Stock structure and fishery definition for bigeye tuna in the eastern Pacific Ocean

1st external review of data used in stock assessments of tropical tuna in the EPO
Oct. 2-6, 2023

Outline

- Stock structure of bigeye tuna in the Pacific Ocean
- Fishery definitions for bigeye tuna in the eastern Pacific Ocean
  - Longline fisheries
  - Floating-object purse-seine fisheries
  - Unassociated purse-seine fisheries
  - Summary

Stock structure - review

SCIENTIFIC COMMITTEE

NINETEENTH REGULAR SESSION

Koror, Palau

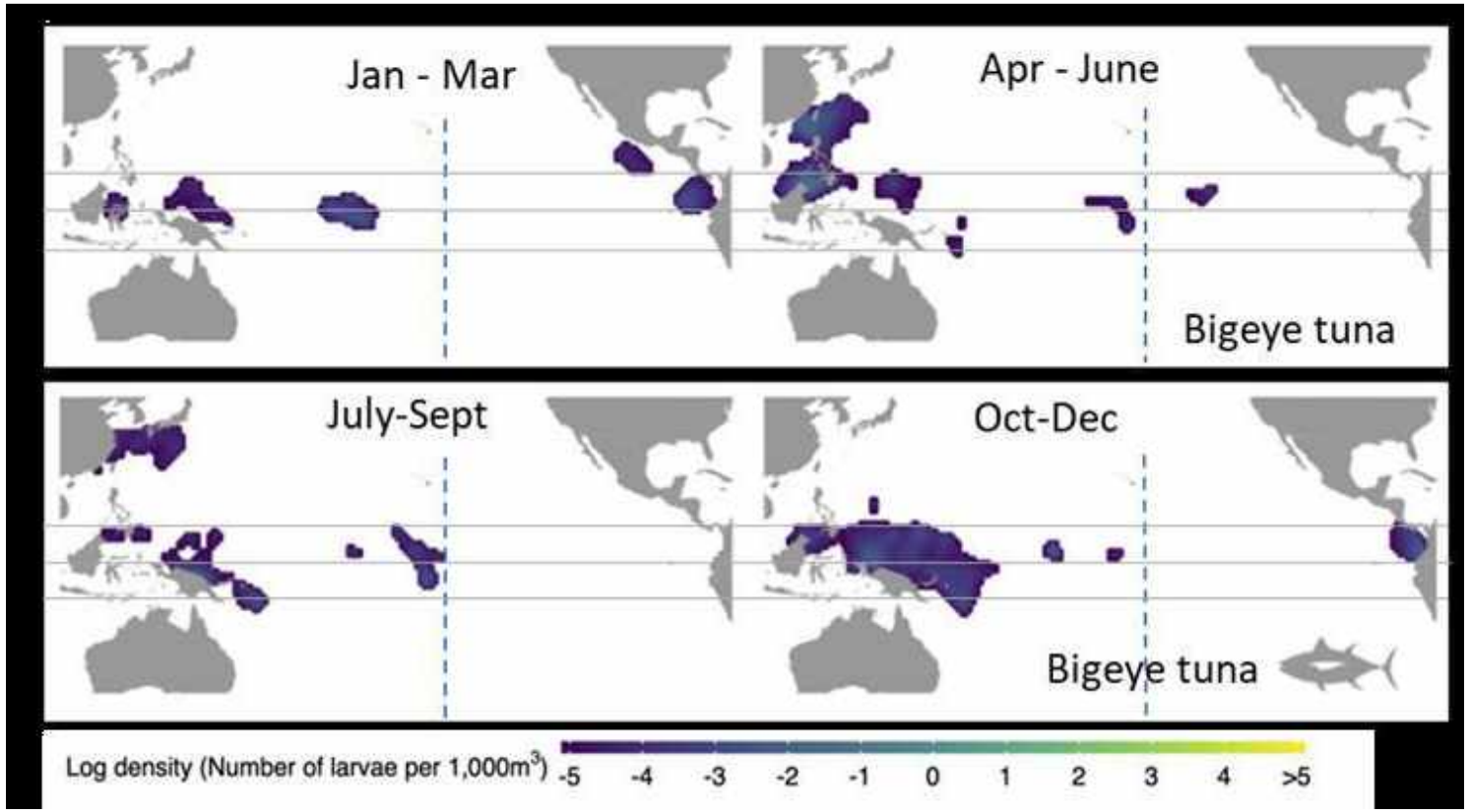
16-24 August 2023

Review and analyses to inform conceptual models of population structure and spatial stratification of bigeye and yellowfin tuna assessments in the Western and Central Pacific Ocean

WCPFC-SC19-2023/SA-WP-02

26 July 2023

Stock structure - spawning

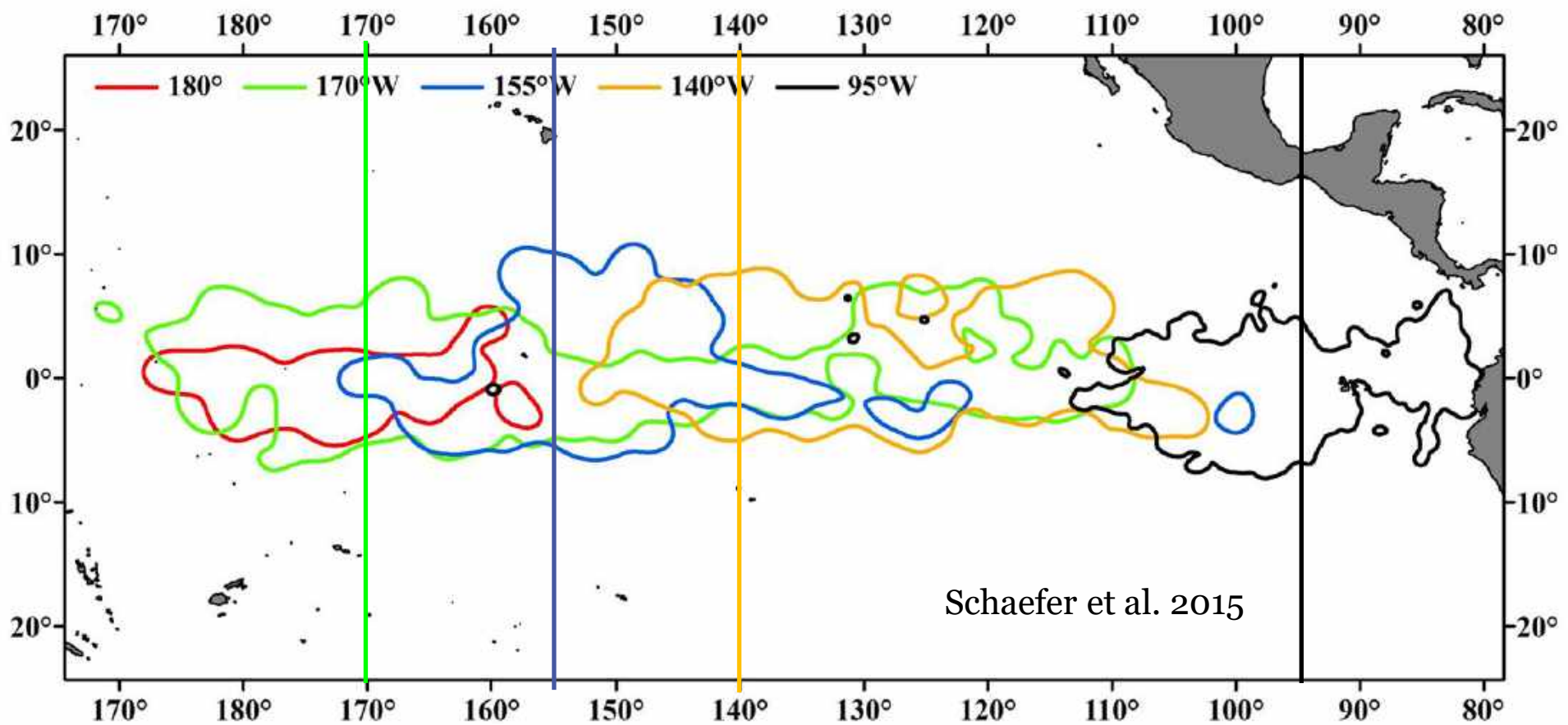


There are three bigeye spawning grounds in the tropical Pacific: EPO, CPO, and WPO

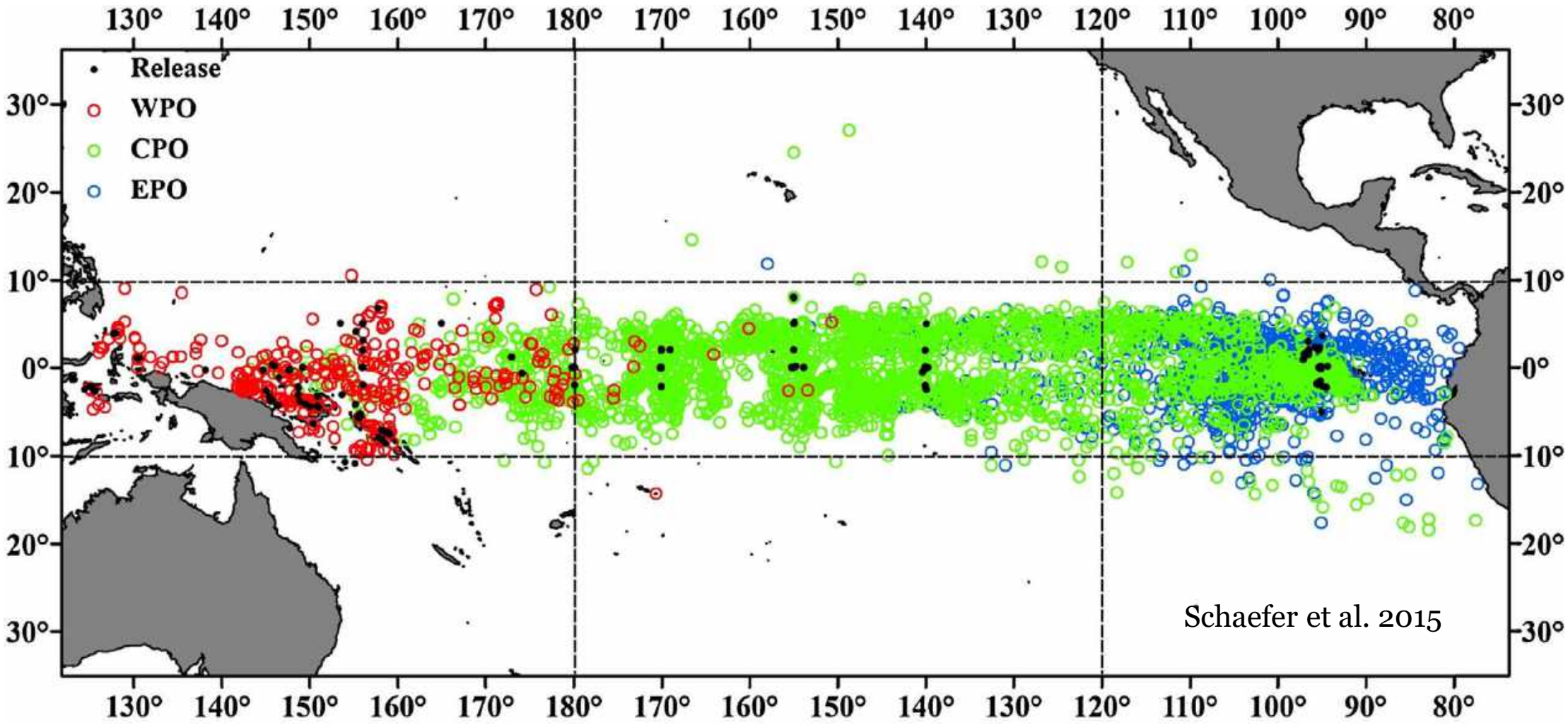
Seasonal larval densities across the Pacific for the period 1960-1985 from geostatistical modelling of the Nishikawa data set by Ijima and Jusup (2023).

Stock structure – movement of juvenile (archival tags)

95% volume contours calculated from a kernel density function for all archival tag positions

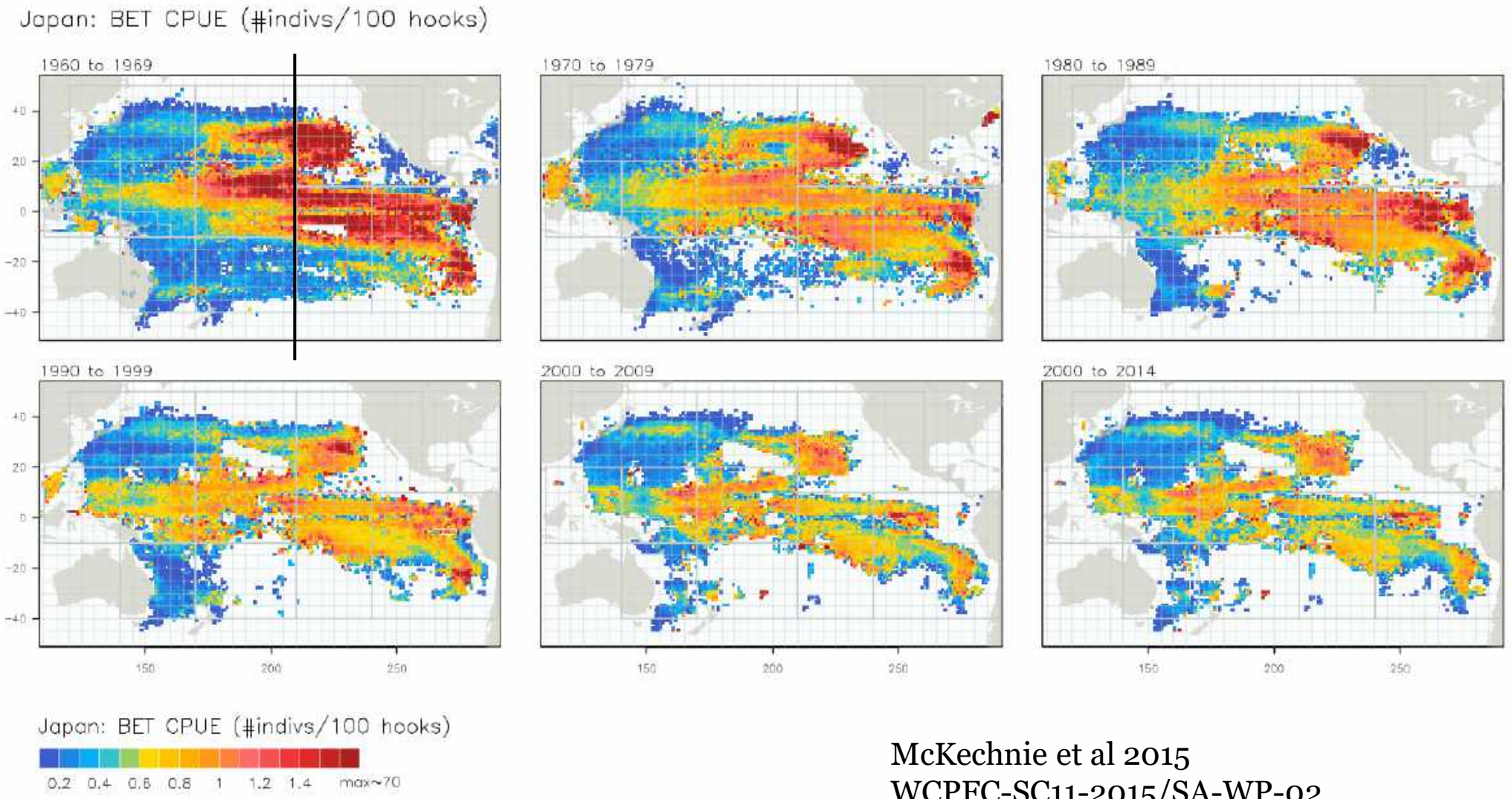


Stock structure – movement of juvenile (conventional tags)



