# REVIEW OF STUDIES ON CATCH RATES OF COMMERCIAL AND BYCATCH SPECIES BY HOOK TYPE USING IN PELAGIC TUNA LONGLINE FISHERIES

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*SUMMARY*

*Tunas and swordfish are main target of the pelagic tuna longline fishery which incidentally non-targeted species such as sea turtles and sharks. There is a variety of hook types in terms of shapes and sizes, which are separated into three groups, i.e. "J" hooks, Japanese tuna hooks and circle hooks. This document overviewed catch rates for main species and bycatch species reported in the published scientific papers and documents.*

*RÉSUMÉ*

*Les thonidés et l'espadon sont les principales espèces cibles de la pêcherie palangrière ciblant les thonidés pélagiques et capturant les tortues marines et les requins en tant que prise accessoire. Il existe plusieurs types d'hameçons en termes de formes et de tailles, qui sont séparés en trois groupes, à savoir les hameçons en forme de « J », les hameçons thoniers japonais et les hameçons circulaires. Ce document offre un aperçu des taux de capture des principales espèces et des espèces accessoires déclarées dans les documents scientifiques publiés.*

*RESUMEN*

*Los atunes y el pez espada son el principal objetivo de la pesquería palangrera de túnidos pelágicos que captura de forma incidental especies no objetivo como las tortugas marinas y los tiburones. Hay una variedad de tipos de anzuelos en cuanto a formas y tamaños, que se separan en tres grupos, a saber, anzuelos en "J", anzuelos para atunes japoneses y anzuelos circulares. En el presente documento se reseñan las tasas de captura de las principales especies y de las especies de captura fortuita notificadas en los documentos científicos publicados.*

*KEYWORDS*

*Hook type, catch rate, bycatch rate, longlining, target and non-target species*

## 1. Introduction

Pelagic longline fishery targets mainly bigeye (*Thunnus obesus*), albacore (*T. alalunga*), yellowfin (*T. albacares*), bluefins (*T. thynnus*, *T. orientalis* and *T. maccoyii*), swordfish (*Xiphias gladius*), blue shark (*Prionace glauca*), and shortfin mako shark (*Isurus oxyrinchus*). Their swimming depths are different by species, and therefore the set depth of fishing gear is also different in accordance with target. Types of the pelagic longline fishery are classified roughly into two categories, i.e. shallow-set and deep-set, depends on the setting depth. Shallow-set and deep-set are applied to target billfish or sharks, and bigeye, yellowfin, albacore or bluefin tunas, respectively. A few thousand of hooks, in general, are deployed in a single operation. There is a variety of hook types in terms of shapes and sizes, which are separated into three groups, i.e. "J" hooks, Japanese tuna hooks and circle hooks (Mituhasi and Hall 2011; Yokota *et al.* 2006a). Generally, the whole finfish and/or squids are used as baits. There often occur incidental takes, generally called as bycatch, of sea turtles, seabirds and non-target shark species. Towards mitigation of bycatch, numerous studies on catch rates for target and non-target species of several fishing gears or operation methods have been conducted (e.g. Afonso *et al.* 2012; Gilman *et al.* 2006). In the gear

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modifications, many scientists are interested in the hook modifications including implements of large circle hook. As for hook modifications, a lot of studies about the effects of circle, J, and Japanese tuna hooks on the catchabilities of target and non-target species have been conducted based on the experimental research or observations by scientific observers (e.g. Andraka *et al.* 2013). Many studies showed effectiveness of the large circle hook to mitigate sea turtle bycatch. In western and central Pacific, there is the conservation and management measures to reduce sea turtle bycatch. It is summarized as that the longline vessels targeting swordfish in a shallow-set manner are required to employ or implement at least one of the three methods which are to use only large circle hooks, to use only whole finfish for bait, and to use any other measure, mitigation plan or activity that has been reviewed by the Scientific Committee (SC) and the Technical and Compliance Committee (TCC) and approved by the Commission (WCPFC CMM2008-03). On the other hand, recent studies have pointed that the use of large circle hooks could increase bycatch rates for some shark species, concluding that it should be carefully discussed in terms of the advantage and disadvantage of large circle hook application (Reinhardt *et al.* 2017; Semba *et al.* in press). In this study, we compiled previous studies conducted using J hooks, Japanese tuna hooks, and large circle hooks and reviewed from the aspects of the effects on the catch rates of target and non-target species by hook types.

