Comisión Interamericana del Atún Tropical
Inter-American Tropical Tuna Commission

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WORKSHOP TO IMPROVE THE LONGLINE INDICES OF ABUNDANCE OF BIGEYE AND YELLOWFIN TUNAS IN THE EASTERN PACIFIC OCEAN

10th Meeting of the Scientific Advisory Committee San Diego, California USA, 13-17 May 2019

Outline

- Background
- Goals
- Findings
- Recommendations
- Future work

Background

- Bigeye tuna stock assessment fit to longline-derived indices, strong weight:
  - Recruitment shift
  - Fmult sensitive
- Yellowfin tuna stock assessment longline-derived index is the main one:
  - Inconsistent with purse-seine indices
- Retraction of the Japanese fleet, data used to compute the indices:
  - smaller sample sizes
  - Increase uncertainty in the index (not reflected in the stock assessments)
  - non-random distribution of the fleet ("preferential sampling")
- Length composition data is not standardized
  - Represents both the catches and the indices
  - Is changing in the recent years
- Target changes, gear changes? swordfish and albacore catches increased in some areas.
- Increase in vessel efficiency not taken into account

Projects

3. SUSTAINABLE FISHERIES	
PROJECT H.1.c: Investigate potential changes in the selectivity of the longline fleet resulting from changes in gear configuration	
THEME: Sustainable fisheries **GOAL:** H. Improve and implement stock assessments, based on the best available science **TARGET:** H.1. Undertake the research necessary to develop and conduct at least one benchmark stock assessment for yellowfin and bigeye tunas **EXECUTION**: Stock Assessment Program	
Objectives	Evaluate potential changes in targeting on the size composition of the longline catches of bigeye and yellowfin
Background	• The current yellowfin stock assessment shows a pattern of residuals for the recent longline length-composition data

Not funded

Projects

PROJECT H.1.d: Improve indices of abundance based on longline CPUE data	
THEME: Sustainable fisheries **GOAL:** H. Improve and implement stock assessments, based on the best available science **TARGET:** H.1. Undertake the research necessary to develop and conduct at least one benchmark stock assessment for yellowfin and bigeye tunas **EXECUTION**: Stock Assessment Program	
Objectives	• Improve the yellowfin and bigeye indies of relative abundance from longline data • Determine methods to identify targeting in longline fisheries • Develop spatio-temporal models for creating indices of relative abundance from longline data • Develop appropriate longline length composition data for the index of abundance and for the catch
Background	• Indices of relative abundance derived for longline CPUE data are the most important piece of information in the bigeye and yellowfin stock assessments • Only the Japanese data are currently used to create these indices

Partially funded

Workshop goals

Data:

- Review and revise longline catch, effort and size data with spatial information (operational level data)

Analyses:

- Improve the indices of relative abundance for yellowfin and bigeye tuna based on longline catch and effort data:
  - Methods to identify targeting in longline fisheries
  - Delta-GLM models
  - Spatiotemporal models
- Develop appropriate longline length-composition data for the index of abundance and for the catch

Preparatory work:

- Memorandum of Understanding with Korea, China, Chinese Taipei, Japan
- Access to operational level data

CPC	CPUE data	Size composition data	Spatial range
Korea	Nov 08 2018 – May 17 2019	Nov 08 2018 – May 17 2019	Pacific Ocean
Chinese Taipei	Dez 27 2018 – May 17 2019		Pacific Ocean
China	Jan 20 2019 – May 17 2019		Eastern Pacific Ocean
Japan	Jan 21 2019 – Fev 15 2019	Jan 21 2019 – Fev 15 2019	Pacific Ocean

- Visiting scientists:
  - Dr. Sung Il Lee (Korea, Oct 08-28 2018)
  - Dr. Keisuke Satoh (Japan, Jan 21 – Feb 16 2019)
  - Dr. Simon Hoyle (Consultant, Jan 28 - Feb 15 2019, ISSF funding)

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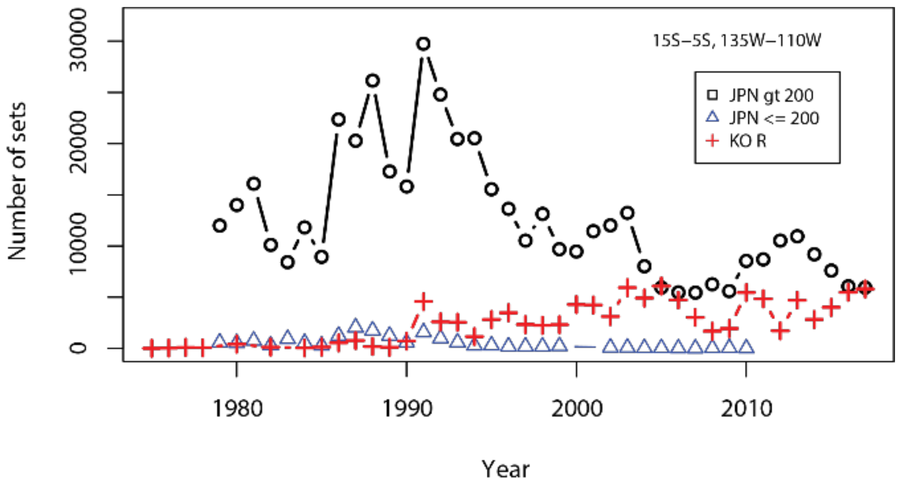
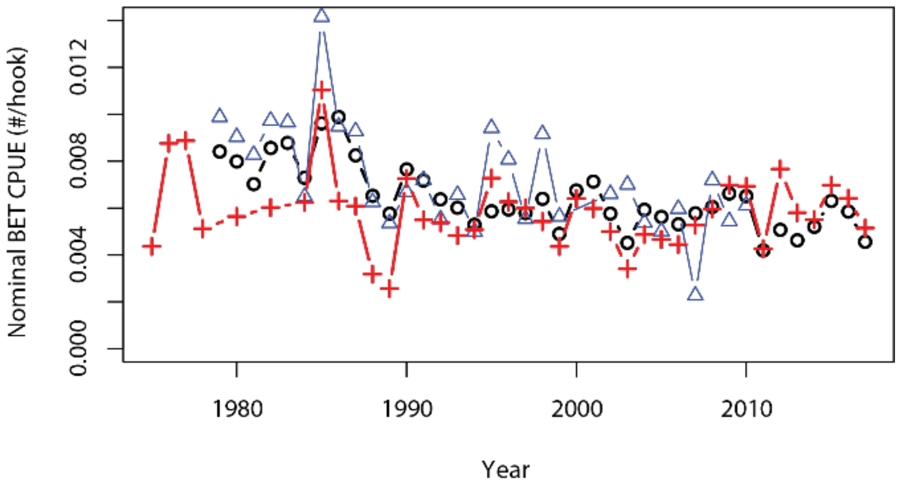
Review and revise operational level data and size-composition data

- Exploratory data analysis by fleet
- Comparisons among fleets
- Focus on Japan and Korea – largest spatiotemporal coverage
- Apparent different trends between Japan and Korea resolved by controlling for area of operation and vessel size



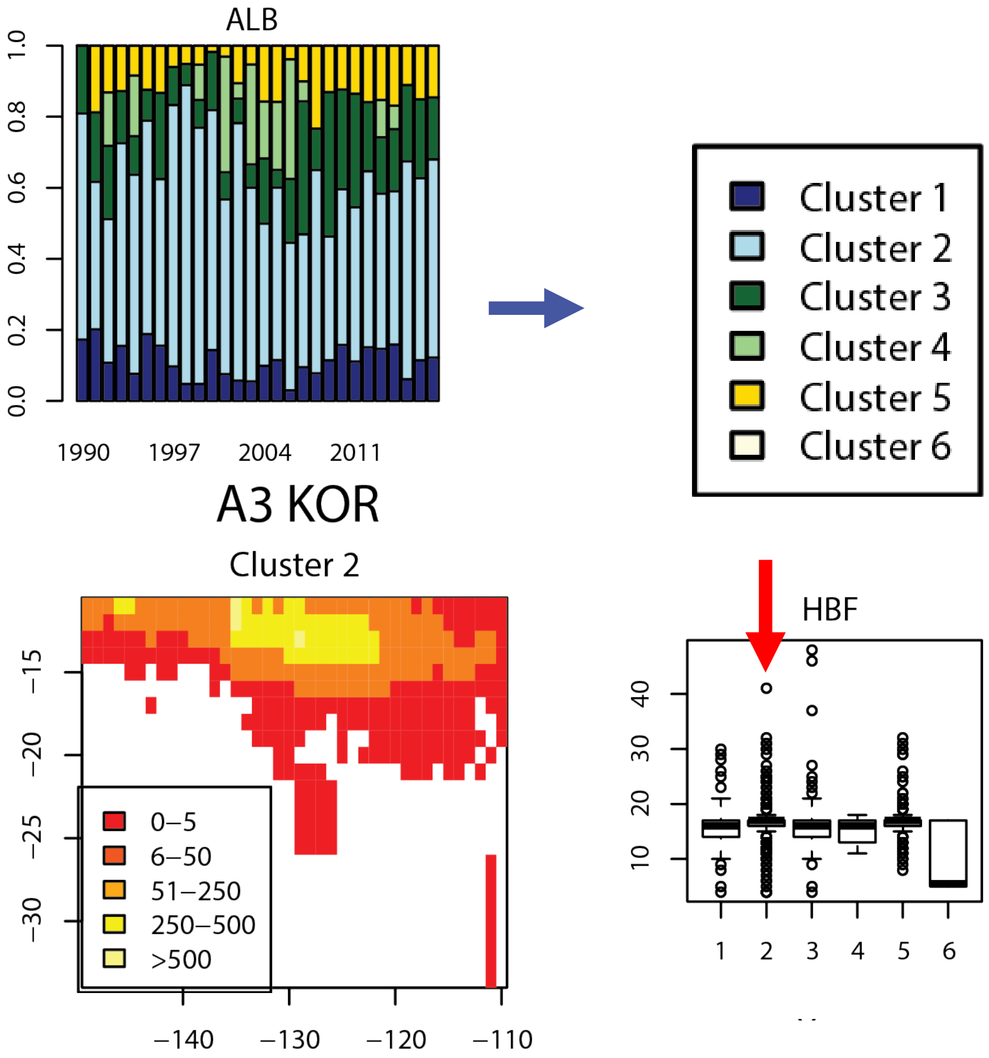


Improve the indices of relative abundance: targeting

- Four methods for identify targeting in longline fisheries explored:
  - Hoyle's cluster method
  - Okamura's method
  - Hybrid methods
  - Satoh's method

