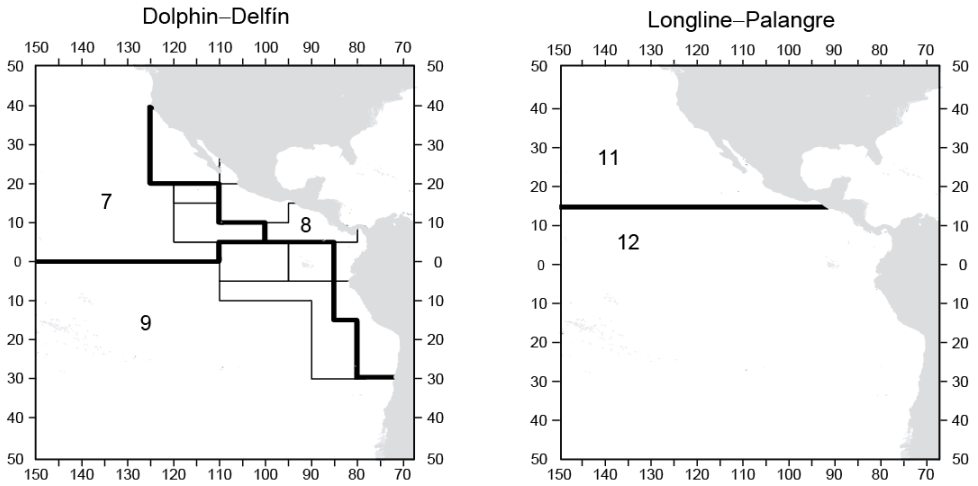
Analysis of large-scale spatial patterns in yellowfin tuna catch data from purse-seine and longline fisheries

SAC-04-04d

Background

- Fishery stratification is used in assessments to address differences in stock and fishery dynamics.
- As fisheries evolve, it is useful to reevaluate stratum definitions.



- SAC-04-04d presents an analysis of large-scale pattern in yellowfin purse-seine and longline catch data for the purpose of defining alternatives to these current stratifications.

Materials and methods

- Purse-seine data for yellowfin
  - Sets on tunas associated with dolphins for large vessels (size-class 6)
  - Length-frequency data for 2000-2011
  - Catch (tons) and effort (days fishing) data for 1975-2011

