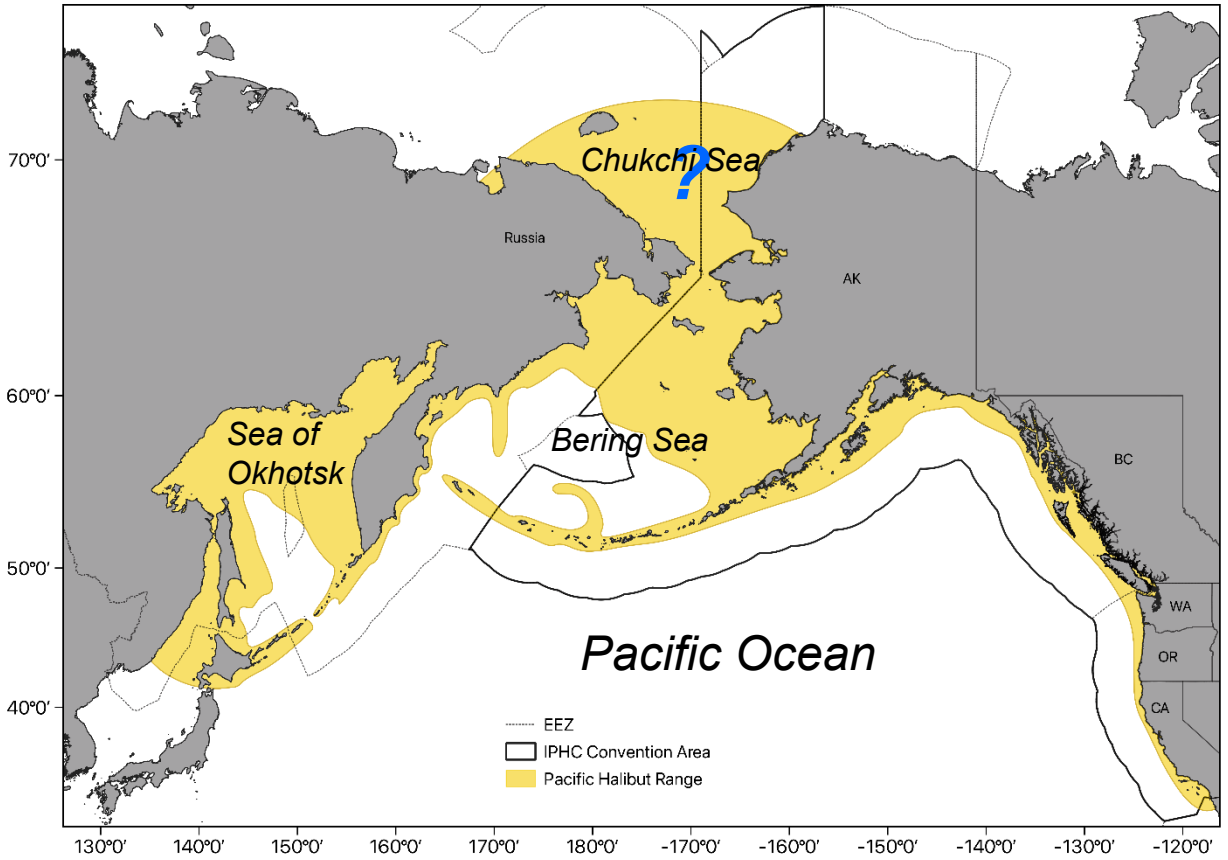
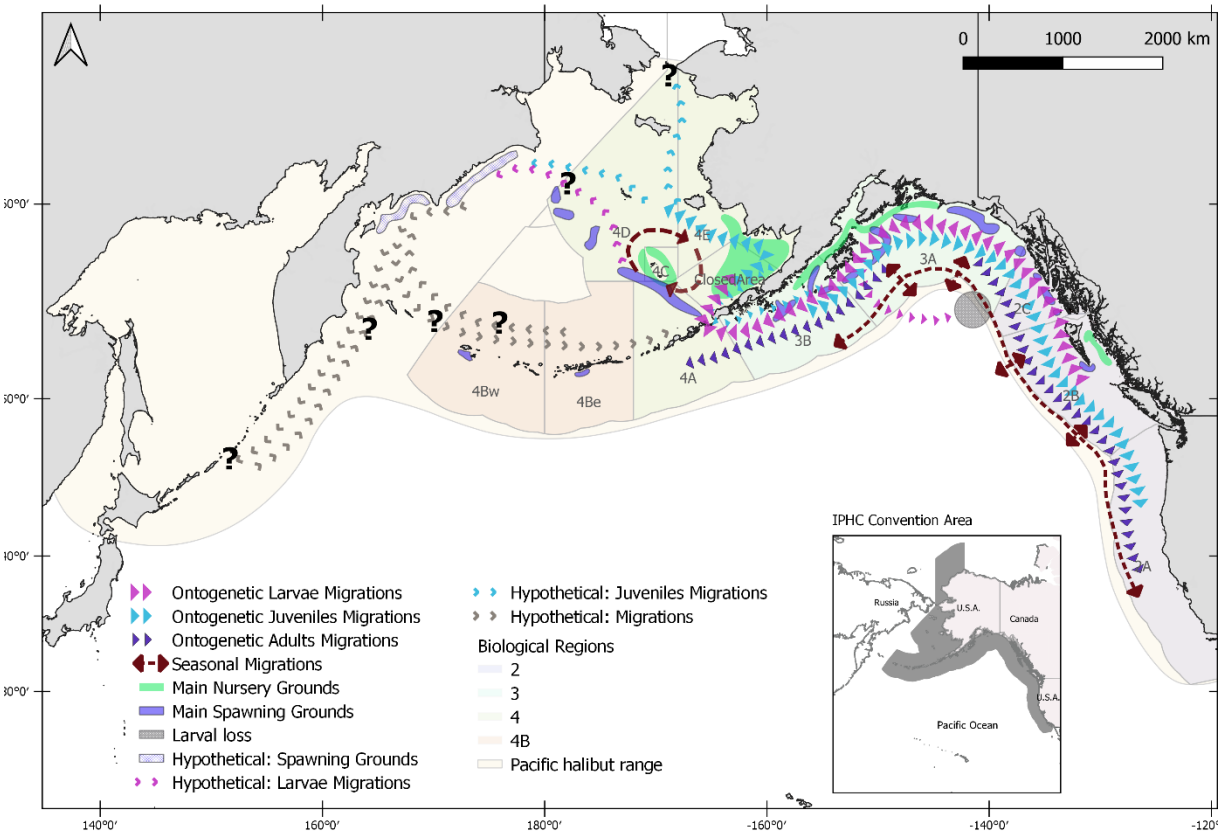
FLEXIBLE FISHERY-INDEPENDENT SURVEYS IN A CHANGING WORLD

