Comisión Interamericana del Atún Tropical
Inter-American Tropical Tuna Commission

CIAT
IATTC

Fishery Definitions for the Yellowfin Tuna Assessment

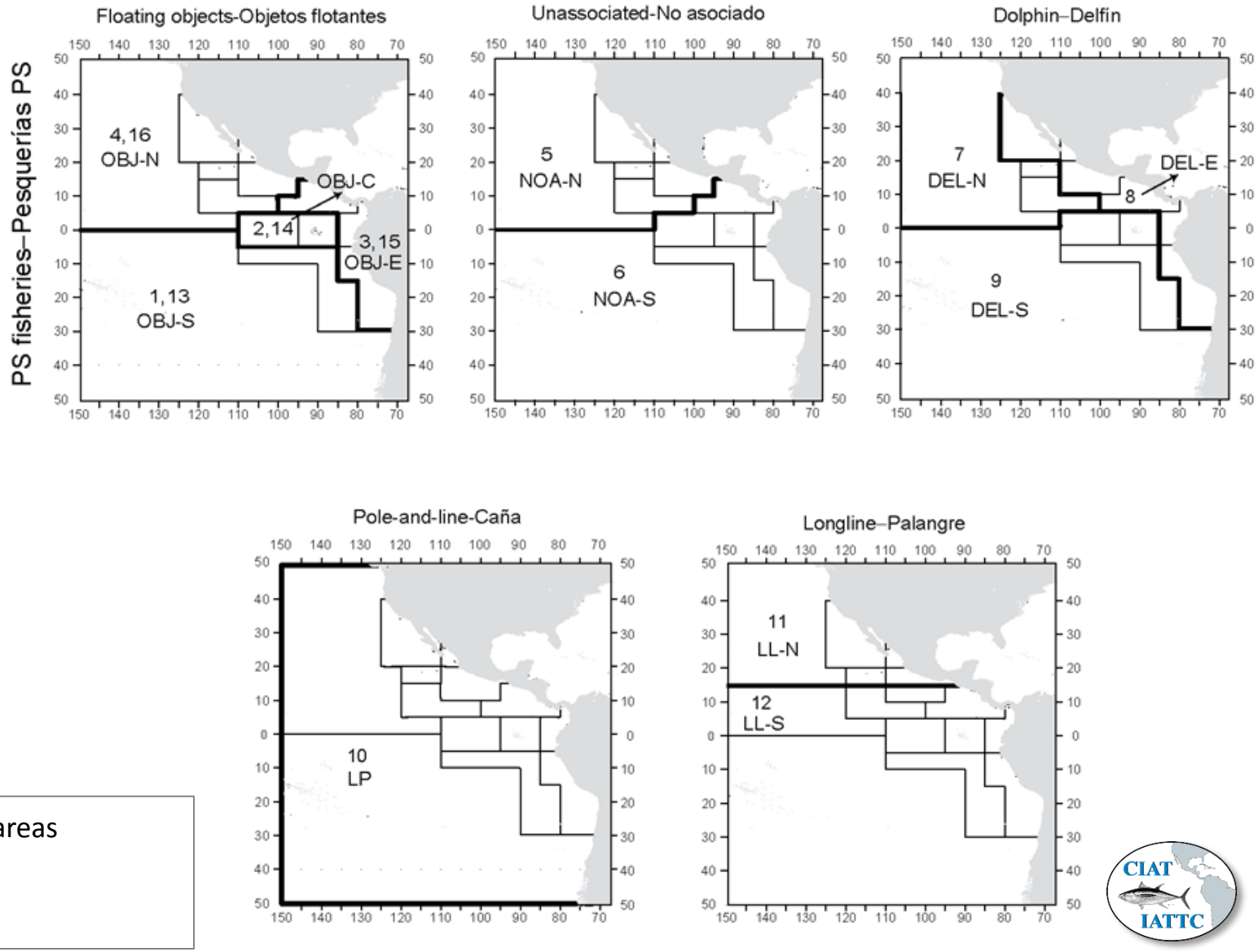
Yellowfin Tuna External Review, La Jolla, California, USA, 2- 6 December 2019

Outline

- Background
- Data
  - Purse-seine
  - Japanese high-seas longline
- Methods
- Results
  - Purse-seine
  - Japanese high-seas longline
- Discussion

Background: fishery definitions SAC 10 model

- Previous fisheries constructed from port-sampling areas.
- Use length-frequency data to define new fisheries.
- Rationale: want to take fleet catch out of the correct sizes.



___ IATTC length-frequency sampling areas

___ Fishery definition areas

Data

- Purse-seine
  - Length-frequency data collected by IATTC port-samplers during catch unloading.
  - Sample data associated with the unloading of individual wells (*i.e.*, not necessarily set-specific).
  - Years 2000 – 2018.
  - Three types of purse-seine sets:
    - Sets on dolphin-associated tuna (“DEL” sets);
    - Sets on floating-object-associated tuna (“OBJ” sets);
    - Sets on unassociated tuna schools (“UNA” sets).
  - Fork length measured to the nearest *mm* (but data processing based on lengths rounded to the nearest *cm*).
  - Ancillary data available: set type; date of the first set to fill the well; 5° latitude and 5° longitude.

Data

- Japanese high-seas longline
  - Length-frequencies (2 *cm* resolution; in numbers) by year x month x 5° latitude x 10° longitude.
  - Years 2000 - 2009.
  - Data from commercial vessels only; data not collected by observers.
  - Ancillary data available: year; month; 5° latitude; 10° longitude.

