in 2024.

Costs do not include the costs associated with IPHC's Seacat water column profilers. As in 2025, at this stage we anticipate such costs to be covered by the IPHC's General Fund.

Cost estimates are largely based on information from the 2024 FISS and outcomes of the 2025 charter bidding process, and it is important to note there is high uncertainty in the any catch and cost projections for 2026 this far in advance. Final cost and accounting information will be available at the end of the 2025 fiscal year and will be used to refine these preliminary projections at that time.

Table 3. Comparison of preliminary projected net revenue for the 2026 Base Block and Reduced Loss designs.

Design	Projected net revenue
Base Block	−$1,818,000
Reduced Loss	−$536,000

INTERMEDIATE DESIGNS

Here we present several intermediate designs that could be considered if supplementary funding became available or if greater losses might be considered acceptable to the Commission (Table 4). As before, revenue estimates are very preliminary and subject to change as inputs are revised following the 2025 FISS season.

Option 1 in Table 4 is the Reduced Loss design (Figure 5), and Options 2 through 6 successively add stations or charter regions based on scientific priorities. Option 2 (Figure 8) samples the same charter regions as Option 1, but the partial regions are now fully sampled, reducing the risk of bias within those regions. IPHC Regulatory Area 4B is added in Option 3 (Figure 9), which is therefore the least expensive of the options in Table 4 that includes sampling of some kind in all Biological Regions (assuming the NOAA trawl survey provides coverage in Region 4). Option 4 (Figure 10) improves spatial coverage in Biological Region 3 by adding a charter region in IPHC Regulatory Area 3B, while Option 5 (Figure 11) adds FISS sampling to Region 4 with a charter region in IPHC Biological Region 4A. Option 6 (Figure 12) includes all charter regions from the Base Block design (Option 7, Figure 4), together with three revenue-positive regions in Biological Region 2 that are not part of the Base Block Design.

Table 4. Comparison of 2026 preliminary revenue projections for the Reduced Loss design, the Base Block design and design options providing intermediate coverage. For each design, the final column shows the difference in projected revenue from the design in the previous row.

Design	Sampled IPHC Regulatory Areas (with number of FISS charter regions)	Projected net revenue ($US)	Difference ($US)
Option 1: Reduced Loss	2B(2 full, 2 partial), 2C(3), 3A(1 partial)	−536,000	
Option 2	2B(4), 2C(3), 3A(1)	−556,000	−20,000
Option 3	2B(4), 2C(3), 3A(1), 4B(1)	−860,000	−304,000
Option 4	2B(4), 2C(3), 3A(1), 3B(1), 4B(1)	−1,012,000	−152,000
Option 5	2B(4), 2C(3), 3A(1), 3B(1), 4A(1), 4B(1)	−1,240,000	−228,000
Option 6	2B(4), 2C(3), 3A(4), 3B(2), 4A(1), 4B(1)	−1,740,000	−500,000
Option 7: Base Block	2B(2), 2C(2), 3A(4), 3B(2), 4A(1), 4B(1)	−1,818,000	−78,000

DISCUSSION

The **Base Block** design has a projected net loss of around $1,818,000 and therefore will rely on supplementary funding for implementation. Unlike the Base Block design, the preliminary **Reduced Loss** design does not have extensive spatial coverage, with sampling concentrated in regions of greatest Pacific halibut density in IPHC Biological Region 2, only 30 FISS stations in Biological Region 3, and no FISS sampling in Biological Regions 4 and 4B. Such a design comes with a greater risk of bias relative to the Base Block design due to the increased chance of stock changes being unobserved. Despite the uncertainty being properly propagated, of increasing concern is the potential for the space-time model expectations to move toward the long term mean in the absence of new data. This 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, as was the case in 2024. Given current spatial variability and uncertainty in the magnitude of younger year classes (2016 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 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.

The implications for the assessment would be of increasing concern if designs like the Reduced Loss design were implemented beyond 2026 due to increasing uncertainty and risk of bias in stock trend estimates and the unrepresentativeness of the biological samples. Further, as was evident at AM100 and AM101, reduced FISS designs that do not fully inform stock distribution with annual sampling in all IPHC Regulatory areas lead to reduced stakeholder confidence in the FISS results and in the aggregate scientific information from the stock assessment. As it did with the relatively conservative mortality limits set for 2025, this may have a strong effect on the perception of risk and on decision making by the Commission if reduced survey designs continue to be consecutively implemented.

RECOMMENDATION

That the Scientific Review Board **NOTE** paper IPHC-2025-SRB026-09, which presents an evaluation of design options for 2026-28, including a preliminary option accounting for the secondary FISS objective of cost effectiveness.

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 2012. IPHC setline charters 1963 through 2003 IPHC-2012-TR058. 264p.

IPHC 2018. Report of the 13th Session of the IPHC Scientific Review Board (SRB) IPHC-2018-SRB013-R. 17 p.

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.

IPHC 2025. Report of the 101st Session of the IPHC Annual Meeting (AM101) IPHC-2025-AM101-R. 52 p.

R Core Team (2024) R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/.

Thorson, J. T., Shelton, A. O., Ward, E. J., and Skaug, H. J. 2015. Geostatistical delta-generalized linear mixed models improve precision for estimated abundance indices for West Coast groundfishes. ICES Journal of Marine Science 72(5): 1297-1310. doi:10.1093/icesjms/fsu243.

Thorson, J. T. 2019. Guidance for decisions using the Vector Autoregressive Spatio-Temporal (VAST) package in stock, ecosystem, habitat and climate assessments. Fisheries Research 210: 143-161. doi:10.1016/j.fishres.2018.10.013.

Webster, R. A. 2016. Space-time modelling of setline survey data using INLA. Int. Pac. Halibut Comm. Report of Assessment and Research Activities 2015: 552-568.

Webster, R. A. 2017. Results of space-time modelling of survey WPUE and NPUE data. Int. Pac. Halibut Comm. Report of Assessment and Research Activities 2016: 241-257.

Webster, R. 2019. Space-time modelling of IPHC Fishery-Independent Setline Survey (FISS) data. IPHC-2019-IM095-07 Rev_1. 19 p.

Webster, R. A., Soderlund, E, Dykstra, C. L., and Stewart, I. J. (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.

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

Webster, R., Stewart, I., Ualesi, K., Jack, T. and Wilson, D. (2025). 2025 and 2026-29 FISS Designs. IPHC-2025-AM101-14. 15 p.

