Spatial structure assumptions for the new bigeye tuna population dynamics model in the eastern Pacific Ocean

Carolina Minte-Vera, Cleridy Lennert-Cody, Haikun Xu, Juan Valero, Mark Maunder, Kurt Schaefer, Dan Fuller, Jon Lopez, Alexandre Aires-da-Silva

CAPAM

Spatial Stock Assessment Models

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Outline

- Background
- Methods
- Results
  - Tagging data
  - Fishery data
- Proposals for spatial assumptions
- Conclusions

Background

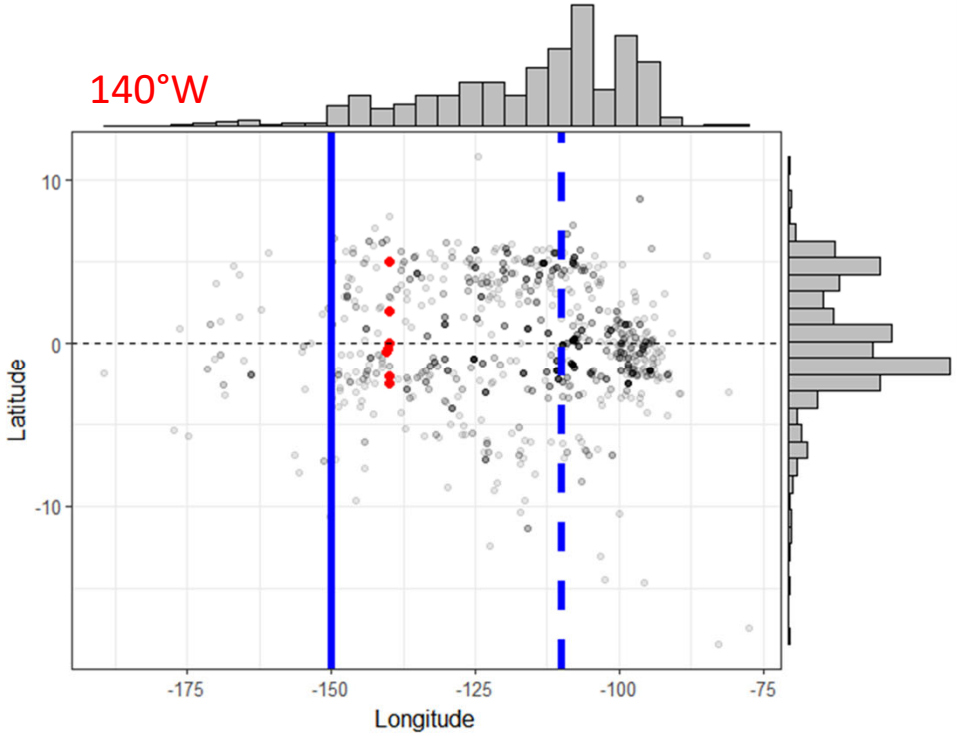
- Tagging shows evidence of regional dynamics
- The current assessment is a one area model.
- Model shows recruitment patterns that might be caused by spatial misspecification
- Currently constructing a spatial stock assessment model
- What spatial structure should be used?

Methods

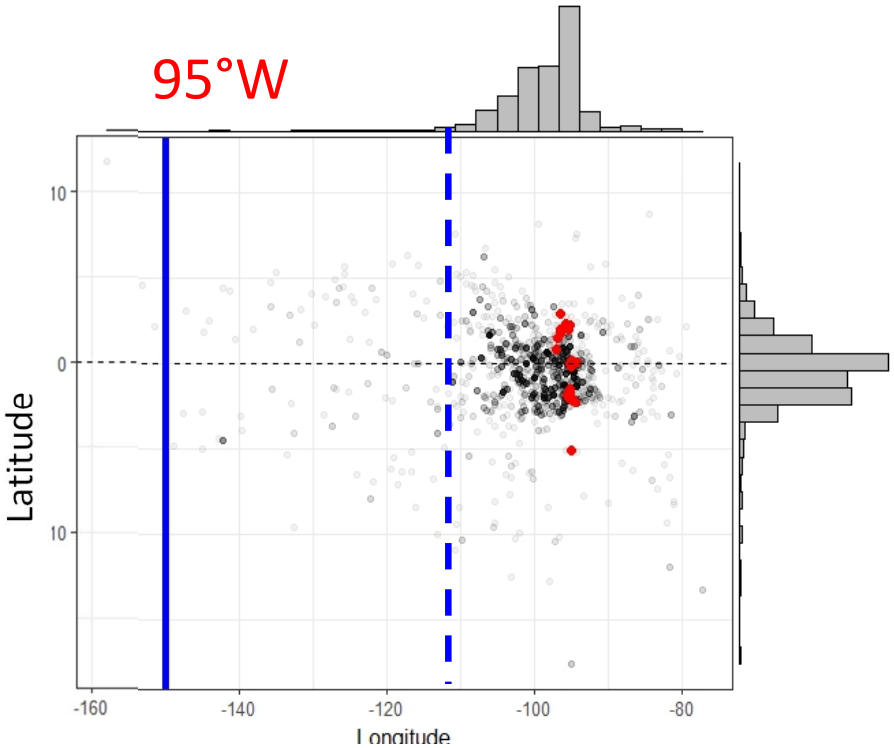
- Evidence from tagging data
  - Equatorial eastern PO 2000 to 2006 (Schaefer and Fuller 2009)
  - Equatorial central PO 2008 to 2012 (Schaefer et al 2015)
  - Hawaii
  - Japanese studies in the eastern Pacific Ocean
- Fisheries data
  - Japanese longline data (CPUE and Length Frequencies) early years (<=1991) and late years (>1996)
  - Purse-seine floating objects (CPUE and Length Frequencies) from 2000-2017
  - Multivariate tree-based methodology (see Lennert-Cody et al, 2018's CAPAM presentation)

Results

Recoveries by **release location of** fish with 6 month or more at liberty



Conventional tagging data in the equatorial EPO



PS effort = 1x

Longitude

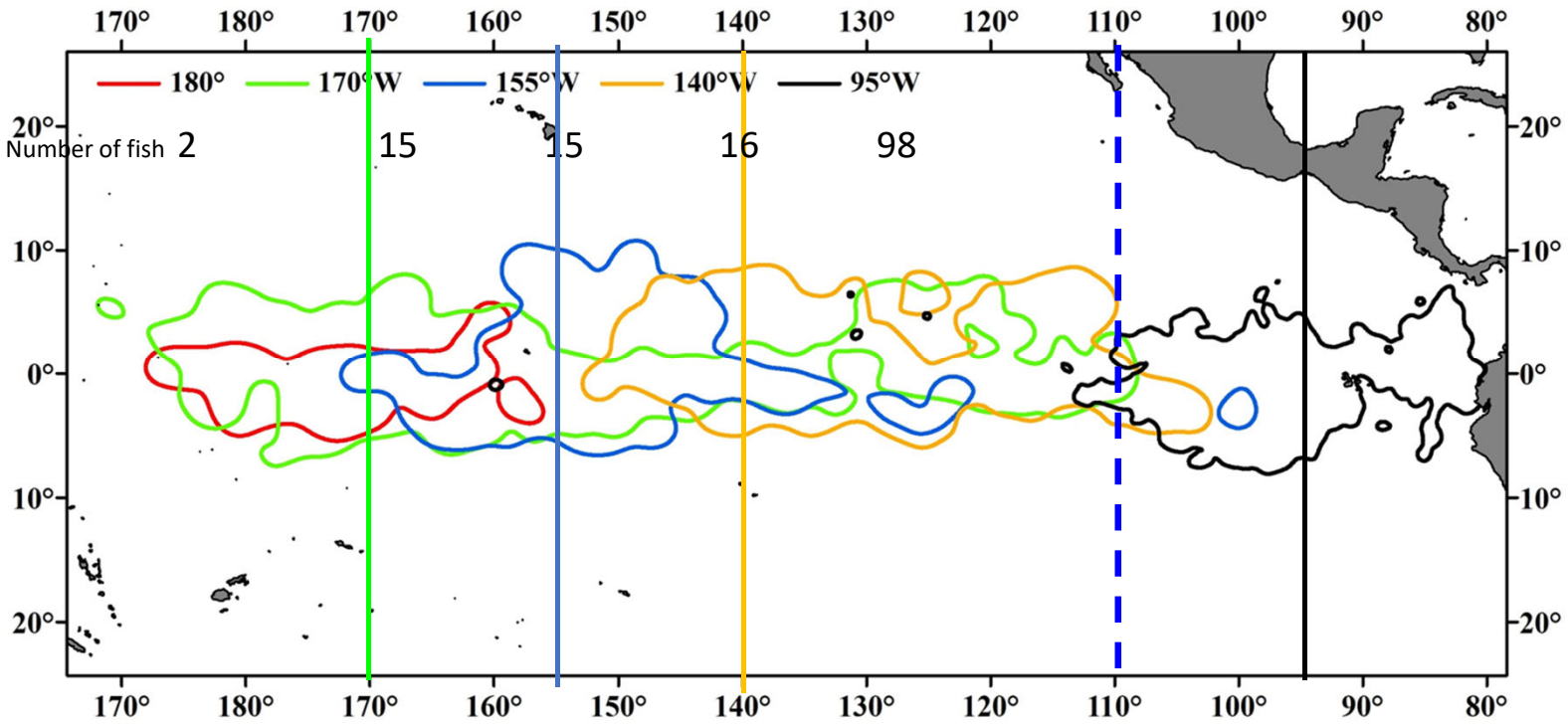
PS effort = 4x

95% of fish released at 95°W were recovered east of 110°W.