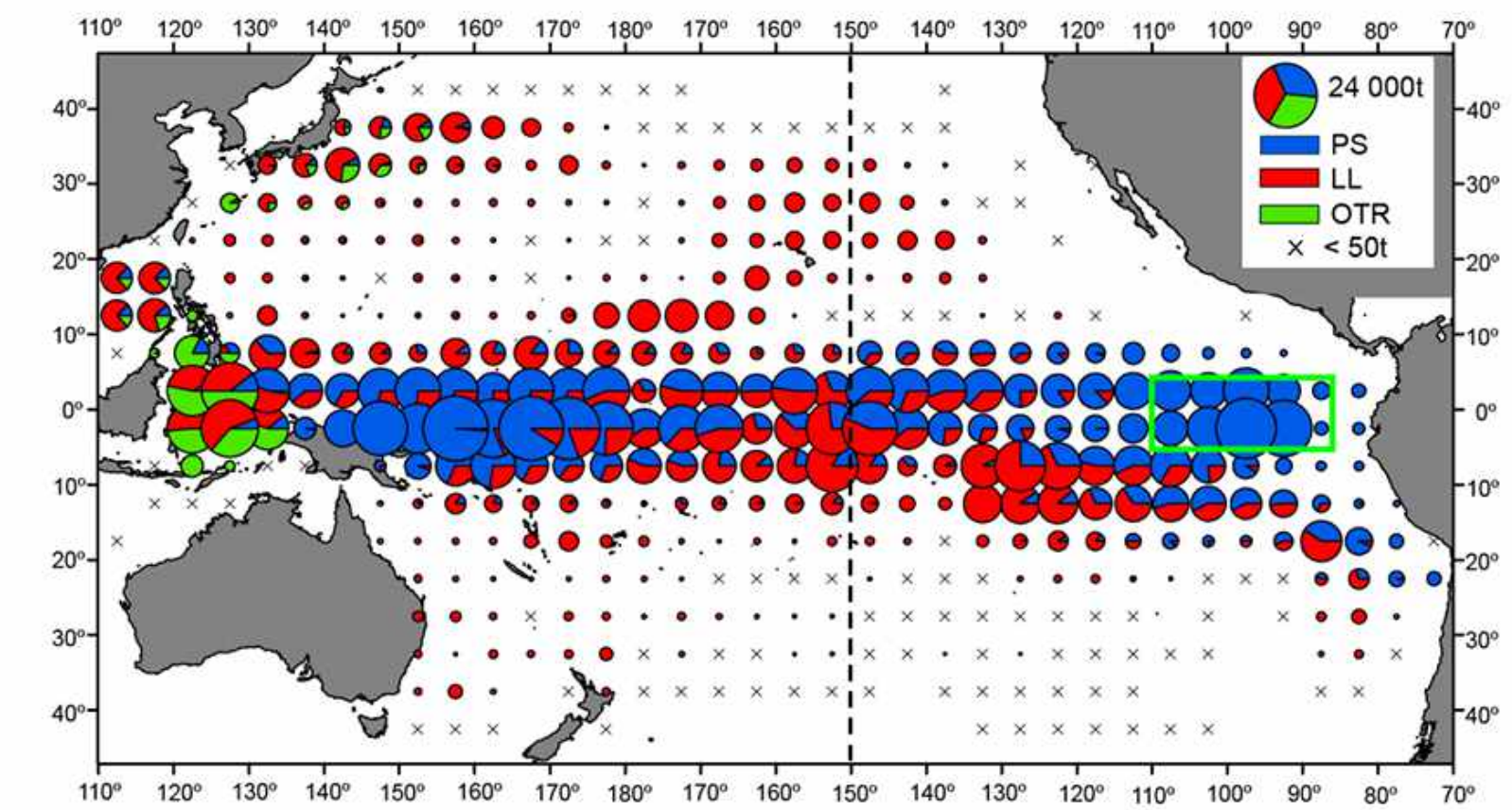
Schaefer et al. 2015

Stock structure – longline CPUE



McKechnie et al 2015
WCPFC-SC11-2015/SA-WP-02

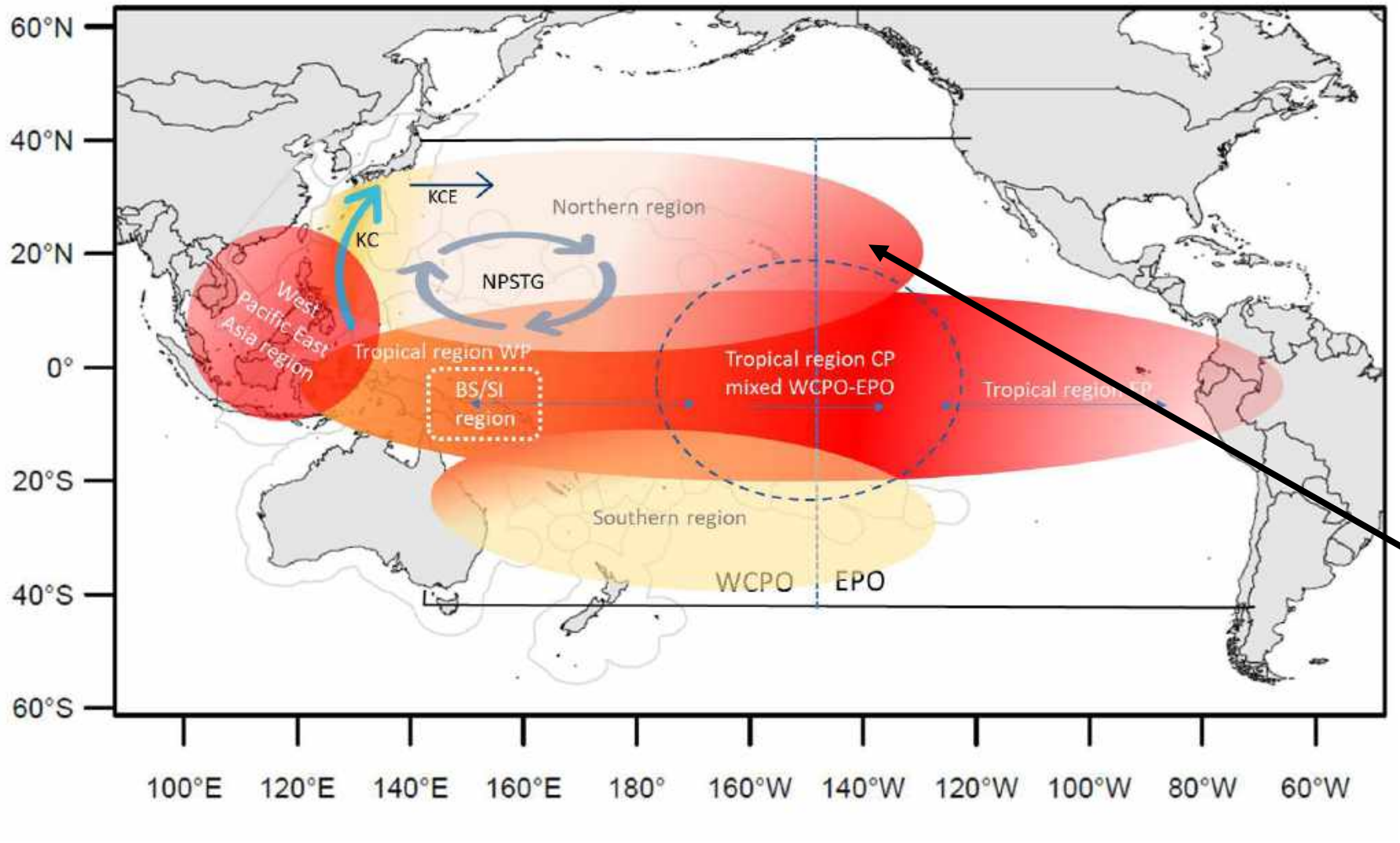
Stock structure – catch distribution by gear type



Valero et al. 2019
WSBET-02-09

Figure 1. Distribution of the catches of bigeye tuna in the Pacific Ocean, by 5° x 5° area and gear type, 2008-2012. The sizes of the circles are proportional to the catch. The vertical dashed line at 150°W marks the western boundary of the eastern Pacific Ocean (EPO). The green rectangle represents the Central area used Valero et al. 2018. PS: purse seine; LL: longline; OTR: other gears.

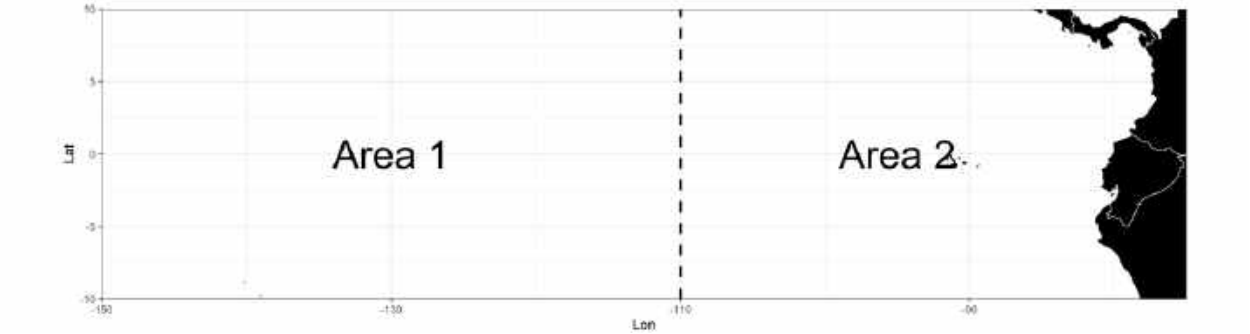
Stock structure – conceptual model



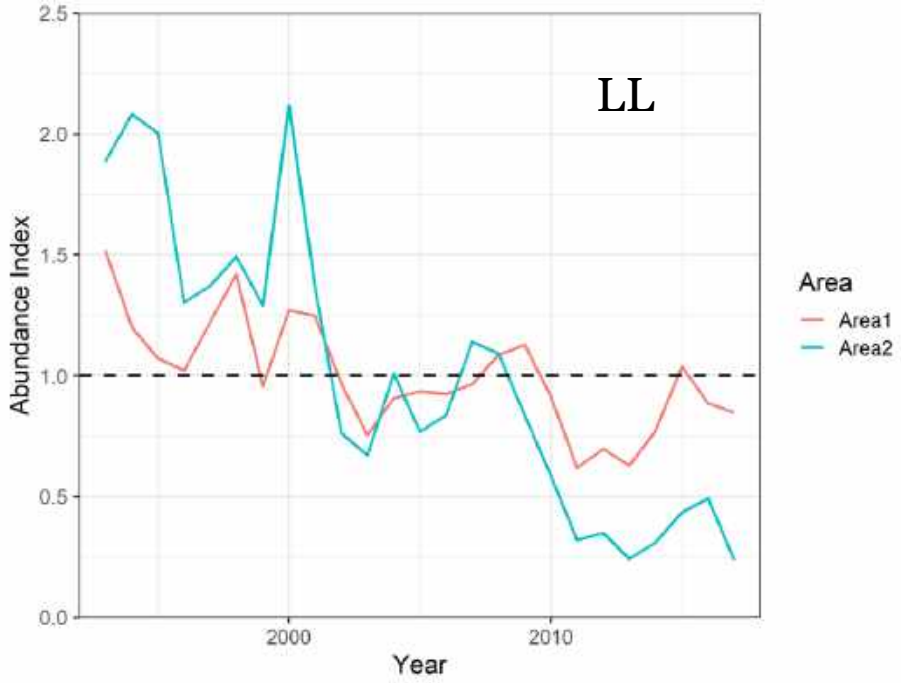
Hamer et al 2023
WCPFC-SC19-2023/SA-WP-02

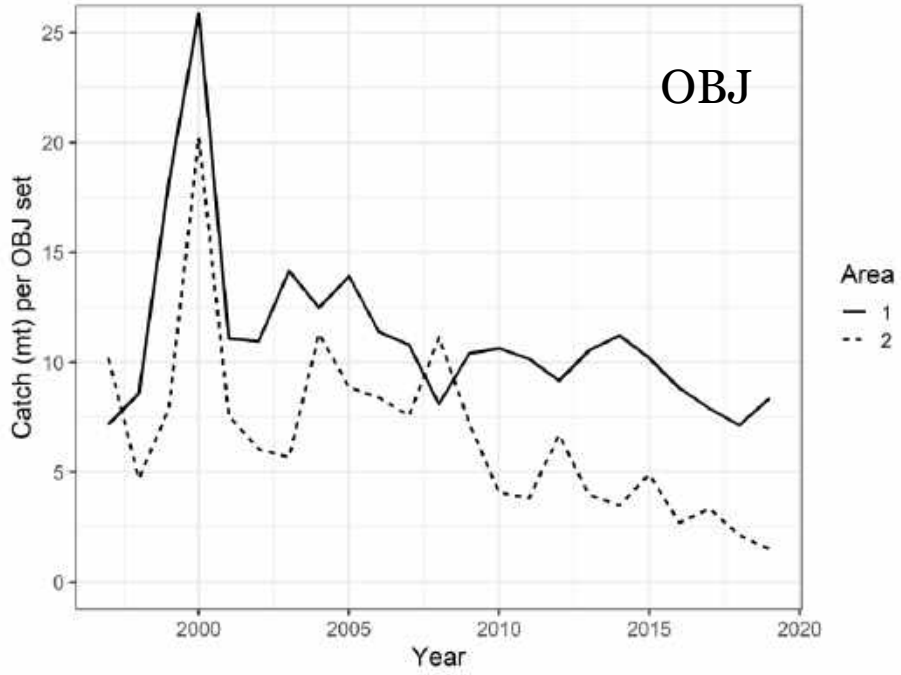
Schaefer (2009): bigeye tuna in the northern EPO area are a separate 'substock' based on tagging and life history

