Comisión Interamericana del Atún Tropical
Inter-American Tropical Tuna Commission


# Current indices of relative abundance for bigeye and yellowfin in the EPO from standardized longline data, and their potential problems

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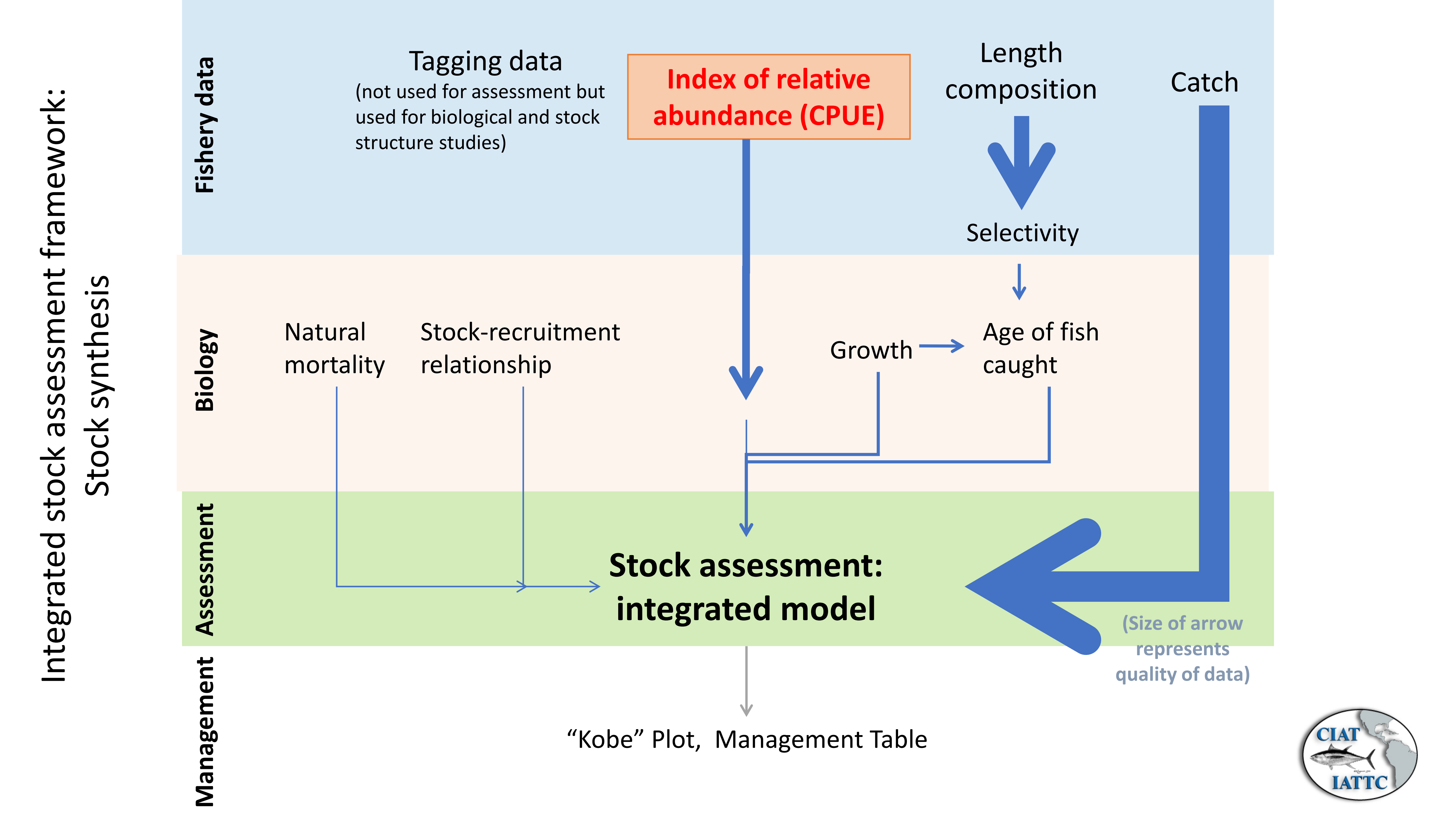
WORKSHOP TO IMPROVE THE LONGLINE INDICES OF ABUNDANCE OF BIGEYE AND YELLOWFIN TUNAS IN THE EASTERN PACIFIC OCEAN
La Jolla, CA, Feb 11-14, 2019

# Outline

- How are the indices obtained
- Current indices of abundance
  - YFT
  - BET
- Potential problems
- Opportunities



Integrated stock assessment framework:
Stock synthesis
Fishery data
Biology
Assessment
Management
Tagging data
(not used for assessment but used for biological and stock structure studies)
Index of relative abundance (CPUE)
Length composition
Catch
Selectivity
Natural mortality
Stock-recruitment relationship
Growth
Age of fish caught
Stock assessment: integrated model
(Size of arrow represents quality of data)
"Kobe" Plot, Management Table
CIAT
IATTC

How are the indices obtained

INTER-AMERICAN TROPICAL TUNA COMMISSION
COMISIÓN INTERAMERICANA DEL ATÚN TROPICAL

**WORKING GROUP TO REVIEW STOCK ASSESSMENTS**

**7TH MEETING**

LA JOLLA, CALIFORNIA (USA)
15-19 MAY 2006

**DOCUMENT SAR-7-07**

STANDARDIZATION OF YELLOWFIN AND BIGEYE CPUE DATA FROM JAPANESE LONGLINERS, 1975-2004

by

Simon D. Hoyle and Mark N. Maunder

# How are they computed

**Input data**

- Japanese fleet data
- Catch in numbers per hook
- Aggregated by:
  - year-quarter
  - 5 degrees latitude X 5 degrees of longitude
  - Hooks between floats category

**Standardization model**

- Delta lognormal approach:
- Two components:
  - Probability of encounter with a binomial model
  - Positive values with a lognormal model
  - Both models include the factors: year_quarter, lat_lon and hbf

# How are the indices obtained

- Delta GLM approach
- Binomial distribution (probability of zero catches)
- Lognormal distribuition for the positive values
- Index as the back-transformed least squared means for the two model components

Data were analyzed with a delta GLM with a binomial distribution for the probability $w$ of catch being zero and a probability distribution $f(y)$ for non-zero catches, as in Equation (1) (E.J. Dick, NOAA Santa Cruz, personal communication; see Stefansson (1996) for a description of the method). Analyses were carried out to estimate an index for each year, which was the product of the back-transformed least-squares means for the two model components, $(1\text{-}w)\cdot E(y|y \neq 0)$. The variance of the likelihood function was weighted by effort.

$$\Pr(Y = y) = \begin{cases} w, & y = 0, \\ (1 - w) f(y) & \text{otherwise} \end{cases} \qquad (1)$$

The following combinations of explanatory variables were examined as categorical variables: latitude*longitude interaction, HBF. In the delta component, effort was also examined, since the probability of zero catch is likely to be affected by effort. Time was included as a categorical variable in all models.

$$w = g(\text{Year*quarter, latitude*longitude, HBF, effort})$$

$$f(y) = h(\text{Year*quarter, latitude*longitude, HBF})$$

Two distributions, gamma and lognormal, were examined for the non-zero data.

Hoyle and Maunder 2006, SAR 7 - 07

# Hooks between floats

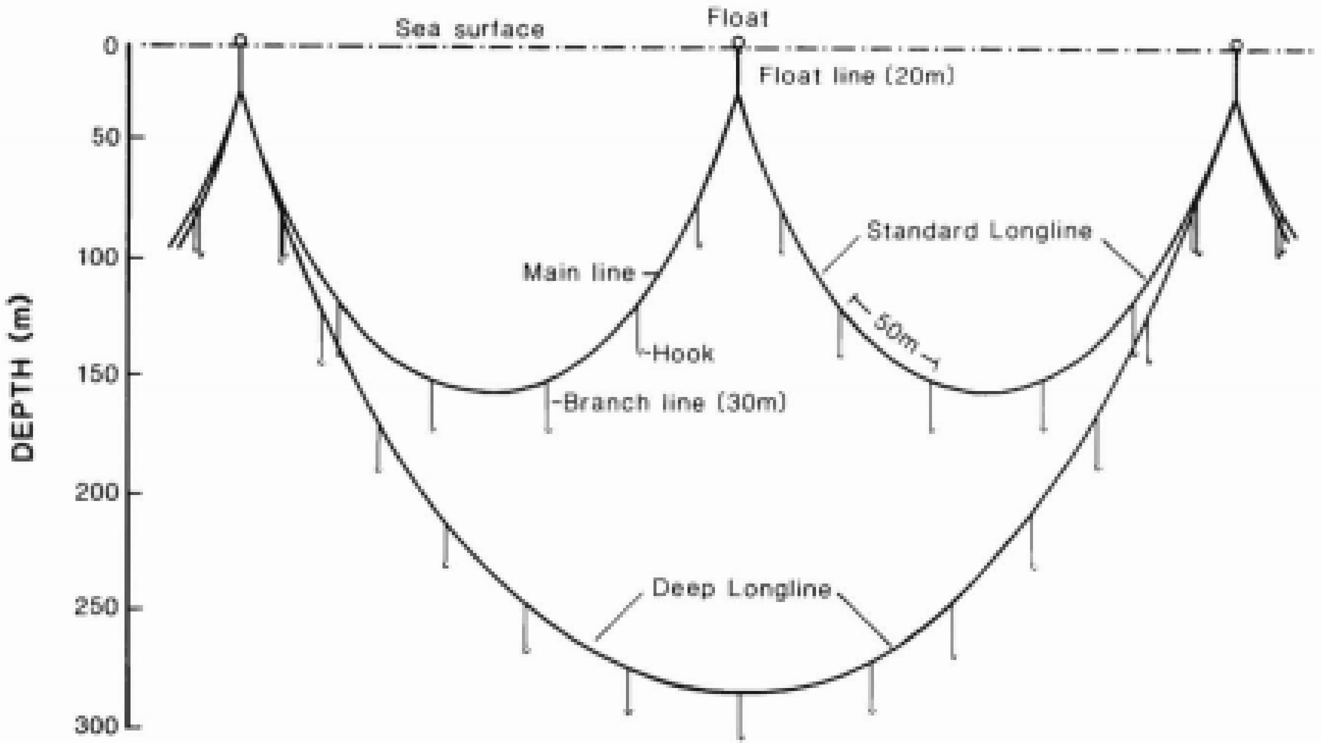



Figure 1.—Standard and deep longline gear as used by Japanese fishermen. The standard gear has an average of 6 branch lines per basket of mainline; deep-longline gear has about 13 branch lines (adapted from Suzuki et al., 1977).

In Sakagawa et al 1987

https://spo.nmfs.noaa.gov/sites/default/files/pdf-content/MFR/mfr494/mfr4949.pdf

**TABLE 1**. Akaike Information Criterion (AIC) values for alternative model configurations. Model configuration is represented by the factors yrqtr (time effect), latlong (latitude-longitude interaction), and hbf (hooks between floats).

