ISC/11/SHARKWG-2/04

A summary of blue shark (*Prionace glauca*) and shortfin mako shark (*Isurus oxyrinchus*) tagging data available from the North and Southwest Pacific Ocean

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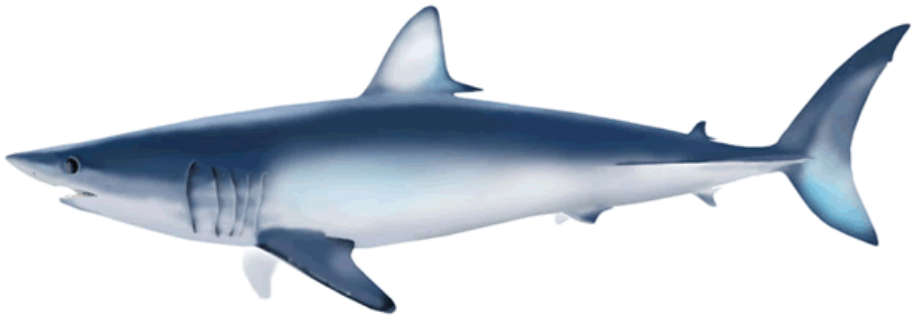

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Executive Summary

The ISC Shark Working Group has identified tagging data as potentially useful data to examine stock structure hypotheses and provide information on movements for stock-assessments in support of population management. Shark tagging programs in the Pacific have been in operation since the 1960's but there is still limited information on the stock structure of highly migratory pelagic sharks, and movement data from these programs generally have not been included in stock assessments. The tagging data presented here do not support a hypothesis of panmixia of blue shark or shortfin mako stocks in the Pacific Ocean. Rather this evidence suggests at least northern and southern sub-populations of both species, demarked by the equator.

Introduction

Recent reviews of the current state of biological knowledge about blue and mako sharks indicated uncertainty about stock structure in the Pacific Ocean (Nakano and Stevens 2009; Stevens 2009). The ISC Shark Working Group has identified tagging data as potentially useful data to examine stock structure hypotheses and provide information on movements for stock-assessments in support of population management (ISC 2011). In general, tagging data can inform spatially explicit aspects of assessment models (eg. advection-diffusion, population structure), provide basic biological information (eg. growth rates), contribute to fishery specific parameters (eg. fishing mortality), and corroborate other information (eg. spatial structure inferred from genetics or CPUE trends, etc.).

Shark tagging programs in the Pacific have been in operation since the 1960's but data from these programs have generally not been included in stock assessments of sharks. However, tagging data have been considered in varying ways for estimation of population-level parameters for stock-assessment in general (Hilborn 1990; Sibert *et al.* 1999; Maunder 2001). Conventional tagging data have been used previously to estimate blue shark movement and fishing mortality rates from the Atlantic (Aires-da-Silva *et al.* 2009).

This paper summarizes blue and shortfin mako shark tagging data collected within the Pacific Ocean from several research programs.

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Data and Summaries

Data from tagging programs run by NOAA's Southwest Fisheries Science Center (SWFSC), Japan's National Research Institute of Far Seas Fisheries (NRIFSF), and New Zealand's Ministry of Fisheries (NZMF) were available (Table 1).

SWFSC began an angler based pelagic fish tagging program in 1968 with most effort focused in the northeast Pacific and on billfish species, with some effort on pelagic sharks. In the early 1970's some tags were also distributed for sharks to Australia and New Zealand resulting in some tag-recapture data from the southwest Pacific. Prior to 1995, most of the tags in this program were deployed from recreational fishing vessels, many through a recreational shark tagging program run by the California Department of Fish and Game between 1983 and 2000. In recent years, the SWFSC has been conducting research tagging during an annual shark survey.

New Zealand data are current as of 30 June 2011. Most of these tags were deployed from recreational vessels as well.

NRIFSF has conducted a tagging program of sharks in the Pacific Ocean since 1996. Most of the Japanese tags in the North and South Pacific Ocean were released from research cruises and fishery training vessels, and observers, respectively. The recaptured sharks were reported mainly from commercial vessels in both ocean basins.

Table 1. Conventional tagging data summary by program.