Methods

- Data processing
  - All length-frequency data grown/shrunk to the mid-month of each quarter (assessment has quarterly time step).
  - Counts of fish aggregated to larger size intervals, by quarter x year x area (5° square or 5 ° x 10 ° rectangle).
  - Larger size intervals: ≤ 39 *cm*; 40 – 49 *cm*; 50 – 59 *cm*; … ; 150 – 159 *cm*; ≥ 160 *cm*.
  - Data for each gear (DEL sets; UNA sets; OBJ sets; longline) analyzed separately.
  - The data unit for the analysis was a quarter x year x area.

Methods

- A regression tree-type approach was used to explore spatial and seasonal structure in length-frequency distributions by gear type.
- Predictors: quarter; cyclic quarter; 5° latitude; 5° (10°) longitude (note: year not used as a predictor).
- Methodology is similar to CART, but with the following differences:
  - Multivariate instead of univariate response;
  - Different measure of heterogeneity used (not sum of squares);
  - Small tree is grown and not pruned.

Methods

- Multivariate response:
  - Proportion of individuals in each size interval
    $\{p_l(j)$, j=1,…,# size intervals for "cell"$l\}$, where a cell = quarter x year x area.

- Measure of heterogeneity (“impurity”) for a collection of cells $\{l\}$
  - Kullback-Leibler divergence: $I_{KLD} = \sum_l \sum_j p_l(j) log\left(\frac{p_l(j)}{\bar{p}_{\cdot}(j)}\right)$
  - Puts more weight on discrepancies with greater proportions of fish.

Methods

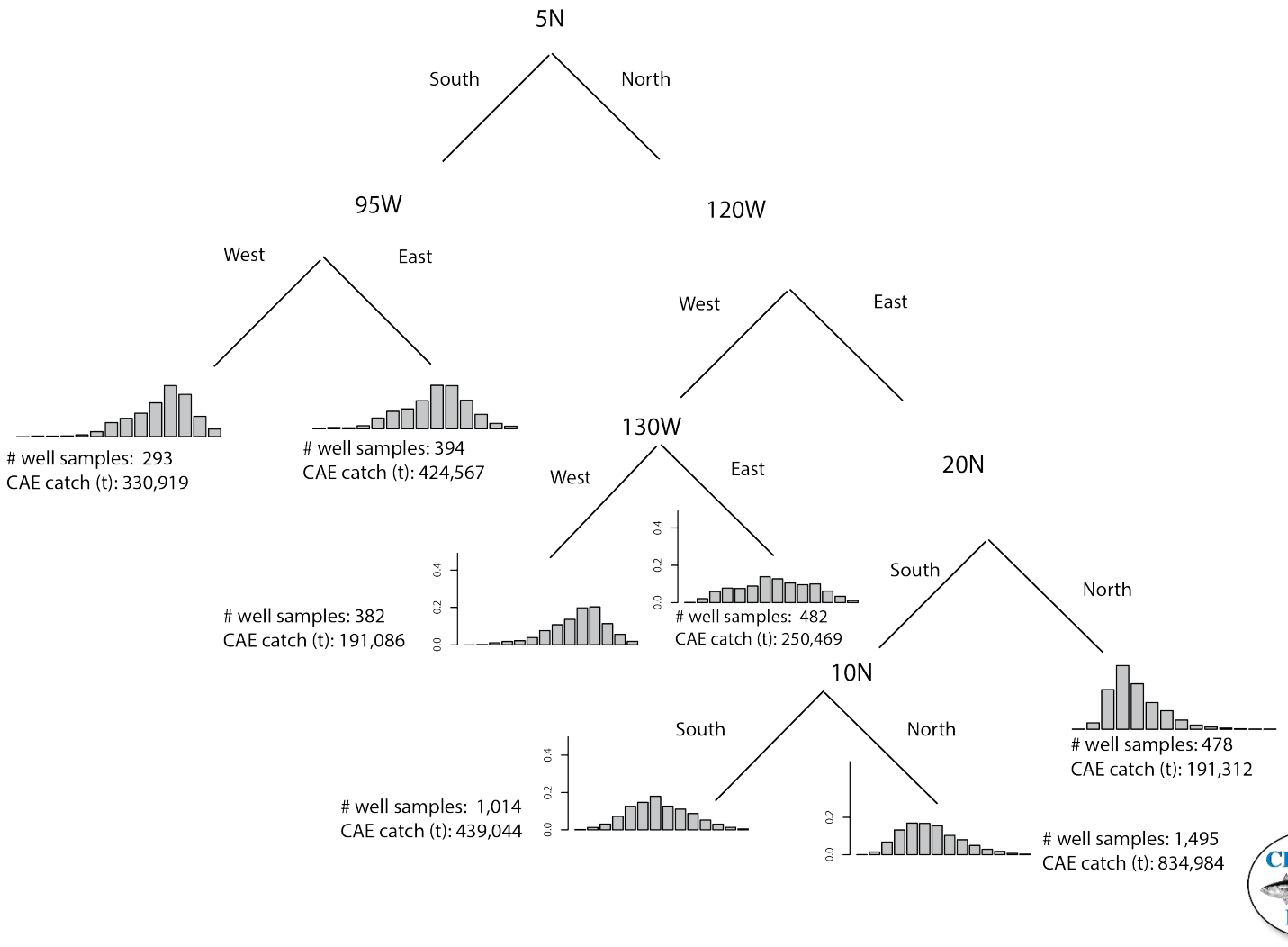
- A small tree is grown by binary recursive partitioning.
- Branches with small amounts of sample data and catch usually were not further partitioned.
- The unpruned tree is used to explore options for candidate fishery strata, where candidate strata are compared based on the percent variability explained.