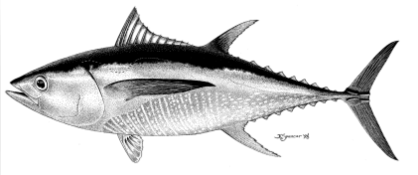
| Fishery | Model | Distribution | AIC binomial | AIC positive | AIC total | Rank |
|---|---|---|---|---|---|---|
| BET N | yrqtr.latlong.hbf | lognormal | 932.5 | 32961.1 | 33893.5 | 1 |
| BET N | yrqtr.latlong | lognormal | 925.6 | 33085.7 | 34011.3 | 2 |
| BET N | yrqtr.hbf | lognormal | 2009.0 | 37964.4 | 39973.4 | 3 |
| BET S | yrqtr.latlong.hbf | lognormal | 5330.8 | 210615.3 | 215946.1 | 1 |
| BET S | yrqtr.latlong | lognormal | 5361.0 | 211401.6 | 216762.6 | 2 |
| BET S | yrqtr.hbf | lognormal | 7321.4 | 222199.5 | 229520.8 | 3 |
| BET S | yrqtr.latlong.hbf | gamma | 5330.8 | 305207.1 | 310537.9 | 4 |
| YFT N | yrqtr.latlong.hbf | lognormal | 4064.8 | 13623.0 | 17687.8 | 1 |
| YFT N | yrqtr.latlong. | lognormal | 4071.0 | 13646.6 | 17717.6 | 2 |
| YFT N | yrqtr.hbf | lognormal | 4335.2 | 14590.0 | 18925.1 | 3 |
| YFT N | yrqtr.latlong.hbf | gamma | 4064.8 | 32368.0 | 36432.8 | 4 |
| YFT S | yrqtr.latlong.hbf | lognormal | 16200.5 | 157953.4 | 174153.9 | 1 |
| YFT S | yrqtr.latlong | lognormal | 16244.2 | 158246.1 | 174490.3 | 2 |
| YFT S | yrqtr.hbf | lognormal | 20478.9 | 186610.9 | 207089.7 | 3 |
| YFT S | yrqtr.latlong.hbf | gamma | 16200.5 | 294736.9 | 310937.4 | 4 |

Hoyle and Maunder 2006, SAR 7 - 07

# Effect of the number of hooks between floats and the CPUE (Japanese fisheries in the EPO)

“The catch rate increased with HBF for bigeye, as expected given that bigeye forage at depth, and average hook depth tends to increase with HBF. Catch rate of yellowfin declined with HBF”

Yellowfin tuna



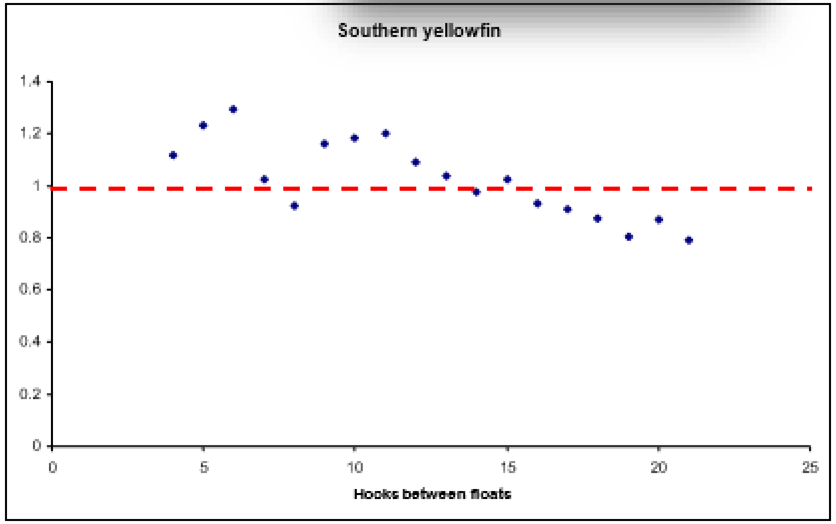
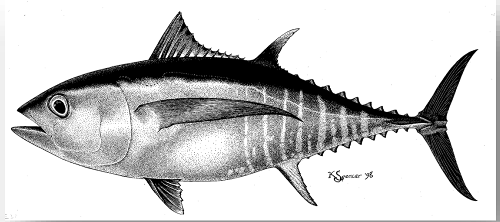



**FIGURE 12:** Relationship between the number of HBF and CPUE for yellowfin in the north southern fisheries.

Bigeye tuna



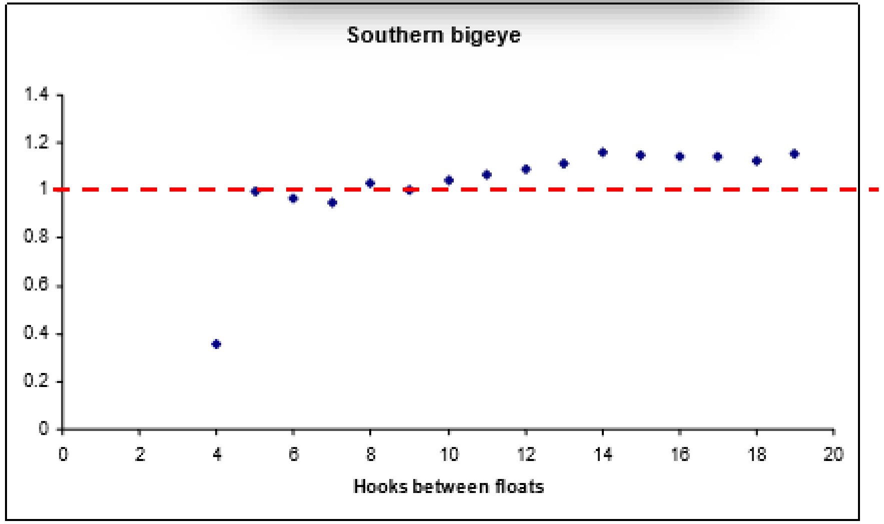



**FIGURE 11**: Relationship between the HBF and CPUE for bigeye in the northern and southern fisheries.

Hoyle and Maunder 2006, SAR 7 - 07

# Ratio of the CPUE standardized by all factors to CPUE standardized by time only

## Yellowfin tuna

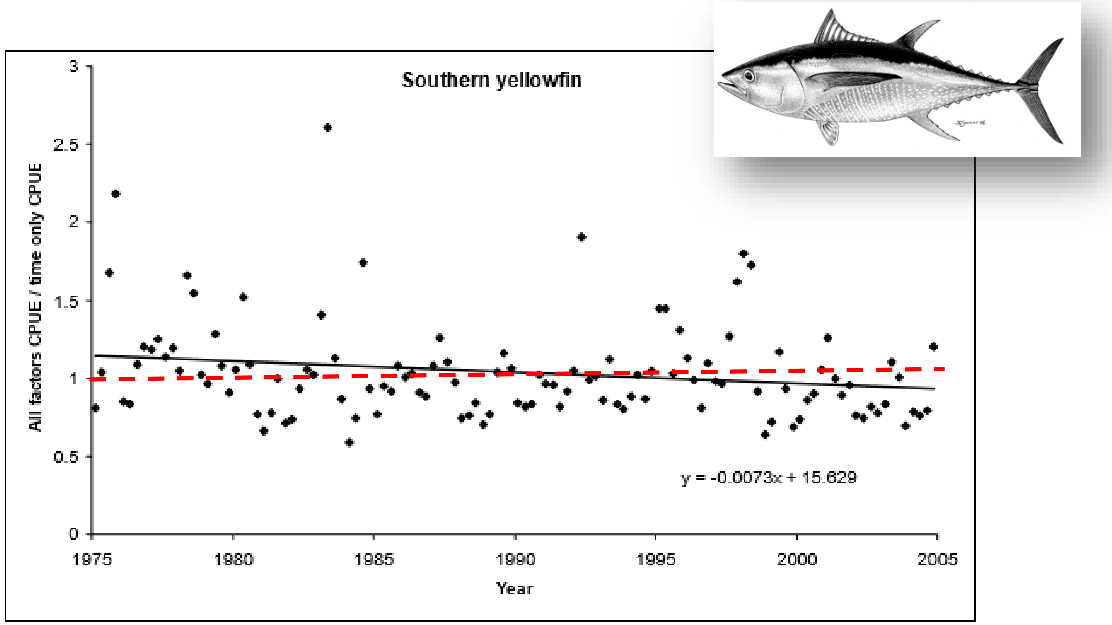



**FIGURE 8:** Ratio of CPUE standardized by all factors to CPUE standardized by time only for yellowfin tuna in the southern fishery

## Bigeye tuna

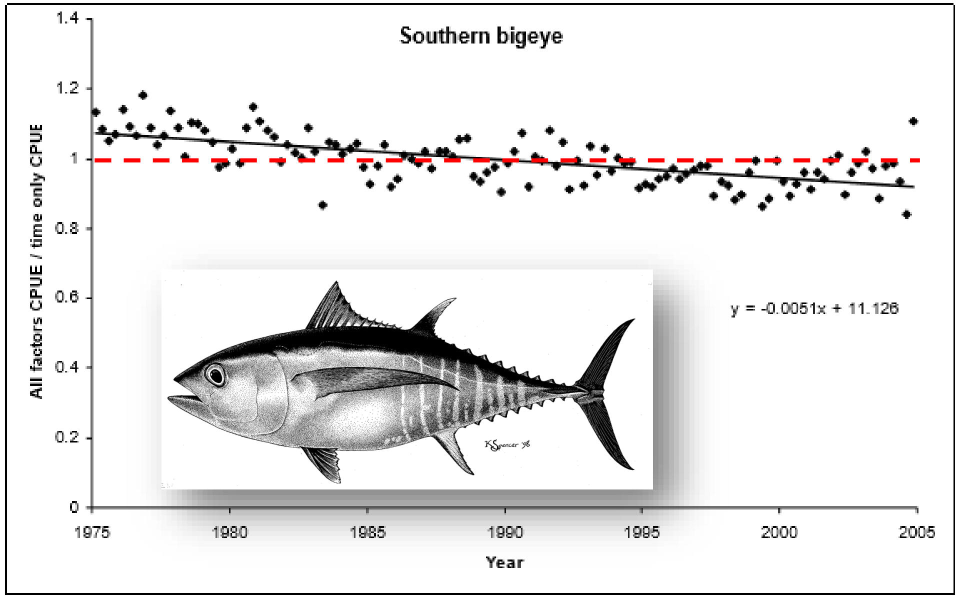
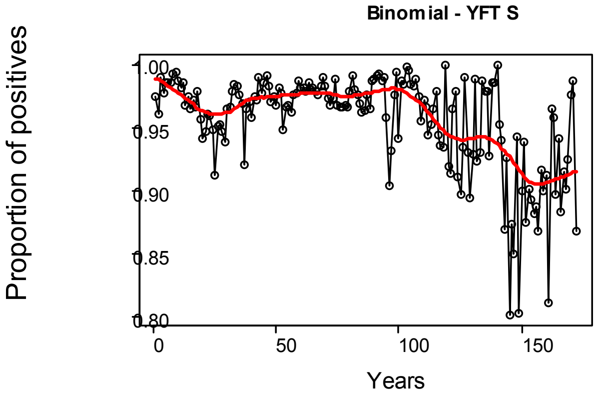


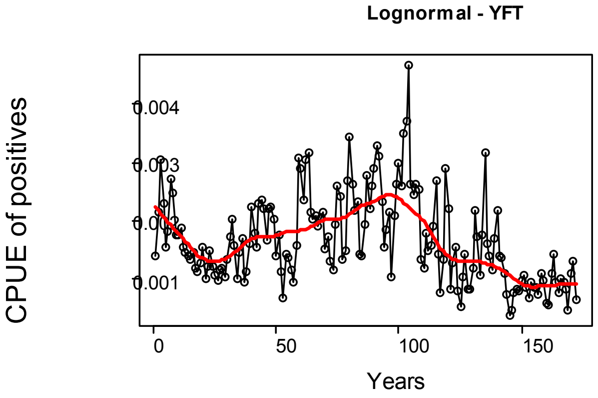

**FIGURE 9:** Ratio of CPUE standardized by all factors to CPUE standardized by time only for bigeye tuna in the southern fishery.

