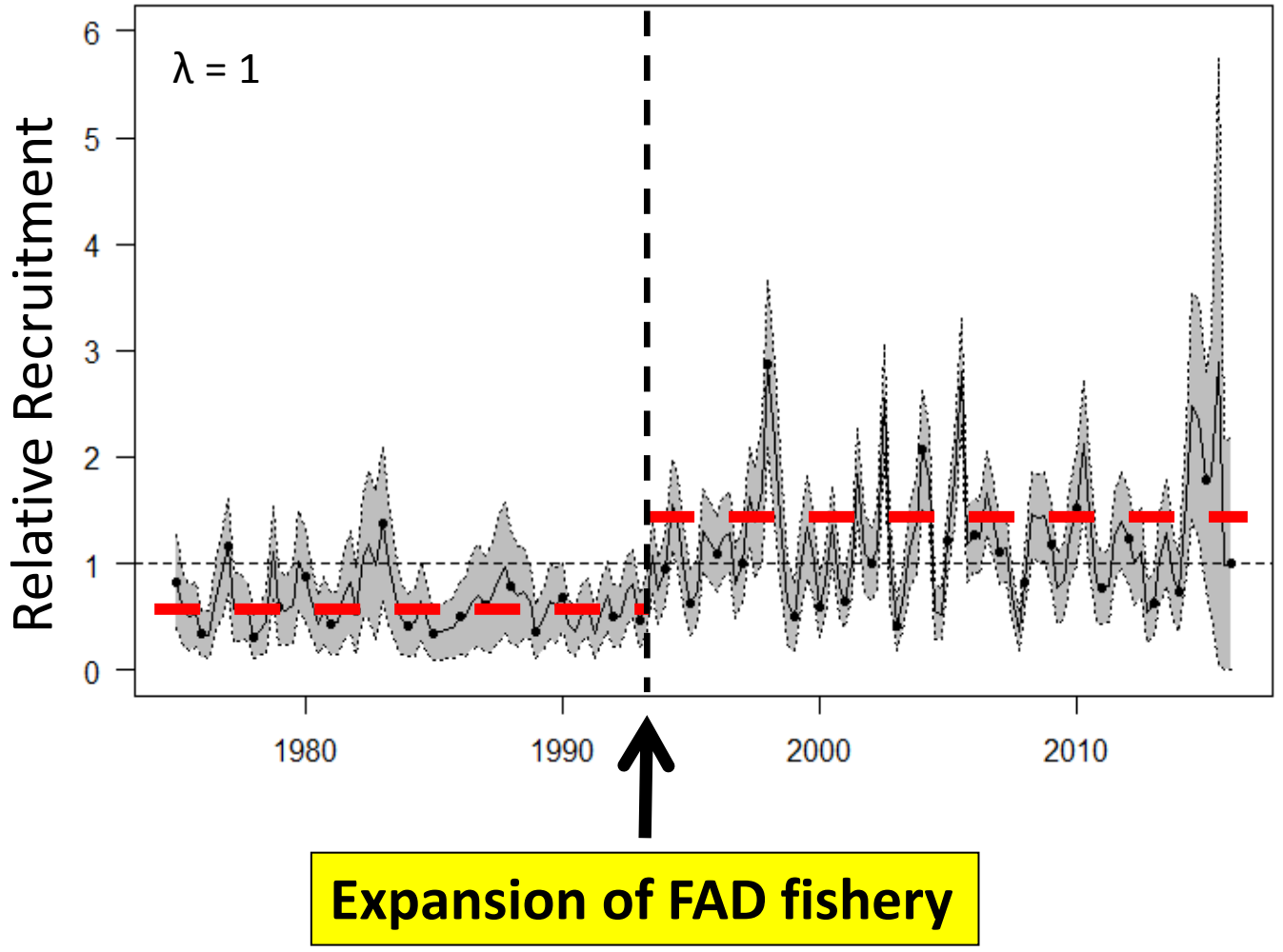
Bigeye tuna in the EPO

Outline

- Summary of the issues with bigeye tuna in the EPO
- Defining spatial structure
- Movement
- Spatial stock assessment models
- Integrating tagging data
- Other information
- Application
- Management implications
- Tagging design