The 110°W boundary is supported by the data

Results

Archival tags, fish 30 days or more at liberty



95% volume contours calculated from a kernel density function for all archival tag position estimates using a 1° search radius and a 0.01° output cell size

Most of the time the fish tagged at 95°W stay east of 110 ° W (98 fish)
Fish tagged at 140 °W tend to have eastward movement, some cross the 110°W meridian

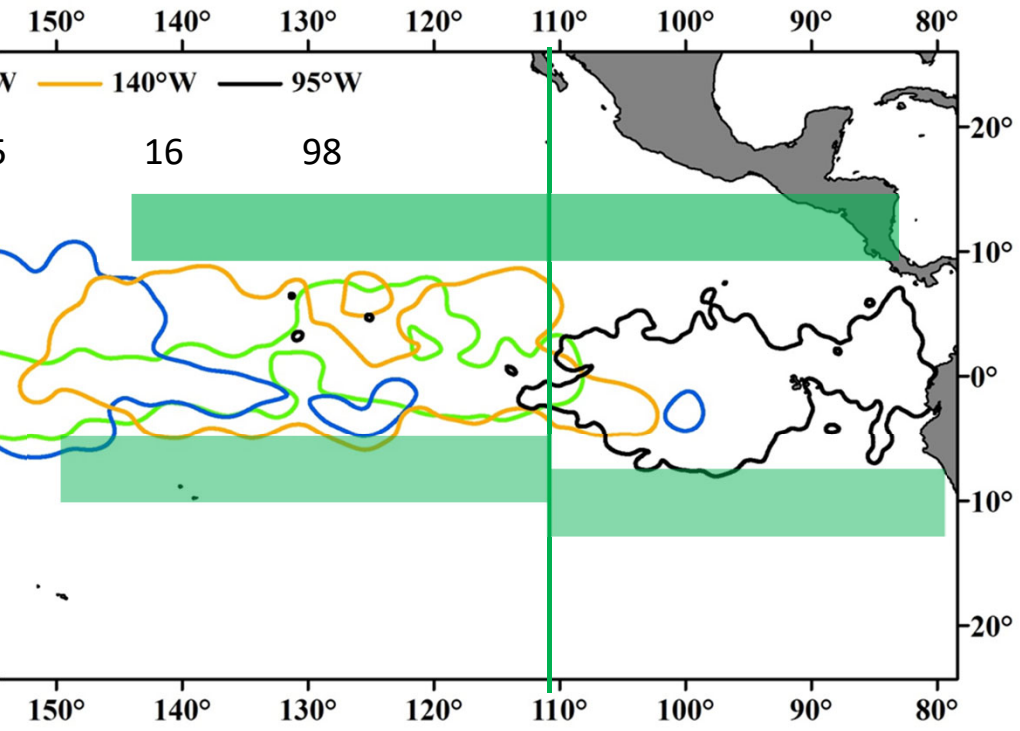
The 110W boundary is also supported by the archival tagging data

Schaefer (2014) presentation for SAC, data from Schaefer et al (2015) and Schaefer and Fuller (2009).

Equatorial tagging data

supports northern and southern boundaries

Archival tags

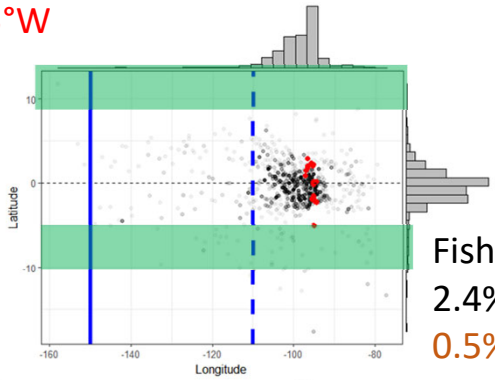


95% volume contours calculated from a kernel density function for all archival tag position estimates using a 1o search radius and a 0.01o output cell size

Conventional tags

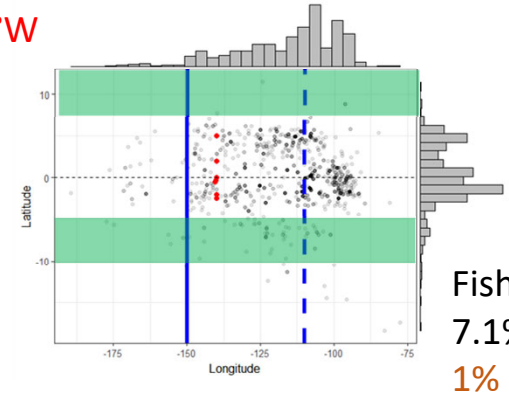
Recoveries by release location

95°W



Fish tagged at 95W:
2.4% moved south of 5S
0.5% moved south of 10S

140°W



Fish tagged at 140W:
7.1% moved south of 5S
1% moved south of 10S

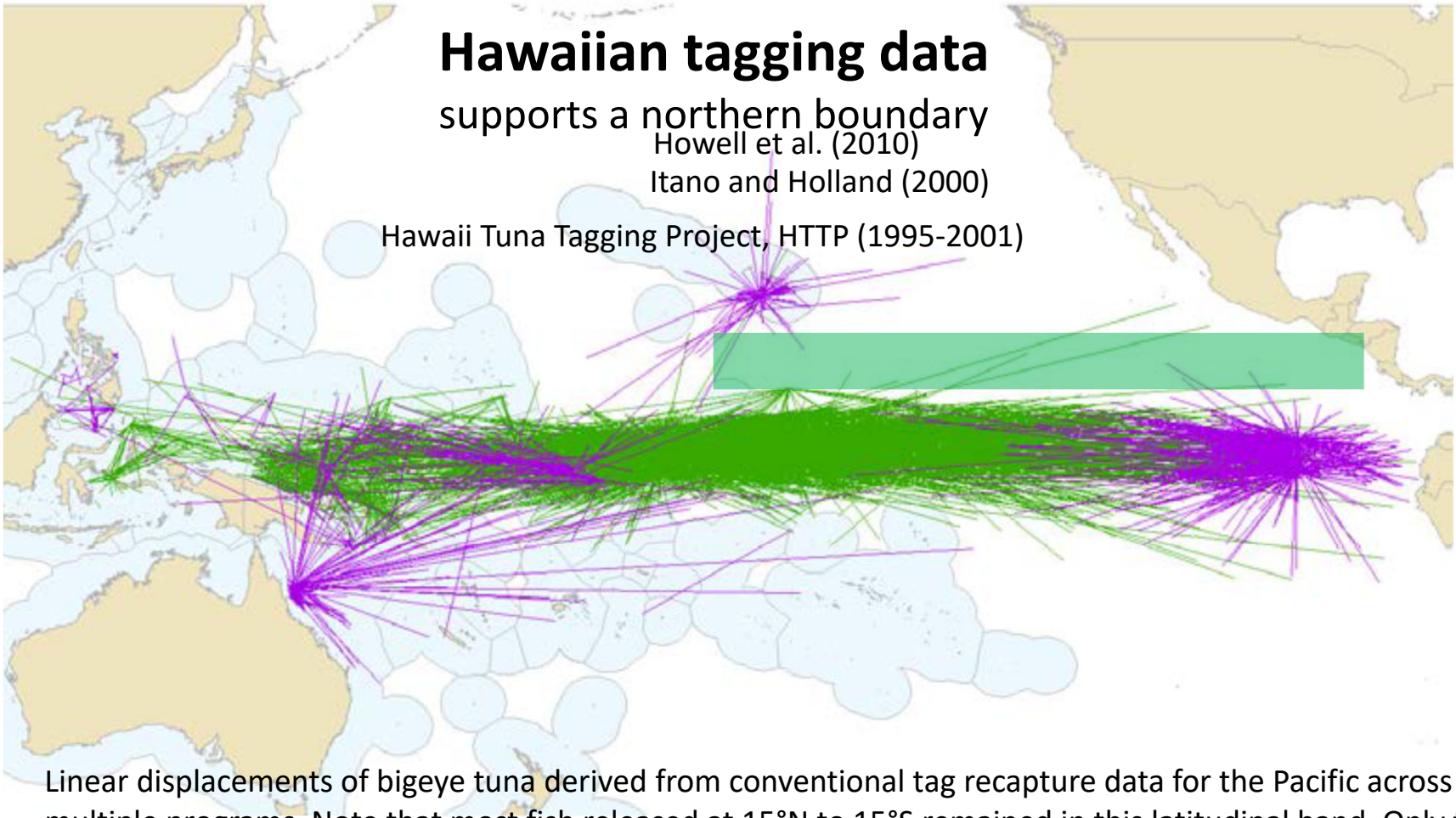
Hawaiian tagging data

supports a northern boundary

Howell et al. (2010)

Itano and Holland (2000)

Hawaii Tuna Tagging Project, HTTP (1995-2001)



