Note for discussion on the Indian Ocean (IO) swordfish (SWO) CPUE

Additional thoughts and comments for the document:
"CPUE issues for the WPB9 (2011) (Dale Kolody)"

Tom Nishida
National Research Institute of Far Seas Fisheries (Japan)
and
Toshihide Kitakado
Tokyo University of Marine Science and Technology (Japan)

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P1- Stock structure (SS)

We need the results of IOSSS. Our preliminary thought of the IO SS is the 3 stocks hypothesis, which is based on CPUE trends (Fig. 1) and the SWO ecology (spawning and feeding areas, currents and other factors) (Fig 2). But CPUE is based on the Japanese data. We need to see CPUE trends from others which will be discuss next section. If other (useful) CPUEs show similar trends as the Japanese one and IOSSS results show also the similar result, three stock hypotheses is considered to be realistic. Then in such case it is worth to attempt the stock assessment (SA) by region.

P2- Different CPUE series
P3-Sharp drop of JPN STD CPUE in SW IO in 1990's
P6-Changes in species targeting

We should not look at the STD TWN CPUE as it has been repeatedly discussed in WPTT and WPT in the past, i.e., simply it does not include the appropriate correction factor (number of hooks between floats: NHF) to adjust the biases caused by changes of targeting. This is especially critical for TWN SWO STD CPUE as they quite often change target species, i.e., for some operation they target SWO, while other cases for ALB, YFT or BET. Thus TWN CPUE did not show the realistic CPUE trends.

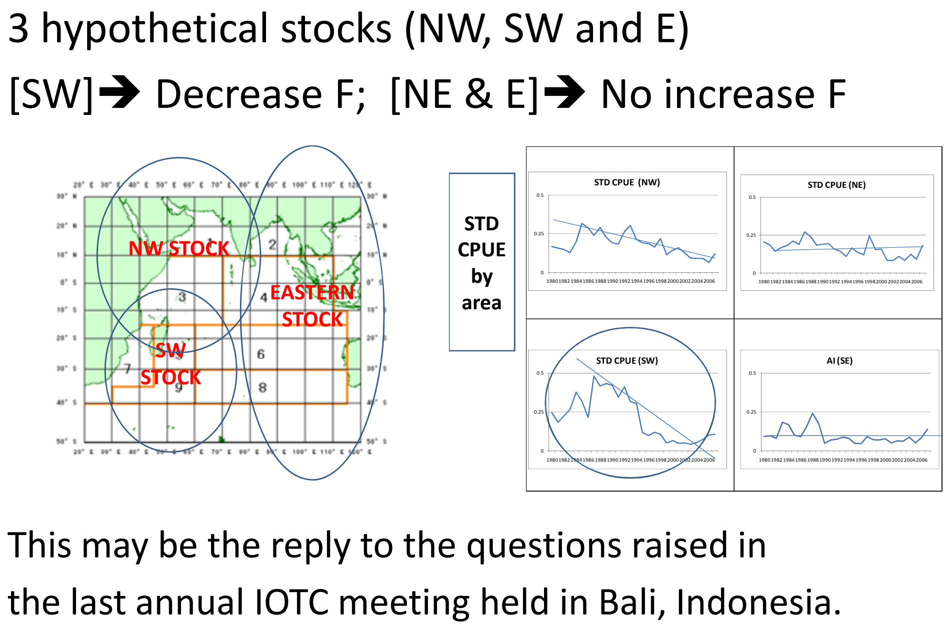


Fig 1 3 hypothetical SWO stocks in the IO based on the JPN STD CPUE trends (trends in North, SW and SE have heterogeneous patterns) and also ecology & life history of SWO (Fig 2 below).