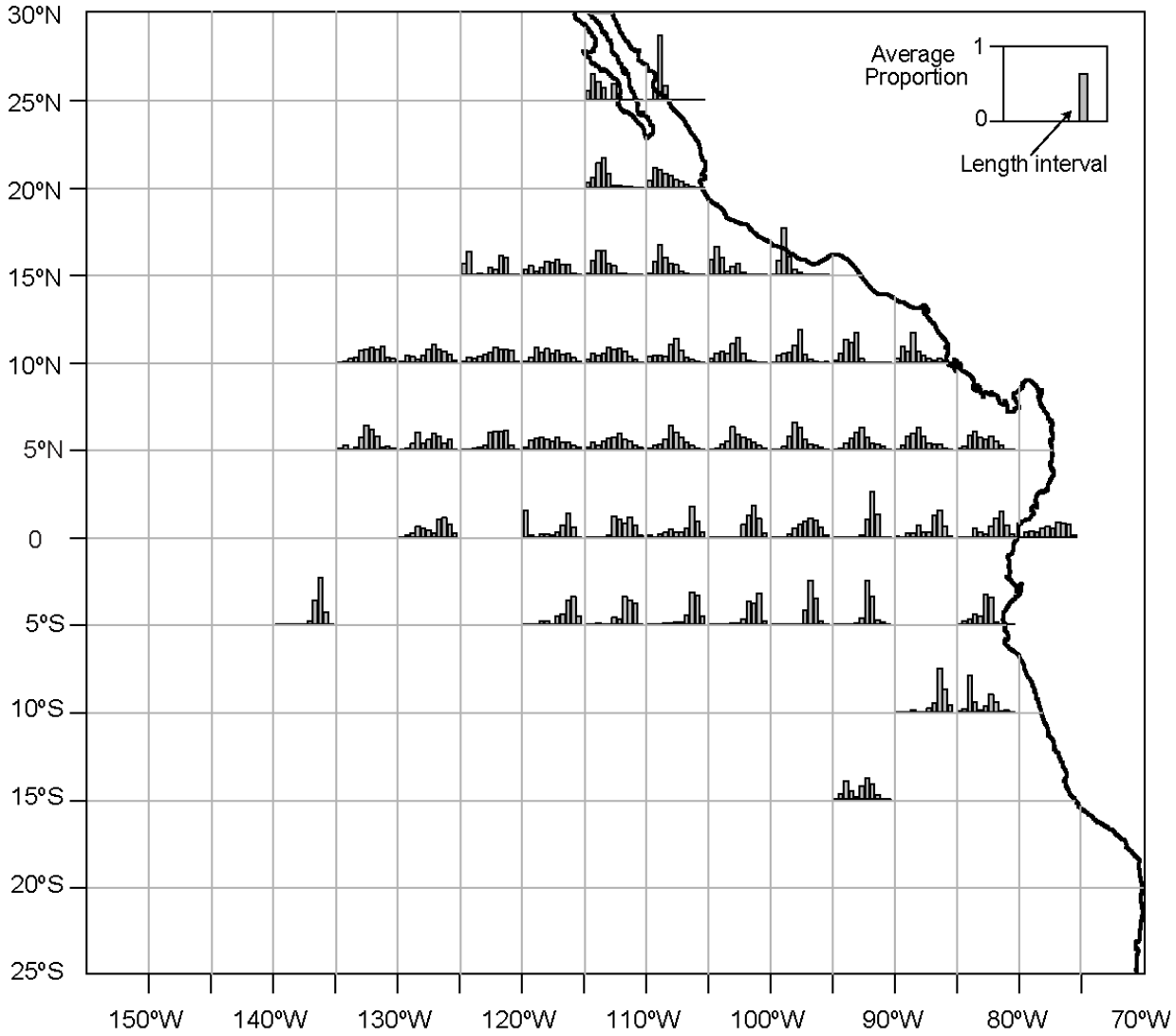
- Japanese longline data for yellowfin
  - Length-frequency data for 2002-2010
  - Catch (numbers) and effort (number of hooks) data for 1975-2011