Results: DEL sets

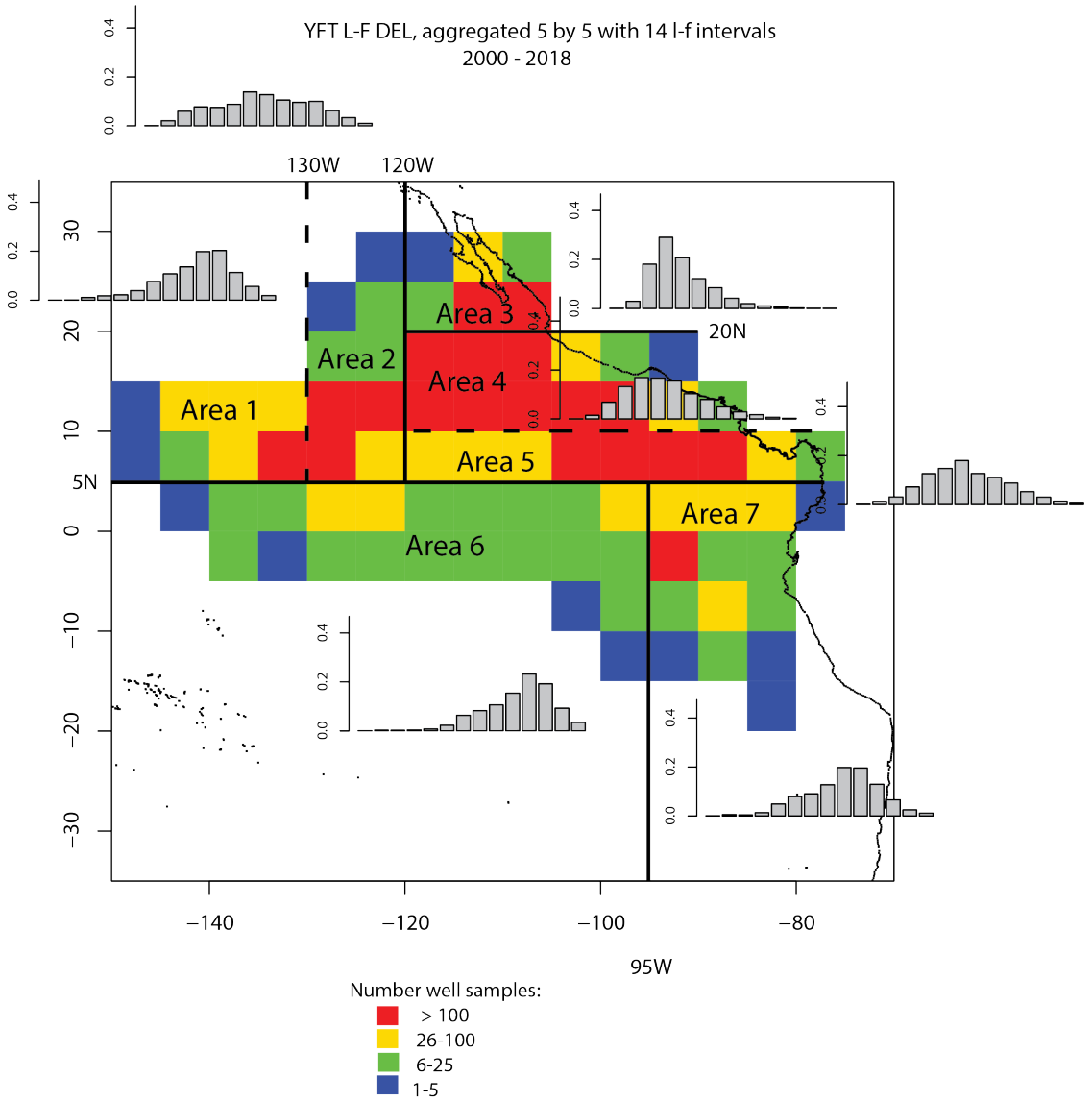
- Largest fish found south of 5N, and west of 120W north of 5N.
- Seasonality not present near top of tree.
- Highest variability explained with few partitions, compared to other set types and longline.

NOTE: Branch length is uniform (i.e., NOT proportional to variance explained)