## 2. Materials and methods

We collected previous scientific literatures related to the studies on effects of J hook, Japanese tuna hook, and large circle hook on catch rates of target and non-target species in pelagic longline fisheries in the Atlantic, the Indian, and the Pacific Oceans. A total of 40 cases of 33 publications were reviewed and compiled with the catch rates of main target and bycatch species, such as bigeye tuna, yellowfin tuna, albacore tuna, skipjack tuna (*Katsuwonus pelamis*), swordfish, striped marlin (*Kajikia audax*), sailfish (*Istiophorus platypterus*), escolar (*Lepidocybium flavobrunneum*), dolphinfish (*Coryphaena hippurus*), wahoo (*Acanthocybium solandri*), longnose lancetfish (*Alepisaurus ferox*), blue shark, shortfin mako shark, bigeye thresher shark (*Alopias superciliosus*), pelagic stingray (*Pteroplatytrygon violacea*), leatherback turtle (*Dermochelys coracea*), olive ridley (*Lepidochelys olivacea*), loggerhead turtle (*Caretta caretta*), and green turtle (including black turtle; *Chelonia mydas*). The fishing layer of depth is changed with target species, and thus we divided all the cases into 3 categories; shallow-set, deep-set, and others. We used the number of hooks between floats (hbf) as a factor of the categorization. The shallow and deep sets were defined as the hbf of 10 hooks and less, and more than 10 hooks, respectively, based on the previous study (Common Oceans (ABNJ) Tuna Project 2017). If there was not information on the hbf in the case, it was regarded as others. The number of study cases which recorded significantly higher catch rate in J hook versus large circle hook and Japanese tuna hook versus large circle hook, or the number of cases without significant difference was counted by each species. The smallest and biggest number of hbf and number of hooks and sets observed were cited from the literatures by each species.

## 3. Results

As a result of review, the literatures for shallow-set, deep-set, and others were 25 cases of 21 literatures, 6 cases of 5 literatures, and 9 cases of 7 literatures, respectively (**Tables 1-3**). The numbers of study cases with recording significantly higher catch rates in J hook versus large circle hook, in Japanese tuna hook versus large circle hook, and without significant difference were shown in **Tables 4 and 5.** In the shallow-set fishing strategy, almost all the previous studies recorded higher catch rates on tunas and sharks in large circle hook or no significant difference between J hook and large circle hook. Oppositely, almost all the studies recorded higher catch rates on sea turtles in J hook than large circle hook. As for swordfish and the other teleost fishes, it was absent of significant difference between J hook and large circle hook. There were a few comparative studies of catch rates between Japanese tuna hook and large circle hook, therefore it has no specific outcome except for sea turtles which had slightly more studies recording higher catch rate in Japanese tuna hook. Only a few studies existed for deep-set fishing strategy, thus there was no remarkable tendency in catch rate by the difference of hook types. However, we note that a study case for leatherback turtle and olive ridley recorded no significant difference between Japanese tuna hook and large circle hook.