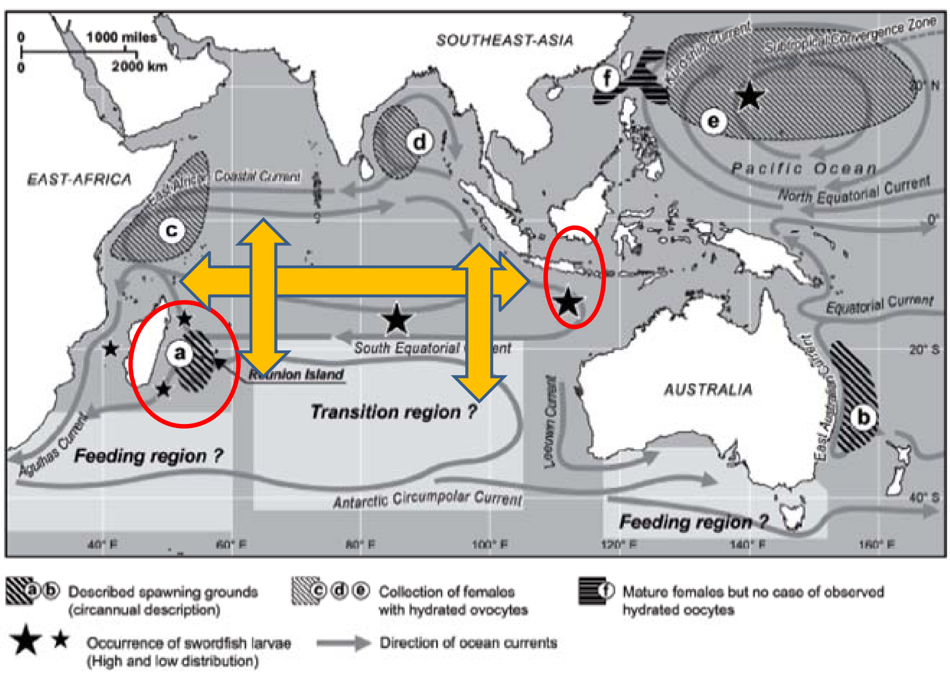
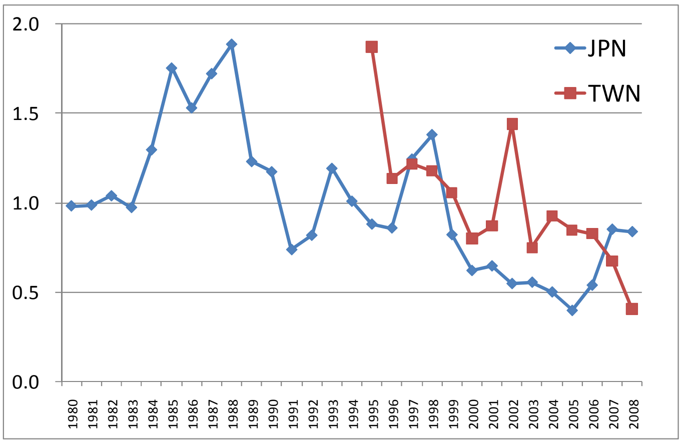


Fig. 9. Map showing all available information on the reproductive biology of swordfish in Indian Ocean and in the western Pacific Ocean.

Fig 2. Schematic diagram of SWO 2 spawning areas, feedings zones and ocean currents (after Poisson, 2009)

TWN LL has NHF information after 1995. In the past we compared STD CPUE (YFT, BET and SWO) between TWN and JPAN after 1995 which all include the NHF (correction factors). Then we realized that it improved the situation better, i.e., both trends become similar (Fig 3). However as TWN CPUE data have occasional big spikes thus we still have some difficulties to compare between two CPUE after 1995.



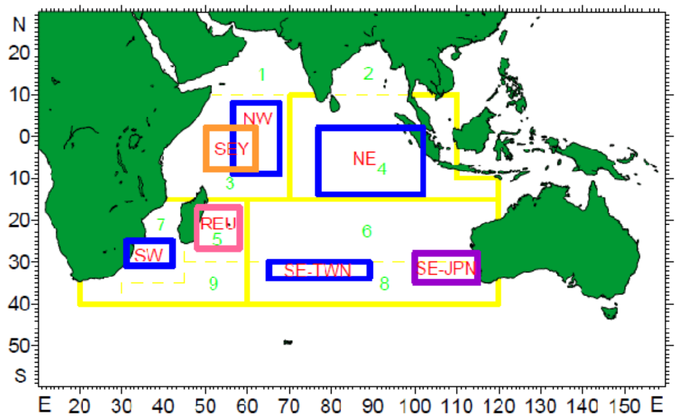


Fig 3. Comparison of STD IO SWO CPUE between Japan and Taiwan (upper) in the common and core SWO fishing grounds (lower)

