AN EXPLORATION INTO JAPANESE SIZE DATA OF TROPICAL TUNA SPECIES BECAUSE OF A PROMINENT SIZE-FREQUENCY RESIDUAL PATTERN IN THE STOCK ASSESSMENT MODEL

Document SAC-07-03d

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Collaborative work between NRIFSF and IATTC

7th Meeting of the Scientific Advisory Committee La Jolla, 9-13 May 2016

Introduction

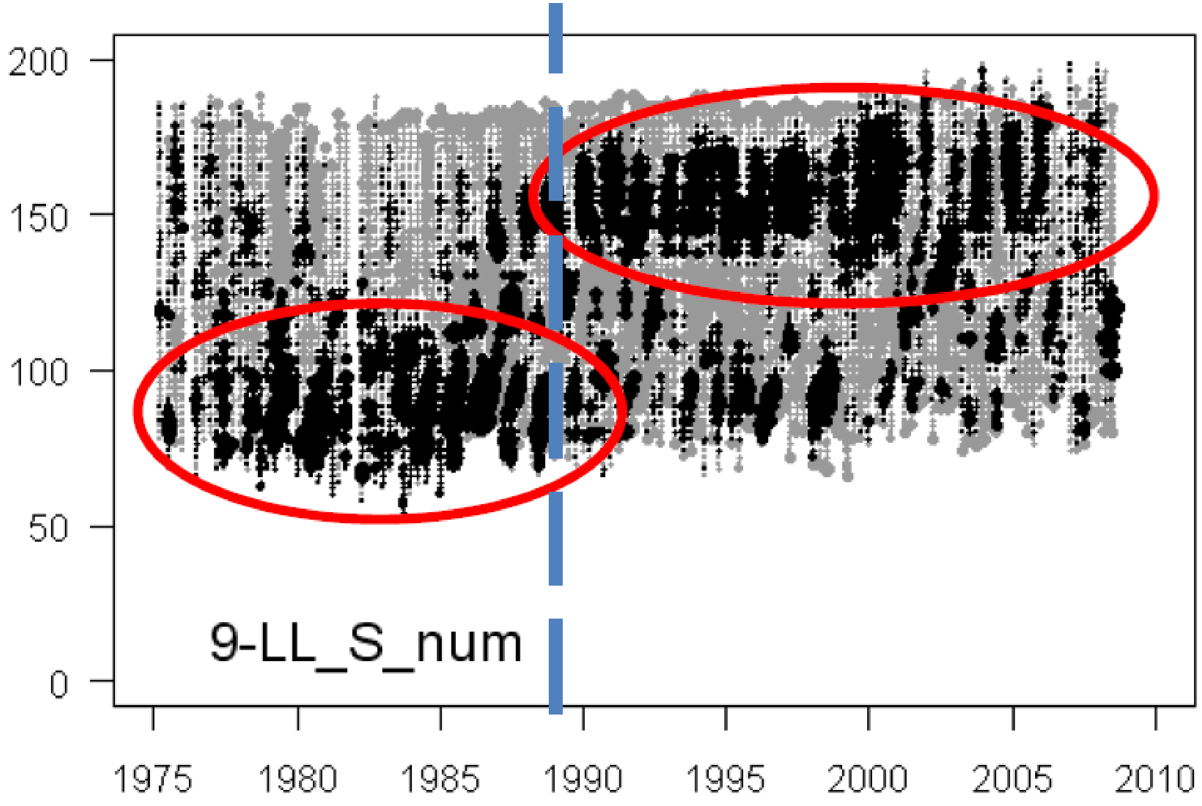
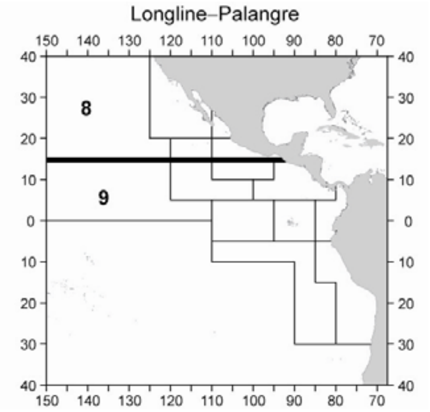


Figure 12 of the document BET-01-05 (2010) at external review of IATTC bigeye tuna assessment in 2009

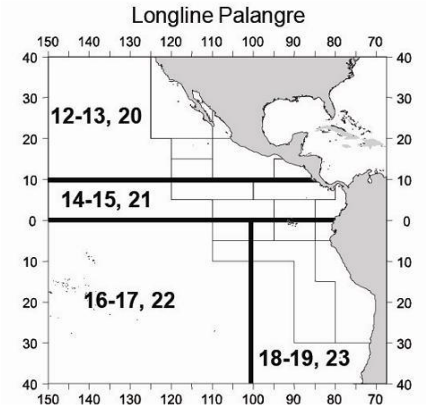
- ✓ A prominent residual pattern in the size frequencies of LL (Japanese LL).
- ✓ Japanese LL fishery seems to have suddenly begun to catch larger fish after 1990.
- ✓ The size-composition are very influential on parameter estimates and any resulting management advice.

Introduction

New spatial definitions

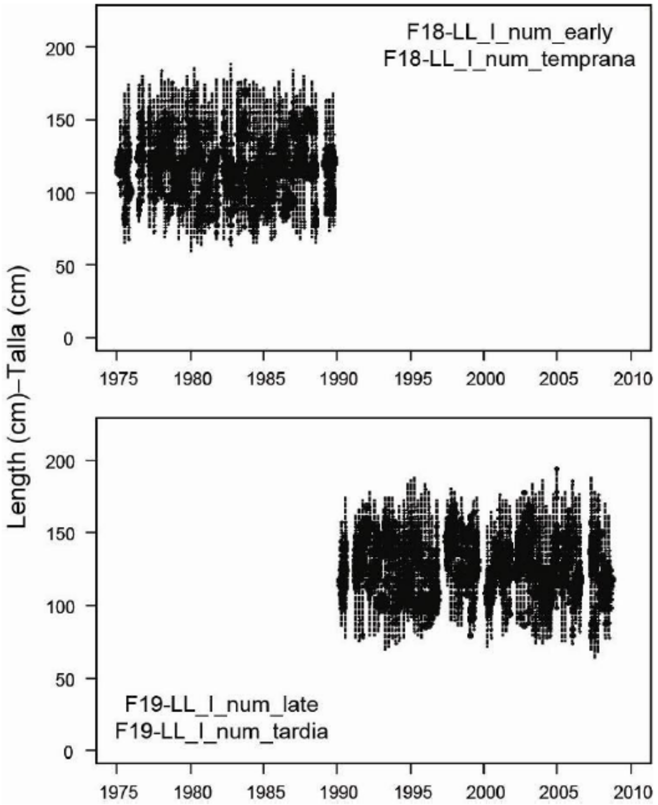


From figure 2.1 of document SARM 10-06b (2010)



From figure 2.1 of document SAC-01-08a (2011)

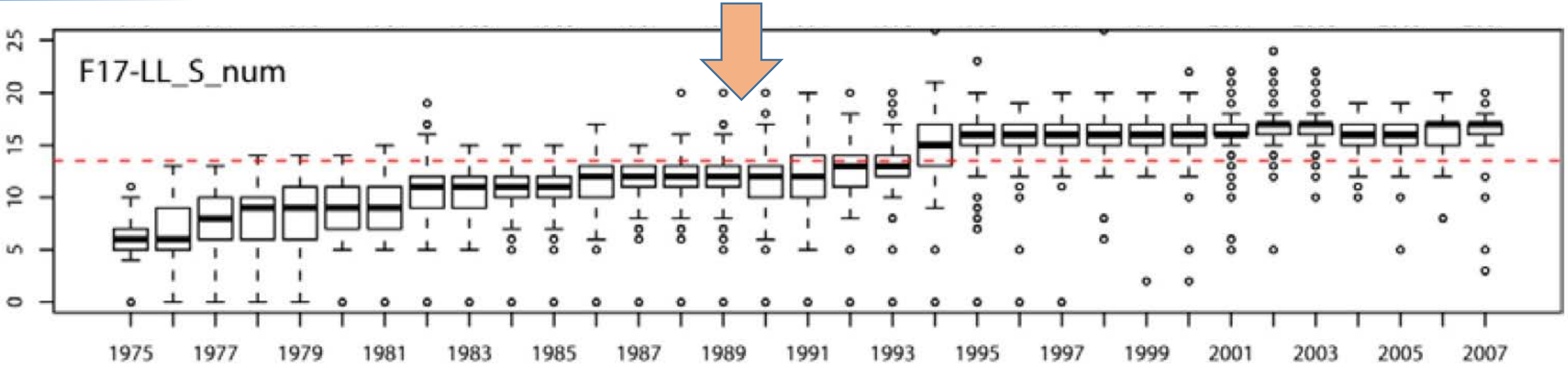
Time-varying selectivity



From figure 2.6f of document SAC-01-08a (2010)

- ✓ New spatial definitions (Lennert-Cody 2010, 2013)
- ✓ Time-varying selectivity (Aires-da-Silva *et al*. 2010)
- ✓ Implementing these attempts, prominent residual pattern was partially improved, but was not eliminated.

