ISC/09/BILLWG-2/10

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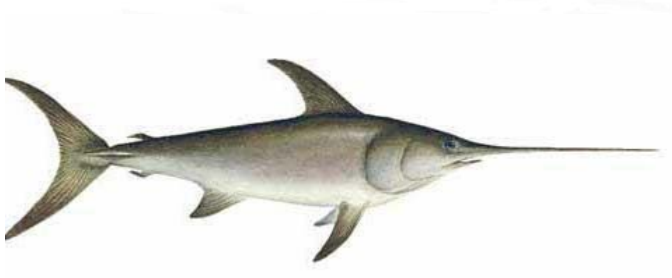

Working document submitted to the ISC Billfish Working Group Workshop, 19-26 May 2009,Busan, Korea. Document not to be cited without author’s written permission.

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Introduction

Billfish is mainly caught by Korean tuna longline fishery as by-catch in the Pacific Ocean. The main fishing ground of billfish during the last decade was the central Pacific Ocean. However, in 1997-1998 when the highest catch was recorded in the Pacific Ocean (Fig. 1), a stronger El-Nino period (Franke *et al*., 2002), additional fishing grounds of billfish were formed in the western coastal waters of Mexico (Fig. 2). This suggests that interannual changes in the catch of billfish in the Pacific Ocean is possibly affected by changes in spatial distribution of the catch.

The aim of the study is to look at spatial variations in the fishery catch of billfish in the Pacific Ocean and examine factors affecting interannual changes in the fishery catch, focusing on the changes of the fishery catch in the western coastal waters that may be related to global climate changes.

Materials and Methods

The logbook data for a 5 x 5 degree area collected from Korean tuna longliners operated in the Pacific Ocean during 1991-2007 were used for the study. Sea surface temperature (SST) observed by the five-channel Advanced Very High Resolution Radiometer (AVHRR) of NOAA's national environmental satellite during the last decade was used for examining oceanographic conditions of the Pacific Ocean. The most recent Pathfinder AVHRR data set was the AVHRR Pathfinder SST version 5. Further, in order to look at relationship between catch of billfish and global climate, equatorial SOI (southern oscillation index) as an index of global climate change such as

El-Nino was downloaded from the web site of Climate Prediction Center of NOAA. Furthermore, because Brander (1994) reported that fisheries data typically have non-normal distribution and relationships between fisheries data and environmental properties are typically non-liner, multiple regression model (MRM) used in this study is statistically compared with generalized additive model (GAM) in order to select an adequate model.

Results and Discussion

Main billfish species caught by Korean tuna longline fishery were swordfish (SWO), blue marlin (BUM) and black marlin (BLM) (Fig. 1) and a main fishing ground of the species was the central Pacific Ocean except for 1997-1998 when additional fishing ground was formed in the western coastal water of Mexico (Fig. 3). The yearly average SST in the central and eastern Pacific Ocean, in particular in the western coastal waters of Maxico, during 1997-1998 was higher than the SST during the rest of study period (Fig 4). The phenomenon in 1997-1998 is a typical characteristic of El-Nino event.

The study was firstly focused on the changes in the billfish catch in the western coastal waters of Maxico which could affect interannual changes in the catch in the entire Pacific Ocean. As factors affecting interannual changes in the catch in the western coastal waters of Maxico, two factors were assumed; one is variations in stock abundance and the other is changes in oceanographic conditions induced by global climate changes. Further, CPUE (catch/hook) in the entire Pacific Ocean and equatorial SOI were used for the study as indices of variation of stock abundance and global climate change, respectively. As a result of the multiple regression analysis, the fishery catch of billfish was significantly ($R=0.66$, $p < 0.05$) estimated by CPUE and equatorial SOI (Fig. 5). The standardized partial regression coefficient of equatorial SOI (-0.47) was minus and larger than that (0.35) of CPUE. This indicates that global climate changes could more affect the changes in the billfish catch than variations of stock abundance.