For the spikes we consider that they were caused by original TWN LL fleet fine scale data by year, month, day and area, i.e., the coverage of the LL fleet activities range nearly 0% to 100%. So if we include the data with nearly 0% coverage which has the large CPUE then such CPUE will create large CPUE (spikes). Thus we should screen out such data with lower coverage, for example, we need to use the data which fleet cover more than 50% then we expect the stable and realistic TWN STD CPUE. This will be the future. However as Kolody (2011) mentioned we may not see the real trend as we limit to core areas even after we take care of the coverage problems. In addition we may not have enough data to estimate STD SCPUE after the screening.

Regarding other CPUEs, at least the La Reunion (IO SW region) nominal CPUE is similar to those of Japanese CPUE (Fig 4). Even more TWN CPUE is also similar to other two, although CPUE between Japan and Taiwan has large discrepancies during 2007-2009, which may be caused by the poor coverage problems of the Taiwan CPUER data as mentioned before. Thus until this problem is solved we still should not use and compare with TWN CPUE even the data with NHF after 1995.

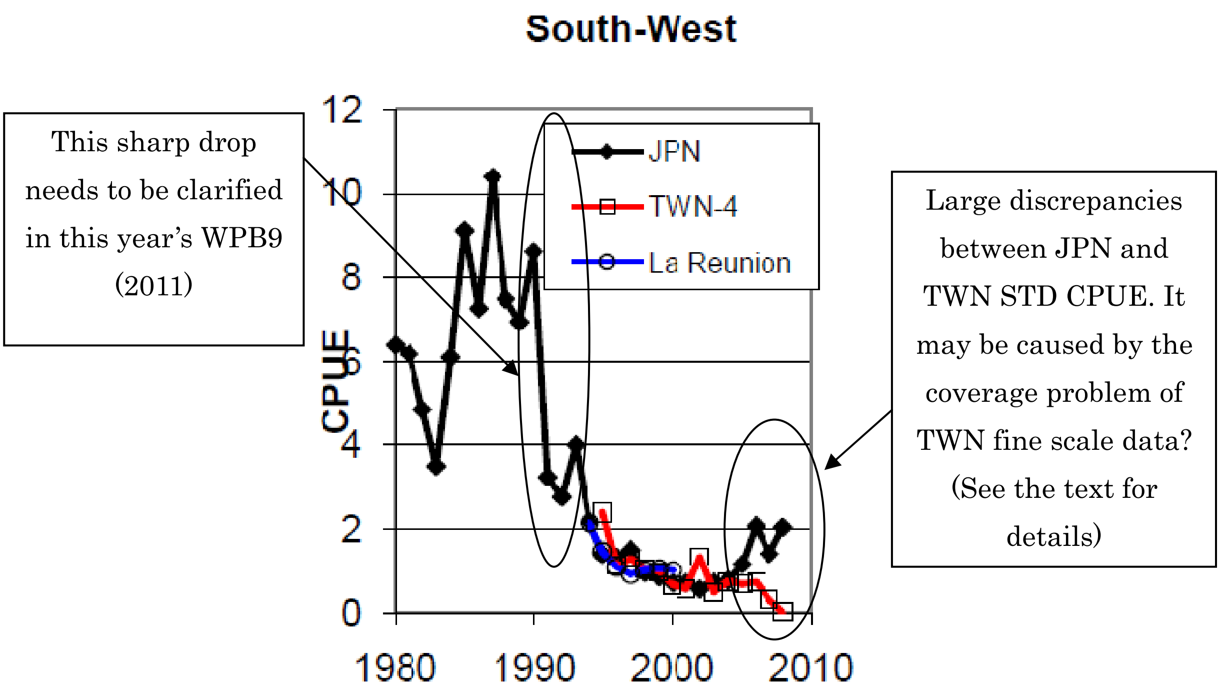


Fig. 5 Comparison of CPUEs among Japan, Taiwan and La Reunion (after Kolody, 2011).