- Three used to estimate targeting

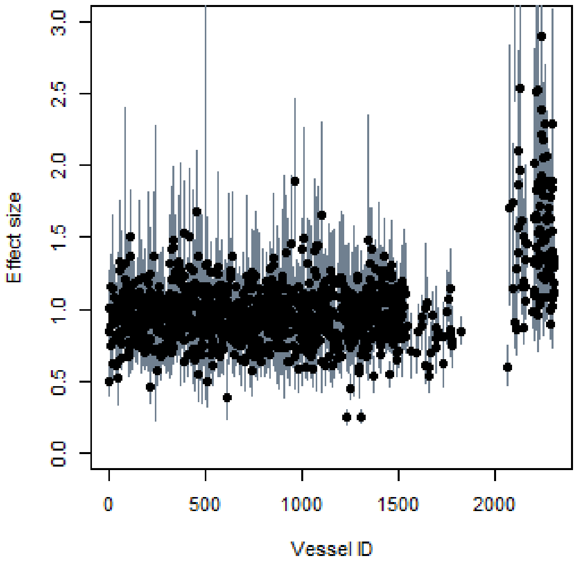
- Hoyle's cluster method selected



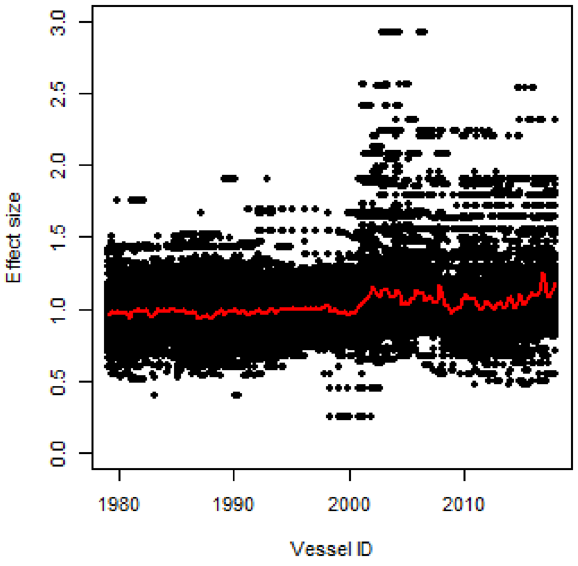
Improve the indices : delta-GLM models

- Models for each fleet and joint model
- Indices are weighted by sample size
- Vessel effects are important
- Clusters effects are important

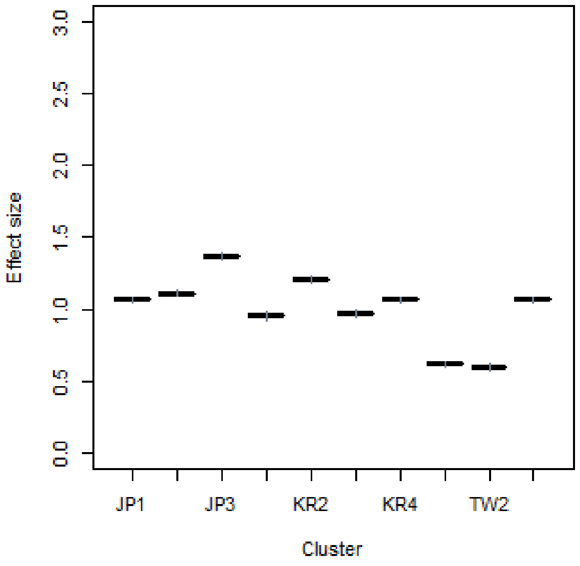
Vessel effects



Vessel effects



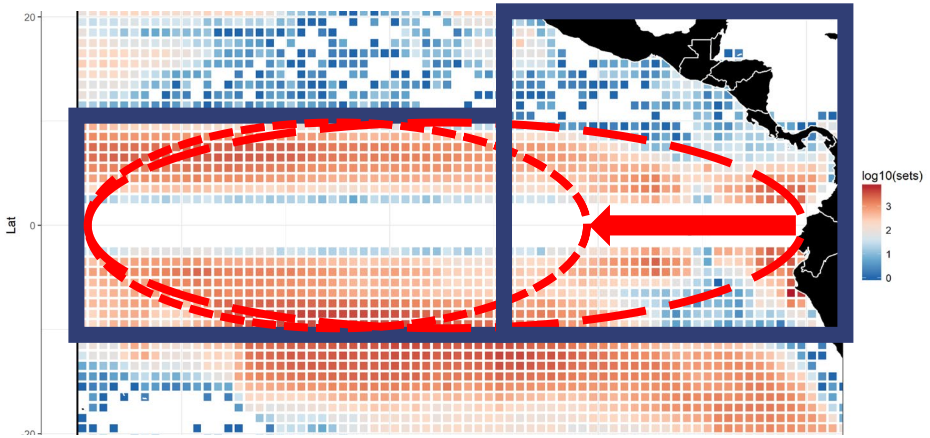
Cluster effects



Improve the indices : spatiotemporal models

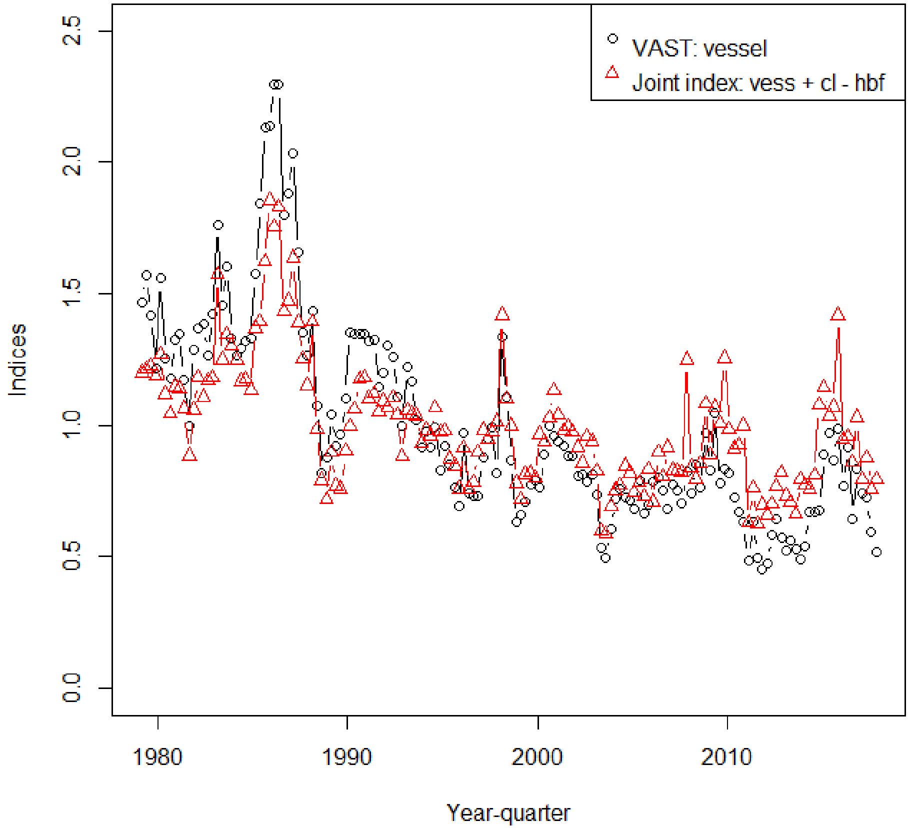
- Models for Korea, Japan and Korea + Japan developed
- Very long run time:
  - aggregated data (1 by 1) used
  - only spatial correlations modeled
- Vessel effects important: even if not included in the model,

  aggregation by vessel influent in the results (indicates importance of weighting when producing the estimate)
- Allowed for estimation of indices for “data-poor” areas
- Uncertainty in estimates increased over time



Improve the indices : comparison of approaches

- Similar trends but not equal
- Vessel effects important
- Targeting: no enough time to find the most appropriate way to model it in the spatiotemporal models, important in the delta-GLM
- Sample size weighting *versus* area weighting?
- Neither approaches address changes in length composition
- Catchability may be related to environment

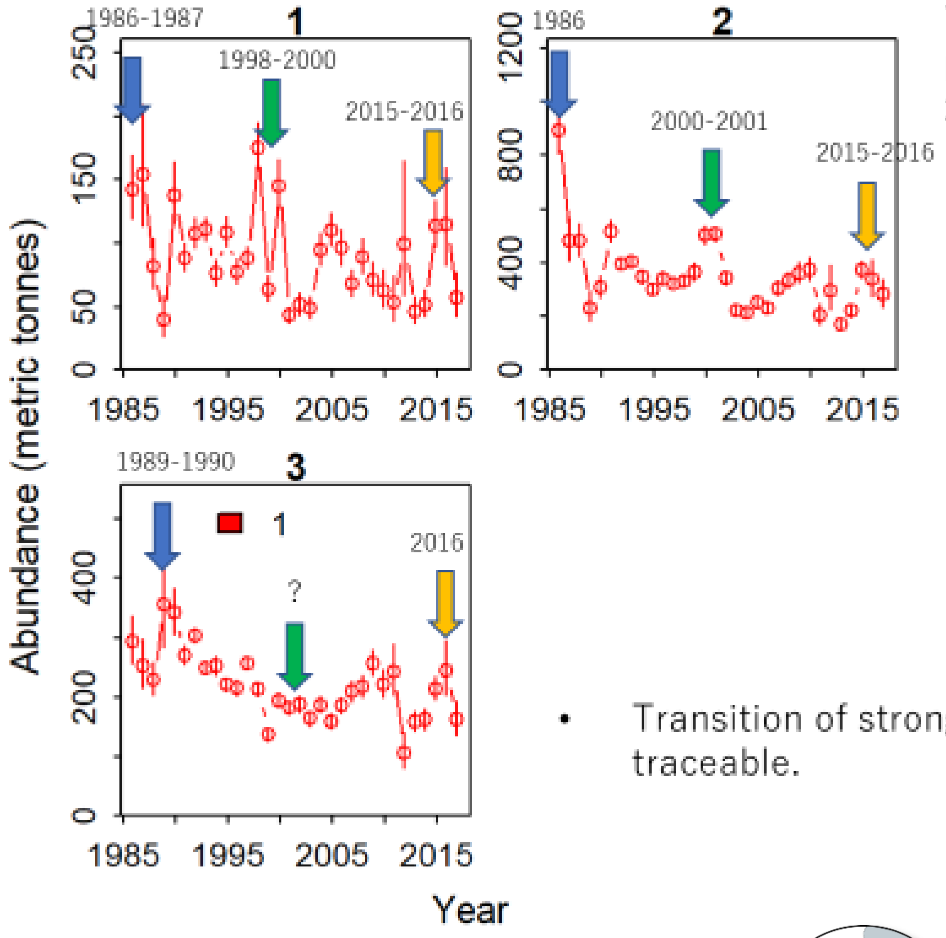


Appropriate longline length-composition data for the index of abundance and for the catch

- Spatiotemporal model by size class attempted:
  - Only JPN data
  - Not all operational level data is matched to the size composition data
  - The matching process may take long
- Computational challenges are large:
  - Annual time step (as opposed to quarter – assessment)
- Indication that abundance and spatial distribution depends on size class
- **Ultimate goal**
  - **TO BE CONTINUED….**

Results

12. Abundance index



- Transition of strong traceable.

Recommendations from the workshop participants:

1. Data availability
2. Data collection
3. Analyses
4. Diagnostics
5. EPO Indices of abundance

Recommendations: 1. Data availability

a. ***Commend*** Japan, Korea, China, and Chinese Taipei **for making the operational-level data available**

b. ***Commend*** **Japan and Korea for making the size-composition data with fine spatial resolution available**

c. *Request* the IATTC staff to prepare a document stating the reasons why the operational-level data, and the corresponding fine scale size-composition data by sex, **should be made available for research for longer periods of time.**

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Recommendations: 2. Data collection

a. *Encourage* CPCs to **continue collecting size-frequency data** at levels of coverage adequate for computing indices of abundance by size class.

b. *Continue* or *start* **interviews with fishers**.

c. Retrospectively ***match*** **operational data with length-composition data** and ensure that they are linked for future data collection.

Recommendations: 2. Data collection

d. Continue *retrieving* **unique identifiers for vessels** in the Japanese database prior to 1979, and do so for other fleets where needed.

e. ***Compile*** **information about technological changes to vessels** in order to understand changes over time that can be used in the CPUE standardization.

f. *Encourage* CPCs to require the **recording in vessel logbooks of the use of light sticks**

g. *Encourage* **Chinese Taipei to provide all available logbook data to data analysts**, representing the best and most complete information possible.

Recommendations: 3. Analyses

a.***Continue* the collaborative work** among the IATTC staff, external collaborators, and CPC scientists.

b. *Compare* the **length-composition data for the Japanese fleet** recorded by vessel **crews and by on-board observers**

c. ***Examine* the reliability of logbook data by comparing with the observer data**.

d**. *Examine* the "target" field** (tuna, swordfish, shark) reported in the Japanese logbook data and see what characteristics relate to the different targets.