YFT DEL, aggregated 5 by 5 with 14 l-f intervals, 2000-2018



Results: DEL sets



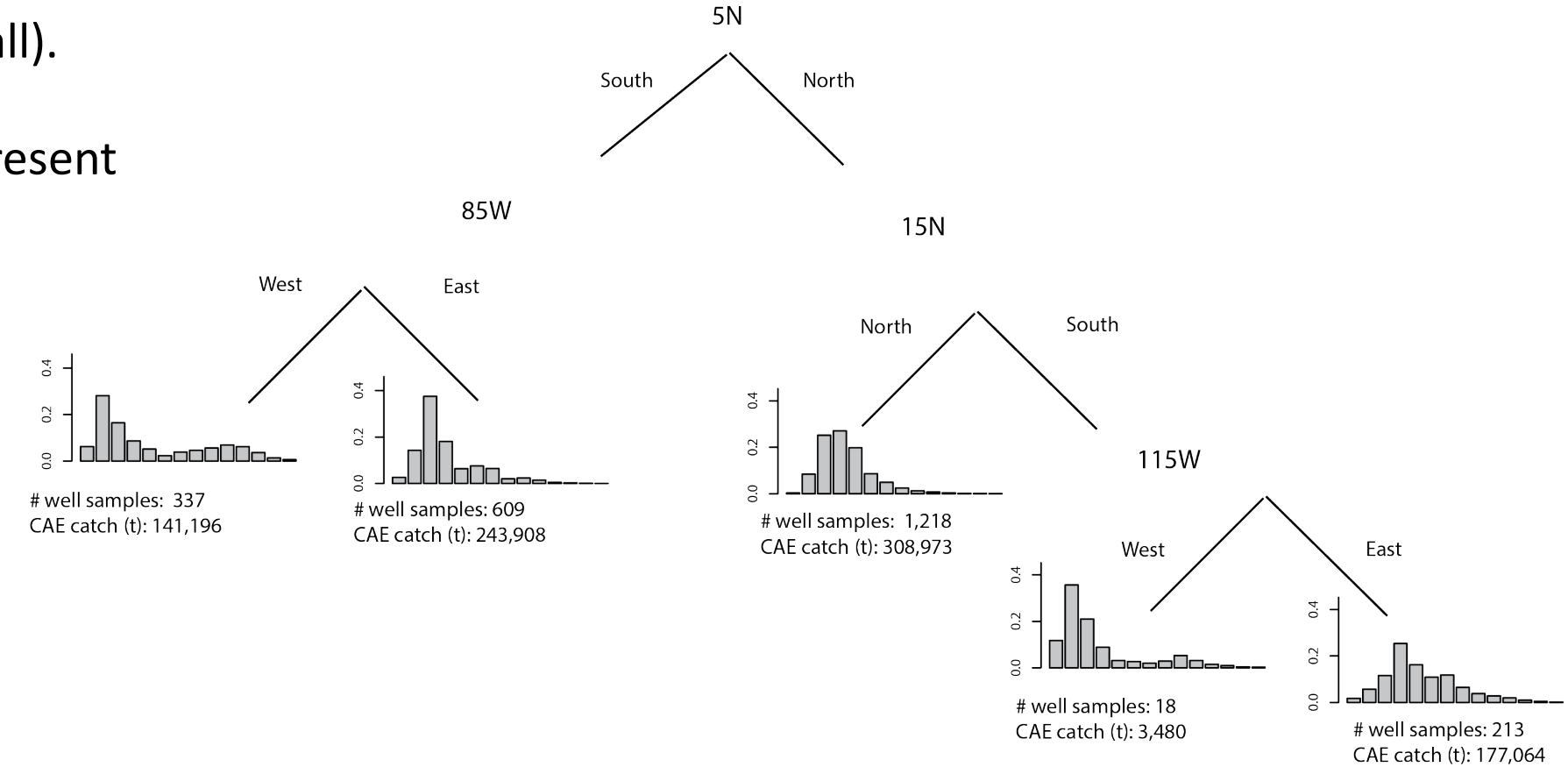
Strata*	% Variability explained
2-area combination (initial partition)	
Areas 1+2+3+4+5+; Areas 6+7	12.7%
3-area combinations	
Areas 1+2; Areas 3+4+5; Areas 6+7	18.5%
Areas 1+2+3+4+5; Area 6; Area 7	14.1%
4-area combinations	
Area 1; Area 2; Areas 3+4+5; Areas 6+7	19.5%
Area1+2; Area 3; Areas 4+5; Areas 6+7	22.1%
Areas 1+2; Areas 3+4+5; Area 6; Area 7	20.0%
5-area combinations	
Area 1; Area 2; Area 3; Areas 4+5; Areas 6+7	23.0%
Areas 1+2; Area 3; Area 4; Area 5; Areas 6+7	23.1%
Areas 1+2; Area 3; Areas 4+5; Area 6; Area 7	23.5%
Selected: *All 7 areas*	25.5%
"Unorthodox" area combinations	
Areas 1+6+7; Area 2; Area 3; Area 4; Area 5	22.6%

* Subjective decisions made in the selection of the 7 areas: not to further split Area 1, Area 2, Area 6 or Area 7 (based on sample size and seasonality of the fishery in those areas).