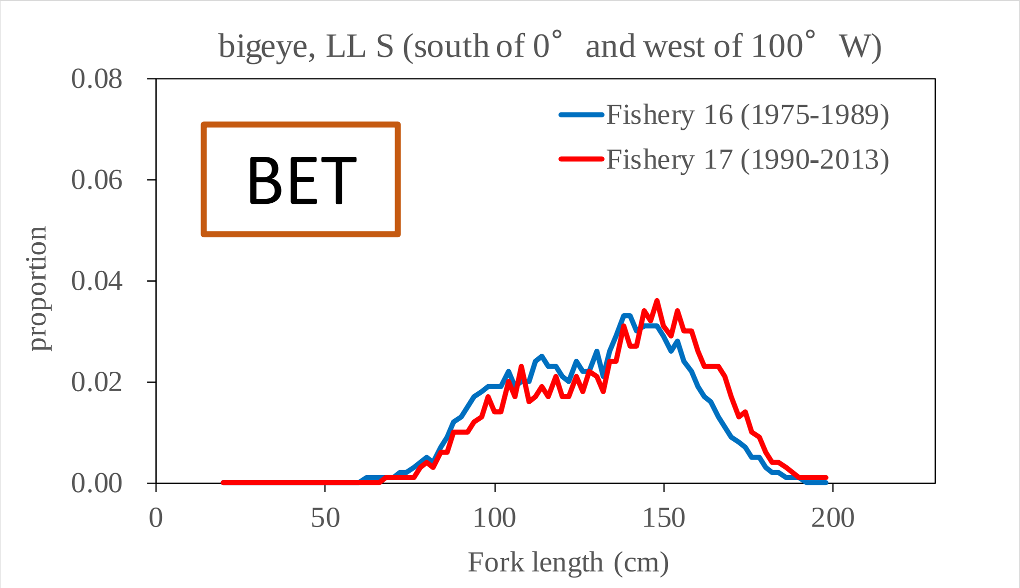
Introduction

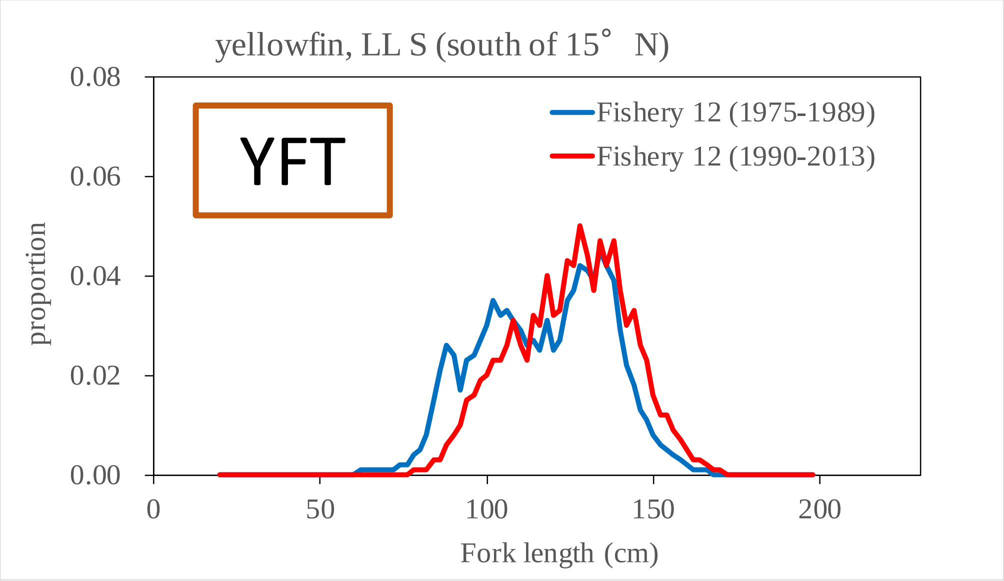


From figure 18 of document BET-01-05 (2010)

- ✓ Aires-da-Silva et al. (2010) hypothesized that the residual shift resulted from a change in operational practices (NHBF; the number of hooks between float) around 1990
- ✓ NHBF is often considered as a proxy for target species
- ✓ An increase in NHBF was observed around 1989-1990, but it was not abrupt.
- ✓ Thus, the change in fishing operations detected through NHBF is not considered the reason for the shift in residual in 1990.

Introduction





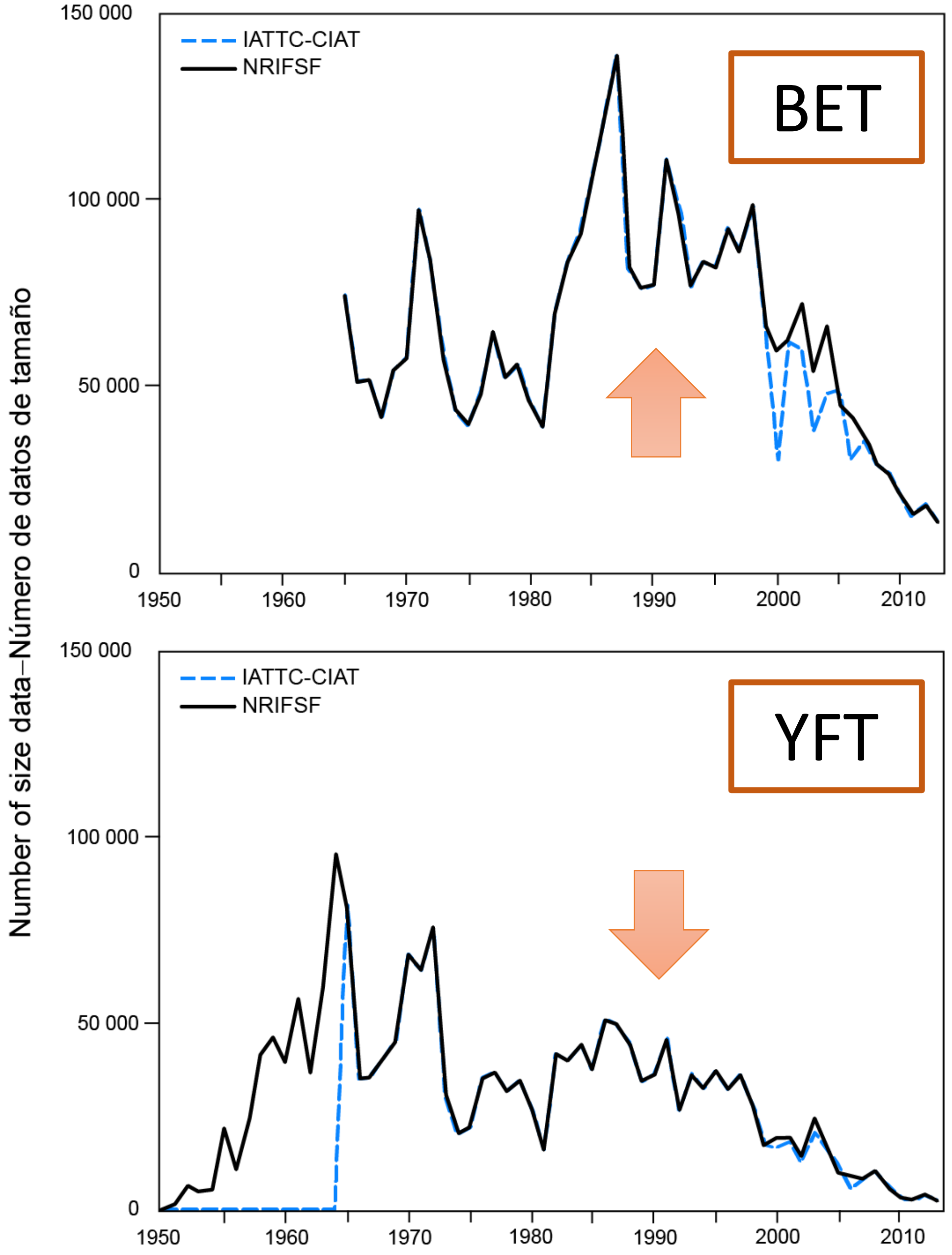
- ✓ In a preliminary investigation, similar differences in size composition were also detected for yellowfin.
- ✓ A clear explanation of the shift in size composition would improve the modelling.
- ✓ Collaborative work between the IATTC and Japan is needed to address the problem.

Length frequency of LL for two periods (early; 1975-1989 (blue line), later; 1990-2013 (red line)) of bigeye (upper panel) and yellowfin (lower panel) by area in the eastern Pacific Ocean. The area definition and fishery number is same those of the stock assessments in 2015.

Preliminarily comparison

- ✓ Preliminarily comparison between the IATTC and NRIFSF size data bases was conducted.
- ✓ If some discrepancies existed around 1990 between the two size data bases, it might be a reason for the residual shift.
- ✓ The detail results of the comparison are summarized in Appendix.

Preliminarily comparison



- ✓ Basically the two data-base showed good consistency except for 1999-2010.
- ✓ There are no large discrepancy around 1990 between the two databases.
- ✓ Around 2002 when the submitted spatial resolution has changed there could be some try and error for the compiling method of size data and then it leads to the lack of size data. (It had been already corrected)

Comparison of the number of Japanese longline size data for bigeye (upper panel) and yellowfin (lower panel) between the IATTC (dashed line) and NRIFSF (solid line) databases.

Hypotheses

Three hypotheses to explain the size composition shift are developed

①Change in Japanese LL fishing strategies, such as selection of fishing ground and/or fishing season between the two periods (pre- and post 1990),

②Development of new fishing gear that affected the sizes of tuna caught around 1990, and

③Change in the size data collecting and reporting system around 1990.

Summary

① Change in Japanese LL fishing strategies, such as selection of fishing ground and/or fishing season between the two periods (pre- and post 1990) → No

② Development of new fishing gear that affected the sizes of tuna caught around 1990 → No

③ Change in the size data collecting and reporting system around 1990

1. Commercial vs. training → No (but it is important to specify the vessel type for submitted size ata for better estimation of selectivity)
2. Unit of fish size (weight vs. length) → Yes !

Hypotheses

Three hypotheses to explain the size composition shift are developed

①Change in Japanese LL fishing strategies, such as selection of fishing ground and/or fishing season between the two periods (pre- and post 1990),

②Development of new fishing gear that affected the sizes of tuna caught around 1990, and

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HYPOTHESIS 1: Change in Japanese LL fishing strategies, such as selection of fishing ground and/or fishing season