Recommendations: 3. Analyses

e. *Analyze* **observer data that include hook-by-hook information** to evaluate whether gear setup changes within a set.

f. *Evaluate* the data to determine **whether swordfish are caught in the same sets as bigeye tuna.**

g. *Review* **observer** data to **identify secondary targeting** and define, if necessary, new data fields to be added to logbooks.

h. ***Conduct*** **cross-validation studies on fishery data** from time periods with good spatial coverage or with survey data to evaluate **biases caused by poor spatial** and/or by **preferential sampling.**

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Recommendations: 3. Analyses

h. [cont] ***Investigate* the use of environmental variables to impute CPUE in spatial cells with no data**.

i. *Use* **length-compositions** estimated with by VAST models and

spatially **weighted by catch** to represent the **catches**,

spatially **weighted by CPUE** to represent the **indices of abundance**

j. *Review* all the available information related to the **effect of El Niño and La Niña** oceanographic conditions on CPUE

k. *Investigate* the **seasonality** feature in VAST.

Recommendations: 4. Diagnostics

a. *Compare* vessel effects by flag.

b. ***Define* a set of standard diagnostics** that should be applied to the spatio-temporal modeling.

c. *Develop* diagnostics to identify when the **correlation structure changes** in space or time.

d. When using the results of clusters analyses in the model to standardize for targeting (e.g., the cluster ID is used as a factor in the CPUE standardization model), ***examine* the year effect by cluster** for differences.

e. *Compare* **CPUE among flags in areas where their effort overlaps**.

f. *Construct* **influence plots and step plots**.

g. *Continue* **simulations** to test spatial-temporal models. Use simulation studies to assess the effect of aggregating data (e.g. by spatial cell-time-vessel vs. spatial cell-time).

Recommendations: 5.EPO abundance indices

a. Targeting by vessel/gear versus spatial targeting: **exclude spatial targeting in VAST** because this is a density effect and it is confounded with the spatial components of the model.

b. *Compute* indices of abundance for the four areas of the spatial assessment from **Japanese data and from post-1990 Korean data.**

c. ***Exclude* the data associated with the clusters** of the fleet-specific cluster analyses of catch composition that had a **high proportion of CPUE for striped marlins**, except for area 1 for the Japanese fleet (because of the high proportion of bigeye in the striped marlin clusters in that area). Clustering should be done using **Hoyle's method**. Use cluster as a catchability covariate factor. **Include the eliminated cluster in a sensitivity analysis.**

Recommendations: 5.EPO abundance indices

d. **Further *investigate* targeting** to determine how best to model targeting in VAST (e.g., formulation of targeting effects, specify target at the vessel*cell*year level rather than set, set-by-set targeting is probably not happening, etc.).

e. Further *investigate* the **size-based CPUE model**.

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Conclusions

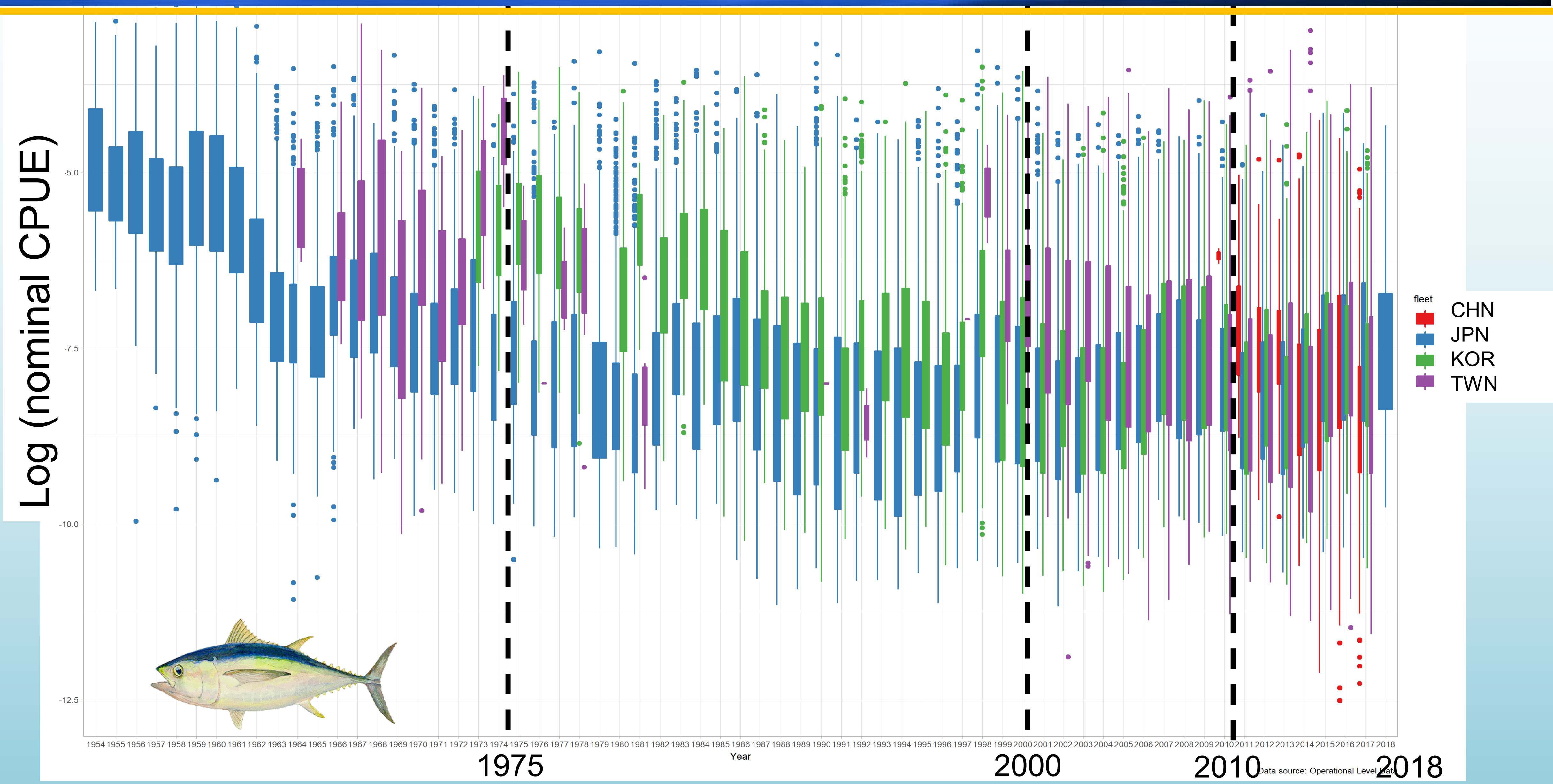
- First collaborative longline workshop in the IATTC with main longline CPCs
- Experiences shared from similar processes in other oceans – external collaborators and invited speakers
- Advances of the understanding of the data - national scientist
- Advances on technical aspects of standardization models
- Focus on bigeye
- The work is in progress, there is much to be done

Why do the staff needs access to the operational level data/ size data for longer for research and continuation of collaborative work?

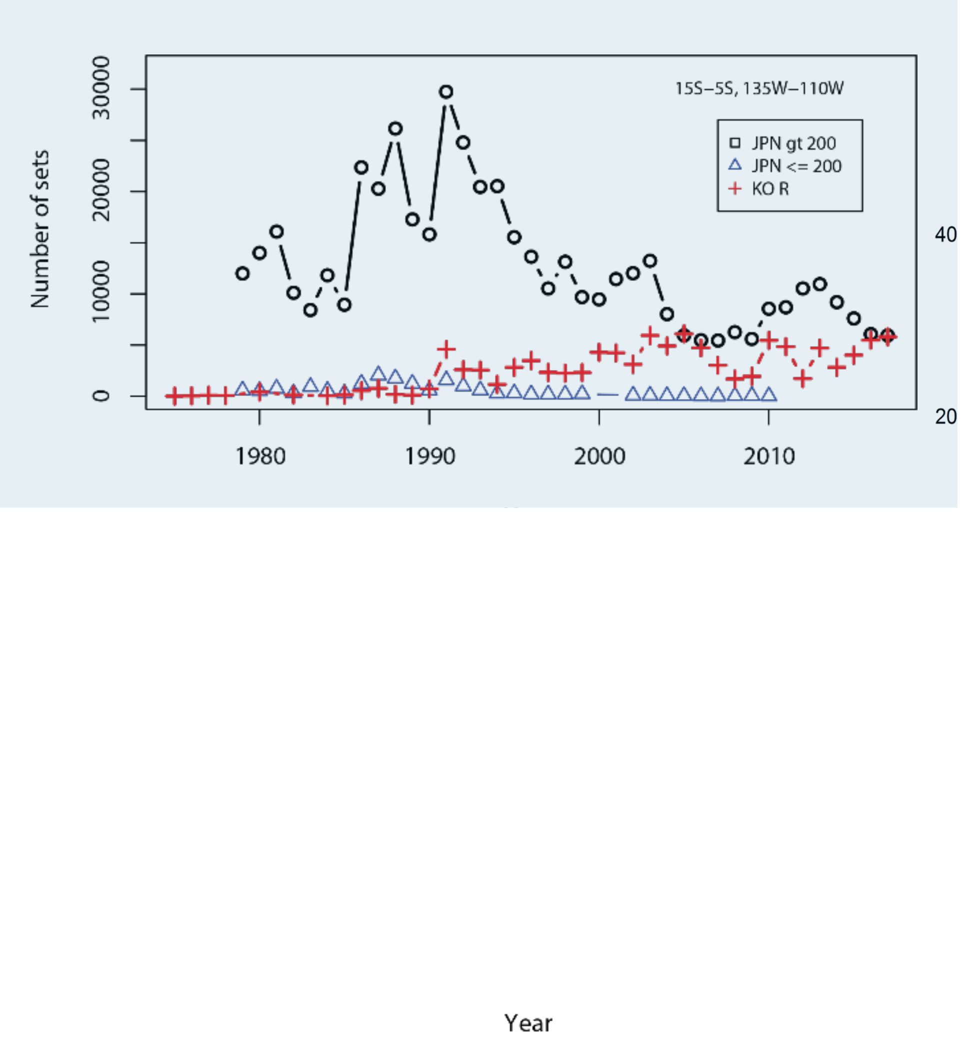
- Indices:
  - Vessel effects are important (increase in catchability)
  - Spatiotemporal models have long run time and are computationally demanding
  - Model development and diagnostic takes time
  - Indices should be by size class
  - Focus on bigeye tuna, yellowfin tuna and other species not addressed
- Overall improvement of stock assessments
  - Stock structure/fisheries structure: analyses local trends in abundance and length-frequencies
  - Natural mortality and growth: analyses of length-frequencies by sex

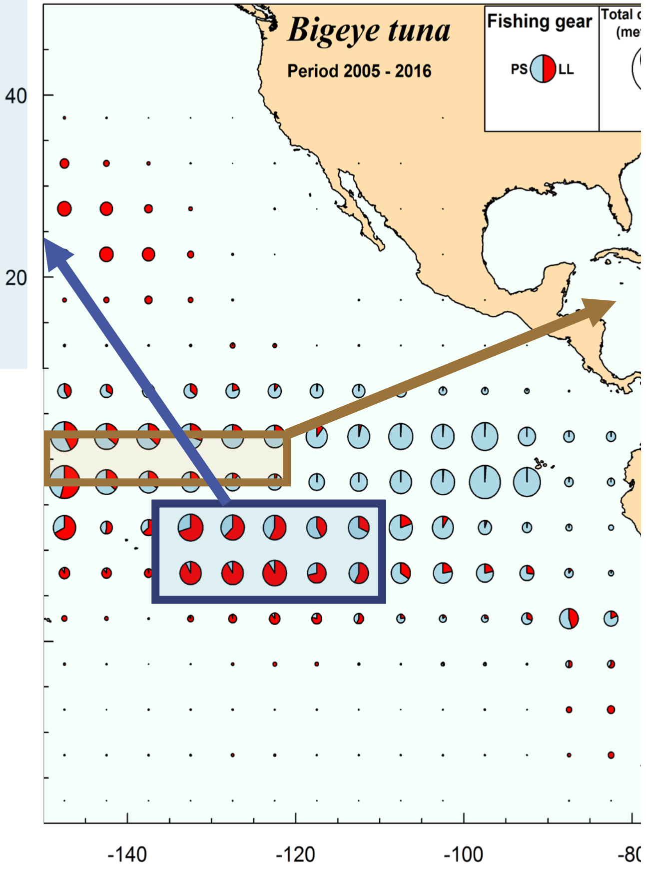
Thank you!