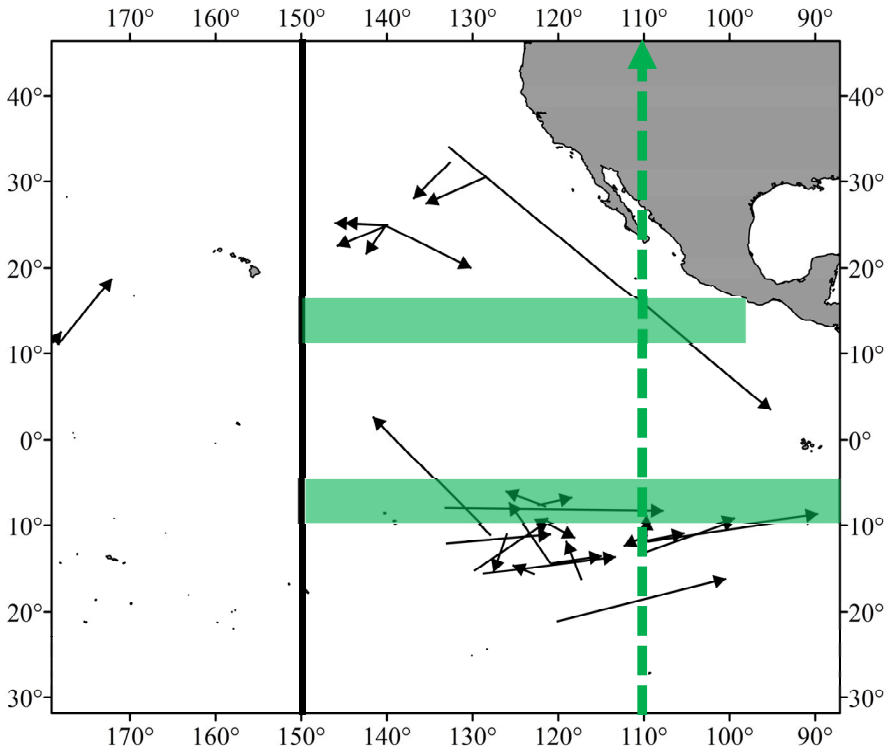
Linear displacements of bigeye tuna derived from conventional tag recapture data for the Pacific across multiple programs. Note that most fish released at 15°N to 15°S remained in this latitudinal band. Only two significant datasets at higher latitudes are shown

Figure from: http://www.wpcouncil.org/wp-content/uploads/2014/11/Final-Bigeye-Workshop-Report.pdf

Japanese tagging data

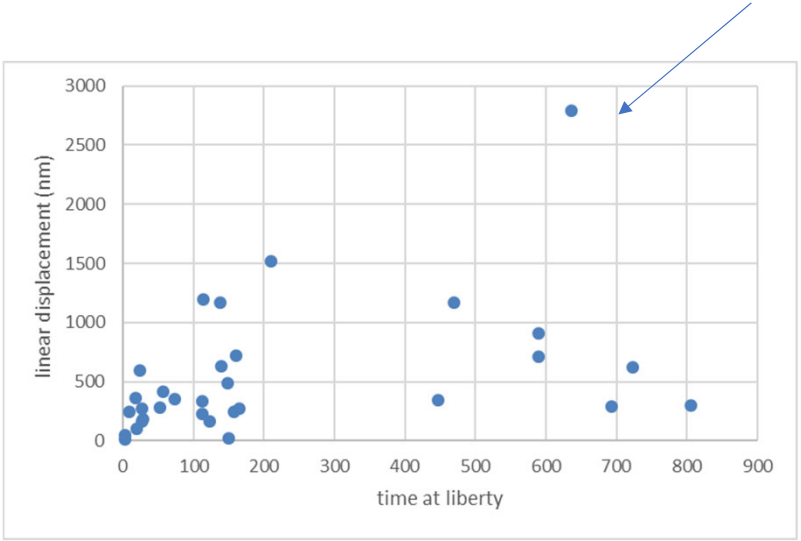
Archival and conventional tags (n=32)

Fish tagged **north** of 10-15N stayed in the area, with one exception



Fish tagged in the **south** moved predominantly in longitude, and mostly east. Some fish tagged south of 10°S moved slightly north, indicating some diffusion

Even fish with long time at liberty are likely to have short linear displacements, in general



(personal communication from K. Satoh)

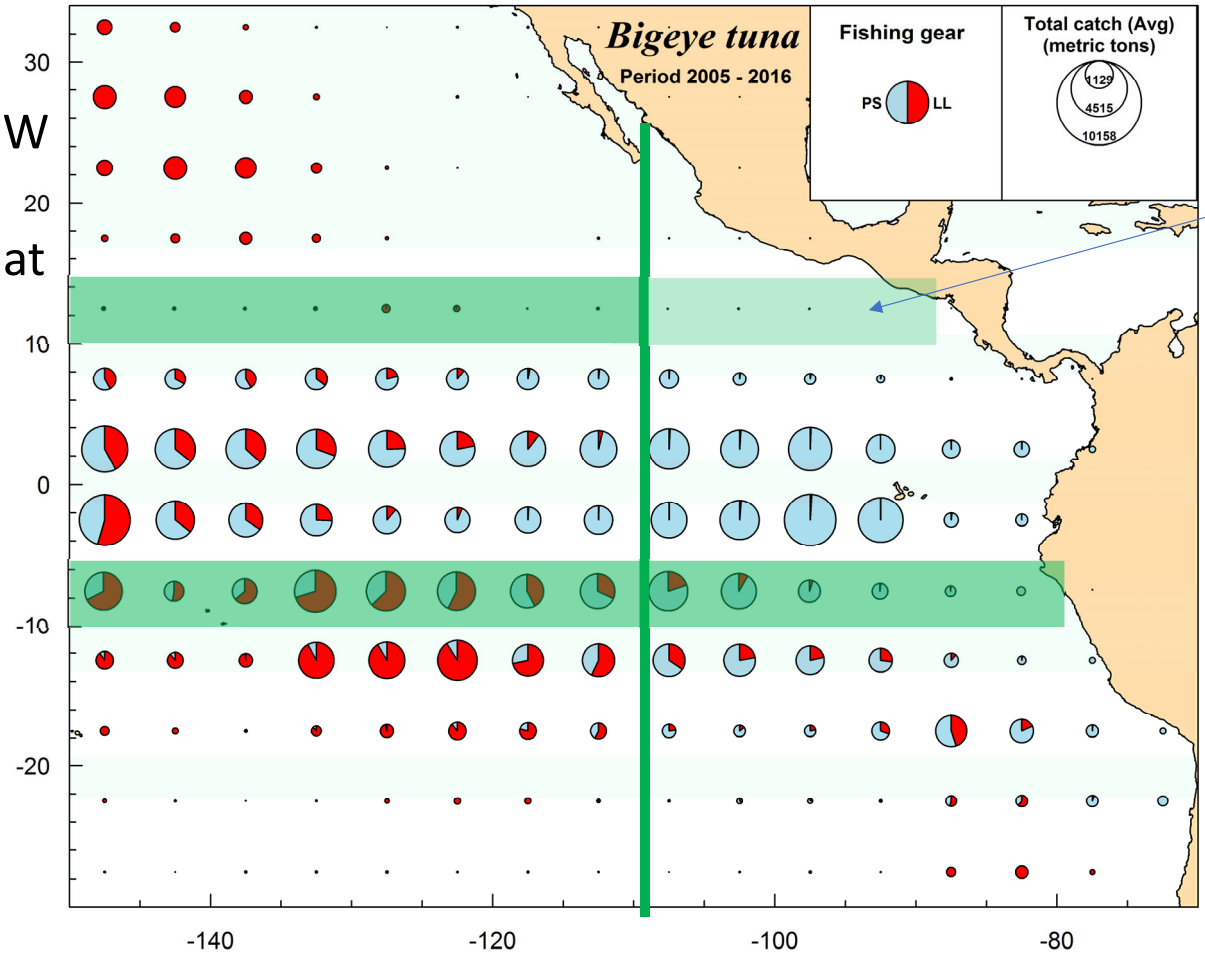
Summary tagging data:

First split at 110°W

Secondary splits at 10-15°N

And

5-10°S

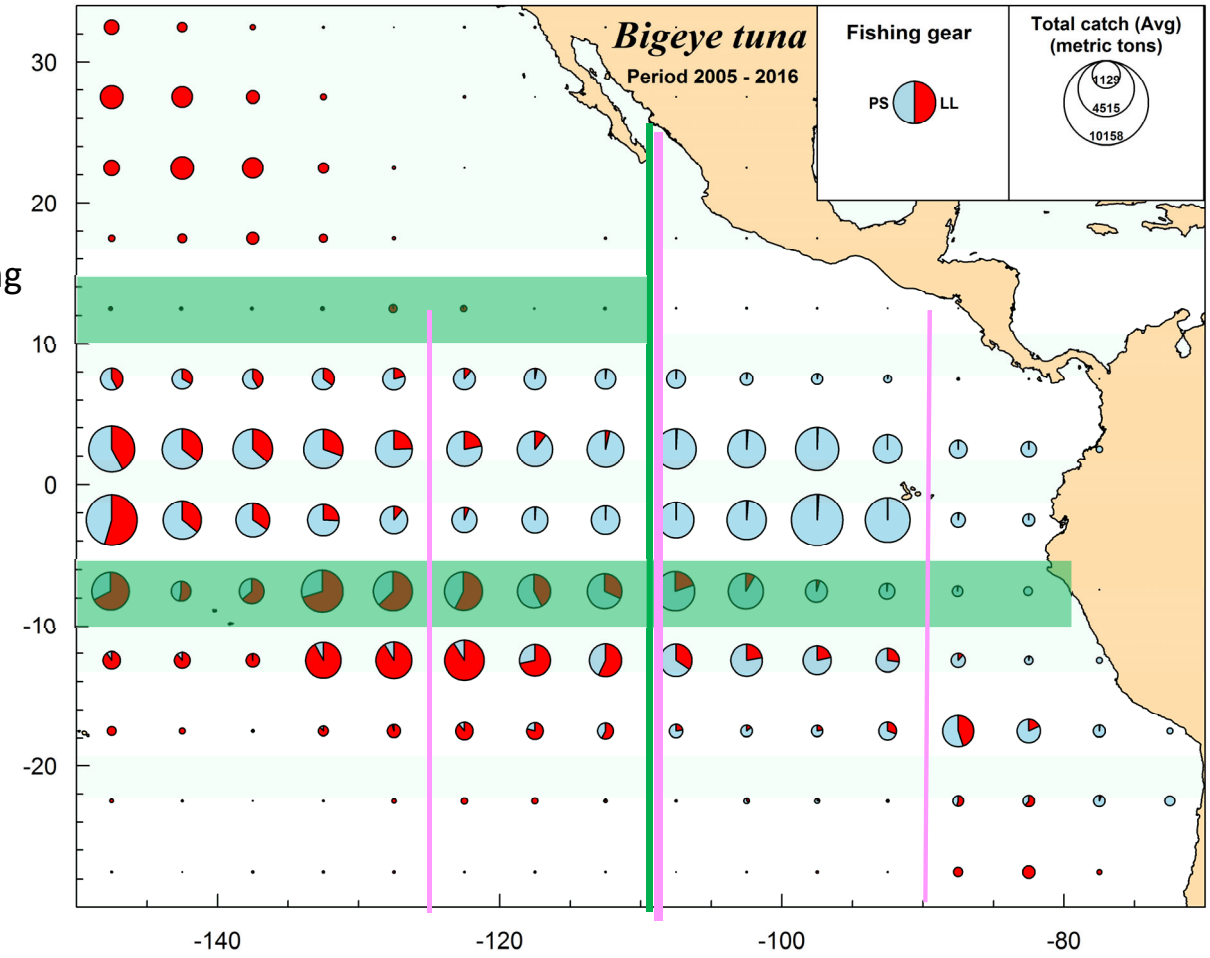


Simplify to one area

tagging data

Results tree analysis Purse-Seine data on Floating Objects

The tree analysis using CPUE was unstable, only used LF



West of 110°W
Tree 3: 125°W

PS-OBJ LF data
Tree 1: 110°W

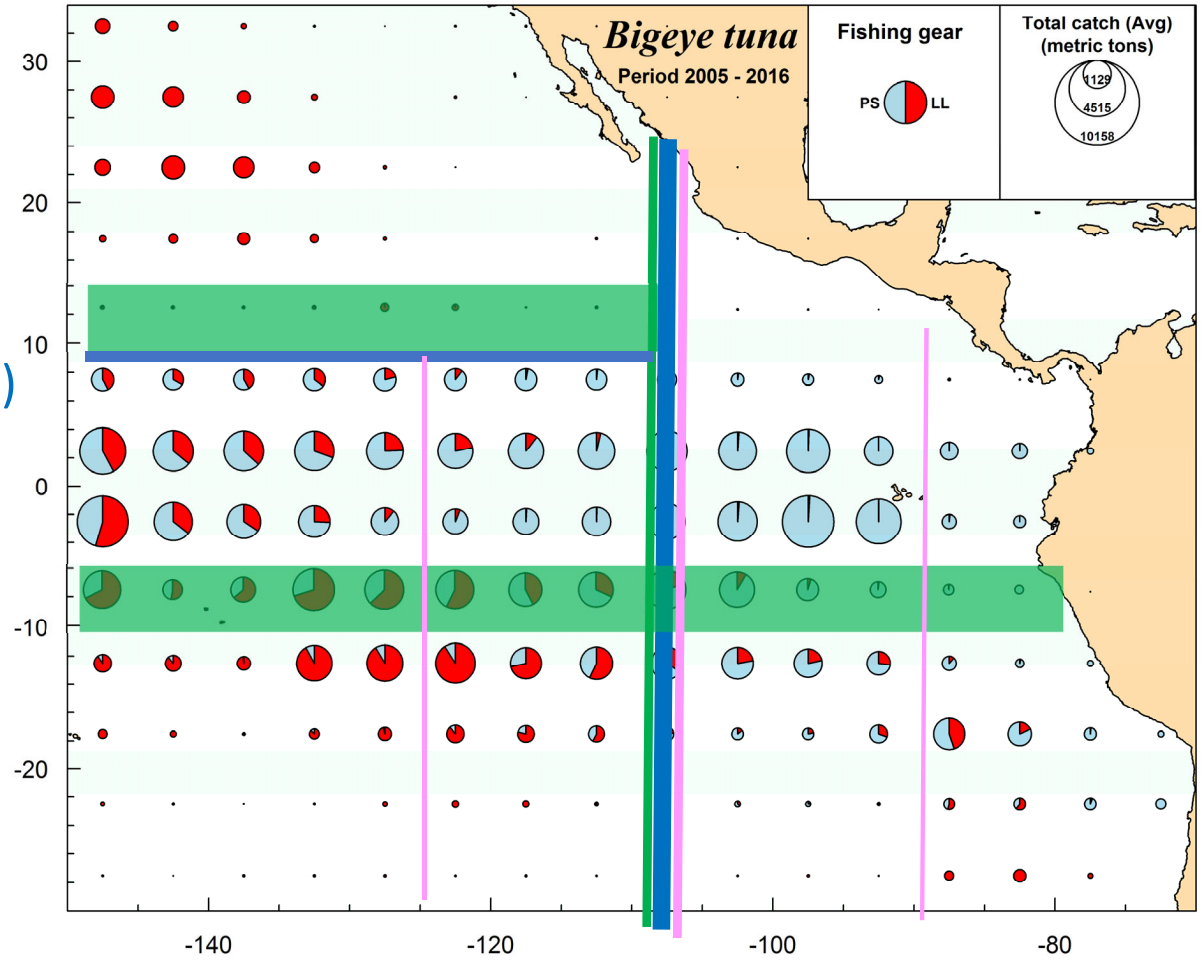
East of 110°W
Tree 2: 90°W

tagging data

PS-OBJ LF data

Results tree analysis: early longline data

LF + CPUE:
10°N
second best (0.61)



Tagging

LF + CPUE:
110W best (0.63)