Evidence in CPUE data



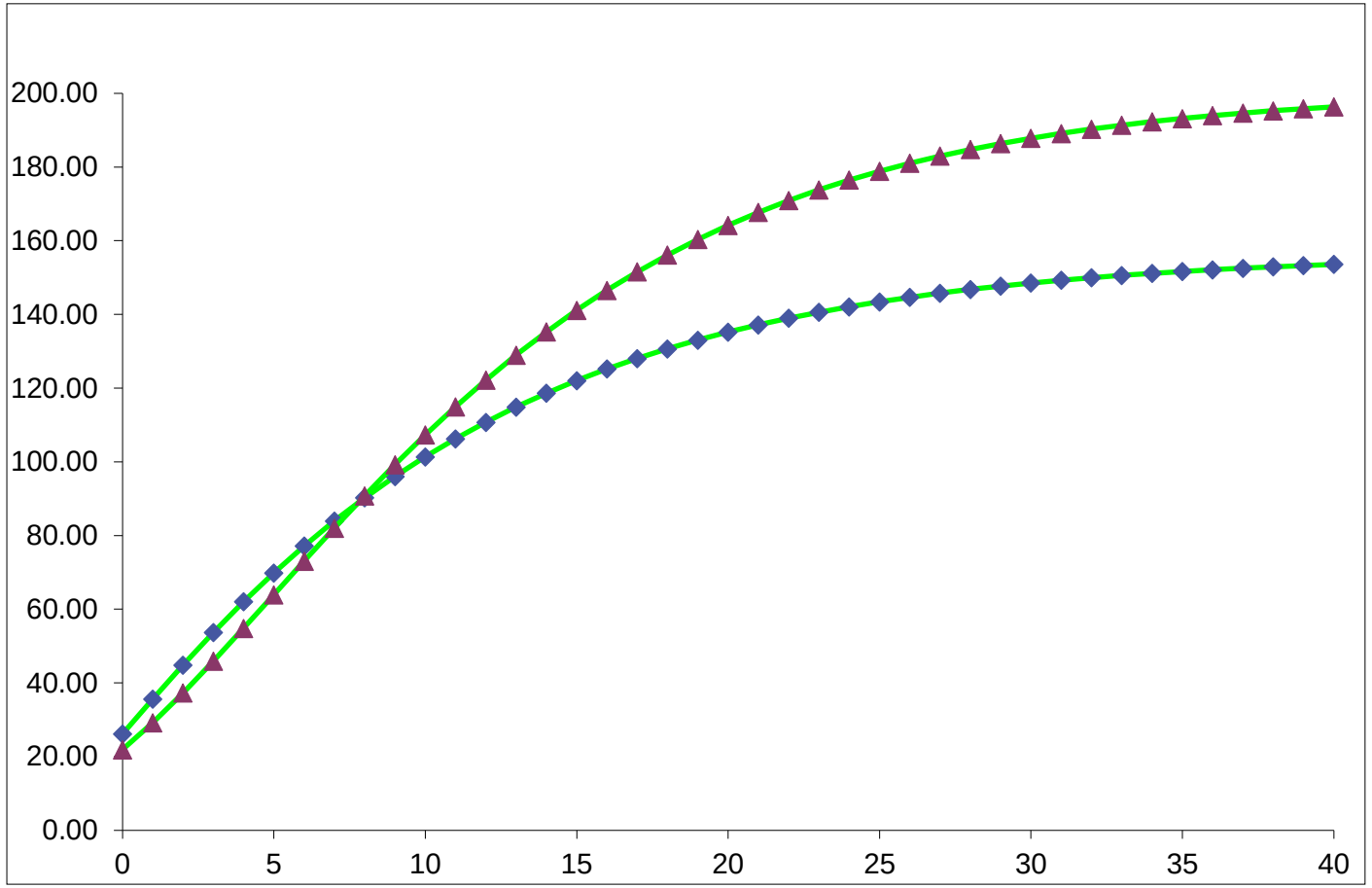
Different depletion trends between the EPO and CPO also suggest there might have more than one bigeye population in the EPO





Stock structure – different biology between WCPO and EPO

Different growth curves



Different sizes at maturity:
EPO: 135 cm
WPO: 103 cm

Stock structure – summary

- Genetic studies: no evidence against panmixia across the PO
- Tagging studies: limited mixing between the far east and far west of the PO; significant mixing in the CPO with more bigeye moving eastward than westward
- Larval studies: three tropical spawning grounds: WPO, CPO, and EPO
- Biological studies: notably different growth and maturity curves between the EPO and WPO (limited data were collected in the CPO)

- Likely three tropical bigeye stocks in the tropical PO: a WPO stock, an EPO stock, and a CPO stock that reside on both sides of the management boundary
- A Pacific-wide model is ideal but is hampered mainly by spatially-varying biological parameters and the lack of tagging data for adult bigeye

Stock structure – issues

Potential issues with the bigeye assessment for east of 150W:

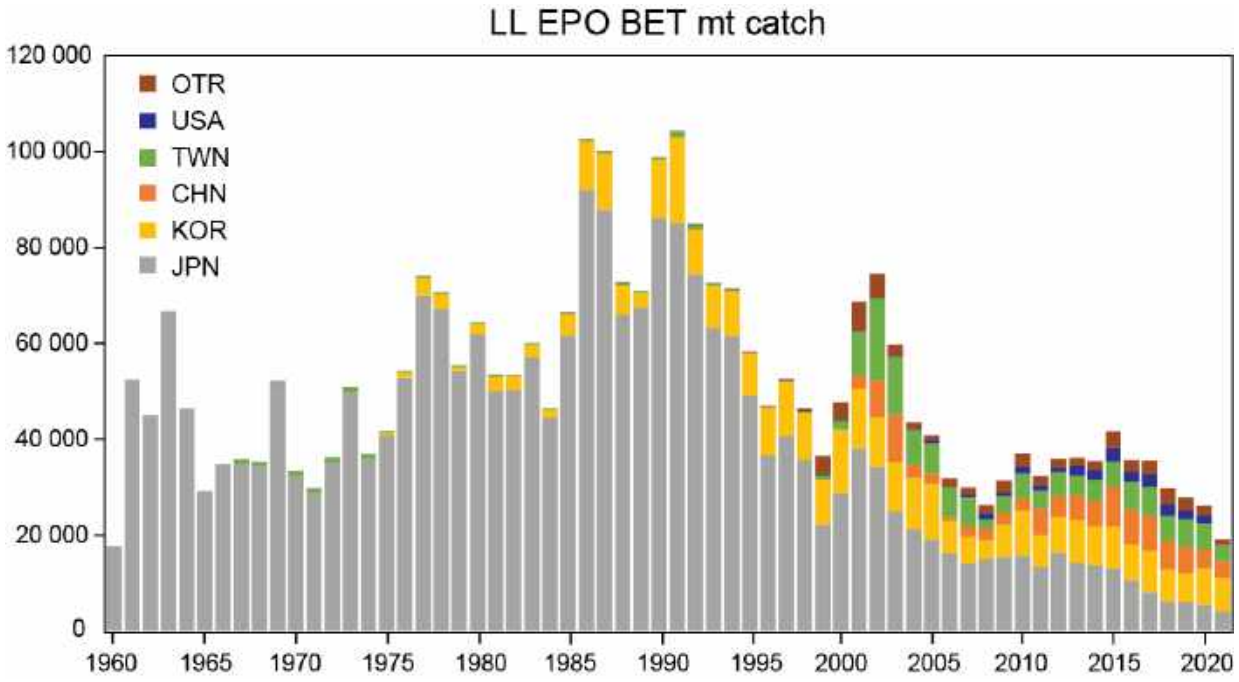
- Time-varying catchability and selectivity (environmental-driven influx/outflux of the CPO population)
- The impact of CPO catches on the east-of-150W population is ignored
- The biological parameters for the east-of-150W population are likely different from those estimated for the EPO population

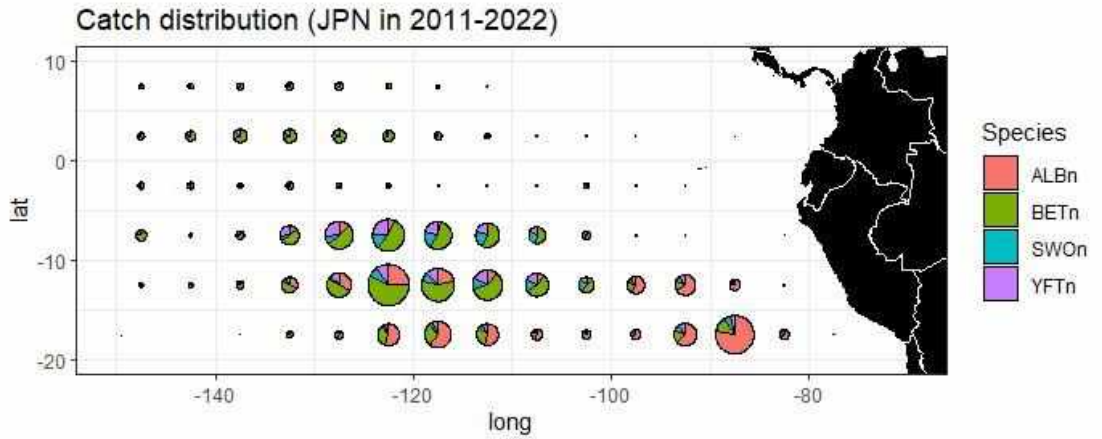
Fishery definition: method

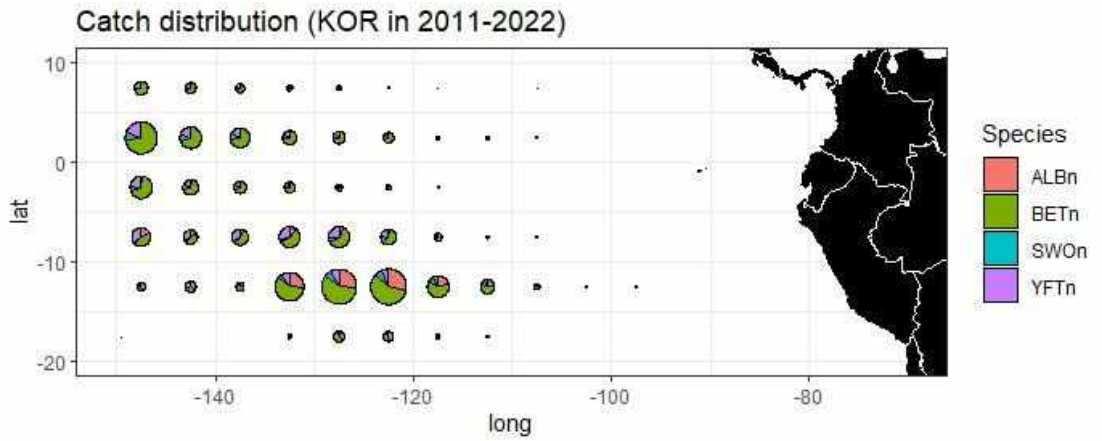
- Fisheries are defined by fitting a regression tree algorithm to gear (longline/purse-seine) and purse-seine set type (floating object/unassociated) specific LF data
- Based on an open-source R package: https://github.com/HaikunXu/FishFreqTree
- LF data can be grouped by latitude, longitude, quarter and cyclic quarter
- The regression tree algorithm uses recursive partitioning to search for hierarchical binary decision rules that provide the greatest decrease in the heterogeneity of length composition data
- The regression tree is hierarchical and may exhibit a certain degree of instability: several competing candidates are considered for each partitioning to search for the best combination of splits

Fishery definition: longline

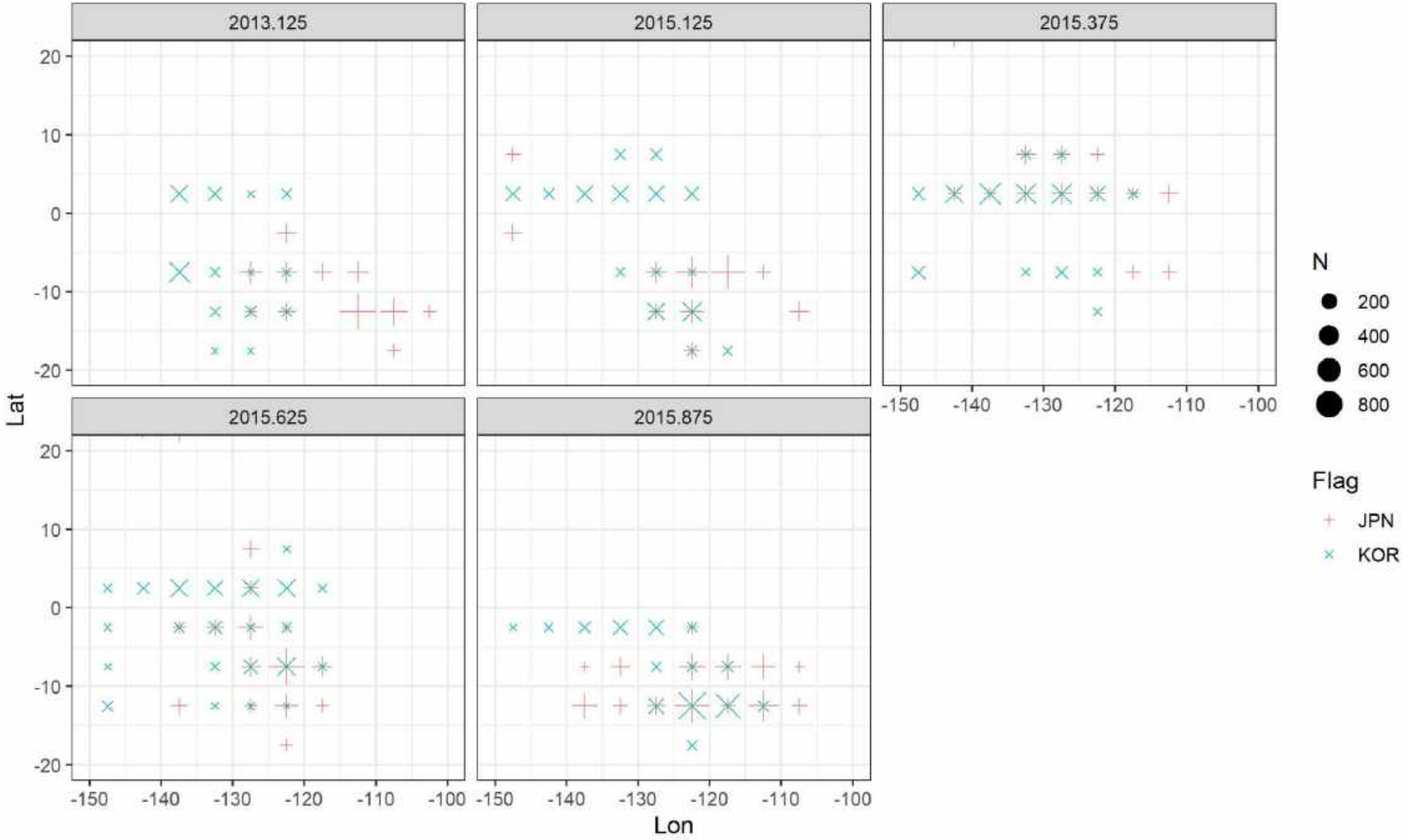
Longline fisheries are defined separately for the two most important longline fleets (Japan and Korea) due to different LFs in the same spatiotemporal windows



