Skipjack catch per unit effort (CPUE) in the WCPO from the Japanese pole-and-line fisheries

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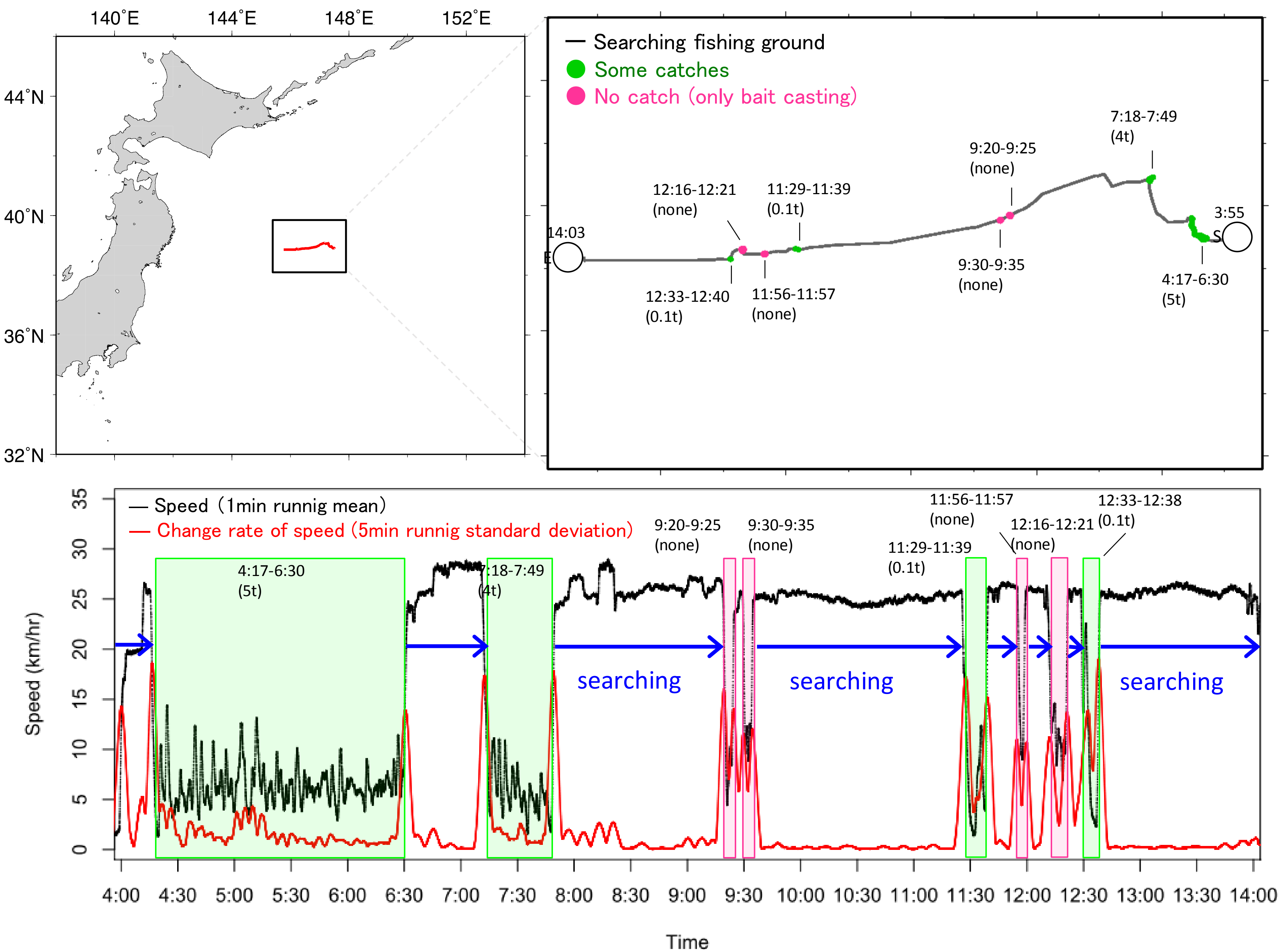
Outline

1. About Japanese Pole-and-line fisheries
   (fisheries itself, vessel behavior, category, historical changes of number of vessel)
2. Methods
   (Plan for CPUE standardization, Data processing, about vessel ID)
3. Results
4. Summary

