ABSTRACT

Incidental by-catch and associated discarding are difficult to estimate on the basis of logbook information because they are poorly reported by fishing masters and their importance varies with several interrelated factors. The purpose of this paper is to inform the commonly discarded fishes of the Indonesian tuna longline fishery in the Indian Ocean. The study was carried out during 2010 – 2011 following six commercial tuna longline vessels based in Port of Benoa. Discards composition was dominated by longnose lancetfish and pelagic stingrays which composed almost half of total discards. Almost half of total catch are discards and half of discards are disposed dead or dying.

KEYWORDS: By-catch, discards, longline, Indian Ocean

INTRODUCTION

The term “by-catch” is widely used in scientific or popular literature which has variety of interpretation, and some might overlapping or contradictory. But in general it can be described as a fraction of the catch that consists of non-target species (Romanov, 2002, Pauly, 1984, Alverson & Hughes, 1996). By definition, by-catch is pre-determined, while the decision to retain or discard may occur during the fishing take place, at some time later during the vessel trip, or, at times, on return to port. Following Alverson et al. (1994) by-catch has been customarily used to identify (1) species retained and sold, (2) species or sizes and sexes of species discarded as a result of economic, legal, or personal considerations, and (3) non-targeted species retained and sold, plus all discards.

By-catch has two components: by-product, the non-target species that is retained and sold (Chapman, 2001) and discards, is a portion of the catch returned to the sea as a result of economic, legal, or personal considerations (Alverson et al., 1994). It has either no or limited commercial value (Chapman, 2001) but might play important ecological role.

Incidental by-catch and associated discarding are difficult to estimate on the basis of logbook information because they are poorly reported by fishing masters and their importance varies according to interrelated factors (Rochet and Trenkel, 2005). The issues raised from by-catch and discarding are, however, of increasing concern because such practices are responsible for economic loss, juvenile mortality, ecological effects on key species that are relevant to the overall ecosystem structure and functioning, and added threat to endangered or high ethical value species (Amande et al., 2008).

However concern on this matter, especially in the Indian Ocean was little and the information available are so far limited, while the issue of by-catch has become particularly significant in the region. The purpose of this paper is to describe information of the discards on tuna longline fishery in Indian Ocean including catch rate, nominal CPUE and condition at release from 109 – 122°E and 10 – 16°S of Indian Ocean.

MATERIALS AND METHODS

Study Area and Data Sampling

The data analyzed were part of the result of numerous trips from onboard observation following commercial tuna longline vessels conducted from 2010 – 2011. In this study category discards is assigned to a portion of the catch returned to the sea as a result of economic, legal, or personal considerations (Alverson et al., 1994) and it has either no or limited commercial value (Chapman, 2001). These data were taken on a daily 5x5-degree square basis by vessel, fishing date, location of deployment, number of hooks, condition at release, daily deployed hooks, catch in number and length (FL), while weight never been measured. Samples were taken during fishing operation in Indian Ocean (south of Java and Nusa Tenggara) as shown in Figure 1.

Nominal CPUE (Catch Per Unit Effort)

The nominal CPUE in tuna longline fishery was described as the number of hooks used on certain area of fishing, while hook rates calculated as number of fishes caught per 100 hooks.
Figure 1. Study area and location of the 6 longline vessels fishing ground.

RESULTS

Catch Composition

A total 5,570 species of fishes, reptiles, and sea mammal during 2010-2011 were managed to be recorded and classified onto two groups which is target species comprised of albacore (Thunnus alalunga), yellowfin tuna (Thunnus albacares), and bigeye tuna (Thunnus obesus); and non-target species, consist of by-product and discards.

The catch of tuna as target species only contributed 18.47% of total catch and 81.52% were categorised as by-catch with discards dominated with 51.11% followed by by-product with 30.41% (Table 1).

Table 1. The catch composition of tuna longline vessels based in Port of Benoa.

