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Iinvestigation of the sharp drop of swordfish CPUE of Japanese tuna longline fisheries in 1990's in the SW Indian Ocean

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Abstract

To elucidate the causes of the sharp drop of Japan LL CPUE in the SW IO area, we investigated following 6 points, i.e., (1) to see if the decreases are different between CPUE in no. vs. weight, (2) to see if the sharp decrease patterns in SW are observed in other regions, (3) to see if the decrease in SW are different in 2 types of resolution of CPUE between 1x1 (fine scale) and 5x5 (coarse), (4) to see if CPUE are robust during the sharp drop period in the SW IO, (5)to see if CPUE in other countries show the sharp decrease in the SW and (6) to see other factors (ENV, targeting q and others) affect the decrease.

Results of all investigation showed the consistent decrease of JPN CPUE in 1990's in the SW IO including other CPUE in Spain, Taiwan and La Reunion. Furthermore Japan had large catch and effort in the same period when there was a big CPUE drops in 1990's, which implies that CPUE in that period is robust thus realistic. As a conclusion, the sharp drop is considered to be realistic but we don't know which steepness among different degrees of decrease (drop) is the real one.

Contents

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1. Reviews

To elucidate the causes of the sharp drop of Japan LL CPUE in the IO SW areas, Japanese CPUE papers presented in the past WPB01-08 (2006-2010) were reviewed as a first step. SW IO is defined in Fig. 1 and Table 1 summarized the review.

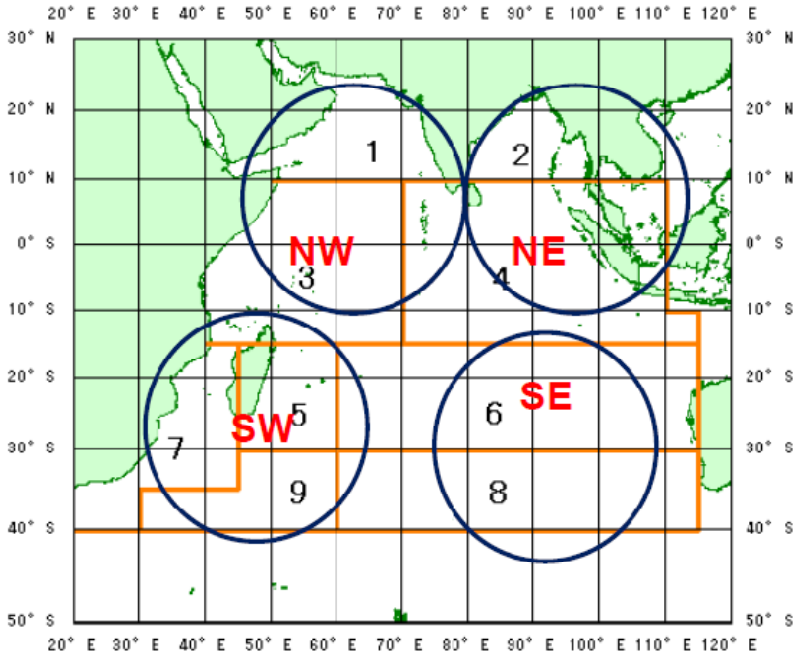
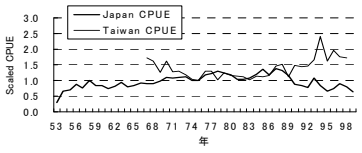
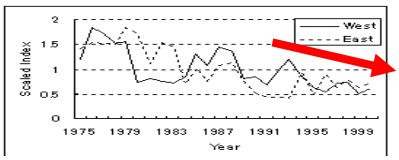
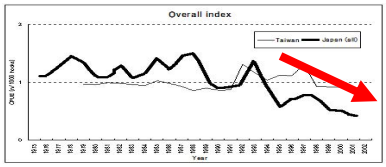
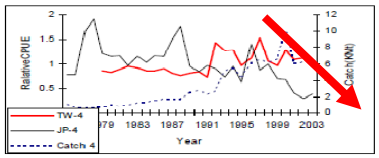
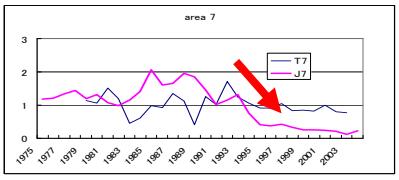
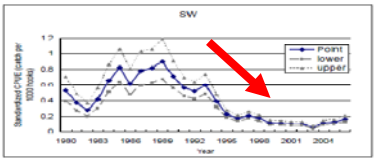
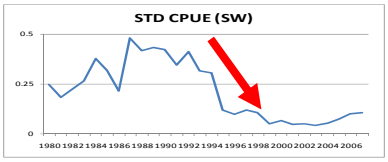
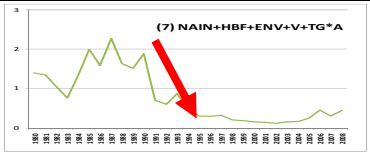
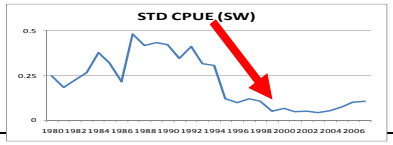


Fig.1 Four(4) regions used in the recent GLM for STD CPUE. SW IO is defined in the map.

