Review of Neritic Tuna Fisheries in the Maldives

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Abstract

Indian Ocean tuna fisheries exploit a number of neritic tuna species, including bullet tuna (*Auxis rocheii*), frigate tuna (*Auxis thazard*), kawakawa (*Euthynnus affinis*) and longtail tuna (*Thunnus tonggol*). Of these, kawakawa and frigate tuna are caught in the Maldives fisheries using pole-and-line, handline and trolling and form minor proportions of total tuna landings. Throughout history, pole-and-line vessels landed the bulk of frigate tuna while trolling vessels dominated the kawakawa catch prior to mechanization of the fleet. Catches for both species have shown irregular trends influenced by fishery, environmental and socioeconomic related factors. Highest recorded catch of frigate tuna was observed in 1973 reaching over 6,000 tons, with similar catches being observed in 1996 (6,485 t) and 1995 (5,456 t). Kawakawa catch has shown less variations, peaking during period 1993-1998 with an average of roughly 3,000 t. Catch of both species has seen prominent declines from 2010 onwards coinciding with the introduction of fishery logbooks. Based on catch rates, frigate tuna has been suggested to show east-west migration within the atolls, in phase with the oscillating monsoon currents (Anderson, Waheed and Nadheeh, 1998). No such movement was observed for kawakawa. Studies on stock structure and estimates of abundance are virtually non-existent for both species. Despite availability of a continuous CPUE data series on the Maldives PL fleet, which was used for stock assessment of Indian Ocean kawakawa, the results so far have been dubious due to low level of information on exchange between different components and non-representativeness of the Maldives CPUE series for the whole Indian Ocean kawakawa catch.

1. Introduction

Indian Ocean tuna fisheries exploit a number of neritic tuna species including, bullet tuna (*Auxis rocheii*), frigate tuna (*Auxis thazard*), kawakawa (*Euthynnus affinis*) and longtail tuna (*Thunnus tonggol*). Of these, kawakawa and frigate tuna are exploited in the Maldives using pole-and-line (PL), handline (HL) and by trolling (TR).

Until around early 1990s, there was a distinct troll fishery that targeted kawakawa (Anderson et al., 1998). Maldives tuna fishery has invariably preferred skipjack and yellowfin tuna over frigate and kawakawa. In the past, this preference has been attributed to factors such as general preference for skipjack tuna in the diet and better product quality derived from skipjack and yellowfin tuna. In the recent past, access to overseas markets for skipjack and yellowfin tuna has increased demand and consequently catch of the species, whereby decreasing contribution from neritic species. Additionally factors such as diversion of effort, developments to the data collection system and changes in the sampling program have diminished current understanding of the neritic tuna resources of the country.

2. Catch and catch trends

Collection of fishery statistics in Maldives began in 1959 and until 1970, four species of tuna (skipjack, yellowfin, frigate and kawakawa) were aggregated into three groups; large skipjack, small skipjack and yellowfin tuna, frigate and kawakawa. Records for the period (except from 1962 to 1965 where data is missing) show a combined average catch of neritic tunas to be on average 2300 t annually. Despite inter annual variations, kawakawa and frigate tuna observed a general increasing trend. Catch trend for both species are presented in Figure 1 and discussed in the following sections.

Kawakawa catch trend

Kawakawa catch has increased erratically throughout the years, peaking in 1996 at nearly 3800 t. Similar catches were also recorded in 1993 (3500 t) and 1998 (3600 t). Slightly more than 3000 t were landed in 2009. Catch has since declined to 890 t in 2014 (70% decline). A catch below 1000 t was only observed in the period 1970-79 (average catch of 742 t). The rapid decline in catch, or the reported catch, since 2009 was the most prominent observed over several consecutive years. This has been attributed to the decline in pole-and-line effort and the introduction of the fishery logbooks with gradual phasing out of the traditional island/council office data collection system (Ahusan and Adam, 2015) discussed in Section 5.

One of the major developments in the tuna fishery was the mechanization of the fishing fleet beginning from 1970. During the period, pole-and-line vessels were removed from fishery, effectively reducing effort. Unlike frigate tuna, Kawakawa landings were not greatly affected during the mechanization years. This was due to the dominance of the trolling fleet in kawakawa landings which contributed to negate the impact of the reduction in PL effort. It was observed that relative contribution from the trolling fleet was highest during these years as noted in Section 3.

Kawakawa catch and catch rates are thought to have been affected by factors such as fishing pattern, increased fishing power and demand. Additionally, environmental factors are also thought to play a role in catch and catch rates of kawakawa in the Maldives. Anderson, Waheed and Scholz (1998) showed that over the period of 1970-97, catch rates by *masdhonis* were 60% higher during El Niño years than during non-El Niño years, and on average, 11% higher for *vadhu dhonis*.