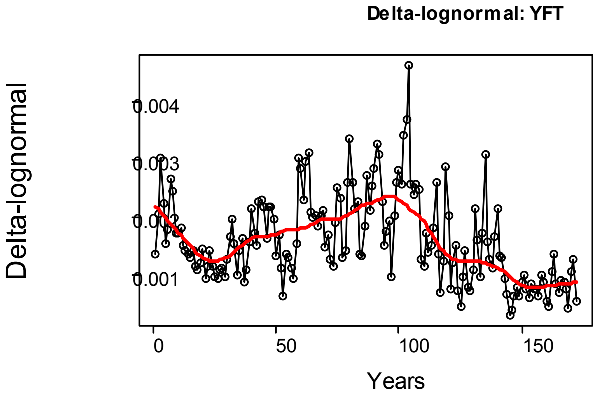
Hoyle and Maunder 2006, SAR 7 - 07

# Indices by component

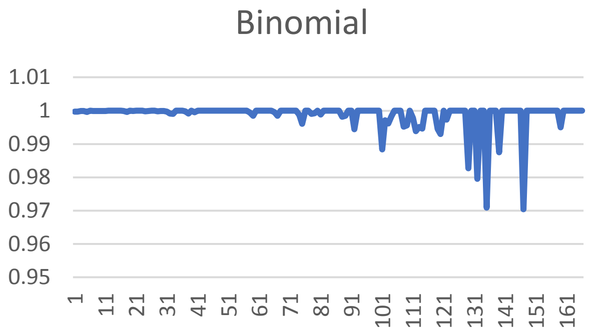
## YFT

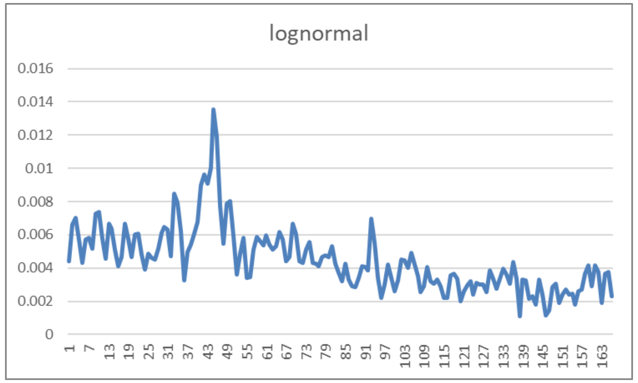


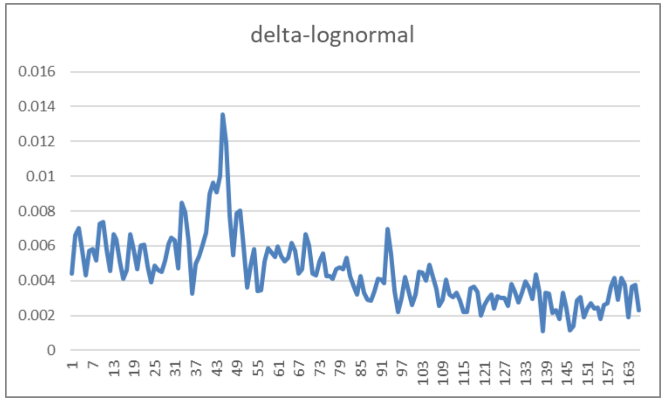




## BET - Central

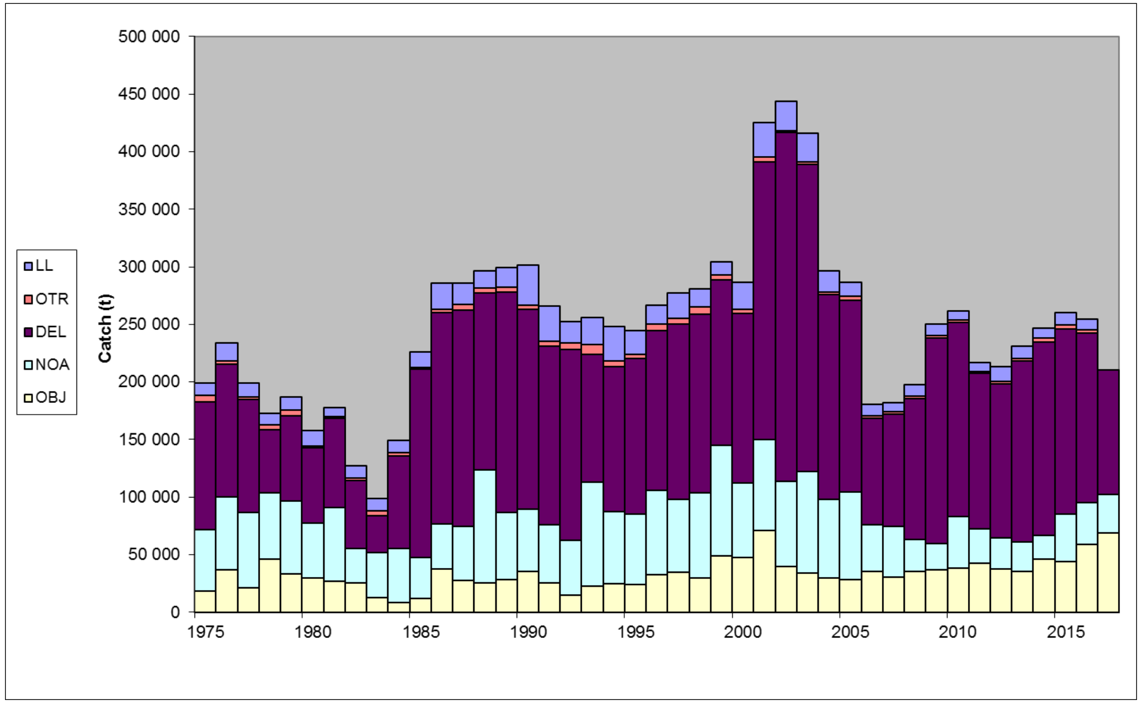


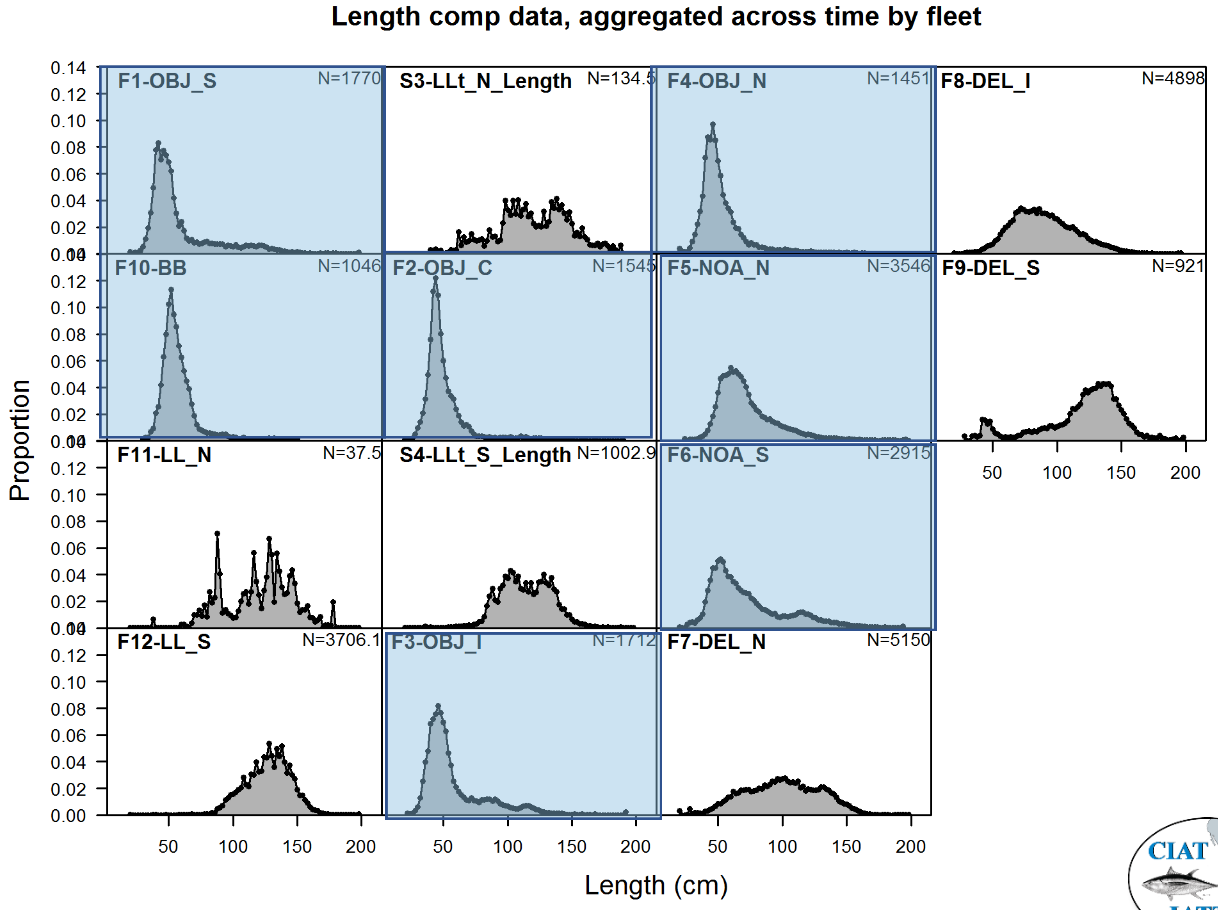



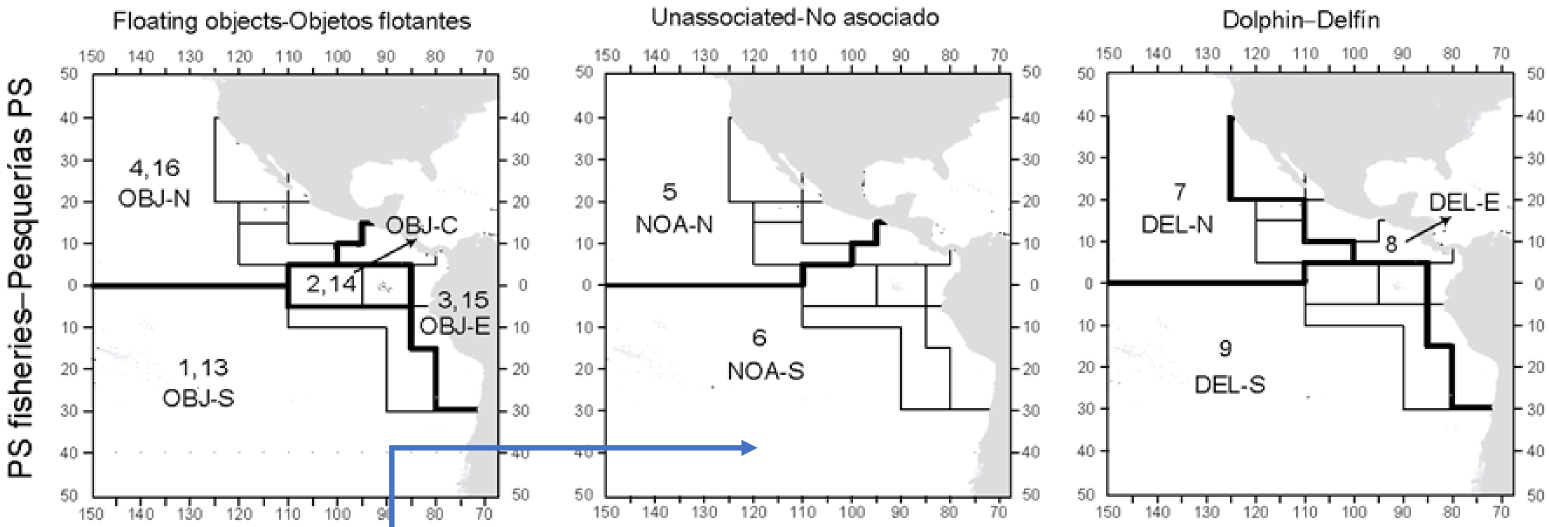
# Yellowfin tuna stock assessment

- purse-seine (PS) fishery (~ 96-98% of the catch in weight) and longline (LL) fishery (~2-4%)



