The Impossible Task of Free School Verification: Can "unassociated sets" exist in the western Indian Ocean?

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The Echebaster Indian Ocean purse seine skipjack, yellowfin and bigeye fishery is in the process of MSC certification and their unit of certification according to the Public Comment Draft Report (PCDR) is unassociated free schools of skipjack, yellowfin and bigeye tuna (www.msc.org[4]). Its Conformity Assessment Body (CAB) defines free schools (section 5.2.6, page 116) "to be those made on schools of tuna, the presence of which is indicated by sea-surface bird activity or by the presence of bait fish in the water. Free schools sets are truly unassociated sets, meaning that they take place at some distance away from any FAD of other floating objects or megafauna. Associated sets are generally considered to be those that take place at a distance of 5nM [nautical miles] or less from a FAD."

With this definition, the certification deals primarily with unassociated free schools of tuna caught outside an exclusion zone of 78.57 sq nM around FAD associations. Similar exclusion zones should apply around natural logs, marine mammals, whale sharks, and sea-mount associations. In other words, unassociated free school sets should only occur outside of exclusion zones around these objects and animals.

How many dFADS?

The most recent meeting of the IOTC Scientific Committee stated that at least 10,000 drifting FADs (dFADS) were being monitored by the EU-purse seiners at any given time in 2013 (IOTC-SC17, 2014). These dFADs and logs with GPS-equipped buoys have unique electronic identification allowing them to be 'seen' only by vessels that deployed them. Many also have acoustics devices for estimating biomass underneath and around them and the information gets relayed to the vessel at frequent intervals. Maufroy et al. (2014) note that FADs are released into targeted areas and times to strategically manufacture tuna schools allowing vessels to maximize their fishing effort.

Given there is a large number of dFADs at any given time, with a 78.57 sq nM exclusion zone around each one, it may be useful to estimate the total exclusion zone footprint in the purse seine fishing area. An estimate of the current purse seine fishing area in the western central Indian Ocean is 1.671[5] million sq nM (see Figure 1).

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[4] https://www.msc.org/track-a-fishery/fisheries-in-the-program/in-assessment/Indian-ocean/echebastar_indian_ocean_purse_seine_skipjack_yellowfin_and_bigeye_tuna
[5] Estimate of the purse seine fishing ground was made by drawing a polygon on Google Earth map and copying its properties in the widget in http://www.earthpoint.us/Shapes.aspx.

Maufroy et al. (2014) reported that in 2013 there were at least 9,700 dFADs being monitored (i.e., dFADs with tracking devices attached) while the SC (2014) reports that at present at least 10,000 dFADs were being monitored by the EU purse seine fleet in 2014. This figure is now likely to be even higher since 18 additional large purse vessels have been introduced to this fishery since that estimate was made. Given that the original estimate was based on a fleet of 34 active EU-purse seiners, the current number of dFADs deployed is likely on the order of 15,000 at any given time, assuming the 18 new vessels[6] employ a similar fishing strategy.