From Table 1 we can observe the consistent decrease or drop of the CPUE during 1990-1995, but the period of the decrease are slightly different by year amongst different methods. It is also noticed that the degree of decease in the (whole) western Indian Ocean is much less than the one in SW IO. This shows that the significance of the decrease of drops of CPUE appear mainly in the SW IO.

In addition we can also see that the degrees of the decrease based on 5x5 GLM analyses is slightly less than those based on 1x1.

Table 1 Reviews of the decrease (drop) of the JPN CUPE in the past WPB meetings.

YR	WPB #	Author	unit	No of area	ENV	V	SW STD CPUE in 1990's	
2000	01	Yokawa	5x5 M	1	no	no	(whole IO) Gradual decrease	
2001	02	Yokawa	5x5 Q					
2003	03	Yokawa		8			(West IO) Mild to sharp decrease 1993-95	
2004	04	Yokawa		8				
2006	05	Nishida		9	yes		A7 (MOZ) Sharp decrease 1994-1996	
2008	06	Semba		4			(SW IO) Sharp decrease 1993-1995	
2009	07	Nishida	1x1 M	NW SW NE SE			(SW IO) Sharp drop 1993-1994	
2010	08	Nishida				yes	(SW IO) Sharp drop 1990-1993	
2011	09	Nishida					(SW IO) Sharp drop 1992-1995	

2. Investigation to see if the decreases are different between CPUE in no vs. weight.

As the 2nd step, we investigate if the degrees of the decrease are different in CPUE between number and weight. We used nominal fine scale CPUE (number and weight) in SW IO. Fig. 2 shows the results and there are no significant different in the trends and also the degrees of decrease in CPUE between number and weight.

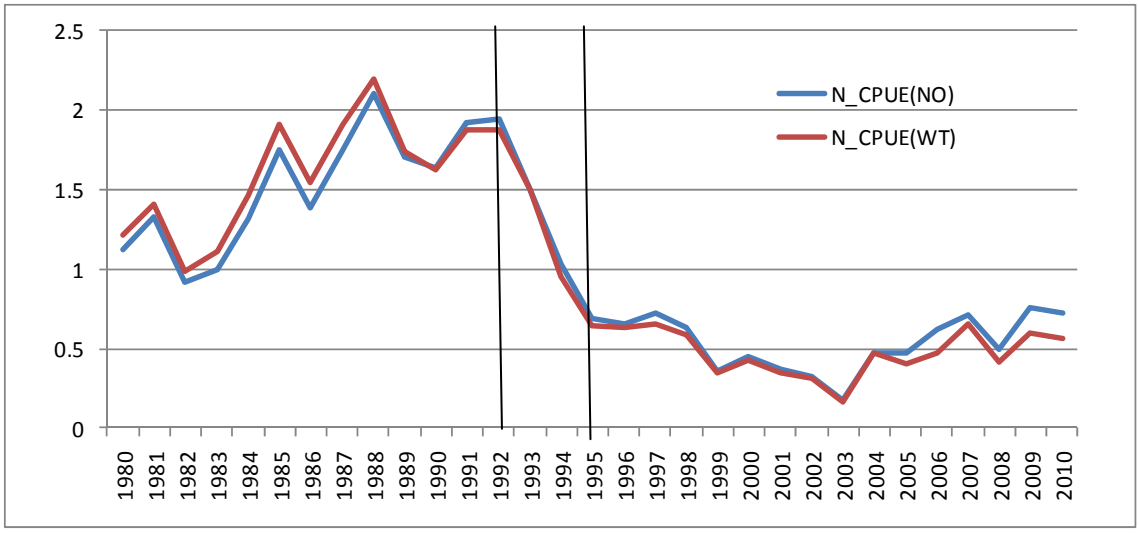


Fig. 2 Comparisons JPN tuna LL SWO fine scale nominal CPUE between in number and weight (kg) (scaled). The sharp drop was observed in1992-1995.

3. Investigation of the trend patterns of the nominal CPUE by region to see if the sharp decrease patterns in SW are observed in other regions

We further investigated trend patterns of the nominal CPUE using the same data as in Fig. 2 by region. Fig 3 shows the results. Patterns of trends between CPUE in number and weight are similar except the one in NW. Patterns of CPUE in SW are significantly different from others except the CPUE in number in NW.

From this fact we may consider two stock structure hypotheses, i.e., SW stock and major stock in other waters (Fig 2). SW may be intermingled with part of the major stock in the northern border. Furthermore Fig 4 (upper) showing CPUE trends by area re-confirm these two heterogeneous patterns (stocks).