<table>
<thead>
<tr>
<th>Vessel Code</th>
<th>Number of Catch</th>
<th>Target</th>
<th>By-Product</th>
<th>Discards</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>%</td>
<td>N</td>
<td>%</td>
</tr>
<tr>
<td>LL_01</td>
<td>1,054</td>
<td>141</td>
<td>13.38</td>
<td>142</td>
</tr>
<tr>
<td>LL_02</td>
<td>936</td>
<td>235</td>
<td>25.11</td>
<td>140</td>
</tr>
<tr>
<td>LL_03</td>
<td>926</td>
<td>377</td>
<td>40.71</td>
<td>124</td>
</tr>
<tr>
<td>LL_04</td>
<td>848</td>
<td>309</td>
<td>36.44</td>
<td>131</td>
</tr>
<tr>
<td>LL_05</td>
<td>670</td>
<td>353</td>
<td>52.69</td>
<td>216</td>
</tr>
<tr>
<td>LL_06</td>
<td>1,136</td>
<td>279</td>
<td>24.56</td>
<td>276</td>
</tr>
<tr>
<td>Total</td>
<td>5,570</td>
<td>1,694</td>
<td>30.41</td>
<td>1,029</td>
</tr>
</tbody>
</table>

Regardless of target and by-product, discards composition was dominated by longnose lancetfish (Alepisaurus ferox) 32.73% and pelagic stingrays (Pteroplatytrygon violacea) 11.62% which comprised almost half of total discards. Later followed by crocodile shark (Pseudocarcharias kamoharai) 6.07%, snake mackerel (Gempylus serpens) 0.41%, ocean sunfish (Mola mola) 0.14%, olive ridley turtle (Lepidochelys olivacea) 0.07%, and hammerhead shark (Sphyma sp.), tappertail ribbonfish (Trachipterus fukuzakii), false killer whale (Pseudorca crassidens), alongside with leatherback sea turtle (Dermochelys coriacea) which composed each 0.02% (Figure 2).
Nominal CPUE (Catch Per Unit Effort).

Total 262,527 hooks were set from six vessels during 2010 – 2011 and longnose lancetfish got the most hook rate with 0.645 per 100 hooks followed by pelagic stingrays, crocodile shark, and snake mackerel with 0.237, 0.073, and 0.008 per 100 hooks. While the other also occurred but occasionally to rare, like the present of tappertail ribbonfish, hammerhead shark, false killer whale, and leatherback sea turtle which only popped out once with hook rate 0.0004 per 100 hooks (Table 2).

Catch at Release

Of total 3,398 catch at release data (in number), 27.93% were informed released alive, 24.75% injured, 4.37% dying, 42.78% dead, and 0.18% wrecked (Table 3).

Table 3. The catch composition of tuna longline vessels based in Port of Benoa.

<table>
<thead>
<tr>
<th>Vessel Code</th>
<th>A1</th>
<th>A2</th>
<th>A3</th>
<th>A4</th>
<th>A5</th>
</tr>
</thead>
<tbody>
<tr>
<td>LL_01</td>
<td>19</td>
<td>-</td>
<td>43</td>
<td>39</td>
<td>-</td>
</tr>
<tr>
<td>LL_02</td>
<td>175</td>
<td>-</td>
<td>04</td>
<td>228</td>
<td>-</td>
</tr>
<tr>
<td>LL_03</td>
<td>86</td>
<td>-</td>
<td>27</td>
<td>309</td>
<td>3</td>
</tr>
<tr>
<td>LL_04</td>
<td>140</td>
<td>3</td>
<td>25</td>
<td>392</td>
<td>1</td>
</tr>
<tr>
<td>LL_05</td>
<td>212</td>
<td>557</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>LL_06</td>
<td>846</td>
<td>-</td>
<td>38</td>
<td>248</td>
<td>3</td>
</tr>
<tr>
<td>TOTAL</td>
<td>1478</td>
<td>560</td>
<td>137</td>
<td>1216</td>
<td>7</td>
</tr>
</tbody>
</table>

Table 3. Nominal CPUE of commonly discards from tuna longline vessels based in Port of Benoa from 2010 – 2011.