Tagging
PS-OBJ LF data

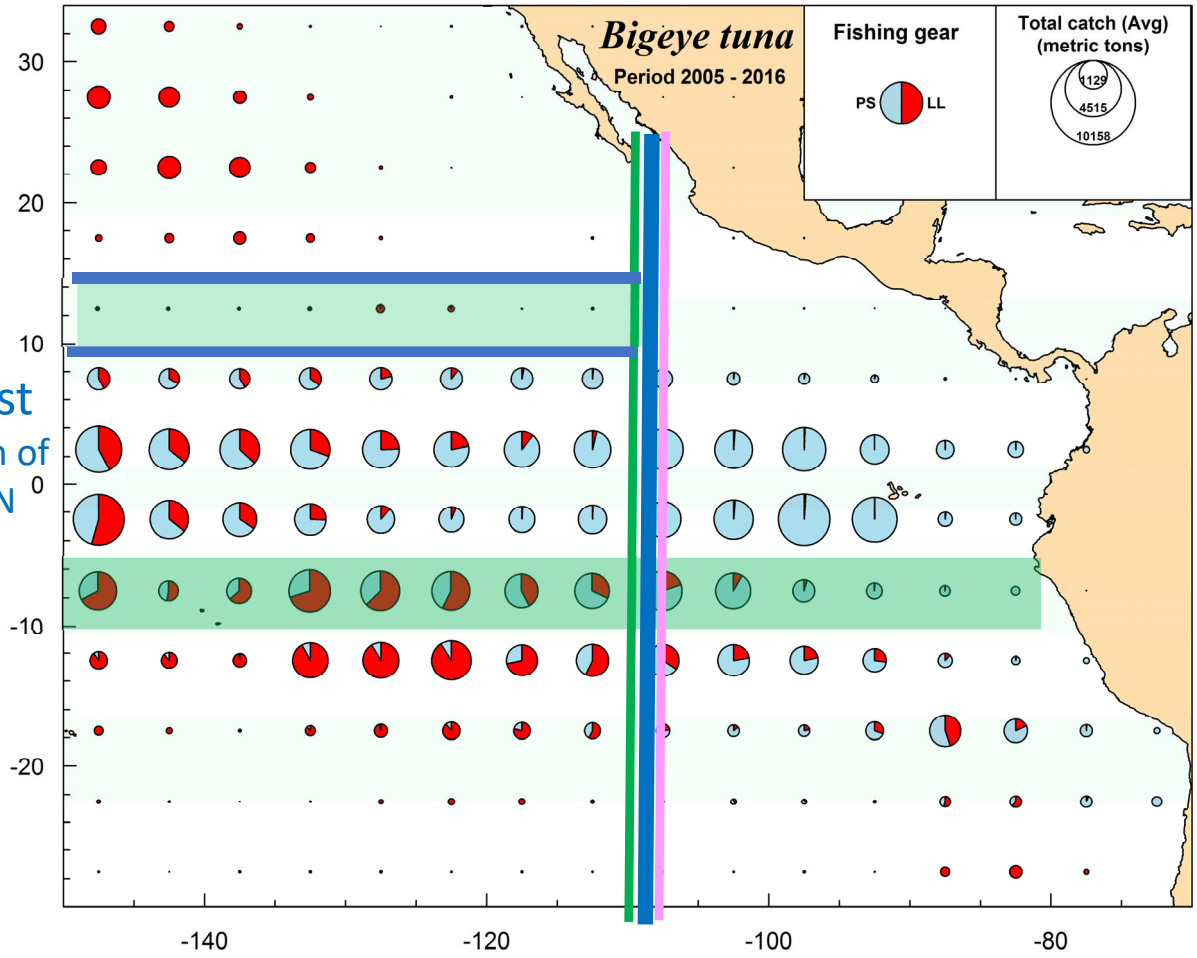
early LL data

Results tree analysis: early longline data

LF: 15°N best

LF+CPUE: 10°N best

But no CPUE trends north of 15°N and south of 20°N



Tagging

PS-OBJ LF data

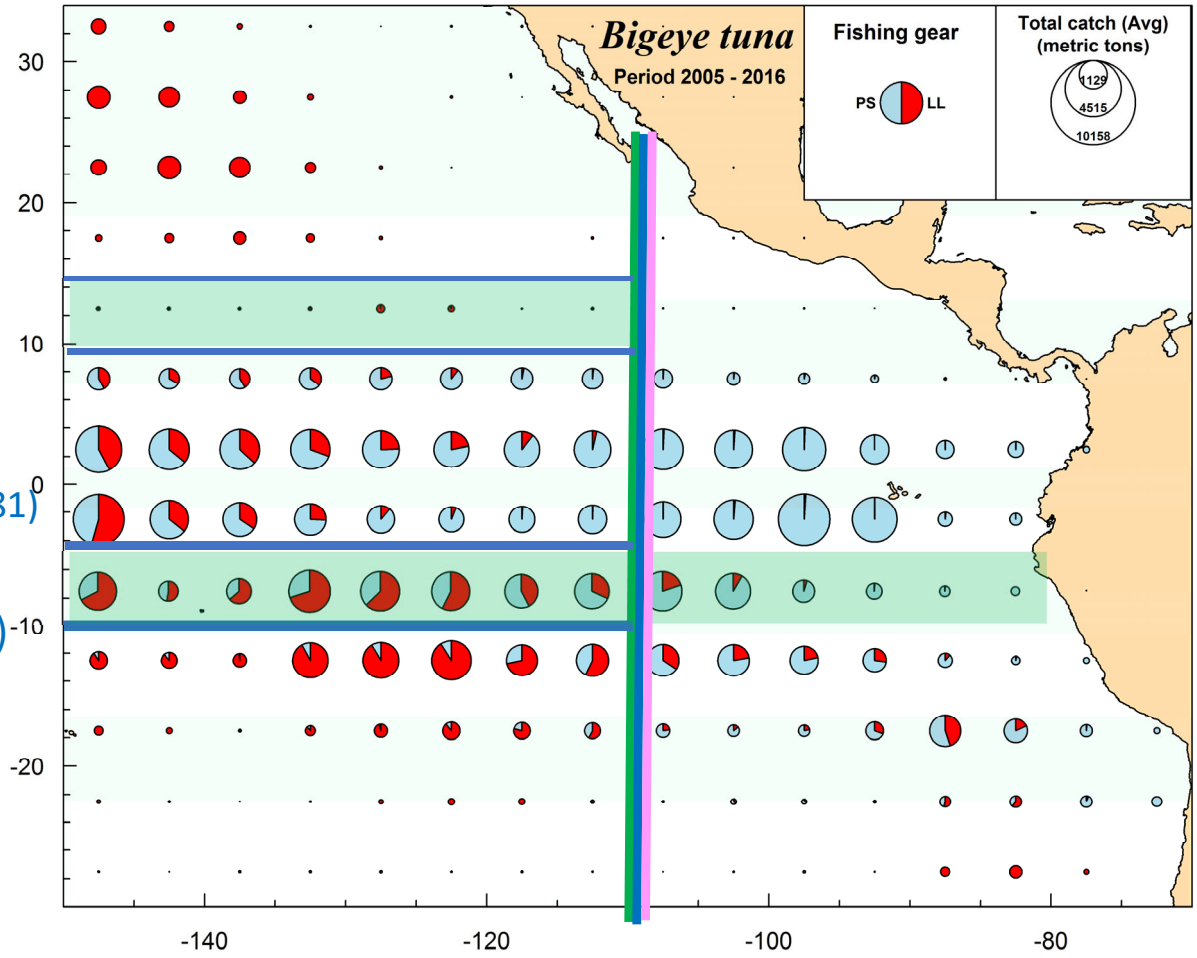
early LL data west of 110W

Results tree analysis: early longline data

LF + CPUE

5°S 2nd best (0.81)

10°S: best (0.90)

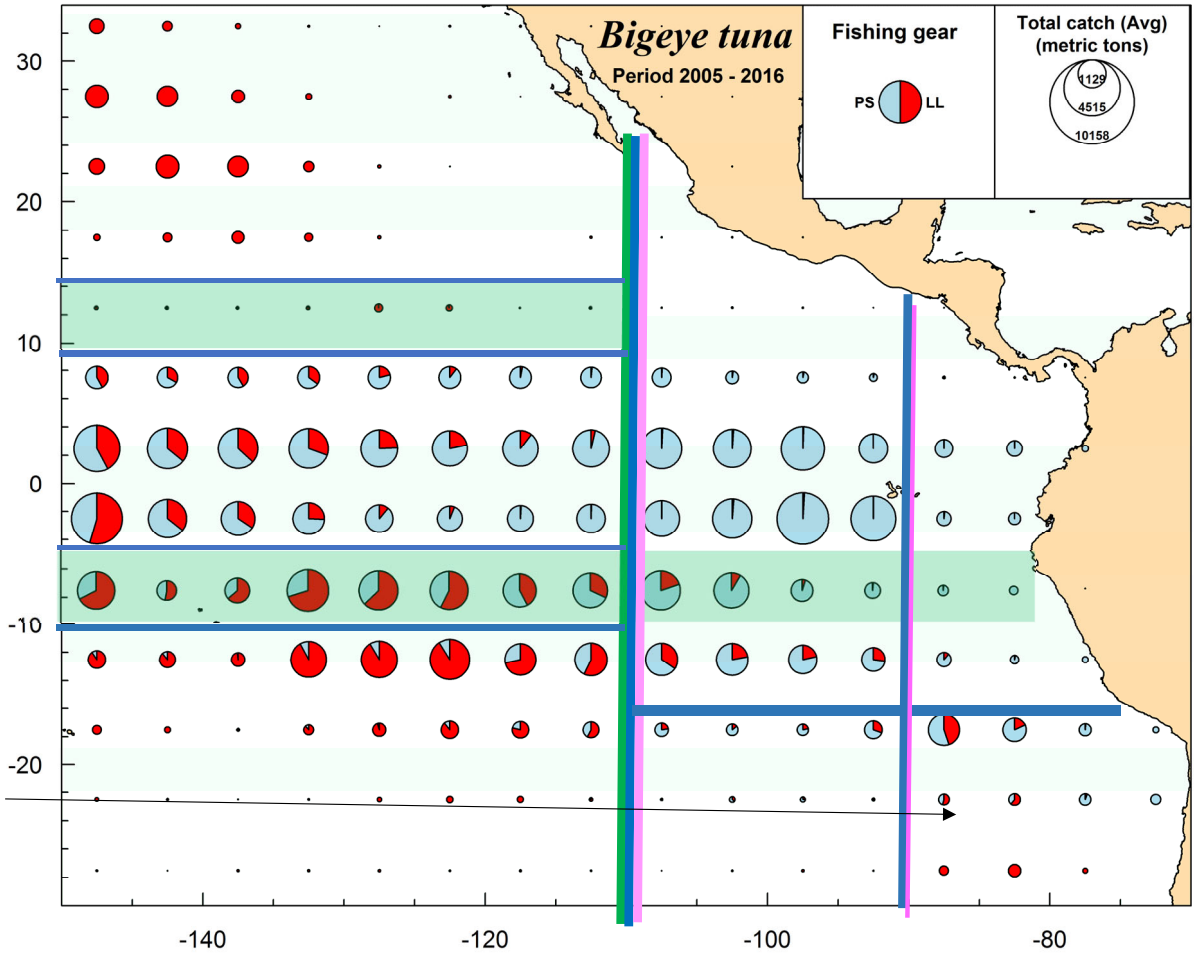


Tagging

PS-OBJ LF data

early LL data west of 110W and south of 10N

Results tree analysis: early longline data



attempt to isolate the southeast corner

Tagging

PS-OBJ LF data

early LL data east of 110W

LF + CPUE

15°S: Best (0.72)