Materials and methods

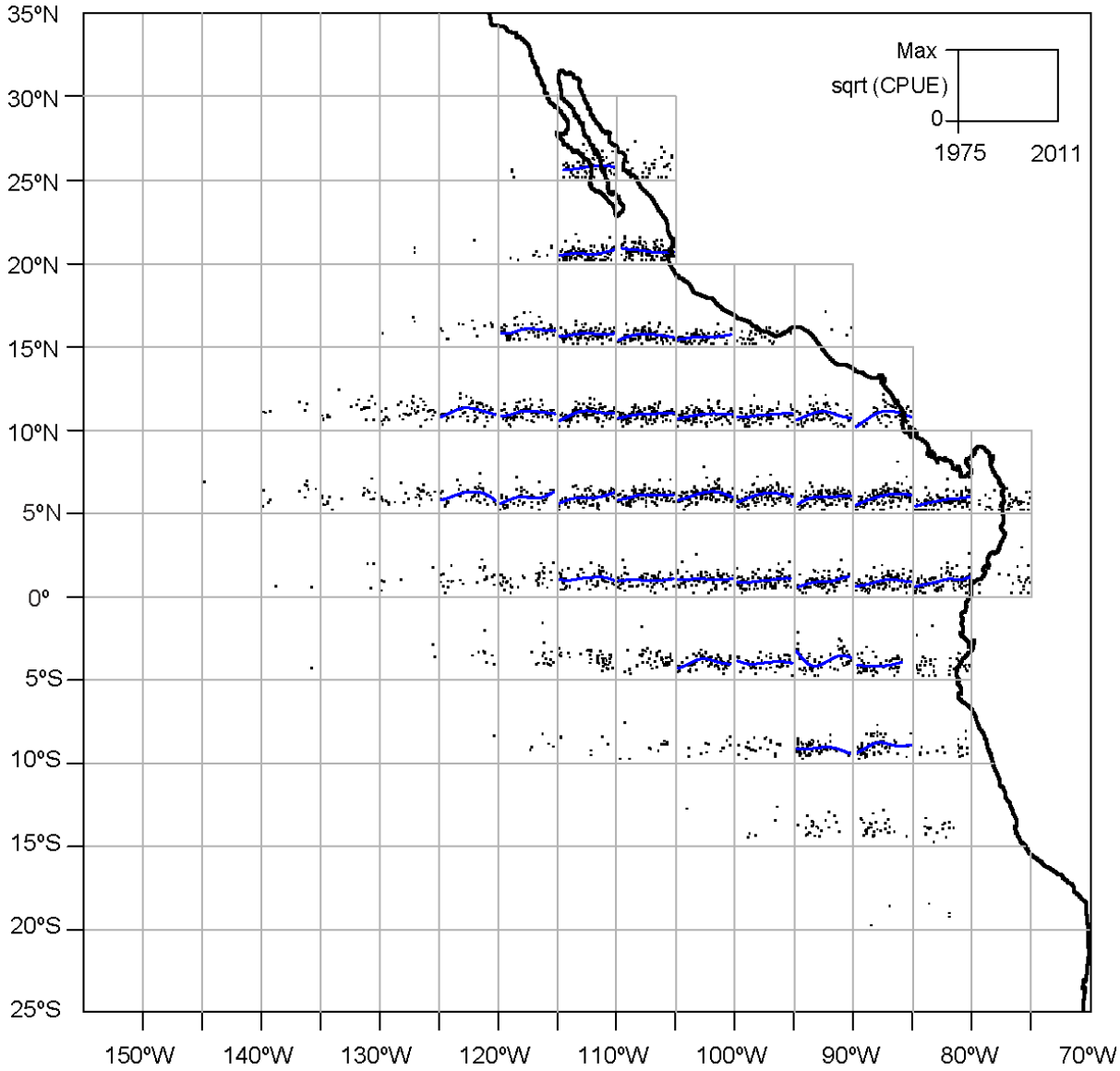
- Catch data summaries computed on a fine-scale spatial-temporal grid
  - Purse-seine: 5° latitude by 5° longitude by quarter (Jan-Mar; Apr-Jun; Jul-Sep; Oct-Dec)
  - Longline: 5° latitude by 10° longitude by quarter

- Catch data summarized by:
  - Binned frequencies (length-frequency counts)
  - Smooth catch-per-unit-effort (CPUE) trends (penalized cubic regression splines)