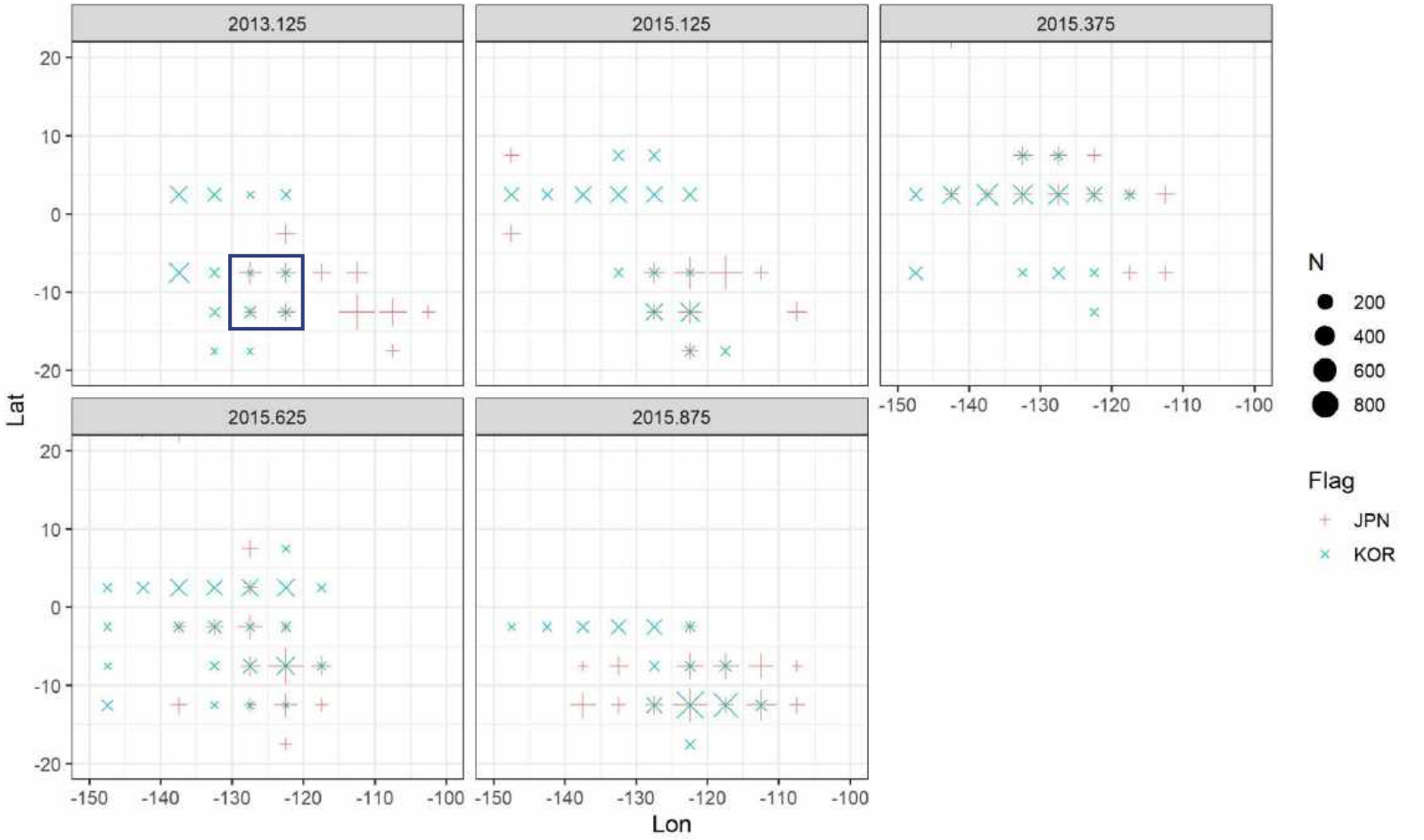


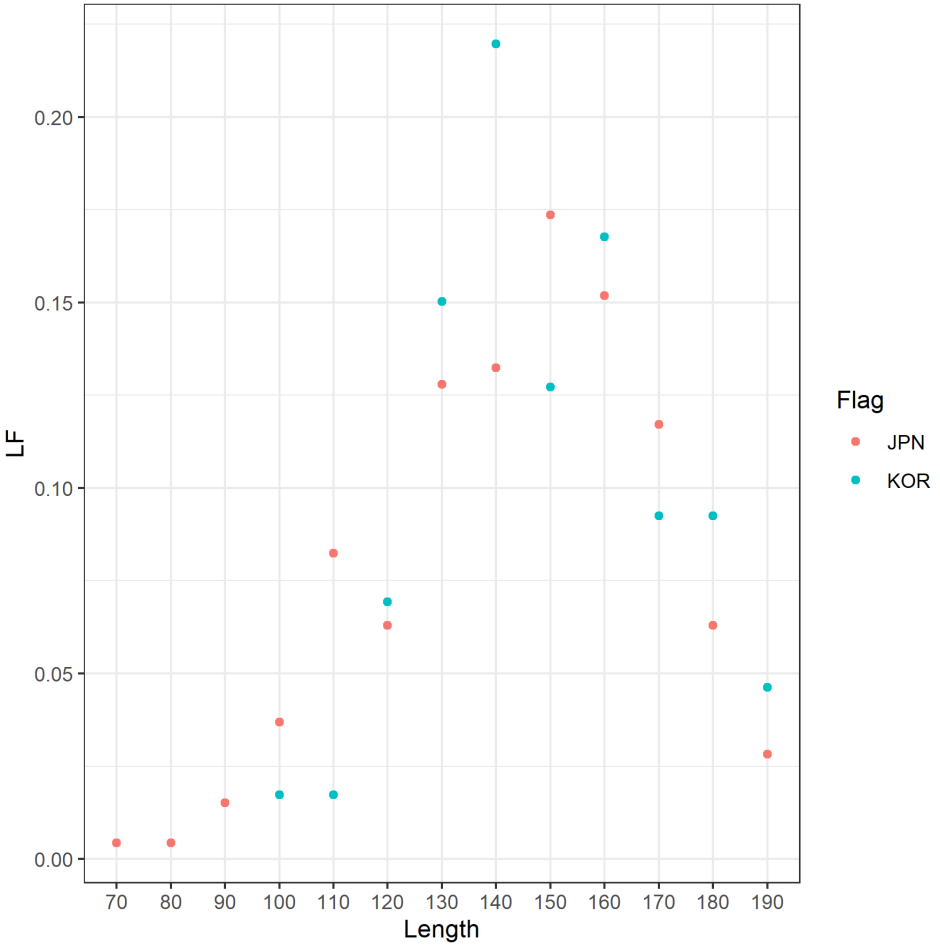


Compare JPN and KOR LF in the same spatiotemporal windows

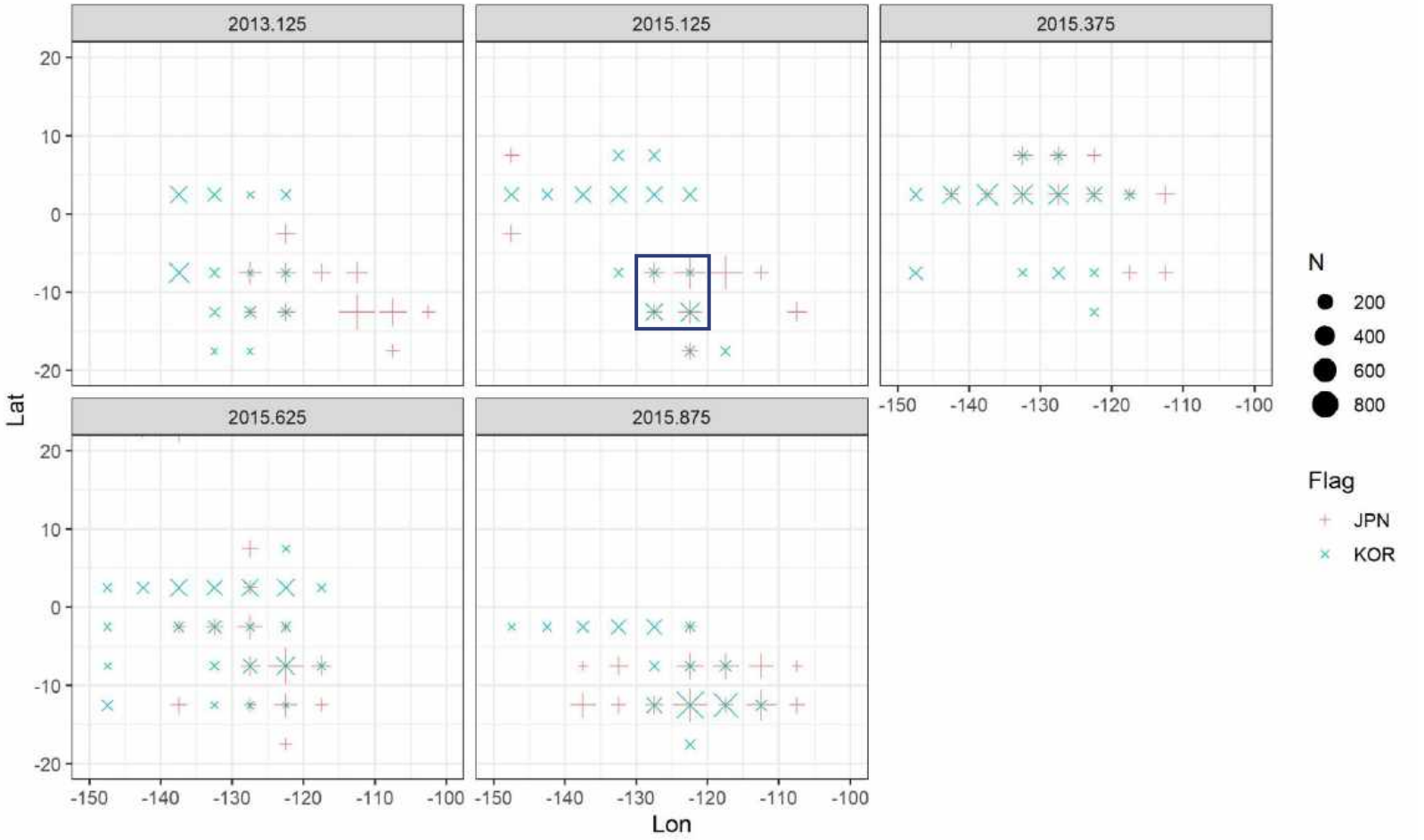


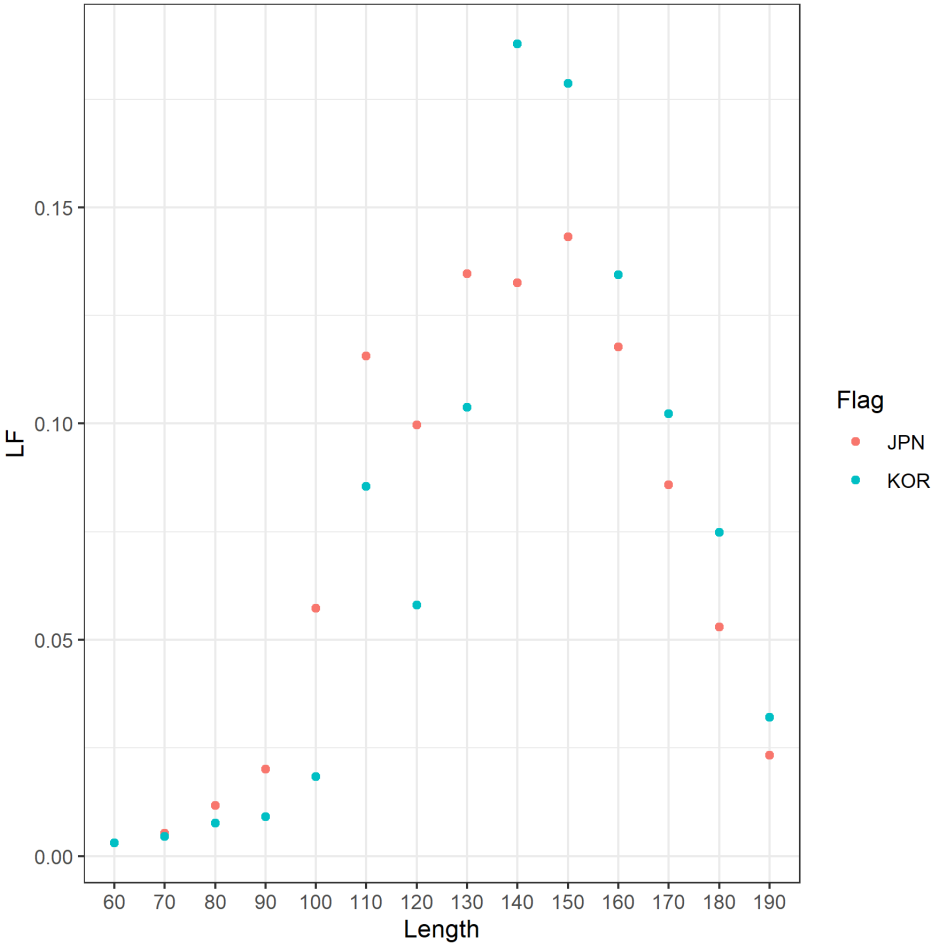
Example 1: KOR catches more large bigeye