As Kolody (2011) mentioned that we will need to compare with the Spanish CPUE and La Reunion in this year's WPB9 (2011) which may be able to enlighten our uncertain problems in SW IO SWO CPUE. Without TWN STD CPUE, the Japanese and the Spanish CPUE have their trends in the longer period thus it is critical if these two show similar trends especially in 1990's. If so, we will have a confidence that this sharp drop is realistic. But keeping in mind, the degree of sharpness might be exaggerated for the Japanese CPUE which should be examined and clarified in this year's WPB9. Additional idea for the problem is discussed in page 8-9.

P4- Spatial distribution of effort has changed over time.

We know this problem but the way how to handle this problem is not easy task. We need further discussion in the pre- CPUE working meeting.

P7- Environmental (ENV) factors
P8- Alternative Satirical Model

It is apparent that ENV will influence the distribution of SWO and other tunas which also affect fleet movements due to changes of fishing grounds. The Global Ocean Data Assimilation System (GODAS) data in NOAA National Centre for Environmental System (NCEP) have been used for LL STD CPUE works not only in the IOTC, but also in other tuna RFMO, non-tuna RFMO, Research Institutes and Universities in the world. It has been questioned about the accuracy of the NCEP data. For this time we investigated the validity (accuracy) of the data by theory, case studies and sea truth in the separated document. Please note that NCEP data also use the satellite information.

As a result it was concluded and recommended that the NCEP data are valid and many users in the above mentioned agencies (good e.g., GAO developed by Marsac, IRD, France and IOTC SC chair and for others see the separate document) have been actively using and will continue to use such data for various purposes. If we do not use ENV data, it will not able to standardize nominal CPUE satisfactorily which will create further and larger uncertainties.

The NCEP data is 1/2 x 1/3 deg based data which is more suitable for the 1x1 CPUE data. In 2008 we used and matched the 5x5 CPUE data with 1/2 x 1/3 based NCEP data but we did not see strong significant affects of ENV data to 5x5 based CPUE. In 2009 and 2010 we started to use the 1x1 CPUE data and applied to NCEP data which produced more clear pictures (results) improving STD CPUE.

It is true that neighbouring ENV data as well as CPUE are auto correlated in space and time. To solve this we need use the Geostatistical approaches to reduce biases caused by spatial auto correlation (e.g., Nishida and Chen, 2004) and also by available methods for temporal auto correlations problems. However it will take a tremendous computing time in case of spatial GLM as we need to consider the giant VAR-COV metrics especially for the fine scale data, it will take a good computing time and we need the large frame computer to do this work.

Based on the study by Nishida and Chen (2004) results between normal GLM and spatial GLM suggest that point estimates are similar but the normal GLM tends to under estimate the variances due to spatial auto correlation problem. The late Dr Kirkwood (previous IOTC SC Chair) was often puzzled by the very narrow confident intervals (CI) based on the normal GLM. But Nishida and Chen (2004) suggested the actual CI is 1.5-2 times larger than those estimated by the normal GLM (Fig. 6) Thus we should use the spatial GLM especially when there are strong spatial auto correlations.