Purse-seine length-frequencies, Oct-Dec



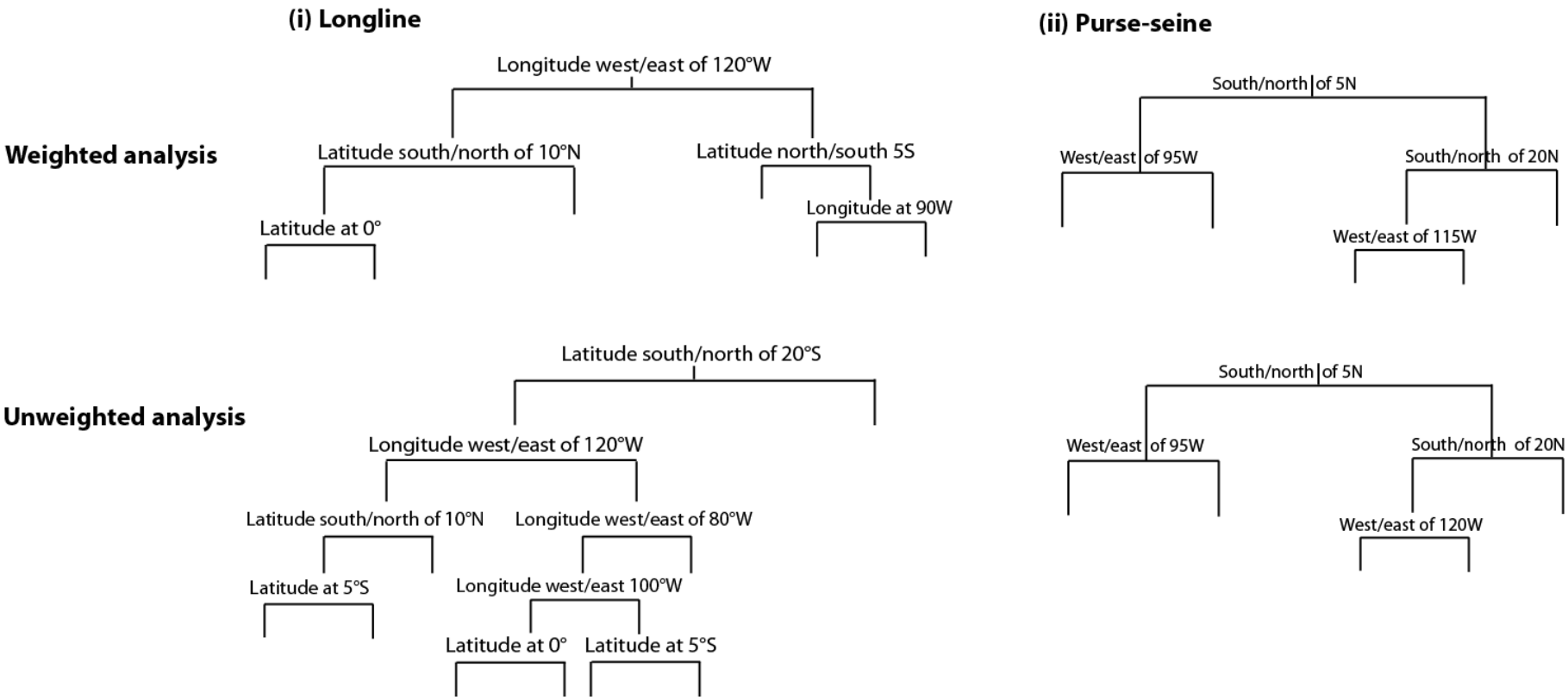
Purse-seine CPUE trends, Oct-Dec



Materials and methods

- For each fishery (purse-seine, longline):
  - Large-scale patterns in length-frequency distributions and smooth CPUE trends were explored using a tree-based method.
  - Predictor variables: 5° latitude, 5° (10°) longitude, quarter
  - Response variables: bin frequencies, first-differenced smooth CPUE trends.
  - The tree-based method simultaneously subdivides the two data types (frequencies, trends) into less heterogeneous subgroups using the predictor variables.
  - Measures of heterogeneity
    - Frequency distributions: Kullback-Leibler divergence
    - First-differenced trends: multivariate sum of squares
  - Unweighted analysis (ignores error about estimated trends) and variance-weighted analyses.