LF: **15°S**:Best

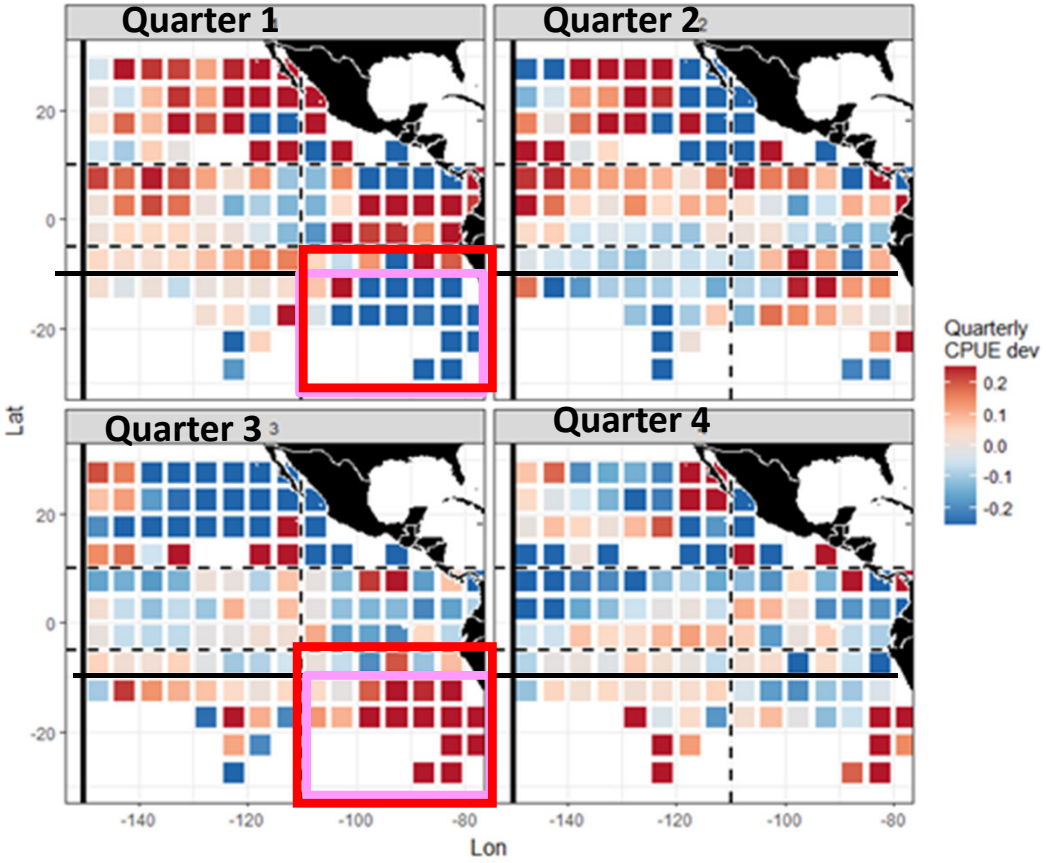
CPUE: **seasonality** (quarter 3) Best

LF + CPUE and CPUE only **90° W** 2nd close competitor (0.69)

also PS-OBJ LF data

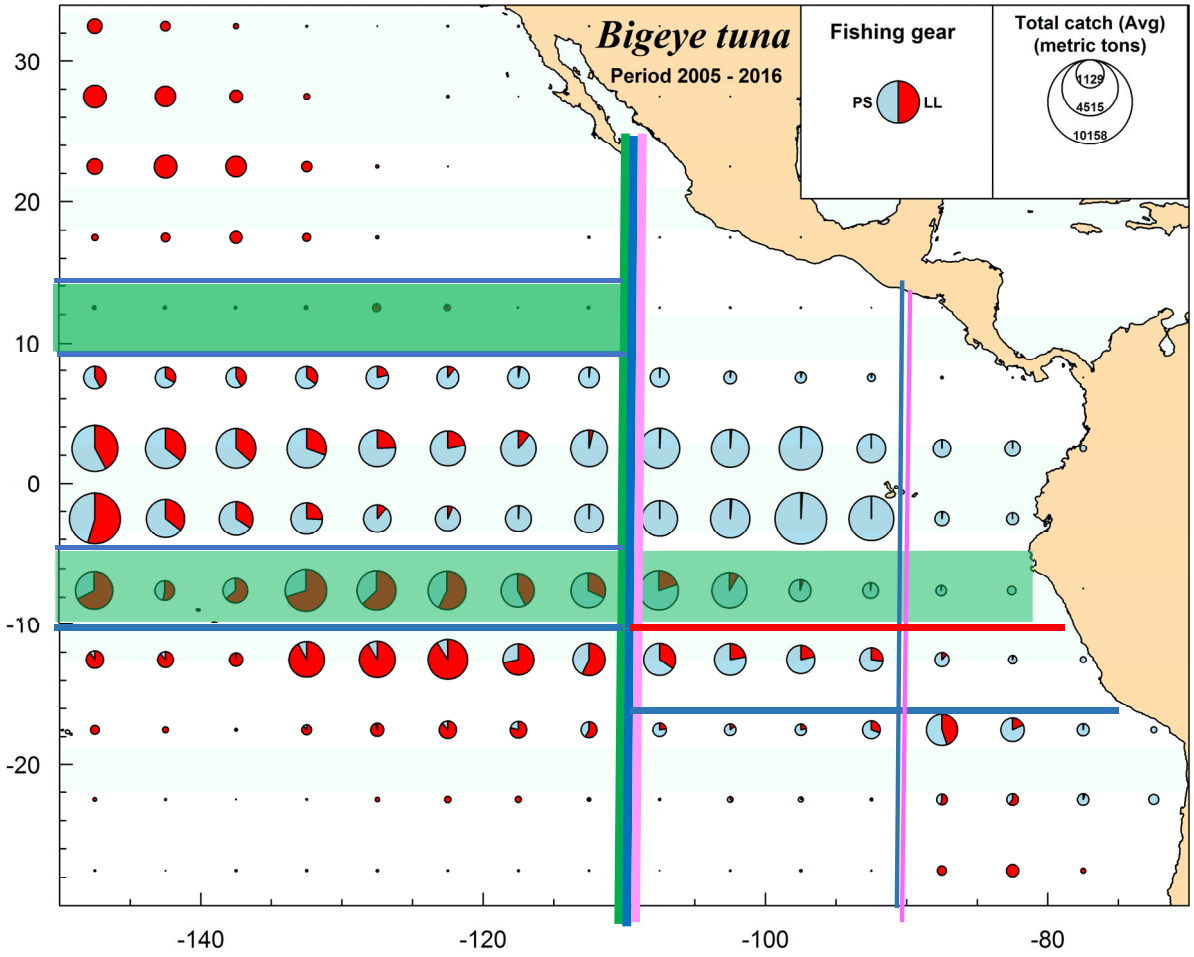
Quarterly anomaly in Japanese nominal Longline CPUE

before the expansion of the OBJ fishery (early LL data <1991)



Quarter 1 and 3:
The area south of 10°S is more homogeneous than the area south of 5°S