# YFT fishery definitions and indices




Secondary indices

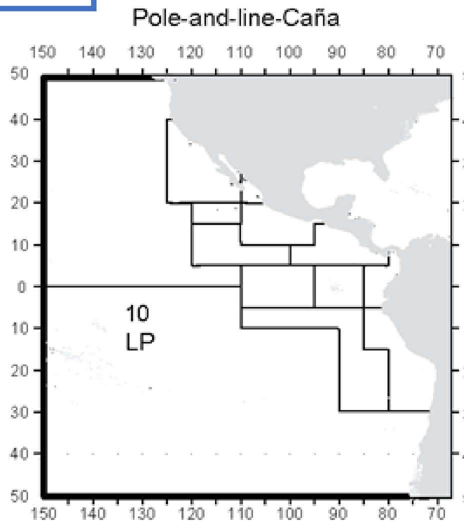
DEL-N

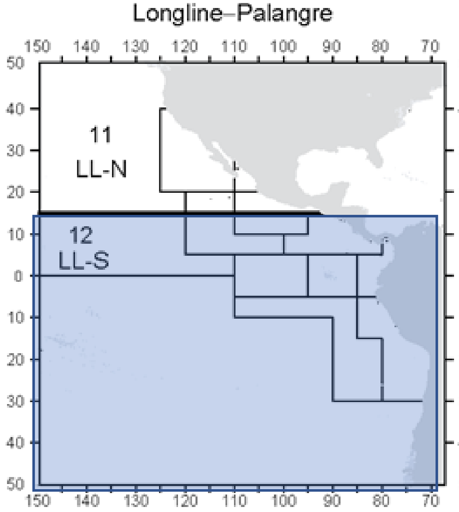
DEL-E

**Secondary indices**

NOA-N

NOA-S




**Main index: longline index of abundance LL-S**

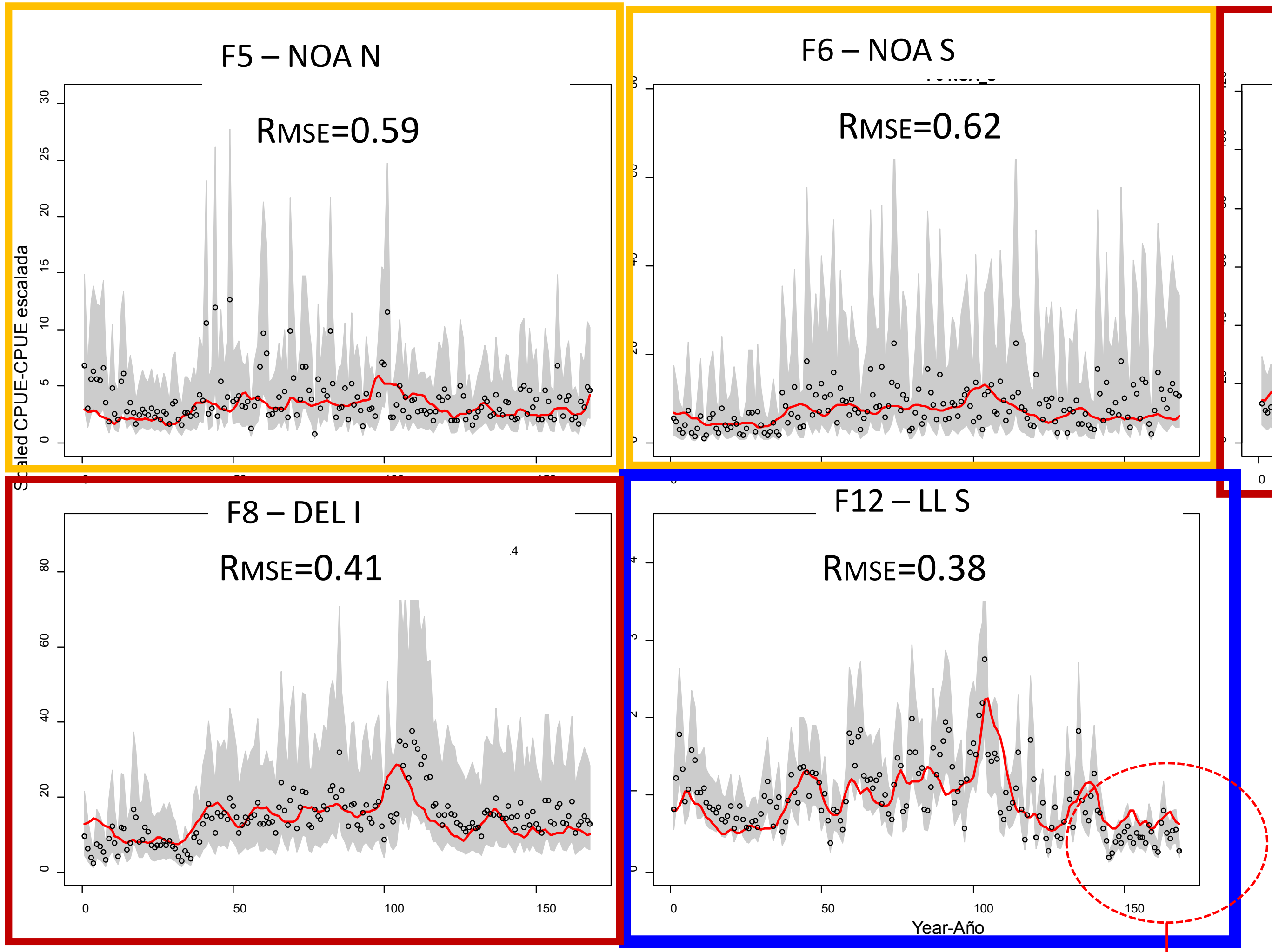
| | |
|---|---|
| ___ | IATTC length-frequency sampling areas |
| ▬ | fishery definition areas |

CIAT IATTC

# Fit to CPUE SAC8 YFT

**Diagnostics**

The stock assessment of YFT is fit to 5 indices of relative abundance, the main index is the longline index (LL_S), the other 4 indices are PS indices



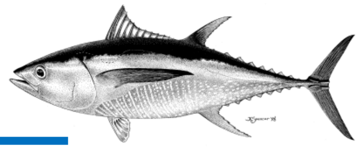

NOA

DEL

LL

In recent years the index for YFT tuna has been decreasing more than those from the PS fisheries, and is lower than predicted by the stock assessment model, while most of the PS indices are larger than the stock assessment model predictions