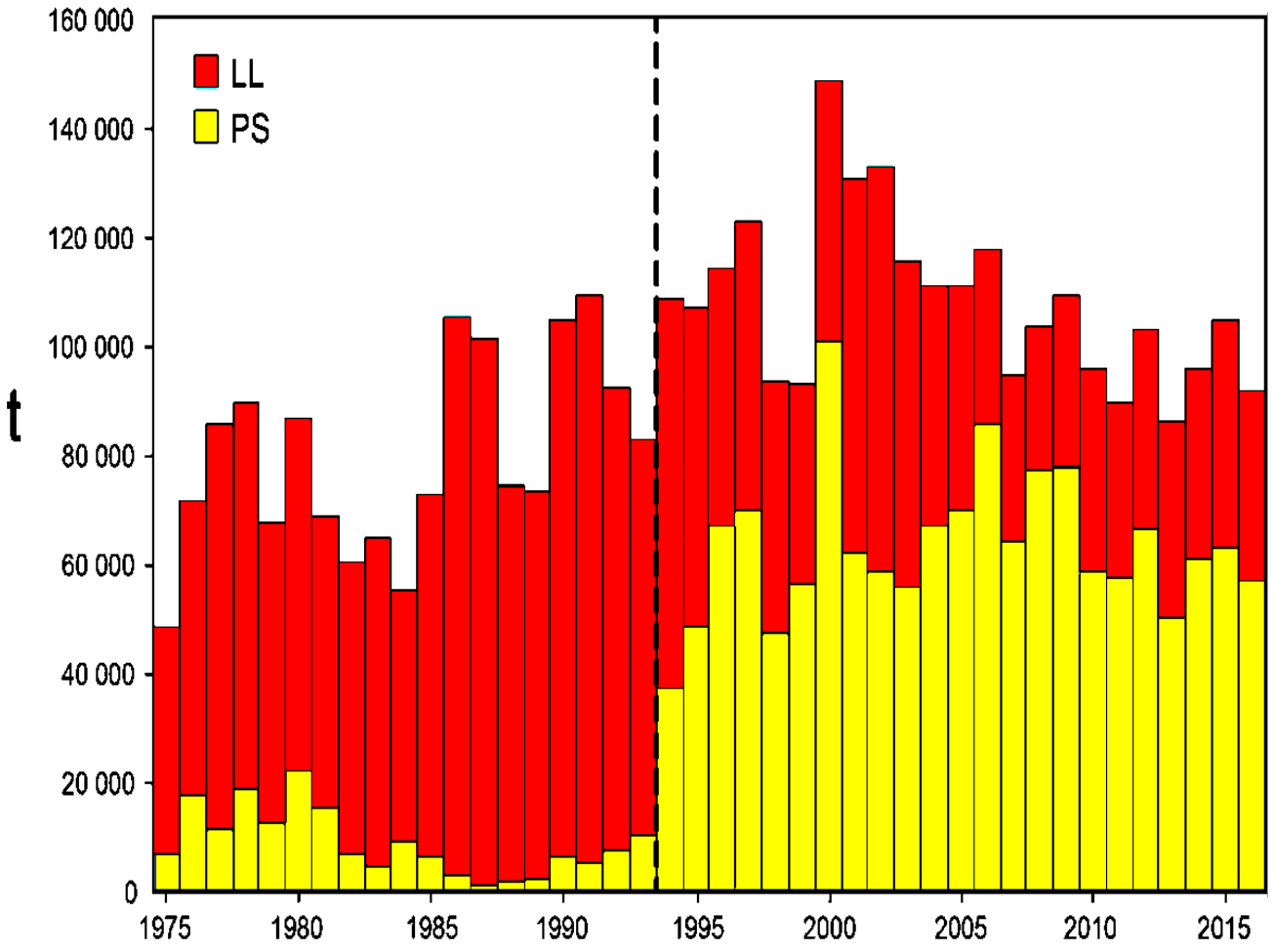
Issues with bigeye tuna in the EPO

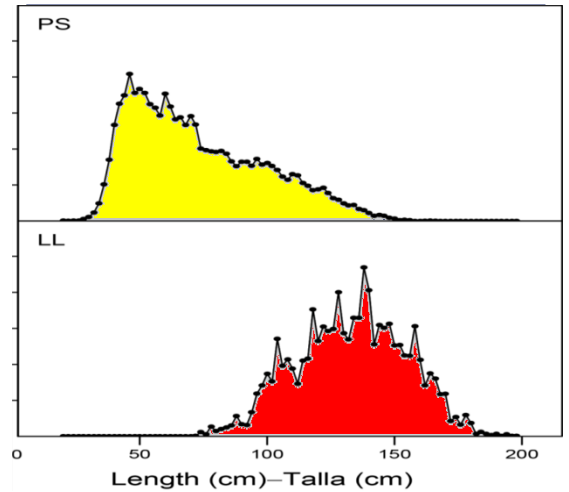
The two-regime BET recruitment pattern



Valero et al (2018) SAC-09-08

Expansion of FAD fishery

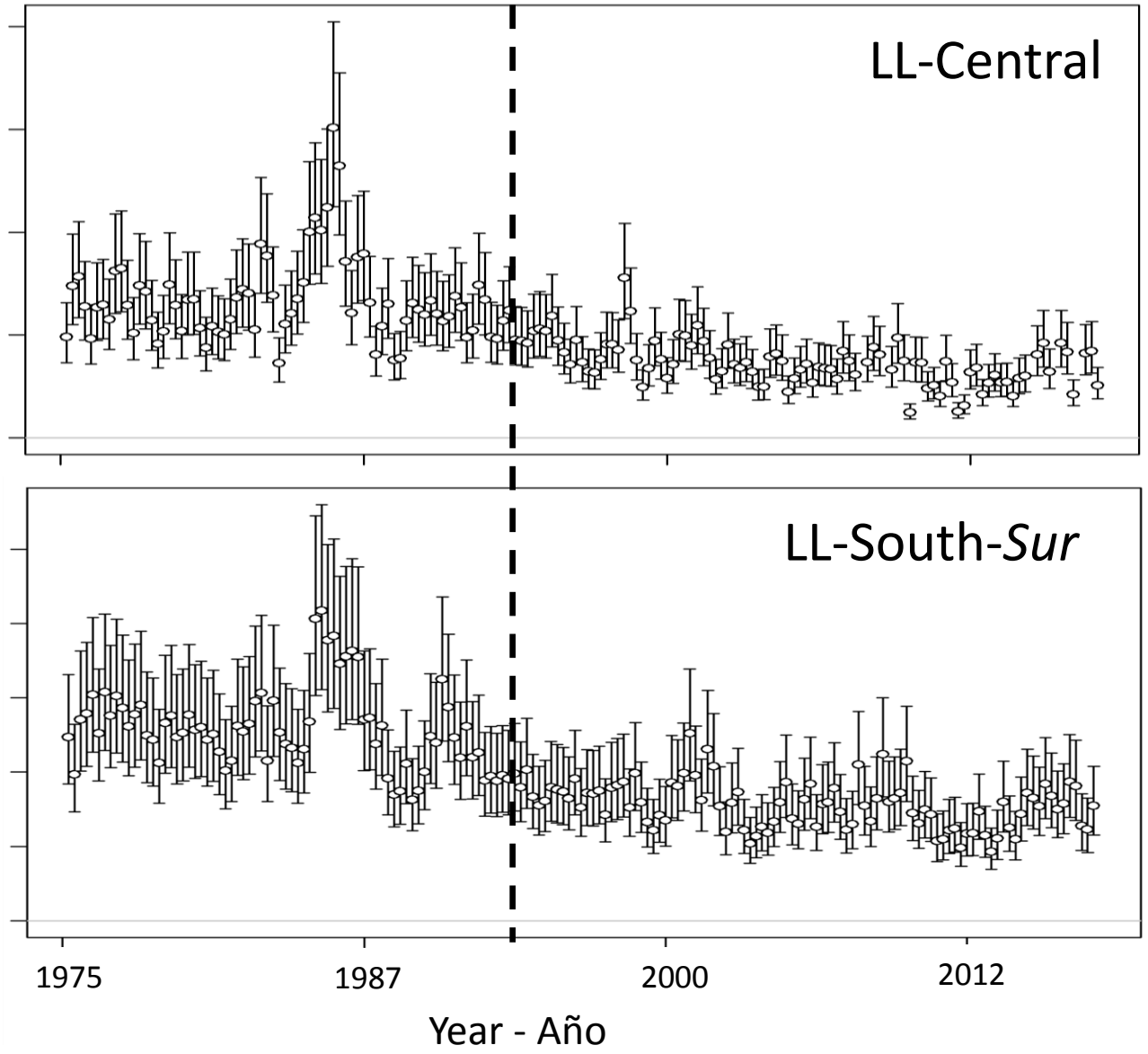