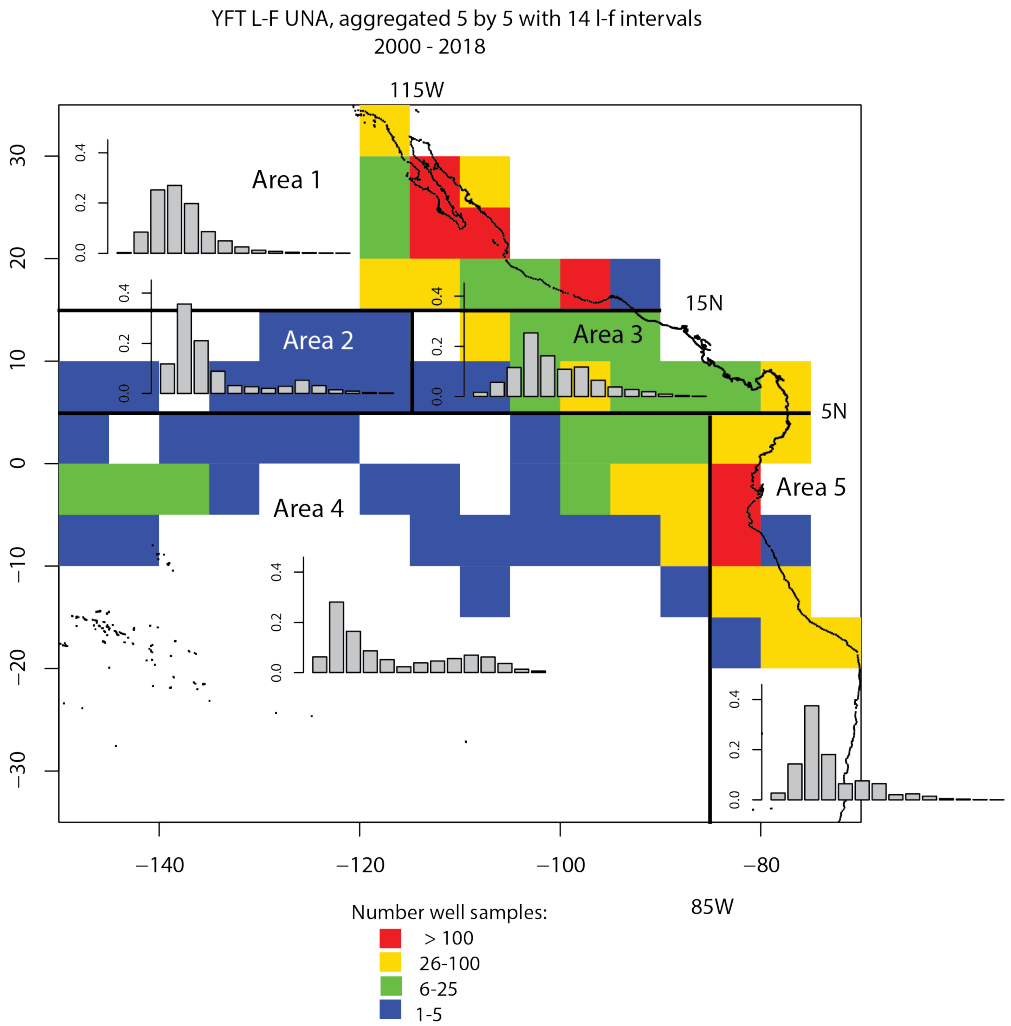
Results: UNA sets

- Largest fish found south of 5N, and west of 115W between 5N-15N (but sample size is small).
- Seasonality not present near top of tree.