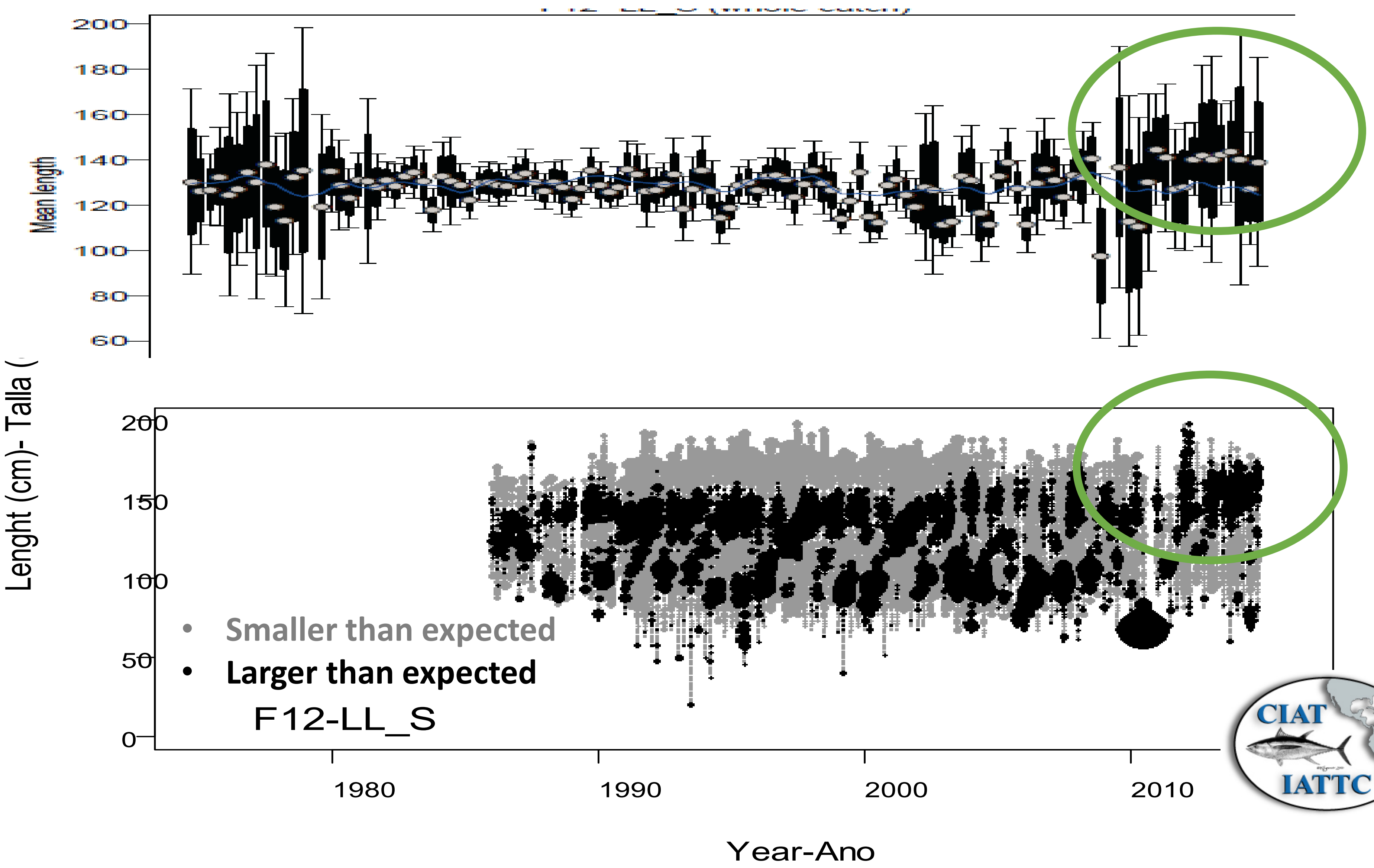
# Fit to length compositions SAC8 YFT

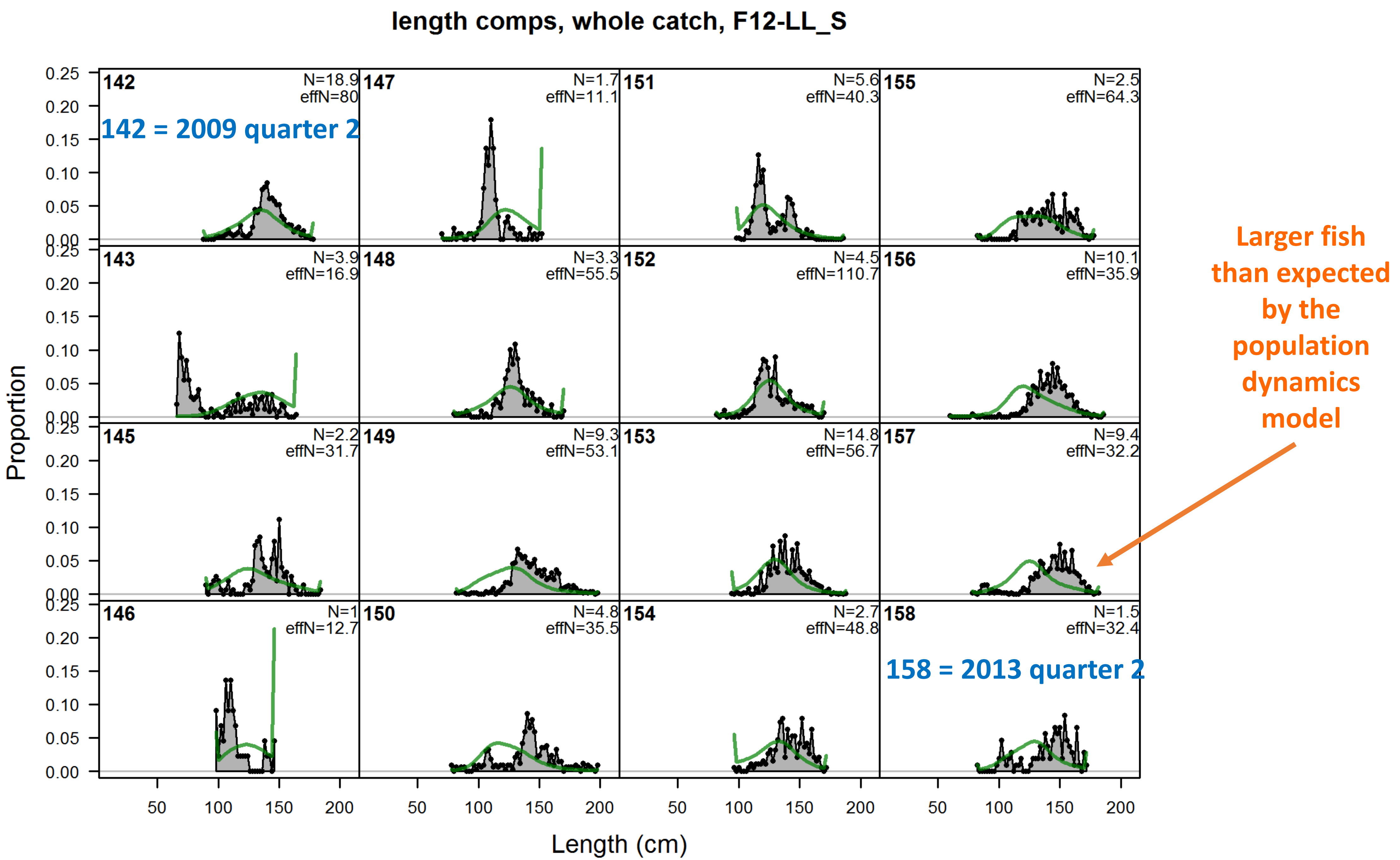


The size composition used for the catches are also used to correspond to the indices:

The length-frequency data for the JPN LL fleet is showing shifts towards larger sizes although the population seems to be stable

The sizes are larger than expected by the stock assessment model (positive residuals)



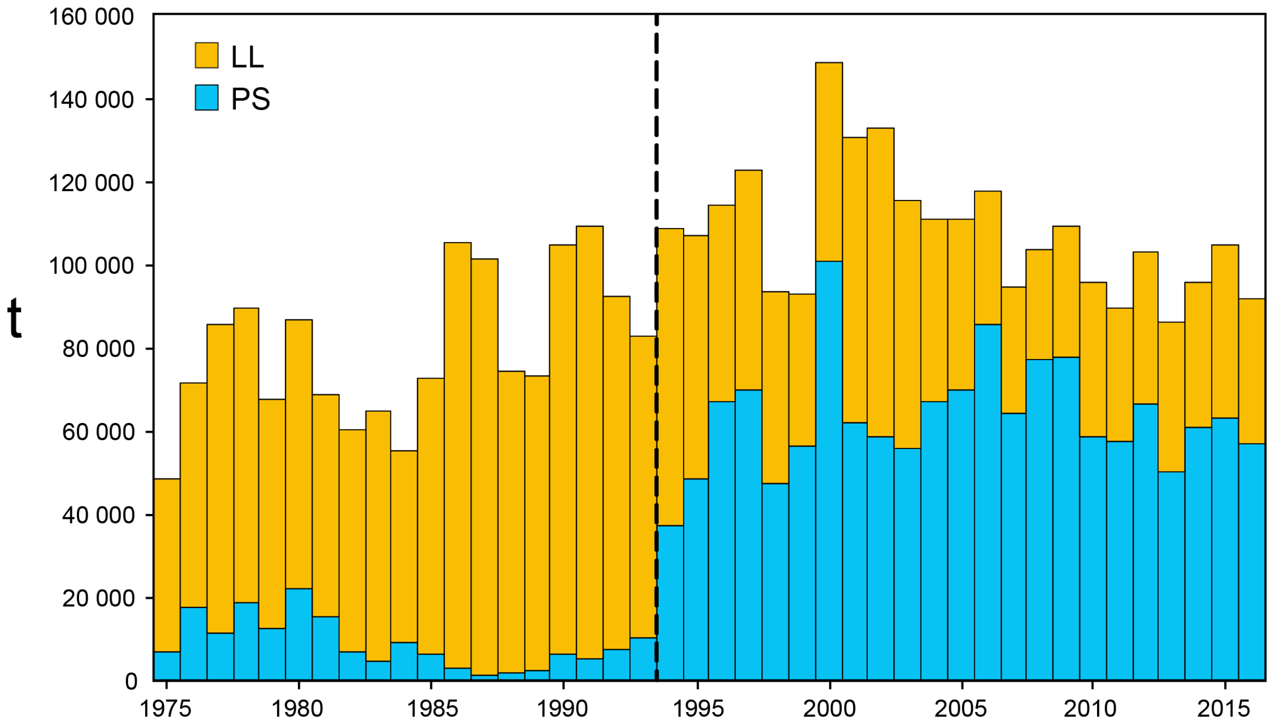


length comps, whole catch, F12-LL_S
Proportion
Length (cm)
142
N=18.9
effN=80
142 = 2009 quarter 2
147
N=1.7
effN=11.1
151
N=5.6
effN=40.3
155
N=2.5
effN=64.3
143
N=3.9
effN=16.9
148
N=3.3
effN=55.5
152
N=4.5
effN=110.7
156
N=10.1
effN=35.9
145
N=2.2
effN=31.7
149
N=9.3
effN=53.1
153
N=14.8
effN=56.7
157
N=9.4
effN=32.2
146
N=1
effN=12.7
150
N=4.8
effN=35.5
154
N=2.7
effN=48.8
158
N=1.5
effN=32.4
158 = 2013 quarter 2
Larger fish than expected by the population dynamics model

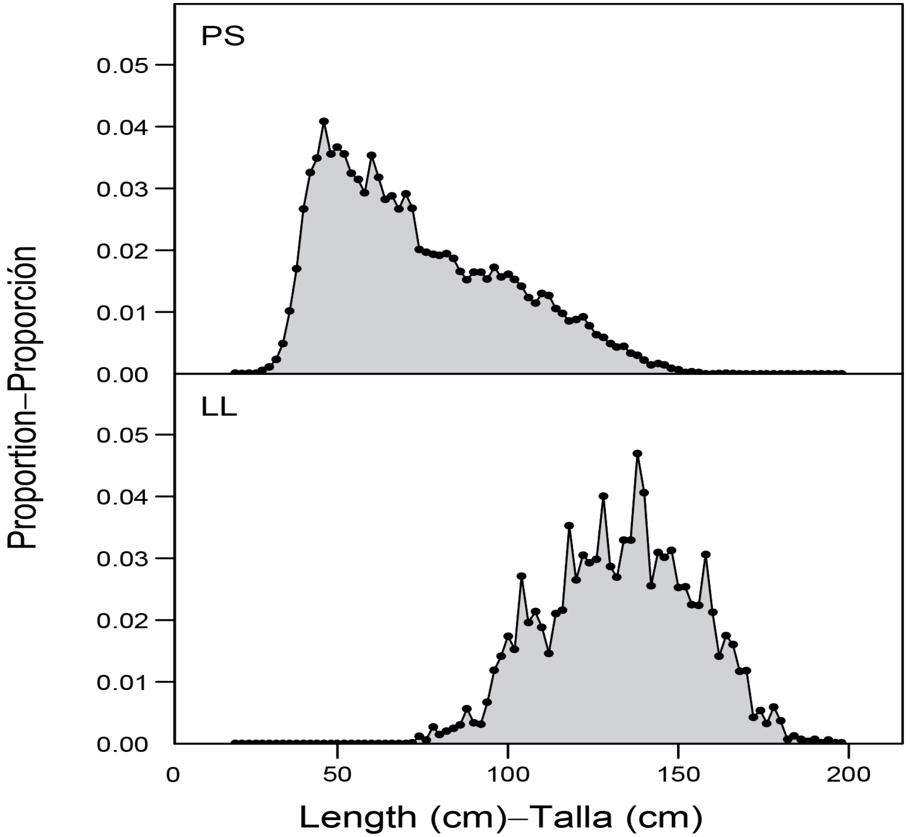
# Bigeye tuna stock assessment

- Sources: purse-seine (PS) fishery and longline (LL) fishery

Expansion of the PS fishery after 1993



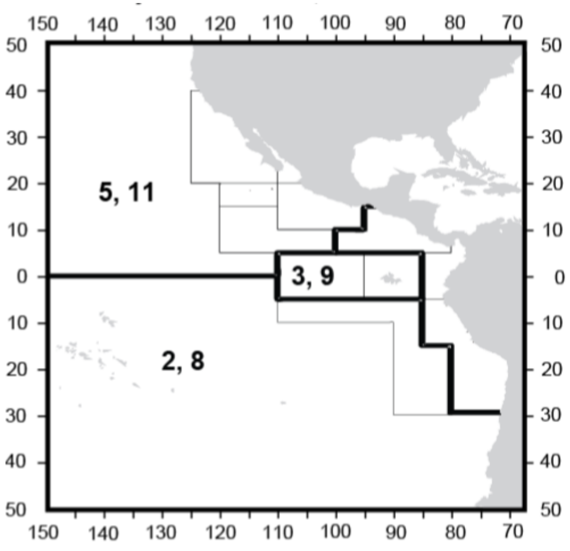

PS fishery catches small-medium bigeye
LL fishery catches medium-large bigeye



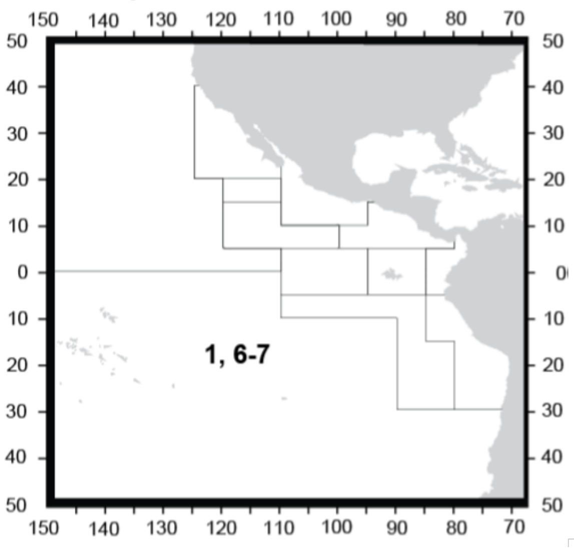
# Indices in the bigeye tuna stock assessment

- Area-as-fleet approach: 11 PS fleets and 8 LL fleets
- Fit to size-composition data for PS and LL fisheries (downweighted)
- Fit to two indices of relative abundance derived from the longline fleet