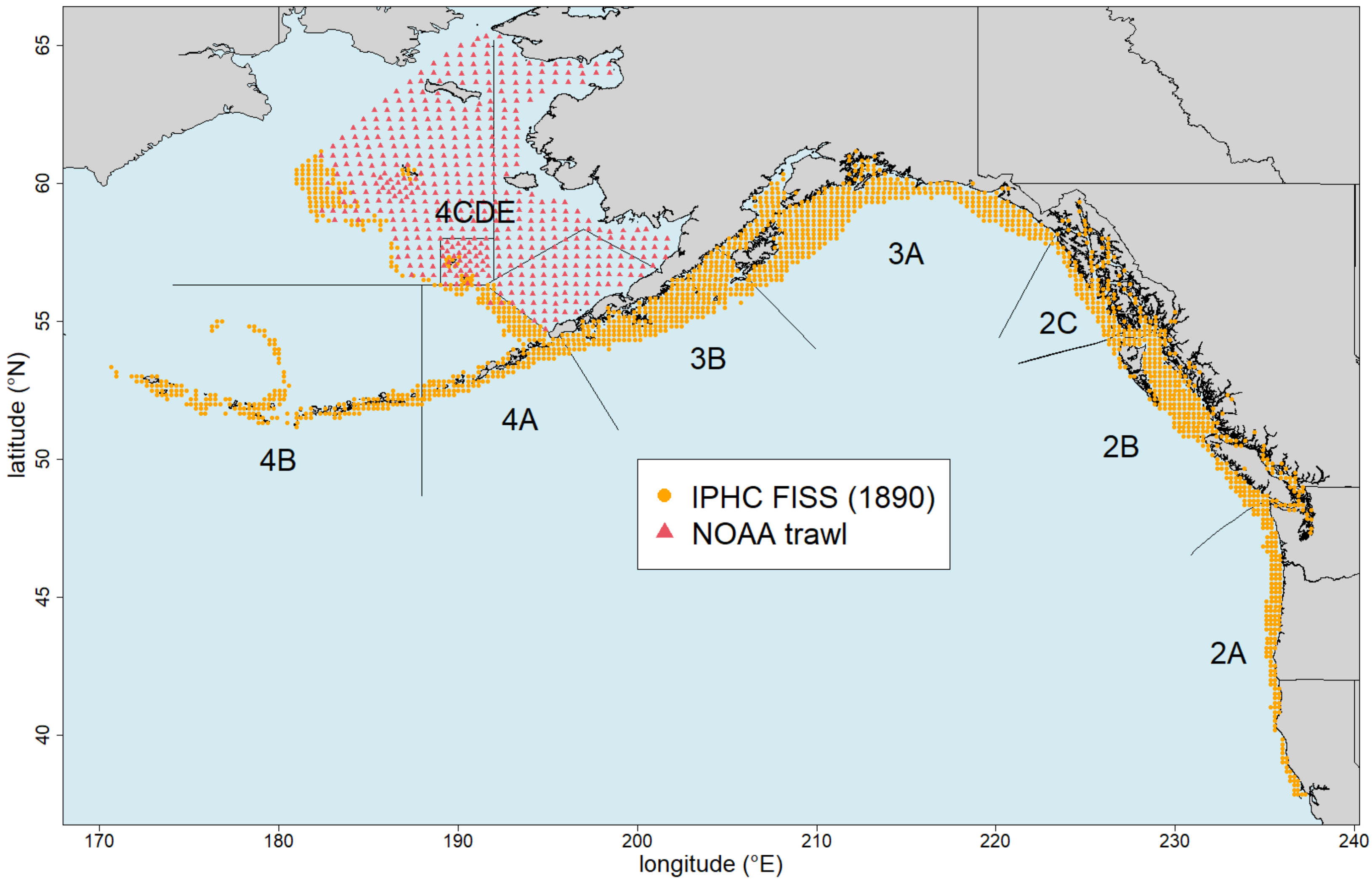

Figure 1. Map of the full 1890 station FISS design, with orange circles representing stations available for inclusion in annual sampling designs. Red triangles represent the locations NOAA trawl stations used to provide complementary data for Bering Sea modelling.

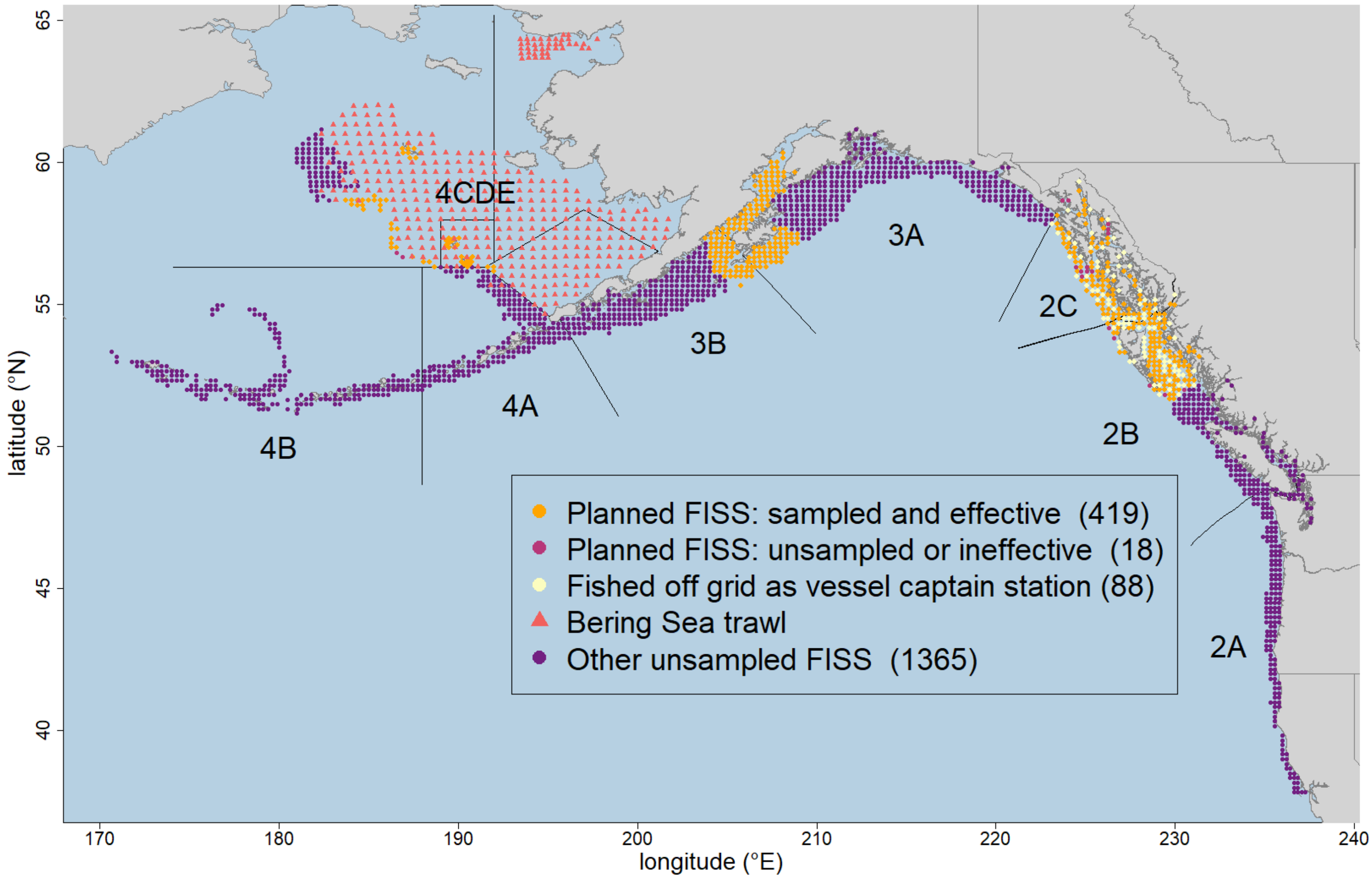

Figure 2. Map of implemented 2024 sampled FISS design showing stations with data used in modelling (orange circles for FISS, red triangles for trawl), along with planned but ineffective FISS stations, FISS grid stations fished off grid as vessel captain stations and other unsampled FISS stations.