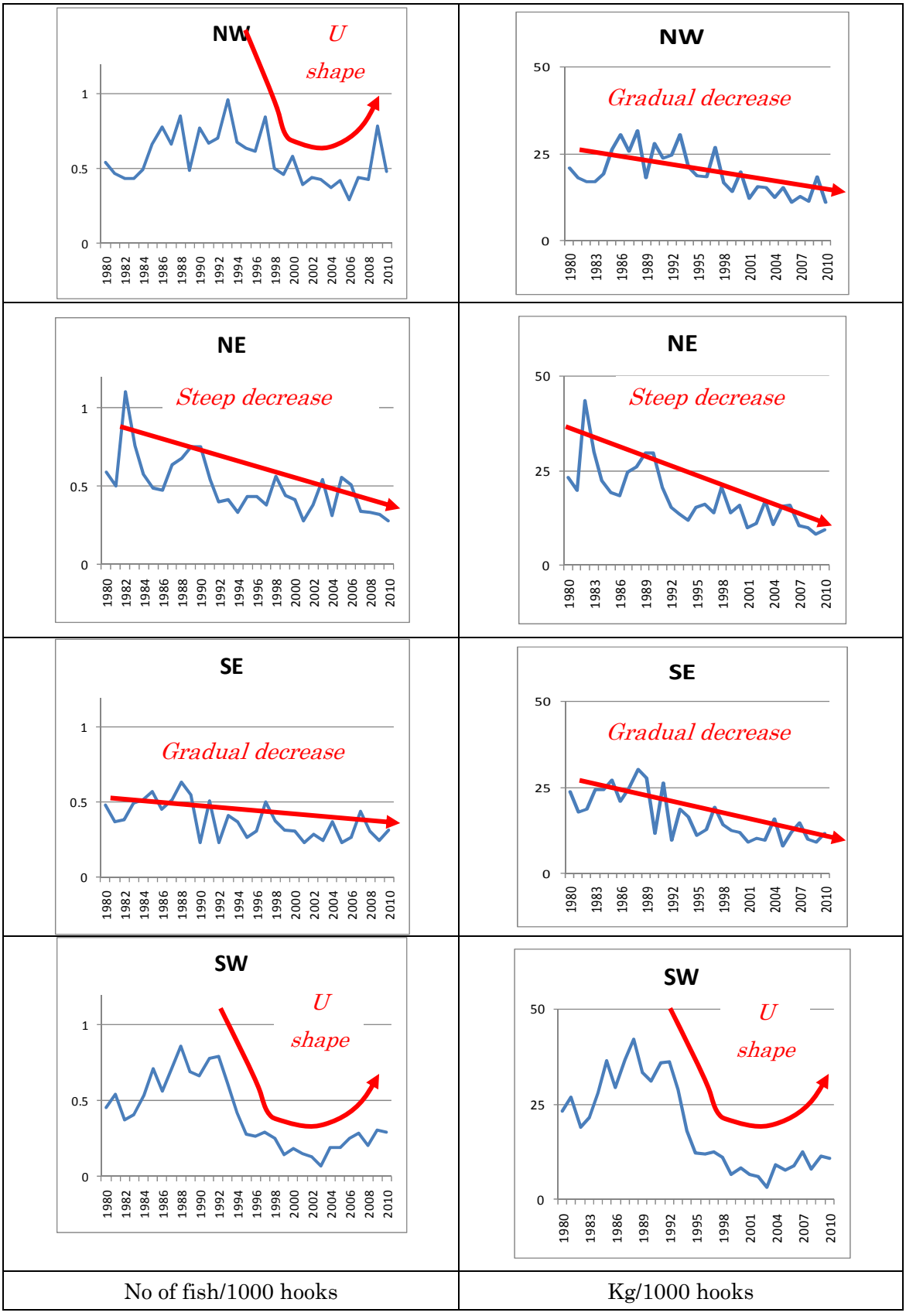
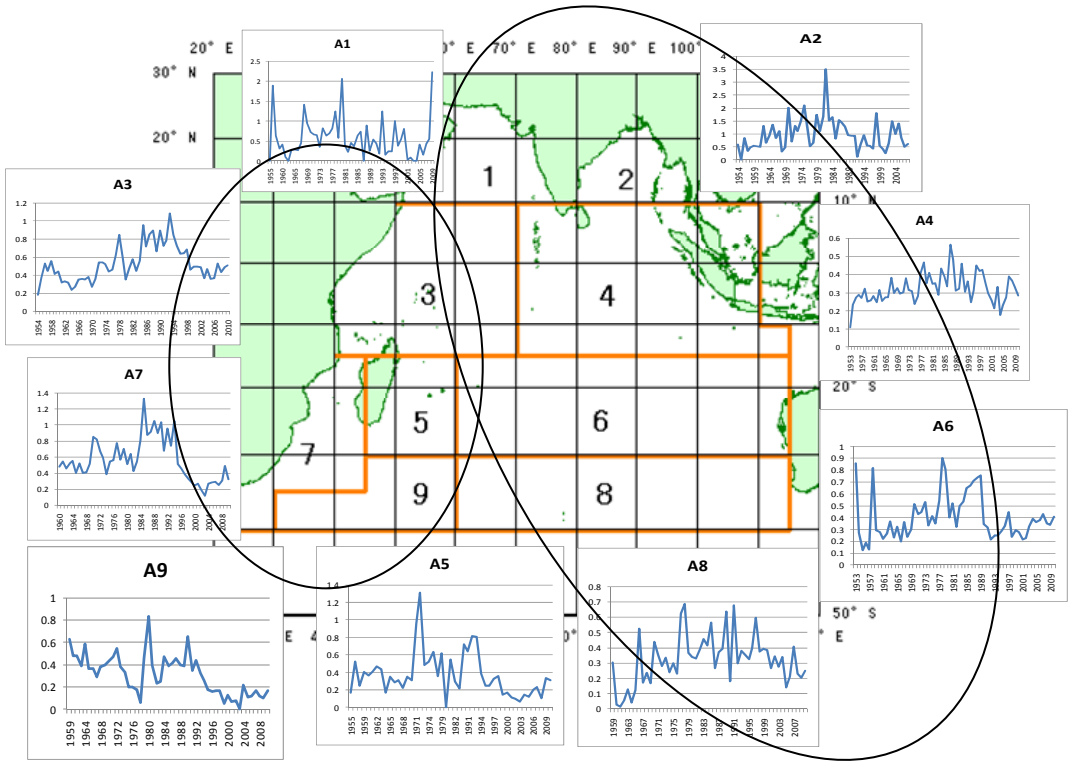