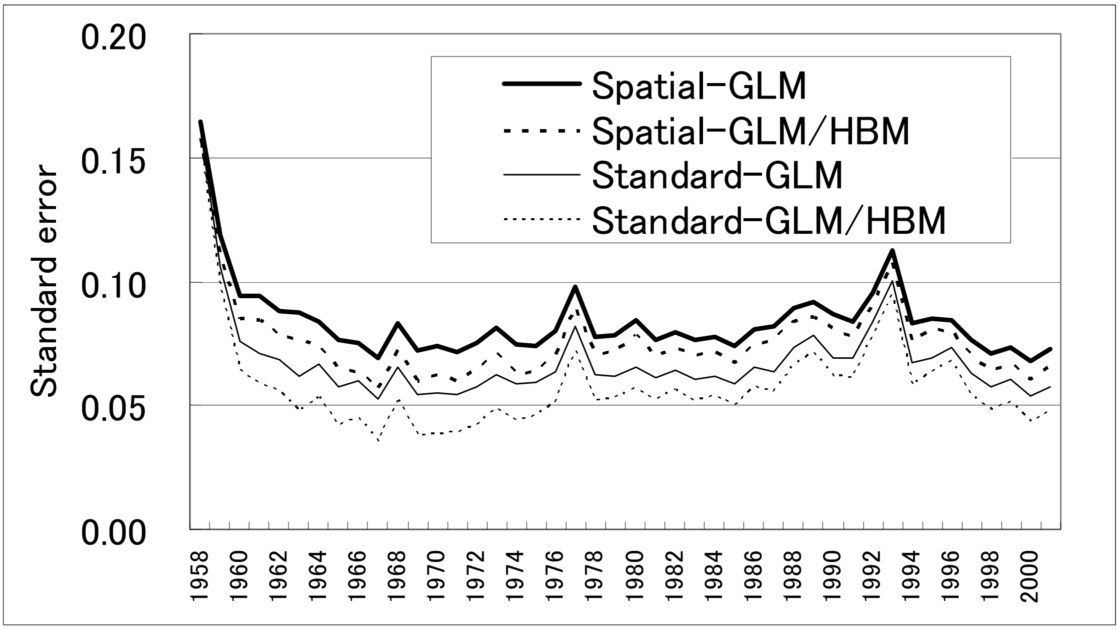


Fig 6 Comparison of 4 CI in YFT STD CPUE (HBM: Habitat based Model) (Nishida and Chen, 2004)

Kolody (2011) provides two good suggestions, i.e., (a) to use the anomalies of the ENV data. As we also concern the correlation among the ENV data, anomalies likely more independent and useful parameters as their data have unique features (by many authors) and (b) to use less interaction terms. In addition as Kolody (2011) also pointed out, the generalized additive models (GAMs) is promising way especially to see if the non-linearity of the possible covariate effects account more the variation of CPUEs across the area etc. This kind of exploration of data may provide us with some chances and enhancement for further modeling in a better way.

As Kolody (2011) mentioned that when we use the AIC it will tend to pick up the model with more parameters. We should examine this by simulation. We plan to do this work in the future.

Comments by Nishida Regarding the simple test in Appendix a (Kolody 2011), correct ENV data are not used. We revised the ENV data after we found the errors but this test used the incorrect data set before corrections. However this test is not appropriate nor valid by a number of reasons, i.e., (a) the area is very limited to only one small region (Seychelles) unlike the normal STD CPUE process applied several sub-areas in the whole IO. The test should be conducted in the whole IO. Otherwise the test is not valid and meaningless; (b) Fisheries data include large uncertainties (less accurate) unlike the very precise information in physics, chemistry, etc. Thus the results of the test showed just apparent similarity between two data sets, i.e., using less reliable fisheries data with R2 (20-40%) and if we conduct this kind of test, we will have similar results by switching ENV data. For example, we will see the similar results if we just switch 2 CPUE. Thus this test is not valid and meaningless. The last paragraph on page 6 in Kolody (2011) is also misleading. SST should not used in LL STD CPUE process. As SWO (for example) is exploited in 50 m in depth in average, we should use direct ENV data affecting SWO habitat of the sea temperature at 50 m which data are available in the NCEP data set. Regarding the recruitment affected by ENV, we should use the SST as it direct affects the spawning activities. Thus we should use ENV date which fit to corresponding life history and ecology of fish.

The more important issue is that we should use independent ENV data as Kolody (2011) mentioned some ENV are auto correlated thus we need to select independent ENV data carefully.

In addition we should not look only at ENV data but for other parameters then we should handle all the parameters synthetically so that we can look at the global situation and powers of contributions of the parameters. Fig. 7 shows some good example.