<table>
<thead>
<tr>
<th>Vessel Code</th>
<th>Total Hooks</th>
<th>NGA N (HR %)</th>
<th>DAV N (HR %)</th>
<th>MOX N (HR %)</th>
<th>CSK N (HR %)</th>
<th>SPY N (HR %)</th>
<th>HAR N (HR %)</th>
<th>TRF N (HR %)</th>
<th>FKW N (HR %)</th>
<th>LKV N (HR %)</th>
<th>LST N (HR %)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LL_01</td>
<td>45,000</td>
<td>573 0.1273</td>
<td>183 0.407</td>
<td>- -</td>
<td>5 0.011</td>
<td>- -</td>
<td>9 0.020</td>
<td>1 0.002</td>
<td>- -</td>
<td>- -</td>
<td>- -</td>
</tr>
<tr>
<td>LL_02</td>
<td>32,280</td>
<td>394 0.1211</td>
<td>106 0.328</td>
<td>3 0.009</td>
<td>52 0.161</td>
<td>- -</td>
<td>4 0.012</td>
<td>- -</td>
<td>1 0.003</td>
<td>1 0.003</td>
<td>1 0.003</td>
</tr>
<tr>
<td>LL_03</td>
<td>37,296</td>
<td>296 0.0794</td>
<td>111 0.298</td>
<td>1 0.003</td>
<td>15 0.040</td>
<td>- -</td>
<td>1 0.003</td>
<td>- -</td>
<td>1 0.003</td>
<td>- -</td>
<td>- -</td>
</tr>
<tr>
<td>LL_04</td>
<td>29,280</td>
<td>231 0.0789</td>
<td>168 0.574</td>
<td>4 0.014</td>
<td>- -</td>
<td>- -</td>
<td>2 0.007</td>
<td>- -</td>
<td>- -</td>
<td>3 0.010</td>
<td>- -</td>
</tr>
<tr>
<td>LL_05</td>
<td>33,600</td>
<td>68 0.202</td>
<td>24 0.071</td>
<td>- -</td>
<td>2 0.006</td>
<td>1 0.003</td>
<td>6 0.018</td>
<td>- -</td>
<td>- -</td>
<td>- -</td>
<td>- -</td>
</tr>
<tr>
<td>LL_06</td>
<td>85,071</td>
<td>131 0.154</td>
<td>30 0.035</td>
<td>- -</td>
<td>117 0.138</td>
<td>- -</td>
<td>1 0.001</td>
<td>- -</td>
<td>- -</td>
<td>- -</td>
<td>- -</td>
</tr>
<tr>
<td>Total</td>
<td>262,527</td>
<td>1,693 0.645</td>
<td>622 0.237</td>
<td>8 0.0030</td>
<td>191 0.073</td>
<td>1 0.0004</td>
<td>23 0.009</td>
<td>1 0.0004</td>
<td>1 0.0004</td>
<td>4 0.0015</td>
<td>1 0.0004</td>
</tr>
</tbody>
</table>

Remarks:

NGA : Longnose lancetfish (*Alepisaurus ferox*)
DAV : Pelagic stingrays (*Pteroplatytrygon violacea*)
MOX : Ocean sunfish (*Mola mola*)
CSK : Crocodile shark (*Pseudocarcharias kamoharai*)
SPY : Hammerhead shark (*Sphyrnidae* spp.)
HAR : Snake mackerel (*Gempylus serpens*)
TRF : Tappertail ribbonfish (*Trachipterus fukuzakii*)
FKW : Fake killer whale (*Pseudorca crassidens*)
LKV : Olive ridley turtle (*Lepidochelys olivacea*)
LST : Leatherback sea turtle (*Dermochelys coriacea*)
DISCUSSION

Catch Rate

The catch composition of target species (in number) was lower compared to that in Pacific Island Countries’ Tuna Fishery Area (PICTFA) (Chapman, 2001) but higher than in Eastern Indian Ocean and Andaman Sea which target species was only as much as 13.51% of total tuna (yellowfin and bigeye) caught from total catch (Rajruchithong et al., 2005). The high catch rate of longnose lancetfish and pelagic stingrays are likely appears in tuna longline fishery in Indonesia i.e. Banda Sea (72.04%, regardless the main catch) (Nugraha & Wagayo, 2006), South of Java (57.73%, regardless the main catch) (Nugraha & Triharyuni, 2009), and West Sumatra (22.45%) (Nugraha & Nurdin, 2006). Combined they composed almost half of the total catch (in number) resulted in high CPUE which is 0.645/100 hooks and 0.237/100 hooks, respectively. Since the species has no commercial value and, to avoid loosening the hook, fishermen discard individuals at sea in such poor condition that survival probabilities are low.

The high catch rate for by-catch, especially discards may have been caused by the type of longline used. Chapman (2001) informed that deep-water sets account for more target species (% by number), with less discards in both tropical and subtropical waters than shallow sets. While the day-night factor is probably not as significant as the shallow-deep factor in determining the amount of discards taken by longliners. But why is that Indonesian fleets still producing a large number of by-catch eventhough deep-water longline was commenced since 1983? (Sadiyah, 2012). The answer probably lies on the type and size of the hook used. Indonesian longliners familiar with conventional J-hook size 3 which is smaller compared to other country reported (Read, 2006; Xu et al., 2006). Using both circle hook and larger J-hook are believed to have impact of reducing the catch rate of discards (Piovano et al., 2010; Domingo et al., 2012; ) and its survival rate (Pacheco et al., 2011) especially for pelagic stingrays and marine turtles.