Fig 3 Trend patterns of nominal CPUE (fine scale data) by region (left in number and right in weight)



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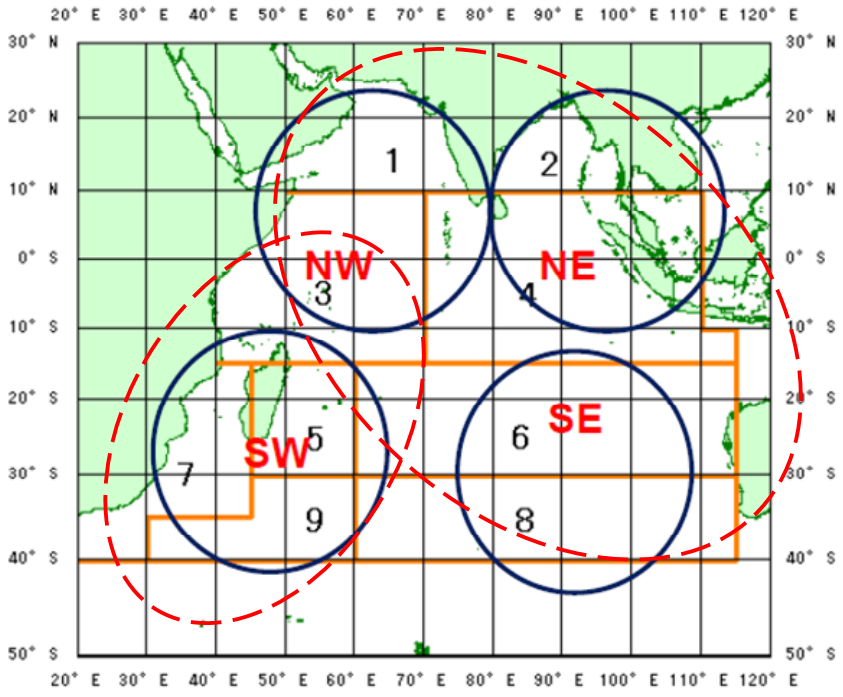
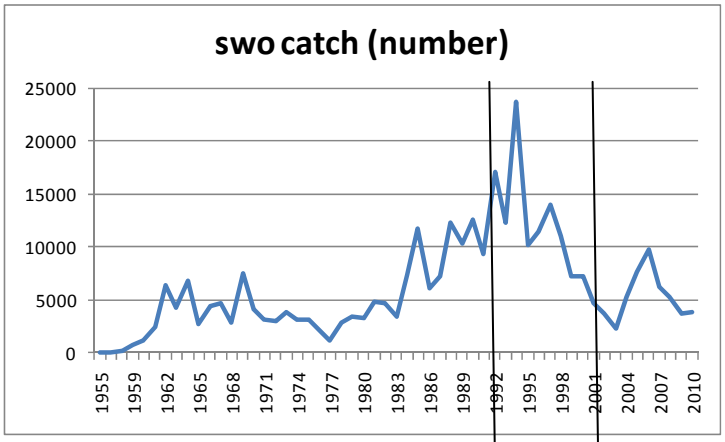


Fig 4. IO SWO 2 hypothetical stock structures based on the pattern recognition of the CPUE trends. There are two clear patterns in CPUE, i.e., U shapes vs. non-U shape patterns in recent years. 2 stocks hypothesis are SW vs. others areas and the SW may be stock intermingled with the northern boundary. This 2 stock hypothesis is the evolved one from 3 hypothetical stock structures (Nishida et al, 2009) after we used more recent updated data

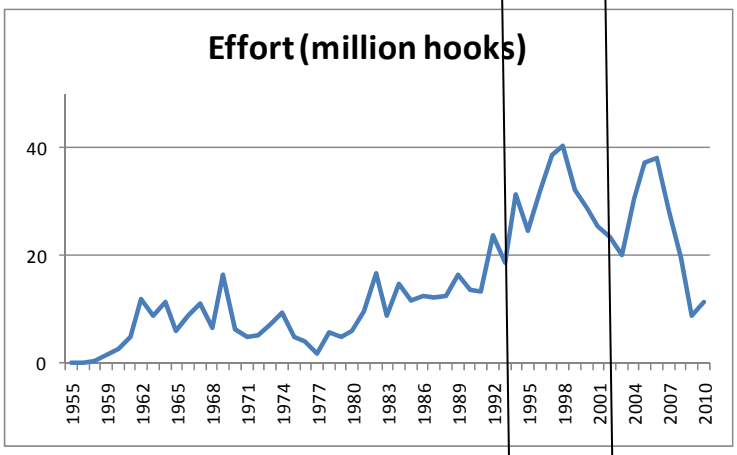
4. Investigation of the 5x5 nominal (large scale) CPUE to see if the decrease in SW IO are different from those in 1x1 (fine scale) CPUE