## 4. Discussion

### *4.1 Catch rates on target and bycatch species*

We concluded that only a few studies for hook type effects on catch rates of target and bycatch species in deep-set fishing strategy were existed whereas sufficient number of studies have been conducted for shallow-set strategy. In addition, the studies using Japanese tuna hooks in both of fishing strategies were also limited. Although it may cause by lack of studies, results were inconsistent between the studies. Two studies recorded higher catch rates on swordfish in large circle hook (Andraka *et al.* 2013; Huang *et al.* 2016) and the others were inversely recorded higher catch rates in Japanese tuna hooks (Andraka *et al.* 2013; Curran and Bigelow 2011). However, the tendencies that albacore recorded higher catch rates in Japanese tuna hook were not different between the studies. Overall, catch rates of each species for the shallow-set strategy represented roughly the same trends between the studies, but not for deep-set strategy because of the lack of studies. It is strongly needed to increase the number of studies with using J, Japanese tuna, and large circle hooks in deep-set longline for the evaluation of effects on catch rates for target and bycatch species.

The study of meta-analysis on the effects by J hook (including Japanese tuna hook) and circle hook on the catch rates for target and bycatch species concluded that many of main target species and shark species recorded higher catch rates in large circle hook and sea turtles recorded higher catch rates in J hook (Reinhardt *et al.* 2017). It means that large circle hook raises bycatch rate of sharks whereas it mitigates bycatch rate of sea turtles. In addition, it was recently indicated that the use of large circle hook may cause substantial increase of absolute number of dead shortfin mako shark in total (Semba *et al.* in press). It is because that the increasing rate of number of bycatch using large circle hook is much higher than the decreasing rate of number of survival although previous study reported that the use of large circle hook reduces the mortality of sharks (Godin *et al.* 2012). In conclusion, the use of large circle hook is not a be-all-end-all solution at this moment. It will be necessary to keep collecting the scientific knowledge.

### *4.2 Large circle hook as a mitigation measure for sea turtle*

The results of this study showed that the large circle hook is effective for reduction of sea turtle bycatch in shallow-set fishing strategy. On the other hand, the effects of large circle hook on reducing bycatch rate of sea turtle in deep-set strategy was unclear although it may cause by the limited available information. In the result of Huang *et al.* (2016), the bycatch rate of leatherback turtle by Japanese tuna hook was almost same with that of large circle hook. The bycatch rates of loggerhead and olive ridley by J hook including Japanese tuna hook were also almost same with that of large circle hook. The study indicates that the large circle hook may not so much effective as it has been mentioned. We will discuss about the reason why the effects of mitigating bycatch on sea turtles for deep-set will be lower than the shallow-set's one. There are direct and indirect effects by the use of large circle hook on reducing bycatch rate of sea turtle. One of the indirect effects is the shift of hooking locations, in other words it will reduce the ratio of deep hooking like as swallowed and increase the ratio of external or mouth hooking (Parga *et al.* 2015). It will be easier to de-hook if external or mouth hooking were increased, therefore it has potential to increase the chance of escape and decrease the number of individuals observed at line hauling. However, it is mainly effective for the shallow-set strategy because the chances to breathe are limited for the lung breathing animal in deep-set strategy. The cases are, for example, when the turtle was caught by the branch line close to a float or spent short time until hauling the branch line. The turtle will be dead in the deep-set strategy before de-hooking even if the cases with external hooking were increased, therefore the bycatch rates with using large circle hook were not decreased. Gilman and Huang (2016) pointed that it is still unclear what is the most important effects of large circle hook, i.e. circle shape or large size on reducing hard-shelled sea turtle bycatch. They also pointed that the circle shape may be more effective to reduce leatherback bycatch than the large size of hook. These factors are essential to discuss on sea turtle bycatch especially in deep-set and further studies are necessary to clarify the mechanisms of bycatch and to improve the mitigation measures.

The effects of large circle hook and/or fish bait on mitigating bycatch of sea turtle have been simulated with assigning the value of reduction rates derived from the studies of shallow-set strategy (Common Oceans (ABNJ) Tuna Project 2017). However, we conclude that the effects of the mitigation measures on sea turtle may have the difference between shallow-set and deep-set, and effects of mitigation measures for deep-set are luck of studies. It is needed to understand whether large circle hook is effective to reduce sea turtle bycatch in deep-set as well as shallow-set. In the future, the additional information on the hbf, a distance between two blanch lines, and the number of blanch line which the turtle was captured to estimate the approximate depth of bycatch will be enable us to be better evaluation on the effects of mitigation measures if a research cruise can afford to record.

