Abstract

Exploring the spatial distribution to analyze the spatial variability of catch compositions of three major billfish species; Sword fish (*Xiphias gladius*), Black marlin (*Makaira indica*) and Sail fish (*Istiophorus platypterus*) from high sea multi-day fishery in Sri Lanka

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Of the five major billfish species in local commercial landings, black marlin (*Makaira indica*), sailfish *(Istiophorus platypterus)* and swordfish *(Xiphias gladius)* are dominant in terms of their contribution to the total national production. There is lacking of studies focused to explore their spatial distribution in order to analyze the spatial variability of catch compositions. Therefore this study aimed to address it using 2016 logbook data and related spatial information.

The spatial distribution of three bill fish species; sword fish (SWO), black marlin (BLM) and sail fish (SFA) was mapped at 05 grid resolution. Spatial variability of catch compositions was analyzed and compared among the three billfish species.

Generally, the spatial distribution of billfish species resulted three distinct spatial clusters as Bay of Bengal spatial cluster (BB), Arabian Sea-Indian Ocean spatial cluster (ASIO) and Indian Ocean spatial cluster (IO), directing along the EEZ boundary of Maldives from the Southwest EEZ boundary of Sri Lanka. Geographically, the spatial areas were identified as 7^0-17^0 N, 75-80 E; 10^0 S-5^0 N, 75^0-80^0 E; 55^0-70^0 E, 0^0-15^0 N respectively for BB, IO and ASIO. The percentage catch contributions were 49 %, 29 % and 21 % respectively for ASIO, BB and IO. Within each spatial cluster, SWO showed highest contribution to the total catch. It contributed 56 % and 45 % respectively for ASIO and IO spatial clusters while 40 % for the BB, where it equals to the SFA. Even though BLM dominated in the IO (43 %) and ASIO (33 %), it was dominated by SFA (40 %) in the BB. SFA showed highest spatial variability while SWO showed the lowest.

It can be concluded that the spatial distribution of selected billfish species from the high sea multi-day fishery in Sri Lanka is quite distinct with clustered spatial pattern. This distinct spatial distribution together with catch variability provides a glimpse of habitat preference of billfish species facilitating the fishing operations. Further, the ASIO is the most preferred spatial area for SWO while BB and IO respectively for SFA and BLM. But the spatial variability of catch compositions can vary due to the gear combinations used and their frequency of operation.

Keywords: Billfish, Logbook, high sea multi-day fishery, spatial distribution, Spatial variability

1. Introduction

Billfishes are highly migratory epipelagic marine fishes that live primarily in the upper 200 metres of the ocean and are widely distributed throughout the tropical, subtropical and temperate waters of the world's oceans (Collette and Nauen 1983; Nakamura 1985; Kitchell et al., 2006). There are six species widely distributed in tropical and subtropical Indian Ocean; Swordfish (*Xiphias gladius*), Black marlin (*Istiompax indica*), Blue marlin (*Makaira nigricans*), Striped marlin (*Kajikia audax*), Indo-pacific sailfish (*Istiophorus platypterus*) and Shortbill spearfish (*Tetrapturus angustirostris*).

Some billfish species are targeted by commercial and recreational fisheries worldwide, but generally billfish species are caught as a by-product of the tuna fisheries (Kitchell et al., 2006.) Billfishes are considered as a non-target species in high sea gillnet and longline fishery of Sri Lanka (Haputhantri and Maldeniya, 2011).

Even though there is no target fishery for billfish in Sri Lanka, it makes considerable contribution to the billfish production in the Indian Ocean. Of the five major billfish species; black marlin, blue marlin, striped marlin, sword fish and sail fish in local commercial landings, black marlin (*Makaira indica*), sailfish *(Istiophorus platypterus)* and swordfish *(Xiphias gladius)* are dominant in terms of their contribution to the total national production.

Understanding the spatial distribution of fish species reveals significant information with regards to species habitat preference while facilitating the commercial fishing activities too. There are lacking of studies in Sri Lanka under spatial domain to identify spatial distribution and characteristics targeting commercial fish species. Therefore this study aimed to explore the spatial distribution of three major bill fish species, black marlin (BLM), sailfish (SFA) and swordfish (SWO) in order to analyze the spatial variability of their catch compositions.