More adequate model for estimating the billfish catch using the equatorial SOI and CPUE as variables was multiple regression model (MRM), because the AIC (Akaike information criterion) of MRM was smaller than that of GAM (Table 1). The GAM also showed non-significant in the estimation (Table 1). This indicates that relationships between fisheries data and indices made from using some environmental factors may be liner.

References

Brander, KM. Patterns of distribution, spawning, and growth in North Atlantic cod: the utility of inter-regional comparisons. In: Jakonsson, J.(Ed.), Cod and Climate Change. Proceedings of a Symposium held in Reykjavik, ICES Mar. Symposia. Copenhagen, Denmark, 1994; pp 406-413

Franke, CR., Ziller, M., Staubach, C., Latif, M. Impact of the El Nino/Southern Oscillation on Visceral Leishmaniasis, Brazil. Emerging Infectious Diseases, 2002; **8**: 914-917.

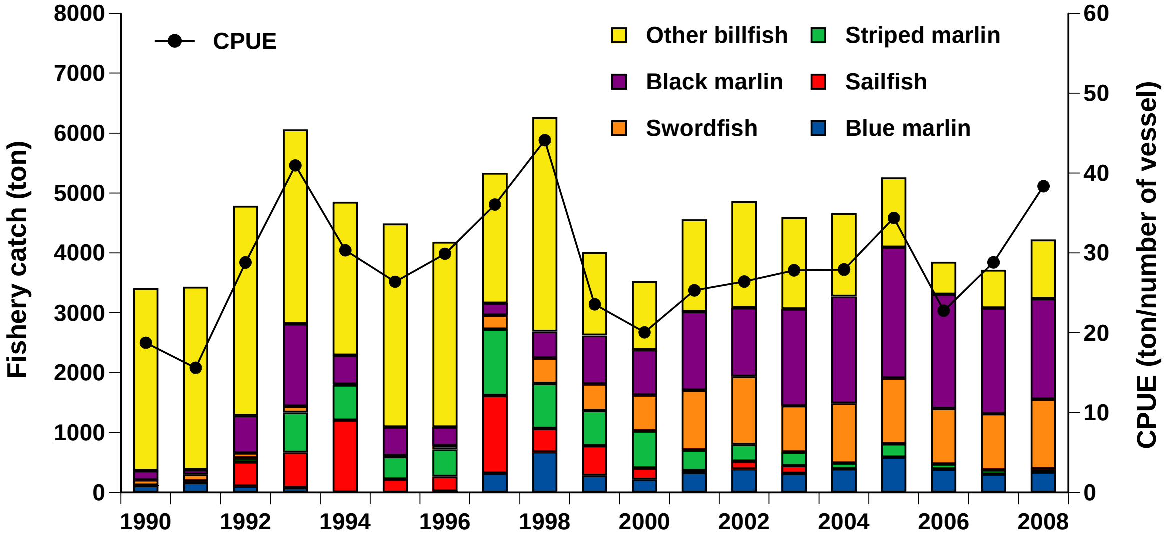


Fig. 1. Interannual changes in catch of billfish by Korean tuna longline fishery in the Pacific Ocean during 1990-2008. The data on billfish catch and number of vessel were obtained from Fishery Production Survey reported by the Ministry for Food, Agriculture, Forestry and Fisheries(MIFAFF) of Korea.