Frigate tuna catch trend

Highest catch of frigate tuna were observed in 1973 with a total of 6600 t. This was followed by stark decline in catch until 1981 which coincided with the period of mechanization of the fishing fleet. In contrast to kawakawa, removal of PL vessels for mechanization (1970-1980) had a bigger impact on frigate tuna catch as pole-and-line is the primary gear for the species. Lowest catches were observed during 1978-81 (mean catch 1600 t) and 1986-88 (mean catch 1700 t). The reported catch in 2013 was a record low with just 566 t being reported. A catch below 1000 t has not been observed in the Maldives since availability of species segregated catch data from 1970 onwards.

Similar to kawakawa, frigate catch has been on a declining trend beginning 2010. About 5200 t were reported in 2009, which declined by 88% by 2014. It is thought that this decline is caused by the same factors as for kawakawa (refer to Section 5).

Catch and catch rates for frigate tuna are also affected by oceanographic variations. Pole-and-line vessel catches and catch rates showed peaks during the strong El Niño years of 1972-73, 1983 and 1993 (Anderson Waheed and Nadheeh, 1998). Likewise, the strong El Niño year of 1998 also showed a peak in frigate catch with 3600 t being landed in the year. This was a 74% increase from the previous year.

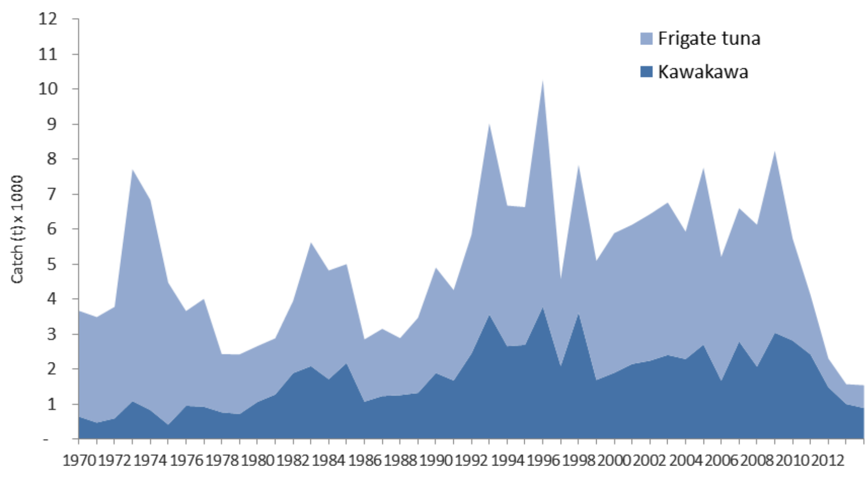

Figure 1. Annual catch (t) of kawakawa and frigate tuna (1970-2014)

3. Gears exploiting neritic tunas

Historically, Maldives had a homogenous fishing fleet where the two main types of fishing vessels, *vadhu dhoni* (trolling vessel) and *masdhoni* (pole-and-line vessel) used single gears; trolling gear pole-and-line respectively. As a result, the fishery data collection system did not identify the gear used until 1989. Therefore, *vadhu dhoni* and *masdhoni* were interchangeably used for trolling and pole-and-line gear respectively in previous literature. Use of handline to catch tunas was a recent development (late 1990s) with the advent of the handline fishery targeting large yellowfin tuna. Pole-and-line, trolling and handline are the primary gears exploiting neritic tunas in the Maldives.

Kawakawa

Pole-and-line and handline are the two main gears that currently land kawakawa (Figure 2). Trolling gear (used by the *vadhu dhoni* fleet) was historically important for kawakawa as it landed the bulk of the catch. For the period, 1979-85, *vadhu dhonis* contributed an average of 62% of the kawakawa catch. Contribution from trolling fleet peaked during the period 1977-78, accounting for 83% of the catch. This was when the *masdhoni* (PL) fishing effort was at a low ebb during the transitional period of *masdhoni* mechanization (Anderson, Waheed and Adam, 1998). Since the mid1990s, pole-and-line gear has consistently dominated the kawakawa catch.

Handline catches of kawakawa have recently increased in contribution, from an average of 72 tons during the period 2000-04 to 300 tons during the period 2009-13. Increased catches from handline could be attributed increased effort from the handline reef fish fishery catering to the local resorts. Being mainly found within the atolls and reef fishing grounds, kawakawa is commonly caught in the reef fishery and often are targeted due to requirement from the resorts. Improved reporting of handline effort and its associated catch is also thought to be a reason for the observed trend (Section 4).