Catch at Release

Of total discards recorded, 27.93% released alive, 24.75% injured, 4.37% dying, 42.78% dead, and 0.18% wrecked. This shows that most of the discards are released dead or with little survival probability and it should be a concern. Indeed most of the species released are less economically valuable but it might ecologically important. So a step of action should be taken in order to not “wasting the sea“, noting that almost half of the total catch are released back. A more in-depth research is needed to investigate the effect of discards both economically and ecologically.

Some Ecological Information on Discarded Species

Longnose lancetfish may play an important role on pelagic food chain as a predator on microneconct organisms (Romanov et al., 2008a) and a prey for billfishes and tunas (Potier et al., 2007a), and together they usually form a schooling. Despite of their massive abundance in the ocean yet no information about the utilisation of this species, especially longnose lancetfish which perhaps due to the number of fine edges. This fish also commonly called “earthquake fish” in Taiwan because the fish are popularly believed to appear following major earthquake events due to alleged sensitivity to disturbances in the ocean floor. This shows that most of the discards are released dead or with little survival probability and it should be a concern. Indeed most of the species released are less economically valuable but it might ecologically important. So a step of action should be taken in order to not “wasting the sea“, noting that almost half of the total catch are released back. A more in-depth research is needed to investigate the effect of discards both economically and ecologically.

There were 2 species of sharks which were recorded as discards, crocodile and hammerhead shark. The bigger portion goes to crocodile shark which becomes abundant species in several areas of World Ocean, in particular Southern Indian Ocean (Romanov & Levesque, 2009) and informed to have highest catch rate in Indian Ocean, while off Western Australia become most frequently caught species (Romanov et al., 2008b). Hammerhead sharks (family: Sphyrnidae) are listed as vulnerable and endangered due to it ranked among the species with lowest productivity. Even tough most of sharks caught were the species which are released dead and utilised especially for their fins while their bodies are disposed.

Not much knowledge about snake mackerel and tapertail ribbonfish, they usually are caught alongside tuna longline fishery but in a minor number (Froese & Pauly, 2009). Snake mackerel is usually marketed frozen or in sausages and fish cakes, in Hawaii, this fish is known as hāuliuli and is considered good eating cooked or fish (Nakamura & Parin, 1993). There yet an information about the utilisation of tapertail ribbonfish, the only interesting fact is that this fish also commonly called “earthquake fish” in Taiwan because the fish are popularly believed to appear following major earthquake events due to alleged sensitivity to disturbances in the ocean floor.
Except in Indonesian waters, the present of ocean sunfish also mentioned by Gamblin et al. (2007) in Seychelles waters. Ocean sunfish or common mola is the heaviest known bony fishes and has an average adult weight of 1,000 kg (Pope et al., 2009), they are recognized as the most fecund extant vertebrate with a single female capable of producing as many as 3,108 eggs at one time (Bass et al., 2005 after Parenti, 2003). The meat of the ocean sunfish is considered a delicacy in some regions, the largest markets being Taiwan and Japan. All parts of the sunfish are used in cuisine, from the fins to the internal organs (Froese & Pauly, 2009).

False killer whale is a cetacean, marine mammal and the third largest member of the oceanic dolphin family (Delphinidae). Knowledge about this species is limited, the only known issue is that this species like to graze longline bait-caught fishes during hauling.

Two kind of sea turtle recorded during this study, the first is olive ridley sea turtle which occurred 4 times, and leatherback sea turtle only once. All of them are released alive with minor injuries. The olive ridley sea turtle is a small extant sea turtle with distribution across Indian Ocean, usually appear as by-catch in longline fisheries but mostly caught by 'ghost fishing" (nets or bits of net that have been lost or jettisoned) (Anderson et al., 2009). According to the observations, L. olivacea seems the most impacted by the fishery and most of the by-catches occurred in the north of the west Indian Ocean (up to the equator) (Amande et al., 2008). Leatherback sea turtle is known to be the largest of all living sea turtles but yet little information about their life history.

CONCLUSION

Discards composition was dominated by longnose lancetfish and pelagic stingrays which composed almost half of total discards, with almost half of total catch are discards and half of discards are disposed dead or dying. Almost half of total catch are discards and half of discards are disposed dead or dying.

AKNOLEDGEMENT

This paper is part of authors’ contribution in research on by-catch and tuna fisheries in Indian Ocean conducted during 2010 – 2011 under Research Institute for Marine Fisheries. Authors would also like to thank to all of scientific observers for their contribution in collecting onboard data throughout the years. With gratitude to Indonesian Tuna Longline company for their support for years of research.

REFERENCES