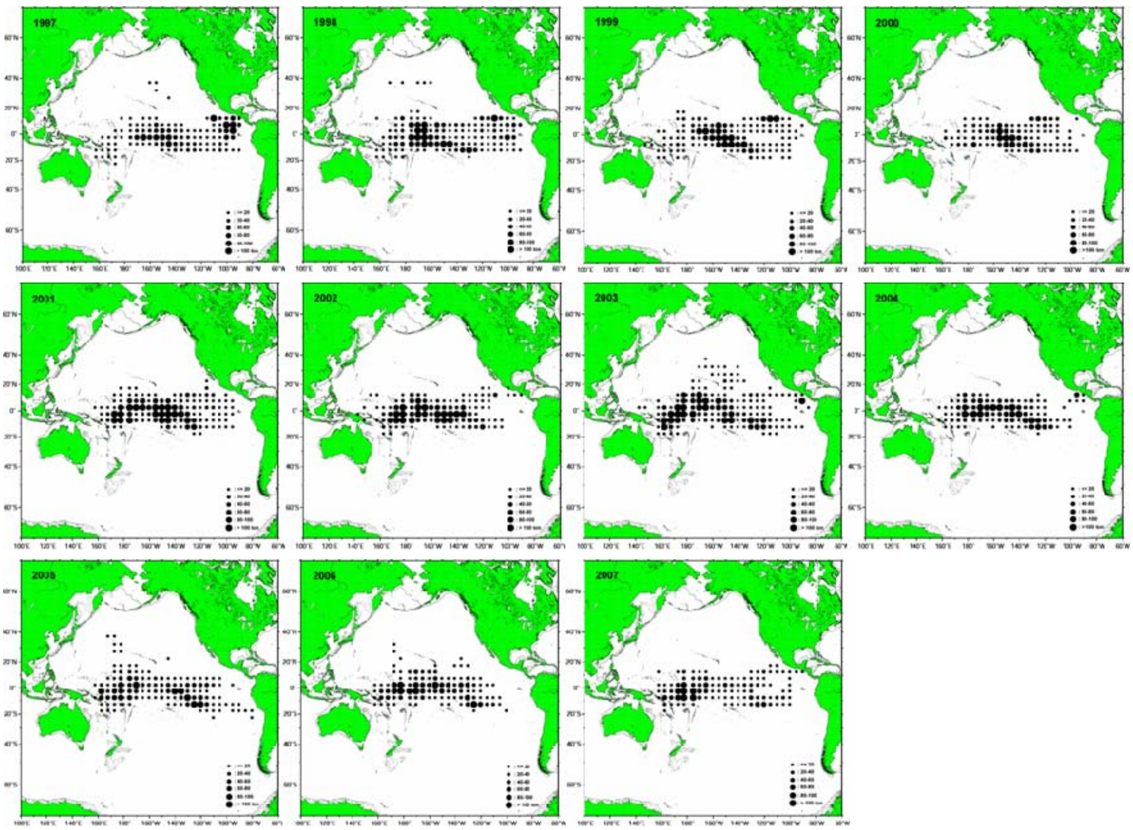
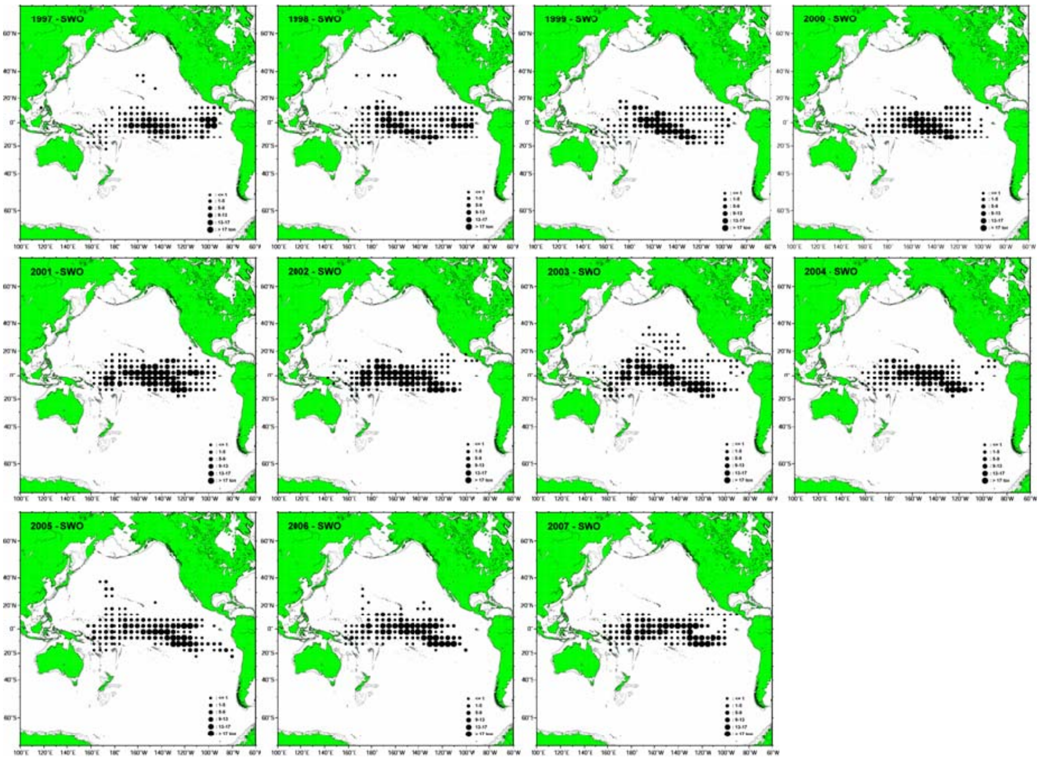