Results: all evidence



Tagging

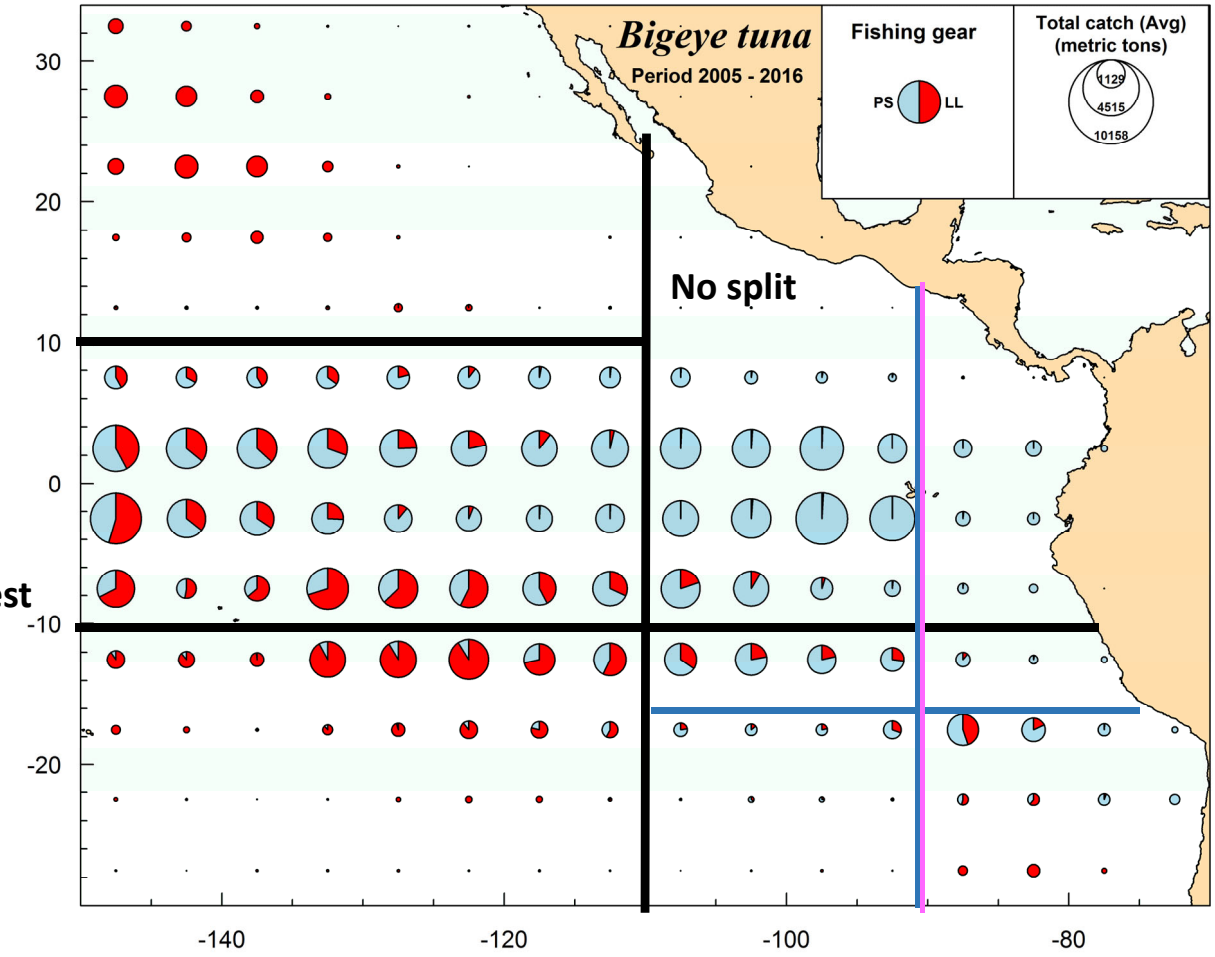
PS-OBJ LF data

early LL data

Quarterly anomaly in Japanese longline CPUE

Proposal for spatial assumptions

Second split at 10N west of 110W t,LL,p



Third split at 10S west of 110W t,LL,p

Fouth split at 10S east of 110W A, p

First split at 110W t,LL,PS

Support:

PS: PS-OBJ LF data

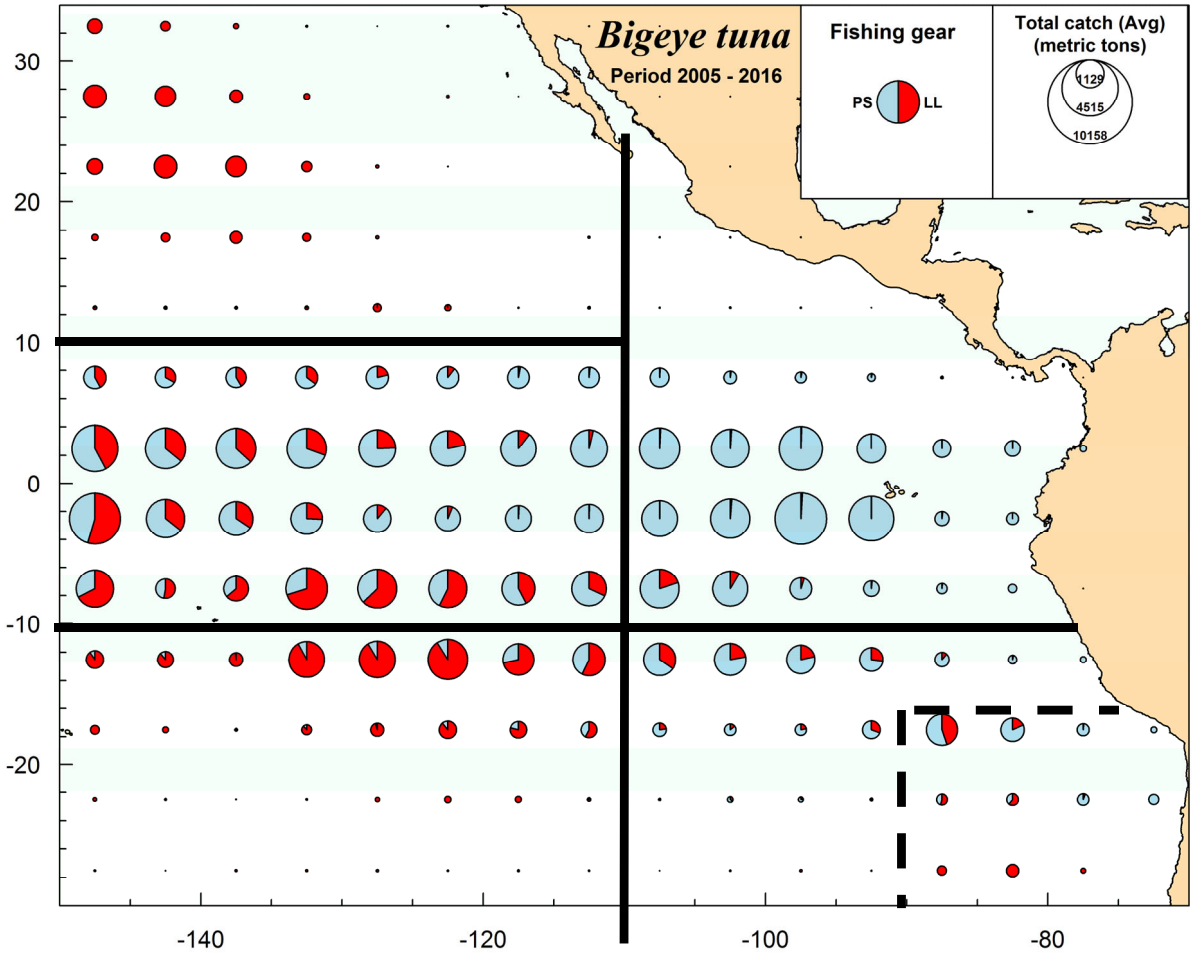
LL: early LL data

O: other considerations

A: Quarterly anomaly in JPN LL CPUE

p: Practical considerations: WCPO bigeye tuna assessment assumption , a “step” boundary is difficult to model

Proposal for spatial assumptions



Support:

PS: PS-OBJ LF data

LL: early LL data

A: Quarterly anomaly in JPN LL CPUE

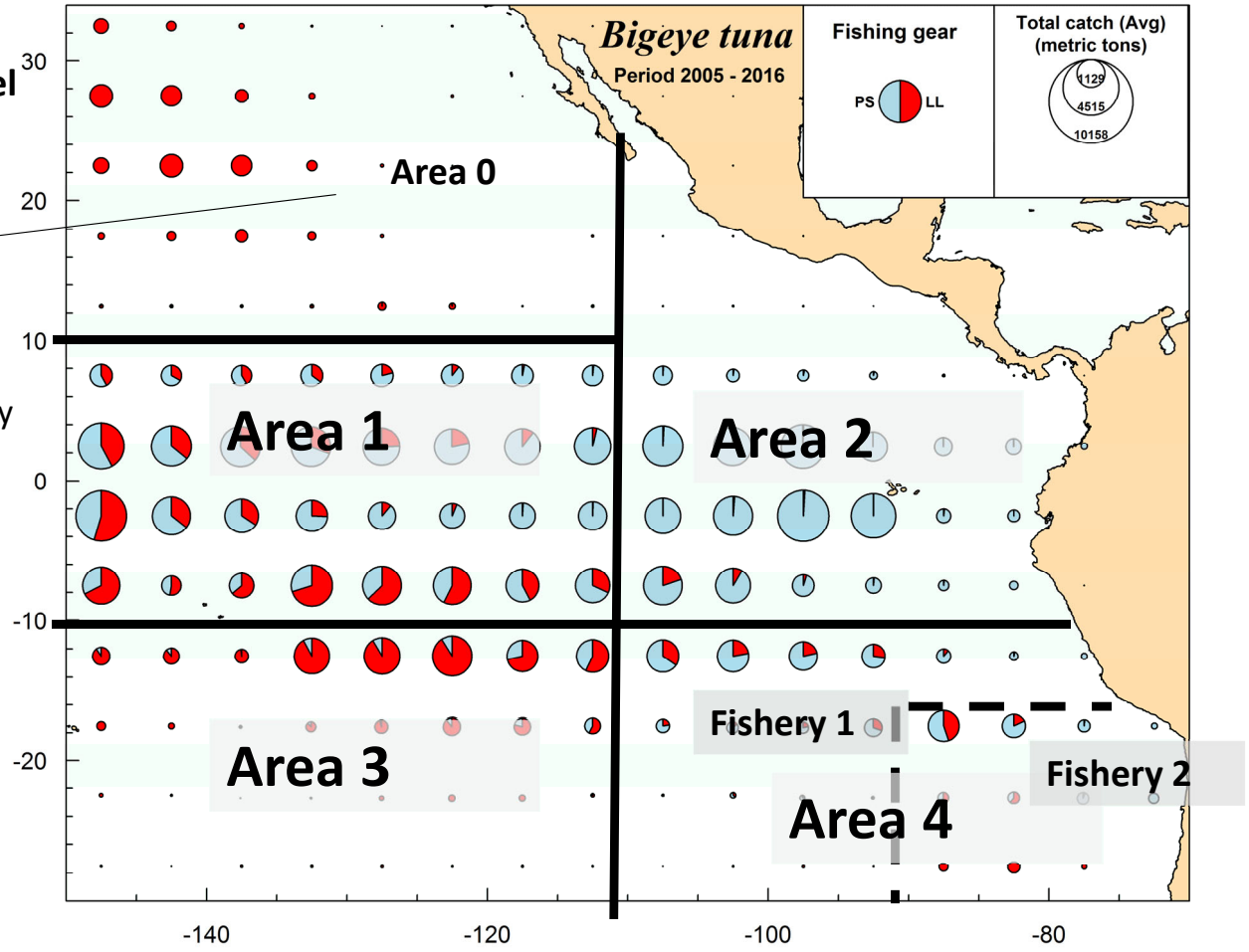
p – practical consideration

Definition of two fisheries for LL and two fisheries for PS (LL, PS)