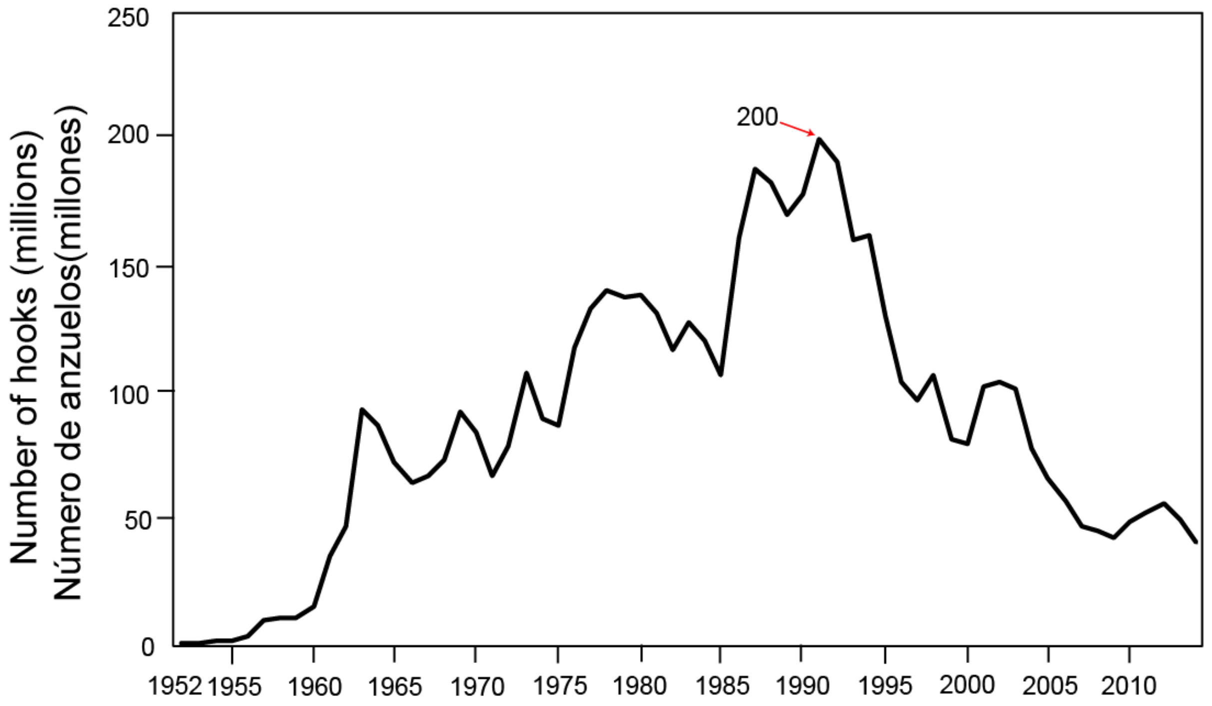


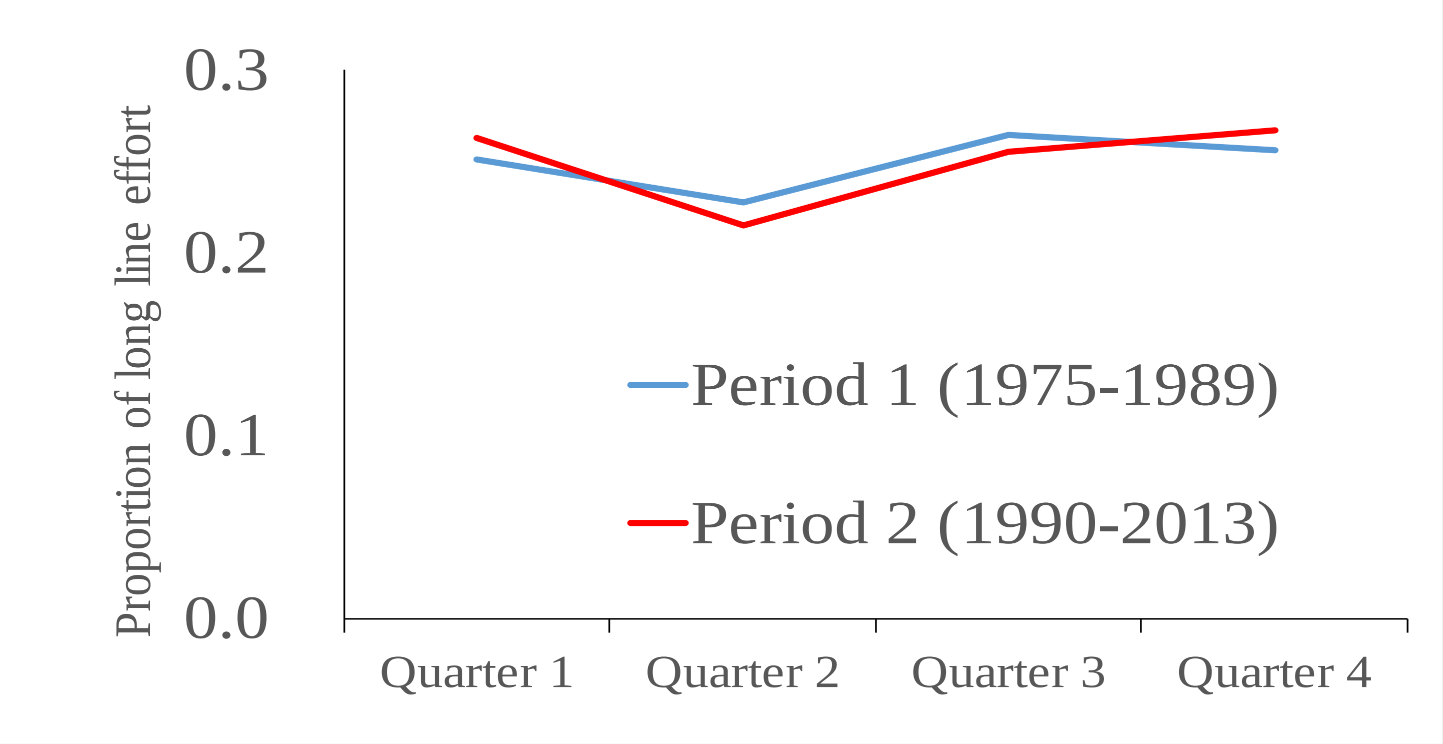
Figure 2.1. Historical changes in number of hooks in the Japanese longline fishery in the eastern Pacific Ocean, 1952-2014. The historical highest number of hooks recorded was 200 million in 1991.

Rational explanation for the hypothesis

- ✓ The number of Japanese longline hooks deployed in the EPO reached its highest historical level in 1991, since when it decreased, with some fluctuations, and fell to 26% of its highest value in 2013.
- ✓ During this decreasing phase, changing the fishing strategy of selecting for the fishing ground spatially and temporally could affect the shift in size composition.

HYPOTHESIS 1: Change in Japanese LL fishing strategies, such as selection of fishing ground and/or fishing season

fishing season

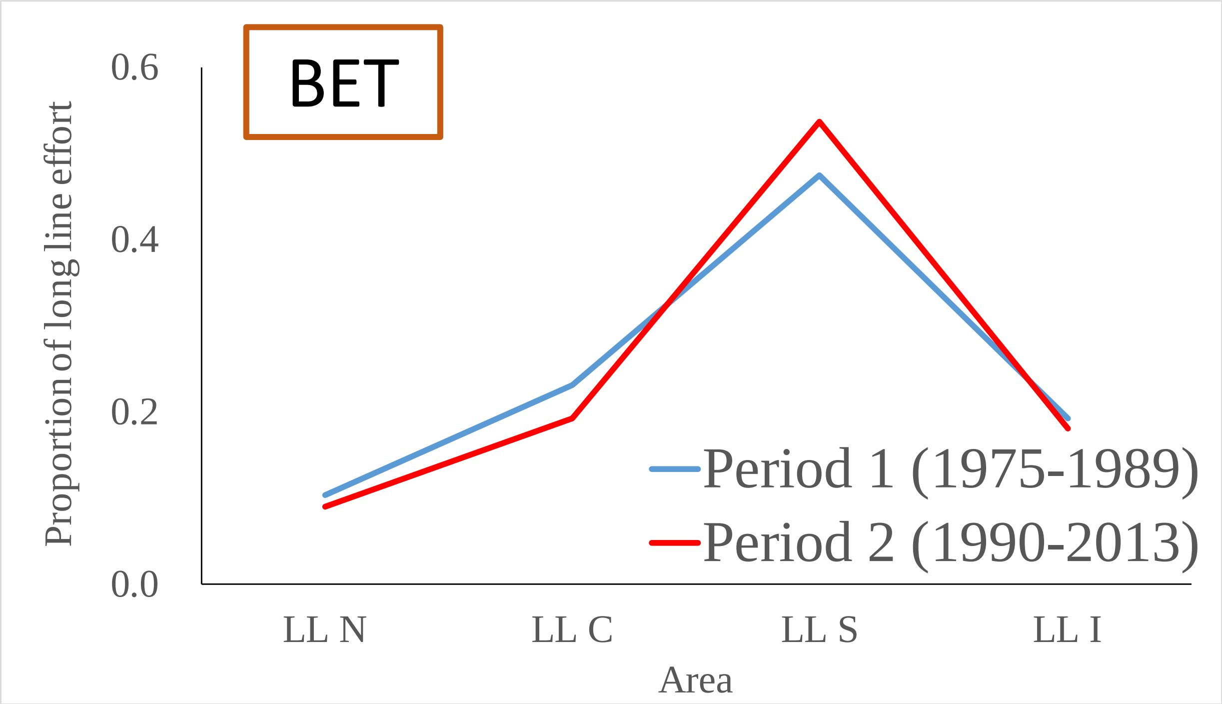


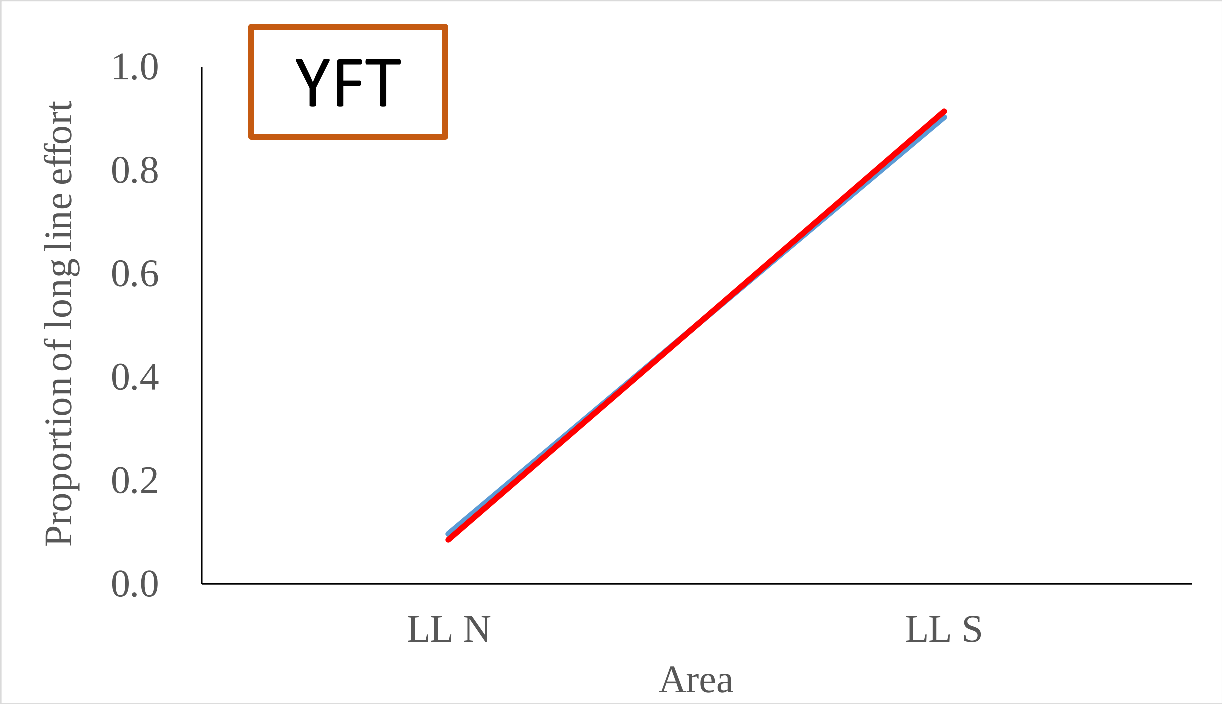
Figures from Table 1
Proportion of Japanese long line effort by season
Blue line (earlier period; 1975 to 1989) and red line (later period; 1990-2013)

- ✓ The difference in seasonal proportion of effort between the two periods was less than 1%, which indicates that the fishing schedule by quarter did not change between the two period.