RAY WEBSTER, IPHC

Range of Pacific halibut



Migration and spawning



Carpi et al (2021)

IPHC Fishery-independent setline survey (FISS)

- Our most important source of data on Pacific halibut
- Provides data for estimating 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

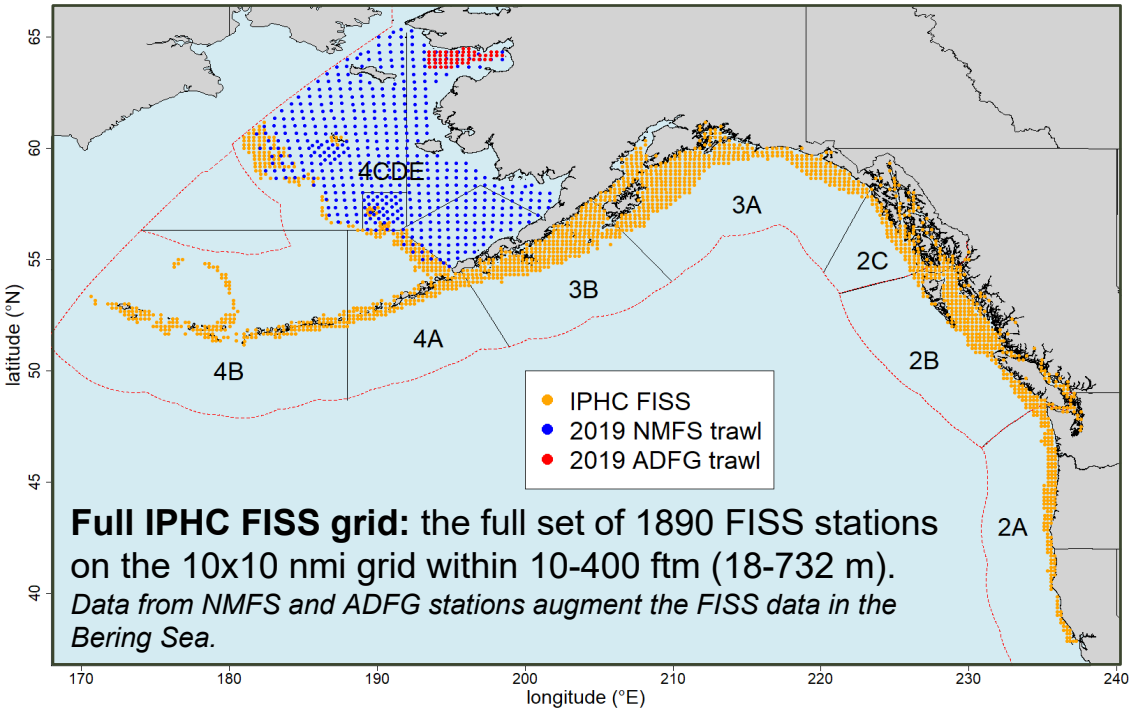
FISS history 1993-2019

- A standardized FISS has been conducted by the IPHC each year since 1993
  - Standardized for bait and fishing gear
- From 1993-97 coverage was limited and generally restricted to the Gulf of Alaska and British Columbia
- The current 10x10 nmi grid design began in 1998
- By 2001, annual coverage occurred in all IPHC Regulatory Areas within 20-275 fathoms

FISS history 1993-2019

- Unsampled habitat meant there was the potential for bias in estimates derived from FISS data
- A sequence of FISS expansions from 2011 to 2019 was undertaken covering previously unsampled habitat in all IPHC Regulatory Areas
- During the expansions, the FISS occupied for the first time 34% of the stations on the full 10 nmi FISS grid that had been previously unsampled
- The result was an improved understanding of Pacific halibut density and distribution
  - Reduced bias and improved uncertainty estimates

The modern FISS: full 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 NMFS and ADFG stations augment the FISS data in the Bering Sea.

Finite survey resources

- The full FISS grid cannot be sampled each year
  - Logistically challenging and cost prohibitive