In the previous studies of sea turtle bycatch on deep-set strategy, the ratios of sea turtle caught by the first and second branch line from the float were 64%, 100%, and 60% in Huang *et al.* (2016), Kim *et al.* (2006), and Kim *et al.* (2007), respectively. It indicates that the sea turtles are spending much time at around surface layer as it is also supported by the biological studies (Eckert 2006; Polovina *et al.* 2004). The fishing strategy that we set all the hooks of the longline gear at deeper than the water depth that sea turtles use frequently may be effective as another mitigation measure for sea turtles as it has been introduced before (Beverly *et al.* 2004; Shiode *et al.* 2005).

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**Table 1.** Summaries of reviewed literatures by study case categorized as shallow-set.

| Reference | Hooks between floats | No of hooks | No of sets | Target | Ocean | With or without using in our study* |
|---|---|---|---|---|---|---|
| Afonso et al. (2011) | 5 | 7,800 | 12 | Tuna | Equatorial Atlantic | T |
| Andraka et al. (2013) | 2-3 | 356,674 | 2,068 | Tuna, Billfish, and Shark | Eastern Pacific | T |
| Andraka et al. (2013) | 3-5 | 134,643 | 248 | Tuna, Billfish, and Shark | Eastern Pacific | T |
| Andraka et al. (2013) | 3-5 | 75,041 | 122 | Tuna, Billfish, and Shark | Eastern Pacific | T |
| Domingo et al. (2009) | 8 | 77,628 | 165 | Swordfish and Sharks | South western Atlantic | T |
| Domingo et al. (2012) | 5 | 39,822 | 61 | Swordfish and Pelagic Sharks | South western Atlantic | T |
| Domingo et al. (2012) | 8 | 45,142 | 107 | Blue Shark | South western Atlantic | T |
| Kerstetter and Graves (2006) | 5 | 14,040 | 39 | Yellowfin | North western Atlantic | T |
| Kerstetter and Graves (2006) | 5 | 16,560 | 46 | Swordfish | Gulf of Mexico Caribbean | T |
| Kerstetter et al. (2007) | 5 | 16,624 | 26 | Swordfish | Equatorial Atlantic | T |
| Minami et al. (2006) | 4 | 48,600 | 52 | Swordfish | North western Pacific | T |
| Pacheco et al. (2011) | 5 | 50,170 | 81 | Swordfish and Bigeye | Equatorial Atlantic | T |
| Piovano et al. (2009) | 5 | 29,254 | 30 | Swordfish | Mediterranean | T |
| Sales et al. (2010) | 5-6 | 145,828 | 229 | Tunas and Sharks | South western Atlantic | T |
| Santos et al. (2012) | 5 | 305,352 | 221 | Swordfish | Equatorial Atlantic | T |
| Watson et al. (2005) | 3 | 427,382 | 489 | Tuna, Swordfish, and Shark | North western Atlantic | T |
| Afonso et al. (2012) | 5 | | | Tuna and Swordfish | Equatorial Atlantic | F |
| Bolten and Bjorndal (2005) | 4 | | | Swordfish | North eastern Atlantic | F |
| Cambiè et al. (2012) | 6-9 | | | Atlantic Bluefin | Mediterranean | F |
| Coelho et al. (2012) | 5 | | | Bigeye, Yellowfin, and Swordfish | Equatorial Atlantic | F |
| Coelho et al. (2015) | 5 | | | Swordfish | Equatorial Atlantic | F |
| Fernandez-Carvalho et al. (2015) | 5 | | | Swordfish and Blue shark | Equatorial Atlantic | F |
| Foster et al. (2012) | 5 | | | Swordfish, Bigeye, and Blue shark | North western Atlantic | F |
| Mejuto et al. (2008) | 5 | | | Swordfish | North to South Atlantic | F |
| Yokota et al. (2006b) | 4 | | | Swordfish and Blue shark | North western Pacific | F |

* The study case used in our study: T; non-use: F.