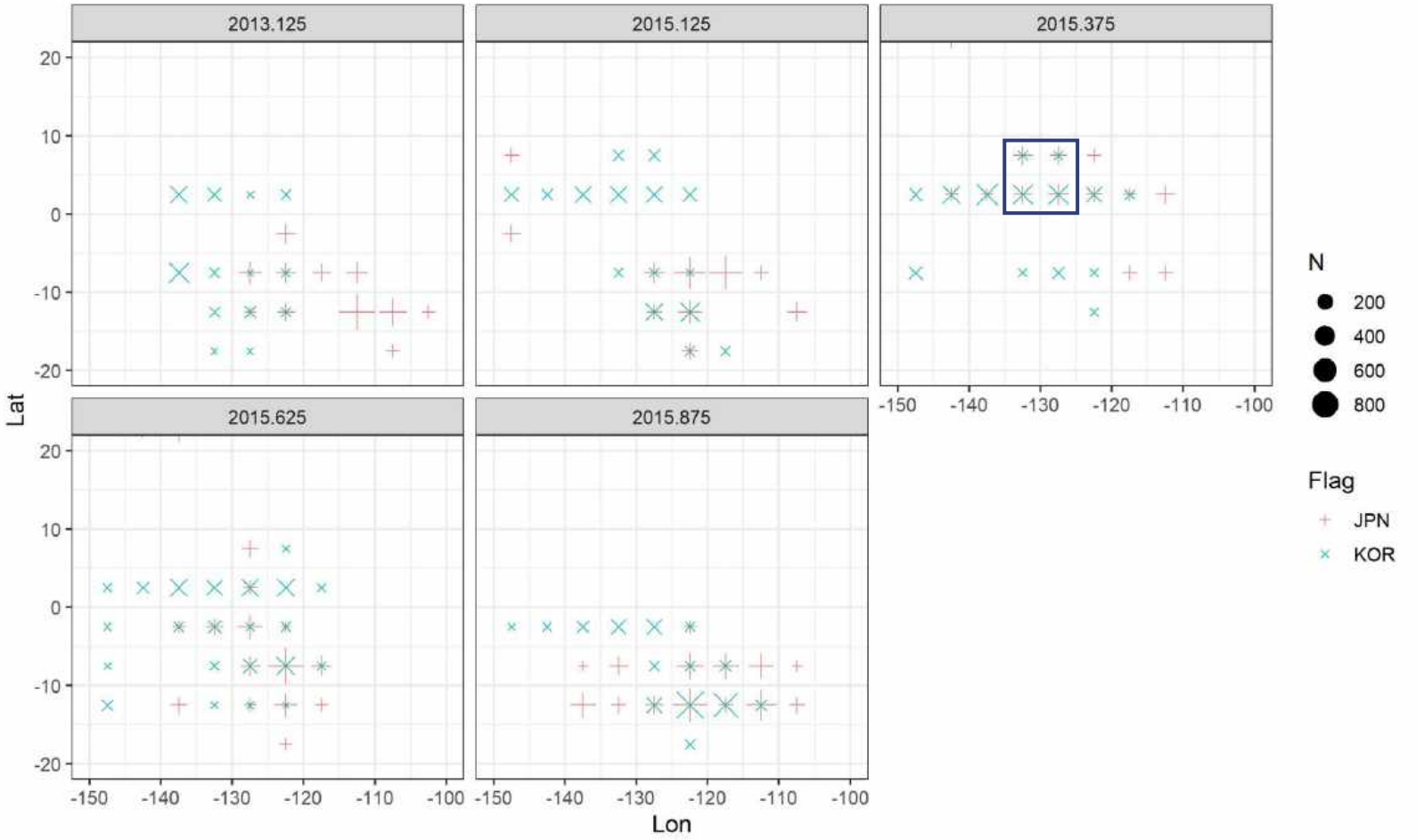


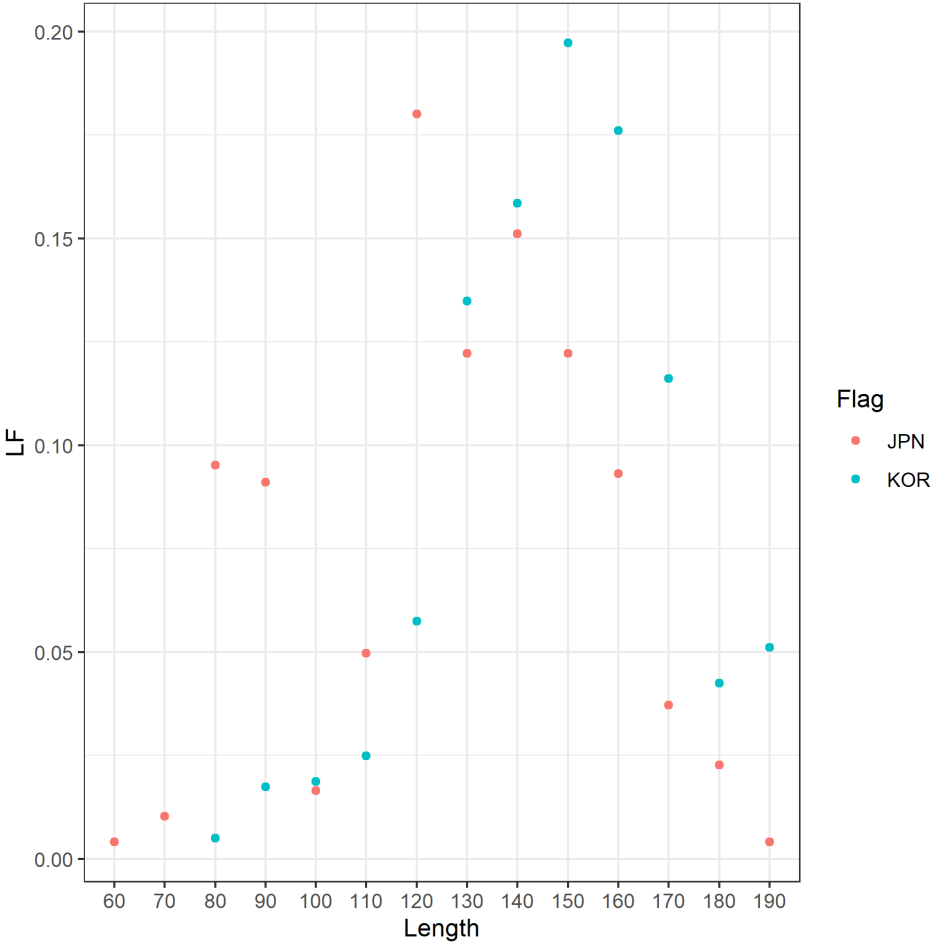
Example 2: KOR catches more large bigeye



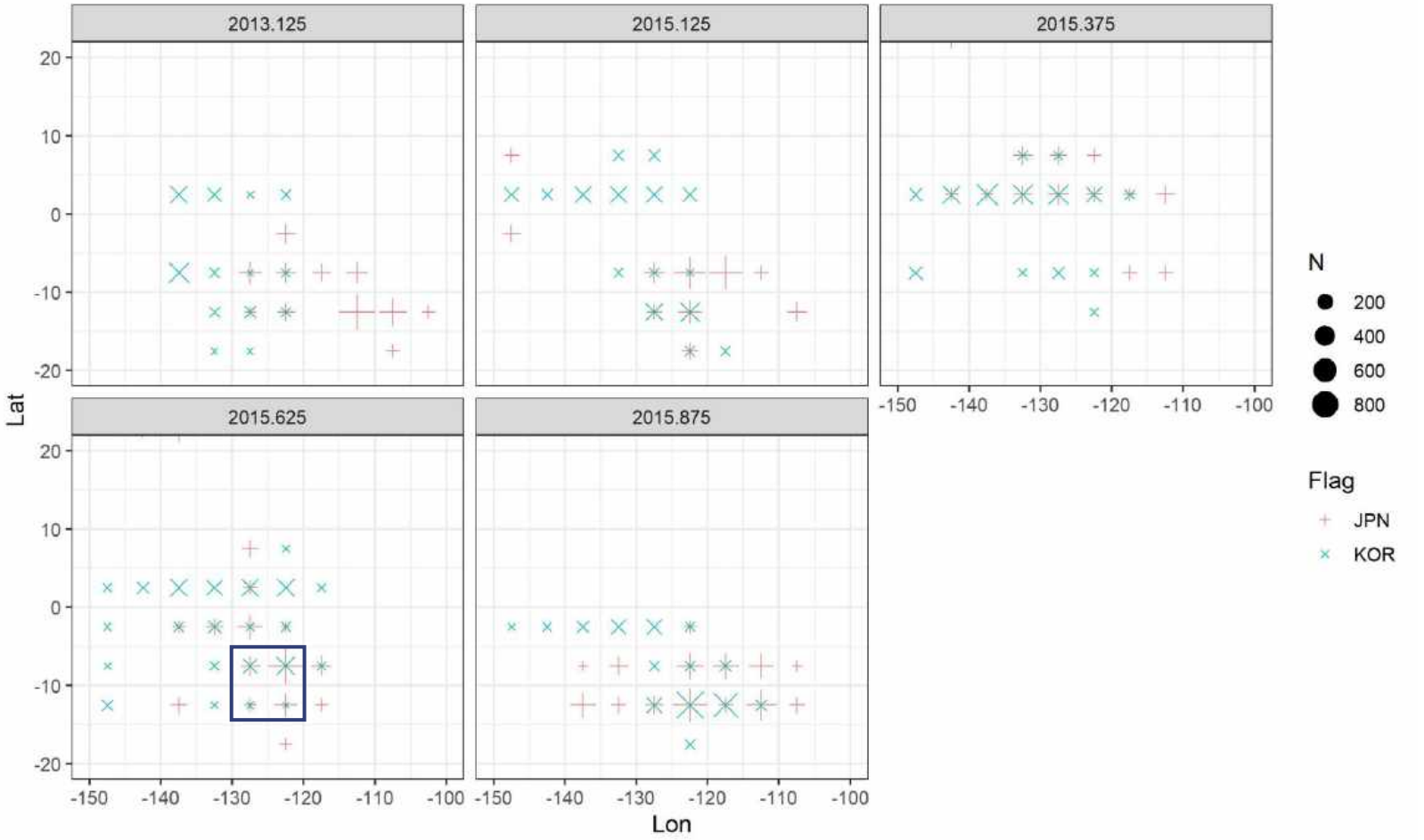


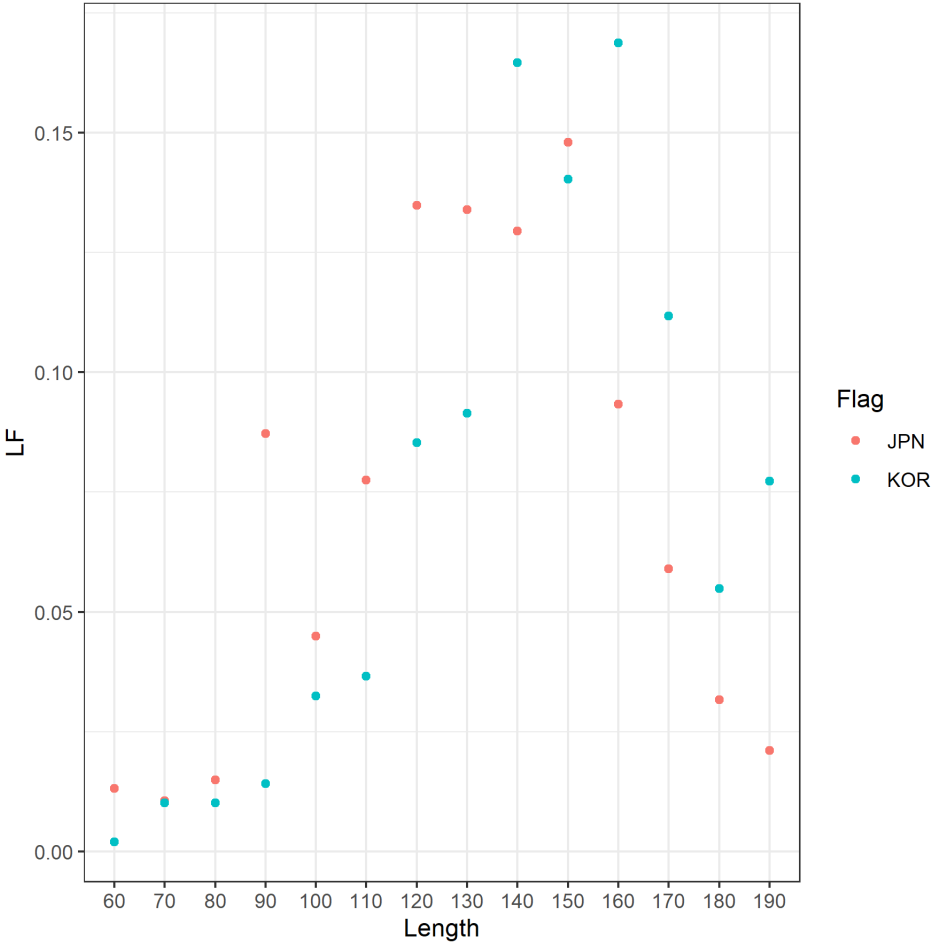
Example 3: KOR catches more large bigeye



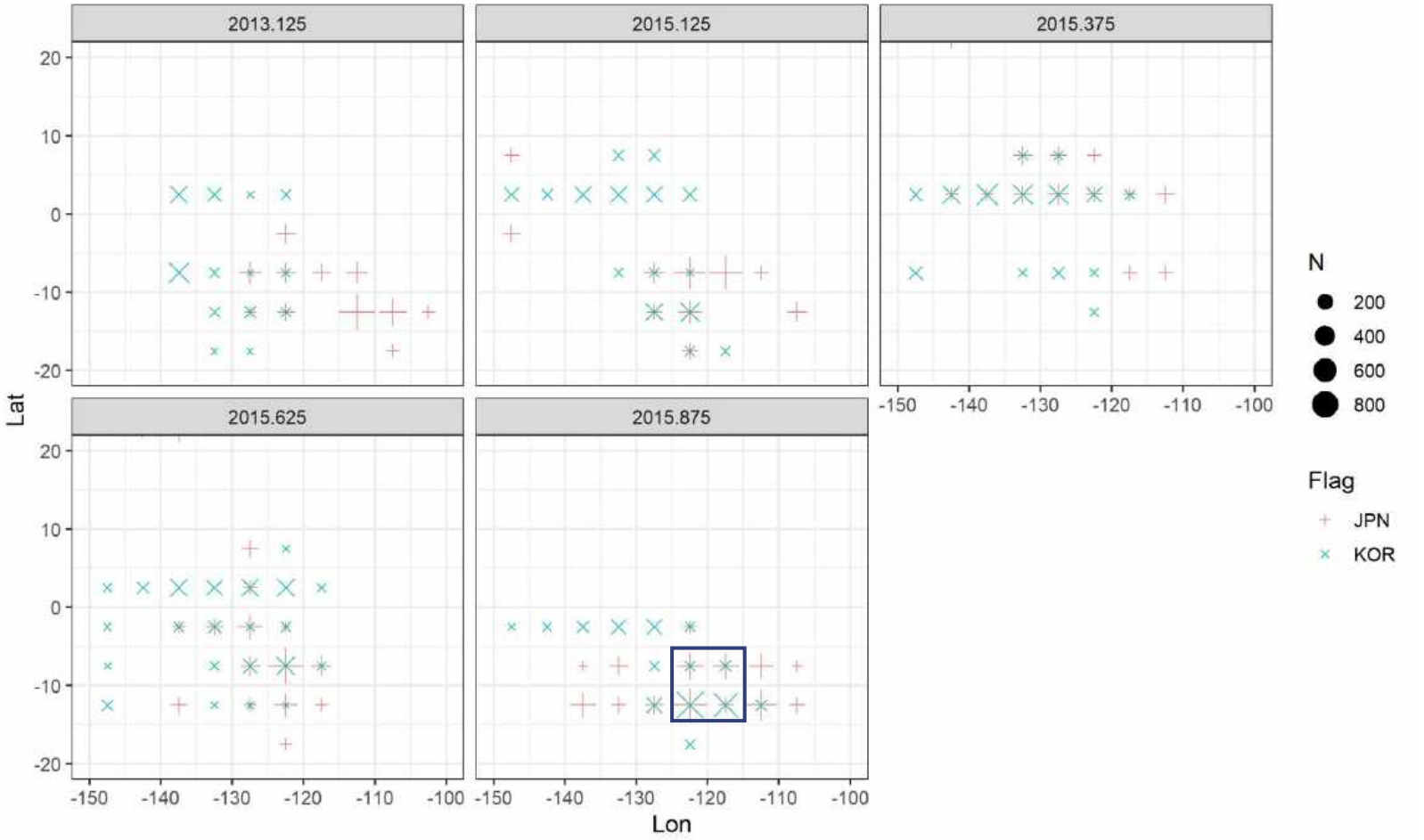


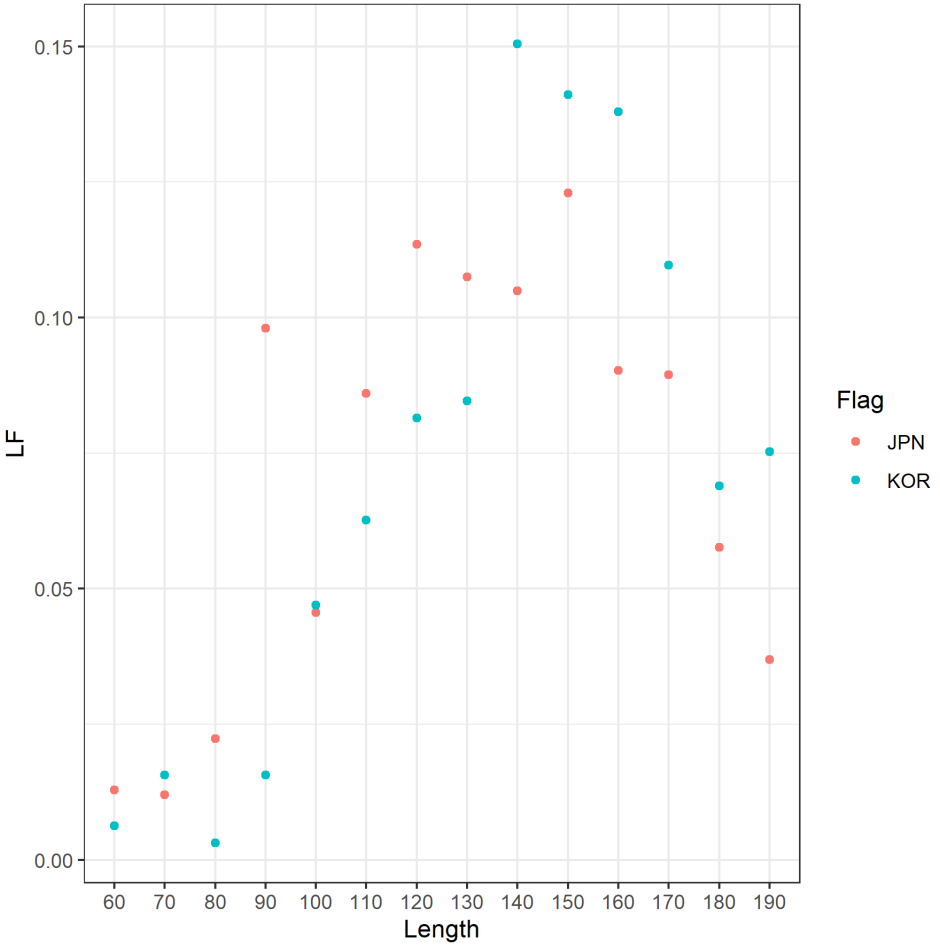
Example 4: KOR catches more large bigeye