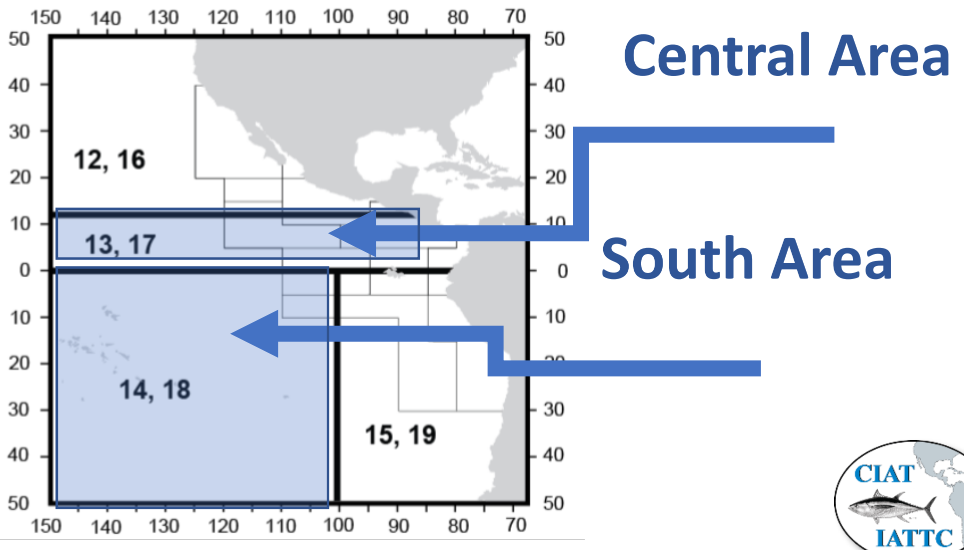
Floating object fishery
dome-shaped selex



