

COMPUTING A GLOBAL RATE OF NON-TARGET SPECIES CATCH (BYCATCH) IN TROPICAL TUNA PURSE SEINE FISHERIES



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I. Abstract

We present estimates of bycatch rates for the tropical tuna purse seine fisheries using observer data for 2011-2015 from all oceans. The term "bycatch" refers to the catch of anything that is not the main reason for which the skipper is fishing, irrespective of its fate (retain or discarded). The target tunas in this fishery are skipjack, yellowfin and bigeye. Note, however, that many of the incidental catches, such as small tuna species, are valuable and are retained and end up being marketed and consumed. Therefore, we also present estimates of bycatch rates excluding minor tunas. We estimate the average 2011-2015 global bycatch rate to be 1.4% of the target tunas caught (0.92% if minor tunas and bonitos are excluded), which is low for a large industrial fishery. Some organizations and individuals give importance to such a single number as a proxy for measuring the environmental impact of a fishery. However, the magnitude of a bycatch rate does not necessarily imply a given level of concern (or lack of it) for any particular species. For example, a bycatch rate of 10% may be of no concern for one species that is highly productive, while one of 1% may be of concern for another, less productive one. The impact of fishing on individual species, target and non-target, needs to be assessed through adequate monitoring and research.

II. Introduction

The incidental catch of non-target species is sometimes referred to as "bycatch," however, there is not a unique definition of what constitutes "bycatch." For some authors this term refers solely to specimens that are discarded dead, while for others it may include specimens released alive, retained non-target species and small-size specimens of target species. In this document, the term "bycatch" refers to the catch of anything that is not the main reason for which the skipper is fishing (see Dagorn and Restrepo, 2011), irrespective of its fate (retain or discarded). Note, however, that many of these incidental catches, such as small tuna species, are valuable and are retained and end up being marketed and consumed. Therefore, to say that they are not targeted may be too strict. Here, it is assumed that the main reason for which tropical tuna purse seine skippers are fishing is to catch skipjack, yellowfin and bigeye tunas. We also consider the alternative that other species of small tunas and bonitos are targeted, in addition to the three main commercial tuna species.

Bycatch of non-target species is highly variable. It depends on the main fishing gears that are used, but can also vary due to other fishing factors such as the skipper's strategy at a given time, Ocean area, time of the year, market prices by species/size, etc. Nevertheless, there is currently an interest in characterizing "bycatch" with a single number that can be used to estimate the overall impact from all tuna purse seine fisheries. This document provides such an estimate at the global level.

This report updates an earlier study by Restrepo (2011) with more recent data.

III. Calculation of weighted bycatch rates

II.1. Weighted bycatch rate for the capture of non-target species

A weighted bycatch rate can be calculated taking into account regional and gear differences in bycatches and in the catch of target tunas. In this initial part of the exercise, it is assumed that the target species of the tropical purse seine fisheries are strictly yellowfin, skipjack and bigeye tunas. Tropical purse seine vessels may at times actively target other species such as minor tuna species or bonitos; these are not included in the calculations in this document.

Table 1 shows the 2011-2015 average retained catch of skipjack, yellowfin and bigeye made by purse seine vessels in the Western and Central Pacific (WCPO), eastern Pacific (EPO), Indian (IO) and Atlantic (AO) Oceans. These average catches are separated into those made by setting on objects (anchored FADs, drifting FADs natural logs, dead animals, etc.) and those made setting on free (unassociated) schools of tuna. For the EPO, sets on tuna-dolphin associations are reported separately (this is the only Ocean region where this fishing mode is used regularly).

Table 1 also provides the catch rate of non-target species (all fish caught except skipjack, yellowfin and bigeye tunas), expressed as a percentage of the catches (retained plus discarded) of skipjack, yellowfin and bigeye combined. These percentages are also separated by set type in each region. These catch rates of non-target species also include both retained and discarded fish.