HYPOTHESIS 1: Change in Japanese LL fishing strategies, such as selection of fishing ground and/or fishing season

fishing ground

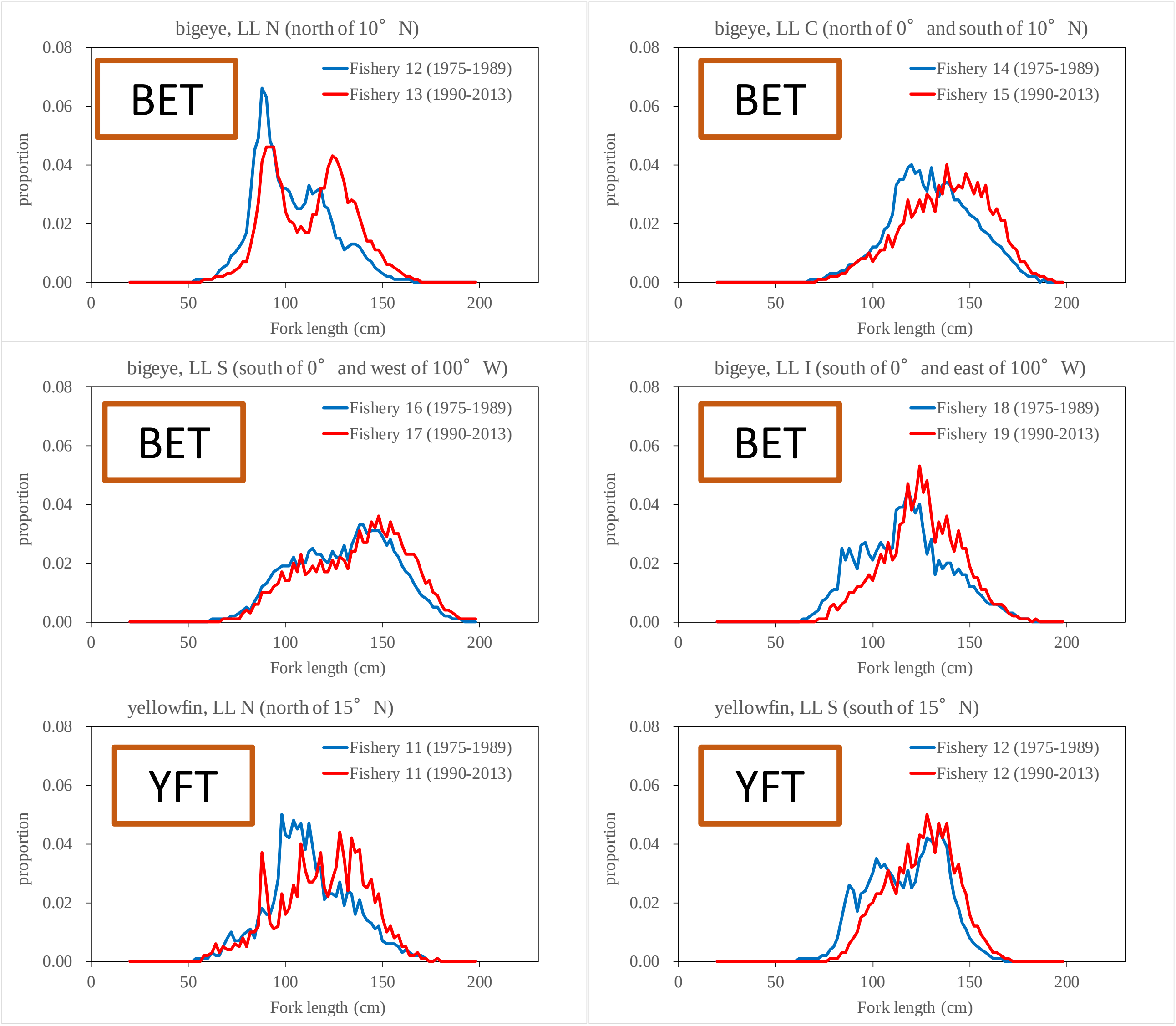




Figures from Table 1
Proportion of Japanese long line effort by fishing ground
blue line (earlier period; 1975 to 1989) and red line (later period; 1990-2013)

✓ The fishing effort slightly focused on the specific area (LL S for bigeye) in the later period

HYPOTHESIS 1: Change in Japanese LL fishing strategies, such as selection of fishing ground and/or fishing season



- ✓ The shift in size composition occurred in all areas.
- ✓ Thus, the change in spatial distribution of effort is not considered responsible for the size shift.

FIGURE 1. Length frequencies by area of bigeye (upper four panels) and yellowfin (lower two panels) during two periods (1975-1989 (blue line); 1990-2013 (red line)). The area definitions and fishery numbers coincide with those of the stock assessments in 2015.

Hypotheses

Three hypotheses to explain the size composition shift are developed

①Change in Japanese LL fishing strategies, such as selection of fishing ground and/or fishing season between the two periods (pre- and post 1990),

②Development of new fishing gear that affected the sizes of tuna caught around 1990, and

③Change in the size data collecting and reporting system around 1990.

HYPOTHESIS 2: Development of new fishing gear around 1990 that affected the size of tuna caught

はえなわの綿糸漁具とナイロン漁具との釣獲率(ＣＰＵＥ)の比較について

近年、各分野においてナイロン製品の進出がめざましく、水産業界でもその使用が広い分野にわたって普及している。はえなわ漁業においても、1975年頃より漁具の一部（枝縄、せきやま、釣元ワイヤー）がナイロンテグス製品に変わり、1989年より小型はえなわ船が、幹縄も含めてすべてがナイロンテグス（表1）を使用し始めた。現在では中型船の一部と小型船のおよそ90％がナイロンテグス漁具を使用しているといわれている。従来から使用されている「綿糸漁具」と近年に使用され始めた「ナイロンテグス漁具」との漁獲効率を比較検討するために、水域と期間を選定して、ビンナガ及びメバチのCPUE（100鈎当りの尾数）をとりまとめた。

表2は東沖漁場の30°〜35°N、140°〜150°E水域で、1989年11月〜12月に操業した資料を、表3には小笠原漁場の25°〜30°N、140°〜150°E水域で、1990年1月〜2月に操業した資材を基に計算したCPUEである。

両水域とも、ビンナガのCPUEはナイロン漁具が綿糸漁具のそれよりも2〜3倍高くなっている。メバチの東沖漁場におけるナイロン漁具のCPUEは、綿糸漁具よりも約2倍の値を示している。従来、メバチの魚群分布が薄い小笠原漁場でも、1990年の値を除けばナイロン漁具のCPUEが綿糸漁具よりも高く、全体としては、明らかにナイロン漁具の漁獲効率のよいことが分かる。

近い将来、中・大型船においてもナイロン漁具が普及すると、1970年代当初、メバチを対象に導入された深縄によってもたらされたCPUEの変化と同様に、まぐろ類に対する漁獲効率の向上が予測される。このことは、資源の相対指数としてのCPUEの取り扱いについて問題が生じ、従来の資源評価に大きく影響を与える。

したがって、今後はナイロン漁具に関する現場の情報を収集すると同時に、漁獲成績報告書への記入等、早急に対策を立てる必要があろう。

表1. 近海ナイロンテグスのはえなわ漁具の標準的な仕様

19 屯 型						
No.	品名	商品名	直径 M/M	1ハタ長さ M	本付	摘要
1	浮縄	テトロン φ3.0〜3.5 M/M	3.0〜3.5	7.5〜9.0	1	5〜6ヒロ（中古品使用）
2	幹縄	ナイロンテグス＃120	1.8	45〜50	11〜12	1200ハタ
3	枝縄	ナイロンテグス＃120	1.8	18〜20	11〜12	
4	積山	なし				
5	釣元	ナイロンテグス＃120	1.8	5M以下	11〜12	
6	サルカン	双葉（小）〜（中）			11〜12	
7	釣針	3.2寸〜3.4寸（死餌）			11〜12	生餌の場合 2.8寸〜3.0寸
8	浮玉	ABS赤玉 8寸	240 M/M		1	
9	幹連結	ナイロンテグス＃150 両端SBL 6 M/付	2.02		11〜12	
10	スナップ	2.6×100 M/M フック0φ			11〜12	

— 35 —

Rational explanation for the hypothesis

- ✓ NRIFSF and a predecessor of NRIFSF interviewed fishing masters at several Japanese landing ports and published the results routinely.
- ✓ According to one of the reports (left panel) described that mainlines made of nylon had been introduced and rapidly spread in commercial fishing operations near Japan (east of 140°E) instead of the traditional main line around 1990.

HYPOTHESIS 2: Development of new fishing gear around 1990 that affected the size of tuna caught

TABLE 1. Annual estimates of Japanese longline effort and logbook coverage in the eastern Pacific Ocean (EPO).
TABLA 1. Estimaciones anuales del esfuerzo de barcos palangreros japoneses y cobertura de los cuadernos de bitácora en el Océano Pacífico oriental (OPO).

Year / Año	Unit / Unidad	Gross registered tonnage / Tonelaje bruto registrada 50-100	100-200	200-500	Total	Hooks per set / Anzuelos por calada	Logbook coverage (percent) / Cobertura de bitácoras (porcentaje)
1988	Hooks—anzuelos	369,600	17,060,665	165,263,954	182,694,219	2605.9	95.6
	Sets—caladas	132	6,526	63,450	70,107		
	% of sets—de caladas	0.2	9.3	90.5			
1989	Hooks—anzuelas	57,600	18,910,573	151,404,922	170,373,095	2614.3	96.6
	Sets—caladas	18	7,252	57,900	65,170		
	% of sets—de caladas	0.0	11.1	88.8			
1990	Hooks—anzuelas	0	18,041,208	160,378,250	178,419,458	2607.9	96.7
	Sets—caladas	0	6,937	61,479	68,415		
	% of sets—de caladas	0.0	10.1	89.9			
1991	Hooks—anzuelos	2,145	15,246,471	185,116,085	200,364,701	2575.6	96.5
	Sets—caladas	1	6,059	71,732	77,792		
	% of sets—de caladas	0.0	7.8	92.2			
1992	Hooks—anzuelos	0	15,416,631	175,867,078	191,283,709	2508.9	93.9
	Sets—caladas	0	6,136	70,107	76,242		
	% of sets—de caladas	0.0	8.0	92.0			

From Table 1 of Uosaki and Bayliff (1999)
We can find very high proportion (around 90%) of large size vessel (200-500 GRT) operated from 1988 to 1992 in the EPO

- ✓ Unfortunately, the report did not directly mention the situation of the new gear in the EPO, but certain descriptions in the report suggest that it was not very popular with the larger vessels in 1990.
- ✓ At that time the Japanese longline vessels in the EPO were almost all larger vessels (Uosaki and Bayliff 1999).