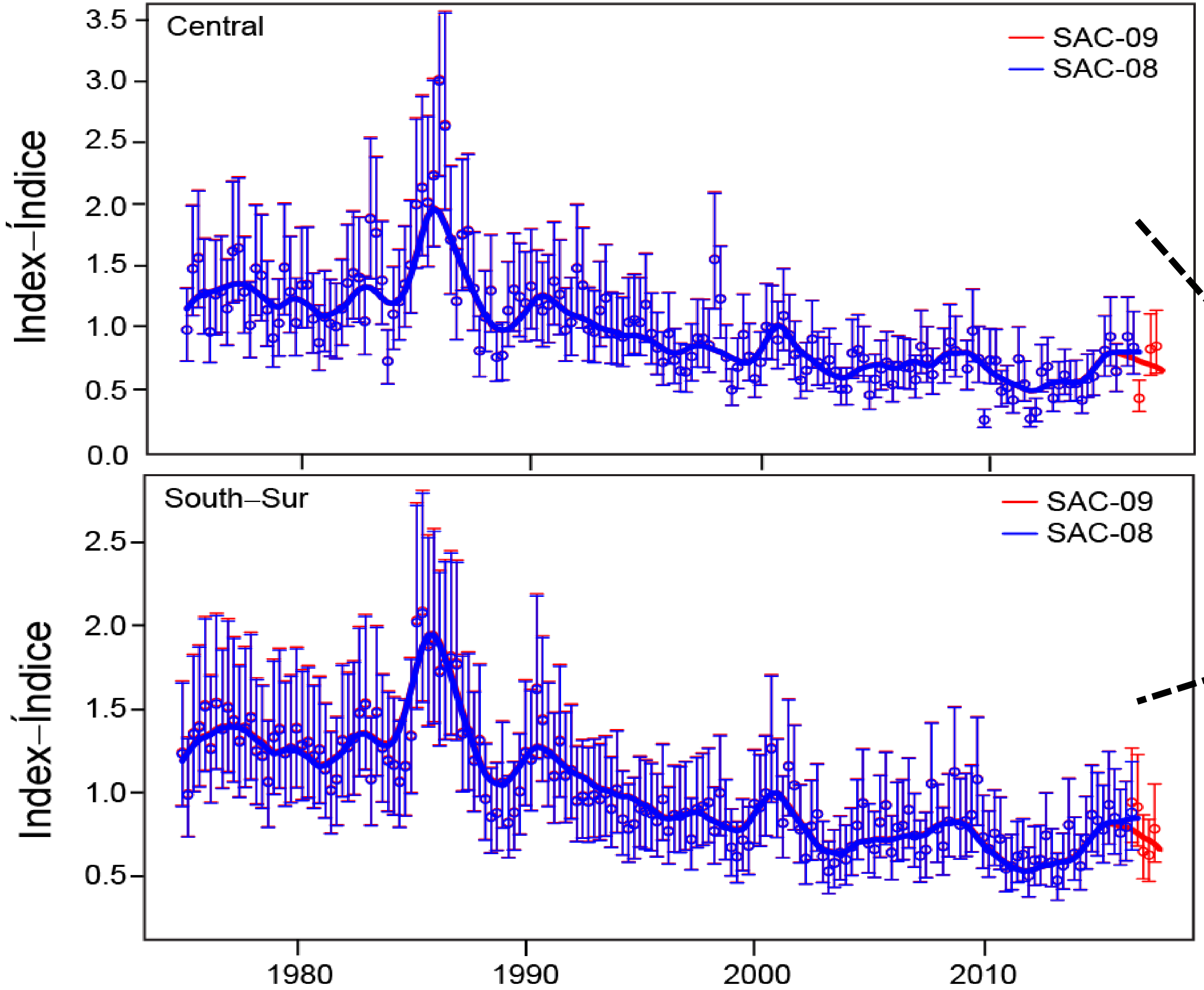

Unassociated fishery
dome-shaped selex

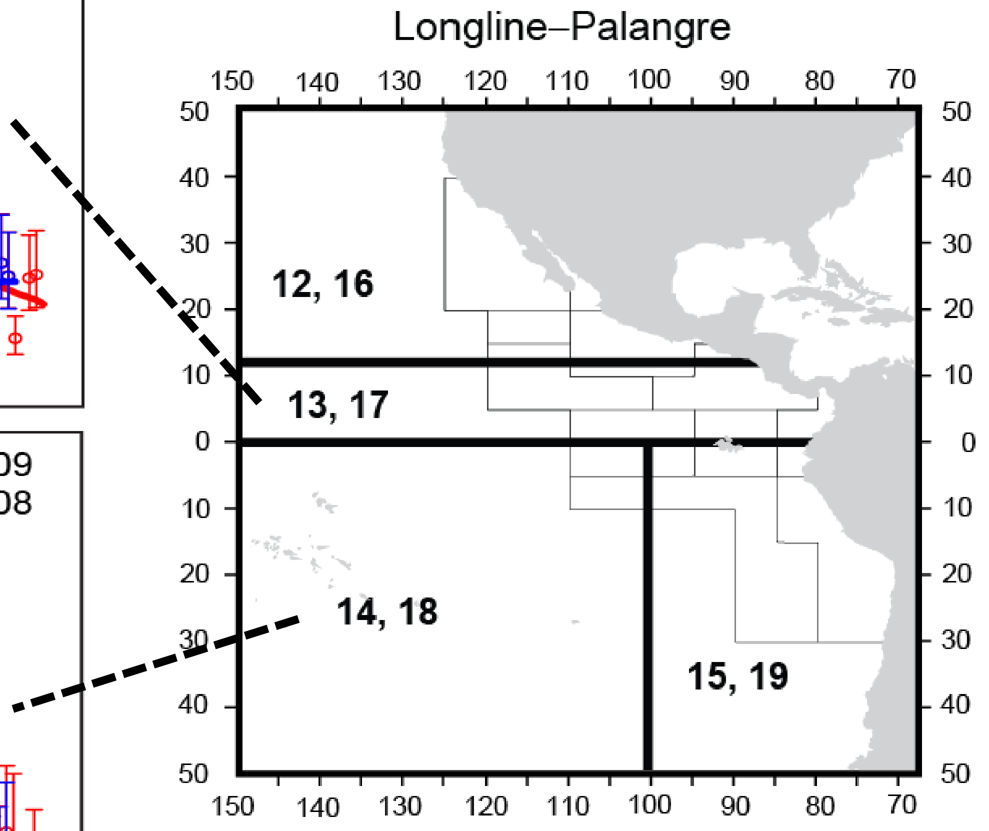



Longline fishery
dome-shaped & asymptotic selex



# Model fit to JPN longline CPUE (base case)

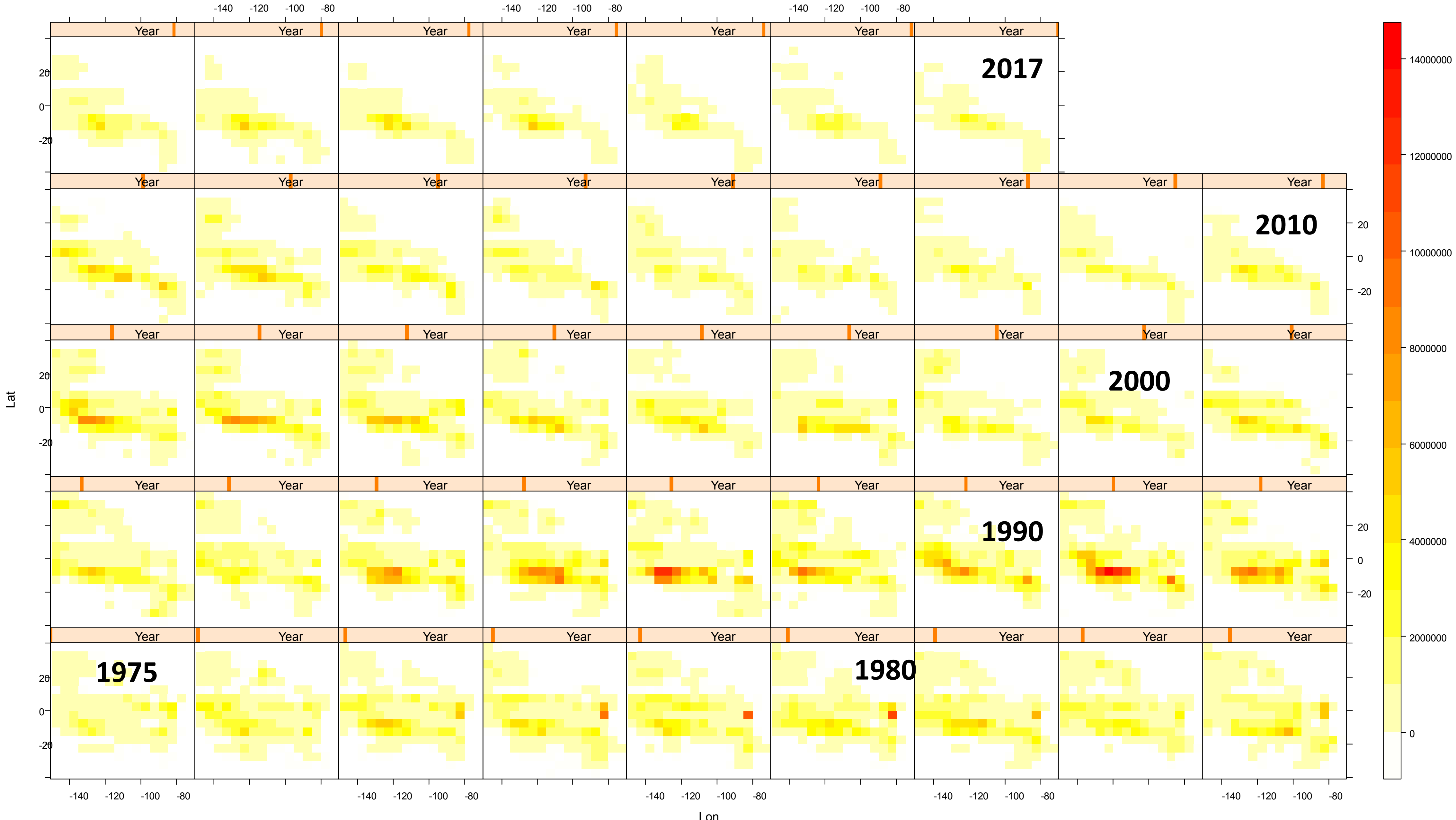


# Retraction of the Japanese fleet in the EPO

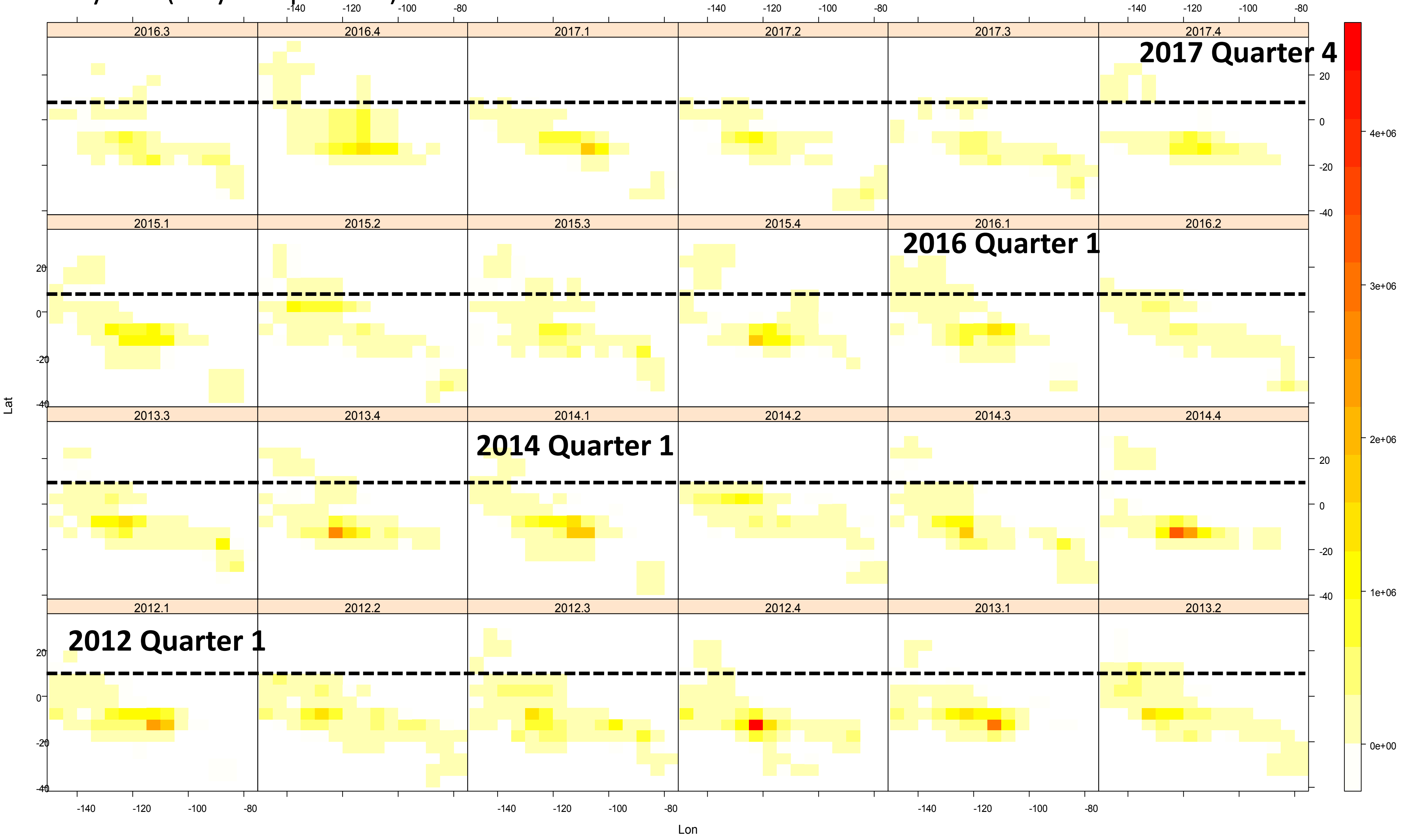
Effort of the Japanese fleet in the EPO (total number of hooks by year )

# Effort distribution (numbers of hooks) of the Japanese fleet in the EPO by year



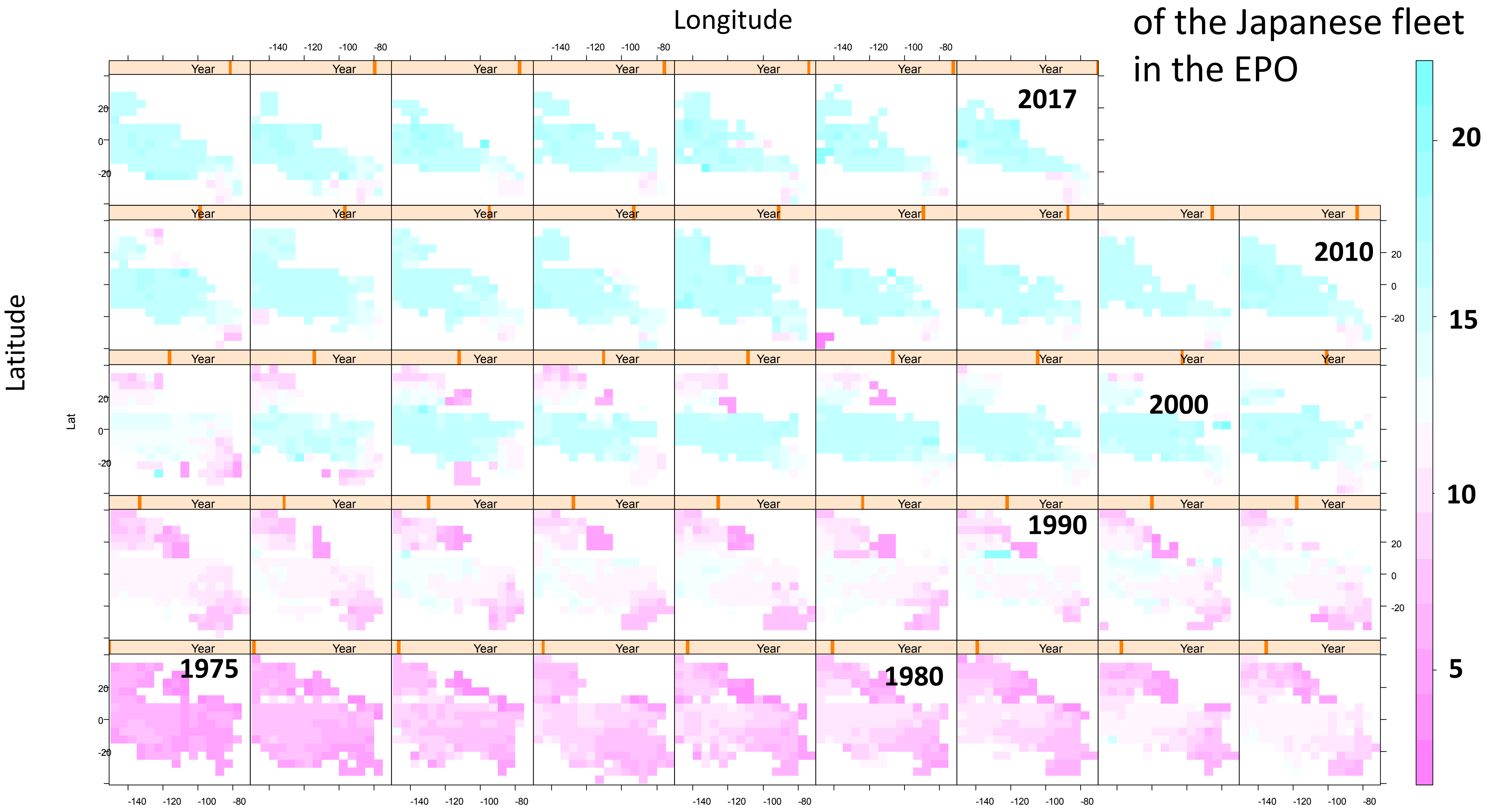
# Effort distribution (numbers of hooks) of the Japanese fleet in the EPO:

most recent 6 years (24 year-quarters)



# Confounding of abundance with changes in gear

Hooks between floats of the Japanese fleet in the EPO



# Changes of JPN LL fishery in EPO: **targeting effects?**

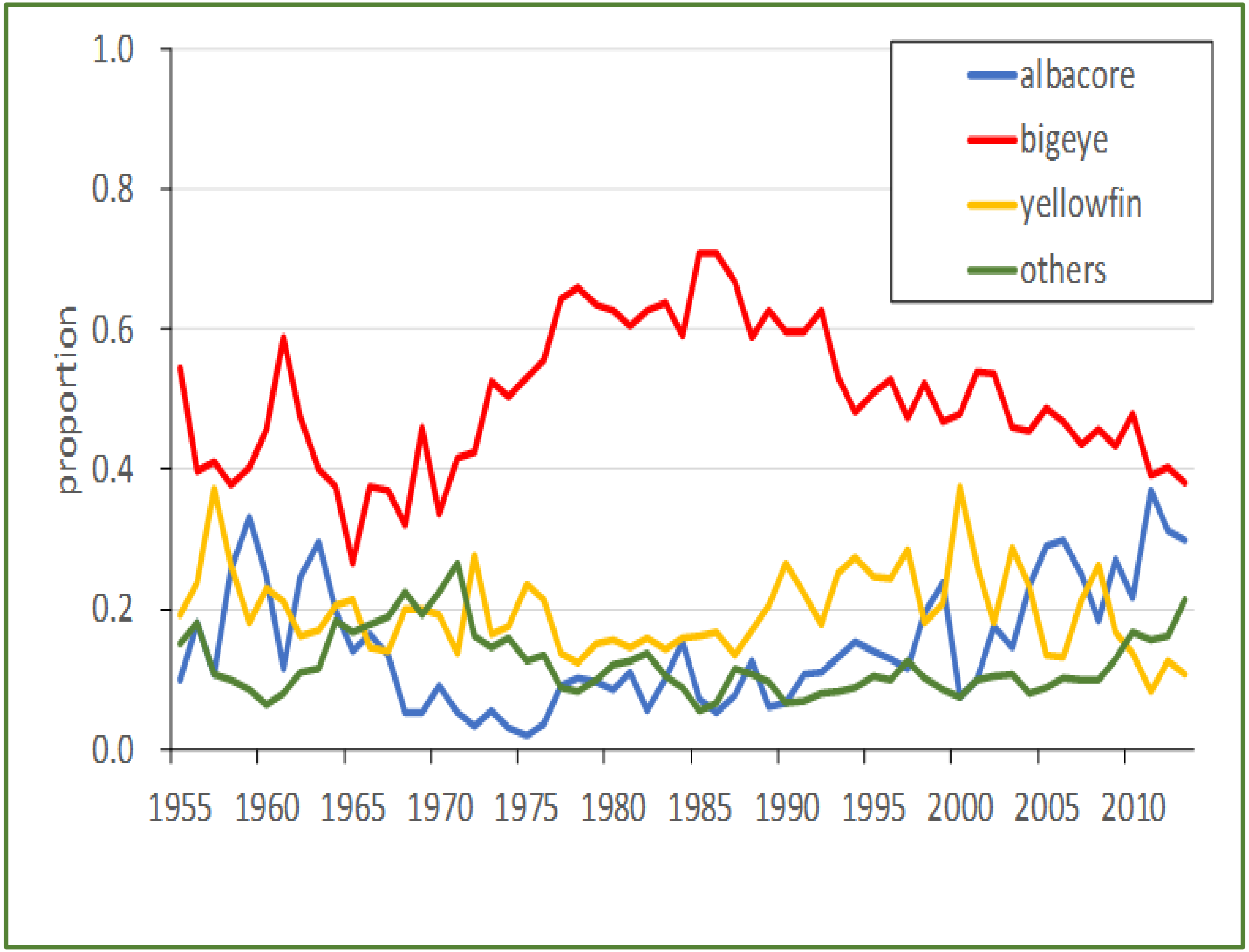



**Figure 1.** Species composition in number of the Japanese longline fishery in the eastern Pacific Ocean. “others” composed of swordfish and marlins.