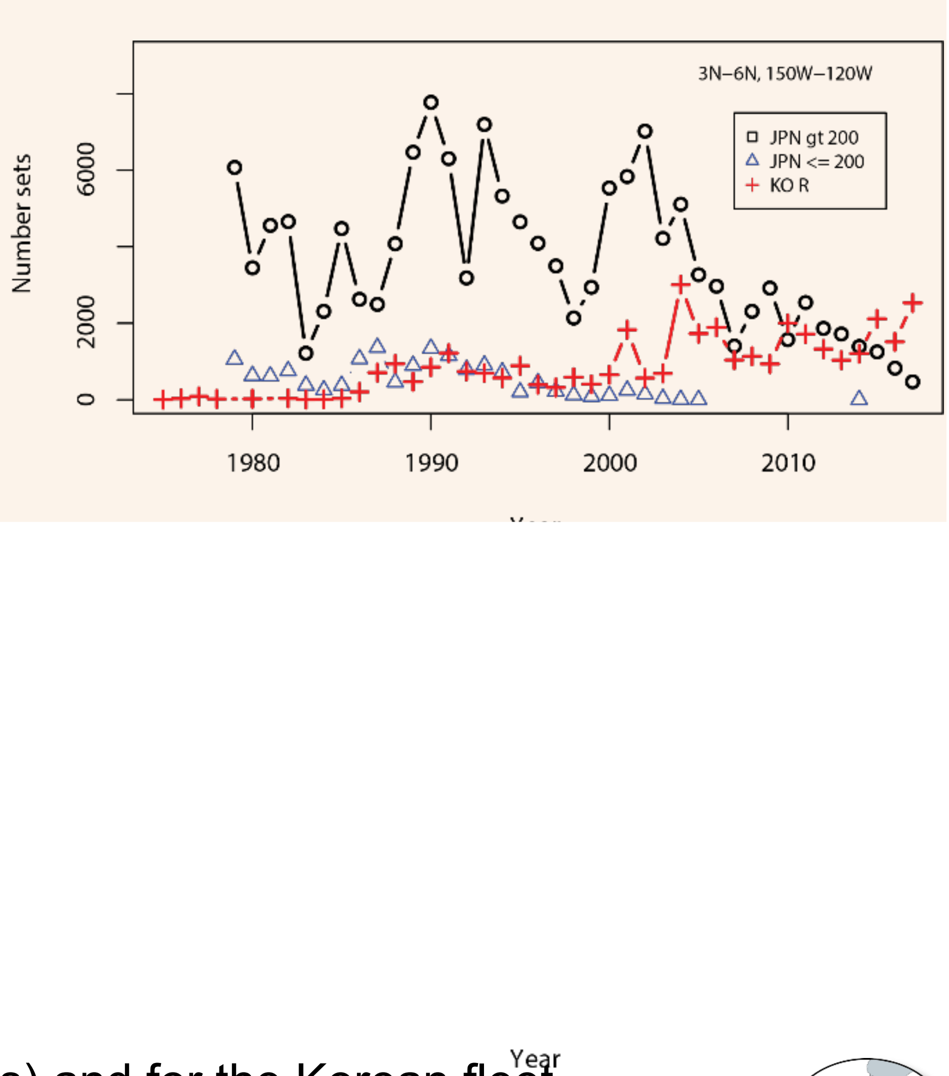
Nominal trends by fleet: bigeye tuna: area 1



Nominal trends by fleet: bigeye tuna







Nominal bigeye tuna CPUE for the Japanese fleet (large and small vessels) and for the Korean fleet.

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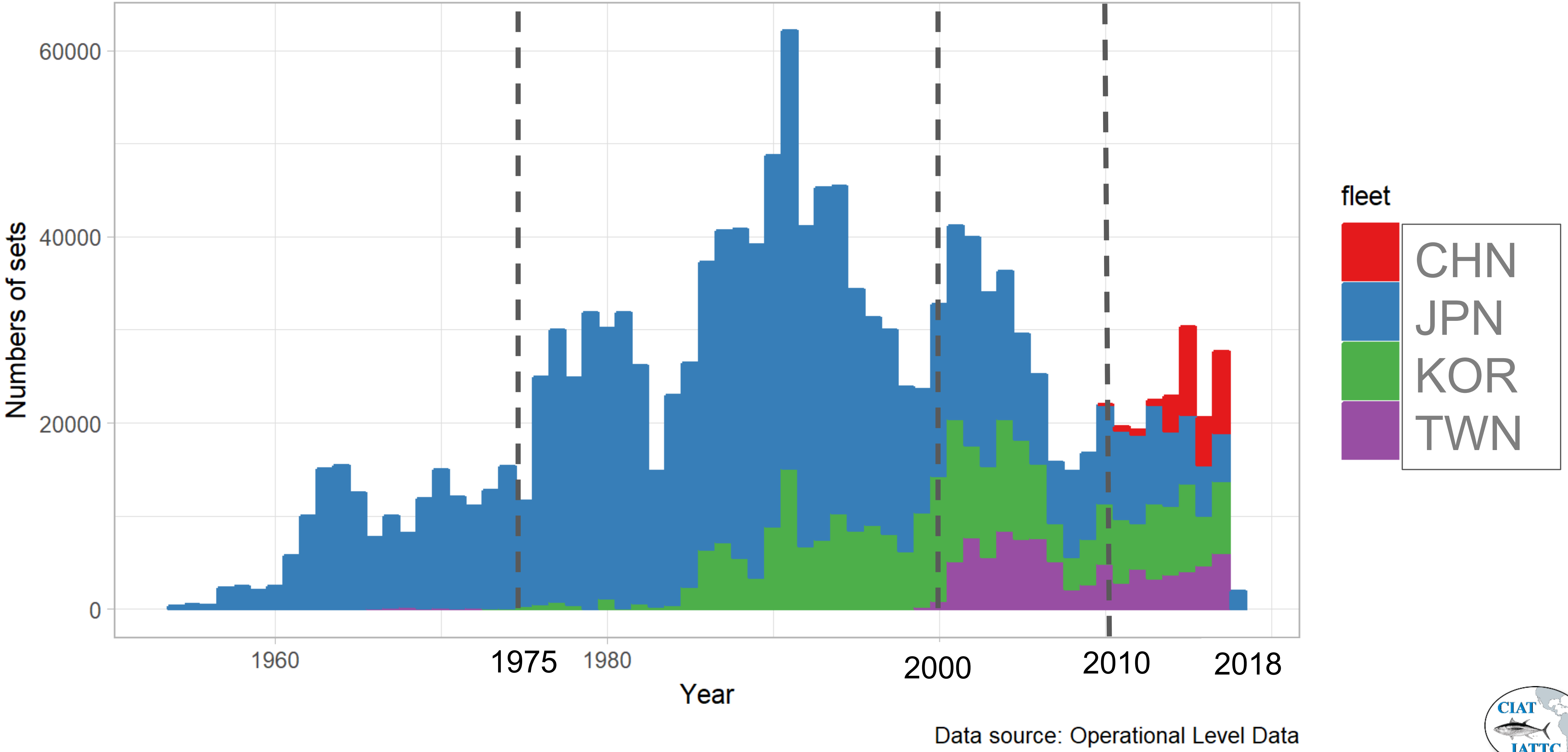
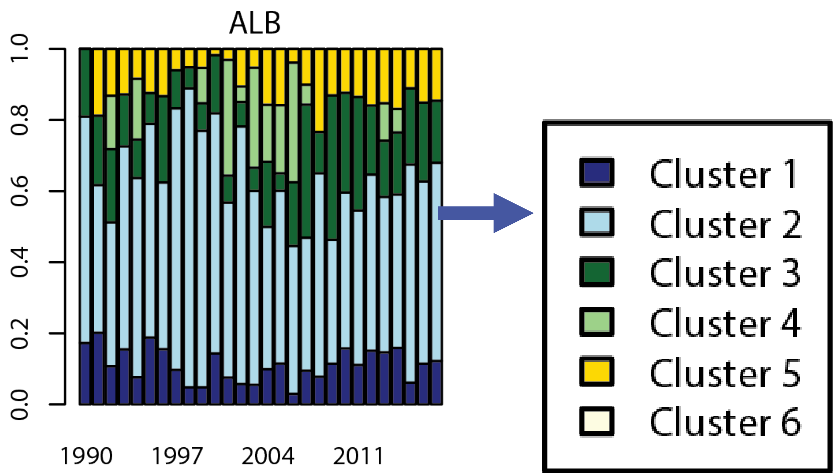
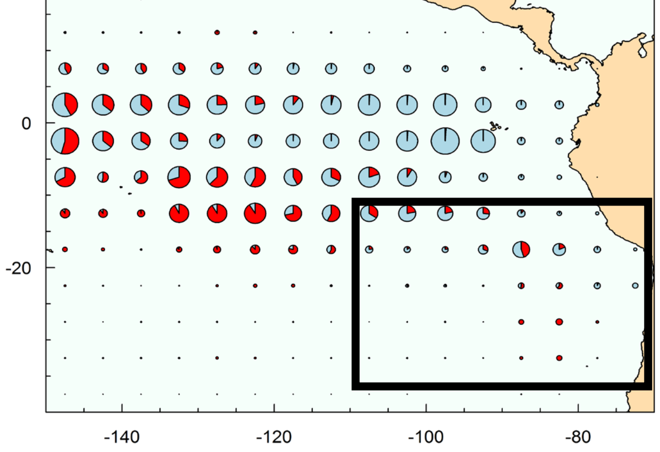
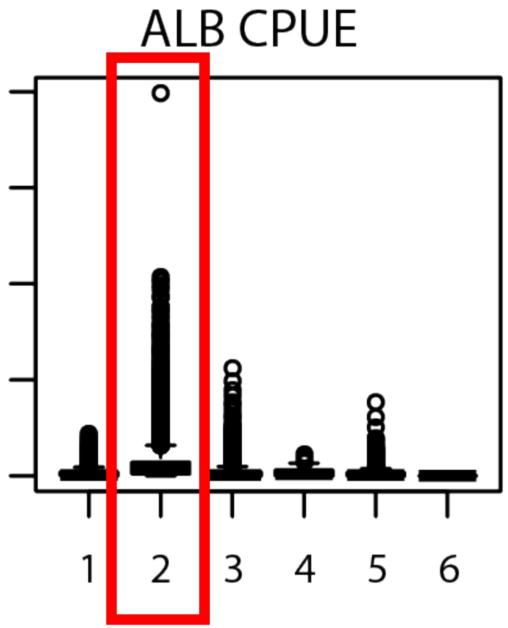
Sample sizes by year and fleet: area 1