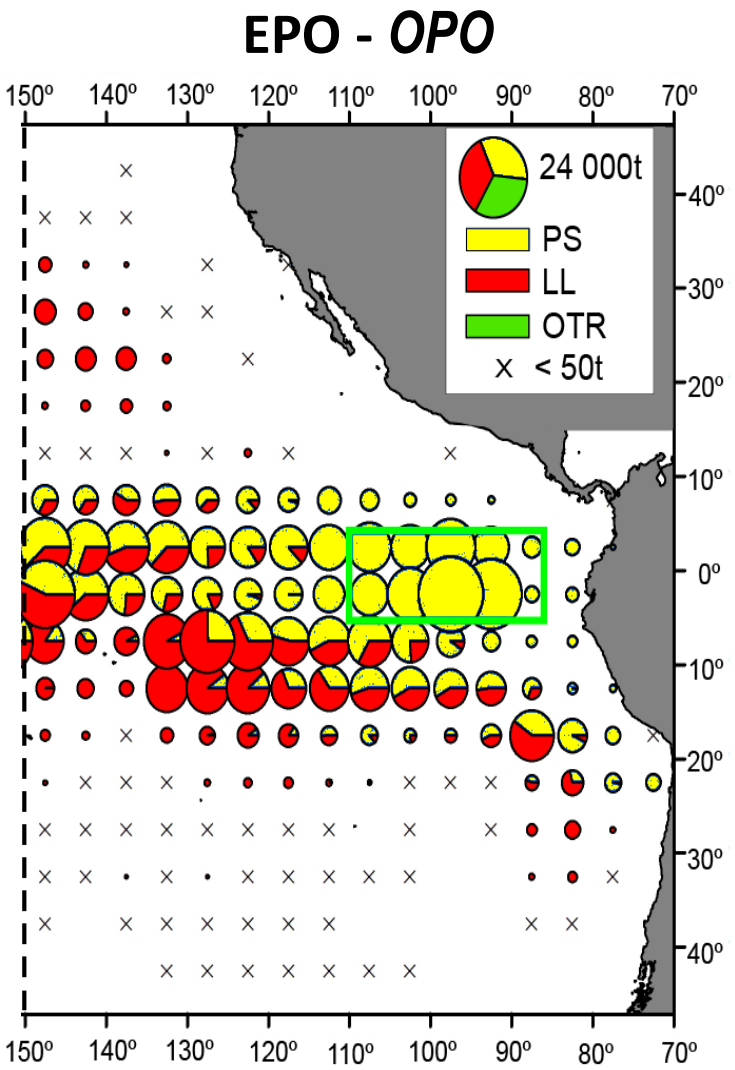
Smaller fish in **Purse Seine** fishery

Valero et al (2018) SAC-09-08

Longline CPUE main source of information



Spatial heterogeneity among fishery catches



BET catch during 2008-2012 (modified from Schaefer et al. 2015)