JPN Pole and line fishery

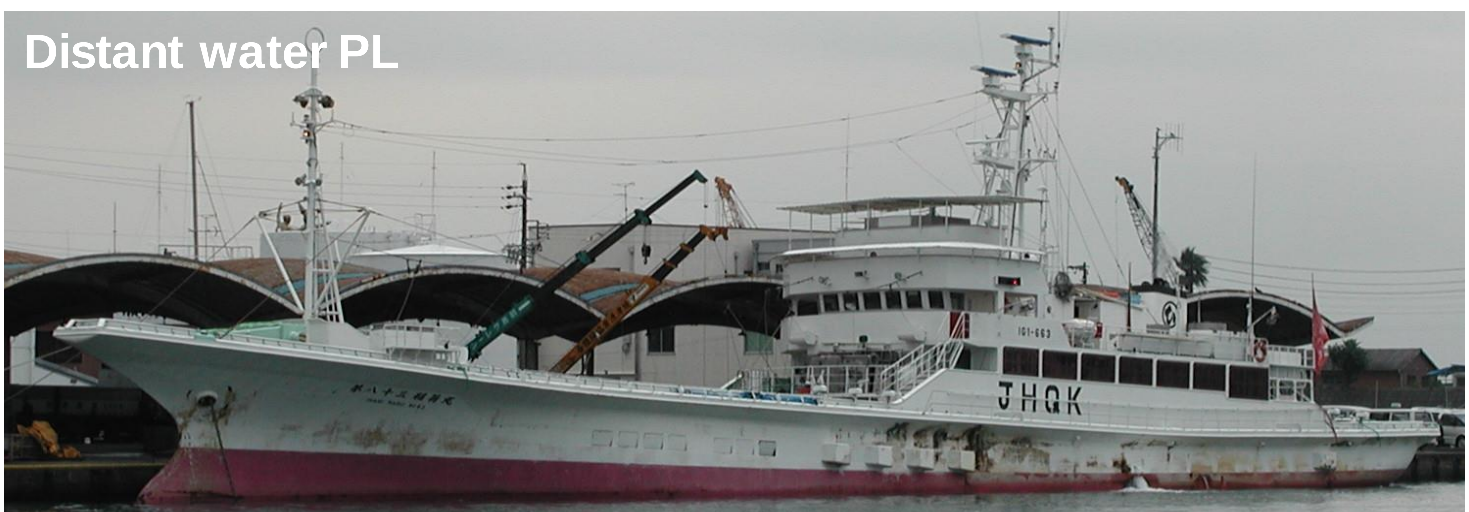
- Use pole and line
- Catch only fish at surface
- Target mainly on SKJ and ALB
- Use hooks with no backstitch
- 10 – 30 poles

Vessel behavior at "fishing" and "searching"



Category of Japanese PL fishery

Category	Vessel Size	Typical characteristics
Costal	< 20 GRT	19 GRT ≒ 17m, 200 hp
Offshore	20 – 119 GRT	110 GRT ≒ 30m, 1000 hp
Distant water	>= 120 GRT	499 GRT ≒ 55m, 2000 hp