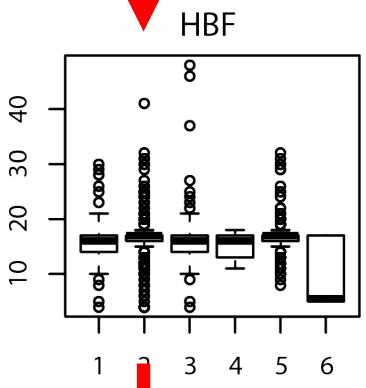
Targeting: example area 3, KOR

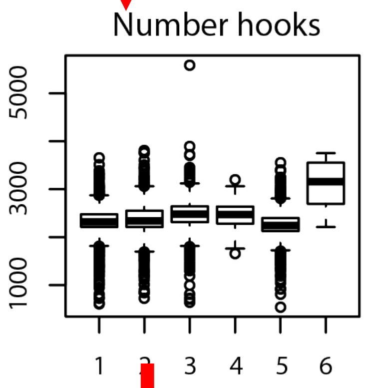


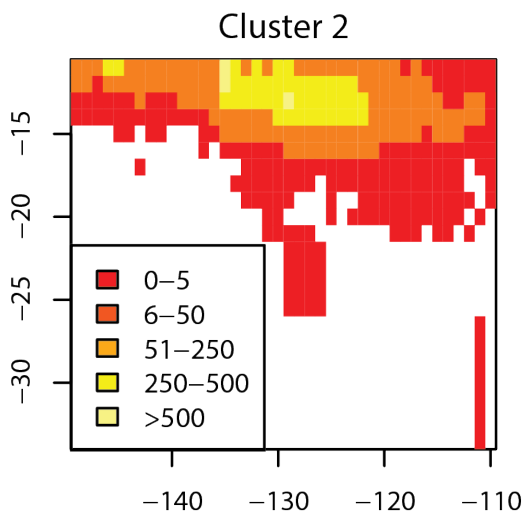


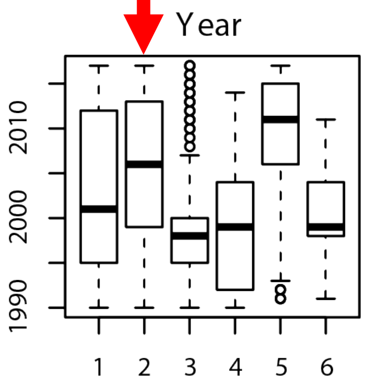


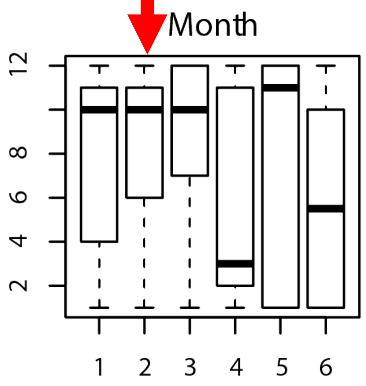
A3 KOR

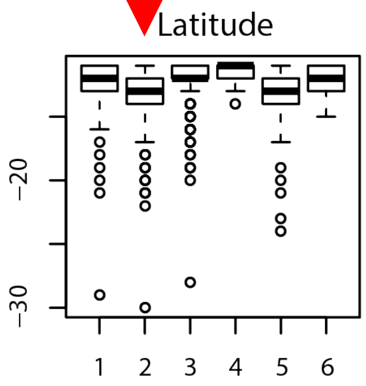


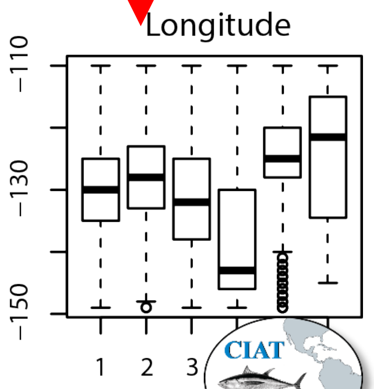






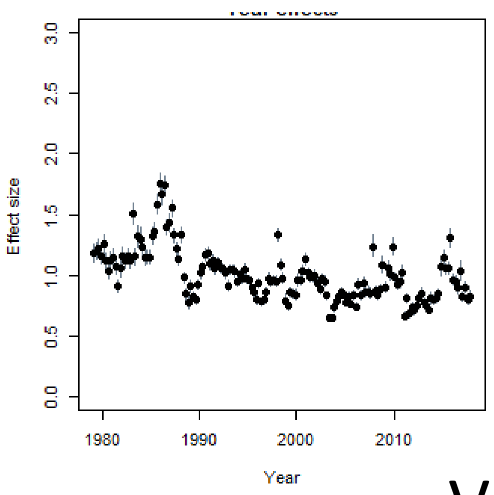




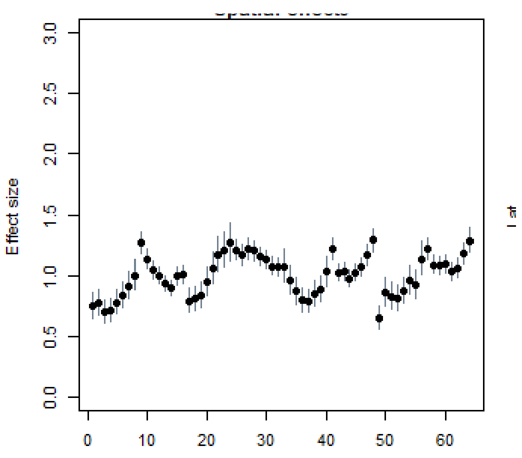


Example diagnostics: Delta- GLM joint model, area 1

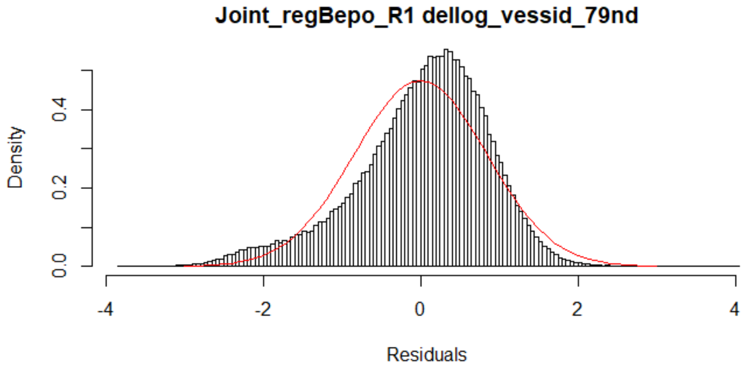
Year effects