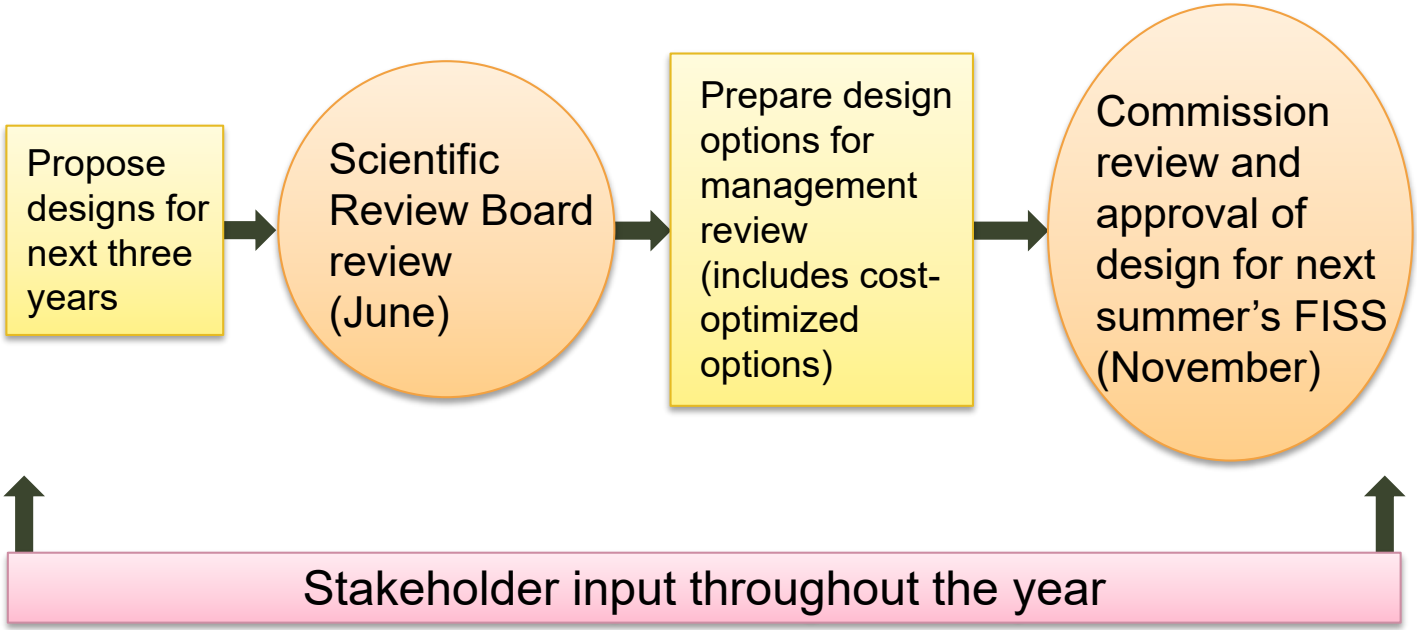
- The IPHC prioritizes sampling effort based on:
  1. **Scientific needs:**
     - Precise estimates of indices of abundance and stock distribution with low potential for bias
     - Requires more frequent sampling in areas with higher variability
  2. **Long-term revenue neutrality:**
     - Increase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

The end of the fixed survey design

In other words, the IPHC FISS no longer has a fixed design:

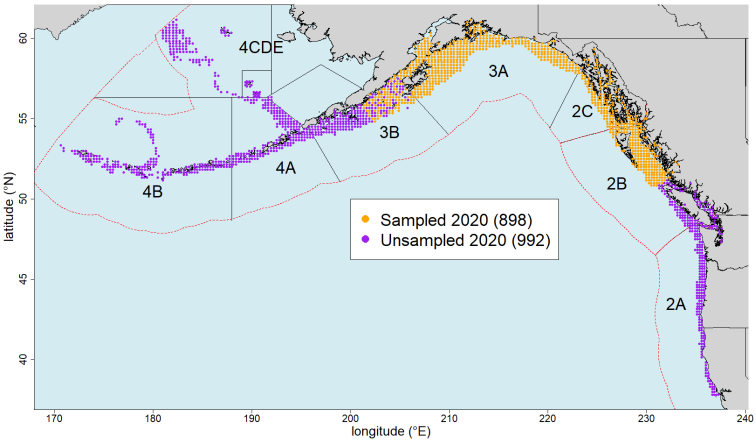
- From 1998 to 2019, the design was largely fixed, with the same stations fished each year in each area (apart from occasional additions).
- From 2020 onwards, stations are selected from the full grid with sampling rate and station distribution designed to meet the IPHC sampling priorities.