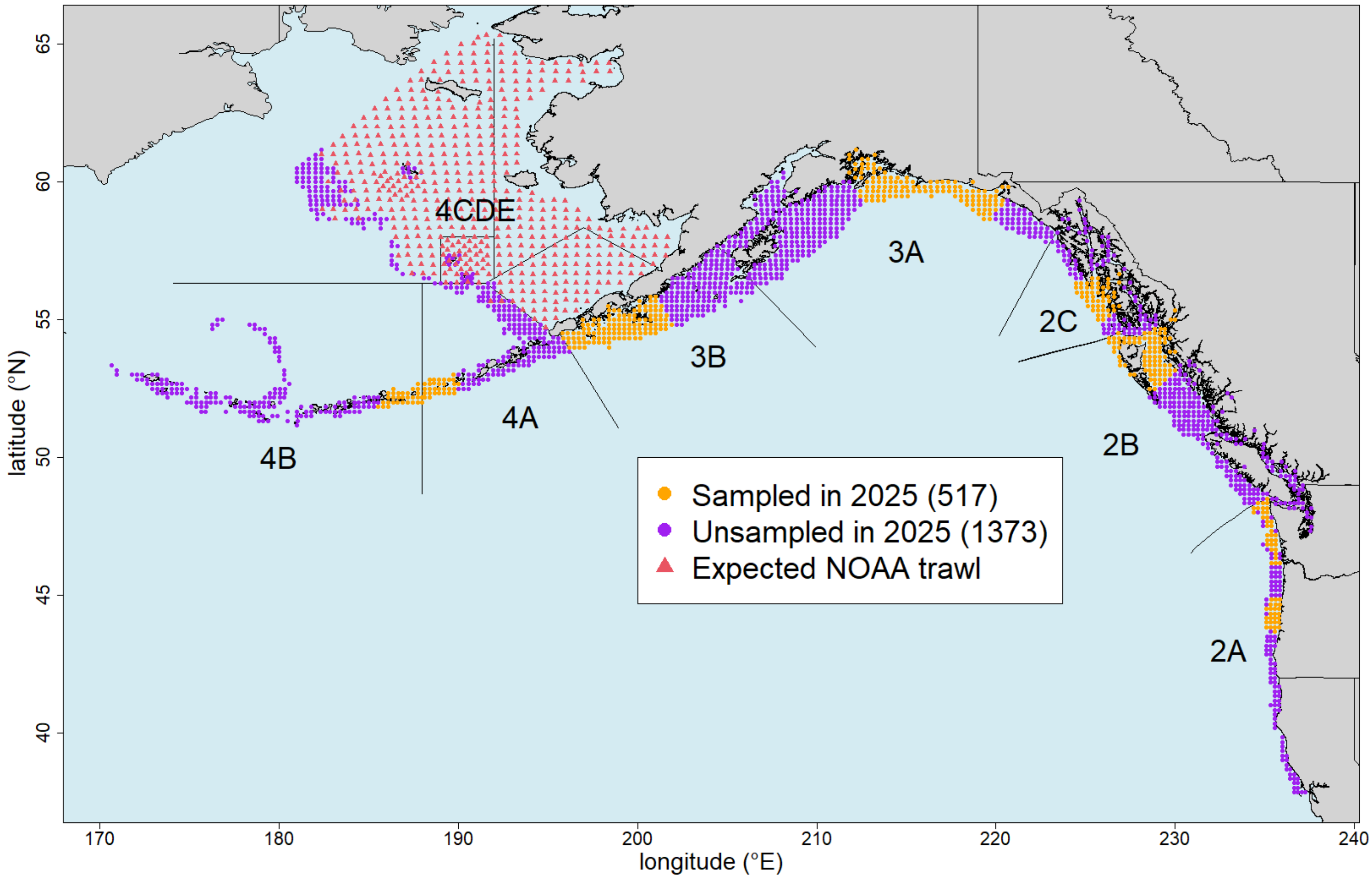

Figure 3. Adopted 2025 FISS design, with planned FISS stations shown as orange circles.