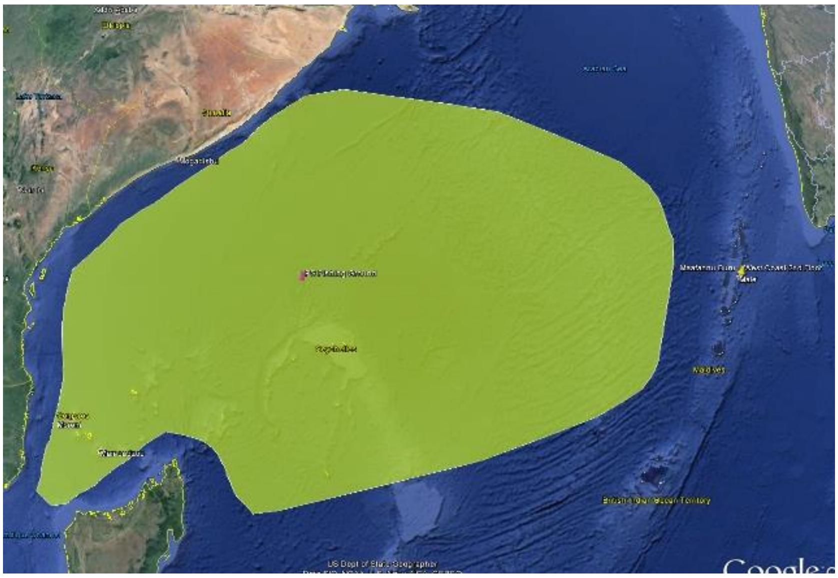

Figure 1: Average area of the purse seine fishing ground in the western central Indian Ocean where EU purse seiner fleet operates. Using the widget given in http://www.earthpoint.us/Shapes.aspx, the area bounded by Google Earth Polygon was estimated at 1.671 million sq nM.

It is also known that a large number of dFADs are not monitored; are released from vessels by operators who have not entirely caught up with the tracking technology; or were released some time ago, either without tracking technology or with tracking technology that has since ceased to function due to battery or other failure. All of these releases contribute to the pool of active dFADs at any given time. Given what is known about the how dFAD fishery operates, we estimate that roughly 1 in 6 of all dFADs (i.e. currently 3,000 dFADs) may be adrift in the area unmonitored and untracked.

How many natural logs?

In addition to GPS-buoy equipped dFADs and logs there are also natural logs, marine mammals, whale sharks and areas of sea-mount associated schools that Echebaster vessels must avoid in their targeting of unassociated free swimming schools. Unfortunately there are no published literature on encounter rates of natural logs in the open ocean. In the Maldives, natural logs are commonly encountered during the north east monsoon season (November – March) when surface currents are mainly from

[6] Rep. of Korea (4 vessels), Sri Lanka (8 vessels) and Mauritius (6 vessels which entered the fleet in 2014) – IOTC-SC (2014).

the east. We have assumed there could be 2,000 natural logs in the western central Indian Ocean that could be acting as dFADs at any one time.

How many marine mammals?

Numbers of marine mammals are difficult to estimate in the Indian Ocean given the lack of population assessments. However, some information is available from the International Union for the Conservation of Nature. About 33 species of marine mammals (whales and dolphins) inhabit the western Indian Ocean. The southwest Indian Ocean breeding population of humpback whales is estimated at 8,500 individuals (IUCN 2012), and the population of Bryde's whales in the southern Indian Ocean is estimated at 13,854 animals (IUCN 2008b). While population estimates for more common marine mammals, such as spinner dolphins and spotted dolphins, do not currently exist, their populations must be very much larger than those of the great whales. For example, the heavily depleted population of spinner dolphins in the eastern tropical Pacific is estimated to be 800,000 (IUCN 2008).

The association of tunas with marine mammals in the tropical Indian Ocean has been subject to some controversy. Despite the denial of any association between tunas and dolphins by purse seine fishermen, it is clear that an association does exist, and is widespread throughout the western Indian Ocean (Anderson, 2014). For example, in the Maldives handline fishery (which targets surface dwelling large yellowfin tuna) Adam and Jauharee (2009) estimated that more than 90% of the large yellowfin schools are first sighted in association with dolphins. With respect to whales, Capietto et al. (2012) noted that 9.6% of all EU-purse seine sets were made on associations with baleen whales during 1980-99.

Note, however, that for the purposes of this discussion it is does not matter if tunas actively associate with marine mammals. The proposed certification requires that sets are not made in close proximity with marine mammals. The nature of any association between marine mammals and tunas is irrelevant.

How many whale sharks?

There have been no population estimates for whale sharks in the western Indian Ocean, but population size may be in the thousands. Given that whale sharks spend most of their time below the surface, it will be impossible for purse seiners to ensure that they do not set in their vicinity.