**Table 2.** Summaries of reviewed literatures by study case categorized as deep-set.

| Reference | Hooks between floats | No. of hooks | No. of sets | Target | Ocean | Remarks*[1] | With or without using in our study*[2] |
|---|---|---|---|---|---|---|---|
| Curran and Bigelow (2011) | 24.7±1.75 | 2,773,427 | 211 | Bigeye | Central Pacific | J vs C | T |
| Curran and Bigelow (2011) | 24.7±1.75 | | 1,182 | Bigeye | Central Pacific | T vs C | T |
| Huang et al. (2016) | 16-17 | 407,677 | 200 | Bigeye | Equatorial Atlantic | | T |
| Kim et al. (2006) | 17 | 44,100 | 21 | Tuna and Billfish | Eastern Pacific | | F |
| Kim et al. (2007) | 16 | 62,464 | 28 | Tuna and Billfish | Eastern Pacific | | F |
| Promjinda et al. (2008) | 15-20 | 6,277 | 13 | Tuna and Billfish | Bay of Bengal and Andaman Sea | | F |

*[1] "J", "C", and "T" mean J hook, circle hook, and Japanese tuna hook, respectively.
*[2] The study case used in our study: T; non-use: F

**Table 3.** Summaries of reviewed literatures categorized as other.

| Reference | Hooks between floats | Target | Ocean | Remarks |
|---|---|---|---|---|
| Carruthers et al. (2009) | Undescribed | Swordfish and Tunas | North western Atlantic | Gear is generally set shallow to fish in the upper 20 m |
| Diaz (2008) | Undescribed | Yellowfin | Gulf of Mexico | U.S. pelagic longline observer program |
| García-Cortés et al. (2009) | Undescribed | Swordfish | South eastern Pacific | Surface |
| Garrison (2003) | Undescribed | Swordfish | Gulf of Mexico | |
| Largacha et al. (2005) | Undescribed | Bigeye | Eastern Pacific | |
| Piovano and Gilman (2016) | Undescribed | Tunas | | Fijian pelagic observer program |
| Ward et al. (2008) | 6-8 | Swordfish | South western Pacific | |
| Ward et al. (2008) | About 30 | Albacore | South western Pacific | |
| Ward et al. (2008) | 10-12 / 30 | Tunas | South western Pacific | |

**Table 4.** The number of study cases of shallow-set with recording significantly higher catch rates in J hook versus large circle hook and without significant difference. The range of hooks between floats and number of hooks and sets observed were cited from the literatures by each species.