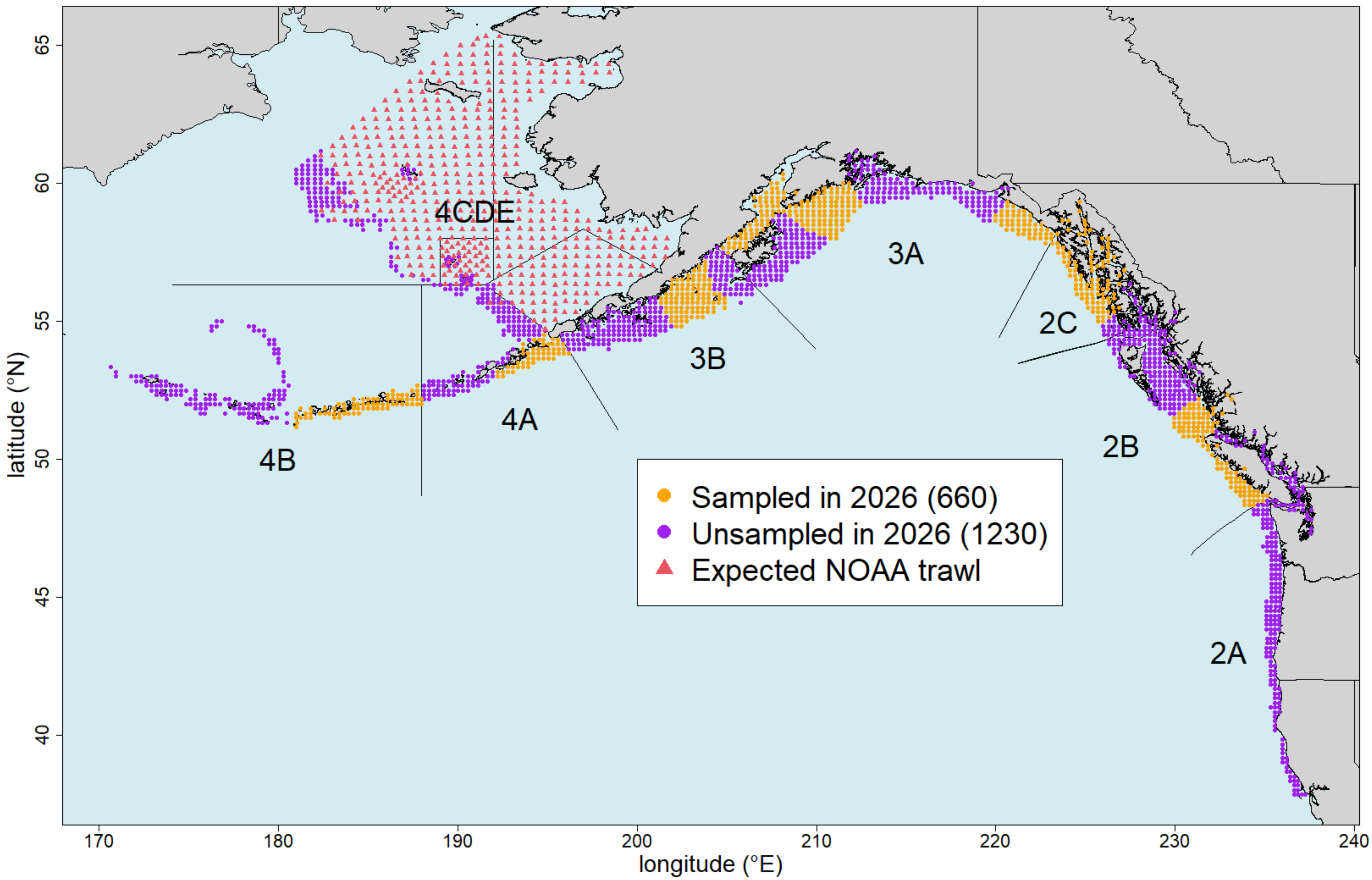

Figure 4. Base Block design for 2026 (orange circles). Design is based on fishing 2-4 complete blocks of stations (charter regions) in the core areas (2B, 2C, 3A and 3B) and previously implemented subareas elsewhere.

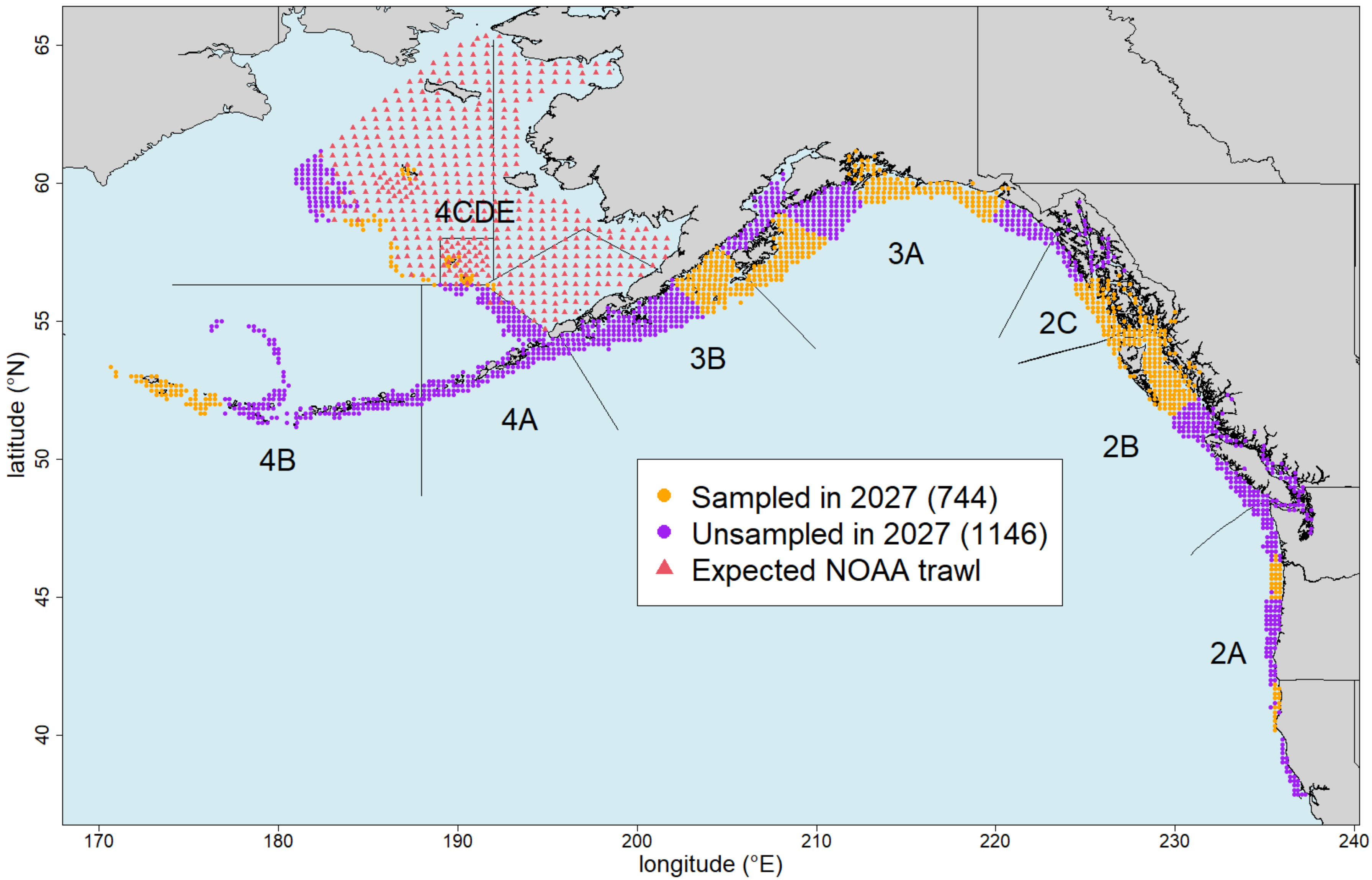

Figure 5. Base Block design for 2027 (orange circles). Design is based on fishing 2-4 complete blocks of stations (charter regions) in the core areas (2B, 2C, 3A and 3B) and previously implemented subareas elsewhere.