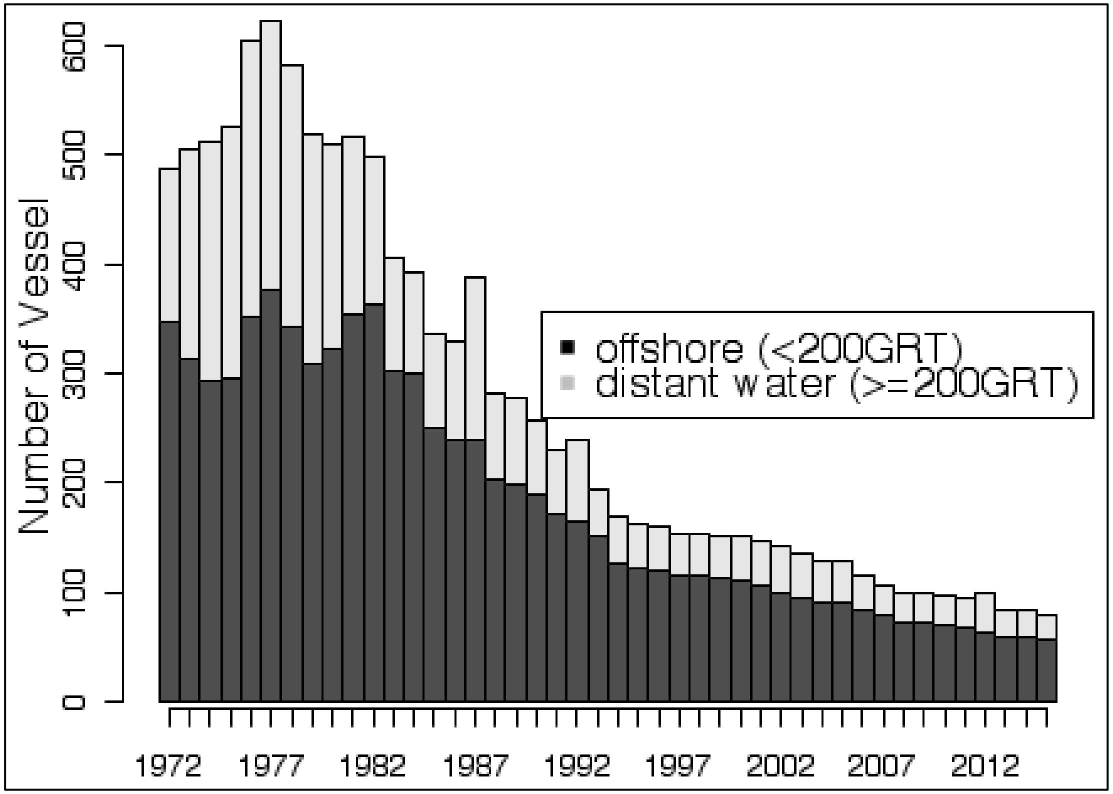
Another categorization

based on fishing license

based on equipment of fish storage

Coastal (-19GRT)	**Small sized** (-19GRT)
Offshore (20-119GRT)	**Middle sized** (20-199GRT) • Water cooler • Unload fresh fish • 2-10 days per cruise • Operate only in northern area
Distant water (120-GRT)	**Large sized** (200-GRT) • Brain freezer + deep freezer • Unload frozen fish • 30-50 days per cruise • Operate in both northern and southern areas

Number of registered vessel



- The highest total number of vessel was recorded in **1977 (PLOS: 377, PLDW: 245)**
- Number of vessel has been decreasing since **1982**
- Number of vessel in 2015 is (PLOS: 56 and PLDW:23)

Historical remarks for JPN PLDW

1972 – vessel size changed from 100-200 to 200-499 GRT due to fishing ground expansion

1980 – permit transition from PL license to PS

1981 – bait tank development live bait death due to high temperature in tropical

1987 – 1st bird radar development

1988 – NOAA receiver install

1991 – 2nd bird radar improvement

1992 – sonar improvement increase demand for fat and fresh SKJ and ALB

Plan for estimating standardized CPUE

- ✓ To consider each vessel's capability
  → identify as VesselID and include as one of main effect

- ✓ Delta-lognormal model (Lo et al., 1992)

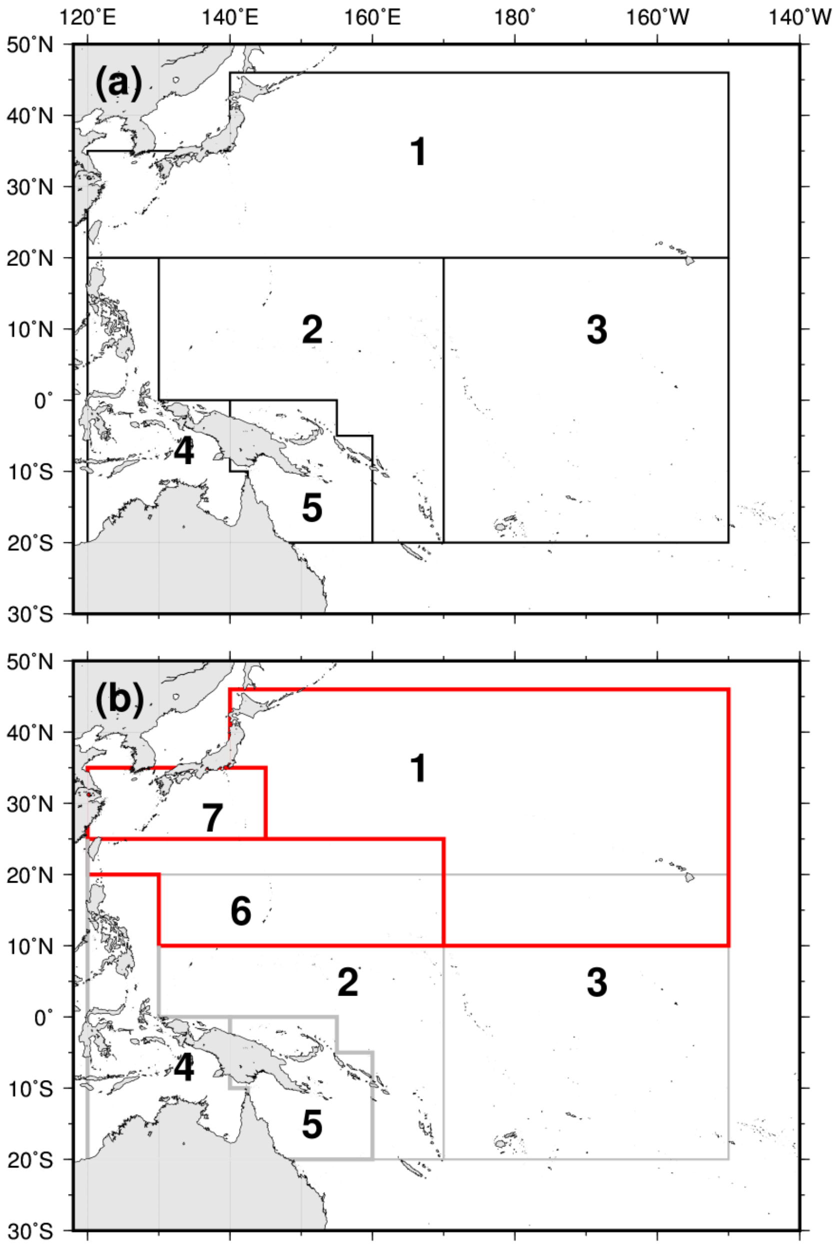
1st Step: estimate non 0 catch ratio by the binominal model

The presence/absence of skipjack catches for a fishing day. The dependent variables were modeled using a binomial error structure to estimate probability of non-zero skipjack catch for a fishing day.

