Identifying Fishing Activities and their Time Allocation in the Maldives Handline Yellowfin Tuna (*Thunnus albacares*) Fishery

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Abstract

Information on the different activities and their time allocation is critical to understand fishing fleets' behavior, to elucidate the unit of fishing effort and to derive informative abundance indices to track changes of fish stocks. The Maldives handline yellowfin tuna fishery, which targets adult and sub-adult yellowfin tuna, is a relatively new fishery that began around mid-2000. This paper aims to reveal the different activities and their time allocation for the fishery using logbook data. Examination of the logbook data for 2017 and 2018 showed bait fishing to require substantial effort in terms of time spent, where around 22% of all daily records reported solely bait fishing. A slightly lower proportion of days were where baiting and fishing both occurred on the same day. About 64% of the days at sea for the entire dataset were where just tuna fishing was reported. The data also contributed to some degree, insights on time allocation for searching/steaming and time spent fishing. The exercise emphasized the importance of studying the dynamics of the handline yellowfin tuna fleet and the importance of widening the observer program and implementing a VMS program that would enable improved understanding of the fleet dynamics.

Introduction

Information on the different activities and their time allocation is critical to understand fishing fleets' behavior, to improve the definition of effective effort for the fishery (Vermard et al., 2010), and to derive informative abundance indices to track changes of fish stocks. Quantifying the duration of the different phases is also important from an economic point of view. In order to do so, scientists rely on data from a number of fishery dependent and fishery independent sources such as observers, logbooks, Vessel

Monitoring System (VMS) (e.g. Watson and Haynie, 2016) and Automatic Identification System (AIS) data (e.g. Natale, 2015). VMS and AIS data are mostly available for large-scale and industrial fleets while observer coverage varies depending on the fleet. In spite of the inherent limitations of logbook data (e.g. reluctance for data provision by fishermen, accuracy and timeliness of data), it remains a cost-effective source of information to study the fleet behavior, catch and fishing effort. In the case of Maldives tuna fisheries, logbooks remain the sole source of such data at a reasonable amount.

The Maldives handline yellowfin tuna (*Thunnus albacares*) fishery is a multi-day fishery that uses live bait to catch surface swimming sub-adult and adult yellowfin tuna. Using log-book data, Adam and Jauharee (2009) estimated that handline line trips were on average 8 days. A trip consists of several distinct phases that happen in succession; departure, steaming to bait grounds, fishing for bait, steaming to fishing ground, tuna fishing and lastly, steaming to port to land the catch. Identifying these phases and their time allocation is crucial for example, to estimate the time-component targeted for actual fishing, as unlike other tuna fisheries (e.g. trolling, longline and purse seine), the handline yellowfin tuna fishery expends a substantial amount of time to harvest livebait used to catch the target species. Spatio-temporal fluctuations in abundance of bait and the difficulties in quantifying effort in the nested bait fishery further exacerbate the issue. In the few fisheries that rely on live bait such as Japanese pole-and-line fishery, bait is sourced from commercial live bait fishers (Hester, 1974), reducing the complexity arising from a nested fishery. Further emphasizing the need to study the time allocation are partly related to target species being fished further offshore and landing ports few and clustered mid-country, requiring considerable travel to land the catch in some cases.

The logbooks, introduced in 2010, for the tuna fisheries is a potential source of operational information to address the gaps in understanding the behavior of the handline yellowfin tuna fleet. The logbooks and the subsequent revisions expanded on the information collected in the previous data collection system; from vessel specific monthly data of catch and effort and the resulting catch of target and non-target species, to trip level catch and effort information relating to bait, target catch, bycatch and discards. This paper attempts to explore the possibility of using logbook data from the fishery to identify the time allocation for the key activities on a trip (bait fishing, searching, steaming and fishing). This activity will pave way for the data to be used to derive an abundance index, which would add to, and refine our understanding of the Indian Ocean yellowfin tuna stock.

Methodology

Tuna logbook data for 2017 and 2018 were used for the paper. The data consist of information on trip (departure and arrival dates and ports, crew number and fuel used), bait fishing, tuna fishing, catch (of

bait, target and non-target species), discards as well as information on interactions with sharks, turtles and seabirds.