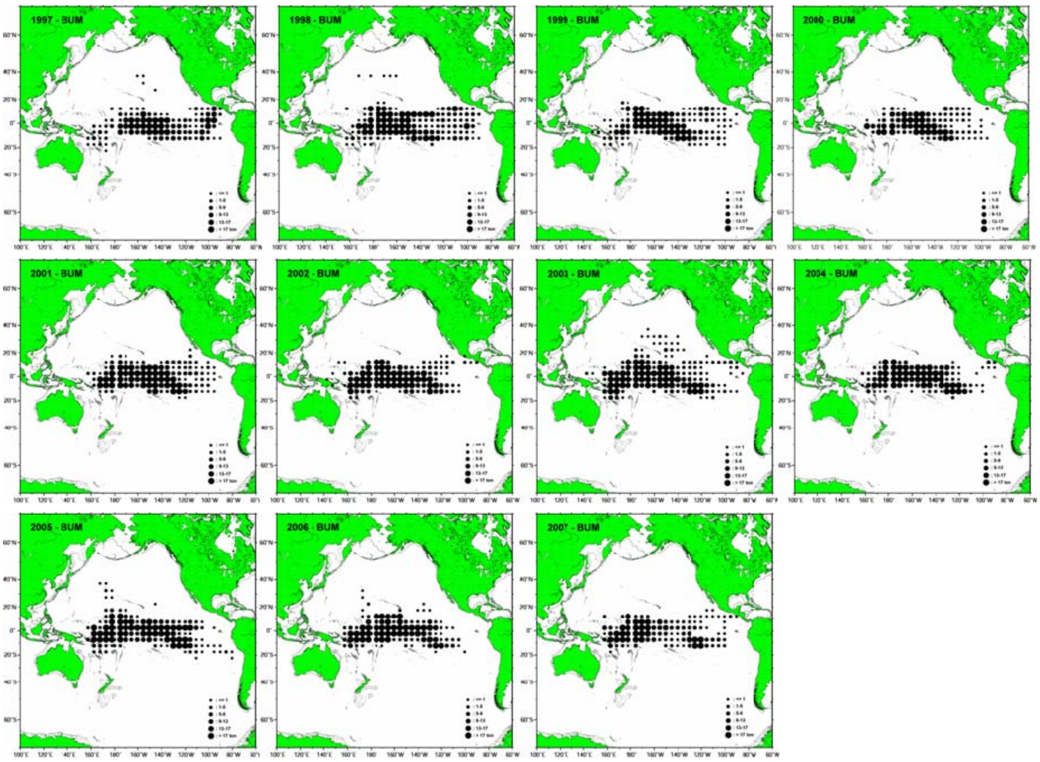