| Species | No. of cases recording significantly higher or non-significantly different catch rate | | | No. of cases recording significantly higher or non-significantly different catch rate | | | Hooks between floats (min-max) | No. of hooks (min-max) | No. of sets (min-max) | Reference |
|---|---|---|---|---|---|---|---|---|---|---|
| | J hook | Circle hook | Non significant | Japanese tuna hook | Circle hook | Non significant | | | | |
| **Tuna** | | | | | | | | | | |
| Bigeye | | 3 | 4 | | | 2 | 2-8 | 16,624-427,382 | 26-2,068 | Andraka et al. (2013); Domingo et al. (2009); Domingo et al. (2012); Kerstetter and Graves (2006); Kerstetter et al. (2007); Pacheco et al. (2011); Sales et al. (2010); Watson et al. (2005) |
| Yellowfin | | 3 | 3 | | 1 | 2 | 2-8 | 16,624-356,674 | 26-2,068 | Andraka et al. (2013); Domingo et al. (2009); Domingo et al. (2012); Kerstetter and Graves (2006); Kerstetter et al. (2007); Pacheco et al. (2011); Sales et al. (2010) |
| Albacore | | 4 | 2 | | | | 3-8 | 14,040-145,828 | 39-229 | Domingo et al. (2009); Domingo et al. (2012); Kerstetter and Graves (2006); Pacheco et al. (2011); Sales et al. (2010) |
| Skipjack | | | | | | 2 | 2-5 | 134,643-356,674 | 248-2,068 | Andraka et al. (2013) |
| **Billfish** | | | | | | | | | | |
| Swordfish | 2 | 1 | 7 | 1 | 1 | 1 | 2-8 | 16,624-356,674 | 26-2,068 | Andraka et al. (2013); Domingo et al. (2009); Domingo et al. (2012); Kerstetter and Graves (2006); Kerstetter et al. (2007); Pacheco et al. (2011); Piovano et al. (2009); Sales et al. (2010); Watson et al. (2005) |
| Striped marlin | | | | | | 1 | 2-3 | 356,674 | 2,068 | Andraka et al. (2013) |
| Sailfish | 1 | | 2 | | 1 | 2 | 2-5 | 16,624-356,674 | 26-2,068 | Andraka et al. (2013); Kerstetter and Graves (2006); Kerstetter et al. (2007); Pacheco et al. (2011) |
| **Other teleost fish** | | | | | | | | | | |
| Wahoo | | | 3 | | 1 | | 5-8 | 16,624-45,142 | 26-107 | Andraka et al. (2013); Domingo et al. (2012); Kerstetter et al. (2007); Pacheco et al. (2011) |
| Dolphin fish | | | 6 | | | 3 | 2-6 | 16,624-356,674 | 26-2,068 | Andraka et al. (2013); Domingo et al. (2012); Kerstetter and Graves (2006); Kerstetter et al. (2007); Pacheco et al. (2011); Sales et al. (2010) |
| Escolar | | | 4 | | | 1 | 2-8 | 16,560-356,674 | 46-2,068 | Andraka et al. (2013); Domingo et al. (2012); Kerstetter and Graves (2006); Pacheco et al. (2011) |
| Longnose lancetfish | — | — | — | — | — | — | — | — | — | |
| **Shark** | | | | | | | | | | |
| Blue shark | | 4 | 5 | 1 | 1 | 1 | 2-8 | 7,800-427,382 | 12-2,068 | Andraka et al. (2013); Domingo et al. (2009); Domingo et al. (2012); Kerstetter and Graves (2006); Kerstetter et al. (2007); Pacheco et al. (2011); Sales et al. (2010); Watson et al. (2005) |
| Shortfin mako | | 1 | 4 | | | 1 | 2-8 | 39,822-356,674 | 61-2,068 | Andraka et al. (2013); Domingo et al. (2009); Domingo et al. (2012); Pacheco et al. (2011); Sales et al. (2010) |
| Bigeye thresher shark | | | | | | 1 | 2-3 | 356,674 | 2,068 | Andraka et al. (2013) |
| **Ray** | | | | | | | | | | |
| Palagic stingray | 2 | | 1 | | 1 | | 2-8 | 14,040-356,674 | 39-2,068 | Andraka et al. (2013); Domingo et al. (2012); Kerstetter and Graves (2006); Pacheco et al. (2011) |
| **Turtle** | | | | | | | | | | |
| Leatherback turtle | 4 | | 1 | | | | 3-8 | 50,170-427,382 | 81-489 | Andraka et al. (2013); Domingo et al. (2009); Domingo et al. (2012); Pacheco et al. (2011); Sales et al. (2010); Santos et al. (2012); Watson et al. (2005) |
| Olive ridley | 1 | | 1 | 2 | | 1 | 2-5 | 50,170-356,674 | 81-2,068 | Andraka et al. (2013); Pacheco et al. (2011); Santos et al. (2012) |
| Loggerhead turtle | 3 | | 3 | 1 | | | 3-8 | 29,254-427,382 | 30-489 | Andraka et al. (2013); Domingo et al. (2009); Domingo et al. (2012); Minami et al. (2006); Piovano et al. (2009); Sales et al. (2010); Watson et al. (2005) |
| Green/Black turtle | | | 1 | 2 | | 1 | 2-5 | 50,170-356,674 | 81-2,068 | Andraka et al. (2013); Pacheco et al. (2011); Sales et al. (2010) |