HYPOTHESIS 2: Development of new fishing gear around 1990 that affected the size of tuna caught

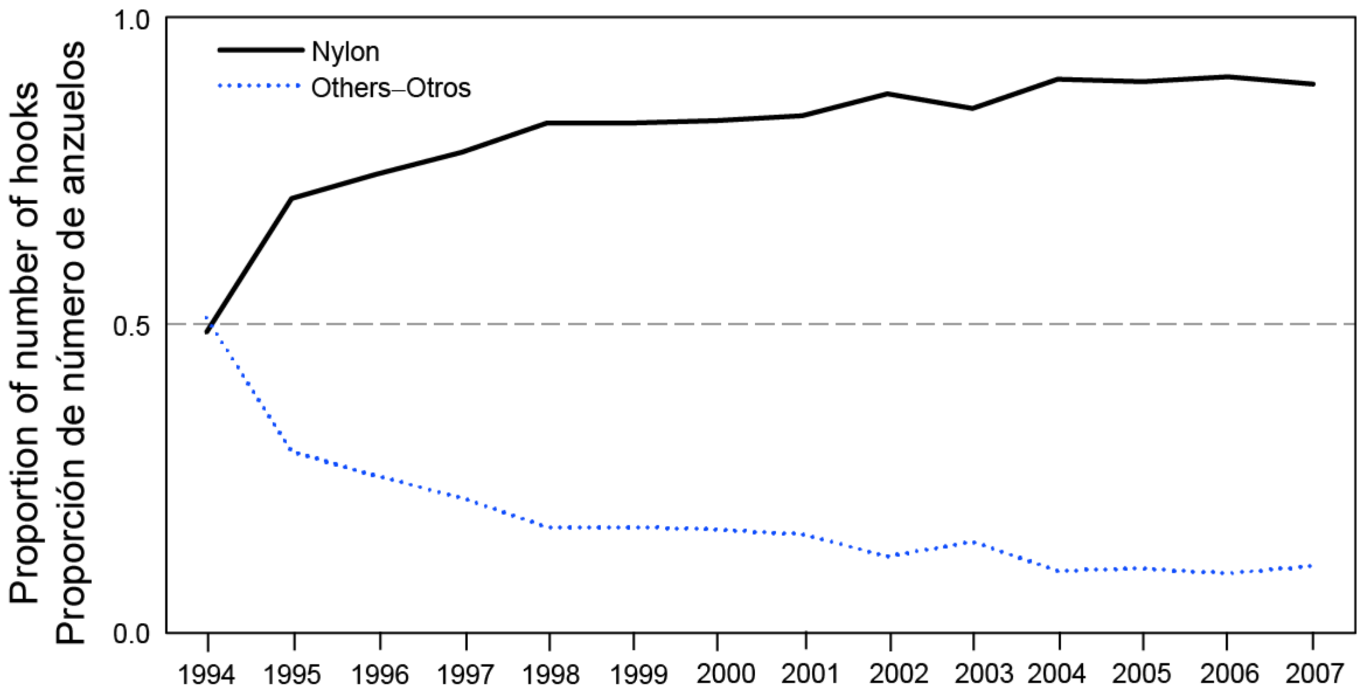


FIGURE 3. Proportion of hooks by main line material, 1994-2007

- ✓ Because the material of the main line was added to the items of mandatory logbook in 1994, subsequent historical changes in the application of the nylon gear can be traced.
- ✓ The proportion of nylon gear was around 50%, and increased gradually to around 90% in 2007.
- ✓ Thus the new gear was apparently not popular for larger longline vessels in the EPO in 1990.

HYPOTHESIS 2: Development of new fishing gear around 1990 that affected the size of tuna caught

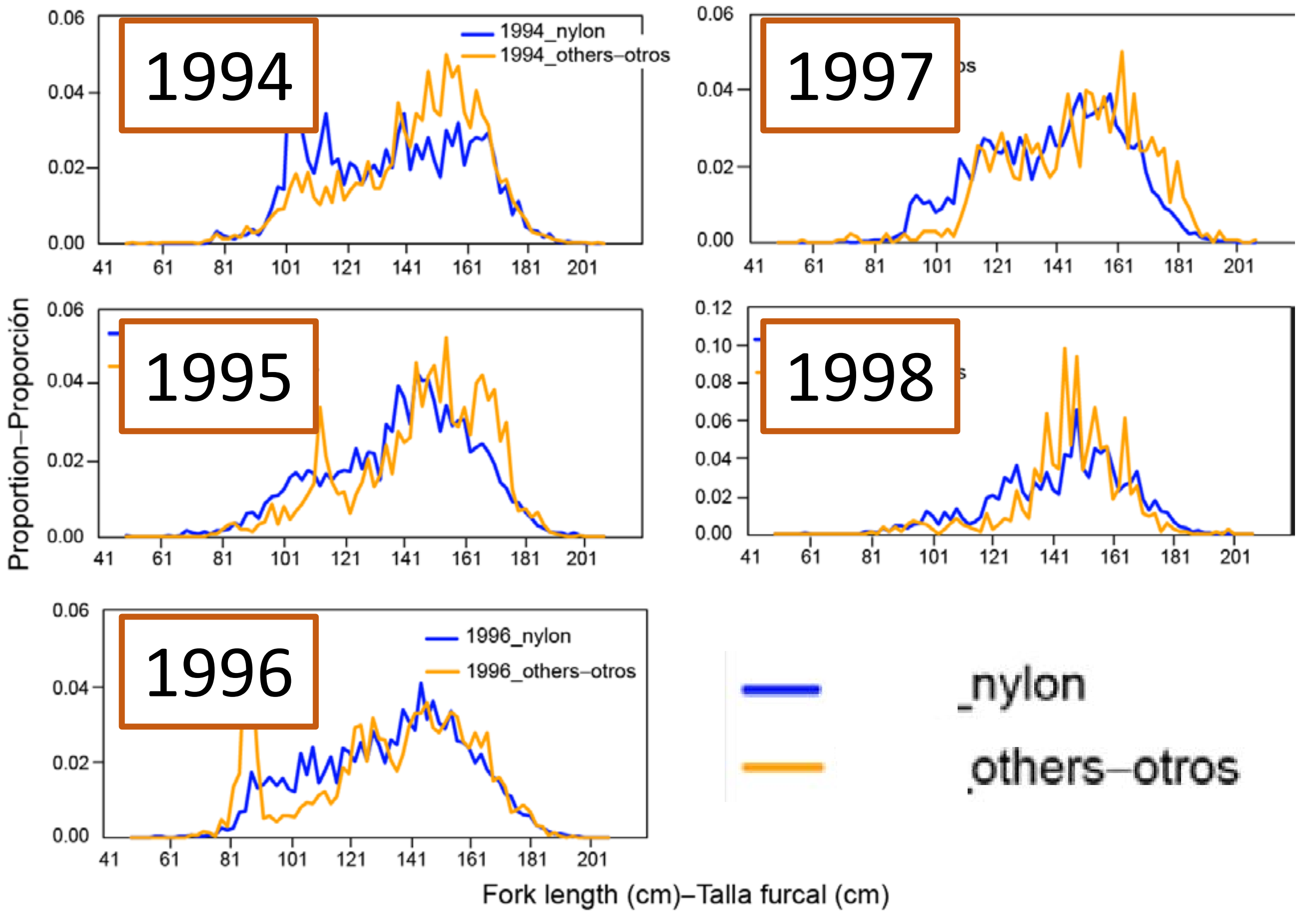


FIGURE 4.1. Length frequencies of bigeye caught by year and material of main line (blue; nylon, orange; others (including traditional *kuronawa*)), 1994-1998. Excludes length data converted from weight.

- ✓ In addition, there were no clear differences in the annual length frequencies by main line material.
- ✓ Thus, the main line material did not much affect the size of fish caught.

Hypotheses

Three hypotheses to explain the size composition shift are developed

① Change in Japanese LL fishing strategies, such as selection of fishing ground and/or fishing season between the two periods (pre- and post 1990),

② Development of new fishing gear that affected the sizes of tuna caught around 1990, and

③ Change in the size data collecting and reporting system around 1990.

HYPOTHESIS 3: Change in the size data collecting and reporting system around 1990