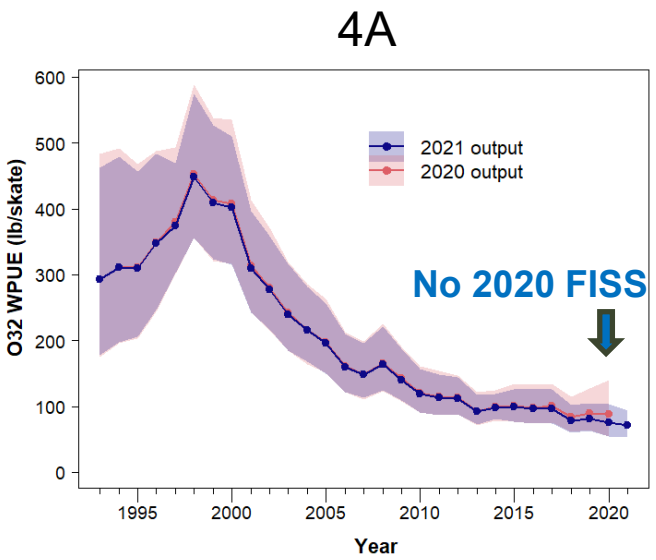
IPHC design review process



Model-based estimation

- Since 2016 the IPHC has used spatio-temporal modelling to estimate indices of abundance
  - Allows consistent estimation throughout the range, while accounting for uncertainty due to incomplete coverage
- Example: COVID-related reductions in 2020





Design evaluation

- Samples drawn from model posterior distributions are used to project the precision and assess the potential for bias for estimates from prospective future FISS designs
  - Proposed designs are evaluated and presented for review by the Scientific Review Board

Table 2. Projected CVs (%) for 2022-25 for O32 WPUE estimated after completion of the proposed 2023-25 FISS designs, and (final column) after completion of the proposed 2023 FISS design only.

Reg. Area	2022	2023	2024	2025	2023 (Estimated in 2023)
2A	13	12	13	15	14
4A	10	9	10	10	12
4B	12	9	10	12	9

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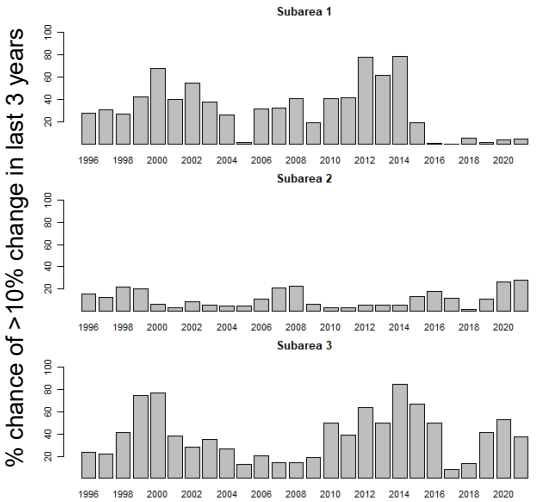

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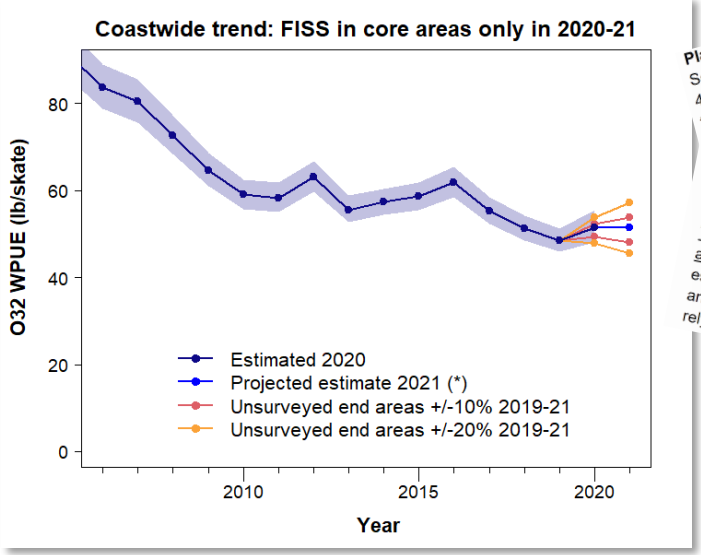
Cost optimization