Country of Program	Species	Year Started	Tagged	Recaptured
USA*	Blue shark	1968	9512	205
New Zealand**	Blue shark	1975	4262	77
Japan***	Blue shark	1996	18180	207
USA*	Mako	1968	5485	354
New Zealand**	Mako	1975	13096	336
Japan***	Mako	1997	433	14

*NOAA - Southwest Fisheries Science Center

**New Zealand Ministry of Fisheries

***Japanese National Research Institute of Far Seas Fisheries

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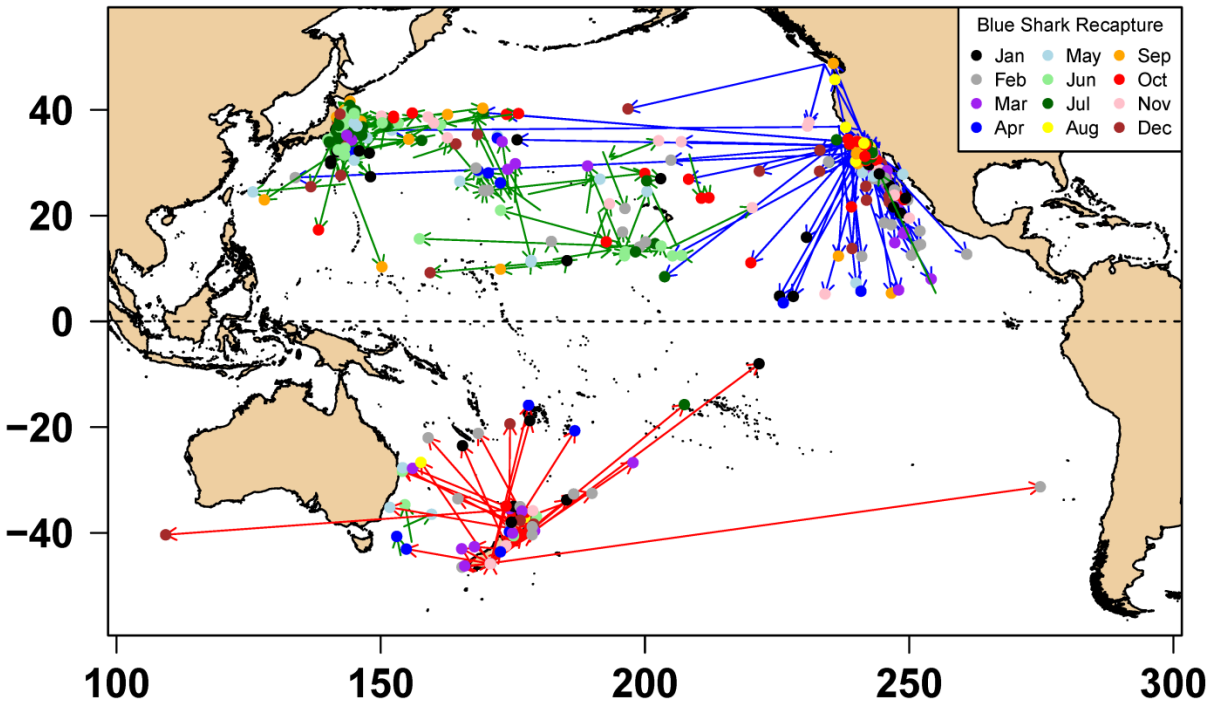

Figure 1. Blue shark tag recaptures. Blue lines are from NOAA – Southwest Fisheries Science Center databases, green lines are from Japanese National Research Institute of Far Seas Fisheries databases, red lines are from the New Zealand Ministry of Fisheries database. Recapture months are depicted by colored circles.