Results: longline and purse-seine trees

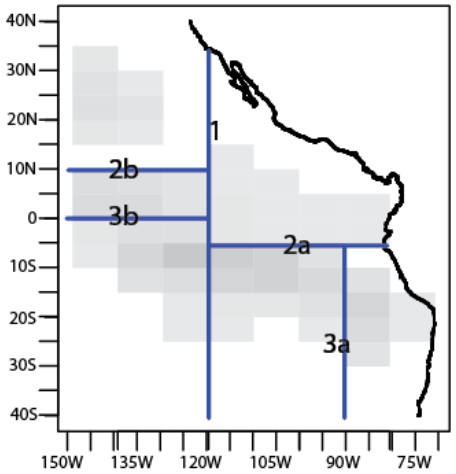


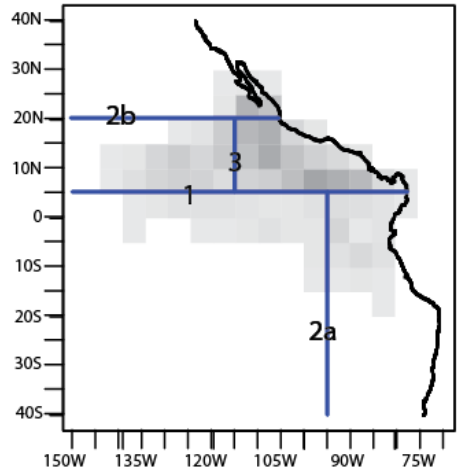
Results: longline and purse-seine trees

(i) Longline

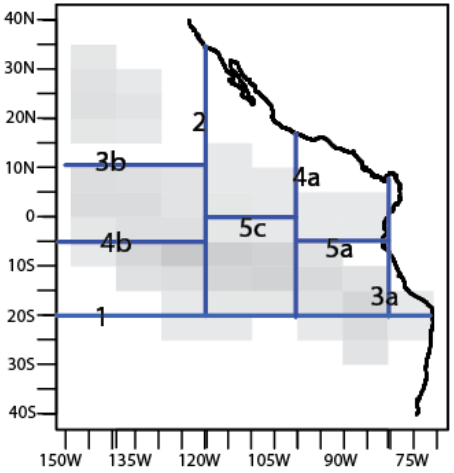
(ii) Purse-seine

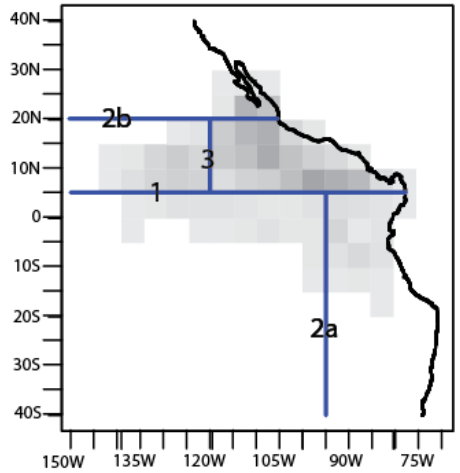
Weighted analysis





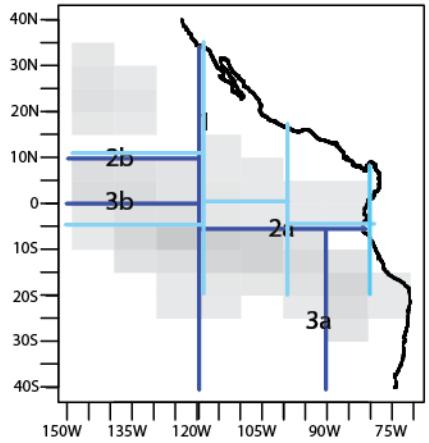
Unweighted analysis



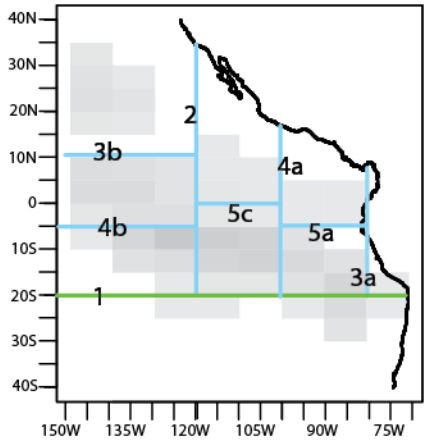


(i) Longline

Weighted analysis



Unweighted analysis



Summary of tree results

- Longline and purse-seine trees share the following spatial structure:
  - a north/south partition of the EPO near the equator;
  - an east/west partition of the northern EPO at about 120°W;
  - an east/west partition of the southern EPO at about 90°-100°W.

- This similar spatial structure can be used to define alternative assessment strata.

- Candidate strata were limited to 4 areas, and a coarse spatial scale.

Candidate assessment strata