How many seamounts?

Literature on seamounts in the Indian Ocean and its tuna association are few. There are however, well-known seamount-associations in several fisheries. In the Maldives *Sato Raha* in Huvadhoo Channel (1.30°N, 73.28°E), *Dheraha* south east of Laamu Atolll (1.81°N, 74.40°E), and the seamount north of Haa Alifu Atoll (7.58°N, 72.73°E) are well-established fishing spots known by local fishermen. While it is not clear that Indian Ocean seamounts have been sufficiently identified, a pertinent questions would be whether the ones known are marked on the electronic charts used by the fishing vessels and/or whether there are mechanism in place to allow vessels to locate and avoid setting on them. An estimate of seamounts in the Indian Ocean is provided by Kitchingman & Lai (2004) which amount to 200 used here for our purpose. Since the top of most seamounts will be more than a single point, the exclusion area around each seamount should be greater than 78.5 nM^2 although that figure will be used here as a highly conservative estimate.

Based on these considerations and from most recent literature (IOTC-SC17, 2014; Maufroy et al., 2014; Baske et al., 2012; Chassot et al., 2014; Fonteneau and Chassot, 2014; and Scott and Lopez, 2014) we make following estimates of FADs, natural logs, marine mammals, seamounts, and whale sharks at any given time in the Indian Ocean purse seine fishing ground.

Table 1: Estimates of dFAD and tuna association points that Echebaster fishery should avoid in finding unassociated free swimming schools in the Western Central Indian Ocean purse seiner fishing ground.

Drifting FADs (dFADs) with GPS-equipped buoys	15,000
Drifting FADs without GPS-equipped buoys	3,000
Floating Objects – Natural logs	2,000
Marine mammals – SWIO humpback whales	8,500
Marine mammals – SWIO Bryde's whales	13,854
Other marine mammals – 31 additional species	Unknown, but likely tens to hundreds of thousands.
Seamounts	200
Whale sharks	Unknown, but likely thousands
TOTAL (highly conservative)	**42,554**
Exclusion zone based on 5nM radius	**3,343,468 Square Nautical Miles**
Estimated area of the PS fishing ground	**1,671,000 Square Nautical Miles**
Proportion of the exclusion zone to be avoided	**200% of the PS fishing ground**

Given that unassociated free schools should occur outside the 78.5 sq nM of the association points (dFADs, logs, marine mammals, whale sharks and seamounts), we estimate the total exclusion zone for Echebaster fishery in the PS fishing ground would be about 3.3 million sq nM (Table 1). With an estimate 1.7 million square nautical miles of purse seine fishing ground there would literally be nowhere to find unassociated free schools in the Western Indian Ocean!

Discussions

A major unknown in the above estimation is the abundance of marine mammals. As an alternative approach, we note that Ballance and Pitman (1998) recorded 589 cetacean sightings during a western Indian Ocean survey that covered 9,784 km (5,283 nM). That equates to one cetacean sighting every 9.0 nM. If an exclusion zone with a 5.0 nM radius (i.e. 10.0 nM diameter) were applied to each sighting, there would be no room for free school fishing. Note that Balance and Pitman (1998) encountered some periods of bad weather during their survey, so some cetacean sightings would have been missed. In a subsequent survey around the Maldives, which had consistently good weather, Ballance et al. (2001) recorded 267 cetacean sightings along a survey track of 1,700 km (918 nM). That equates to one cetacean sighting every 3.4 nm. With such densities, even if the exclusion radius around marine mammals were reduced to one third of the currently suggested 5.0 nM (i.e., to 1.7 nM) there would still be no scope for free school fishing.