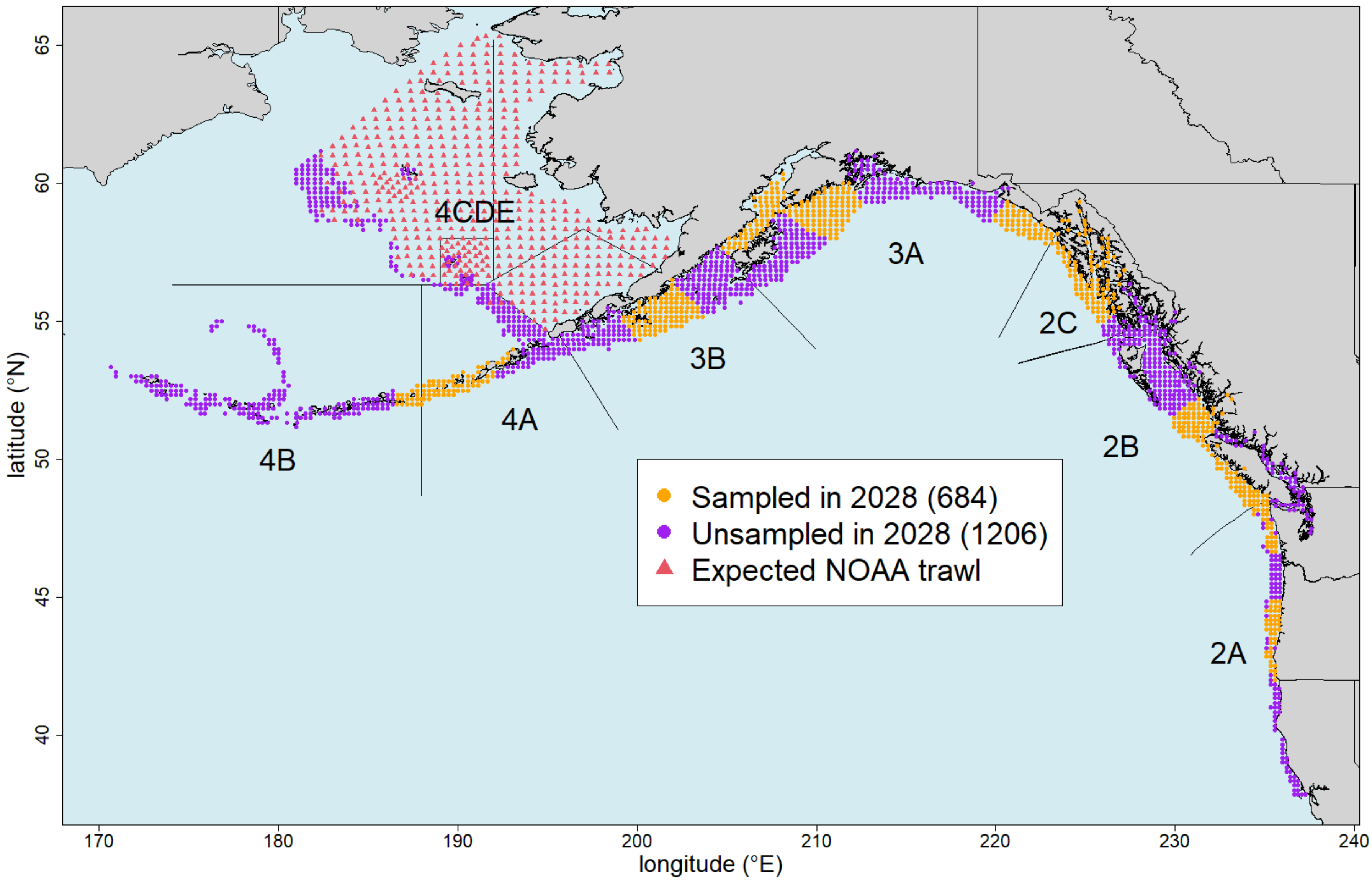

Figure 6. Base Block design for 2028 (orange circles). Design is based on fishing 2-4 complete blocks of stations (charter regions) in the core areas (2B, 2C, 3A and 3B) and previously implemented subareas elsewhere.

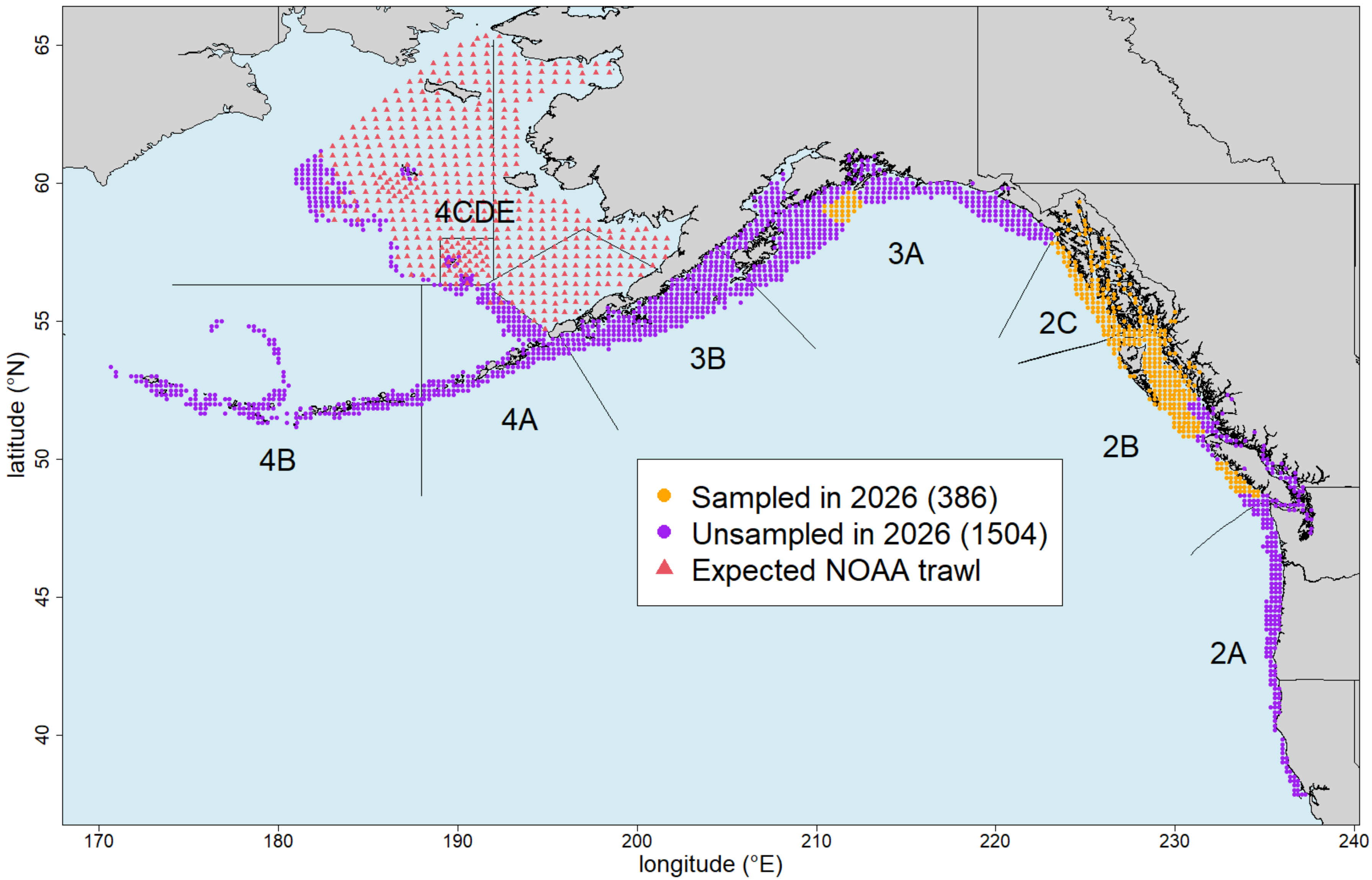

Figure 7. Preliminary Reduced Loss design for 2026 (orange circles). Note that stations in partially-sampled charter regions (2B and 3A) are only for the purpose of illustrating the spatial extent of the design. Actual stations to be fished within partially-sampled charter regions will be selected at a later date based on the priorities in Table 1.