- The FISS is funded by the revenue from the sale of captured Pacific halibut
  - Funding is therefore constrained by the quantity of fish captured and by the operational costs of the FISS
- Science-based designs are optimized for revenue:
  - Increase station density and set length in revenue positive areas
  - Scale back effort in revenue-negative areas
  - Spread sampling over multiple years
    - e.g., Bering Sea shelf edge was fully sampled over 2021 & 2022, although original proposals were for full sampling in both years

Informed decision making

- Communicate risks of reductions to managers
  - What are the implications of reduced surveys for the stock assessment and the species' management?
  - How long can survey effort be deferred before risks become unacceptable?



Planning for 2024 and 2025: If there is no FISS sampling at the ends of the stock in 2023, the Secretariat's proposal for 2024 will include fishing all subareas of IPHC Regulatory Areas 2A, 4A and 4B that were originally proposed for 2023 (Figure 1.2). A clearer picture will emerge once ... are included in the space-time modelling, but in one or more of those areas it may ... pose sampling additional stations earlier than previously planned to help ... precision and bias targets. This may mean adding more stations in ... sampling some subareas in both 2024 and 2025 when they ... once in that period. Given the costs and logistical ... ock's range, we recognize that implementing such ... out supplemental ad-hoc funding.

However, it is anticipated that precision targets will not be met in IPHC Regulatory Areas 2A, 4A and 4B, which failed to meet these targets in 2020-21 due a combination of no sampling (2020), sparse sampling (4A, 4B in 2021) and higher than expected variability (2A in 2021). All three areas contain a designated sampling subarea with relatively high density and potential large year-to-year variability in density: in each case, not sampling these subareas in particular leads to high risk of bias in estimates of WPUE and NPUE indices and stock distribution.

This design is likely to result in indices and biological data that maintain the basic stock assessment inputs but with somewhat higher uncertainty for 2023. Direct stock distribution estimates would be uninformed by new survey data for IPHC Regulatory Areas 2A, 4A and 4B and this would create additional uncertainty in the application of management procedures that rely on annual estimates of stock distribution.

Stakeholder input

- Those involved in the industry have opportunities for input on survey design and implementation:
  - Providing catch information from unsurveyed areas (logbook data, direct feedback)
  - Feedback on the logistical feasibility of given FISS designs (charter bid process, in-season communication)
  - Through the Research Advisory Board (industry group giving advice on IPHC research priorities)
  - Communication with Commissioners (at public meetings or direct communication)
- Industry members are invested in a successful FISS, and can be effective advocates for improved survey designs.

Other aspects of the IPHC approach

- With incomplete coverage, we look for other data sources to augment the survey:
  - Can a calibration be developed between the data sources?
  - (Generally) requires overlap in space and calibration measure (e.g., size distributions).
  - Length-based calibration with NMFS Bering Sea trawl survey currently in use
- Covariate data in unsampled areas may help improve estimates
  - Habitat and environmental covariates
- Monitor other sources of data:
  - Observer data, recreational catch, etc., may give information on changes in areas with limited FISS coverage

Summary of IPHC approach

- We have developed a survey design process that can meet changing needs:
  - Survey plans that are flexible and responsive to changing information (and limited budgets)
    - We review designs annually and are not locked into a particular design
  - Effort is targeted where information is most needed
    - Highest densities, rapidly changing regions, greatest uncertainty
  - Ideally, sampling frequency and coverage is sufficient to provide precise, unbiased estimates for stock assessment input
  - Risks of survey reductions due to budgetary constraints are communicated clearly to managers
- Model-based estimation is key to the success of our approach:
  - There's no clear path back to unbiased design-based estimates of abundance indices
  - Other users of IPHC data should also avoid using raw averages due to variable spatial coverage

Summary of IPHC approach

- The result is a survey that is responsive to changing environmental and economic conditions and is robust to unexpected events such as the COVID-19 disruption in 2020.
- Thus, the IPHC's flexible FISS is well-positioned to continue the effective monitoring of Pacific halibut in our changing world.