2nd Step: estimate positive catch by the lognormal model

Non-zero skipjack catch for a fishing day after zero catch records have been excluded. The dependent variable was modeled assuming a lognormal error structure.

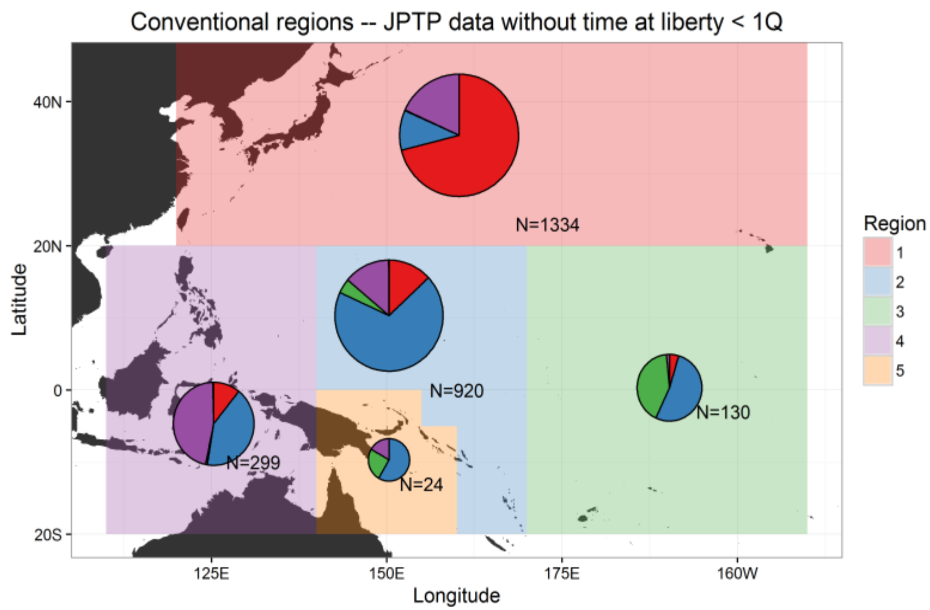
Area for CPUE in 2016 and alternative area (SA-IP-09)

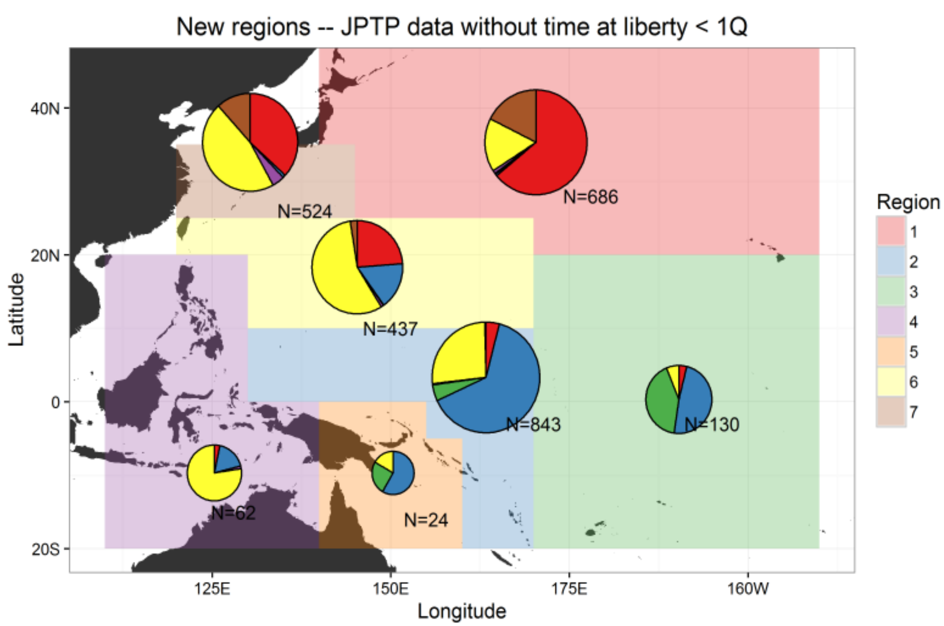


- ✓ 2016 areas are same as 2014 assessment
- ✓ Area1: PLOS
- ✓ Area 2 and 3 : PLDW

- ✓ Western subtropical area were added because of recent Japanese tagging program to improve stock connectivity and movement
- ✓ Northern boundary of tropical area (region 2 and 3) was down to south (10N)