YFT UNA, aggregated 5 by 5 with 14 l-f intervals, 2000-2018



Results: UNA sets

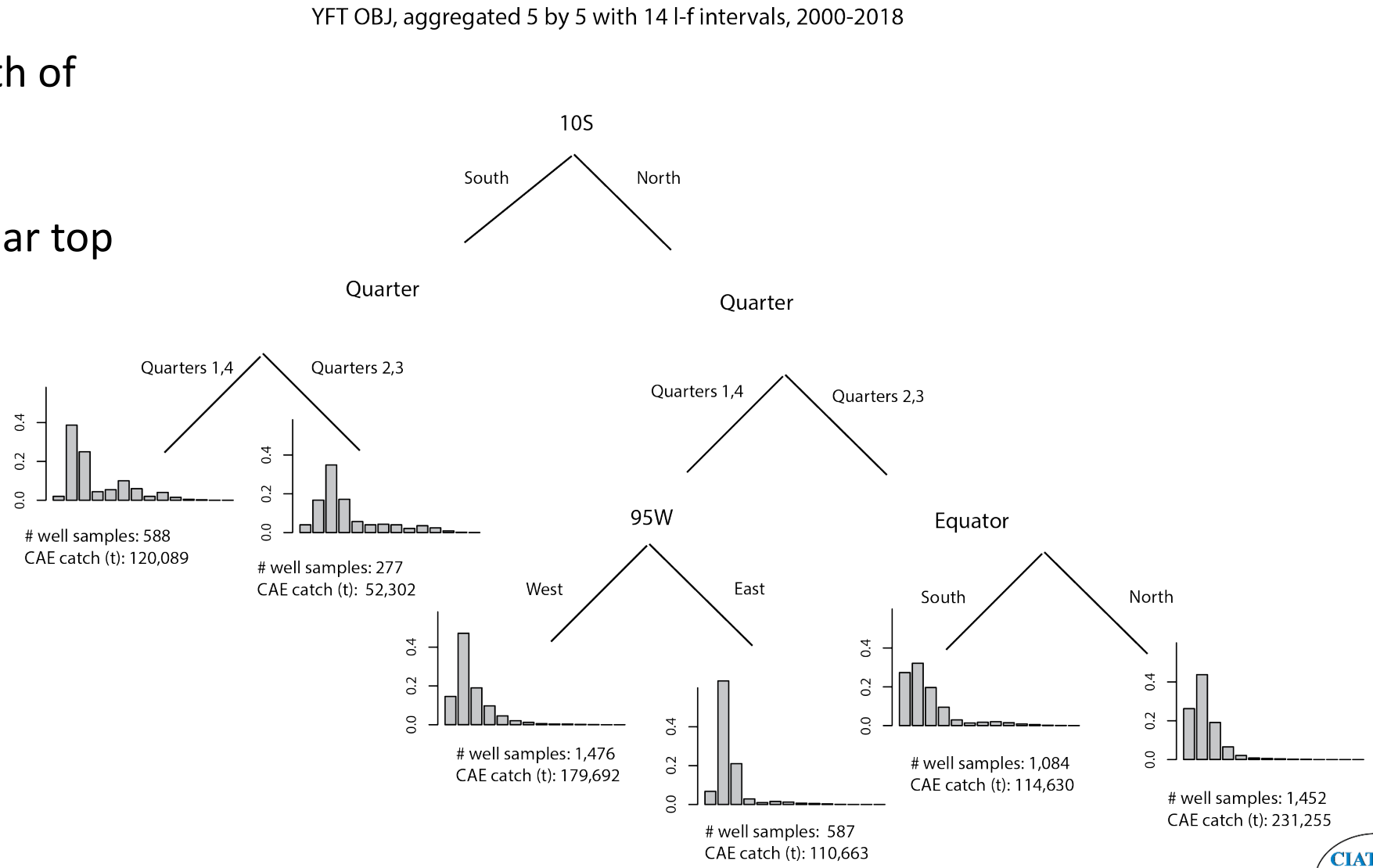


Strata	% Variability explained
2-cell combination (initial partition)	
Areas 1+2+3; Areas 4+5	5.5%
3-cell combinations	
Area 1; Areas 2+3; Areas 4+5	7.2%
Areas 1+2+3; Area 4; Area 5	9.2%
4-cell combinations	
Areas 1+2+3; Area 4; Area 5,Q1; Area 5,Qs2-4	10.8%
Areas 1+2+3; Area 4, Qs1-2; Area 4, Qs3-4; Area 5	10.5%
Area 1, Qs4-2; Area 1, Q3; Areas 2+3; Areas 4+5	8.7%
Area 1; Area 2; Area 3; Areas 4+5	8.0%
Area 1; Areas 2+3; Area 4; Area 5	10.9%
5-cell combinations	
Area 1; Area2; Area 3; Area 4; Area 5	11.7%
Area 1; Areas 2+3; Area 4; Area 5, Q1; Area 5 Qs2-4	12.4%
Area 1; Areas 2+3; Area 4, Q1-2; Area 4; Q3-4; Area 5	12.1%
Area 1, Qs4-2; Area 1, Q3; Areas 2+3; Area 4; Area 5	12.3%
All 8 cells	
Area 1, Qs4-2; Area 1, Q3; Area 2; Area 3; Area 4,Qs1-2; Area 4,Qs3-4; Area 5,Q1; Area 5, Qs2-4	16.0%
"Unorthodox" cell combinations	
Area 1; Areas 2+4; Area 3; Area 5	11.5%

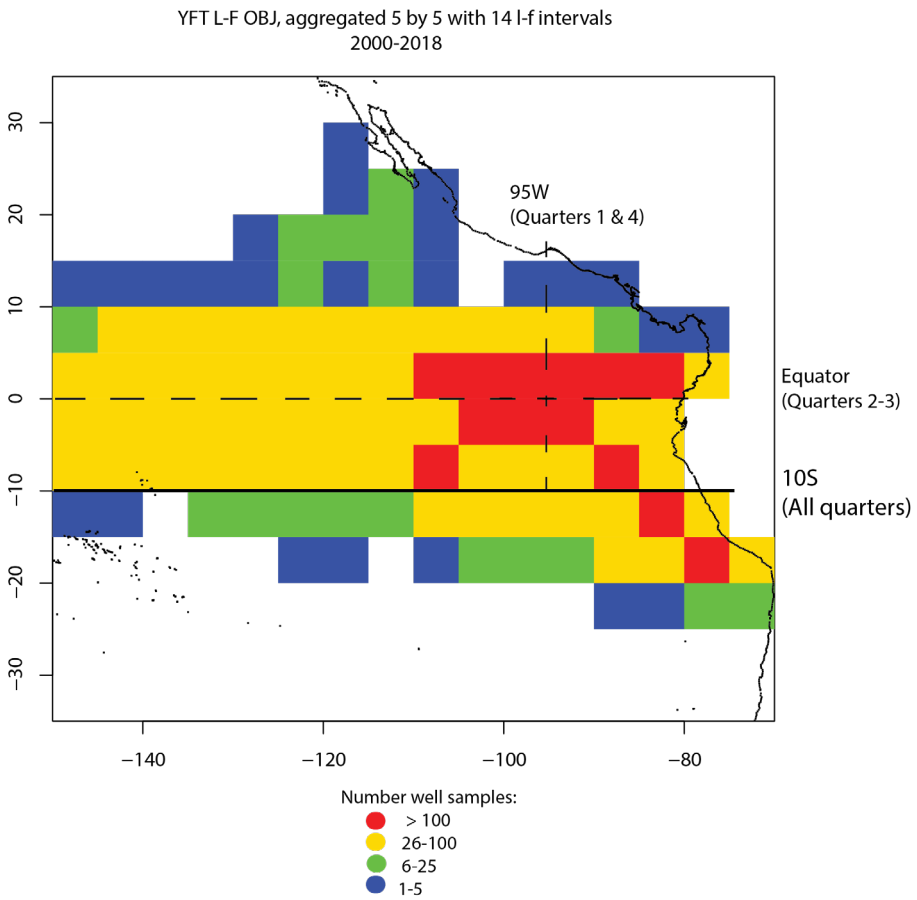
Selected:

Results: OBJ sets

- Largest fish found south of 10S.
- Seasonality present near top of tree.