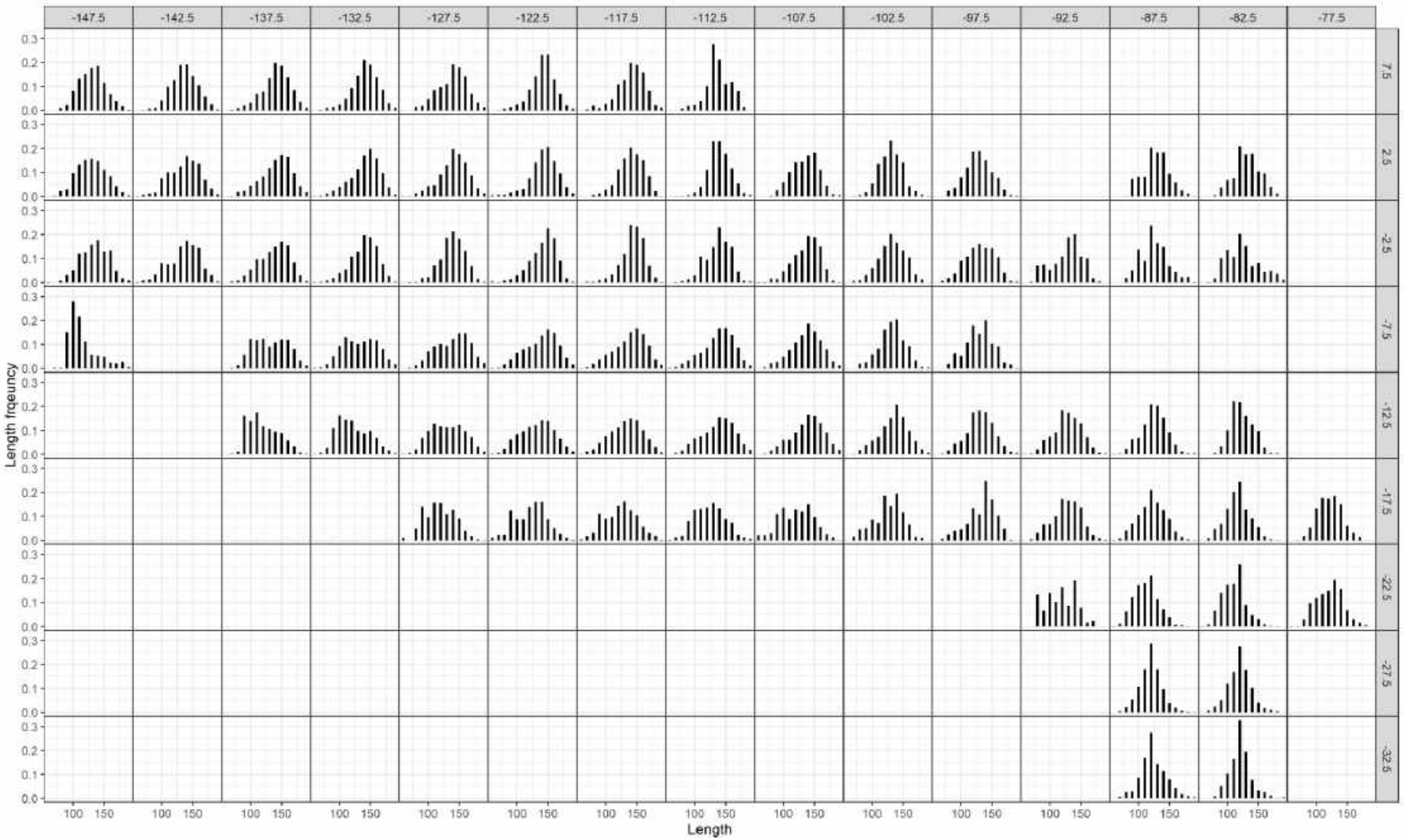


Example 5: KOR catches more large bigeye

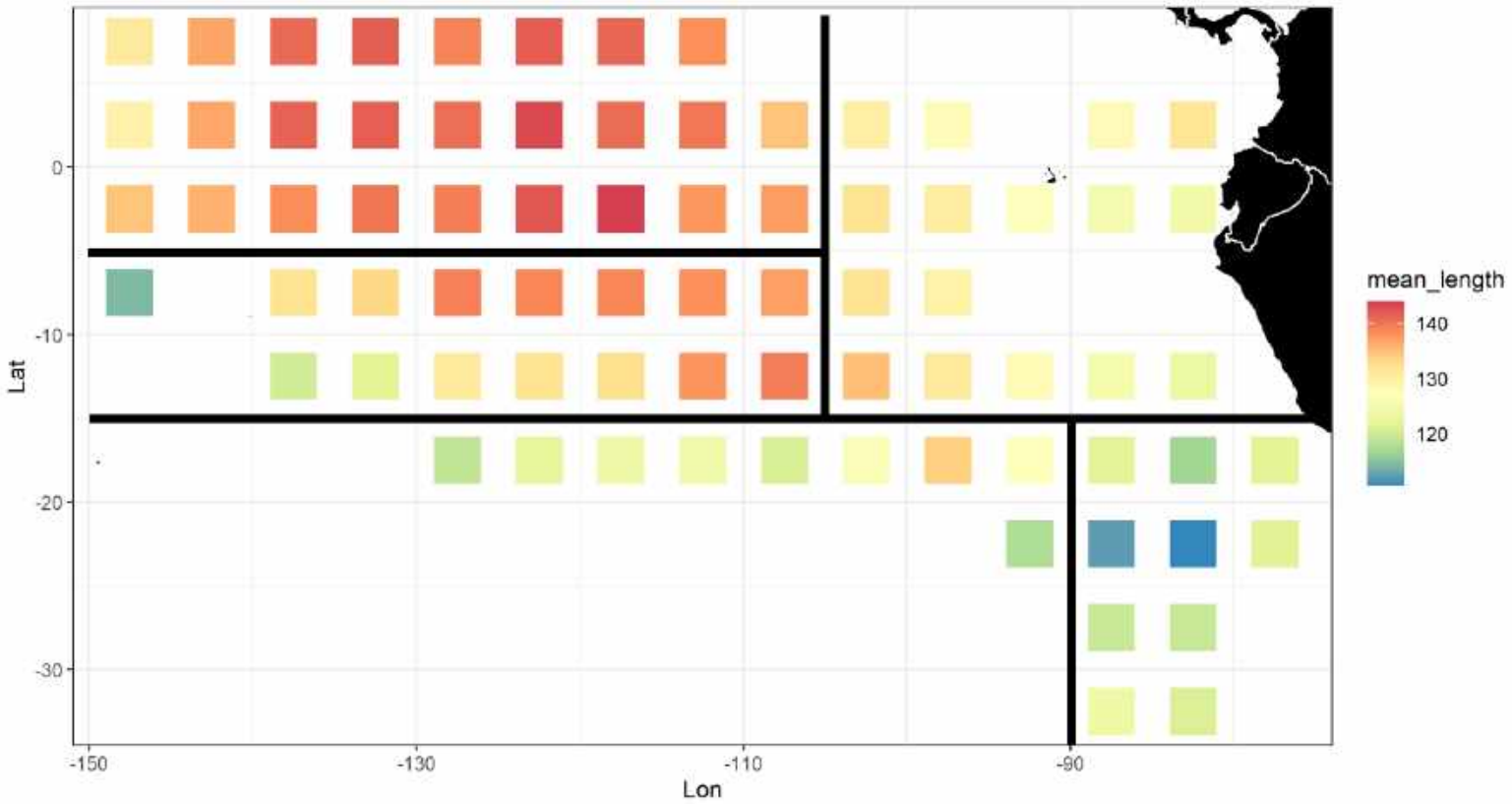




Fishery definition: longline (Japan)

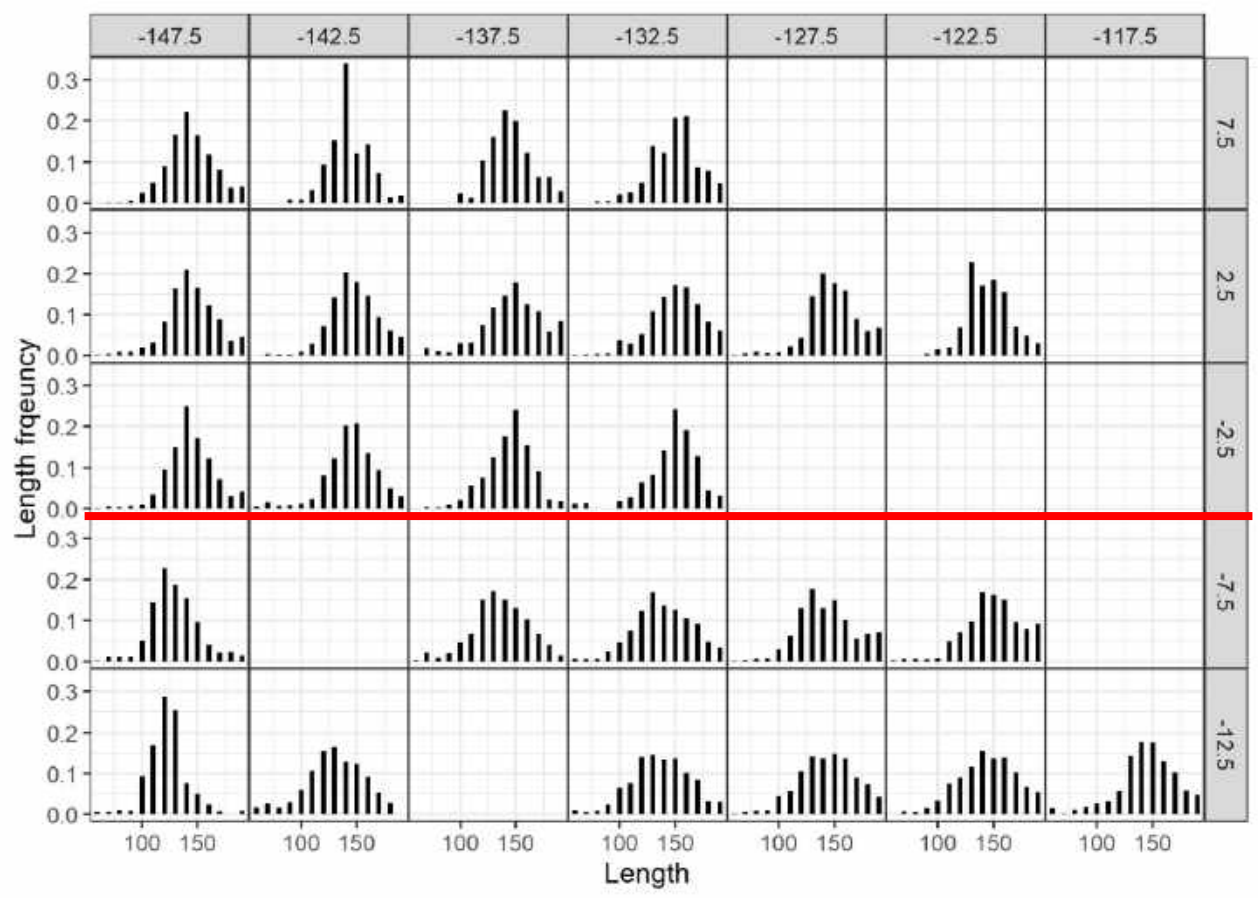


Fishery definition: longline (Japan)



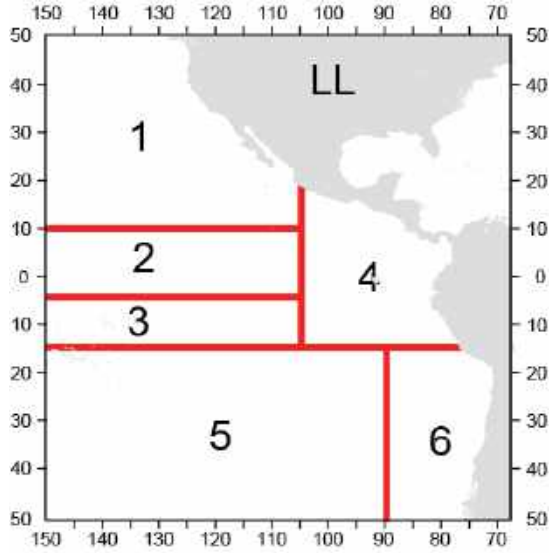
Split	Key	Value	Variance explained
Split1	Latitude	15°S	8.07%
Split2	Longitude	105°W	10.91%
Split3	Latitude	5°S	13.01%
Split4	Longitude	90°W	14.12%

Fishery definition: longline (Korea)



Split	Key	Value	Variance explained
Split1	Latitude	5°S	5.44%

Fishery definition: longline (all)



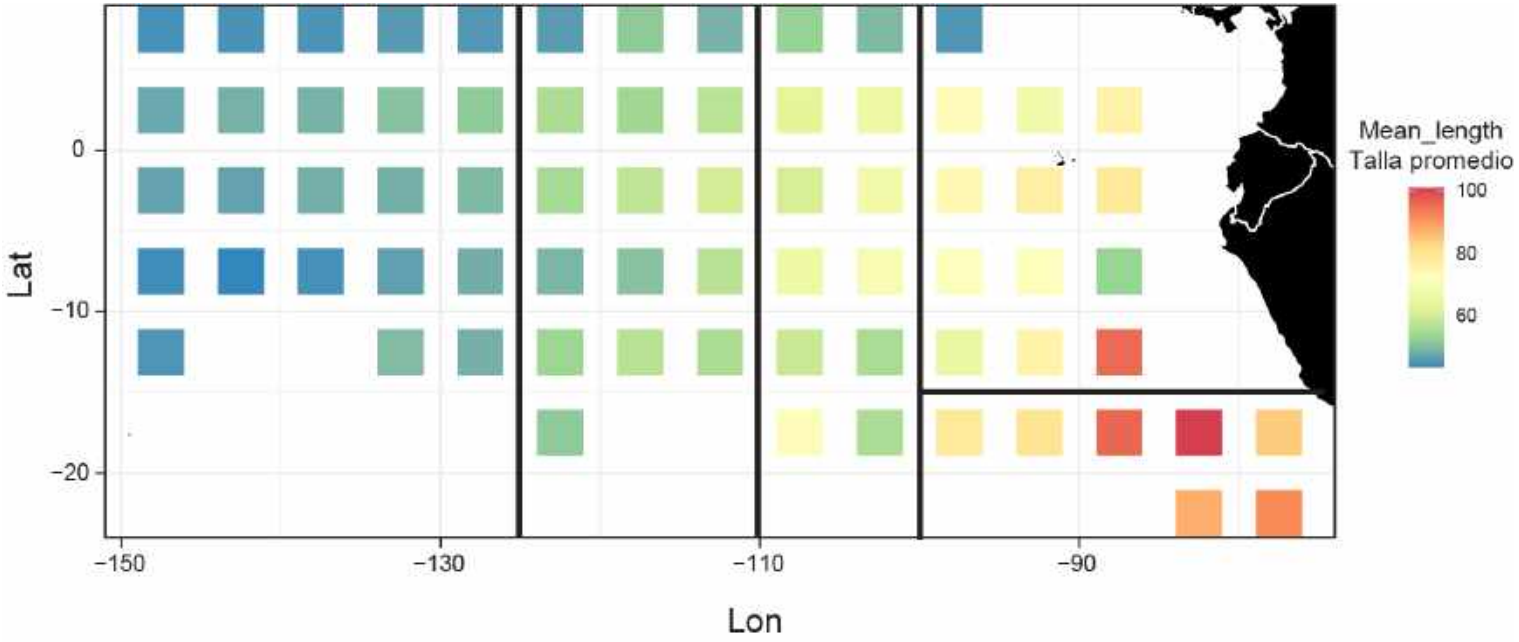
Fleet Number	Gear	Flag/Set type	Area	Catch data	Unit
1	LL	Japan	1	Retained catch only	1,000s
2			2		
3			3		
4			4		
5			5		
6			6		
7		Korea	2		
8			3		
9		Japan	1		tons
10			2		
11			3		
12			4		
13			5		
14			6		
15		Korea	2		
16			3		