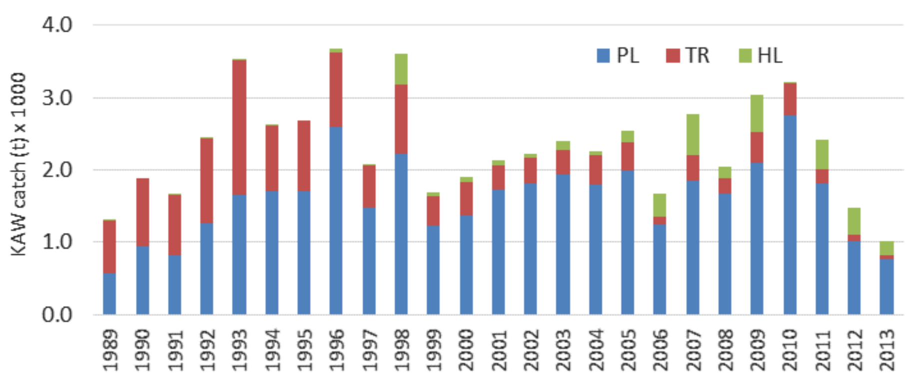

Figure 2. Kawakawa catch (t) by gear, 1989-2013.

Frigate tuna

Unlike for kawakawa, pole-and-line has been the dominant gear landing frigate tuna throughout history (Figure 3). This was because, in contrast to kawakawa, frigate tuna was not commonly caught by the large trolling fleet that existed prior to mechanization. Contribution from the trolling fleet was just 10% in the period 1970-97 (Anderson, Waheed and Adam, 1998). It has since declined to about 5% in the period 1998-2014. Similar to kawakawa, frigate tuna caught using handline gear has seen a rise since 2005 peaking at 308 t in 2012. Handline catch was on average 21 t for the period 1994-2004. Possible reasons for the apparent increase from HL are discussed later.

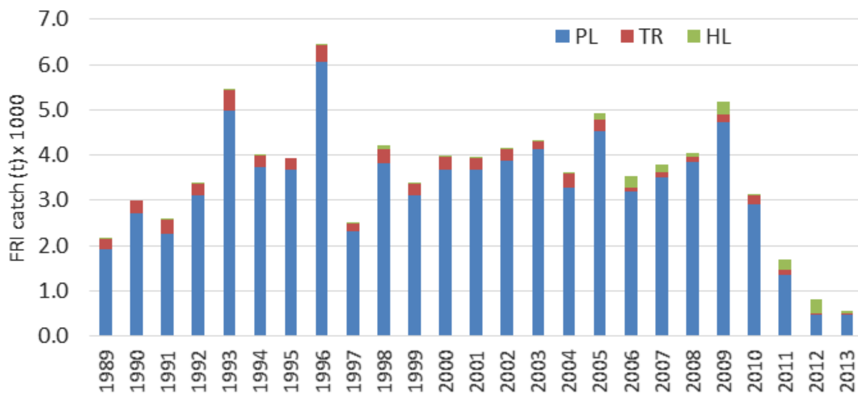

Figure 3. Frigate tuna catch (t) by gear, 1989-2013.

4. Effort trend

Fishing effort in the Maldives is recorder by the number of days fishing. Ministry of Fisheries and Agriculture (MoFA) began collecting gear specific effort data in 1989, prior to which, it was recorded by vessel type. Figure 4 shows effort trends for the main gear types for tunas in the Maldives. Combined effort for the three gears increased until 1995, from about 225 thousand to 272 thousand effort days. The following years saw gradual reduction in total effort except for few years in between (200-203 and 2008-2009).

The most prominent trend in the effort series is the declining PL effort from 1996 to 2012, with a 64% decline in the period. A reduction in PL effort would be deemed to have a similar effect on neritic catch as PL is the main gear for both species. However, interestingly, catch trend for both species does not show a clear declining trend until 2009 (this was the period before the change in data collection system). Despite a 64% reduction in effort, catches of kawakawa and frigate showed 19% and 22% reduction in catches from 1996 to 2012.