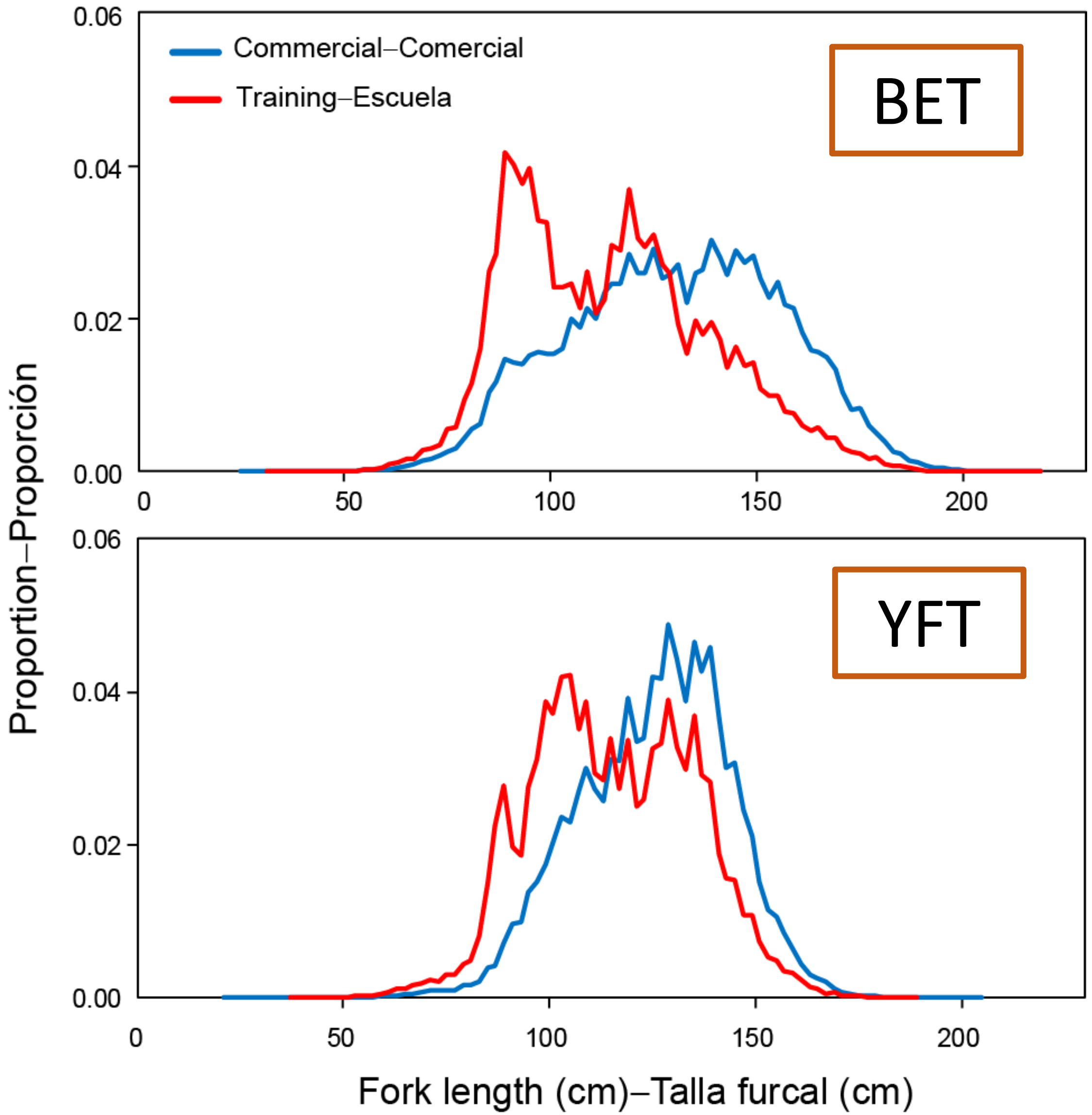
Rational explanation for the hypothesis

- ✓ In preliminary comparison between two data-bases of IATTC and NRIFSF, the two things were recognized.
- ✓ The vessel type (commercial or training) was not specified in the size data submitted, and also
- ✓ Until 2010, the raw weight data were converted to lengths before being submitted.
- ✓ There were two components to be investigated, the vessel type (commercial or training) and the unit of fish size (weight or length).

* training vessel; Vessels belonging to the Japanese local governments that are used for teaching fisheries and training vessel crews

HYPOTHESIS 3: Change in the size data collecting and reporting system around 1990

Commercial vs. training vessels

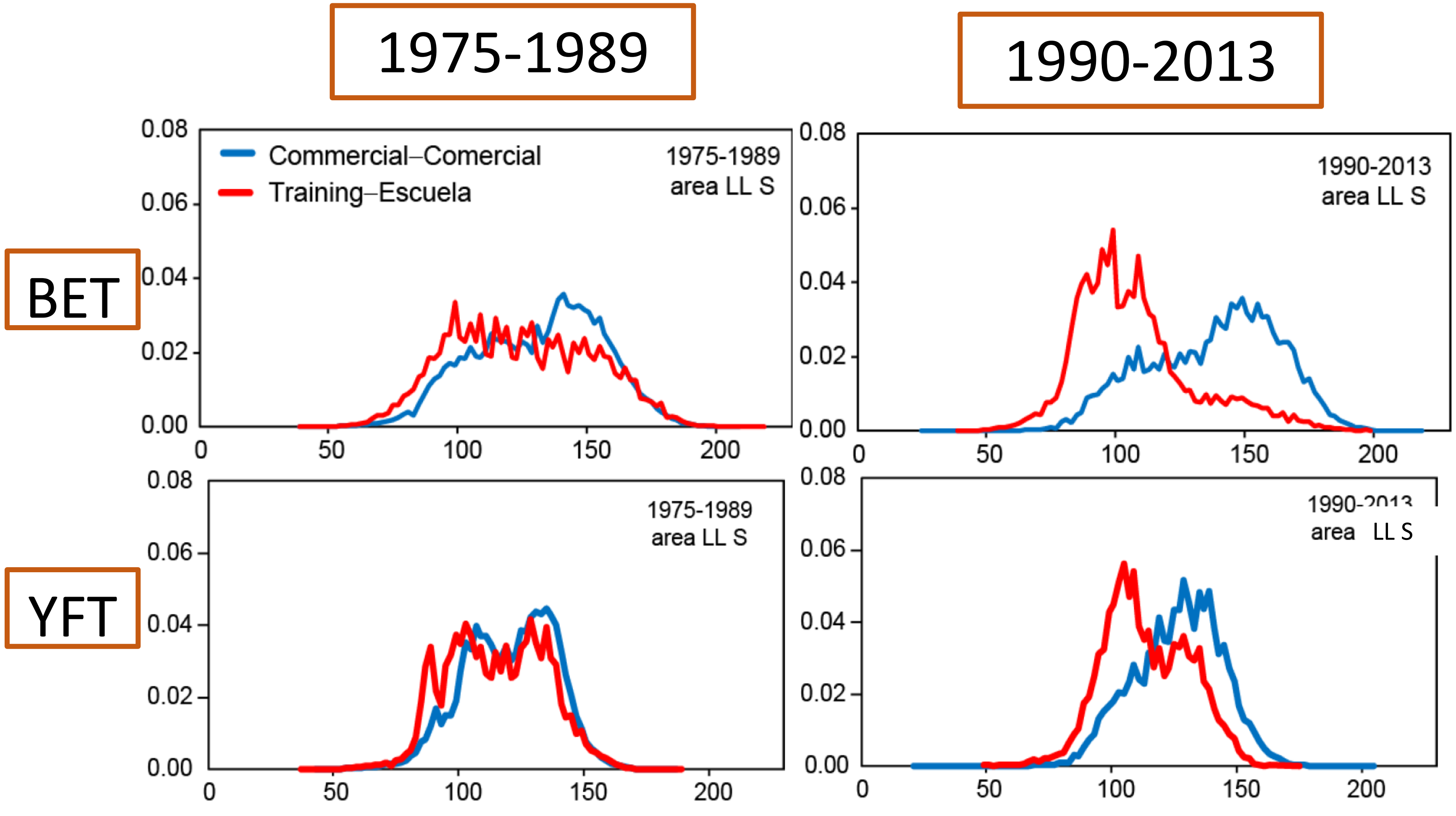


- ✓ A comparison of length frequencies of bigeye by vessel type showed a lower proportion of 80-100 cm fish, and a higher proportion of fish over 140 cm, for the commercial vessels
- ✓ Yellowfin from commercial vessels showed higher proportions of fish over 120 cm compared to those from training vessels.

FIGURE 5.3. Comparison of length-frequencies of bigeye (top panel) and yellowfin (bottom panel) between commercial vessels (blue line) and training vessels (red line), 1975-2013.

HYPOTHESIS 3: Change in the size data collecting and reporting system around 1990

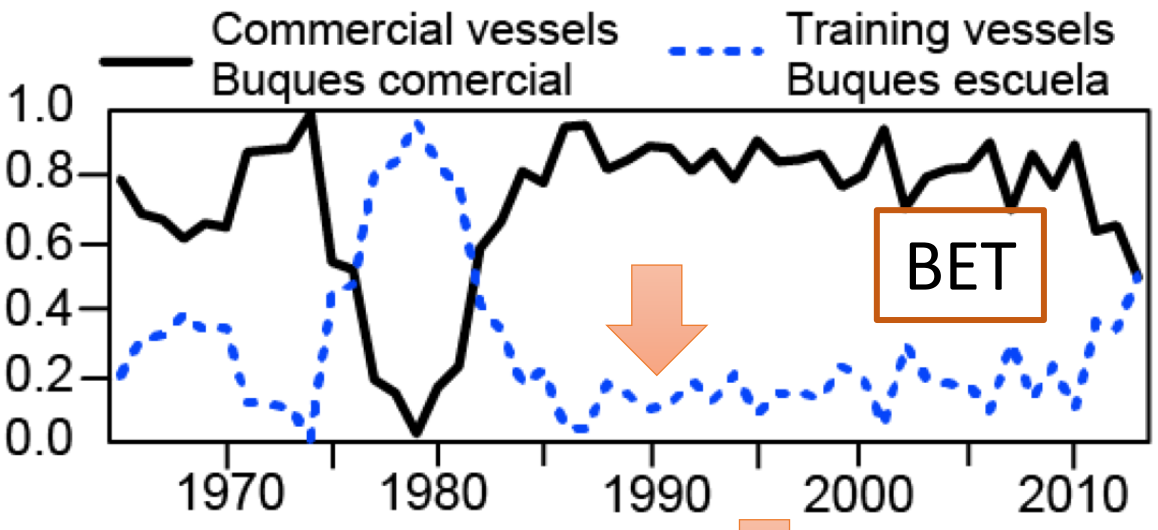
Commercial vs. training vessels

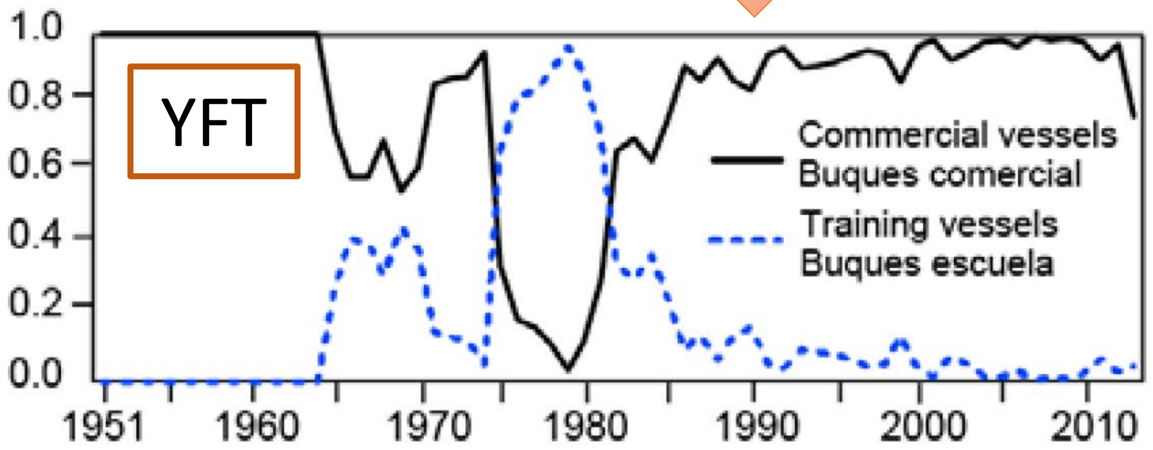


- ✓ The length frequencies of both species broken down by period, vessel type and area, suggested that the differences between vessel types were clear for both periods and both species in many cases.