Fig. 2. Horizontal distribution of fishery catch of billfish collected in logbook (5°□5°) of Korean tuna longline fishery in the Pacific Ocean. The fishery catch of billfish is summed in blue marlin, Striped marlin, swordfish and black marlin.


1997 - SWO
1998 - SWO
1999 - SWO
2000 - SWO
2001 - SWO
2002 - SWO
2003 - SWO
2004 - SWO
2005 - SWO
2006 - SWO
2007 - SWO


1997 - BUM
1998 - BUM
1999 - BUM
2000 - BUM
2001 - BUM
2002 - BUM
2003 - BUM
2004 - BUM
2005 - BUM
2006 - BUM
2007 - BUM

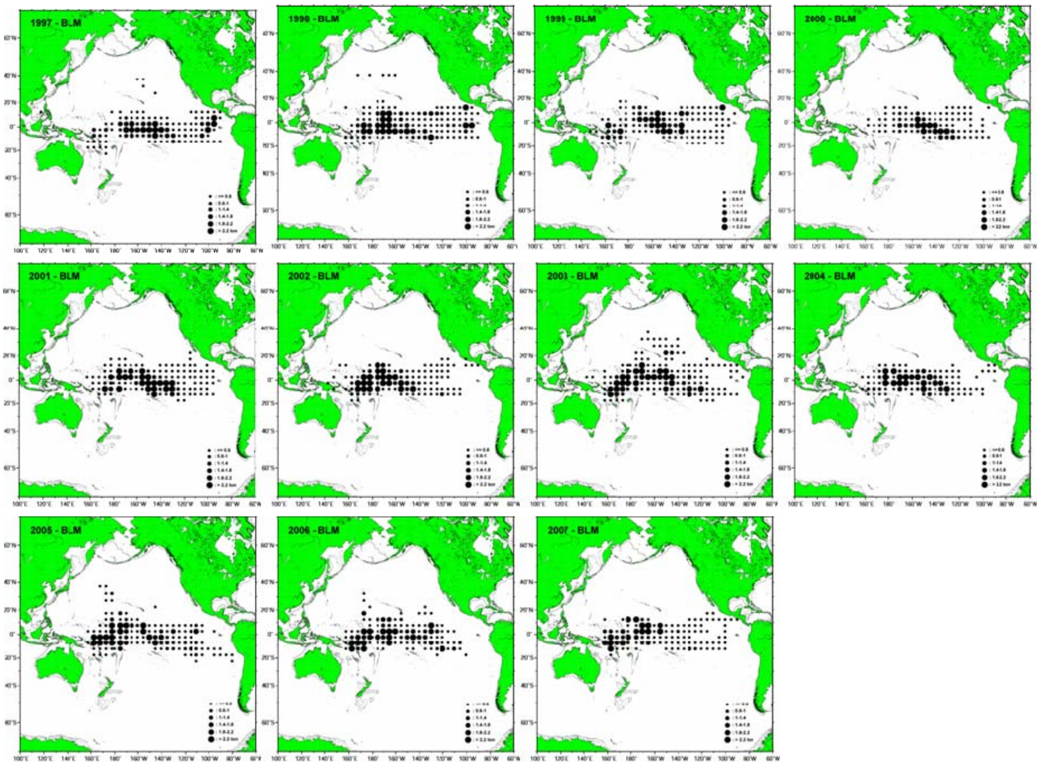


Fig. 3. Horizontal distribution of fishery catch of SWO (Swordfish) (top), BUM (Blue marlin) (middle) and BLM (black marlin) (bottom) collected in logbook (5° x 5°) of Korean tuna longline fishery in the Pacific Ocean.