The last column and row in the table provide a bycatch rate weighted by the amount of catch made in the different set types in each region, or weighted by the amount of catch retained in the different regions for a given set type. The number at the bottom right-hand side of the table is a global average bycatch rate of non-target species.

Table 1. Retained catch of target tunas and bycatch rate of non-target species by ocean region and set type, and breakdown by year. The last column and row show the average bycatch rates, weighted by the amounts of target tuna caught.

Region	Target tuna catch 2011-2015*				Non-target species catch (%)**			Weighted rate %
	Object	Dolphin	Free School	Sub-tot	Object	Dolphin	Free School	
WCPO	883,933		954,695	1,838,627	1.03		0.33	0.67
EPO	288,308	155,191	118,417	561,916	1.12	0.10	0.25	0.65
IO	258,941		64,412	323,353	2.84		0.47	2.36
AO	201,867		72,950	274,817	8.39		1.97	6.69
					2.24	0.10	0.43	1.40

Breakdown by year:

Region	Target tuna catch 2011-2015*				Non-target species catch (%)**			Weighted rate %
	Object	Dolphin	Free School	Sub-tot	Object	Dolphin	Free School	
WCPO	883,933		954,695	1,838,627	1.03		0.33	0.67
2011	908,517		646,769	1,555,286	1.24		0.64	0.99
2012	895,513		969,405	1,864,918	0.86		0.35	0.60
2013	916,971		1,005,572	1,922,543	0.93		0.27	0.59
2014	934,558		1,145,404	2,079,962	1.12		0.23	0.63
2015	764,103		1,006,325	1,770,428	0.98		0.17	0.52
EPO	288,308	155,191	118,417	561,916	1.12	0.10	0.25	0.65
2011	268,764	139,213	131,421	539,398	1.00	0.10	0.28	0.59
2012	279,806	135,836	114,610	530,252	1.10	0.09	0.28	0.67
2013	277,798	161,704	106,732	546,234	1.19	0.08	0.22	0.67
2014	304,767	172,648	78,589	556,004	1.35	0.07	0.23	0.79
2015	310,405	166,554	160,733	637,692	0.97	0.15	0.23	0.57
IO	258,941		64,412	323,353	2.84		0.47	2.36
2011	258,740		58,688	317,427	1.47		0.64	1.31
2012	220,402		60,874	281,276	2.91		0.28	2.34
2013	276,127		68,397	344,523	4.35		0.94	3.67
2014	265,429		64,946	330,375	2.95		0.27	2.42
2015	274,008		69,154	343,162	2.51		0.22	2.05
AO	201,867		72,950	274,817	8.39		1.97	6.69
2011	178,819		69,484	248,302	11.30		3.01	8.98
2012	197,305		74,738	272,043	10.45		1.53	8.00
2013	202,627		78,197	280,823	7.95		1.19	6.07
2014	209,746		67,337	277,083	5.90		2.02	4.95
2015	220,839		74,995	295,834	6.35		2.12	5.28
					2.24	0.10	0.43	1.40

* Retained catches of skipjack, yellowfin and bigeye tuna from WCPFC, IATTC, IOTC and ICCAT.

** Bycatch rates for species other than bigeye, yellowfin and skipjack tunas. These rates are calculated on the basis of tonnes (of a given species) caught relative to the amount of skipjack, yellowfin and bigeye landed and discarded. Sources:

WCPO: 2011-2015 observer data by P. Williams (SPC, pers. comm.)

EPO: 2011-2015 observer data by M. Hall (IATTC, pers. comm.)

IO: 2011-2015 French PS observer data by L. Dagorn (IRD, pers. comm.)