Note that the calculations presented here are not meant to be precise. Rather they are used to illustrate the scale of the issue. The exact distribution of dFADs, marine mammals and whale sharks, which as a first approximation is assumed here to be even, can be discussed. The exact numbers of dFADs, logs, marine mammals and whale sharks, or the exact size of the exclusion zone around each sea-mount or whale can also be argued over. But the broad conclusion will be the same: the total combined area of all exclusion zones will be larger than the area of the purse seine fishery. In other words, using the definition proposed by the CAB, there may be no truly unassociated tuna schools in the western Indian Ocean.

Note also that it would in any case be almost impossible to verify a free school set. Observer coverage is currently very low, and even if an observer were on board, that observer has no way to tell whether or not a FAD, log, marine mammal, whale shark, or seamount is within 5nM (and certainly not when sea conditions are anything other than flat calm). The vessel captain is not even privy to the location of other tracked FADs in the area, and given that many FADs do not have locator beacons, it is actually impossible to monitor and enforce this critical aspect of the certification.

An existing condition of this proposed certification is demonstration of the chain of custody starting at time of the bailer tipping the catch onto the conveyor belt. However, there is also an absolute requirement that sets are accurately classified as associated or free school. The assessment team itself found that at the time of its site visit, traceability with respect to the type of set with which catches are associated could not be verified and management was considered insufficient. As demonstrated here, there are too many dFADs and marine mammals in the western Indian Ocean to allow confident, accurate classification of free school sets. The whole basis of this proposed certification is therefore invalid.

Recent Developments

At the most recent IOTC Commission meeting in Busan, South Korea, April/May 2015, the European Union instigated in passing a binding resolution that allows each purse seine vessel to use up to 550 dFADs at any given time including purchasing up to 1,100 satellite tracked dFADs in any given year. These 'limits' may reflect the absolute high end of what the largest EU vessels deploy, and actually incentivize the use of more dFADs by vessels in the Indian Ocean who may anticipate future dFAD allocations. To put this dangerously high 'limit' in context, according to the Secretariat of the Pacific Community, the average FAD usage for the Western and Central Pacific Ocean purse seine fleet is about 100 dFADs per vessel per year (Hampton 2010). The resolution allows monitoring (tracking) maximum of 550 dFADs at any given time, but allows vessels to deploy additional dFADs to replace malfunctioning units or ones deliberately turned off because they have drifted outside of the fishing ground becoming uneconomical for vessel to recover. Since the resolution says nothing about controlling actual deployed units or retrieval of malfunctioning dFADs/buoys, the measure will likely exacerbate the dFAD situation in the Indian Ocean by allowing for more deployments into the already large and uncontrolled dFAD pool.

The table below shows the size of the theoretical purse seine exclusion zone if the maximum allowable number of dFADs were deployed in the Indian Ocean in a given year allowed under the newly adopted IOTC Resolution 15/08. With the expanded limit adopted at the IOTC, the exclusion zone becomes almost 4 times larger than the actual purse seine fishing ground in the southwest Indian Ocean.

Table 2: Updated estimates of dFAD and tuna association points that Echebaster fishery should avoid in finding unassociated free swimming schools in the Western Central Indian Ocean purse seiner fishing ground assuming all purse seine vessels deploy the newly adopted IOTC maximum of 1,100 dFADs.

Potential Drifting FADs (dFADs) with GPS-equipped buoys permitted by IOTC in 2015	57,200
Drifting FADs without GPS-equipped buoys	3,000
Floating Objects – Natural logs	2,000
Marine mammals – SWIO humpback whales	8,500
Marine mammals – SWIO Bryde's whales	13,854
Other marine mammals – 31 additional species	Unknown, but likely tens to hundreds of thousands.
Seamounts	200
Whale sharks	Unknown, but likely thousands
TOTAL (highly conservative)	**84,754**
Exclusion zone based on 5nM radius	**6,659,121 Square Nautical Miles**
Estimated area of the PS fishing ground	**1,671,000 Square Nautical Miles**
Proportion of the exclusion zone to be avoided	**398% of the PS fishing ground**

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