- Other CPCs (e.g., Chinese Taipei, China, United States) catch a smaller amount of bigeye in the EPO than Japan and Korea and are assumed to have the same selectivity as Japan
- Longline catches are reported to the IATTC in numbers by some fleets and in weight by others, so two longline fleets (one in number and one in weight) are defined for each longline fishery

Fishery definition: purse-seine

- Purse-seine fisheries are defined separately for floating-object sets and unassociated sets
- More fisheries are defined for floating-object sets because they take the majority of bigeye catch by purse-seine and have a more complete coverage of the EPO
- Purse-seine LF data are collected by port samplers from floating-object and unassociated sets made by class 6 vessels
- Port samplers collect data only from wells with catch from the same set type, sampling area, and year-month

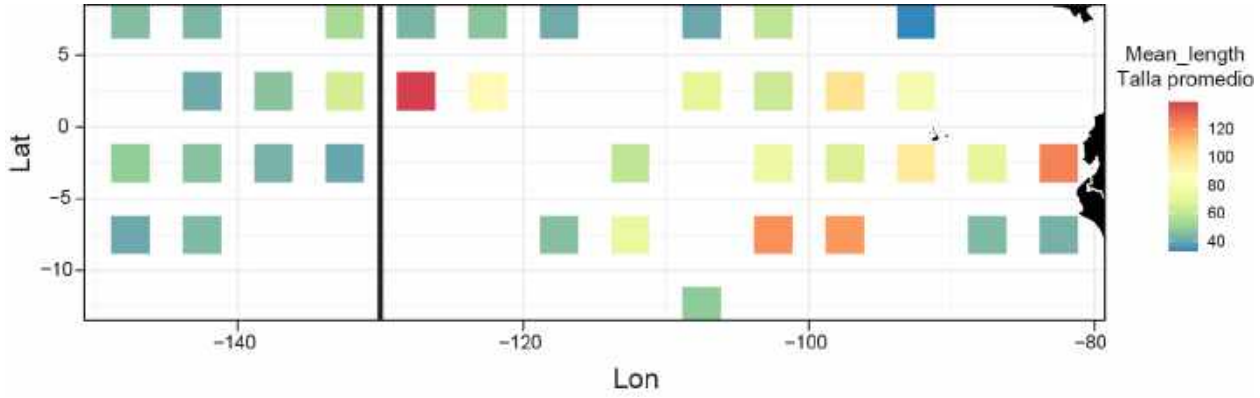
Fishery definition: floating-object sets



Split	Key	Value	Variance explained
Split1	Longitude	110°W	10.53%
Split2	Longitude	100°W	11.92%
Split3	Longitude	125°W	13.21%
Split4	Latitude	15°S	13.93%

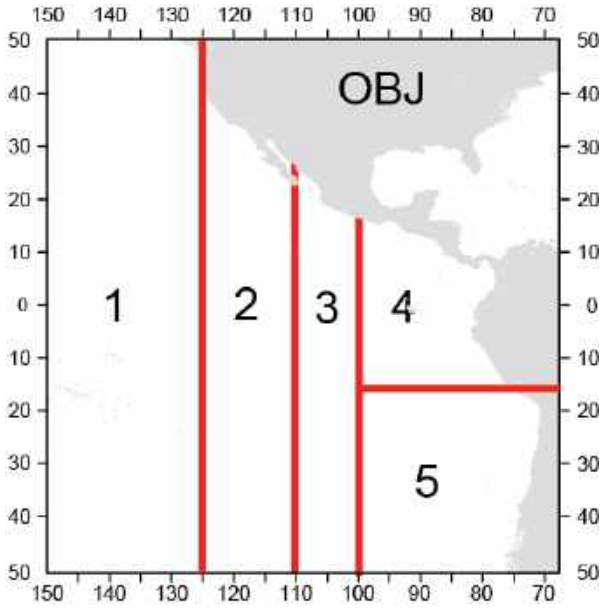
The regression tree provides an identical fishery definition for the OBJ fishery based on standardized LF (LF / annual mean LF), further validating the credibility of the selected fishery definition.

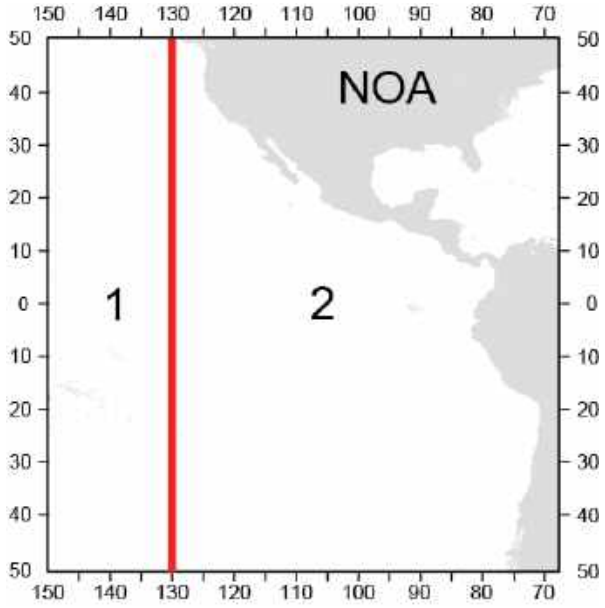
Fishery definition: unassociated sets



Split	Key	Value	Variance explained
Split1	Longitude	130°W	9.14%

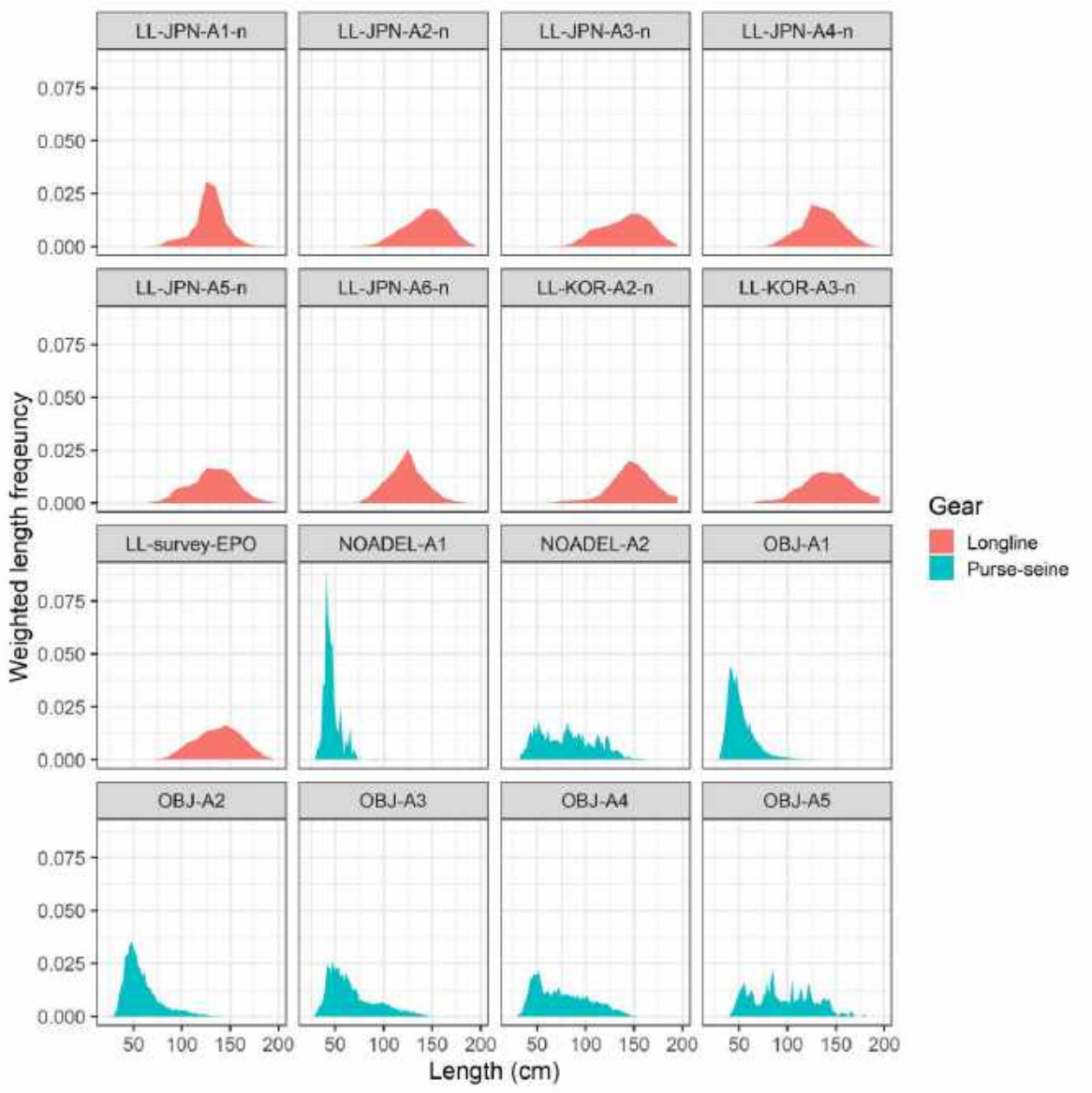
Fishery definition: purse-seine (all)





Fleet Number	Gear	Flag/Set type	Area	Catch data	Unit
17	PS	OBJ	1	Retained catch + discards (inefficiency)	tons
18			2		
19			3		
20			4		
21			5		
22			1-5 (EPO)	Discards (size-sorting)	
23		NOA+DEL	1	Retained catch + discards (all)	
24			2		

Fishery definition: summary



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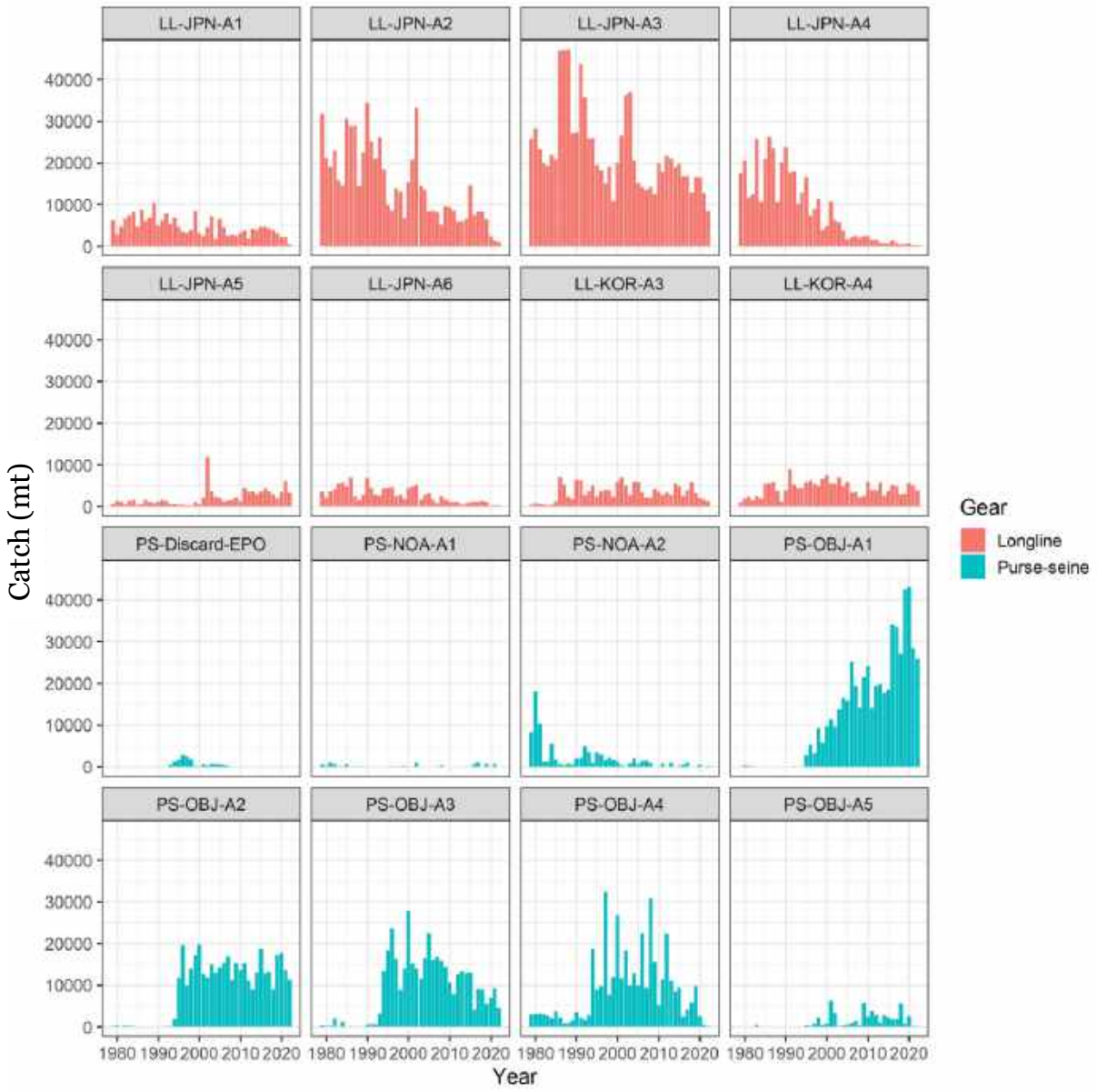
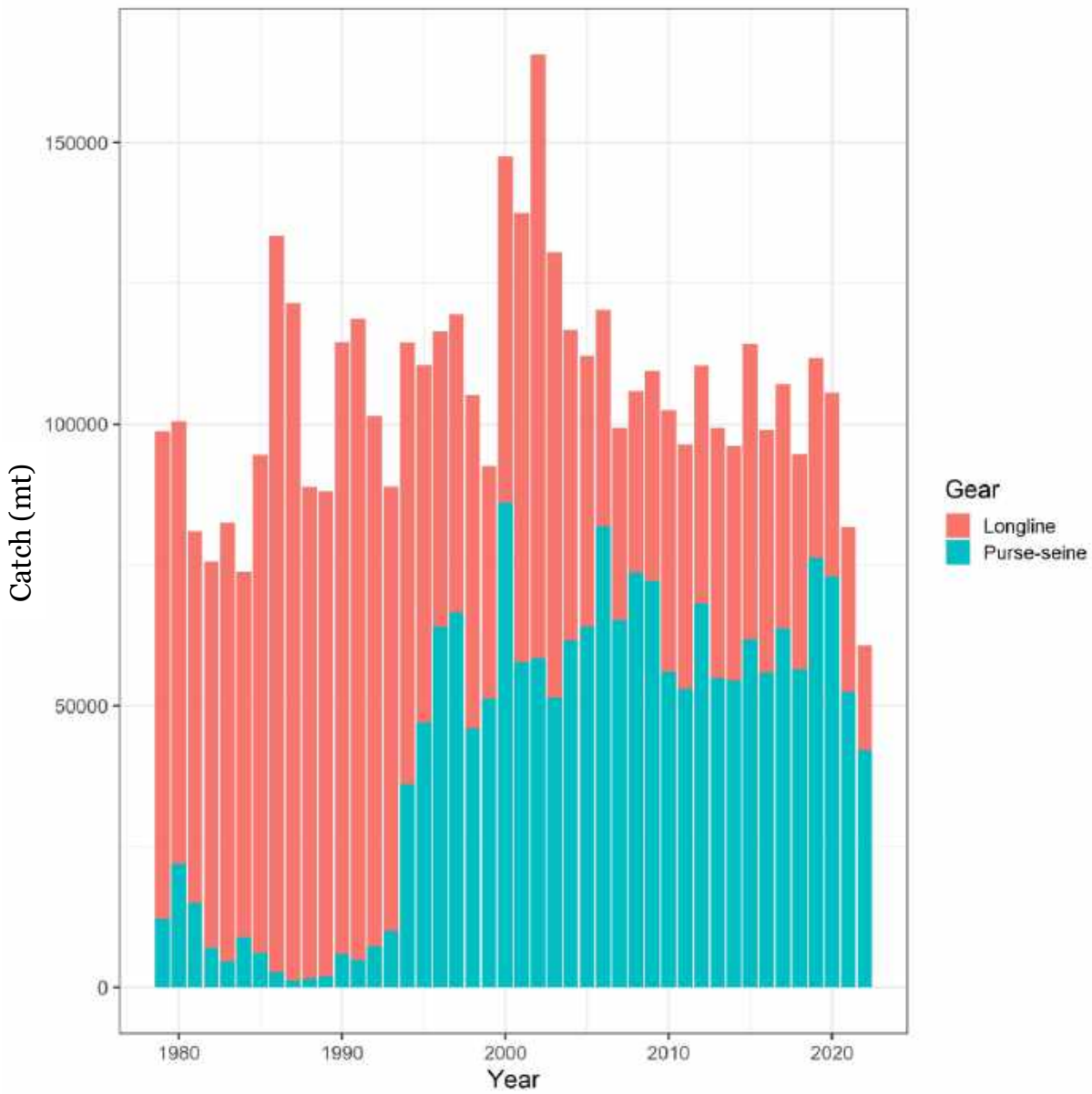
21			5		
22			1-5 (EPO)	Discards (size-sorting)	
23		NOA+DEL	1	Retained catch + discards (all)	
24			2		