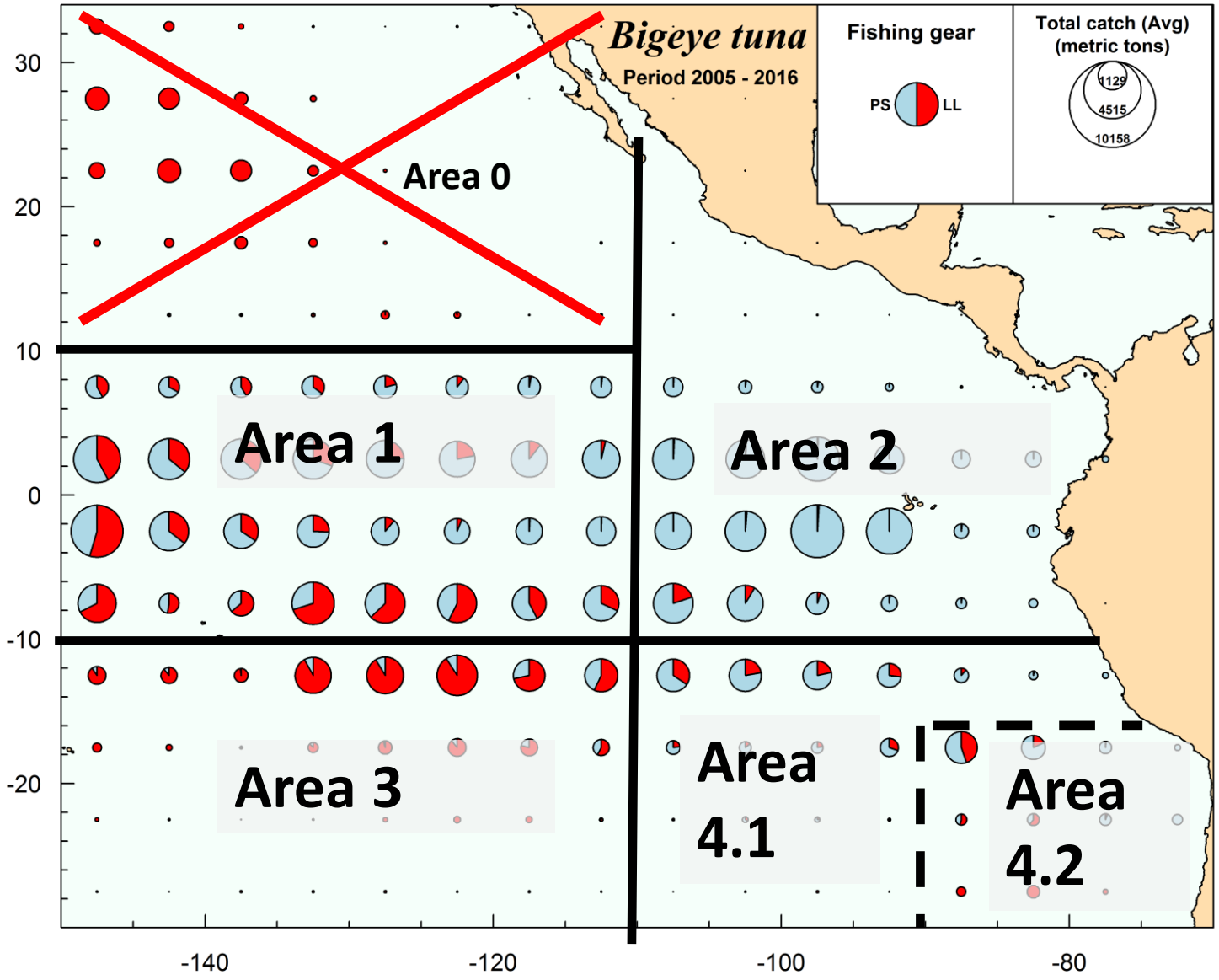
Defining spatial structure

Spatial structure summary

- 110°W
  - Equatorial tagging
  - Longline CPUE and length composition
  - Purse-seine length composition
- 10°N
  - Equatorial tagging
  - Hawaii tagging
  - Japanese tagging
  - Longline CPUE and length composition
  - Limited data between 10°N and 20°N
  - Catches of bigeye tuna are low between 10°N and 15°N
- Hawaii “stock”
  - There is evidence of very limited connectivity between the area north of 10°N-west of 110°W and the rest of the EPO. This area should be excluded from the new stock assessment model.
- 10°S
  - Equatorial tagging
  - Japanese tagging
  - West of 110°W, longline CPUE and length composition