AO: 2011-2015 French PS observer data by L. Dagorn (IRD, pers. comm.) and Spanish PS observer data by H. Murua (AZTI, pers. Comm)

The resulting calculation shows that, globally, tropical tuna purse seine fisheries have an overall bycatch rate of non-target fish of 1.40%. That is, for every 1,000 tonnes of skipjack, yellowfin and bigeye caught (landed and discarded)¹, 14 tonnes of non-target species (including minor tunas) are caught. It is worth noting that many of these fish are retained and commercialized. In West Africa (especially in Cote d'Ivoire) there is a market known as "faux poisson" where damaged or small target tunas are commercialized together with minor tunas, billfishes, sharks and other bony fishes (Amandè *et al.*, 2016). In the eastern Pacific, the percentage of non-target catches that are retained has been increasing for several species, especially during the last decade. For example, the retention of dorado (mahi-mahi) went up from 51% in 2000 to 86% in 2015 (IATTC, 2016).

The global rate of 1.40% in this study is somewhat lower than the 1.62% calculated by Restrepo (2011) using data from the 2000s. At this point, it is not possible to conclude if the difference is due to interannual variability or changes in observer coverage, or both. It is worth noting that observer coverage in the WCPO is near 100% since 2011, whereas it was very small before.

Regionally, the weighted averages show considerable differences, from a low of 0.65% in the EPO, to a high of 6.69% in the AO. In terms of set type, the weighted bycatch rates range globally from as little as 0.10% for sets on tuna-dolphin associations, to a high of 2.24% for sets on objects.

There is considerable inter-annual variability in the bycatch rates, with no apparent trend.

II.2. Weighted bycatch rate for the capture of non-tuna species

Non-target fish caught in the tropical purse seine fisheries include "minor" species of tunas, many of which are retained. These include the *Auxis* group (bullet and frigate tunas) and the *Euthynnus* group (Pacific black skipjack and little tunny). This second calculation is made to show that much of the regional variability in the first calculation is due to the capture of these minor tuna species. The bycatch rates in **Table 2** are as in Table 1, but exclude minor tunas.

¹ Note that in Restrepo (2011) bycatch rates were calculated over landed catches. However, as target tuna discard levels are generally low, differences between rates calculated as in Restrepo (2011) and over total catches are minimum.

Table 2. Retained catch of target tunas and bycatch rate of non-tuna species (excludes minor tunas and bonitos) by ocean region and set type, and breakdown by year. The last column and row show the average bycatch rates, weighted by the amounts of target tuna caught. Data sources are as in **Table 1**.

Region	Target tuna catch 2011-2015				Non-tuna species catch (%)			Weighted rate %
	Object	Dolphin	Free School	Sub-tot	Object	Dolphin	Free School	
WCPO	883,933		954,695	1,838,627	0.88		0.29	0.57
EPO	288,308	155,191	118,417	561,916	1.04	0.10	0.24	0.61
IO	258,941		64,412	323,353	2.58		0.45	2.15
AO	201,867		72,950	274,817	3.06		0.65	2.42
					1.45	0.10	0.31	0.92

Breakdown by year:

Region	Target tuna catch 2011-2015*				Non-tuna species catch (%)**			Weighted rate %
	Object	Dolphin	Free School	Sub-tot	Object	Dolphin	Free School	
WCPO	883,933		954,695	1,838,627	0.88		0.29	0.57
2011	908,517		646,769	1,555,286	1.03		0.59	0.84
2012	895,513		969,405	1,864,918	0.76		0.25	0.49
2013	916,971		1,005,572	1,922,543	0.83		0.24	0.52
2014	934,558		1,145,404	2,079,962	0.84		0.21	0.49
2015	764,103		1,006,325	1,770,428	0.94		0.16	0.50
EPO	288,308	155,191	118,417	561,916	1.04	0.10	0.24	0.61
2011	268,764	139,213	131,421	539,398	0.96	0.10	0.27	0.57
2012	279,806	135,836	114,610	530,252	1.04	0.09	0.27	0.63
2013	277,798	161,704	106,732	546,234	1.08	0.08	0.21	0.62
2014	304,767	172,648	78,589	556,004	1.21	0.07	0.23	0.72
2015	310,405	166,554	160,733	637,692	0.91	0.15	0.22	0.54
IO	258,941		64,412	323,353	2.58		0.45	2.15
2011	258,740		58,688	317,427	1.21		0.62	1.10
2012	220,402		60,874	281,276	2.66		0.28	2.14
2013	276,127		68,397	344,523	4.28		0.91	3.61
2014	265,429		64,946	330,375	2.32		0.23	1.91
2015	274,008		69,154	343,162	2.43		0.21	1.98
AO	201,867		72,950	274,817	3.06		0.65	2.42
2011	178,819		69,484	248,302	2.67		0.18	1.97
2012	197,305		74,738	272,043	3.42		0.45	2.60
2013	202,627		78,197	280,823	4.38		0.98	3.44
2014	209,746		67,337	277,083	2.59		0.47	2.08
2015	220,839		74,995	295,834	2.24		1.14	1.96
					1.45	0.10	0.31	0.92