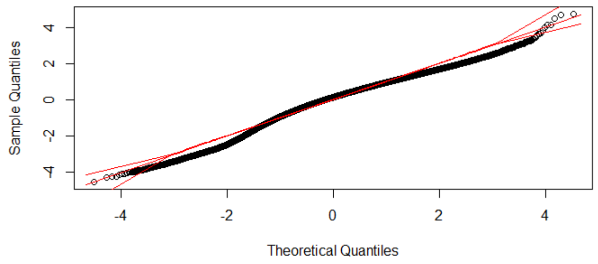


Spatial effects

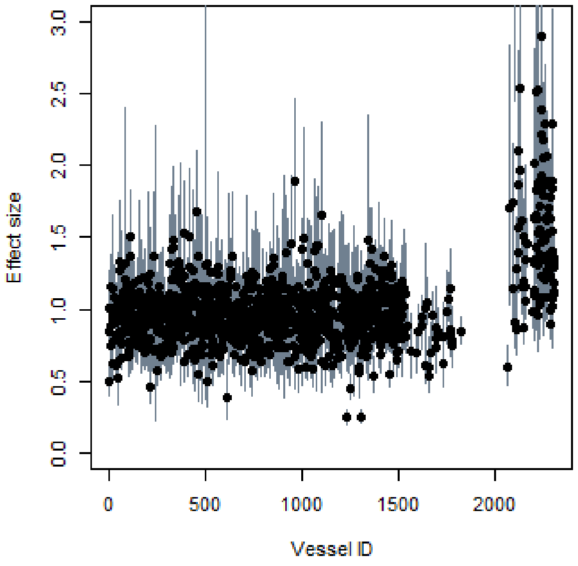


Residuals

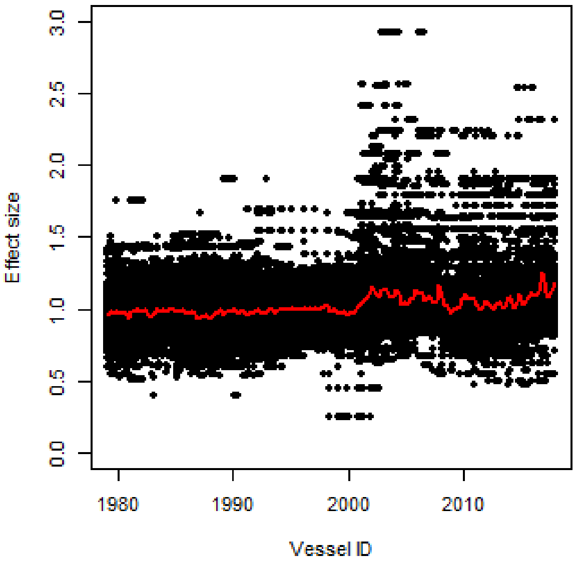




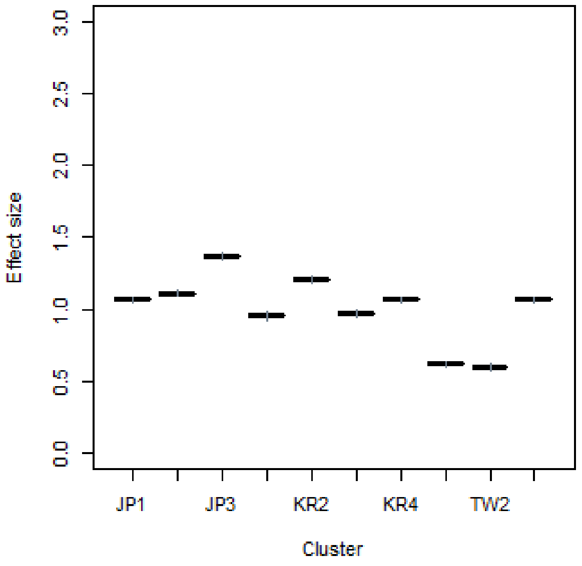
Vessel effects



Vessel effects

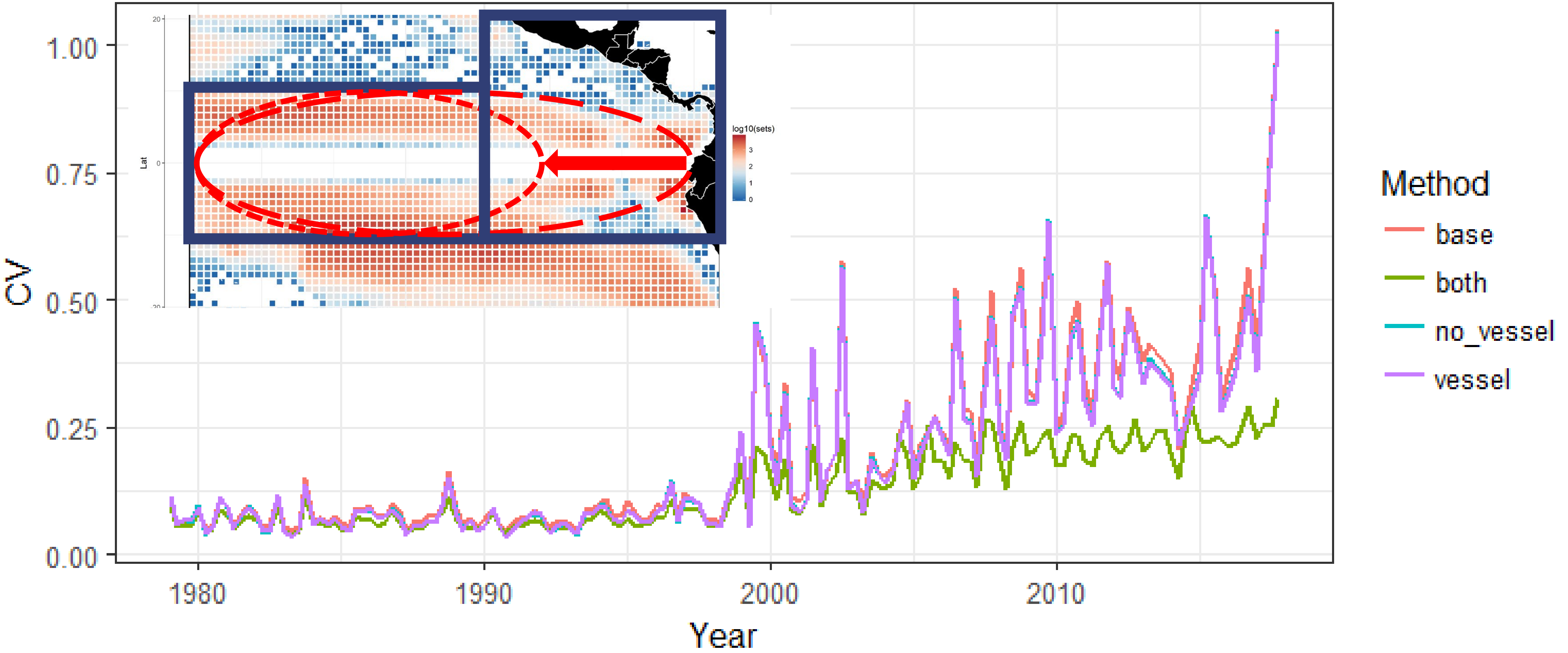


Cluster effects

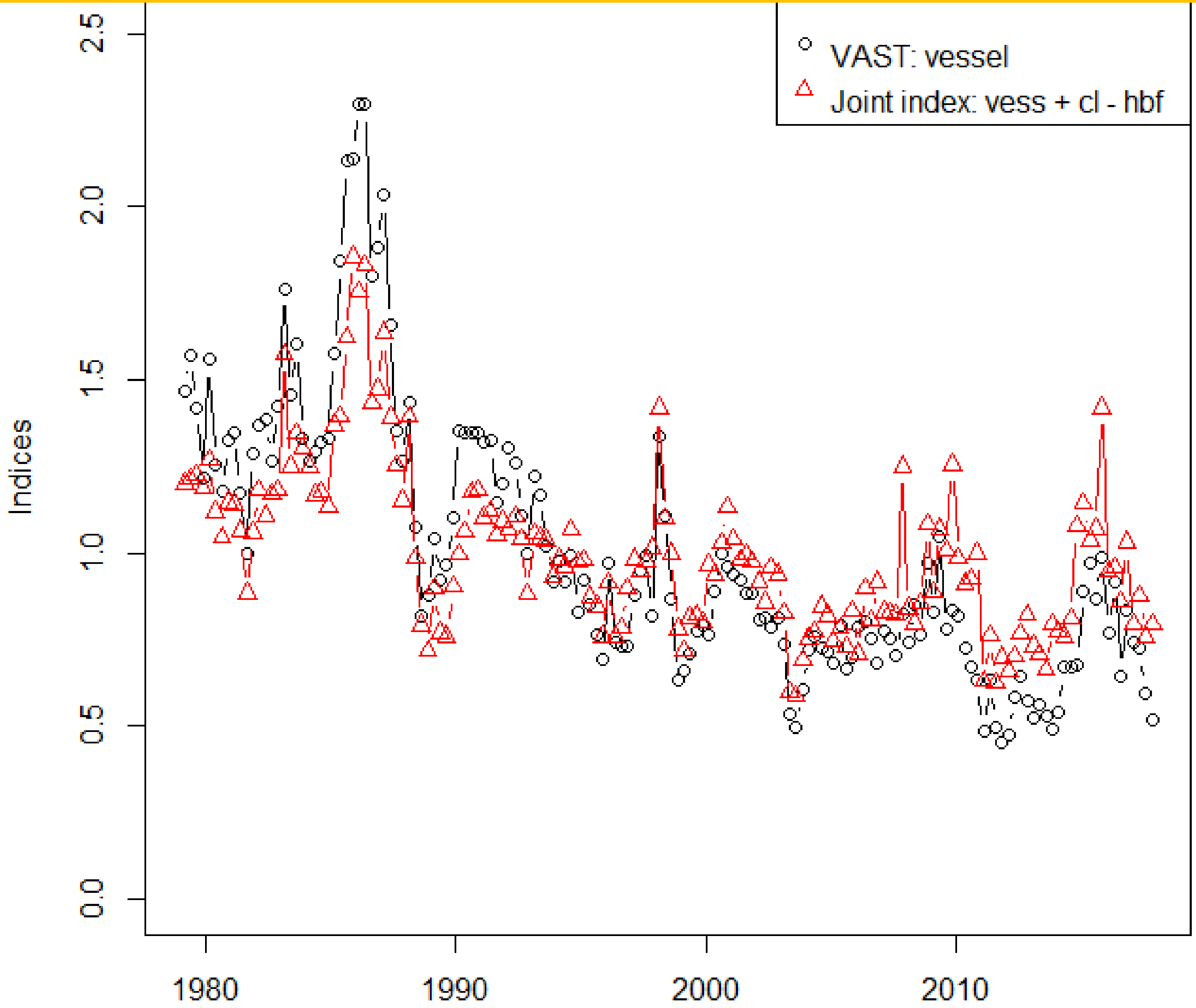


CV of the index of abundance

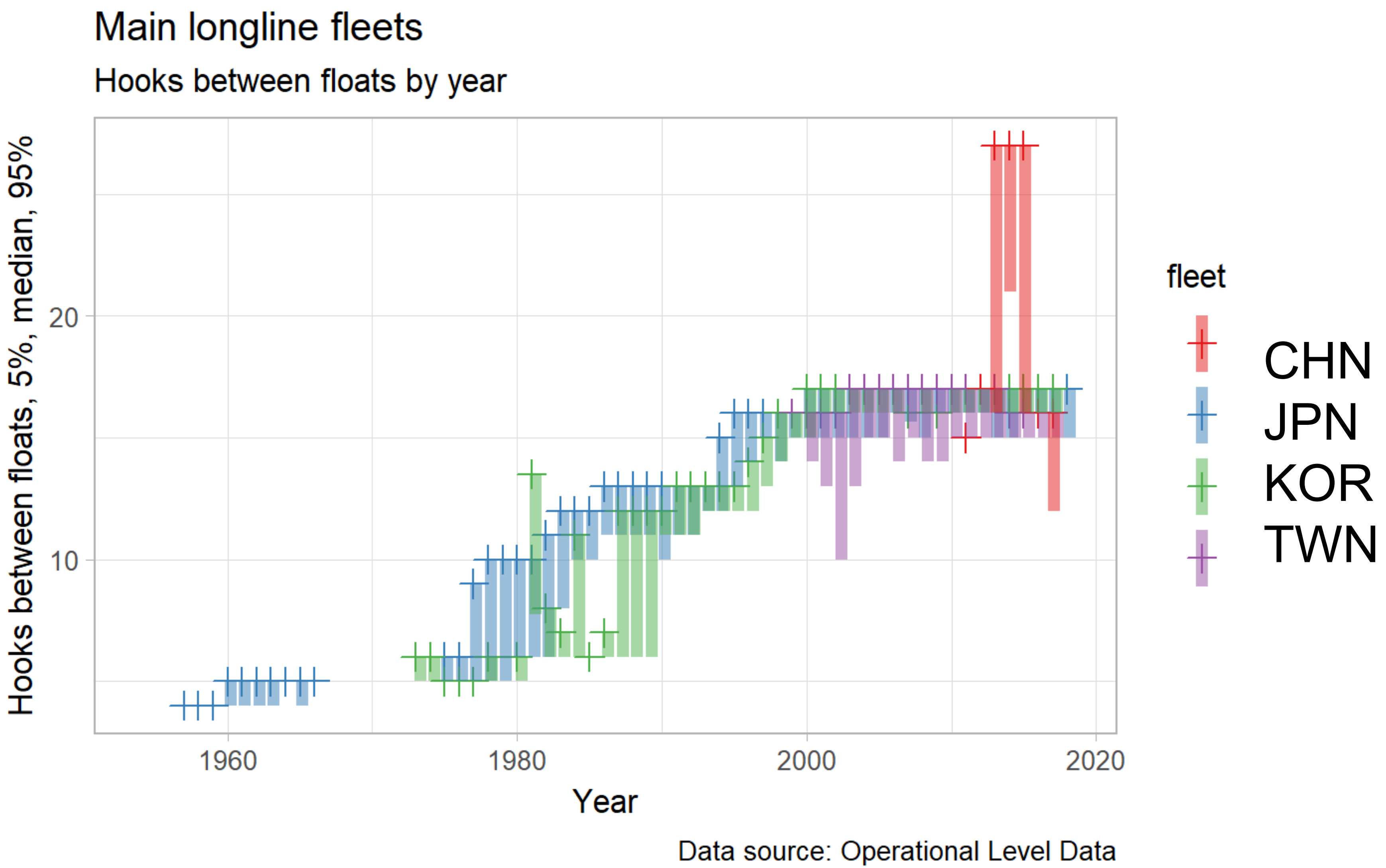
Combining the two tropical areas reduces the uncertainty about the standardized index for the data-poor area+period