**Table 5.** The number of study cases of deep-set with recording significantly higher catch rates in J hook versus large circle hook and without significant difference. The range of hooks between floats and number of hooks and sets observed were cited from the literatures by each species.

| Species | No. of cases recording significantly higher or non-significantly different catch rate | | | No. of cases recording significantly higher or non-significantly different catch rate | | | Hooks between float (min-max) | No. of hooks (min-max) | No. of sets (min-max) | Reference |
|---|---|---|---|---|---|---|---|---|---|---|
| | J hook | Circle hook | Non significant | Japanese tuna hook | Circle hook | Non significant | | | | |
| **Tuna** | | | | | | | | | | |
| Bigeye | | | 1 | | 1 | 1 | 16-25< | 407,677- <2,773,427 | 200-1,182 | Curran and Bigelow (2011); Huang et al. (2016) |
| Yellowfin | | | 1 | 1 | 1 | | 16-25< | 407,677- <2,773,427 | 200-1,182 | Curran and Bigelow (2011); Huang et al. (2016) |
| Albacore | | | 1 | 2 | | | 16-25< | 407,677- <2,773,427 | 200-1,182 | Curran and Bigelow (2011); Huang et al. (2016) |
| Skipjack | | | 1 | | | 1 | an average of 25 | <2,773,427 | 211-1,182 | Curran and Bigelow (2011) |
| **Billfish** | | | | | | | | | | |
| Swordfish | | | 1 | 1 | 1 | | 16-25< | 407,677- <2,773,427 | 200-1,182 | Curran and Bigelow (2011); Huang et al. (2016) |
| Striped marlin | | | 1 | 1 | | | an average of 25 | <2,773,427 | 211-1,182 | Curran and Bigelow (2011) |
| Sailfish | — | — | — | — | — | — | — | — | — | — |
| **Other teleost fish** | | | | | | | | | | |
| Wahoo | 1 | | | 1 | | | an average of 25 | <2,773,427 | 211-1,182 | Curran and Bigelow (2011) |
| Dolphin fish | 1 | | | 1 | | | an average of 25 | <2,773,427 | 211-1,182 | Curran and Bigelow (2011) |
| Escolar | | | 1 | 1 | | | an average of 25 | <2,773,427 | 211-1,182 | Curran and Bigelow (2011) |
| Longnose lancetfish | 1 | | | 1 | | | an average of 25 | <2,773,427 | 211-1,182 | Curran and Bigelow (2011) |
| **Shark** | | | | | | | | | | |
| Blue shark | 1 | | | 1 | 1 | | 16-25< | 407,677- <2,773,427 | 200-1,182 | Curran and Bigelow (2011); Huang et al. (2016) |
| Shortfin mako | — | — | — | — | — | — | — | — | — | — |
| Bigeye thresher shark | | | 1 | 1 | | | an average of 25 | <2,773,427 | 211-1,182 | Curran and Bigelow (2011) |
| **Ray** | | | | | | | | | | |
| Palagic stingray | 1 | | | 1 | | | an average of 25 | <2,773,427 | 211-1,182 | Curran and Bigelow (2011) |
| **Turtle** | | | | | | | | | | |
| Leatherback turtle | | | | | | 1 | 16-17 | 407,677 | 200 | Huang et al. (2016) |
| Olive ridley | | | | | | 1 | 16-17 | 407,677 | 200 | Huang et al. (2016) |
| Loggerhead turtle | — | — | — | — | — | — | — | — | — | — |
| Green/Black turtle | — | — | — | — | — | — | — | — | — | — |