2. Data and Methods

2.1 Data and Data Verification

Catch data and their corresponding position information (Latitudes and Longitutdes) received directly through high sea logbooks in 2016 were used for the analysis. The logbook data were verified in order to identify the data recording and entry errors focusing GPS positions (Latitudes and Longitutdes). The verification was done comparing the Vessel Monitoring System (VMS) data obtained for corresponding fishing events through the tracking logs of VMS database.

2.2 Mapping Spatial Distribution

Spatial distribution of three bill fish species was mapped using the position information (Latitudes and Longitudes) recorded in the logbooks during the high sea fishing operations at five grid spatial resolution. ArcGIS was used as Geographic Information System (GIS) mapping application.

3. Results and Discussion

3.1 Spatial Distribution Maps of Billfish

The spatial distribution of billfish species in the high sea fishing resulted three distinct spatial cluster areas. Generally, the clusters can be defined as Bay of Bengal spatial cluster (BB), Arabian Sea-Indian Ocean spatial cluster (ASIO) and Indian Ocean spatial cluster (IO), which is directing along the EEZ boundary of Maldives from the Southwest EEZ boundary of Sri Lanka. The exact geographic demarcations of three different spatial areas were 7^0-17^0 N and 75^0-80^0 E, 10^0 S-5^0 N and 75^0-80^0 E and 60^0-70^0 E and 0^0-15^0 N represented by BB, IO and ASIO respectively. Some scattered spatial locations were also observed at several high sea locations (Figure 1).

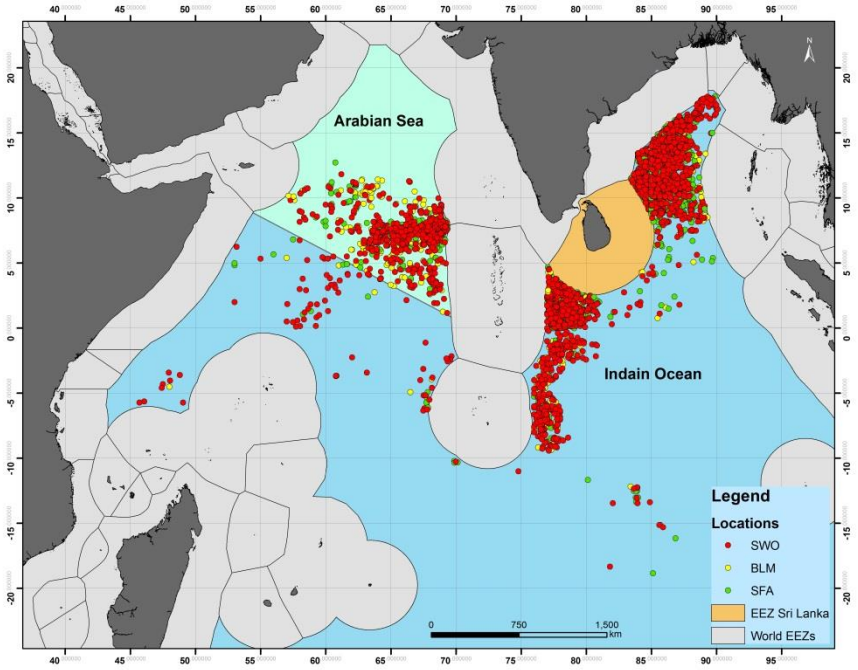

Figure 1. Spatial distribution three major billfish species during high sea multiday fishing in 2016

Further, the separate spatial maps of individual billfish species clearly showed there fishing grounds during high sea multi-day fishing activities in 2016. The SWO and BLM showed nearly the same spatial distribution pattern while SFA showed slight difference in its spatial distribution, particularly in the IO and ASIO (Figure 2). This may be due to the stock status of SFA in those areas.