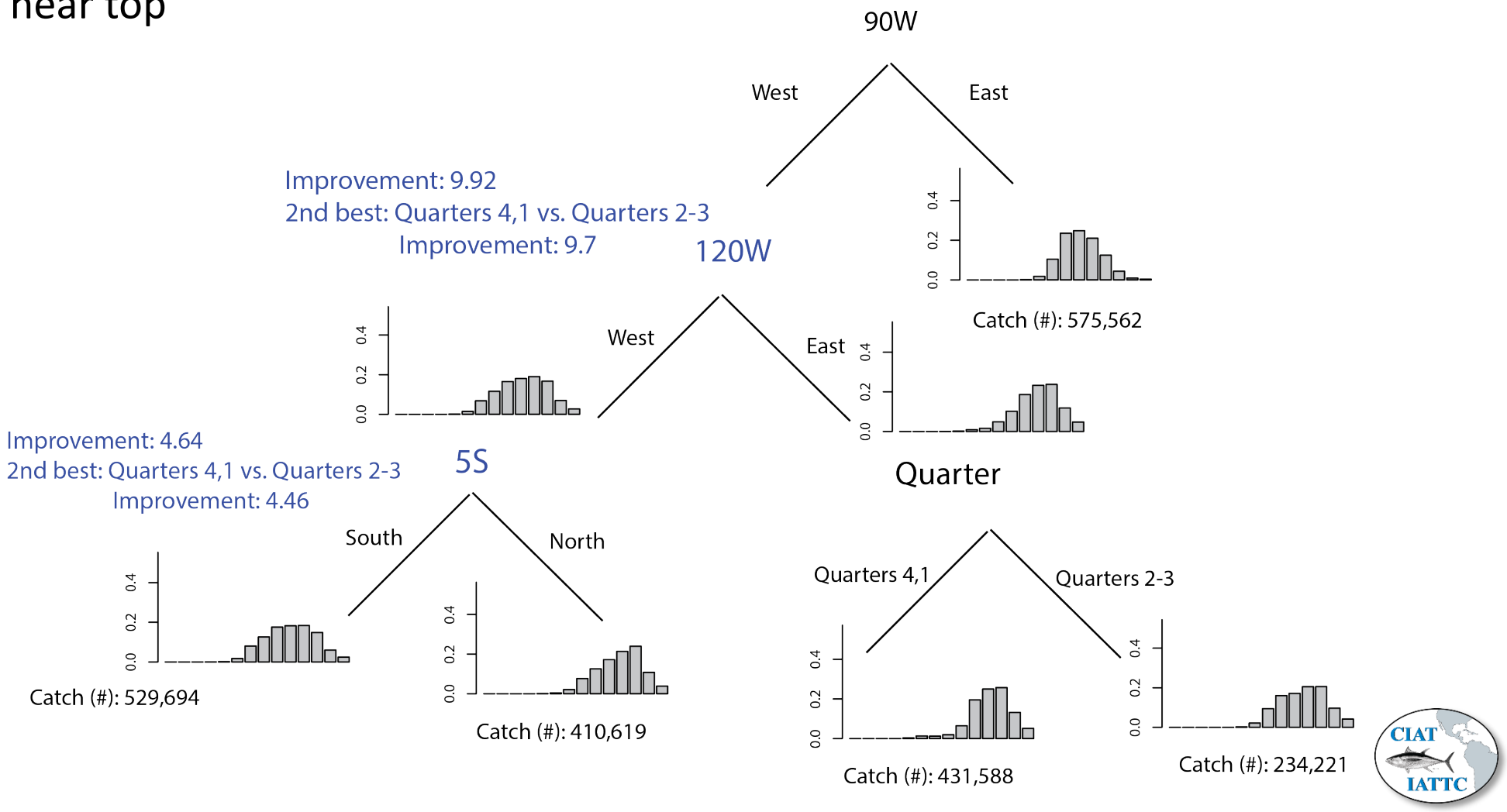
Results: OBJ sets



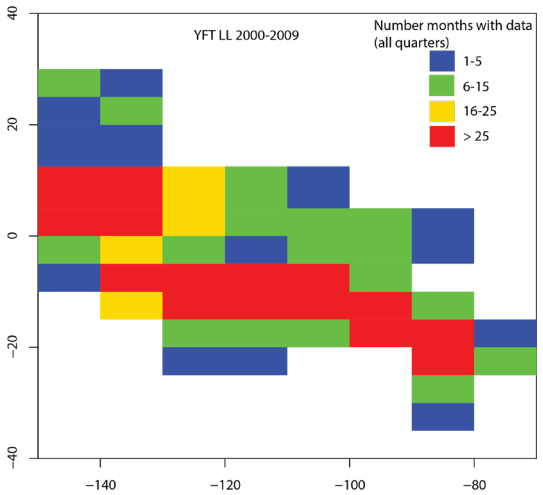
Strata	% Variability explained
2-cell combination (initial partition)	
S of 10S; N of 10S	5.2%
3-cell combinations	
S of 10S; N of 10S Qs 1,4; N of 10S Qs 2,3	7.6%
S of 10S Qs 1,4; S of 10S Qs 2,3; N of 10S	7.0%
4-cell combinations	
S of 10S Qs 1,4; S of 10S Qs 2,3; N of 10S Qs 1,4; N of 10S Qs 2,3	9.4%
S of 10S; N of 10S Qs 1, 4 & W of 95W; N of 10S Qs 1,4 & E of 95W; N of 10S Qs 2,3	8.4%
S of 10S; N of 10S Qs 1,4; N of 10S Qs 2,3 & S of Equator; Qs 2,3 & N of Equator	9.0%
5-cell combinations	
S of 10S Qs 1,4; S of 10S Qs 2,3; N of 10S Qs 1, 4 & W of 95W; N of 10S Qs 1,4 & E of 95W; N of 10S Qs 2,3	10.1%
S of 10S Qs 1,4; S of 10S Qs 2,3; N of 10S Qs 1,4; N of 10S Qs 2,3 & S of Equator; Qs 2,3 & N of Equator	10.7%
S of 10S; N of 10S Qs 1, 4 & W of 95W; N of 10S Qs 1,4 & E of 95W; N of 10S Qs 2,3 & S of Equator; Qs 2,3 & N of Equator	9.7%
All 6 cells	
S of 10S Qs 1,4; S of 10S Qs 2,3; N of 10S Qs 1, 4 & W of 95W; N of 10S Qs 1,4 & E of 95W; ; N of 10S Qs 2,3 & S of Equator; Qs 2,3 & N of Equator	11.5%

Results: Longline

- Seasonality present near top of tree.