The result shows that, globally, tropical tuna purse seine fisheries have an overall bycatch rate of non-tuna species of 0.92%. That is, for every 1,000 tonnes of skipjack, yellowfin and bigeye caught (landed and discarded), 9.2 tonnes of non-tunas are caught. These include billfishes, sharks, rays, and other finfish such as dorados (mahi-mahi) and wahoo. This global rate of 0.92% is somewhat lower than the 1.08% calculated by Restrepo (2011) using data from the 2000s.

Regionally, the weighted averages in **Table 2** show considerably less variation than in **Table 1**, suggesting that "minor" tunas account for much of the regional differences in bycatch rates. Much of the difference appears to be due to catches of minor tunas on floating objects. The Atlantic Ocean's weighted average rate in **Table 2** is 2.42%, considerably lower than the rate of 6.69% in **Table 1**, suggesting that minor tuna species and bonitos are targeted in this region. Indeed, these species are utilized and are important for food security in the region (Amandè *et al.*, 2016).

IV. Concluding remarks

The calculations presented here using data for 2011-2015 indicate that, globally, the bycatch of non-target species in tropical purse seine fisheries represents 1.40% of the amount of target tunas produced. The bycatch rate is 0.92% if minor tuna species and bonitos are excluded. This is a somewhat simplistic calculation that responds to the current impetus to frame bycatch in tuna fisheries as if it could be characterized by a single number. In reality, there is great variation in bycatch, not only regionally and by gear type, but also along time. The rates will obviously vary depending on the relative population sizes and availability of target and non-target species. They will also vary as effective mitigation measures are implemented or due to market prices of retained species.

Recently, there has been a tendency by people involved in sustainability discussions to talk about associated and unassociated (free school) sets in the tropical tuna purse seine fishery as if they were two different fisheries. For example, several government or industry groups have sought certification by the Marine Stewardship Council only for the tuna products caught in unassociated sets, which do have a lower rate of bycatch (**Table 1** and **Table 2**). However, most purse seine vessels make both types of sets during a typical fishing trip. With the exception of some seasonal prohibitions set by RFMOs and natural seasonal changes in free school availability, the two set types do not make up two different "fisheries." The weighted bycatch rate of 1.40% (or 0.92% if minor tunas are excluded) is representative of that single fishery on a global scale.

The weightings used to calculate an overall bycatch rate in this document are proportional to the retained catch of the target tropical tunas. Differences in discard rates of these target tunas between set types or between regions would be expected to affect the weighted averages. However, the bycatch rates used as the basis for the calculations are relative to total catch of target tunas (i.e., including discards), which results in slightly lower bycatch rates in comparison to the analysis carried out by Restrepo (2011), where rates were calculated over landed target tunas.

Importantly, the magnitude of a bycatch rate does not necessarily imply a given level of concern (or lack of it) for any particular species. For example, a bycatch rate of 10% may be of no concern for one species that is highly productive, while one of 1% may be of concern for another, less productive one. The impact of fishing on individual species, target and non-target, needs to be assessed through adequate monitoring and research.

V. Acknowledgements

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