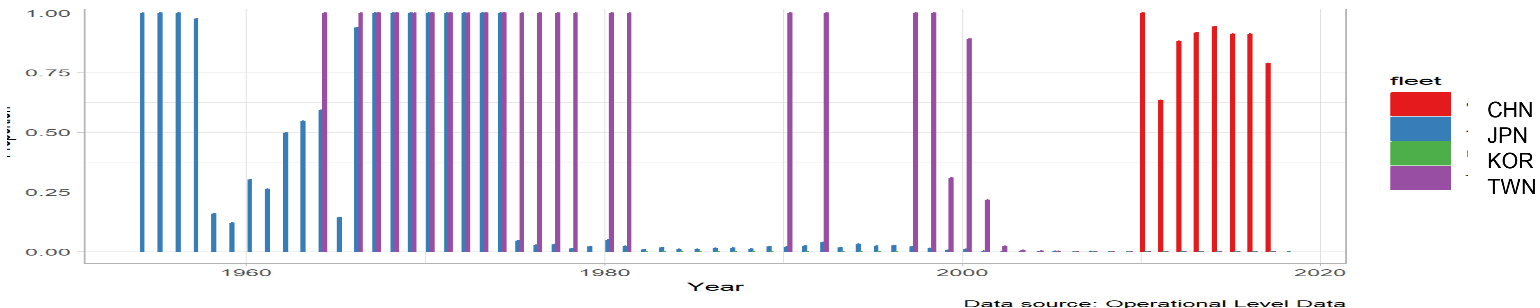
VAST and delta-GLM indices



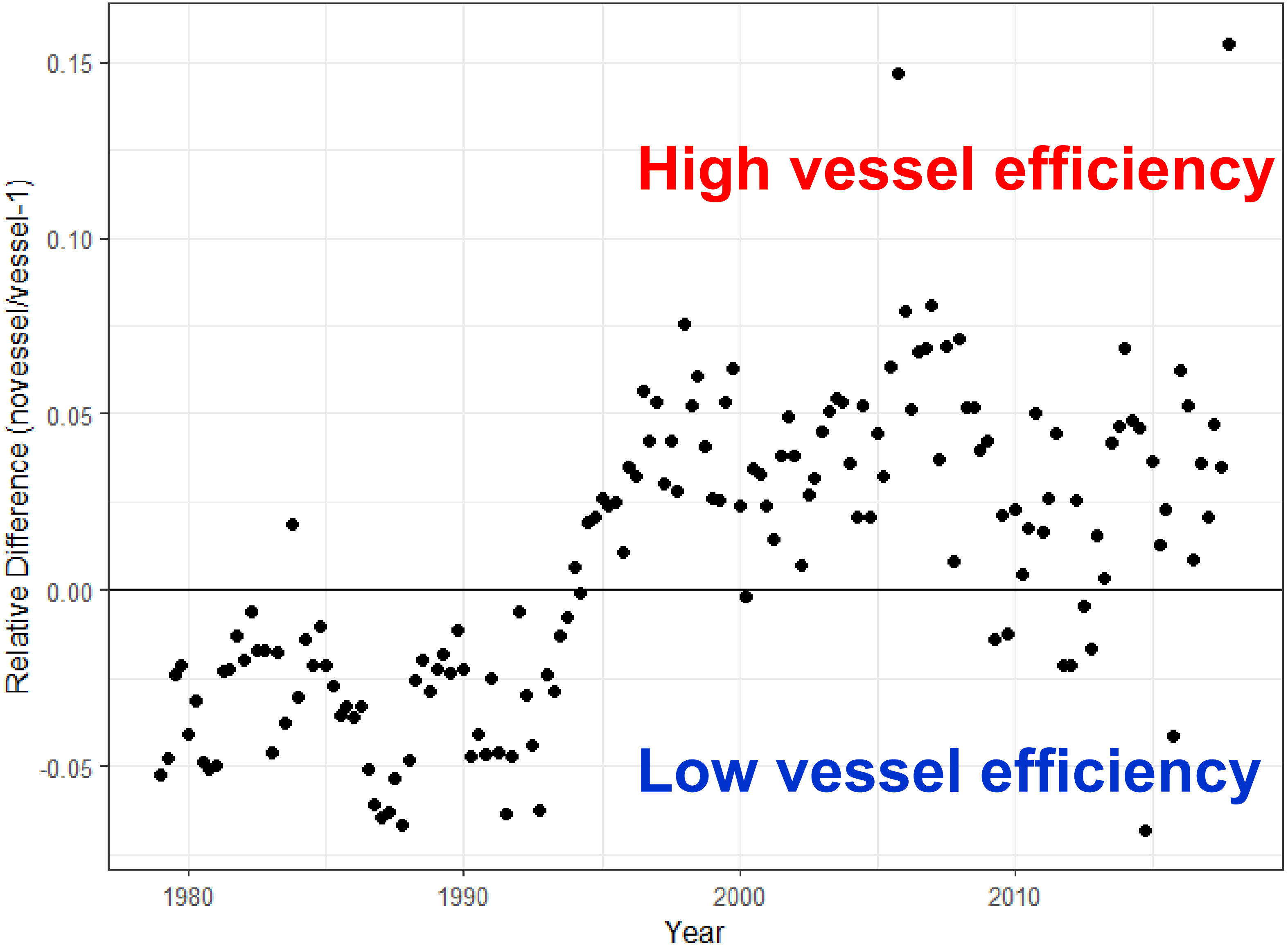
- Bigeye tuna
- **Area 1**
- Joint index:
    - VAST: JPN + KOR
    - Delta-GLM: all fleets