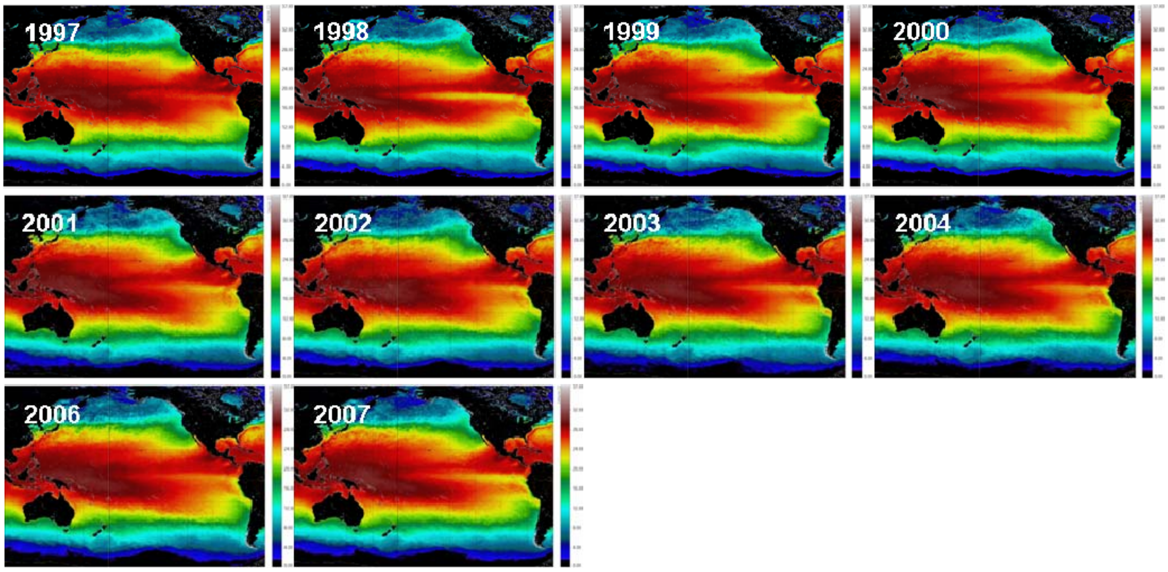


Fig. 4. Spatial distribution of yearly average SST (sea surface temperature) obtained from Pathfinder AVHRR of NOAA's national environmental satellite, 1997-2007.

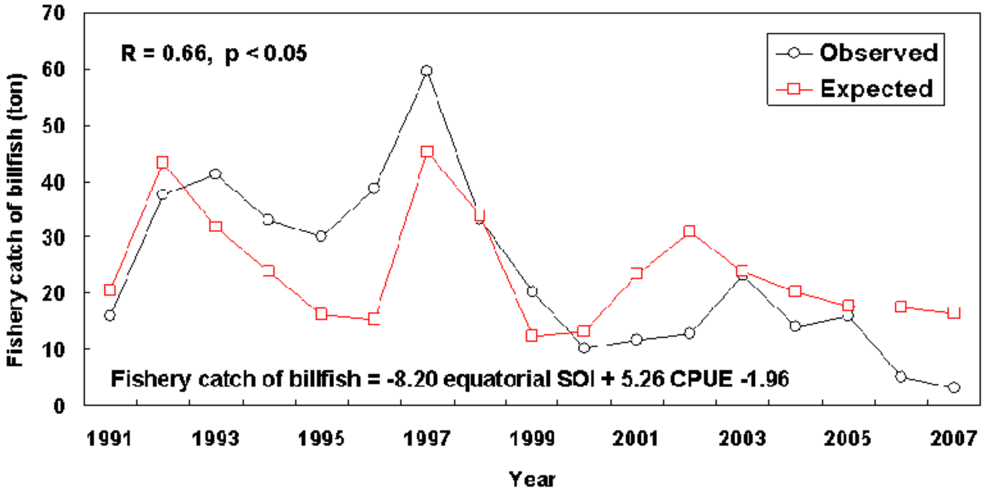


Fig. 5. The fishery catch of billfish (black line) in the western Coastal water of Mexico in comparison with that expected (red line) from a multiple regression model. Independent variables used in the analysis are equatorial SOI and CPUE (catch/100hook) of billfish in the Pacific Ocean.

Table 1. Comparing multiple regression model (MRM) with generalized additive model (GAM)

	Residual *Df*	**Residual deviance**	**F-value**	**p-value**	**AIC**
MRM (Catch=CPUE+SOI)	**14**	**2078.9**	**5.32**	**0.02**	**137.95**
GAM (Catch=s(CPUE)+s(SOI))	**11**	**1226.8**	**1.12**	**> 0.1**	**140.99**