Recaptured skipjack aggregated by release areas





- ✓ **Data from JPTP only**
- ✓ **Pie chart represent number of recaptured tag and colors represent release area**
- ✓ **Most of the recaptured tag were released in same area of the 2014 stock assessment**
- ✓ **Number of recaptured tags were increased from newly added area (subtropical: yellow)**
- ✓ **This newly added area can be expected to improve stock connectivity among areas.**

Data processing

2014 and 2016 assessment

1. Extract distant water and offshore vessel from logbook data in region2 and 3, and reion1, respectively
2. Individual Vessel were identified by license number and ship name.
3. A reference table with year, ship name and license number has been created in each year.
4. This table was used to create a unique vessel index in the logsheet dataset.
5. The few logsheet records that had no associated record in the vessel reference table were deleted from the data set.
6. Vessel for analyzing defined as operating five years continuously and more than ten days a year. Delete data if the vessel was not satisfied these conditions. SKJ catch less than 25% of SKJ and ALB are also removed as targeting albacore.

For 2016 alternative area

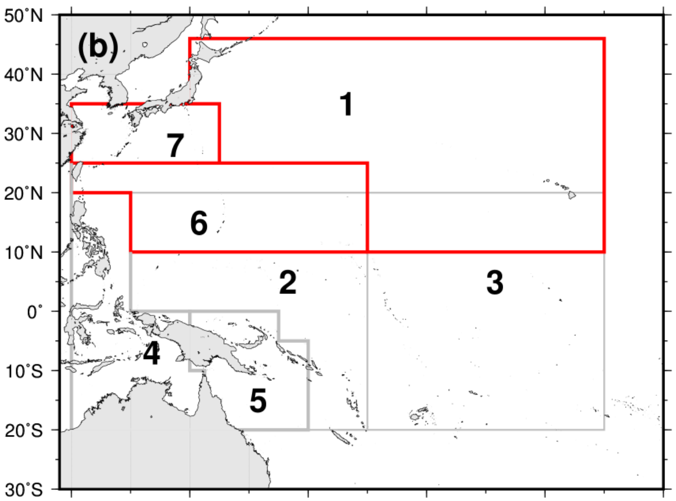
7. Core data are extracted vessels which operated more than 30 years which are expected to be more clear than the all data