Proportion of sets with no HBF information

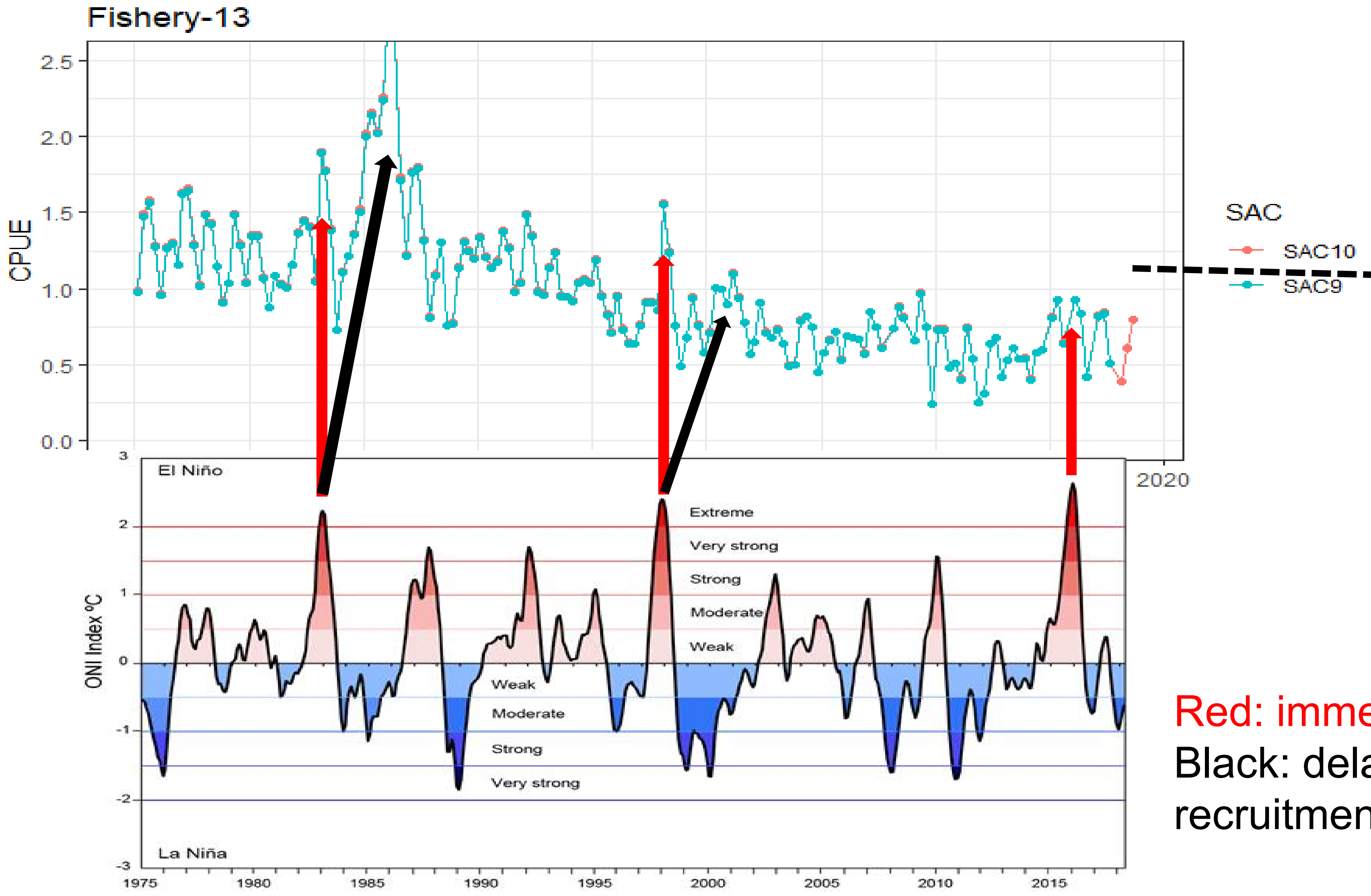


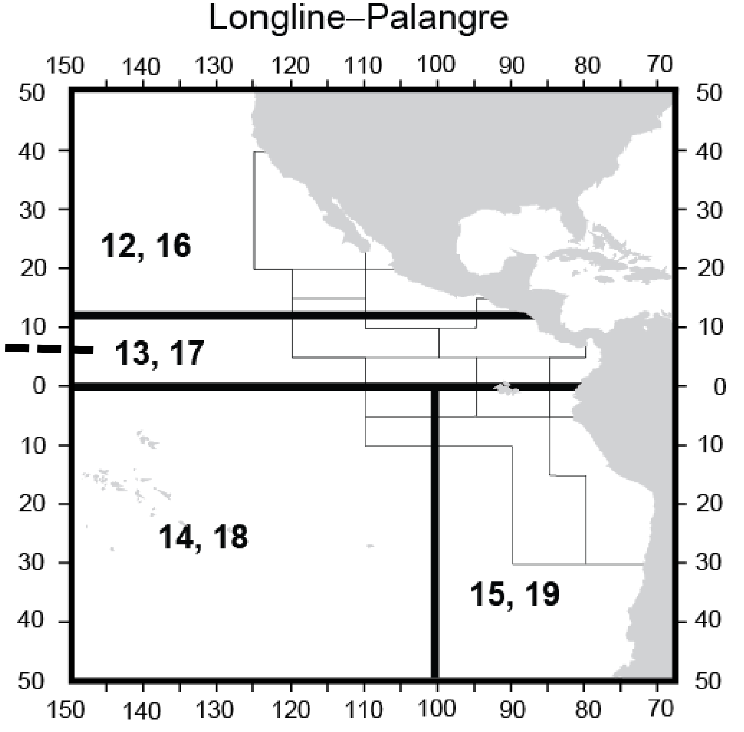
VAST changes in catchability



Japan
prem. results WSLL-01
for bigeye tuna

Influence of the environment on the index of abundance

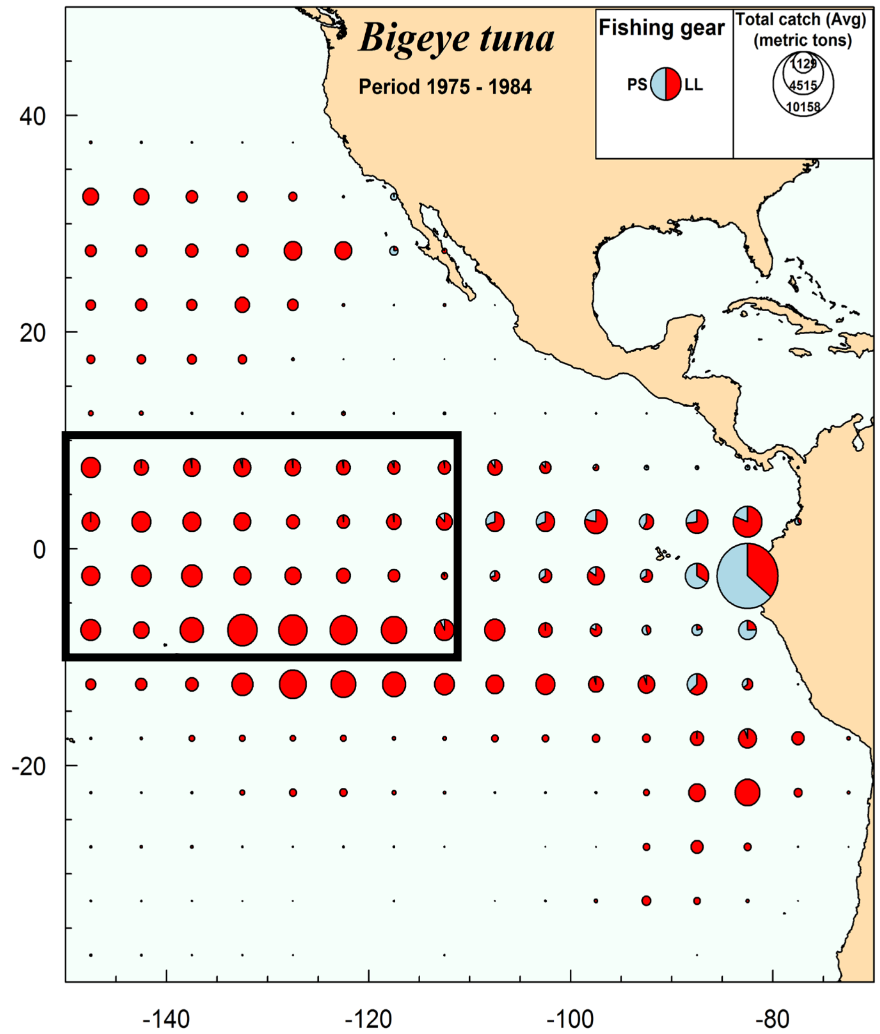




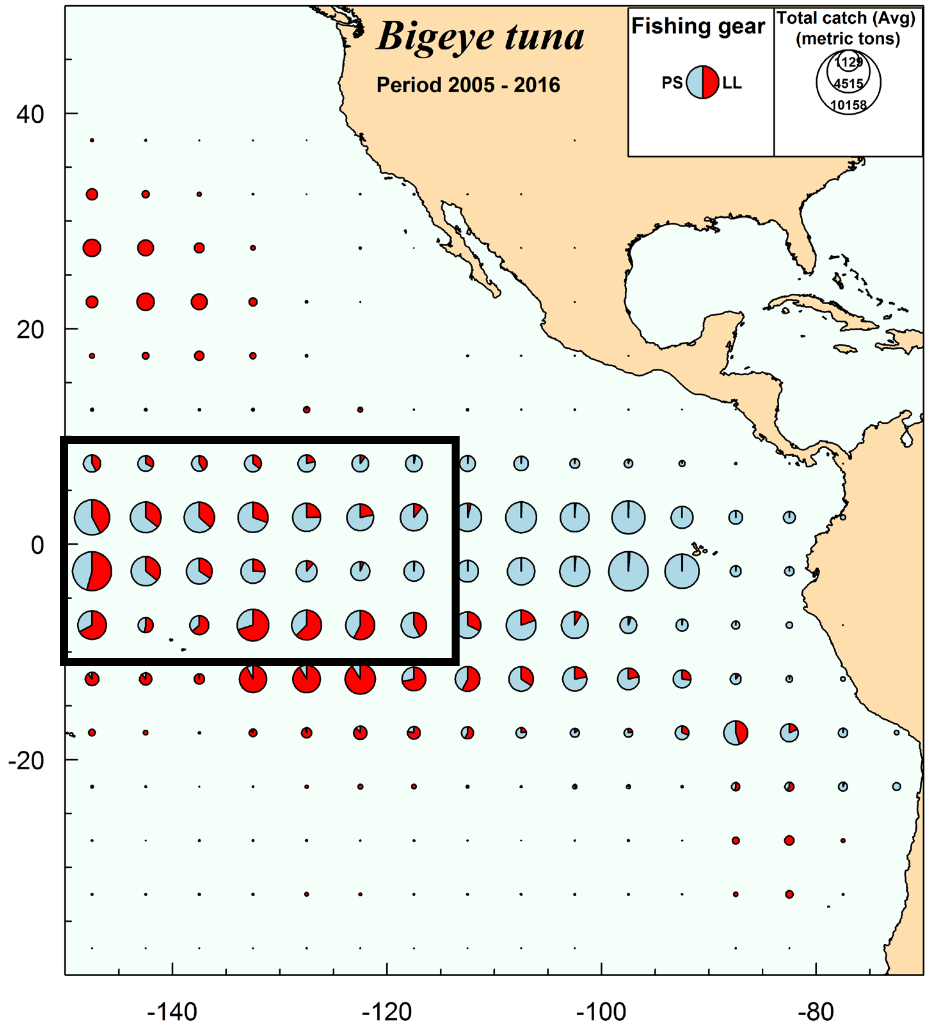
Red: immediate influence
Black: delayed influence through recruitment

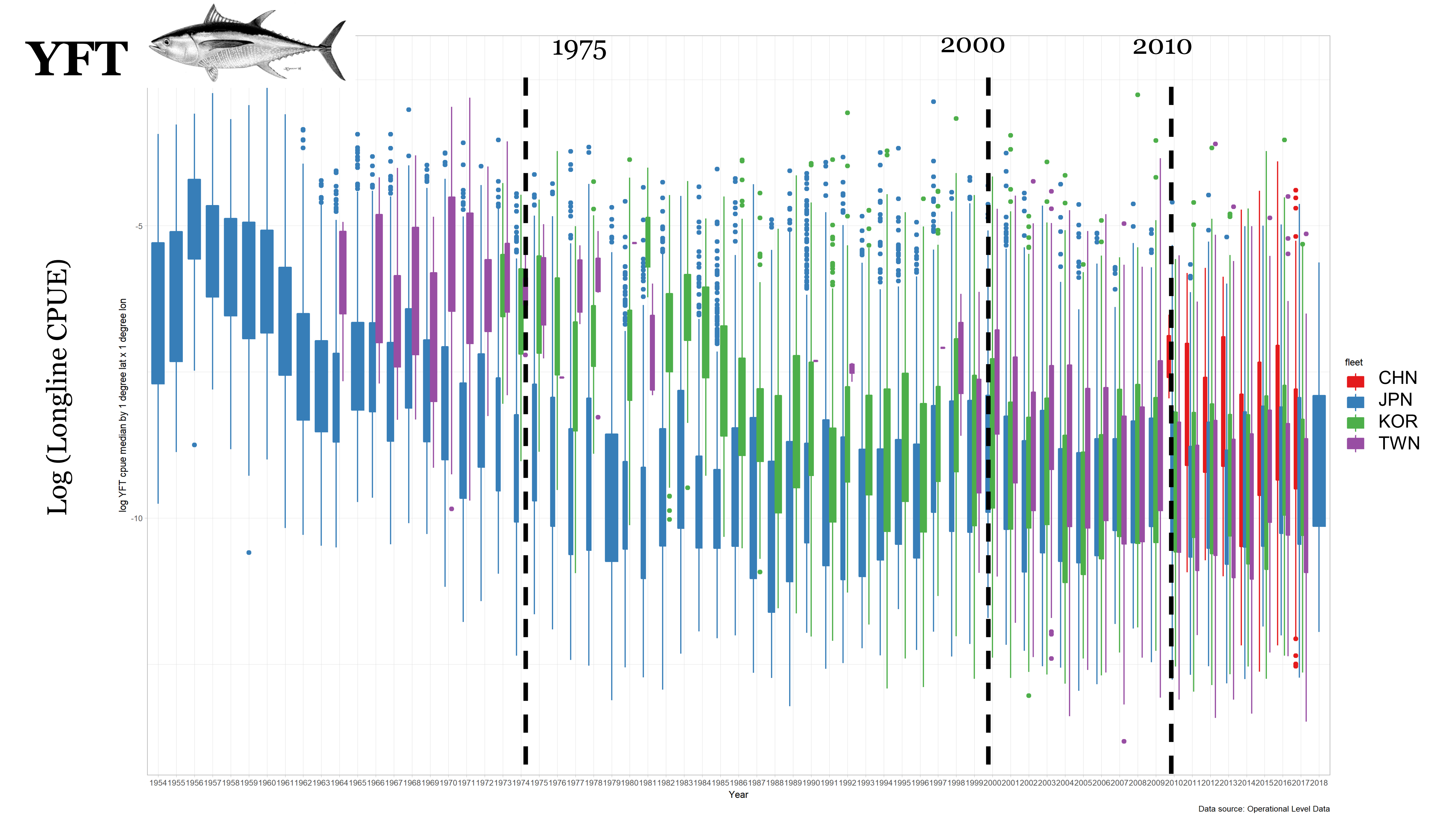
Area of comparison: area 1

1975-1984



2005-2016

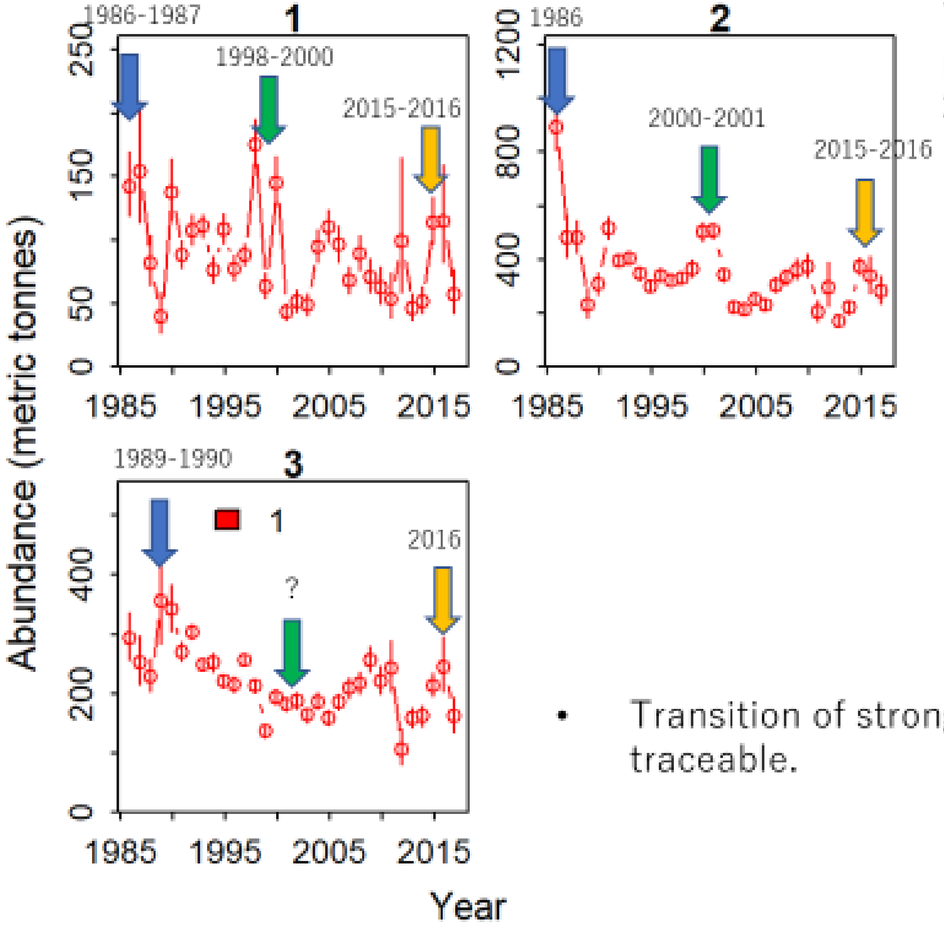



YFT
1975
2000
2010
Log (Longline CPUE)
log YFT cpue median by 1 degree lat x 1 degree lon
-5
-10
1954 1955 1956 1957 1958 1959 1960 1961 1962 1963 1964 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018
Year
fleet
CHN
JPN
KOR
TWN
Data source: Operational Level Data

VAST model by length frequency data

Results

12. Abundance index



s01; juvenile (< 115 cm), younger than age 2
s02; transition (>=115 and < 152 cm), ages 2 - 5
s03; adult (>= 152 cm) , older than age 5

El Niño; 1997-1998 and 2015-2016, La Niña; 2000-2001

Biased on Aires-da-Silva *et al*. 2015

age	Fork length (cm)
0	21.5
1	54.7
2	91.0
3	122.7
4	147.2
5	164.8
6	177.0
7	185.2
8	190.7
9	194.2
10	196.5

- Transition of strong signal of abundance is traceable.

Examples of results

- Exploratory data analysis by fleet:
    - Changes in target
    - Secondary targets
    - Changes in gear characteristic over time
    - Spatial distribution
- Investigations of methods to detect targeting
- Progress on constructing spatiotemporal models by fleet and joint indices
- Progress on constructing delta-GLM models by fleet and joint indices
- First comparison of results from spatiotemporal models and delta-GLM models
- Progress on constructing spatiotemporal models by size class
- Most analysis focused on bigeye tuna

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