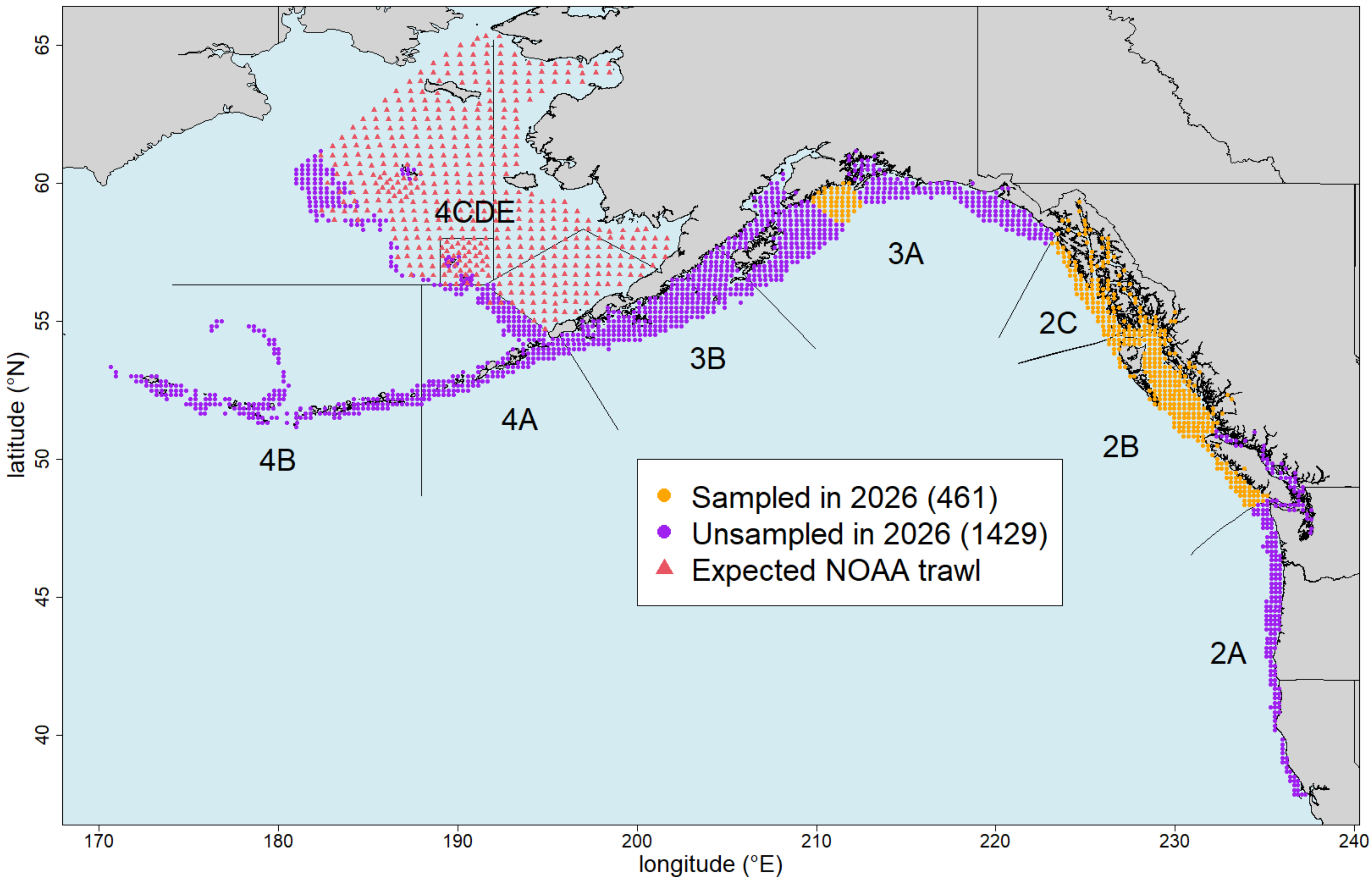

Figure 8. Preliminary Option 2 design for 2026 (orange circles).