Handline effort shows three distinct phases. From 1989, when gear wise effort data collection began, till 1997, handline effort remained quite low. Average effort for the period was at 1200 days. From 1998 – 2004, average effort was at 7 thousand effort days and from 2005 – 2012, average effort jumps to 34,600 days. Possible A number of factors contributed to the observed changes in effort:

- Vessel specific data collection from 2004 onwards (Adam, 2012). This would explain the sudden increase in HL effort from 4600 days in 2004 to 29,600 days in 2005. As data recording was based on vessel type, with gear being assigned, it would have been natural tendency to record the most common gear (i.e. PL).
- A separate form designed to record HL large yellowfin tuna catches was introduced in the early 2000, with only a few forms returned (Adam, Jauharee and Miller, 2015), a possible explanation for the slight increase in HL effort from late 1990 to 2004.

In essence, it is possible to say that the increase in observed HL effort is partly result of improved reporting rates combined with a possible increase in effort as more fishermen turn to HL YFT fishery for economic reasons. It is notable that some islands, especially in the north which were famous for PL fishing now almost exclusively conduct HL fishing for large yellowfin tuna.

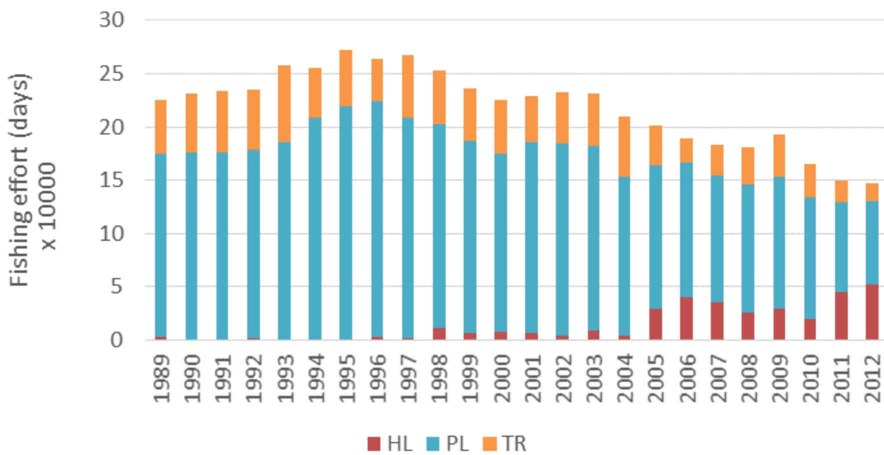

Figure 4. Fishing effort (days) for the period, 1989-2012.

5. Fishery data collection and reporting

Fishery data collection of the Maldives began in 1959 and over the years, developed from a traditional, island office reporting system to the current logbook reporting scheme. The traditional system of data reporting which required an island office official to acquire data from the fishermen and report to MoFA is well described in literature (e.g. Anderson and Hafiz, n.d; Anderson, Waheed and Adam, 1998; Adam, Jauharee and Miller, 2015).

Ministry of Fisheries and Agriculture first introduced logbooks for the tuna fisheries in 2010, which was revised and reintroduced in 2012, with sequent phasing out of the traditional island based data collection system. The logbooks aimed at collecting comprehensive data required for effective management of the fisheries. Data collected through the logbooks would serve to comply with the data requirements from the Indian Ocean Tuna Commission (IOTC).

To enforce data collection through logbooks, provision of logbook data was made a prerequisite for eligibility of fuel subsidies in the years 2010, 2012 and 2013. Afterwards, provision of fishery data was mandated for renewal of fishing license which was required if the catch was destined for export. In addition, MoFA sends reminders to vessel owners (or captains) with overdue logbooks and warnings of suspension of license for serious cases. This certainly had a positive impact on the reporting rates from vessels sought to export the catch, while enforcement lacked for vessels that disposed the catch for local consumption and resorts.

Reported catch of both neritic species has seen a stark decline since introduction of logbooks for tuna fisheries. Kawakawa and frigate tuna declined by 70 and 88% from 2009-2014. Ahusan and Adam (2015) identified that small sized, ageing vessels, which are common in the north of the country were less compliant to the data reporting system due to limited enforcement. Such vessels conducted daily trips, hence closer to the atolls with a possibility of higher proportion of neritic species. These vessels generally disposed their catches to the local islands and small scale processors that distributed fishery products to the local population. Coincidentally, neritic tuna is deemed to be commoner in the north compared to the southern atolls. Such factors would tend to compound the issue of possible non-reporting of neritic catch.

6. Stock relationships

Neritic tunas are commonly found throughout the Indian Ocean and constitute a high proportion of the coastal states' tuna catches. Despite their abundance and importance to national catches of some coastal states, efforts to understand the stock structure have so far been limited. In the absence of reliable evidence relating to stock structure, neritic tunas under the mandate of IOTC are assumed to be distributed as single stocks throughout the Indian Ocean (IOTC-SC16, 2013).