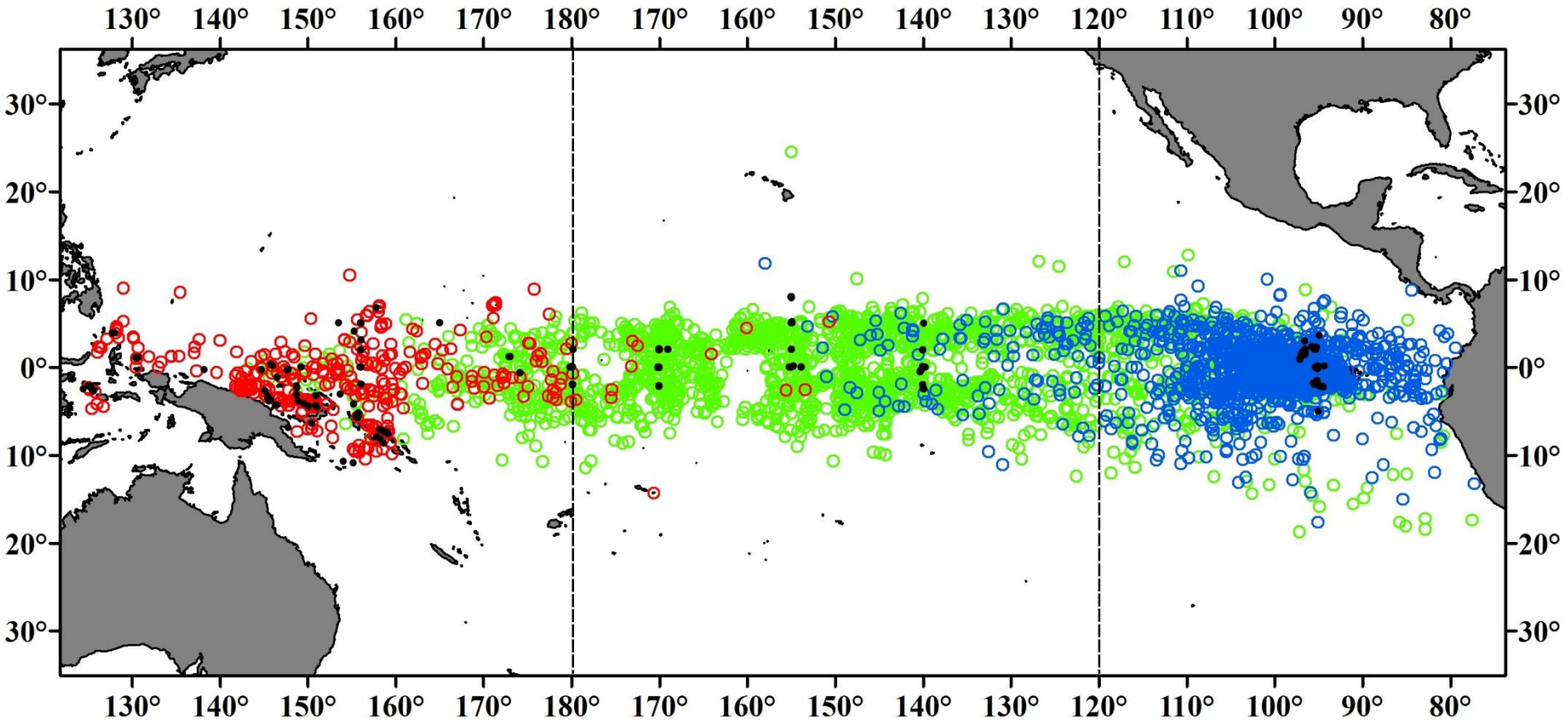
Defining spatial structure

Based mainly on tagging data with support from fishery data

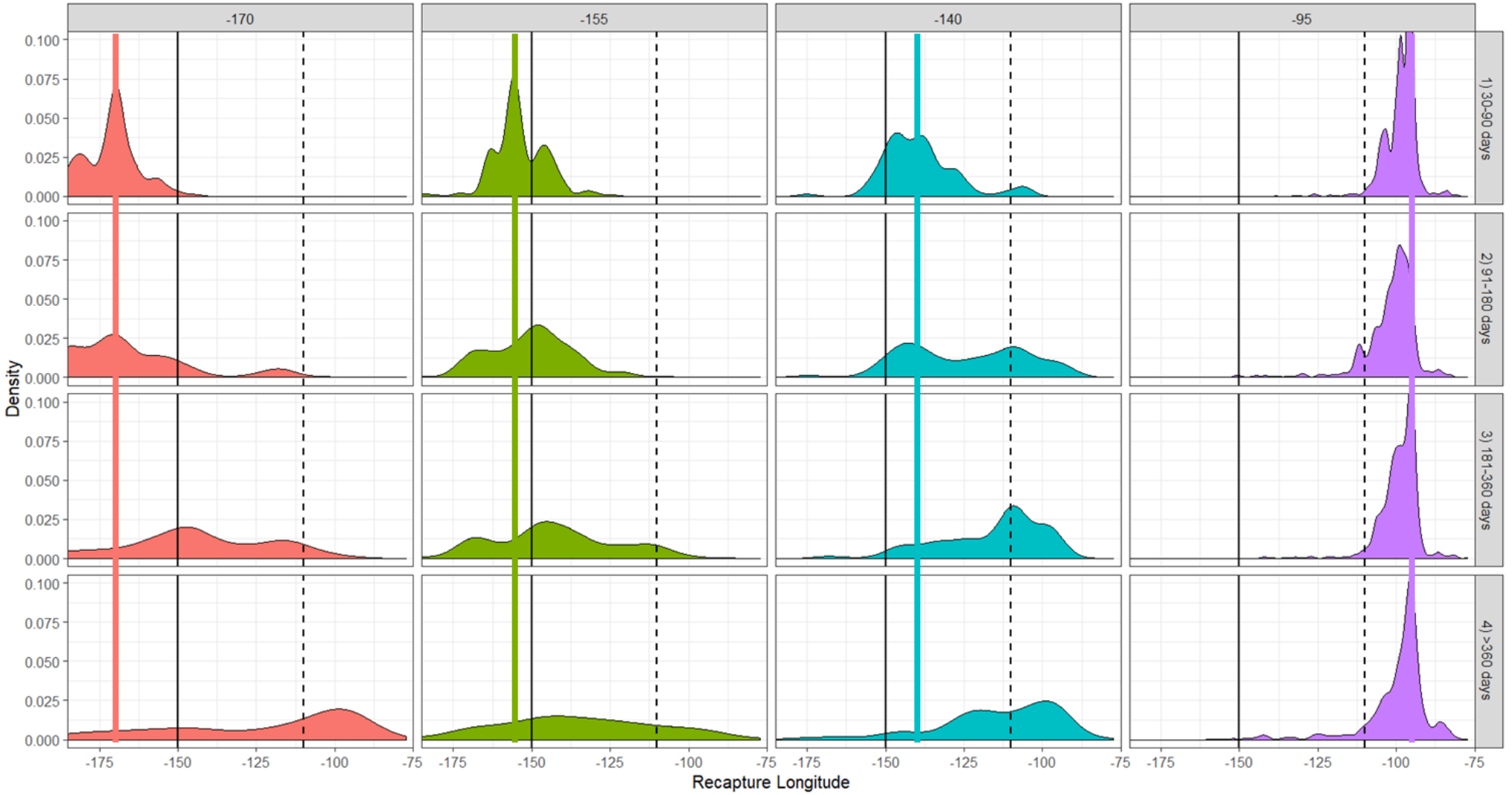


Movement

Dart tag recapture positions (≥ 30 DAL), color coded by area of release, along with descriptive statistics on dispersion and mixing among areas



Movement: conventional tags



1-3 months

4-6 months

7-12 months

>12 months

Movement

- West to East juvenile movement = 16%
- What assumption should we make about adult movement?
- How to specify the other relatively minor movement rates in the spatial model?
- What metrics should be used to compare various movement assumptions in the spatial assessment model?

Spatial stock assessment models

Spatial stock assessment models

- SS model based on current single area SS model
- Can’t resolve recruitment issues
- Growth varies across the pacific