In Table 1 (review), we noticed that the degrees of the decrease in CPUE in the SW IO are slightly lower in 5x5 based CPUE than in 1x1 CPUE. We further investigated this using the 5x5 catch and effort data available in the database in the National Research Institute of Far Seas Fisheries (NRIFSF).

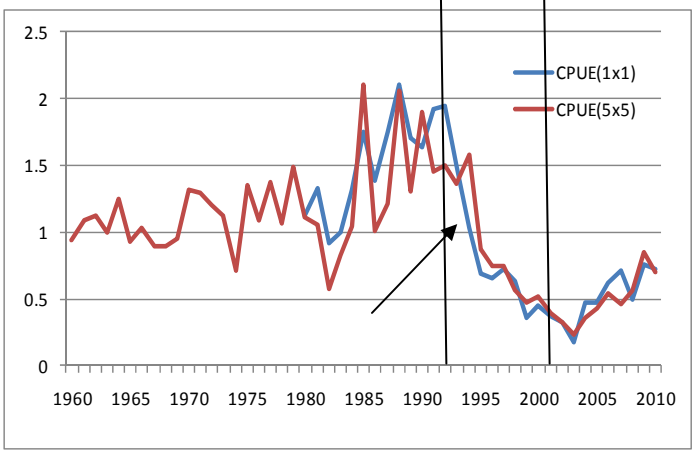
Figs 5 and 6 clearly show that 1x1 based CPUE drop steeper than in 5x5 in 1990-1995. Fig. 5 also shows that during the sharp decrease period (1992-2000), there are larger catch and effort. This effort is due to increase to target southern bluefin tuna (SBT). This indicates that the CPUE in this period is more robust because of large number of catch and effort.



Global JPN LL SWO catches in SW IO



Global JPN effort in SW IO



Nominal JPN tuna LL SWO nominal CPUE in SW IO

Fig. 5 Trends of catch (upper), effort (middle) and nominal JPN LL CPUE (lower) in the SW IO based on the 5x5 data. Comparisons of CPUE between 1x1 vs. 5x5 (lower). See Fig 6 in the next page for the magnified scale graph for CPUE comparisons in Fig. 5.

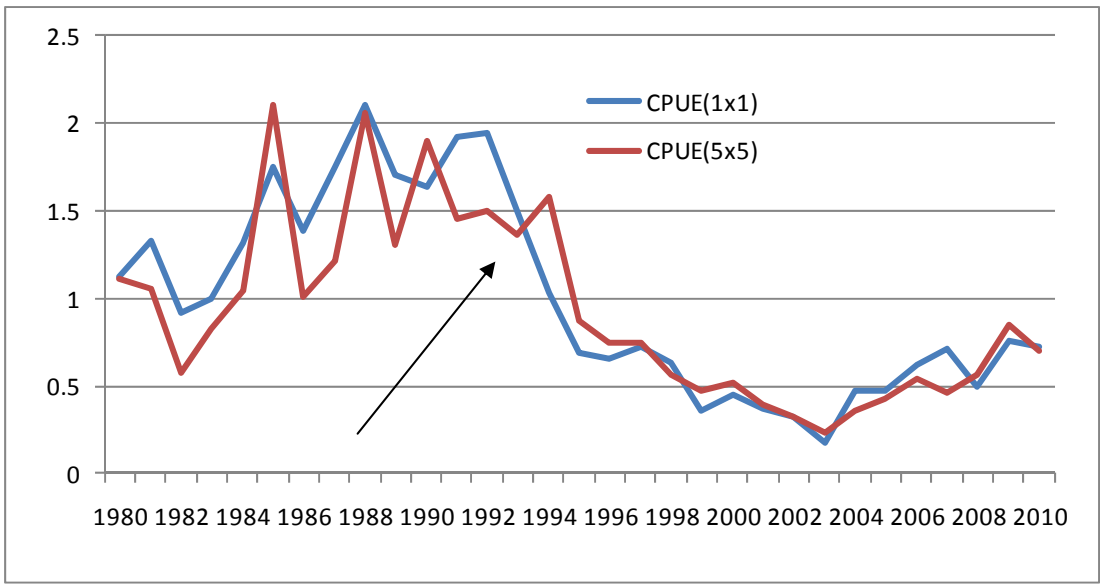


Fig 6 Comparison of nominal JPN LL SWO CPUE between 1x1 and 5x5.
1x1 based CPUE shows much sharper drop than in 5x5 based CPUE