HYPOTHESIS 3: Change in the size data collecting and reporting system around 1990

Commercial vs. training vessels



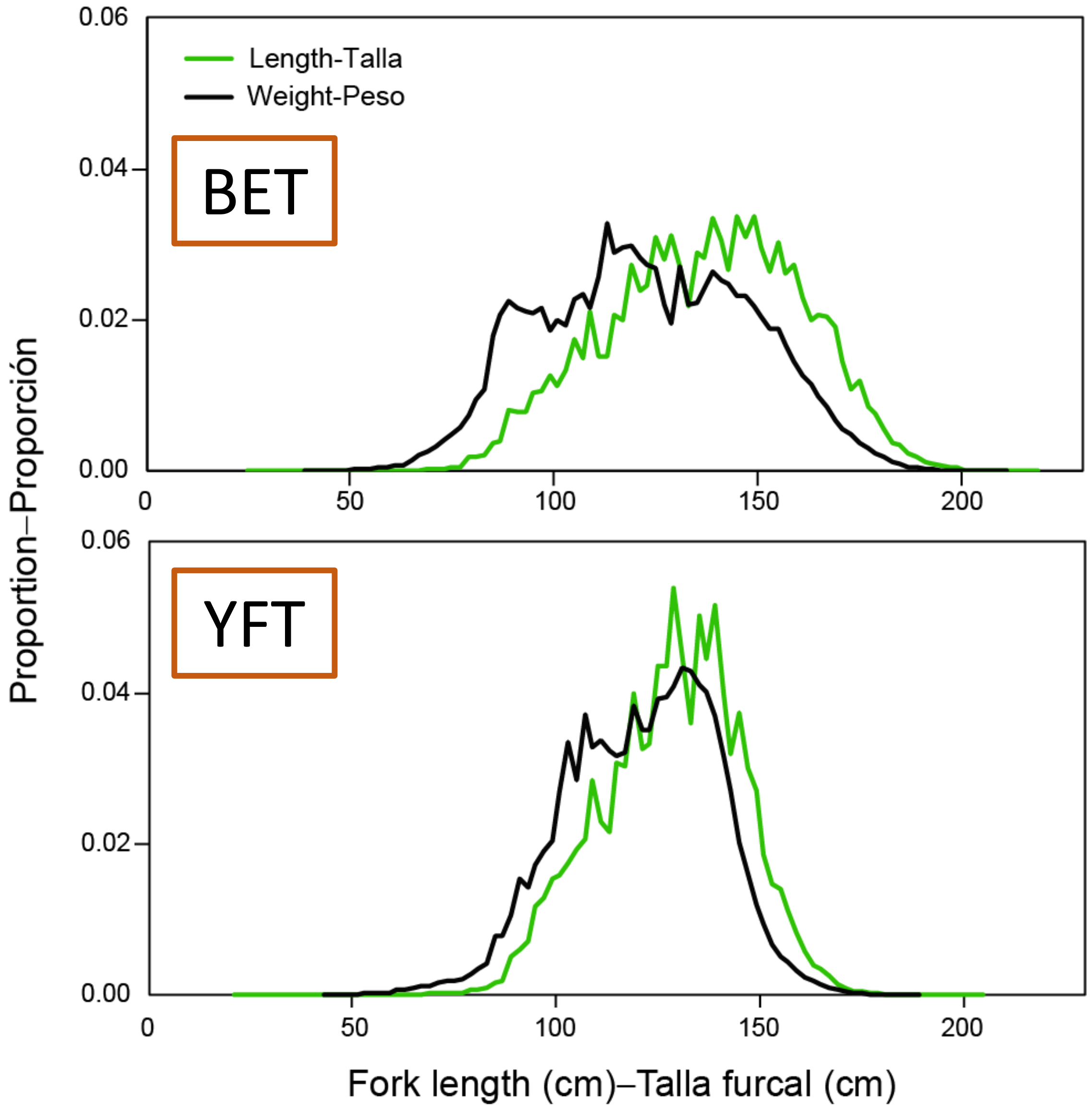


- ✓ Since the proportions of samples by vessel type were similar around 1990, the difference in size composition by vessel type did not directly affect the shift in the residual in 1990

Proportion of number of sample size by vessel type (commercial and training).
top ; bigeye, bottom; yellowfin

HYPOTHESIS 3: Change in the size data collecting and reporting system around 1990

Unit of fish size (weight vs. length)



- ✓ Comparisons of length frequencies by unit of measurement (weight (kg) and length (cm)) indicated that, for both species, the measured lengths were greater than the lengths derived from converting weight data.

FIGURE 6.1. Comparison between length data (green line) and length data converted from weight data (black) for length-frequency of bigeye (top) and yellowfin (bottom).
Using only commercial vessel data

HYPOTHESIS 3: Change in the size data collecting and reporting system around 1990

Unit of fish size (weight vs. length)

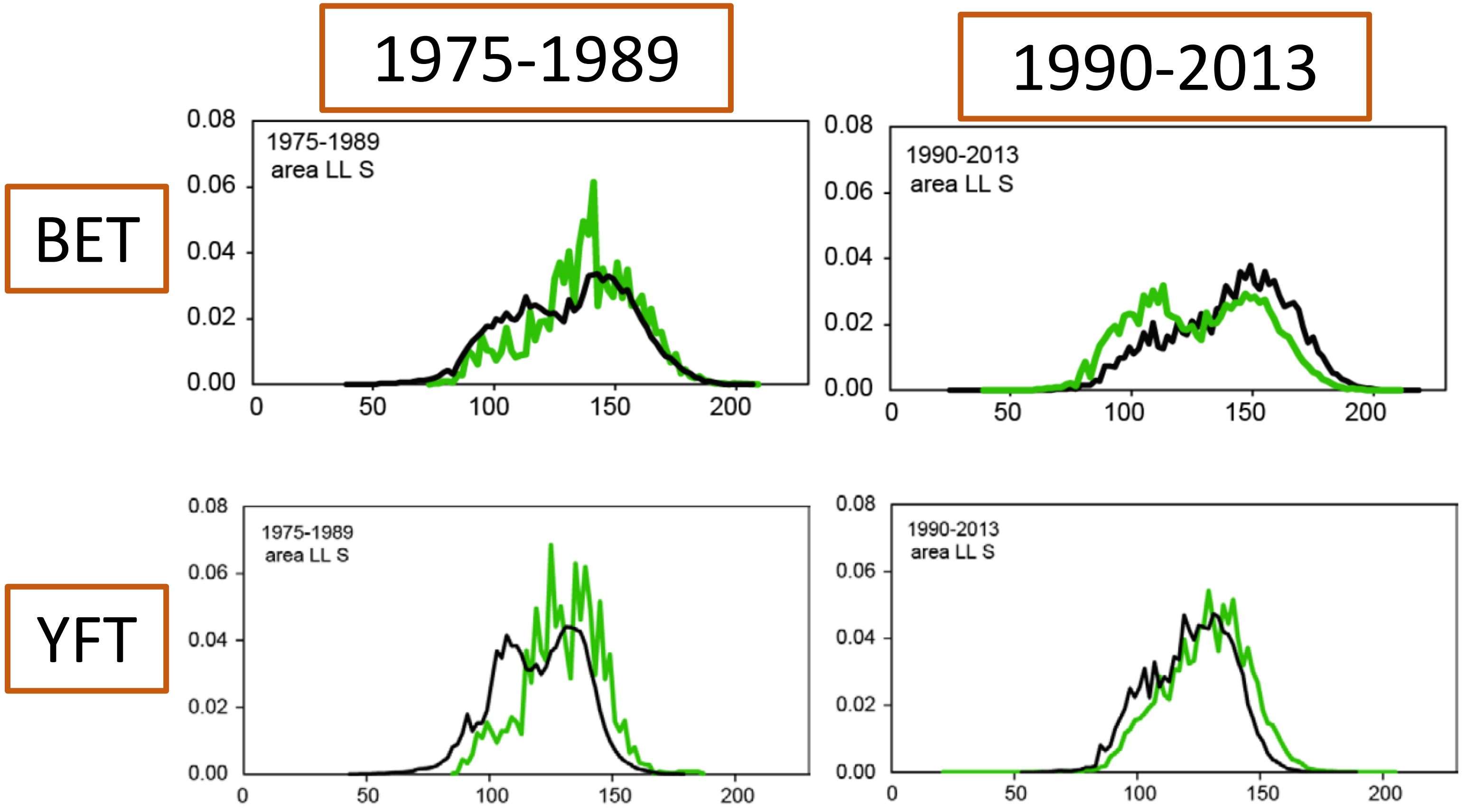
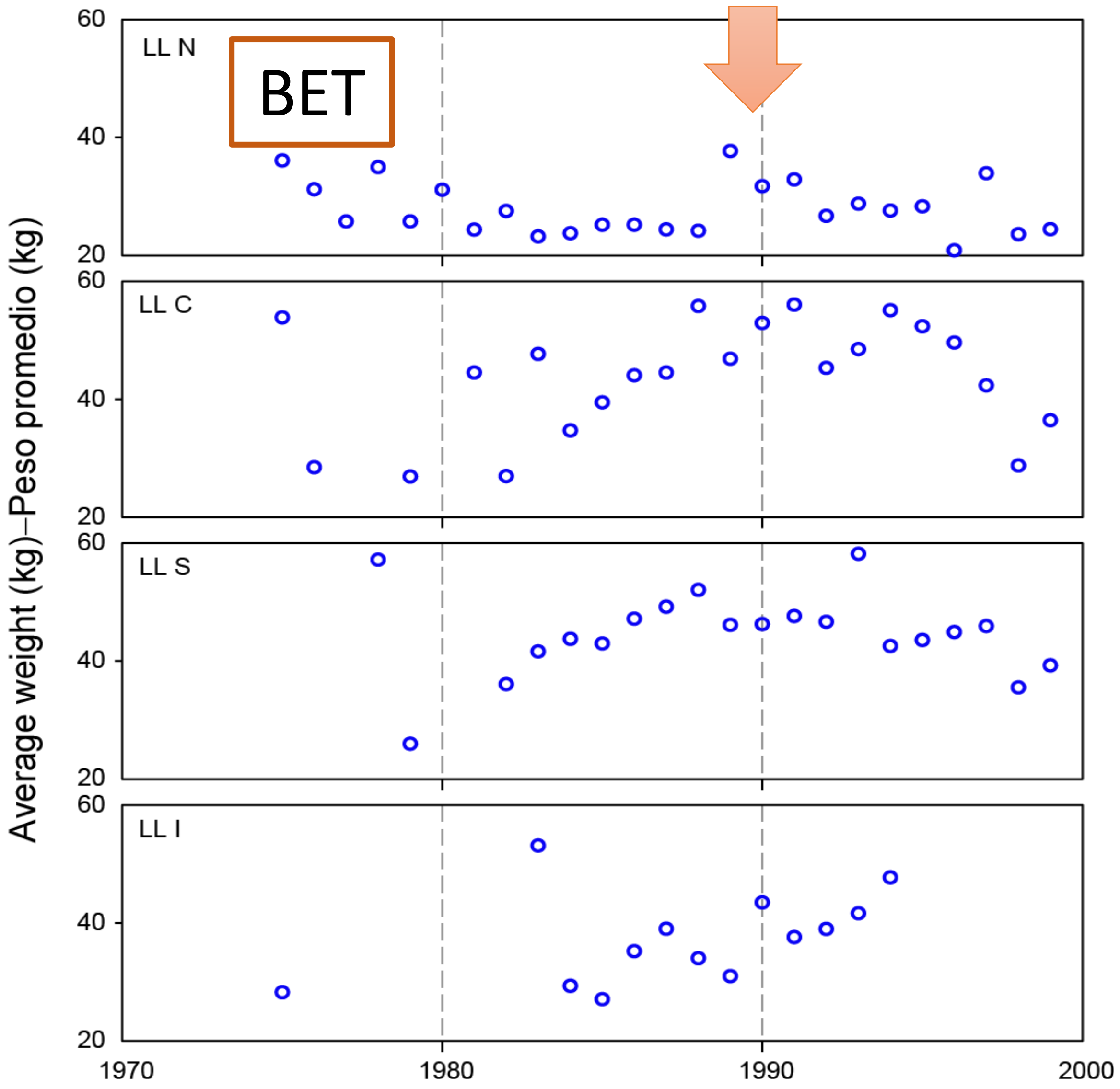