Summary of preliminary BET EPO spatial model

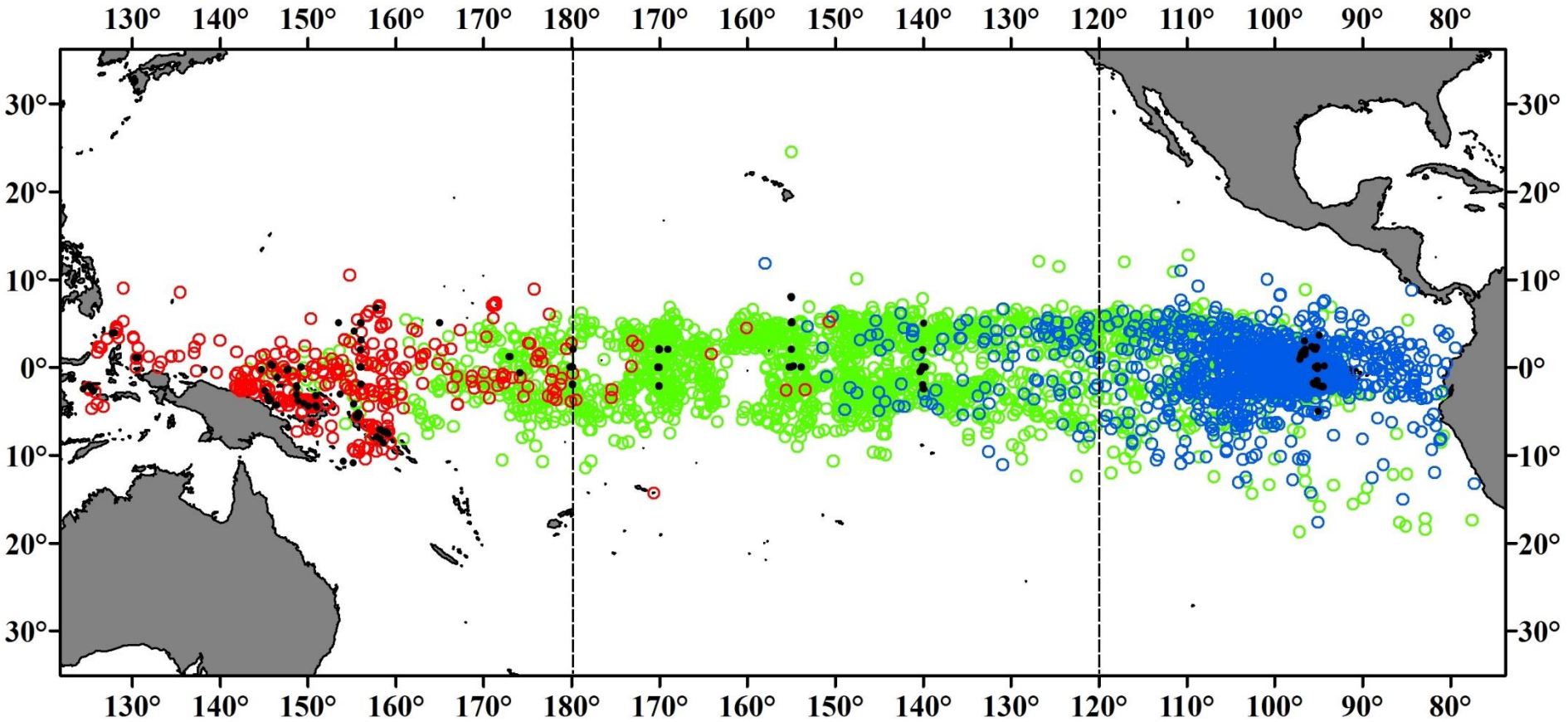
- Spatial models of the EPO with no movement do not remove the recruitment regime shift
- Movement at 16% /Q seems too high, even if just for juveniles
- Including East-West diffusion of adults removes the recruitment shift, however we do not know what are reasonable movement rates for adult BET
- In cases where recruitment shift is removed, regime shift still exists in the fraction of recruits.

Integrating tagging data

Integrating tagging data

- Not attempted
- Limited release points
- Mixing issues
- 2019 tagging program

Dart tag recapture positions (≥ 30 DAL), color coded by area of release, along with descriptive statistics on dispersion and mixing among areas



Other information

Other information

- Longline CPUE
  - Spatio-temporal model
    - Shared q
    - Shared selectivity
    - Multi fleets
- Purse seine CPUE
- Longline LF
  - Spatial weighting
  - Catch vs CPUE weighted
- Purse seine CPUE
  - Spatial weighting
- Otolith, genetics, ……

Application

Application

In progress

Previous independent models

- Central area resolves recruitment regime shift

Current one area models

- Recruitment regime issue

Pacificwide assessments

Bigeye tuna models

Current base case

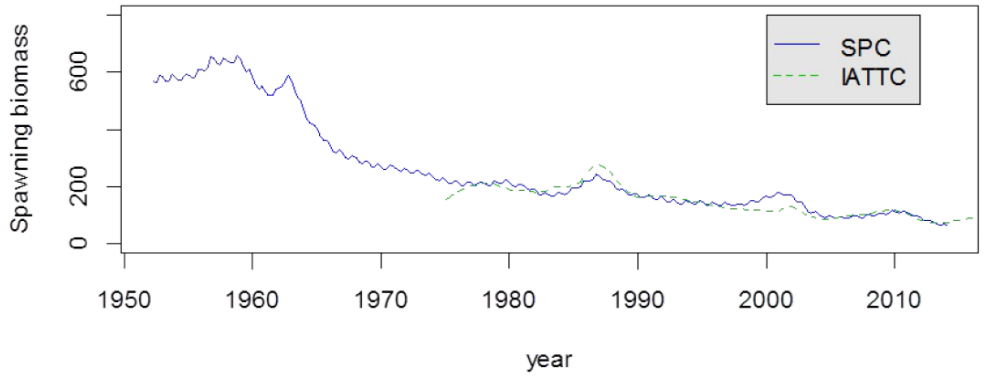
- SS version 3.23b
- Years as Quarters approach
  - Years 1975 to 2017 as Quarters 1 to 168
- Max age 40 quarters (10 years)
- 2-sex model
- Growth is a fixed Richards function
- Fixed age/sex specific natural mortality
- Steepness *h*=1
- 1 Area
- 27 fleets
- 245 parameters
- 3 to 8 hours run time