Proposal for spatial assumptions

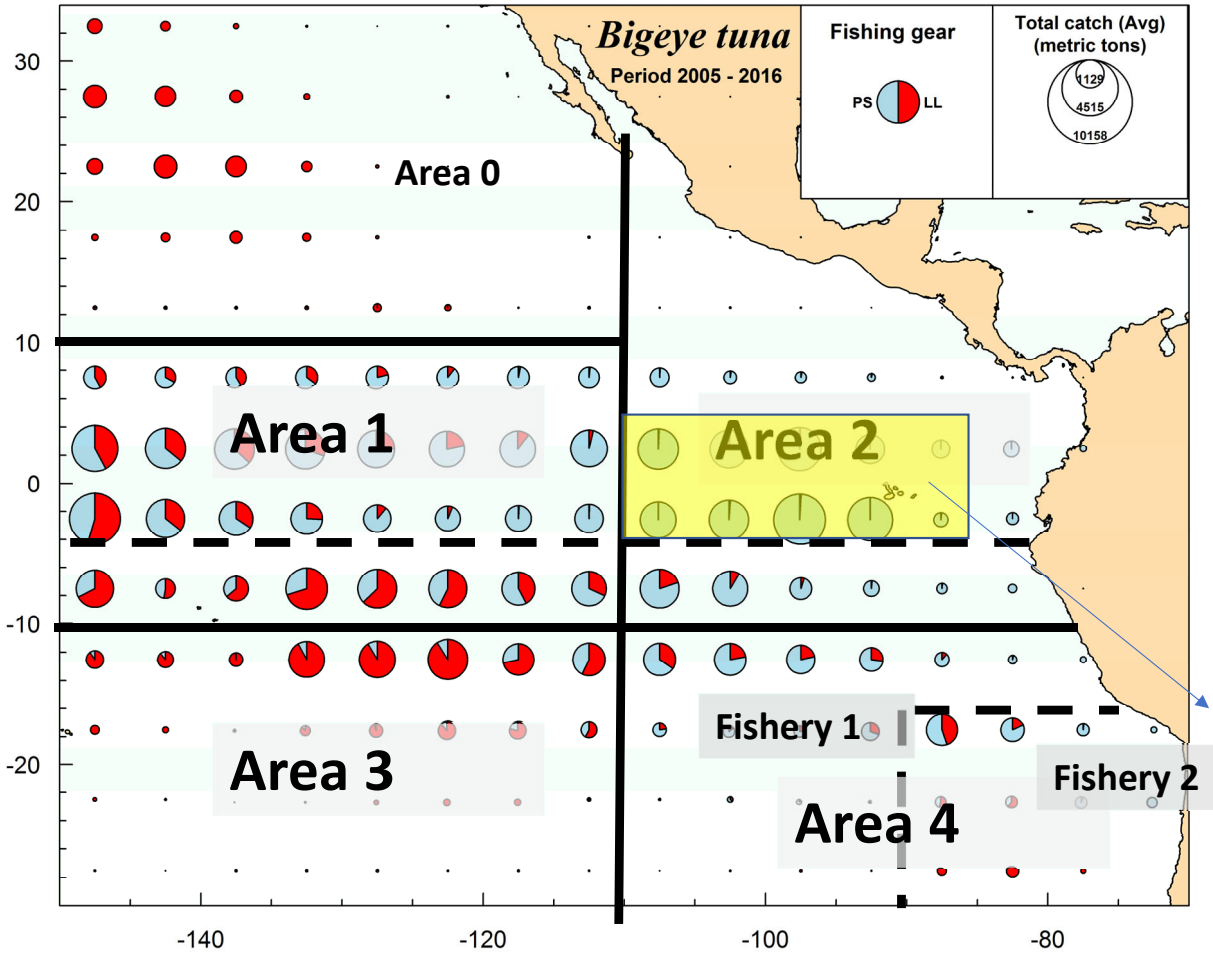
Longline catches to be excluded from the model (at least during the development phase) as there is no evidence of connectivity of Area 0 with the rest

PS catches in Area 0 are very small, should be added to catches in Area 1



Proposal for spatial assumptions

Second scenario
Split at 5°S (LL,p)

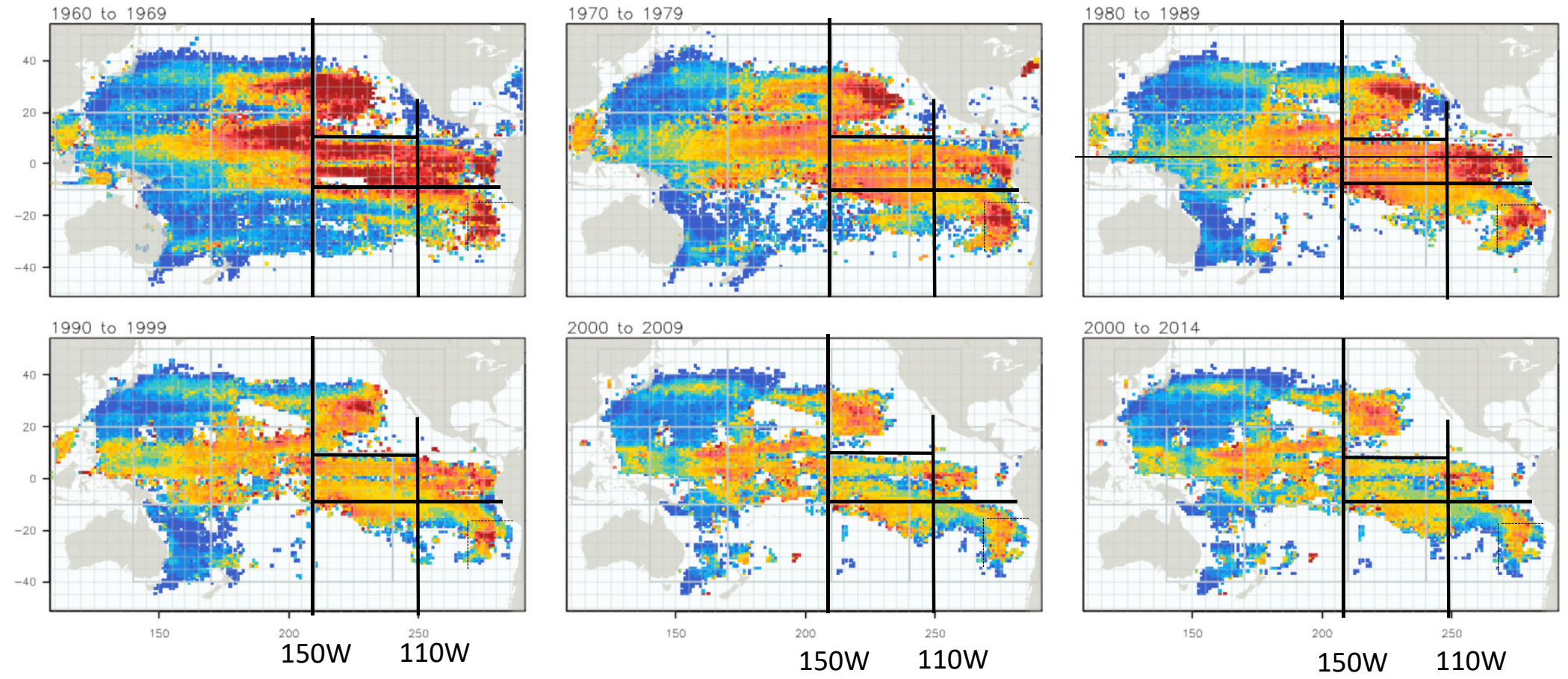


An integrated stock assessment model for this area resolves the recruitment pattern

Aires-da-Silva and Maunder 2010

Japan: BET CPUE (#indivs/100 hooks)

Spatial assumption overlaid on the nominal Japanese CPUE



McKechnie et al 2015

WCPFC-SC11-2015/SA-WP-02

Conclusions

- Tagging data:
  - Should be the main data to use when making spatial assumptions
  - Both archival and conventional tags should be used
  - When done in both sides of a potential boundary gave a stronger support
- Fisheries data:
  - Coincided with tagging data in the main spatial splits, which strengthen the conclusions
  - Could be used in the absence of tagging, provided that is selected with care (widely distributed, homogenous gear)
  - Complements tagging data: longline (adults) and tagging (juveniles), supports that the main spatial structure may apply for all ages.
- Spatial strata: Areas X fisheries
  - Smaller areas with evidence of different selectivity/catchability (e.g. change in gear, oceanography, seasonality) should be set as fisheries
- Parsimony:
  - area with low catches should not be split
  - no step boundaries

Thank you!

We thank the National Research Institute of Far Seas Fisheries (Japan) for the longline fishery data and tagging data.

Average conditions SST