Results: Longline



- To choose one of the two 5-cell stratifications:
  - Select that which explains the most variability in the 1986-1991 data.

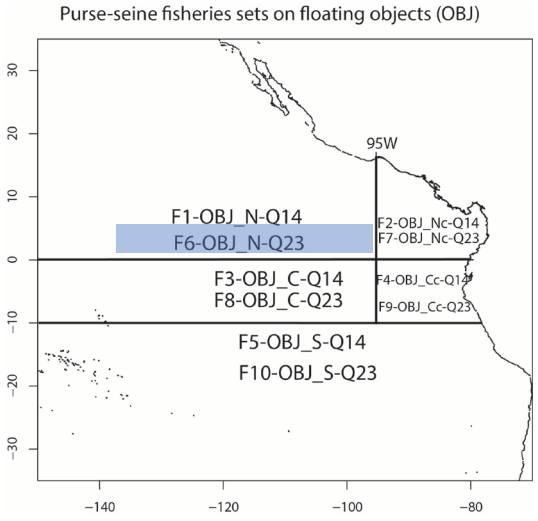
- % Variability explained, 1986-1991 data:
  5-cell: 6.5%
  "Unorthodox" 5-cell: 6.9%

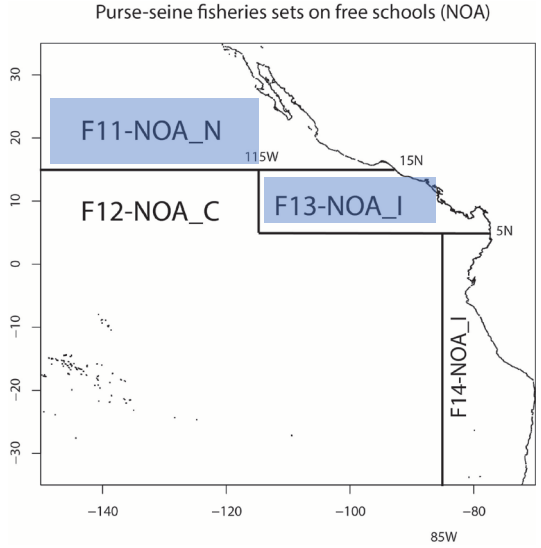
- Following the above, we would choose the "Unorthodox" 5-cell stratification.

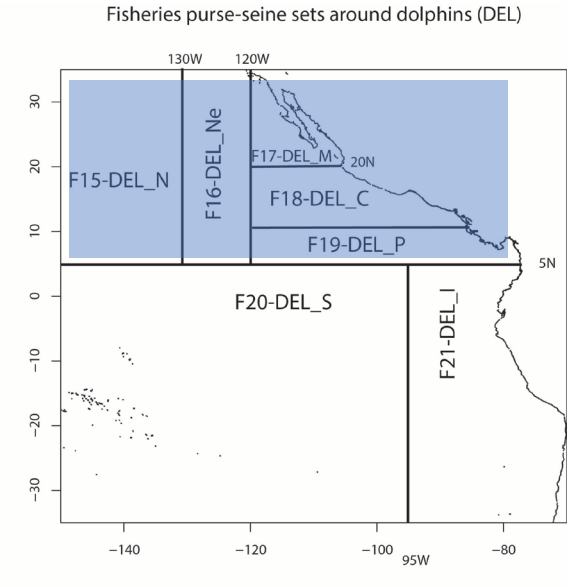
Strata*	% Variability explained
2-cell combination (initial partition)	
W of 90W; E of 90W	5.0%
3-cell combinations	
W of 120W; 90W-120W; E of 90W	7.2%
4-cell combinations	
W of 120W & N of 5S; W of 120W & S of 5S; 90w-120W; E of 90W	8.2%
W of 120W; 90-120W Qs 1,4; 90-120W Qs 2-3; E of 90W	8.6%
5-cell combinations	
W of 120W & S of 5S; W of 120W & N of 5S; 90-120W Qs 1,4; 90-120W Qs 2-3; E of 90W	9.7%
"Unorthodox" 5-cell combination	
W of 120W Qs 1,4; W of 120W Qs 2-3; 90-120W Qs 1,4; 90-120W Qs 2-3; E of 90W <uses quarter split instead of 5S split, west of 120W; this makes everything seasonal within each E/W block because data east of 90W are almost all from quarters 2-3>	9.8%

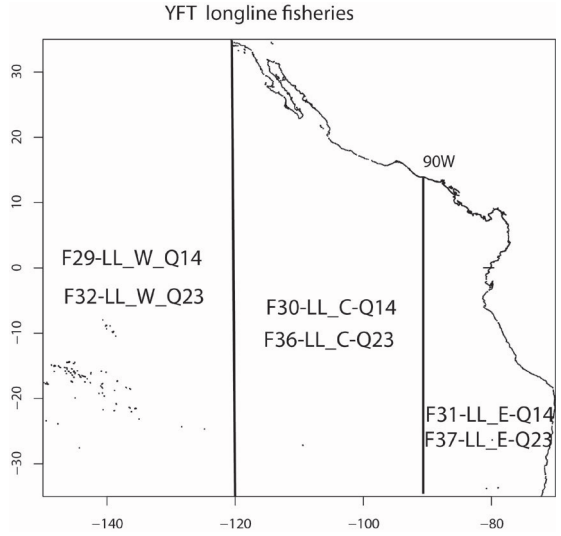
Discussion

YFT models: definition of the fisheries









North reference model

South reference model