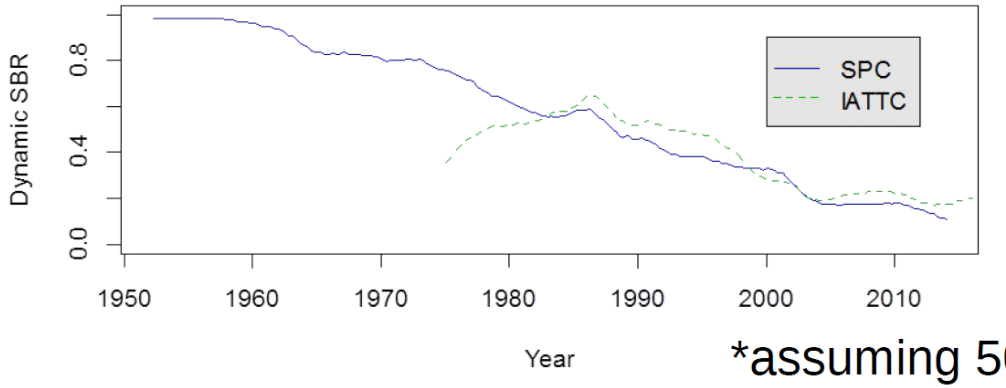
Exploratory spatial

- **SS version 3.3.12**
- Years as Quarters approach
  - Years 1975 to 2018 as Quarters 1 to 172
- Max age 40 quarters (10 years)
- 2-sex model
- Growth is a fixed Richards function
- Fixed age/sex specific natural mortality
- Steepness *h*=1
- **4 Areas**
- **20 fleets**
- **230 to 800 parameters**
- **1 to 3 hours run time**