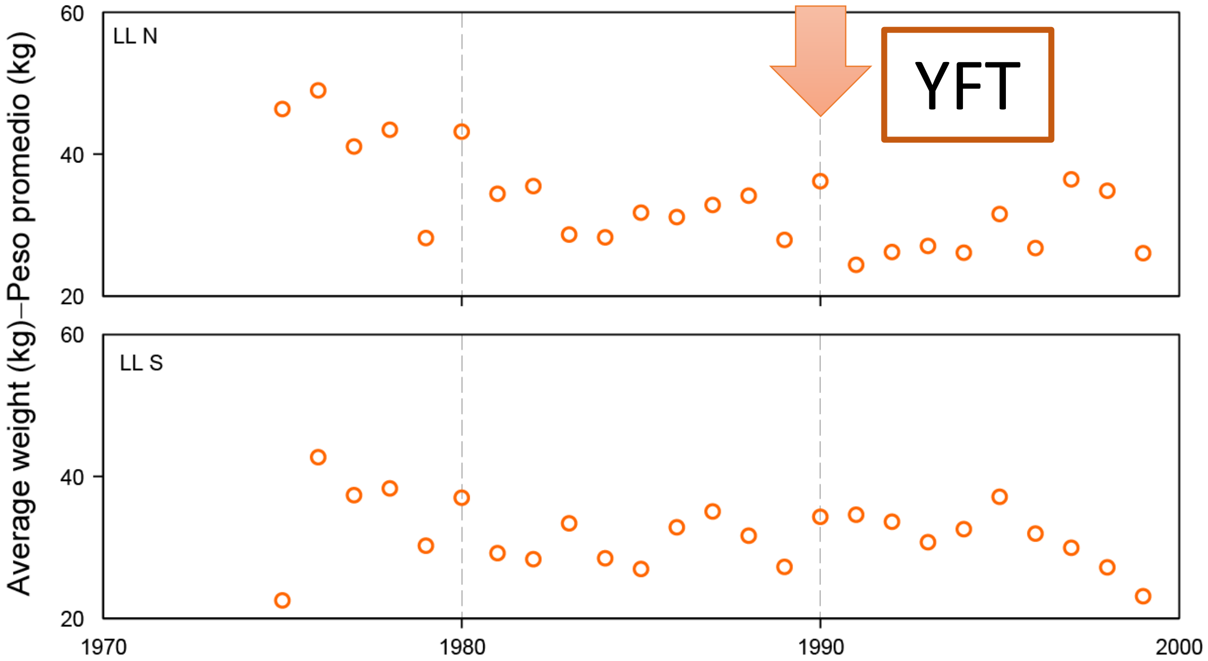
FIGURE 6.2. Comparison of length frequencies of length data (green line) and length data converted from weight data (black line), from commercial vessels only, by area and period (pre- and post-1990.

- ✓ The differences between measured length and converted length were found in many cases when the size data were broken down into area and period for both species.

HYPOTHESIS 3: Change in the size data collecting and reporting system around 1990

Unit of fish size (weight vs. length)

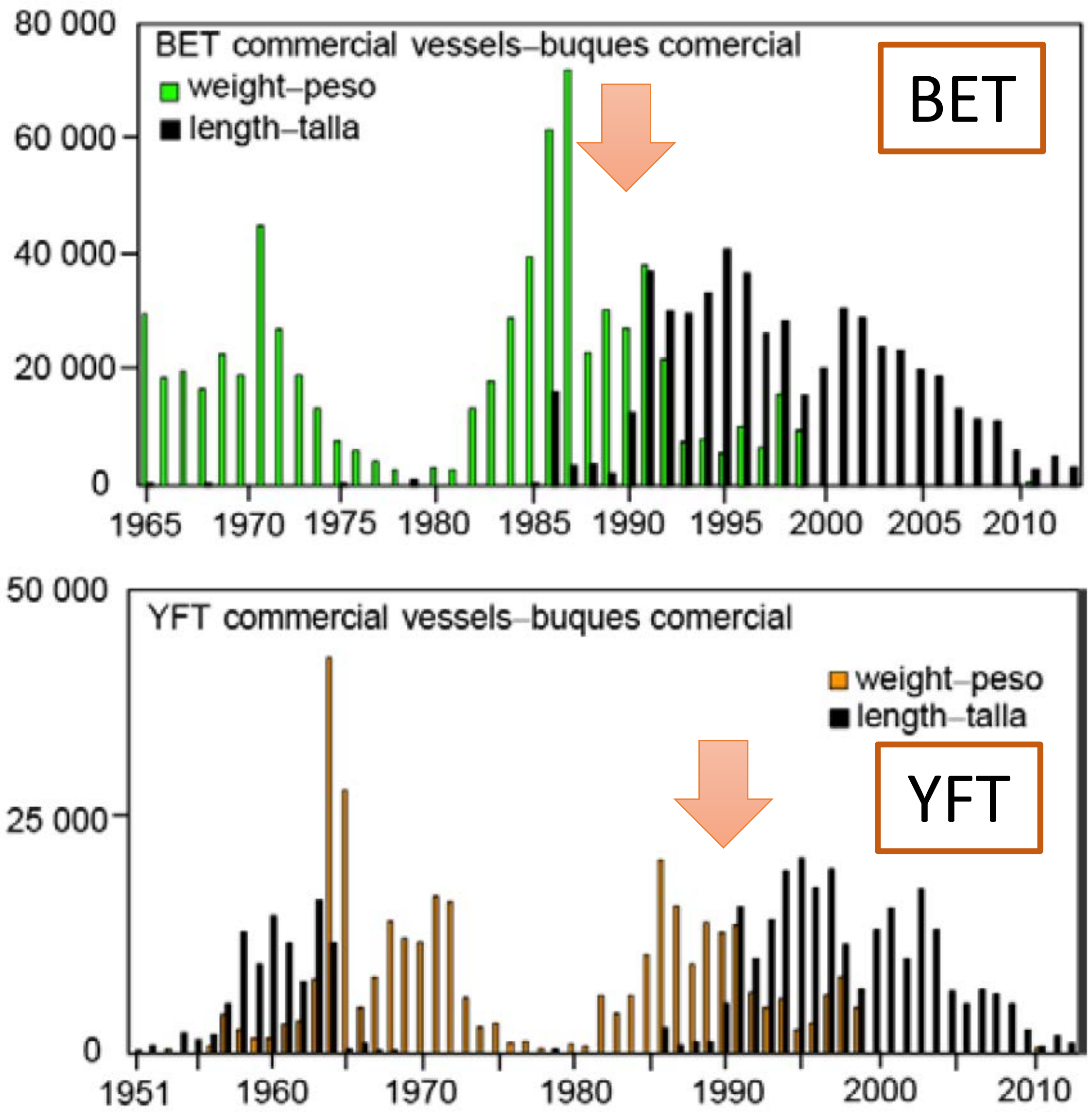




- ✓ Using only the weight data from commercial vessels, the average body weight of fish by area did not show any considerable change around 1990.

FIGURE 6.3. Historical changes in average weight (kg) by area, based on weight data from commercial vessel only.

HYPOTHESIS 3: Change in the size data collecting and reporting system around 1990



- ✓ In response to a resolution by the Commission for the Conservation of Southern Bluefin Tuna (CCSBT), since 1988 Japanese longline vessels that catch southern bluefin tuna are required to measure the fish in length on board.
- ✓ This also affected Japanese longline vessels that caught tropical tuna species.
- ✓ The proportion of length data increased after 1990 for both species, equaled that of the weight data in 1991, and since then length data has dominated.

FIGURE 5.5. Number of Japanese longline size data by vessel type (commercial or training) and unit of fish size (weight (kg) and length (cm).

Summary

① Change in Japanese LL fishing strategies, such as selection of fishing ground and/or fishing season between the two periods (pre- and post 1990) → No

② Development of new fishing gear that affected the sizes of tuna caught around 1990 → No

③ Change in the size data collecting and reporting system around 1990

1. Commercial vs. training → No (but it is important to specify the vessel type for better estimation of selectivity)
2. Unit of fish size (weight vs. length) → Yes !

Conclusion

- ✓ The evidences we present indicate that the shift in size composition in 1990 for both species is unlikely to be due to a real change in the size of fish caught.
- ✓ The combined effects of a change in the data collecting system and the underestimation of fish size from the weight-length conversion probably leads to an artificial shift in size composition.
- ✓ It is important to update Japanese size data with the information about the unit of fish size. The informative size data should be used to improve the previously-developed stock assessment models.
- ✓ Although it is not directly influenced the residual shift, it is also important to specify the vessel type for better modeling of selectivity.

The informative size data with vessel type and unit of fish size after 1975 had been already submitted to IATTC from Japan on February 2016.

Thank you

FRA

CIAT IATTC