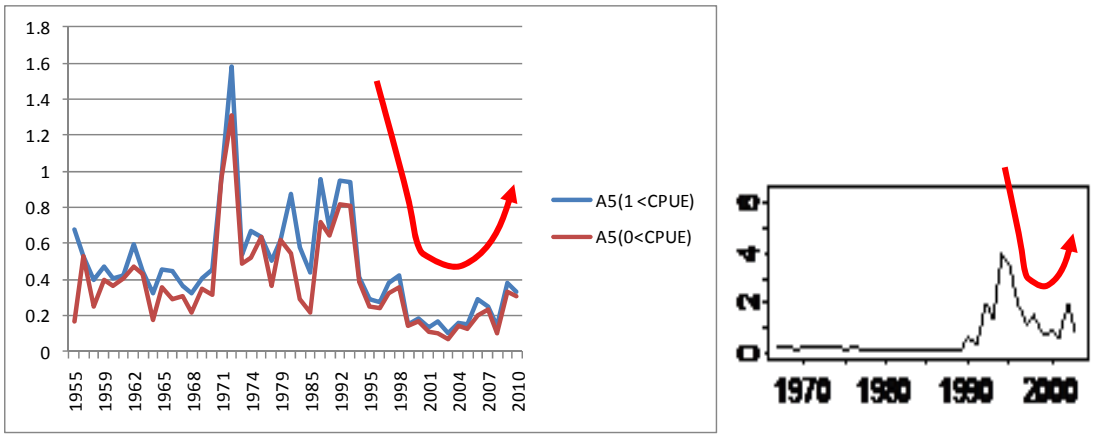
5. Investigation if CPUE are robust during the sharp drop period in the SW IO

We further examined if CPUE are robust by comparing CPUE with and without 0 SWO catch. This is because SWO is bycatch and if effort & catch for SBT increased during the sharp decrease period in 1992-2000, then SWO CPUE may be unstable due to many 0 (zero) catches.

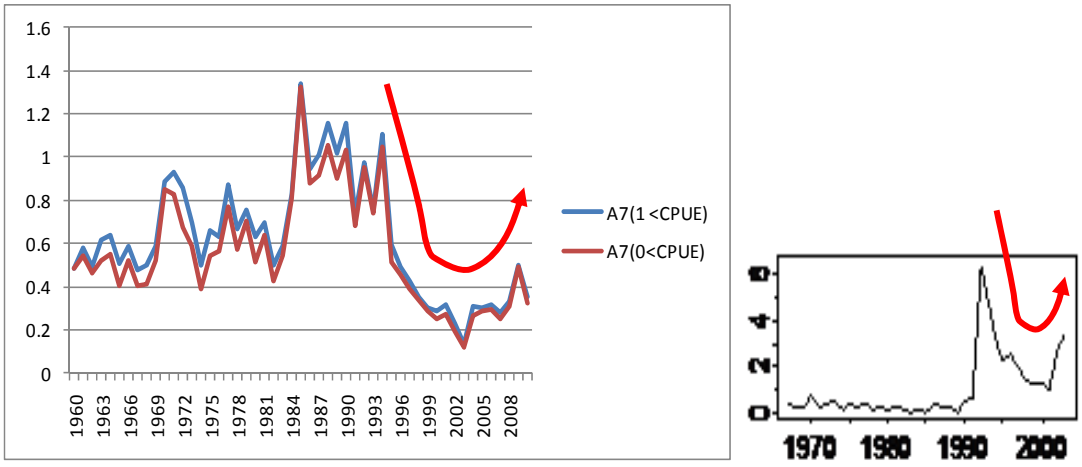
Fig. 7 shows that trends of JPN nominal tuna LL SWO CPUE between with and without 0 catch does not show much different. This implies that SWO nominal CPUE are likely robust and stable. In addition the Taiwan tuna LL nominal SWO CPUE show the similar trend as the Japanese one. These fact further implies that these drop are likely realistic.

Japan

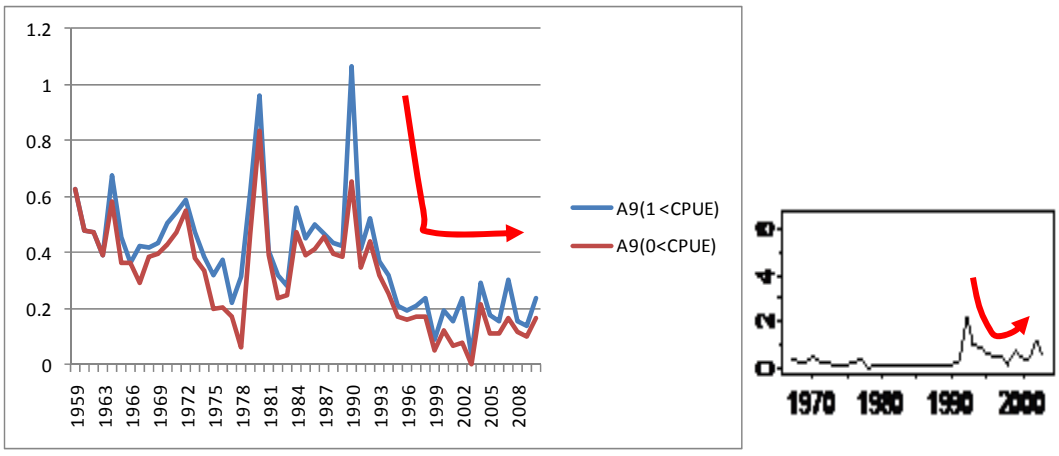
Taiwan



Nominal JPN LL SWO CPUE (area 5)



Nominal JPN LL SWO CPUE (area 7)



Nominal JPN LL SWO CPUE (area 9)

Fig. 7　Trends of nominal LL CPUE in 3 areas of the SW IO

(Left) JPN LL nominal SWO CPUE with and without 0 SWO catch.