Pacificwide assessment

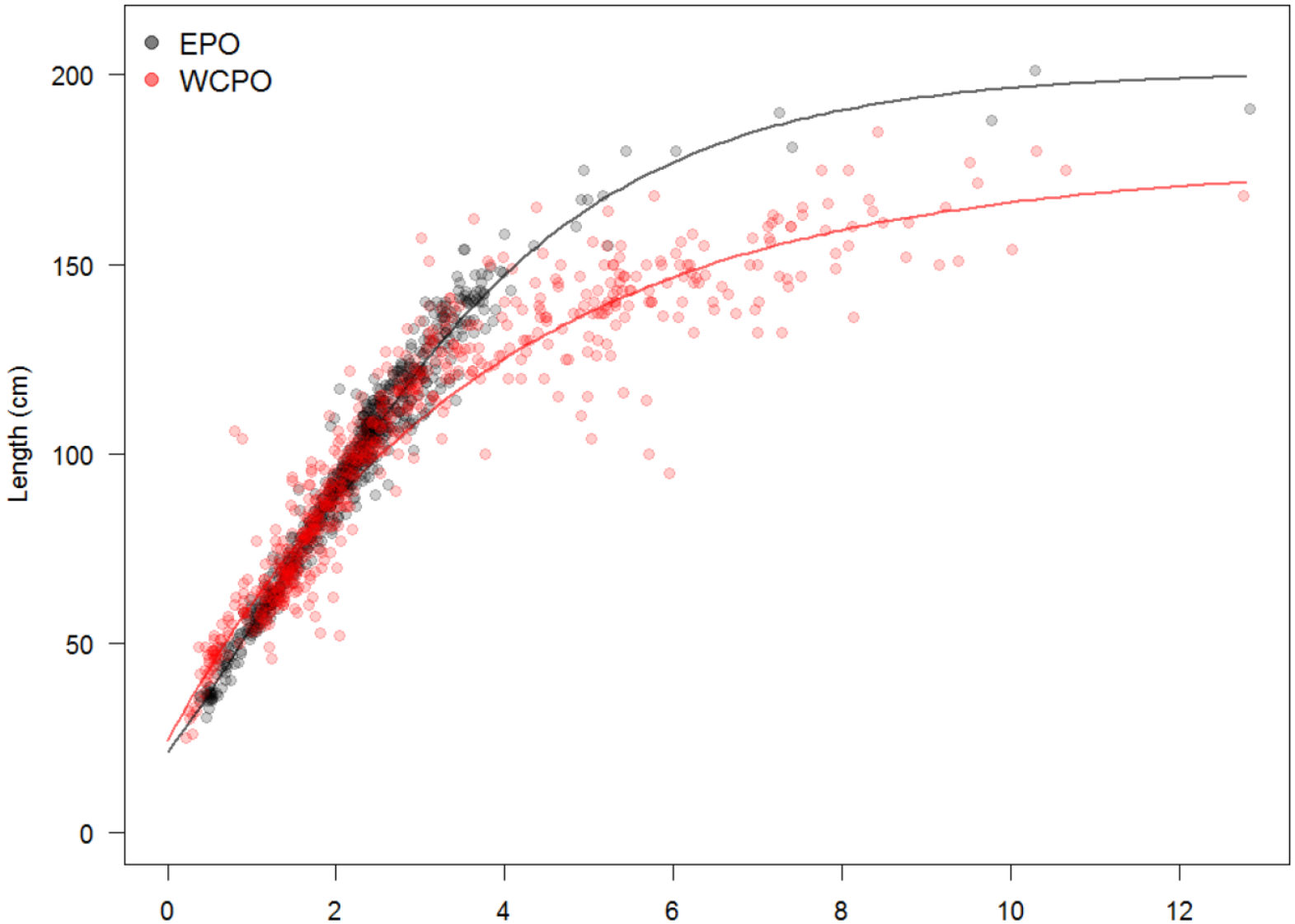
Comparison of 2016 IATTC model*



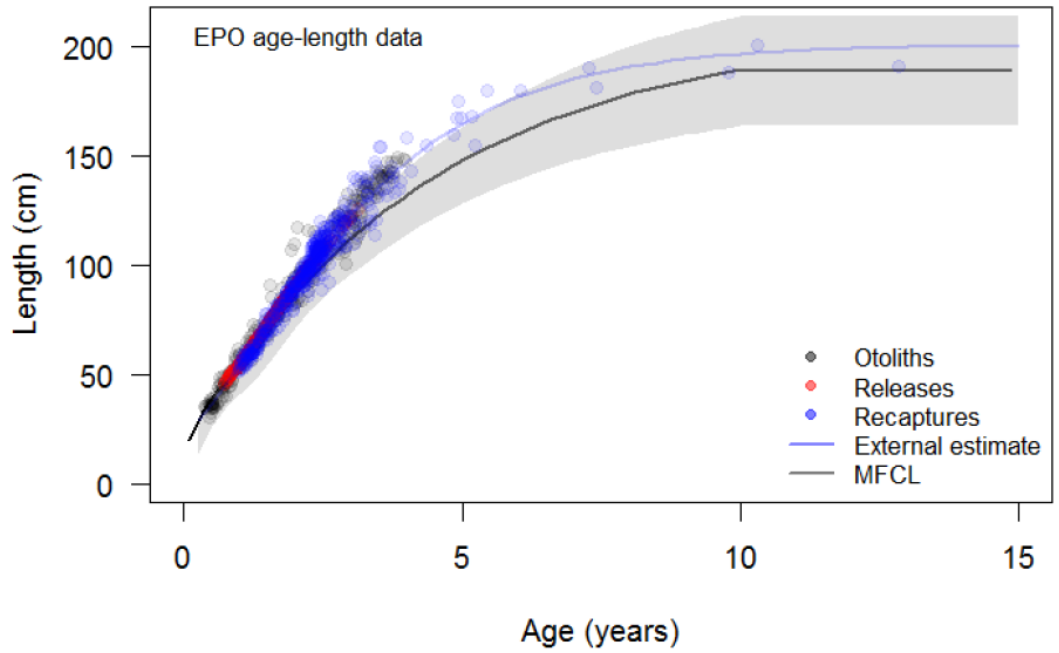


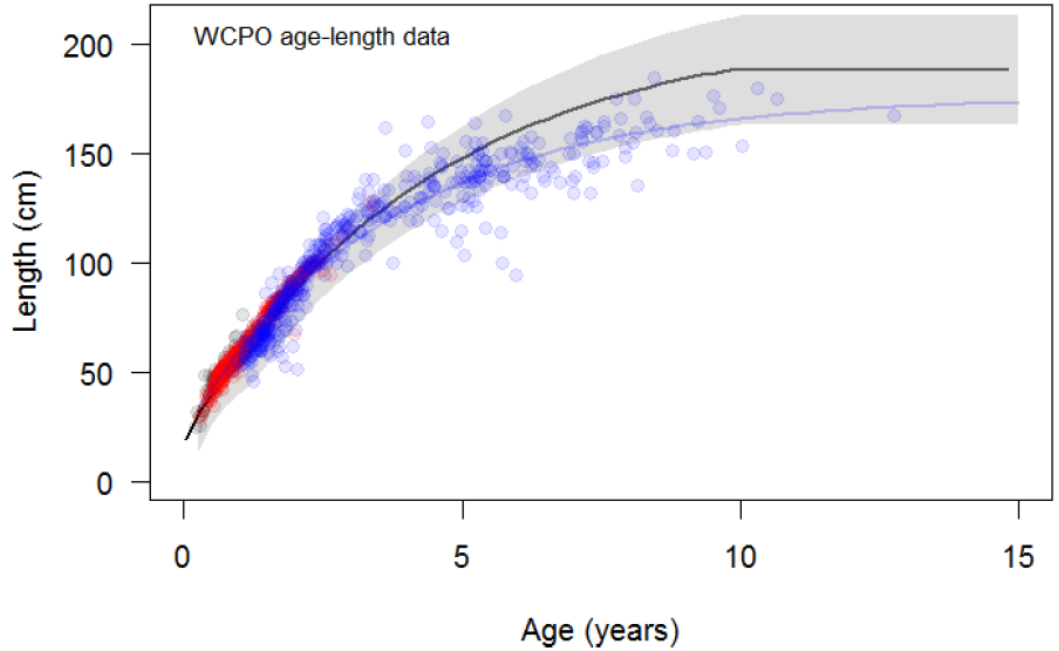
*assuming 50% sex-ratio

External analysis shows equivalent growth in early ages, but older fish 25cm larger (age 10+) in the EPO



*Most tag recaptures from WCPO come from the Western Pacific (Coral Sea between PNG and Australia)





Management implications

- 150 boundary
- Spatial closures
- Hawaii “stock”

Tagging design

Tagging design

2019 tagging program

Practical issues of release points

Can’t tag old fish

Tagging design

Focus Questions

Defining spatial structure

- Have we adequately defined the spatial structure or are there other analyses or data that could be used to define spatial structure? (absolute values of CPUE, habitat variables, Loghurst biogeographical areas, other models such as SEAPODYM)
- Would a simplified two area model split at 110°W be adequate?
- Do we need to include the central Pacific?
- Should the Hawaii “stock” be included in the model?
- How should environmental data best be used with respect to defining stock spatial structure, particularly for pelagic species?
- What new data should be collected to identify stock spatial structure?

Movement

- What assumption should we do about adult movement?
- How to estimate movement rates from archival tags?
- Movement from the central Pacific

Spatial stock assessment models

- What can we learn from other spatial stock assessment models?
- Are we better off using a spatial model rather than a single area model?
- No production aging: should we consider a length based model?
- Is there any simplifying assumption suggested to parametrize the movement matrix as a starting point?

Integrating tagging data

- Do we need to integrate the tagging data?
- How much tagging data is required?
- How can the tagging data be integrated in Stock Synthesis?

Application

- How long does the model take to run?
- How is the tagging data weighted in relation to the other data?
- What kind of model diagnostics should be used?
- Given that recruitment shift can be removed in spatial model, does it necessarily mean that the spatial model is preferred over the one-area model? Namely, how to demonstrate the reliability of the spatial model without reliable estimates of movement rate?

Management implications

- How to give management advice from a spatial model?
- May the effect of spatial closures be better evaluated?
- If we include areas from the CPO (purse-seine and longline) and exclude areas around Hawaii (mostly longline), what would be the management implications?

Tagging design

- How can we determine the tag design given the practical issues with tagging?
  - Restricted tagging points
  - Can’t tag old fish