The dataset was "cleaned" to obtain of trips records where handline gear was the sole gear for the trip and where the catch was landed to selected ports. This was to ensure that the final dataset consisted of trips relevant to the subject, with the final dataset having 1044 trips.

Results and Discussion

Examination of the data showed that handline yellowfin tuna trips are mostly multi-day, in contrast to the traditional pole-and-line tuna fishery. The length of a trip is influenced by factors such as abundance and, distance to bait and fishing grounds. Trip lengths were observed to be between 1 and 23 days, with the most common length being 9 days (Figure 1). Trip lengths could be directly derived from the logbook data. However, since the logbook does not record time of departure and arrival, number of days of a trip can under or over-estimate the actual trip length depending on the time of the day the vessel departed/landed, and its effect on a CPUE relationship is unknown.

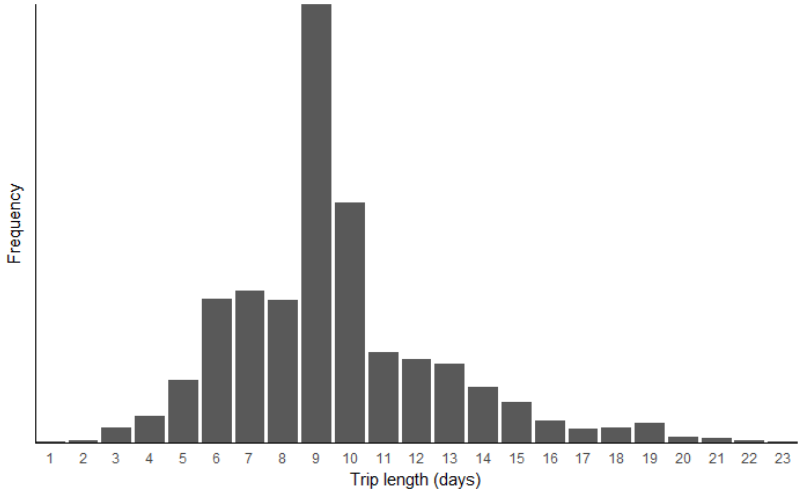

Figure 1. Trip lengths (days)

Bait fishing

Since the fishery relies on livebait to catch tunas, there is a need for an ample supply of bait at the onset of the trip, with additional bait fishing instances should the initial catch be insufficient for the trip. In the handline fleet, two modes of baiting are generally employed; bait fishing during the day, and bait fishing during night. The choice of bait fishing type depends mostly on the type of bait. For example, trigger fish (*Odonus niger*) is caught during daytime. On the other hand, bigeye scad (*Selar crumenophthalmus*) can

be caught by either method. Depending of the efficiency of bait fishing, vessels can resort to tuna fishing on the same day.

Examination of fishing and baiting related data showed that the majority of the days (64%) were where only fishing was conducted, which is expected as catch from a single baiting operation can lasts several days of fishing. The remaining records were split between days where just baiting (22%) and where baiting and tuna fishing occurred on the same day (14%) (Figure 2). Therefore, partitioning the time spent between fishing and baiting is possible for about 88% of records, i.e. they either fish for tunas or bait. The 14% records with both activities (tuna fishing and bait fishing) needs to be addressed separately. Such records (where both fishing was reported for the same day) indicate that the steaming/searching time is short as tuna fishing would normally be carried out during the daylight hours. The variable 'bait fishing duration' gives a more precise effort of bait fishing. Most of the baiting times reported were between 1 and 12 hours (Figure 3). However, the time of bait fishing (day/night) is unavailable, which could be useful to understand the trends in bait fishery.