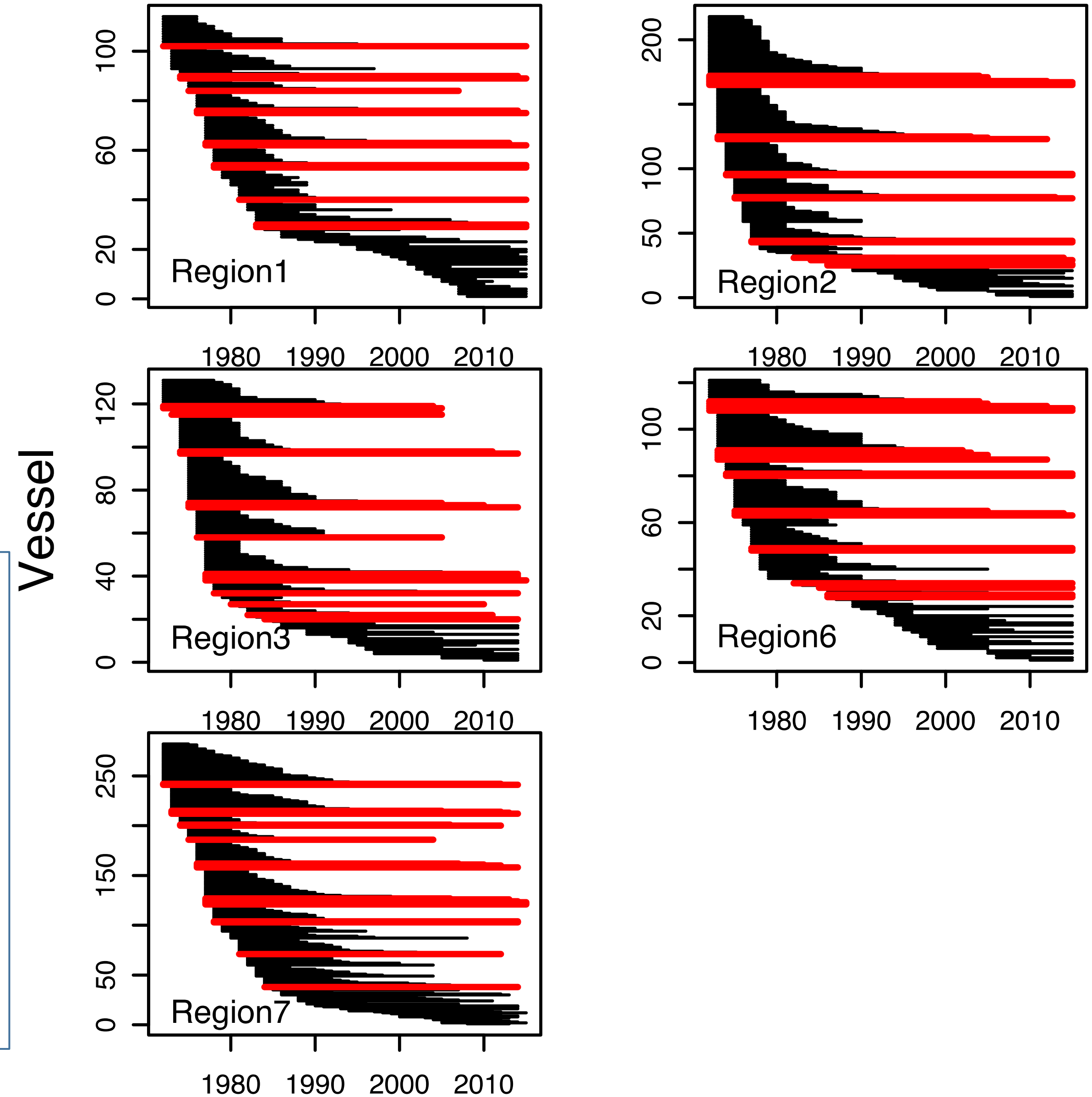
Vessel ID

- Vessel ID of individual fleet identified by the license number from logsheet were assigned to evaluate fishing strategy or skippers experiences through the period.
- When vessel change target species, large changes possibly occur in the catch rate of target species. Vessel effect potentially represent factors that are likely affect fishing ability.
- This analysis can estimate changes in each fleet's fishing capacity from the beginning of new vessels until retirement with low catch rates.
- It can also account for changing levels of fishing by different fishing techniques and targeting strategies.
- If the average vessel effect for a year is above average, then a model with vessel effects will give a lower abundance index for that year than a model without vessel effects.

Time distribution of each unique vessel in each region

(Black: All data, Red: vessels operated more than 30 years)





- ✓ Number of core vessel was approximately 1/10 relative to number of vessel of all available data.
- ✓ Focusing simply on years before 1990, approximately 50 - 60% of vessels closed fisheries.

Modeling for estimating standardized CPUE

$$CPUE(PLDW) = YearQtr + VesselID + LatLong + NumPoles + Device + \mu$$
$$CPUE(PLOS) = YearQtr + VesselID + LatLong + NumPoles + \mu$$

Table 1. Definition of the predictor variables included in the model. JPPL offshore (PLOS; fleet size $\leq$ 200). Region1 for 2014 SA area and Region1 and 7 for 2016 alternative spatial structure.

Variable	**Data Type**	**Description**
YrQtr	Categorical	Unique year and quarter (2 and 3)
latlong	Categorical	5° of latitude and longitude spatial strata (midday position)
VesselID	Categorical	Unique vessel identifier
NumPoles	Continuous	Number of Poles

Table 2. Definition of the predictor variables included in the model. JPPL distant water (PLDW; fleet size $>$ 200). Region2 and 3 for 2014 SA area and Region 2, 3 and 6 for 2016 alternative spatial structure.

Variable	**Data Type**	**Description**
YrQtr	Categorical	Unique year and quarter
latlong	Categorical	5° of latitude and longitude spatial strata (midday position)
VesselID	Categorical	Unique vessel identifier
NumPoles	Continuous	Number of Poles
Bait Tank (BT)	Categorical (2)	1. Vessel does not have bait tank
		2. Vessel has bait tank
NOAA (NOA)	Categorical (2)	1. Vessel does not have NOAA receiver
		2. Vessel has NOAA receiver
Sonar (SN)	Categorical (2)	1. Vessel does not have sonar
		2. Vessel has sonar
Bird Radar (BR)	Categorical (3)	1. Vessel does not have any bird radars
		2. Vessel has 1^{st} or 2^{nd} generation bird radar