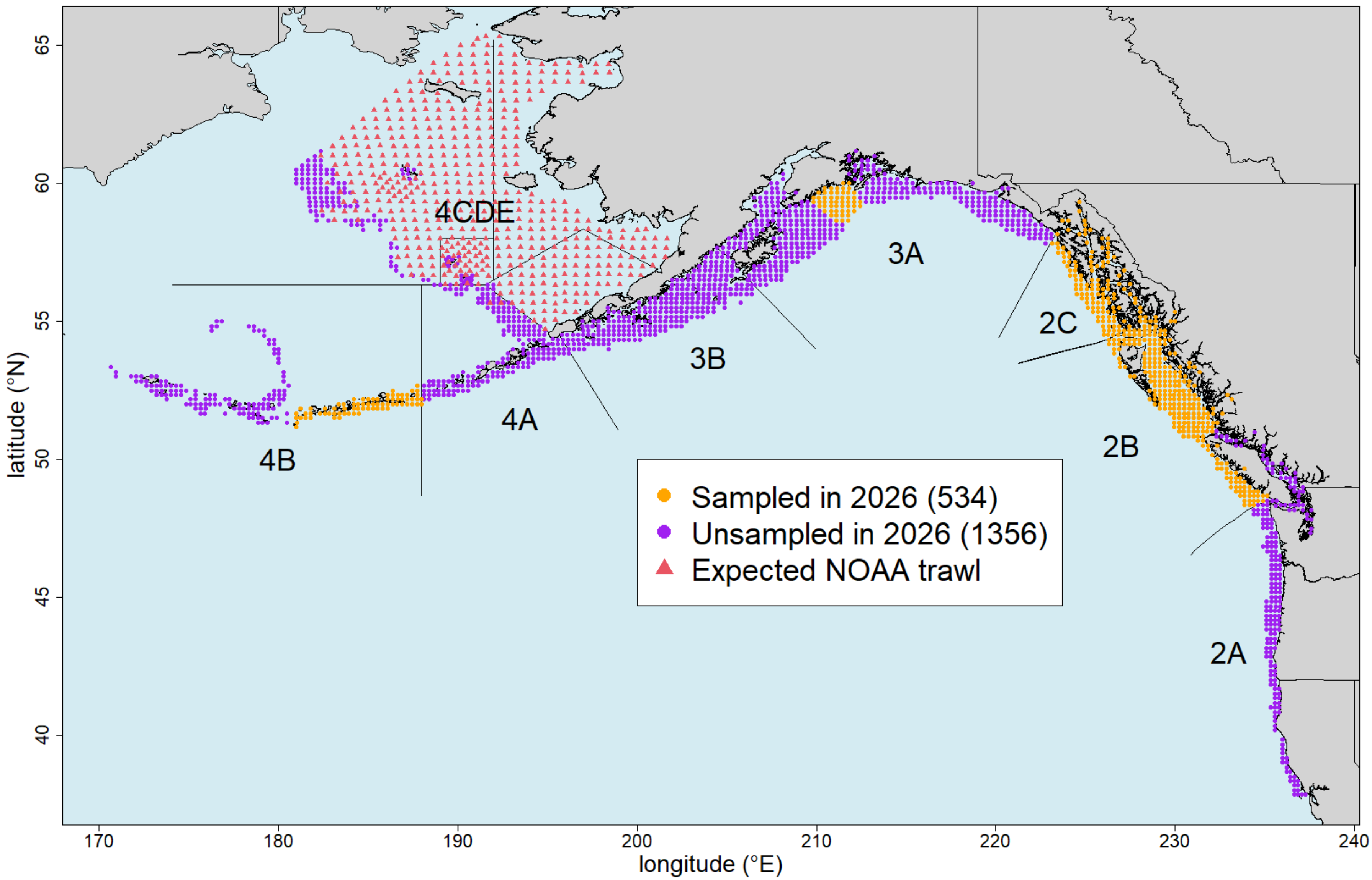

Figure 9. Preliminary Option 3 design for 2026 (orange circles).

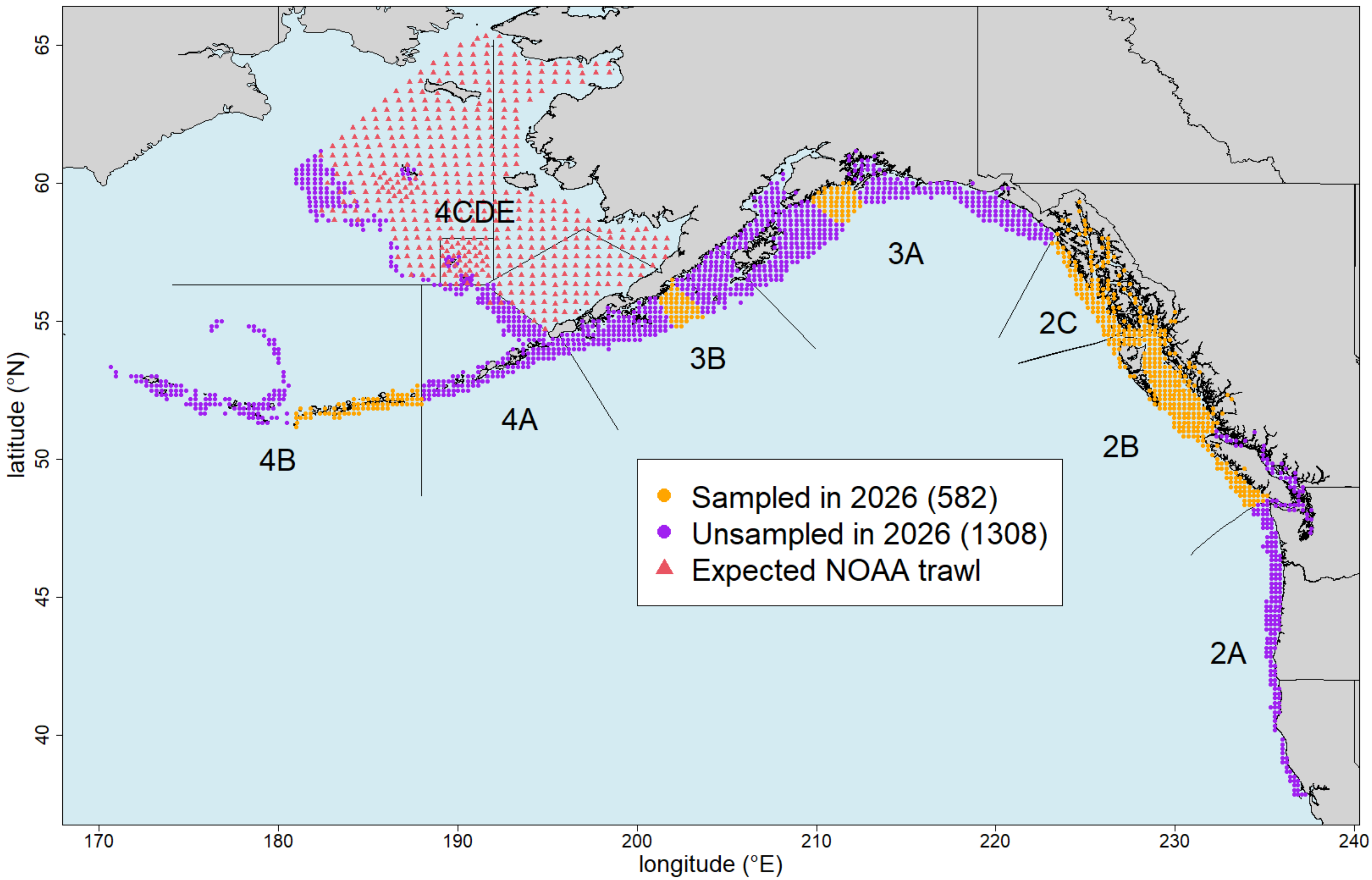

Figure 10. Preliminary Option 4 design for 2026 (orange circles).