(Right) TWN LL nominal catches

6. Investigation of CPUE in other countries during the sharp JPN CPUE period in the SW IO

Finally we investigated other CPUE in SW IO. Figs 8-9 show comparisons of CPUE among Japan, Taiwan, La Reunion and Spain. All show consistent decrease trend although the degrees are different.

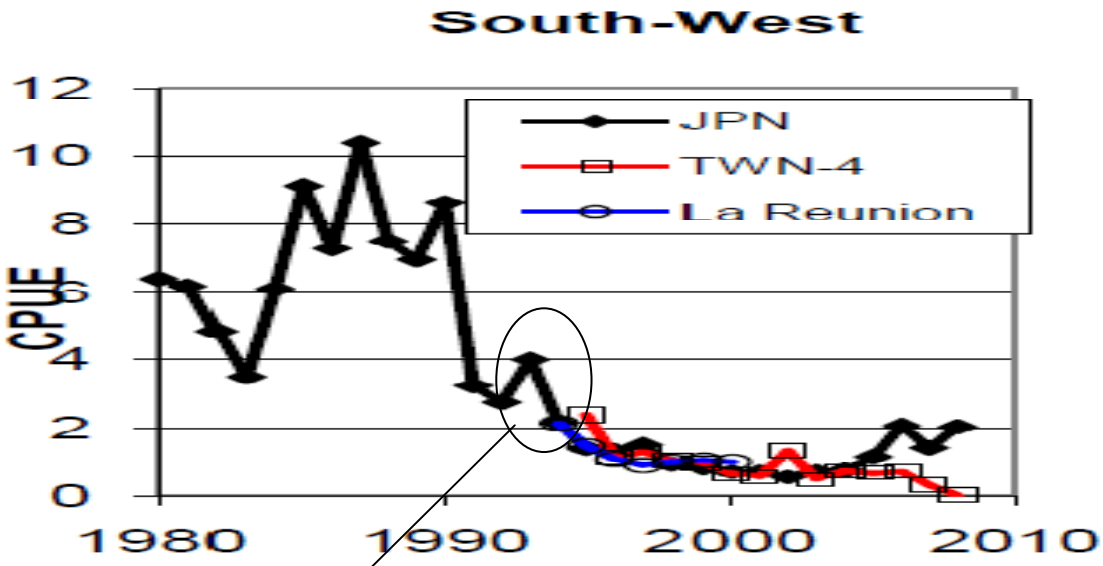
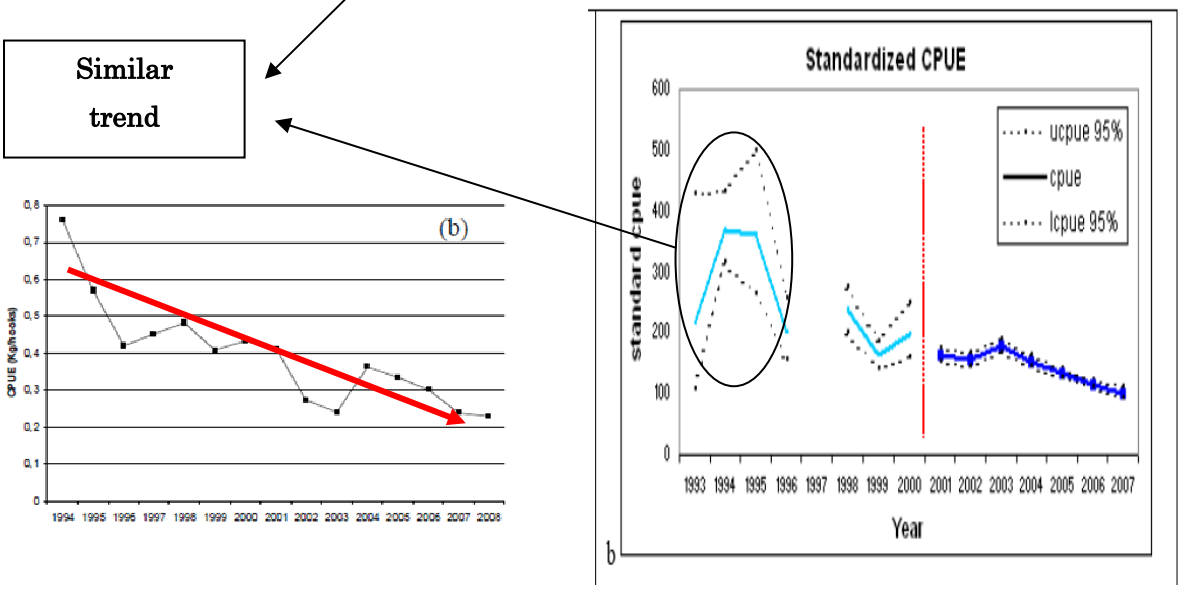


Fig. 8 Comparison of CPUEs among Japan, Taiwan and La Reunion (after Kolody, 2011).