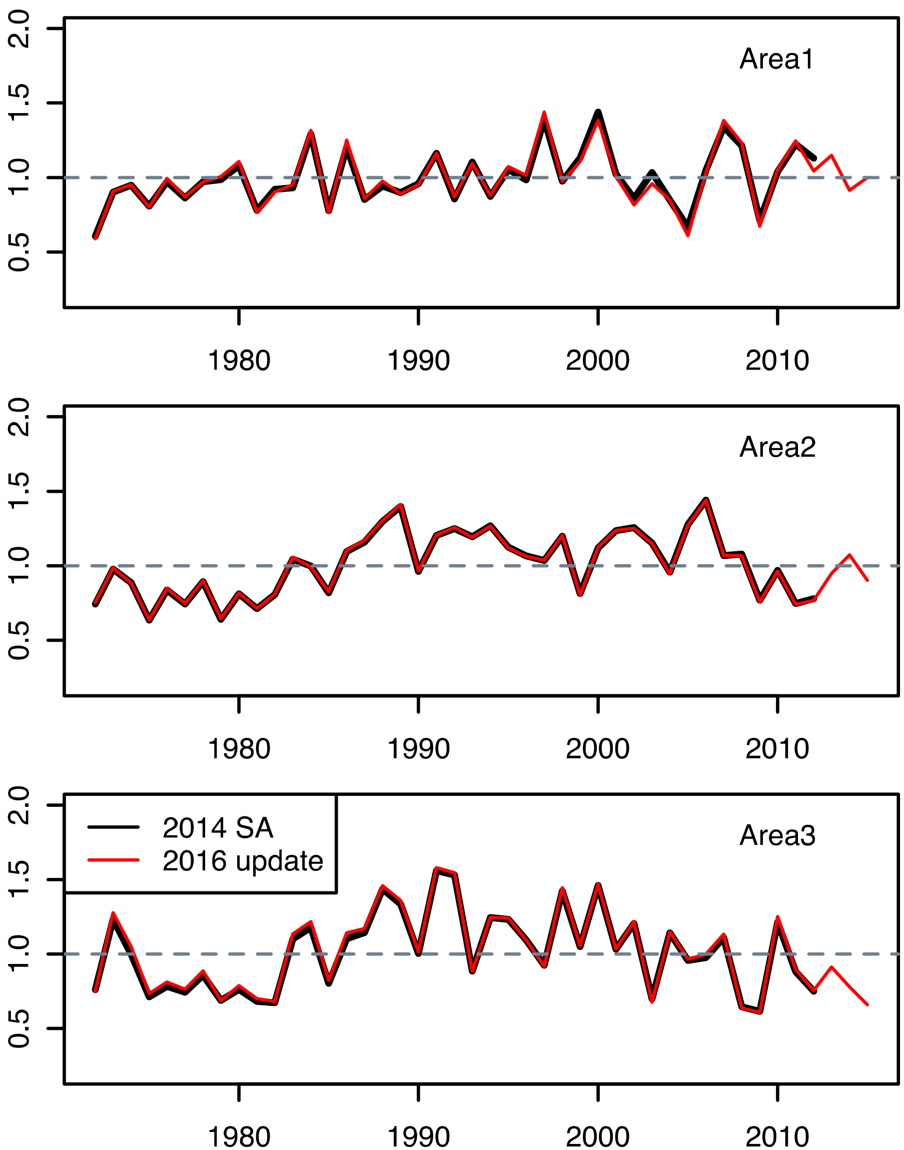
Summary of the final model configuration in 2014, 2016 and 2016 alternative area

	2014 SA	2016 SA (2014 SA area)	2016 alternative SA
Region1 (PLOS)			
[all data]			
binominal		$yrqtr + latlon + vID + poles$	
positive logn		$yrqtr + latlon + vID + poles$	
[core data]			
binominal	-	-	$yrqtr + latlon + vID$
positive logn	-	-	$yrqtr + latlon + vID$
Region2 (PLDW)			
[all data]			
binominal	$yrqtr + latlon + vID + SN + BR$	$yrqtr + latlon + vID + SN$	
positive logn		$yrqtr + latlon + vID + poles + BT + BR$	
[core data]			
binominal	-	-	$yrqtr + latlon + vID + poles$
positive logn	-	-	$yrqtr + latlon + vID + poles + BT$
Region3 (PLDW)			
[all data]			
binominal		$yrqtr + latlon + vID + BR$	
positive logn	$yrqtr + latlon + vID + poles + BT + BR$	$yrqtr + latlon + vID + poles + BR$	
[core data]			
binominal	-	-	$yrqtr + latlon + vID + BT$
positive logn	-	-	$yrqtr + latlon + vID + poles + BT + BR$
Region6 (PLDW)			
[all data]			
binominal	-	-	$yrqtr + latlon + vID$
positive logn	-	-	$yrqtr + latlon + vID + poles + BR$
[core data]			
binominal	-	-	$yrqtr + latlon + vID + poles$
positive logn	-	-	$yrqtr + latlon + vID + poles + BT + BR$
Region7 (PLOS)			
[all data]			
binominal	-	-	$yrqtr + latlon + vID + poles$
positive logn	-	-	$yrqtr + latlon + vID + poles$
[core data]			
binominal	-	-	$yrqtr + latlon + vID$
positive logn	-	-	$yrqtr + latlon + vID + poles$

- Final models were chosen based on the results of reduction of parameters from the full model (included all devices)
- model selection was made by the Akaike information criterion (AIC)

Delta-lognormal indices in each region (2016 area)