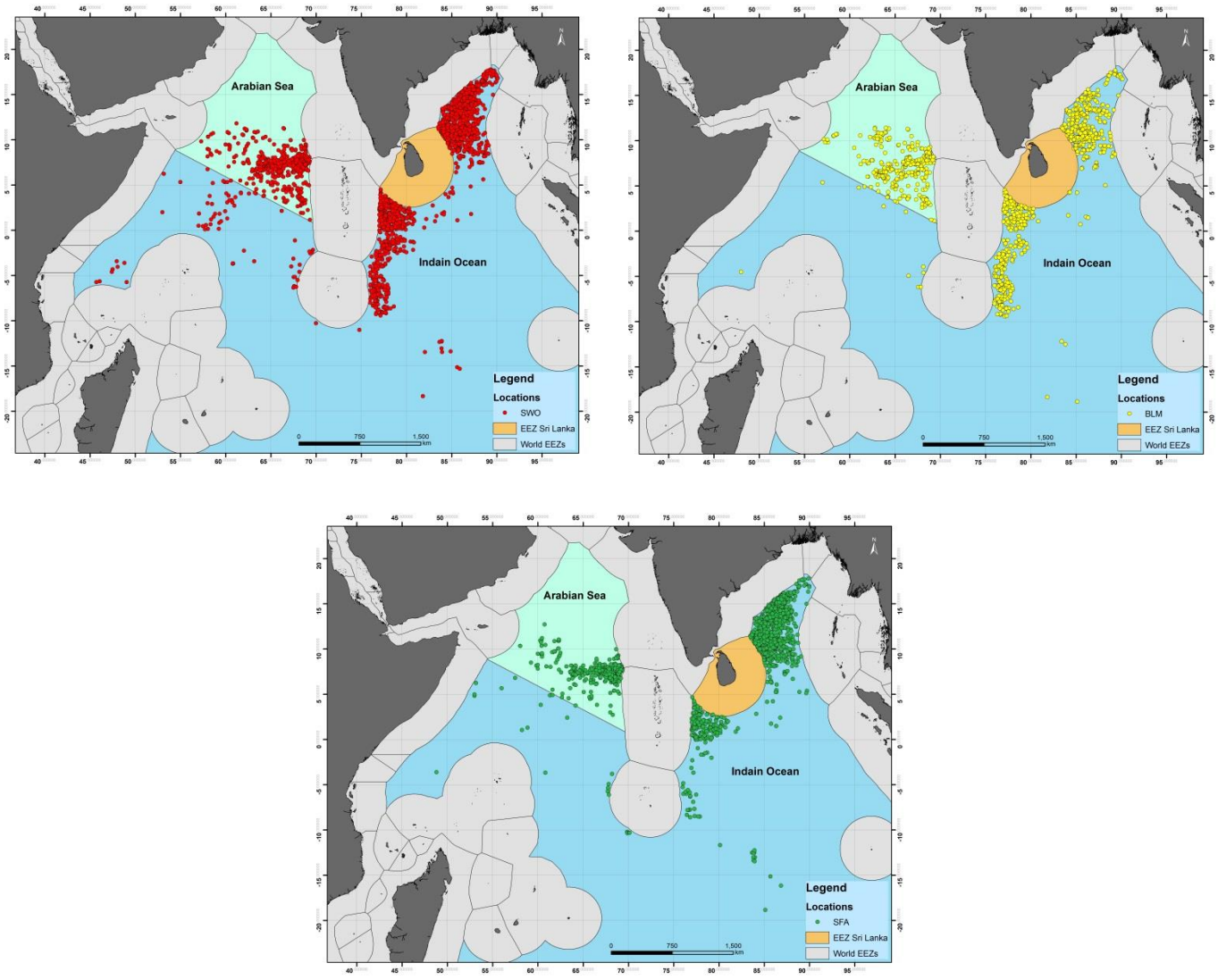

Figure 2. Spatial distribution of individual billfish species

3.2 Spatial Variability of Catch Compositions

The highest spatial variability was observed for SFA. It represented 40%, 12% and 11% among the spatial clusters; BB, IO and ASIO respectively. The SWO showed lowest spatial variability. Within the each spatial cluster, SWO showed highest contribution. It represented 56 % and 45 % respectively in the ASIO and IO while 40 % in the BB, where it equals to the SFA. Even though SFA was dominated by BLM in the IO (43 %) and ASIO (33 %), it was dominated by SFA (40 %) in the BB (Table 1). Higher spatial variability provides a glimpse of spatial variations of

preferred habitats conditions while lower variability could be due to nearly the same habitat conditions.

Table 1: Percentage variability of billfish catch compositions at three distinct spatial areas

	Catch (%)		
	BB	**IO**	**ASIO**
SWO	40	45	56
BLM	20	43	33
SFA	40	12	11

4. Conclusions

It can be concluded that the spatial distribution of selected billfish species from the high sea multi-day fishery in Sri Lanka is quite distinct with clustered spatial distribution. This distinct spatial distribution together with catch variability provides a glimpse of habitat preference of billfish species facilitating the fishing ground preference for high sea fishermen. Further, the ASIO is the most preferred spatial area for SWO while BB and IO are respectively for SFA and BLM. But the spatial variability of catch can vary due to the gear combinations used and their frequency of operation.

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