GLM Model	BIC	R2	
(1) Y+Q+A+YA	287209	13.4	
(2) Y+Q+A+YA+HBF	286908	13.6	
(3) Y+Q+A+YA+HBF+V	283683	20.9	3rd
(4) Y+Q+A+YA+ENV	286394	14.1	
(5) Y+Q+A+YA+HBF+ENV	286083	14.3	
(6) Y+Q+A+YA+HBF+ENV+V	283107	21.4	2nd
(7) Y+Q+A+YA+HBF+ENV+V+TG*A	282775	21.7	best
(8) Y+Q+A+YA+HBF+ML	297437	4.5	NG
(9) Y+Q+A+YA+HBF*ML	297767	4.1	NG

• ENV (no INT) to reduce apparent good fits (9 vs 30)
• V : contributes a lot
•TG*A (best factor last) Area specific TG(ocean fronts)
•ENV contribute to smooth trends

Fig 7 Results of GLM based on different quality of parameters

In conclusion we should continue use ENV data with caution (not use too much interaction terms and not use the correlated EN data etc as suggested by Kolody 2011). Also suggested by Kolody (2011) we especially should use anomalies of the ENV data which will be more useful parameter as they incorporate and based on the long term average, i.e., unique parameter for the special Oceanographic events. Finally we should look at various parameters to understand the global situation in the GLM analyses.

P9- Model Selection

The over parameterization is an importation issue, which causes not only the bias in the estimation/prediction but also increase the standard errors of parameters/predictors. Full simulation for assessing the performance of model selection criterion is demanding, but developing some scenarios specific to the swordfish stocks are worth considering.

(Additional comment) Sharp CPUE drop in SE may be Sub-Area effects in the GLM?

One of reason that we have the sharp drop may be caused by inappropriate sub area definitions. Currently we use 4 sub-areas which were suggested by Fonteneau (IRD) in the past WPB meeting which were based on the famous ecological defined areas (map). However we need to re-examine sub-areas incorporating the fisheries data and the SWO ecology (Fig 2). As the current sub-areas do not consider fisheries we may have the sharp CPUE drop due to the heterogeneous operational situations around the sub-area boundaries. One of the methods to select suitable sub-areas incorporating more fisheries situation is the computer intensive searching method as explained below:

Ichinokawa and Brodziak (2010) developed this method, i.e., "Using adaptive area stratification to standardize catch rates with application to North Pacific swordfish (*Xiphias gladius*)." We may attempt this method in the future. After we define sub areas by this method we should also incorporate the SWO ecology (Fig 2) then decide the final (new) sub areas. In this way we may not have sharp CPUE drops as this method takes care of the fisheries situations (data).

This paper is available as one of the INFO papers in the WPB9 (2011) and its abstract is provided below:

Abstract

This paper develops a new method to objectively construct an area stratification for standardizing catch per-unit effort (CPUE) with generalized linear models (GLMs). This algorithm incorporates the advantages of binary recursion as used in regression trees to minimize a chosen objective function, and extends the concept of stepwise model selection to minimize an appropriate goodness-of-fit criterion for a chosen statistical model, such as GLM. The algorithm can adaptively search for area stratifications that achieved better GLM fits to the CPUE data. The new algorithm, which we call 'GLM-tree', is applied to swordfish CPUE data from Japanese longline vessels in the North Pacific as a case study. The GLM-tree algorithm was conducted with the fishery CPUE data under alternative assumptions about the structural complexity of the GLMs and alternative choices of goodness-of-fit criteria, e.g., Akaike or Bayesian information criteria. Results show that the GLM-tree algorithm created area stratifications more effectively than area stratification determined in an ad hoc manner, and made area stratifications with better fits to swordfish CPUE data until a goodness-of-fit criteria achieved minimum. The algorithm produced many alternative models under different model complexity and area stratifications, which could explain the swordfish CPUE data equally well, because the structural complexity of the GLMs can be compensated by increasing the number of areas. Effects of area stratifications on the estimates of standardized CPUE are also shown to indicate that estimates of the abundance indices tend to converge after a sufficient number of areas have been added.

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