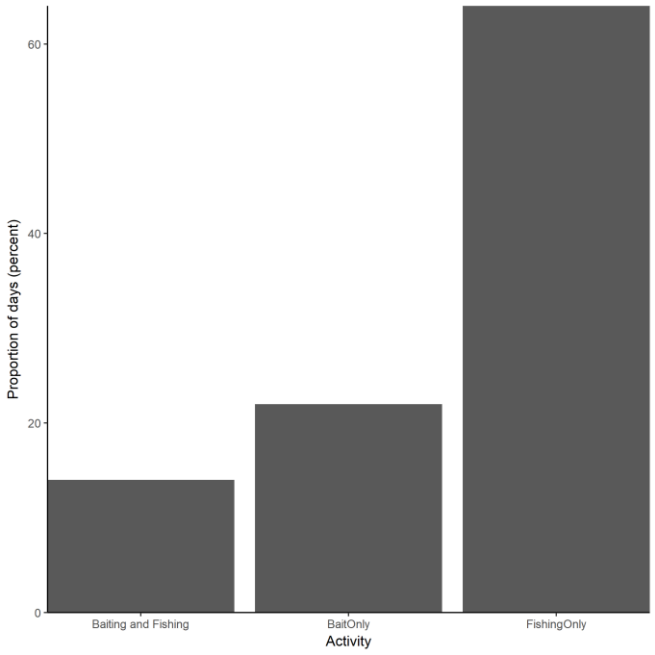

Figure 2. Proportion of days where baiting and fishing, baiting only, and fishing only occurred.

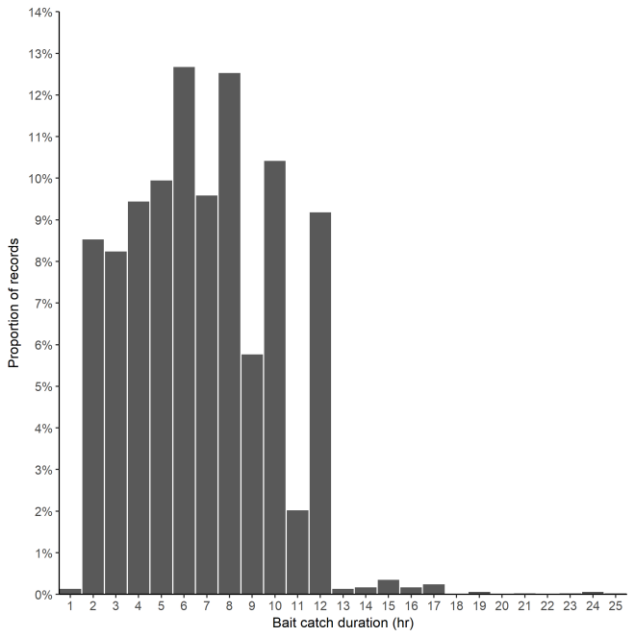

Figure 3. Distribution of bait fishing duration (hrs.) in HL fleet?

Search and steam durations

In the context of fishery dynamics, searching can be defined as actively looking for target schools and steaming as travelling to a school once it has been located. Search time can be a good measure of effort for fisheries targeting motile species, especially for highly migratory species such as tuna, and is more informative for an abundance index than the actual time spent fishing, the latter of which has no relation to abundance of shoals (FAO, 1974). In the handline yellowfin tuna fishery, searching/steaming to bait ground begins immediately upon departure, while searching/steaming to the tuna grounds begin right after baiting has ended. Reported days of baiting and fishing were used to indirectly infer on the search/steam times by studying the number of days where neither baiting nor fishing was reported, which showed a high variance with no discernible pattern.

Fishing durations

Fishing duration is recorded in the logbooks as time fishing began and ended. The results suggest that fishing durations varied between 15 minutes and 21 hours for handline trips. The wide range fishing durations reported, especially more than daylight hours probably results from phrasing in the logbook where ‘fishing start time’ is explained as ‘time vessel heads out to sea’ in search of a school. While some fishermen may have reported the actual fishing time, others may have included searching/steaming time based on the explanation within the parenthesis.

Conclusion

The paper presented the first attempt at using the logbook data from the Maldives handline yellowfin tuna fishery to elucidate the dynamics of the fleet. As expected, the results showed that a substantial amount of effort (days) was spent on bait fishing (~22% of all recorded days), which is not directly related to effort towards harvesting the target species. This highlights the need to study in depth, the fleets' operational dynamics, as the trends and patterns related to baiting is not related to, and would mask the relationship between catch and effort of the target species.

While the work revealed some insights into the time allocation of the different activities, it also informed the possibility of obtaining better information through the logbooks. It is expected that the process will be refined by incorporating information from other sources such as observer and preferably using VMS data, which has the potential to add the spatial dimension to the process. The findings also stress the importance of widening the observer program and of implementing a VMS program. It is expected that this work will assist in developing a Maldives CPUE index for the Indian Ocean yellowfin tuna stock.

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