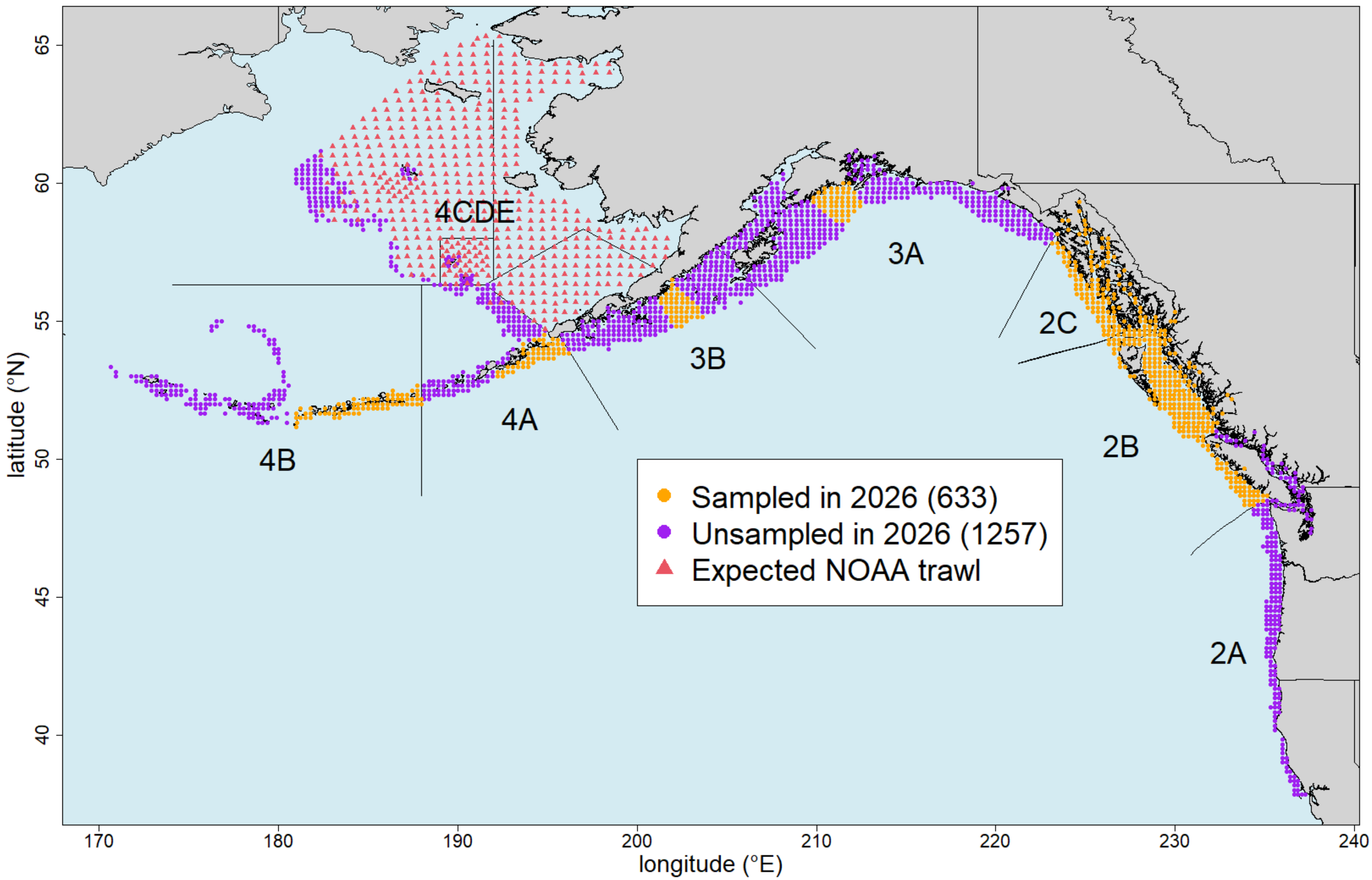

Figure 11. Preliminary Option 5 design for 2026 (orange circles).

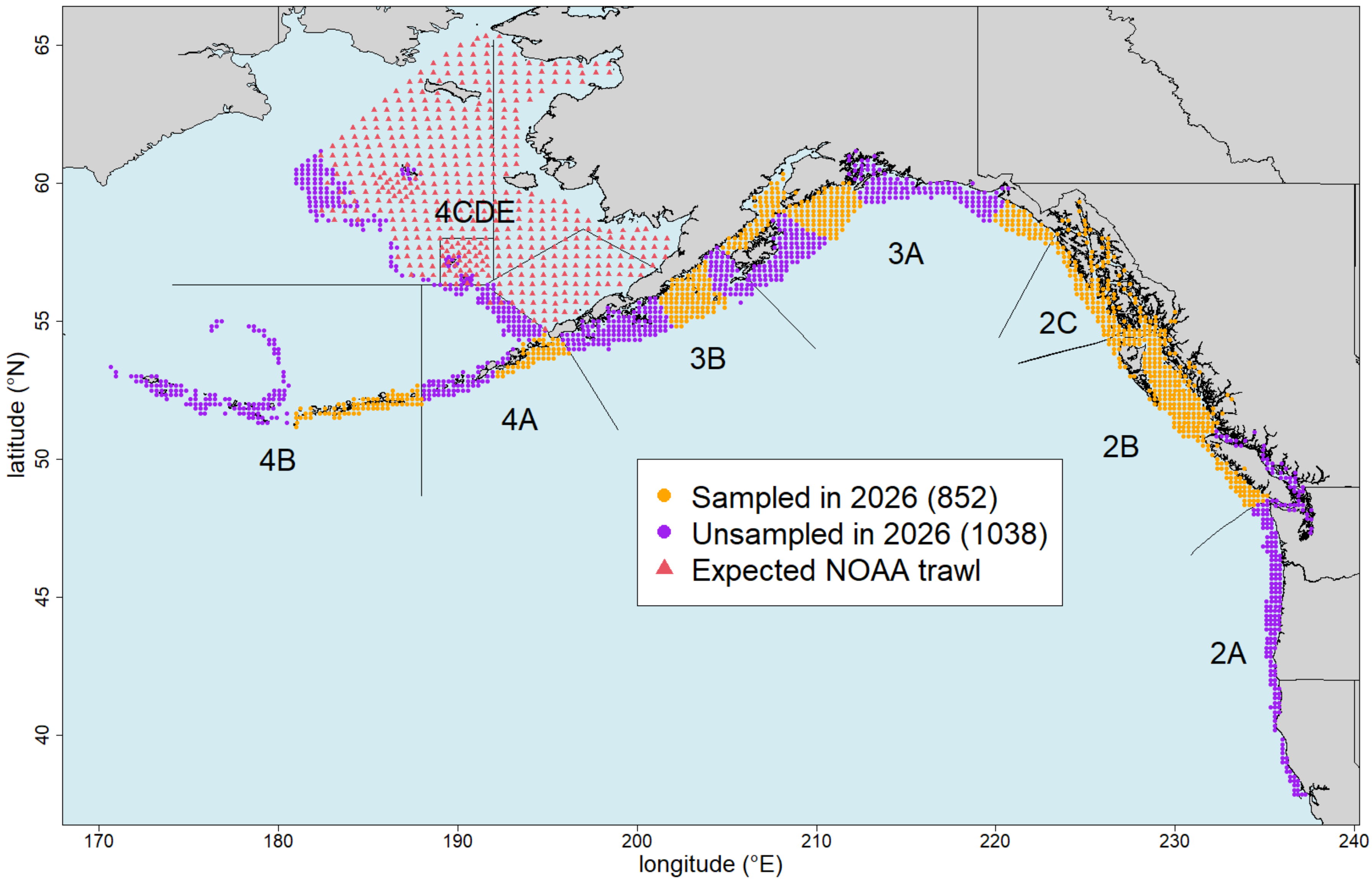

Figure 12. Preliminary Option 6 design for 2026 (orange circles).