La Reunion STD CPUE　　Spanish STD CPUE

Fig 9 Comparison CPUE among Japan (1x1 data), Taiwan, La Reunion and Spain

7. Investigation of other factors (ENV, targeting q and others)

We finally considered environmental heterogeneity of the area, targeting issues and q (technological changes leading to an increase in tuna catch rates *e.g.* changes in longline fishing depth, number of hooks between floats) that might have had a potential negative impact on swordfish catchability and CPUE.

However we incorporate these factors in the STD CPUE and even nominal CPUE show similar and consistent trends to STD CPUE. For example, there is a big shift in number of hooks between floats in the same period of the sharp drop (Fig. 9). But such factor is included and adjusted in the STD CPUE and we observe similar sharp decrease in both STD and N CPU. This implies that this factor did not affect both STD and nominal CPUE. Thus such effects are unlikely related for the sharp drop.

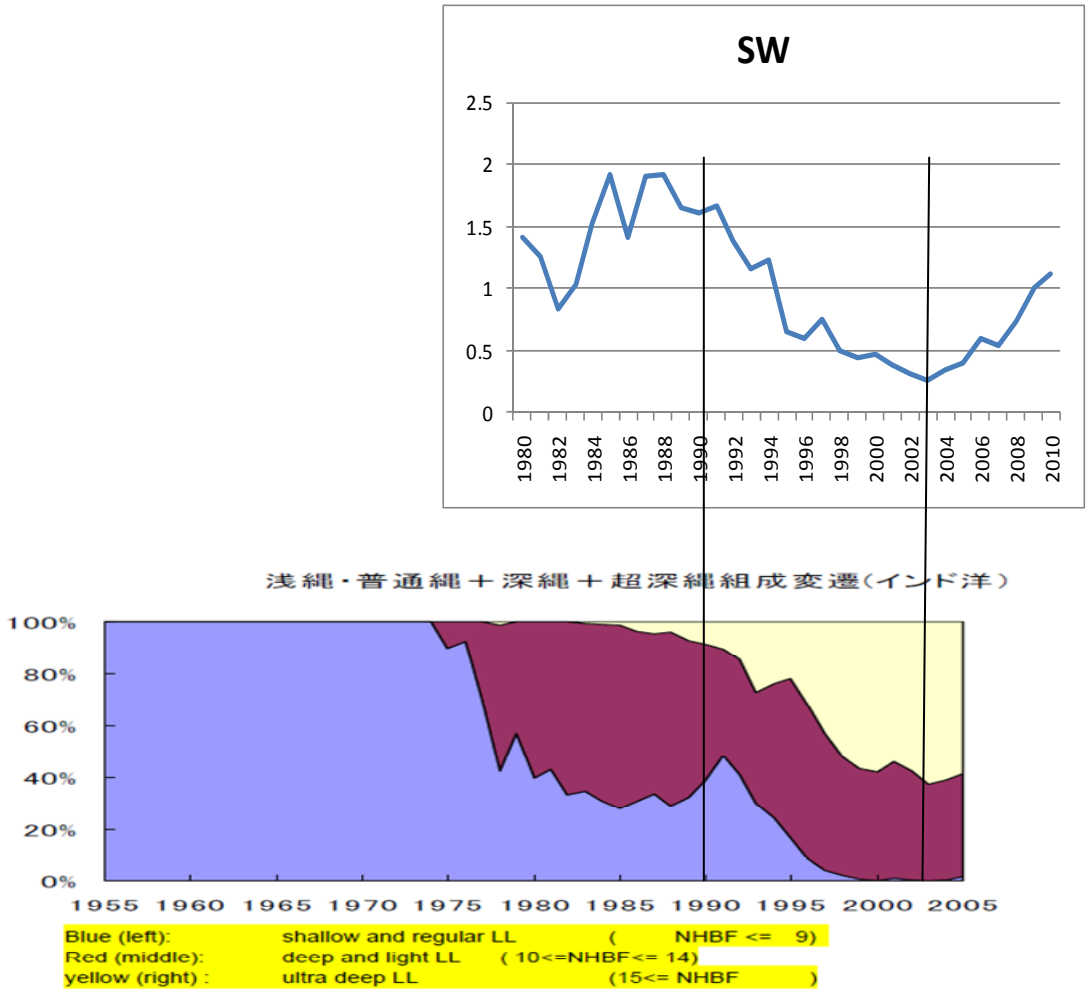


Fig. 9 STD CPUE in SW IO and evolution of no of hooks between floats in JPN tuna LL fisheries

8. Discussion and conclusions

We investigated five factors that might cause the sharp decrease of the JPN CPUE. However all results showed the consistent decrease in 1990's in the SW IO including other CPUE in Spain, Taiwan and La Reunion. Furthermore Japan had large catch and effort in that period when there was a big CPUE drops in 1990's (Fig. 5), which implies that CPUE in that period is robust thus realistic. As a conclusion the sharp drop is considered to be real but we don't know which steepness among different degrees of decreases (drops) is the real one.

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