Fishery definition: catch time series





New!

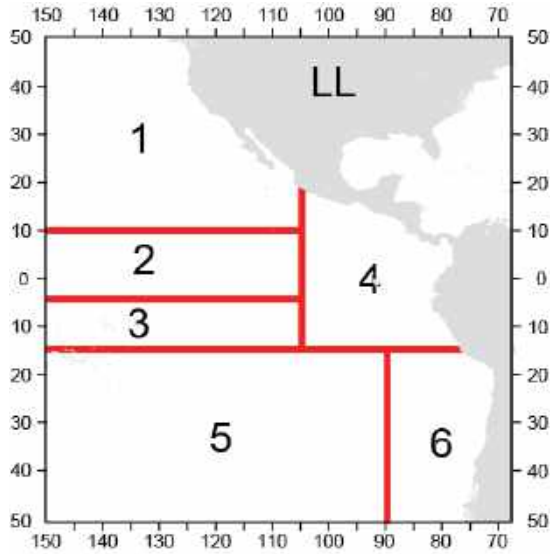
Catch and size data from Korean tuna longline fisheries in the Eastern Pacific Ocean

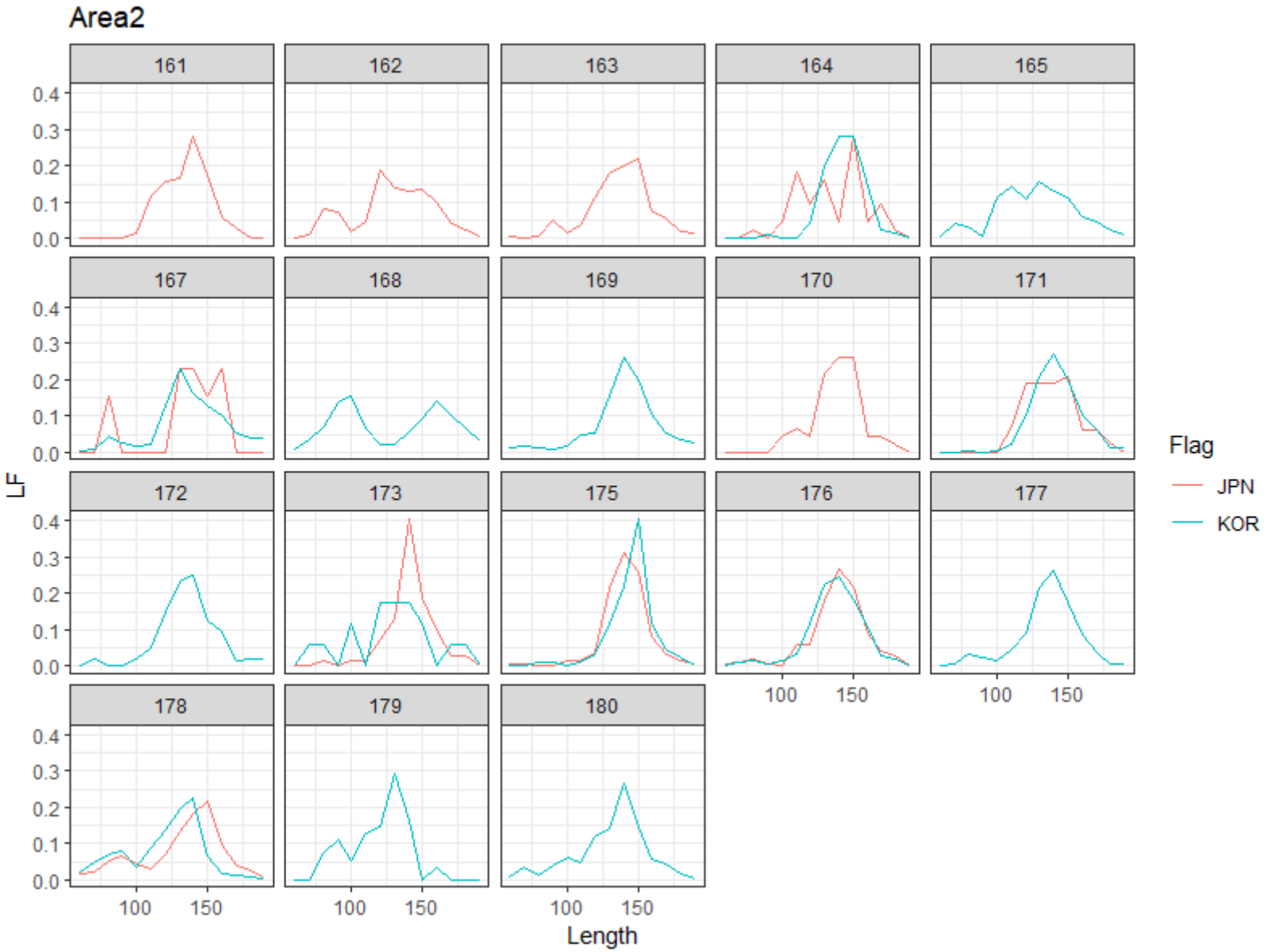
Sung Il Lee, Doo Nam Kim, Mi Kyung Lee and Youjung Kwon

National Institute of Fisheries Science

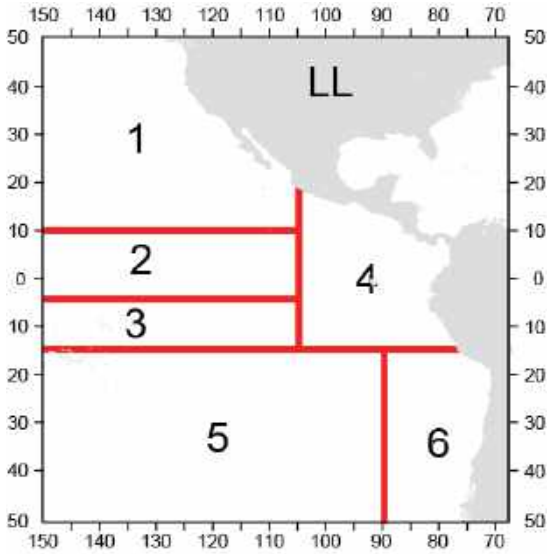
"In general, the median lengths of fish measured by fishermen were larger than those of fish measured by observers. Such differences could be related to the differences between their measurement methods. That is, because observers measured all fish associated with about 70% (in number of hooks) of each haul from its start, their data include measurements from small to large sizes, while fishermen measure only a few fishes per set, and it is likely that their data were biased toward a certain size, for example, which they preferred."

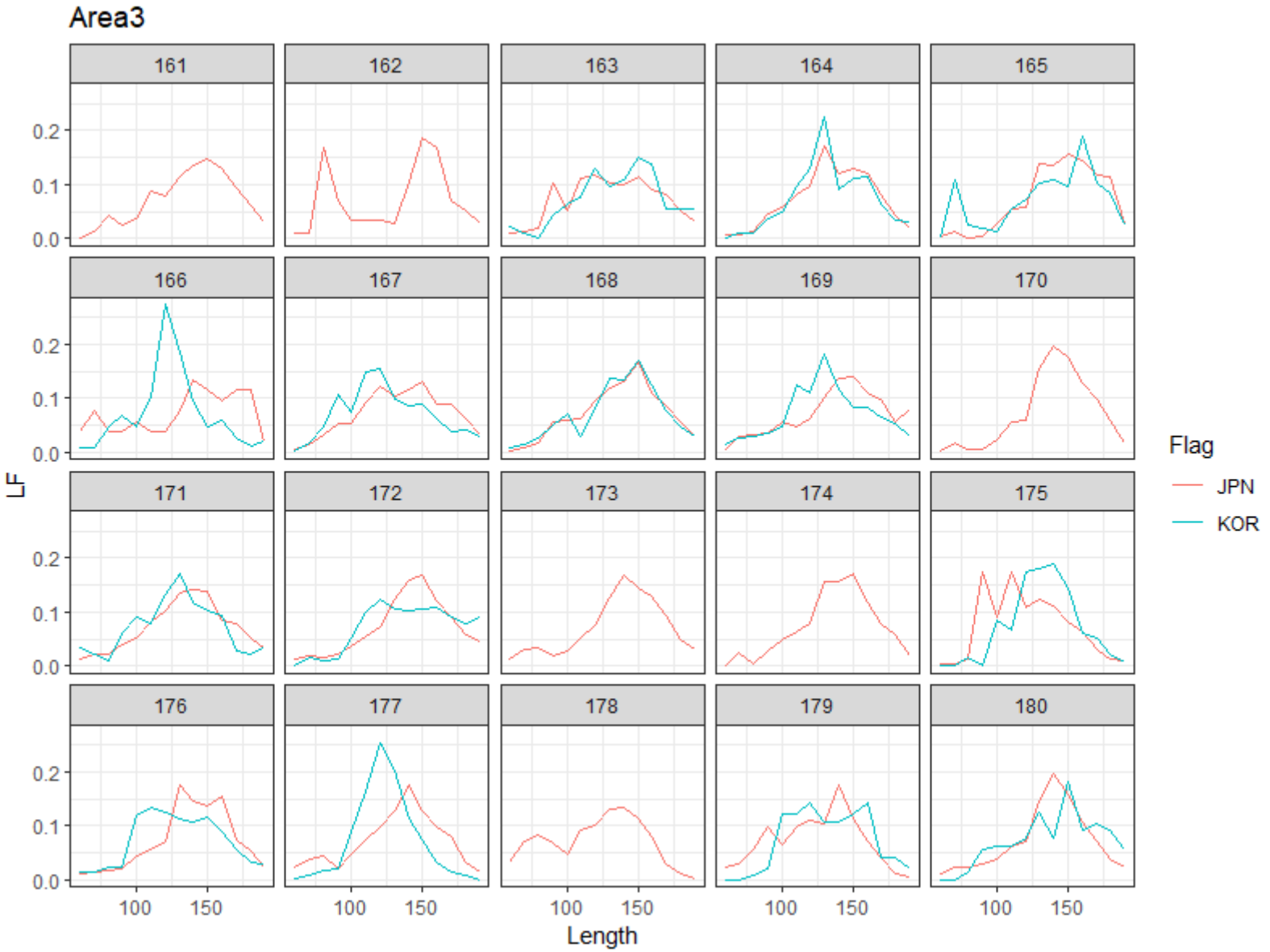
New! JPN vs. KOR observer data



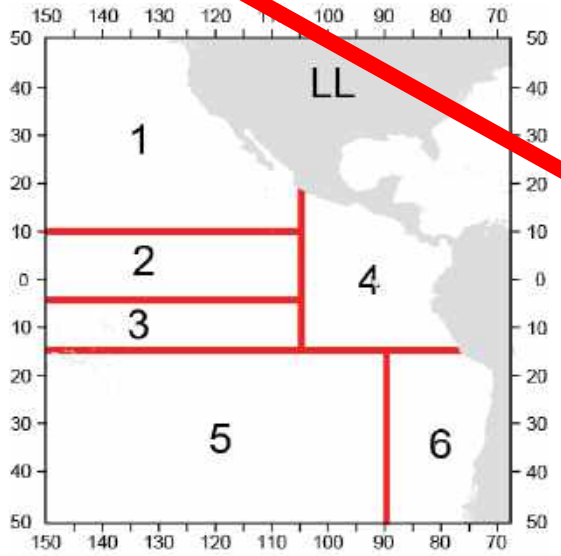


New! JPN vs. KOR observer data





Fishery definition: longline (all)



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1	LL	Japan	1	Retained catch only	1,000s
2			2		
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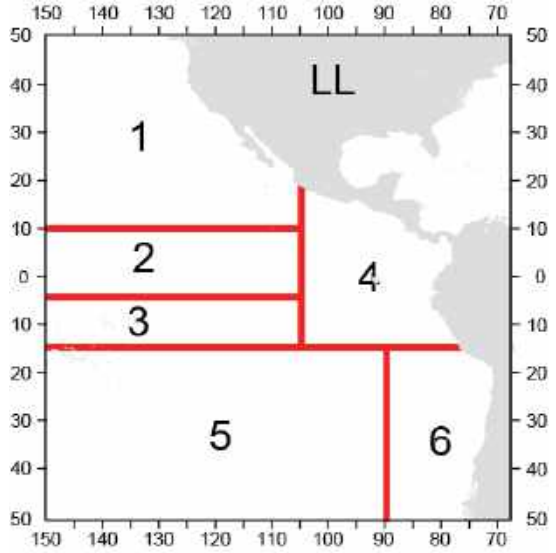
New! Observer data doesn't support different selectivity



Fleet Number	Gear	Flag/Set type	Area	Catch data	Unit
1	LL	All	1	Retained catch only	1,000s
2			2		
3			3		
4			4		
5			5		
6			6		
~~7~~		~~Korea~~	~~2~~		
~~8~~			~~3~~		
9		All	1		tons
10			2		
11			3		
12			4		
13			5		
14			6		
~~15~~		~~Korea~~	~~2~~		
~~16~~			~~3~~		

- Japan and Korea are assumed to have the same selectivity
- Longline catches are reported to the IATTC in numbers by some fleets and in weight by others, so two longline fleets (one in number and one in weight) are defined for each longline fishery


Questions

Fishery definition: longline catch by decade and flag