- ✓ BET and YFT decreases, ALB and others (sword fish and marlins) increase.

From: Satoh et al 2017 SAC8 - presentation

## Changes of JPN LL fishery in EPO: **targeting effects?**

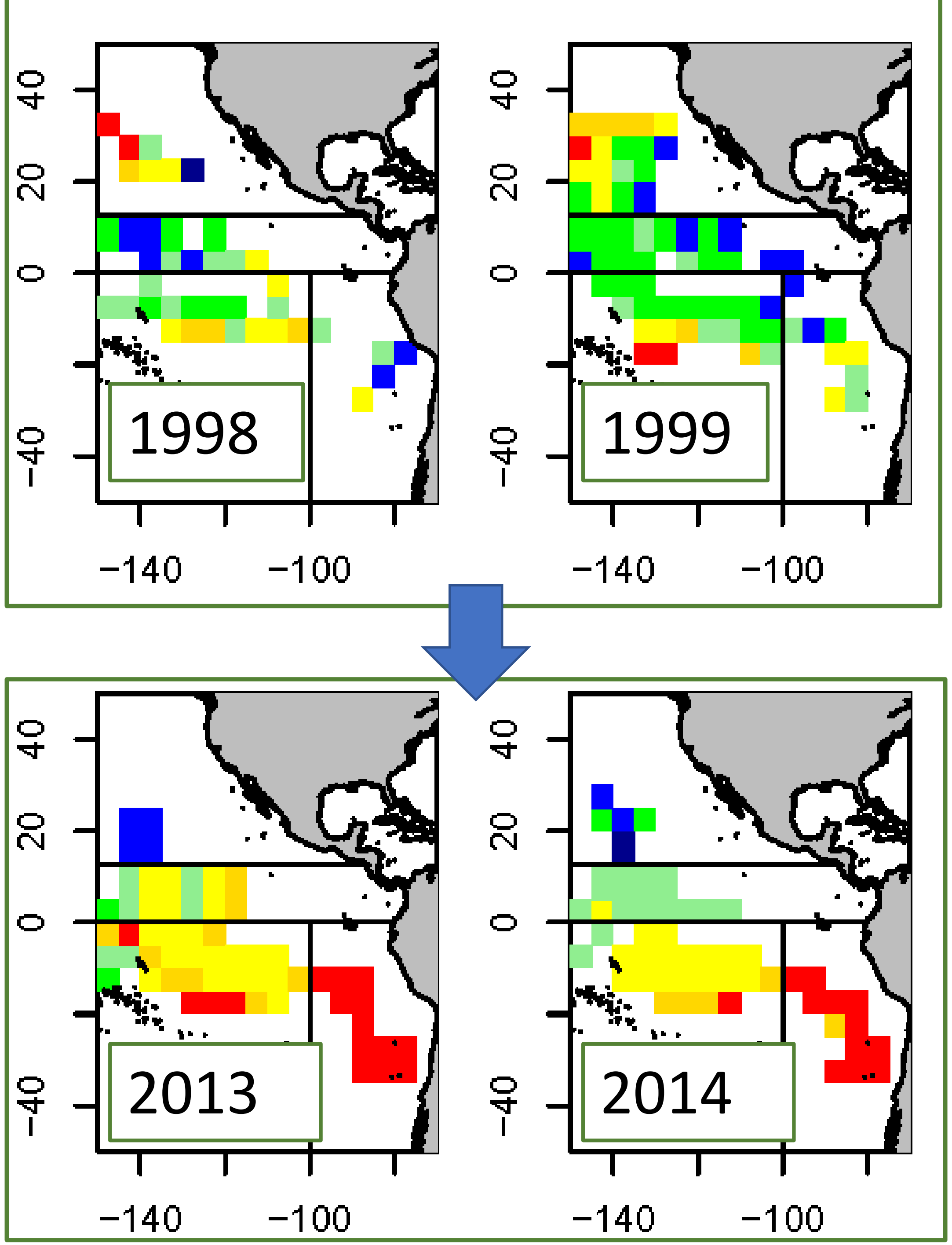



**Figure 2.** Geographical distribution by year of mean albacore ratio:
albacore / (albacore + bigeye + yellowfin + swordfish + marlins)

# Vessel effects?

WCPO – Equatorial area

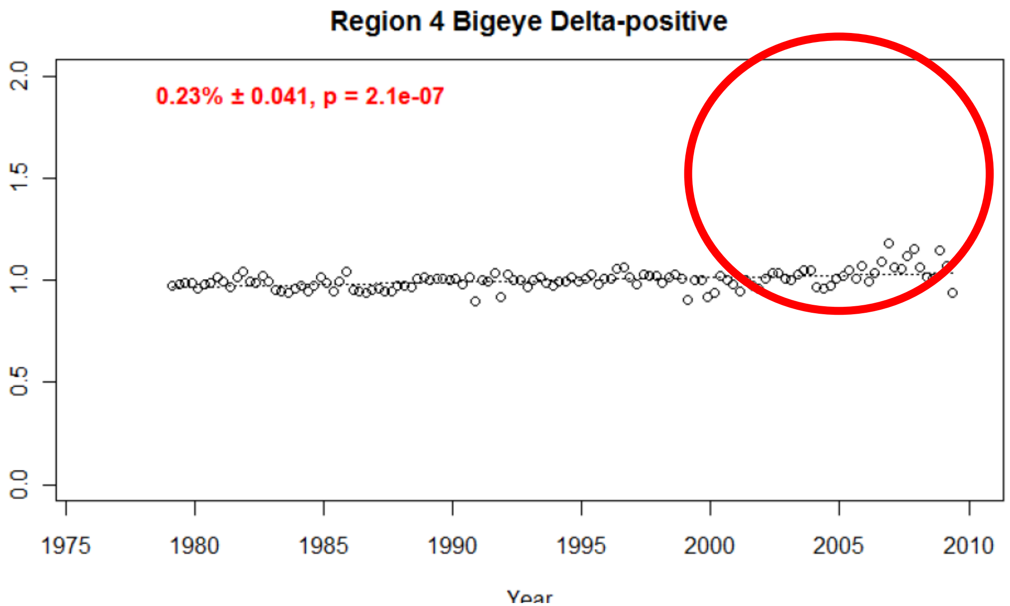
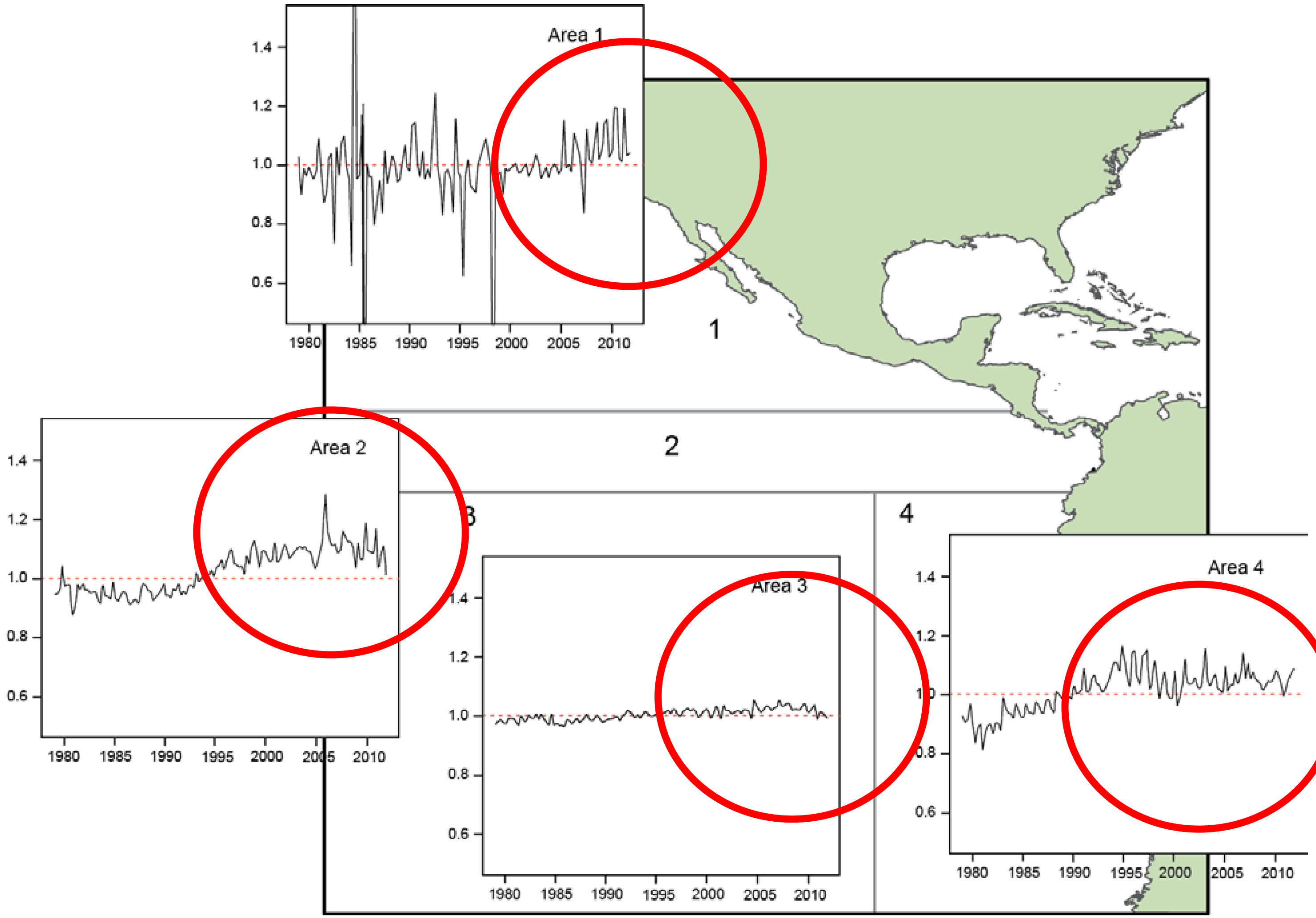



Figure 56 in Hoyle et al 2010

WCPFC-SC6-2010/SA-WP-02




Lennert-Cody et al, 2012, SAC-04-05B

Ratios of standardized year-quarter effect estimated coefficients, by area, from NB GLM models, with and without vessel call sign effects

# Potential problems:

- Mismatch between the index form  LL for YFT and the indices from PS
- Length composition data is not standardized to represent the indices of abundance
- Retraction of the effort of the Japanese fleets: smaller sample sizes, non-random distribution of the fleet “preferential sampling”
- CV=0.15 for BET and CV=0.20 for YFT imply a strong weight of the indices in both assessments
- Increase uncertainty in the index not reflected in the stock assessment, the uncertainty is underestimated
- Possible changes in target species: recent years an increased emphasis in swordfish and albacore in certain areas of the EPO.
- Increase in vessel efficiency not taken into account

# Opportunities:

- New stock assessment for bigeye tuna: revise the spatial definitions
- Potential inclusion of data for other fleets in the standardization
- Use of spatial- temporal models
- Analyze operational level data

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# Thank you!