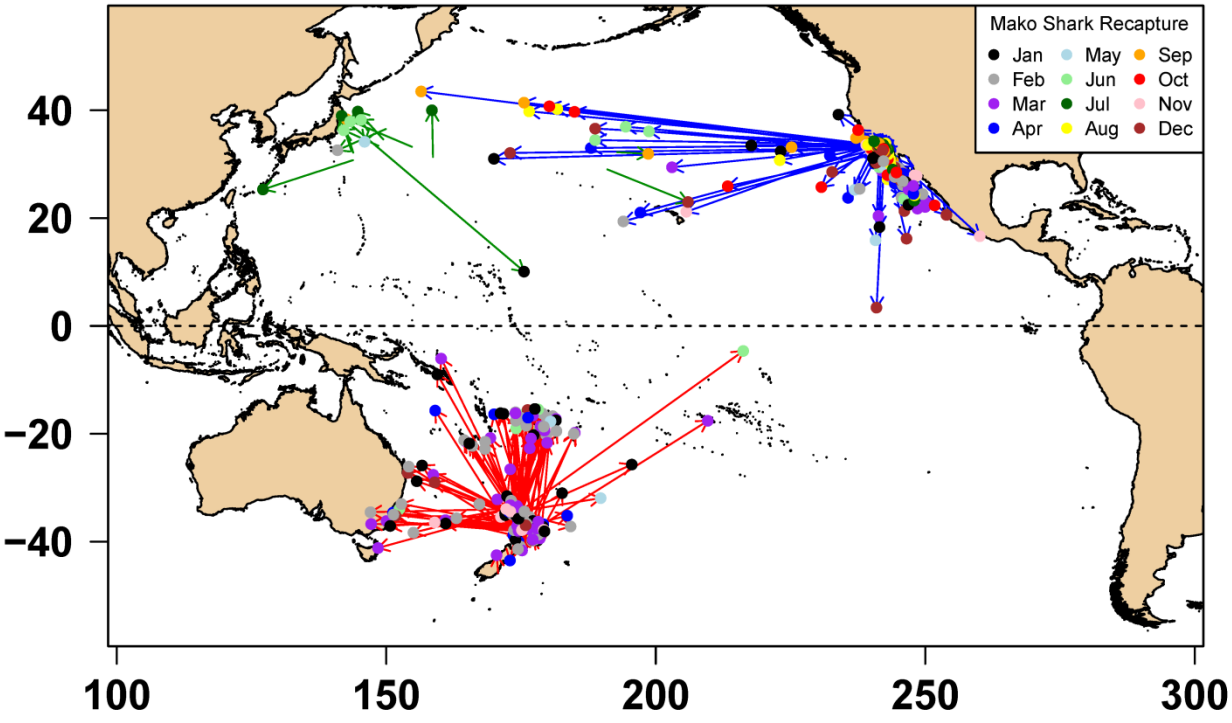

Figure 2. Shortfin mako shark tag recaptures. Blue lines are from NOAA – Southwest Fisheries Science Center databases, green lines are from Japanese National Research Institute of Far Seas Fisheries databases, red lines are from the New Zealand Ministry of Fisheries database. Recapture months are depicted by colored circles.

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Discussion

The tagging data presented here do not support panmixia of blue shark or shortfin mako stocks in the Pacific Ocean. The maximum range of movements suggests at least northern and southern sub-populations of both species, demarked by the equator.

Although most were recaptured within their northeastern Pacific tagging regions, numerous blue sharks tagged in the northeastern Pacific moved to the central and northwestern Pacific, and many were recaptured near the eastern equatorial Pacific. Blue sharks released from the northwestern Pacific were mostly recaptured within this same region, but movements into the central and eastern Pacific were observed as well. Of those tagged in the southern Pacific, some tagged in the southwest Pacific dispersed to the central and eastern South Pacific, as well as one into the Indian Ocean. However, the majority stayed within the southwest Pacific, and many were recaptured near their New Zealand tagging areas. A few tags released on blue sharks by the NRIFSF program in the southern Tasman Sea (between Tasmania and New Zealand) were also recaptured nearby.

Shortfin makos tagged in the northeastern Pacific were mostly recaptured in this same region, although several were also recaptured in the central and western North Pacific. Recaptures of those tagged in the northwestern Pacific were mostly confined to the tagging area, with one moving into the central Pacific, and a few tagged in the central Pacific being recaptured there as well. Tagging in the southwest Pacific suggests a substantial degree of fidelity to this region, primarily remaining within approximately 150°E-160°W longitude, and 20-40°S latitude. The striking pattern of recaptures around 20°S is quite similar to individual movement patterns and general population distribution of striped marlin documented through electronic tagging in the southwest Pacific Ocean (Sippel *et al.* 2011). Possible mixing of the northern and southern populations of shortfin makos appears to be more likely in the eastern Pacific than western. The hemispheric population structure suggested here is consistent with genetics data as well (Michaud *et al.* 2011). While we have not included tagging data from the southeast Pacific in this study, we are aware of some tagging programs (eg. Abascal *et al.* 2011) and hope to include information from that region in a future report.

Temporal structure has not been considered in this cursory examination of the data, but given the quarterly time structure commonly used for data in stock assessments, these data could

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also be summarized to provide quarterly movement rates. Recapture locations are colored by month in Figures 1 and 2 to give a general sense of the temporal pattern shown within these data.

These data are informative about stock structure in the Pacific Ocean, and there appears to be sufficient data to consider inclusion within stock assessment models.

Acknowledgements

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