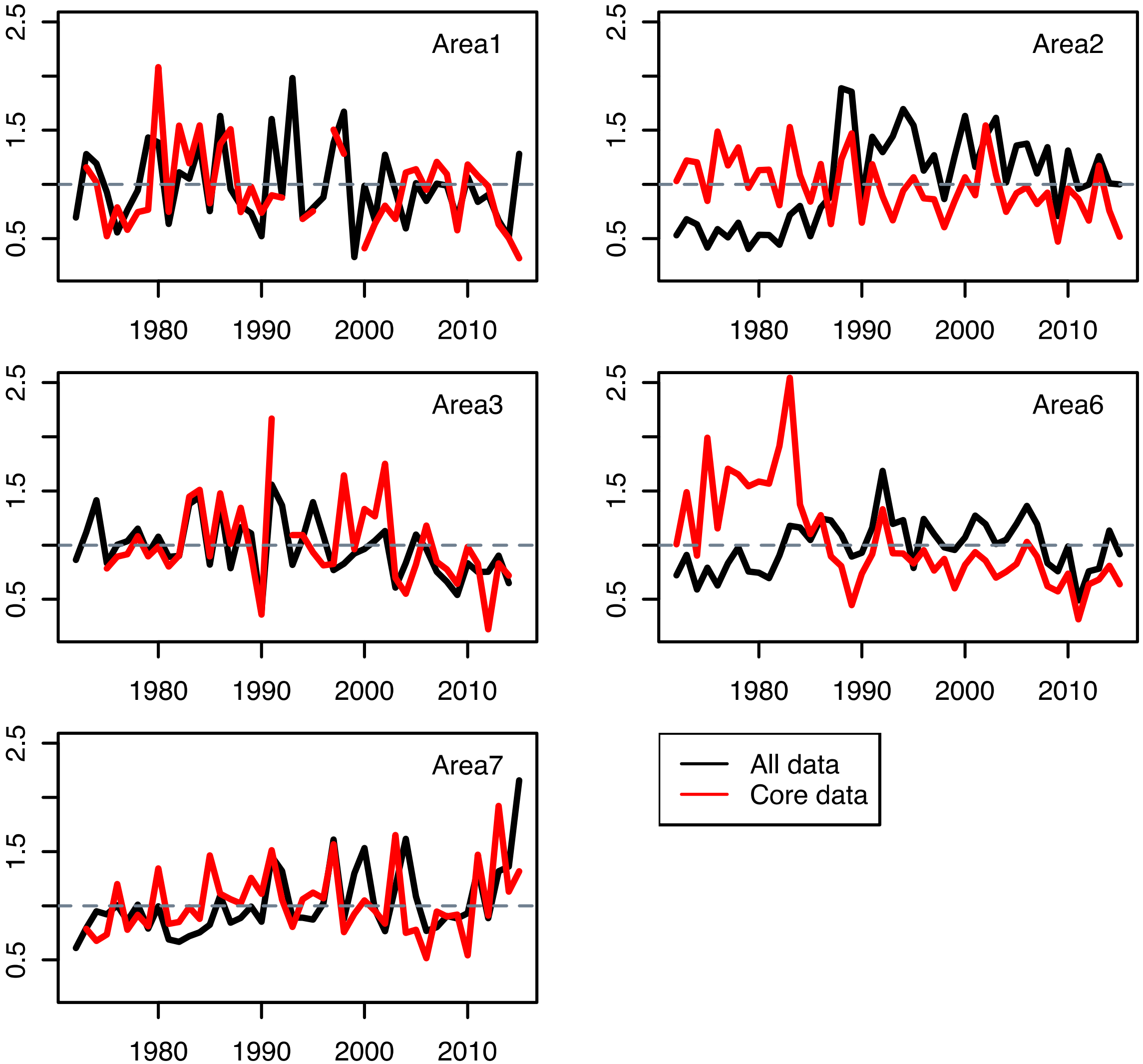
(Black: indices in 2014, Red: indices in 2016)



- ✓ **Overall trends in each region are similar between 2014 and 2016**
- ✓ **Stable but recent changes after 2000 tend to be larger**
- ✓ **Relatively decrease trend was identified after end of 1980's in region 2**
- ✓ **Decrease trend after 1990's was clear in region 3**

Delta-lognormal indices in 2016 alternative area

(Black: all data, Red: core data)



- ✓ Overall trends in region 1, 3 and 7 are similar between all data and core data
- ✓ CPUE in Region 1 decreased its level about ¼ after 2000
- ✓ Both CPUE in Region3 shows continuous decreasing trend through the period
- ✓ Both CPUE in Region7 is stable but increasing after 2010.
- ✓ Trends in region2 and 6 were different, especially before and after middle of 1980's.
- ✓ Continuous decrease in region2
- ✓ sharp drop in middle of 1980 in region6 and keep declining after 1990.

(some signal of the range contraction?)

Summary

- **Skipjack abundance indices by the JPN PL fisheries in the WCPO were updated until 2015 in same area definition in 2014 stock assessment.**

- **No large changes of CPUE were identified between 2014 and 2016 .**

- **CPUE for alternative spatial structure was also estimated using all data and core data that vessel operated for more than 30 years.**

- **Significant differences were identified between CPUE by all data and core data in alternative spatial structure. CPUE by core data before 1990 was larger than CPUE by all data especially in region2 (western tropical) and 6 (western subtropical). This is because there are many vessels operated less than 10 years, which might have bias to estimate CPUE during that period.**

- **CPUE by core data should be used for stock assessment because much clear data have exceptional prospects as input data to represent as abundance index.**