There have been no studies on the stock structure of kawakawa and frigate tuna found in the Maldivian waters. Both species are commonly found close to the atolls, and catches tend to be higher in coastal areas compared to offshore although there has been records of kawakawa and frigate tuna catches from offshore as well.

Based on the limited number of specimens (4 kawakawa) caught from a 12 month exploratory offshore fishing survey conducted off the east coast of Maldives in the early 1990's, Anderson, Waheed and Scholz (1998) suggested that for most purposes kawakawa found around the Maldives may be considered to be a single unit of stock.

Frigate tuna were also reportedly caught up to a 100 miles off shore in the same exploratory fishing survey suggesting mixing with Sri Lankan stocks and that Maldivian frigate tuna might belong to an Indian Ocean or central Indian Ocean stock (Anderson, Waheed and Nadheeh, 1998). On the other hand, based again on the limited number of individuals caught from offshore and distribution of larvae, the authors suggest that for some purposes, Maldivian frigate tuna might be considered to be a separate 'sub-stock'.

With the increase in fishing power in recent years, fishermen have been known to venture further offshore in search of tunas. Hence, previously unfished areas are now being exploited. Collection of spatially disaggregated catch data through logbooks has enabled to explore the catch composition and shows that neritic catches are being caught from offshore. For example, unverified logbook data for 2013 had 80 records of kawakawa and 45 records of frigate catch reported from a single 0.5x0.5 degree geographic quadrant about 80 miles east. In other occasions, kawakawa and frigate tuna catch were reported from about 180 miles east. Neritic catch was also reported from similar distances west of the archipelago. Assuming the data are reliable, neritic catch locations reported in the logbooks suggest that kawakawa and frigate tuna found in Maldives waters are mixed and form part of the Indian Ocean or central Indian Ocean stock.

7. Stock status

To date, there have been limited efforts to estimate the abundance of neritic tuna resources in the Maldivian waters. Anderson, Waheed and Scholz (1998), based on Anon (1997), unpublished report) suggest that kawakawa was not exploited at a level greater than its sustainable yield prior to 1997. Anderson, Waheed and Nadheeh (1998) reports of a surplus production of frigate tuna catch and effort data for the years 1970-1983. It was deemed that inadequacies of data and models used made the interpretations of the results problematic.

There have been recent efforts to understand the status of Indian Ocean neritic tunas stocks using various methods by IOTC. For example, kawakawa stock for the Indian Ocean was assessed in 2015 using a number of approaches. These methods assumed that the stock was distributed throughout the Indian Ocean and were treated as a single stock. Such assessments are hindered by the paucity of data, particularly effort data, from the various tuna fisheries exploiting neritic tunas in the Indian Ocean. For example, in the absence of a better CPUE series, Maldives' standardized pole-and-line CPUE series was used in the Stock Synthesis 3 (SS3) assessment of the Indian Ocean kawakawa (IOTC-2015-WONT05-20-Rev_01). Despite the continuous data series from the Maldives PL fleet, its use to assess Indian Ocean kawakawa stocks is dubious due to the low level of targeting and non-representativeness of the whole Indian Ocean kawakawa catch. Similarly, WPNT05 noted using Maldives CPUE series had large impacts on the results since the fishery represents only a small component of the total and diverse Indian Ocean catches and so cautioned the results of the assessment (IOTC-WPNT05).

8. Movement

Based on catch rates, frigate tuna has been suggested to show east-west migration within the atolls, in phase with the oscillating monsoon currents (Anderson, Waheed and Nadheeh, 1998). No such observations were made for kawakawa and the only observed changes to catch rates were attributed to changing fishing patterns based on monsoonal currents. Further studies are needed to understand the movement patterns and interactions between different fisheries of the Indian Ocean.

9. Summary and discussion

Maldives has a rich tradition of tuna fisheries dating back to a thousand years. Maldivian tuna fisheries have predominantly exploited skipjack and kawakawa using pole-and-line. Neritic tunas (kawakawa and frigate), have always formed minor components of tuna catches. Similarly, Maldives' contribution to the Indian Ocean neritic catch has been negligible especially in recent years.

Both species exhibit fluctuating catches over the data period (1979-2014) with various factors influencing catch. These include changes in fishing power, abundance and catchability due to environmental influences and also level of targeting due to socioeconomic reasons.

Introduction of logbooks to report fishery in place of the traditional island based system has apparently contributed to changes in reporting rates of neritic species. The decline in reported catch of kawakawa and frigate tuna are most significant in decades. Coupled with lack of stringent sampling and data collection as well as studies on stock structure, our understanding of the neritic tuna resources of the Maldives has diminished.

10. References

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