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UPDATED LONGLINE BYCATCH ESTIMATES IN THE WCPO

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Executive Summary

This report updates regional estimates of longline catches, covering the full range of finfish, billfish, shark and ray, marine mammal and sea turtle species that have been recorded in longline observer data. The estimates do not cover domestic longline fisheries in the west-tropical sector of the WCPFC-CA, as SPC holds little representative observer data for these fisheries. Reported catches were used where available, i.e. for bigeye, yellowfin, albacore and skipjack tuna, and billfish species.

It is difficult to obtain reliable estimates of WCPO longline catches from observer data, given the low levels and imbalanced nature of observer coverage, and additionally the low coverage of available aggregate effort data disaggregated by hooks between float in the mid-2000s. Observer coverage has been particularly low in the north west Pacific. As such, the catch estimates for the region north of 10°N, and consequently the catch estimates for the WCPFC Convention Area as a whole, are unlikely to be reliable and should be viewed in that context.

Introduction of flag effects to the catch rate models improved the model fits. However, the catch rate models do not appear to adequately capture targeting behaviour, or spatial variation in catch rates more generally. There may be sufficient observer data to consider explicitly capturing spatial variation in catch rate models in the next iteration of this work, given the recent increases in spatial coverage of available observer data.

A simulation exercise was undertaken to explore how electronic and/or observer monitoring coverage rates, and the approach used to spread this coverage within fleets, may impact the precision of estimated catch rates. More precise estimates of catch rates were generally obtained with partial coverage of all trips (e.g. 10 % of sets per trip) compared to full coverage of sets for a subset of trips (e.g. 10 % of trips), all else being equal. However, the increase in precision was highest for species that are frequently caught, and weakest for rarely caught species. This has implications on how best to allocate resources to collect and process monitoring from longline vessels in the region, particularly any procedures for applying electronic monitoring.

1. Introduction

WCPFC has responsibilities to assess the impact of fishing and environmental factors on non-target species and species belonging to the same ecosystem or dependent upon or associated with the target stocks (article 5d), to minimize catch of non-target species (article 5e), to protect biodiversity (article 5f), and to adopt, when necessary, Conservation and Management Measures (CMMs) for non-target species to ensure the conservation of such species (article 6c).

Hence, since the establishment of the WCPFC a number of measures on non-target species have been implemented:

- The WCPFC is maintaining an open resource that focuses on bycatch mitigation and management in oceanic tuna and billfish fisheries: the Bycatch Management Information System (BMIS, https://www.bmis-bycatch.org/) (Fitzsimmons et al., 2015)
- A resolution has been taken to encourage avoiding the capture of all non-target fish species and encourage prompt release to the water, unharmed (Resolution 2005-03), and
- CMMs have been implemented for billfishes (CMM 2006-04 for striped marlin in the southwest Pacific, CMM 2009-03 for swordfish, CMM 2010-01 for north Pacific striped marlin), and on species of special interest: sea turtles (CMM 2008-03, 2018-04), sharks (CMM 2010-07, CMM 2014-05, CMM 2019-04), for oceanic whitetip shark (CMM 2011-04), for whale sharks (CMM 2012-04), and CMM 2013-08 for silky sharks, cetaceans (CMM 2011-03), seabirds (CMM 2018-03) and mobuild rays (CMM 2019-05).

Most of these CMMs encourage better reporting rates for non-target species. CMM 2007-01 requires 5% observer coverage of effort in longline fisheries under the jurisdiction of the Commission. Peatman et al. (2018) estimated comprehensive longline catch compositions for longline fisheries in the WCPFC Convention Area, with seabird bycatch estimates generated through WCPFC Project 68 (Peatman et al., 2019). The regional estimates of longline bycatch complement equivalent estimates for the large-scale tropical purse seine fishery (e.g. Peatman et al., 2017). This report provides updated catch estimates covering the period 2003 to 2018 for WCPO longline fisheries with the requested inclusion by SC14 of confidence intervals for all estimates. A simulation modelling exercise was also undertaken to explore precision in catch rate estimates with varying levels of observer coverage, with either: partial coverage of trips and full coverage of sets; and, full coverage of trips and partial coverage of sets.

2. Data and methods

The data and methods used in this study were based on those from Peatman et al. (2018). A summary of the approach is provided here, with an emphasis on aspects that have been revised and improved. The overall approach was to fit catch rate models to available observer data, use the catch rate models to estimate catch rates for aggregate longline effort data, and then to apply the catch rates to effort to obtain catch estimates.

Following Peatman et al. (2018), estimated catches were generated for 45 species, or groups of species, covering the full range of finfish, shark, marine mammal and sea turtle species observed in longline catches. However, reported catches were used where available, i.e. for albacore, bigeye, skipjack and yellowfin tuna, and for all billfish species. Seabird catches are not included here, as they have been estimated and reported separately through WCPFC Project 68 (Peatman et al., 2019).

The catch estimates cover longline fishing from 2003 to 2018 in the WCPFC Convention Area (WCPFC-CA), including the region overlapping the IATTC Convention Area. Catch estimates do not include catches from the domestic longline fisheries of the Philippines, Vietnam and Indonesia, referred to in this report as 'west-tropical domestic fisheries', as SPC holds little representative observer data for these fisheries. Catch estimates also do not include former shark-targeted longline fisheries in the Papua New Guinea (PNG) and Solomon Islands (SB) EEZs as these fisheries are not included in aggregate longline catch and effort data held by SPC.

As described in Peatman at al (2018), hooks between float (HBF) specific aggregate catch and effort data, i.e. 'L_BEST_HBF' data, were used to estimate the proportions of aggregate effort data by HBF categories. K-means clustering was applied to aggregate longline catch data to partition longline effort into groups with similar species compositions.

2.1. Catch rate models

Generalised Estimating Equations (GEEs) were used to model catch rates, in order to account for correlation between observations within observer trips. Catch rate models were fitted to observer data for each of the 45 species / species groups, except for whale shark for which there were insufficient recorded catch events in the dataset. Models were fitted using the R package 'geepack' (Højsgaard et al., 2006) in R v 3.6.1 (R Core Team, 2019). An 'exchangeable' working correlation structure was used where possible, where residuals from observations from the same observer trip are correlated, with a shared correlation parameter for all observer trips. It was not possible to fit models with exchangeable correlation structures for some models. In these instances independence between residuals within trips was assumed. Poisson-like error structures were used where possible, with a two-stage delta-lognormal modelling approach implemented if necessary to account for zero-inflation. Explanatory variables included in the models were: year, sea-surface temperature (SST) and HBF, included as cubic splines; and categorical variables for flag, and the species composition cluster for the 'L_BEST' strata. The year effect was modelled as a spline rather than a categorical variable to prevent over-fitting to temporal variation in catch rates, i.e. smoothing of year effects. SST and HBF were included as splines to account for potential non-linearity in effects on catch rates. Species composition cluster was included to account for the effects of fishing strategy and targeting on catch composition.

The specification of the Poisson-like models was

$$E[Y_{ij}] = \mu_{ij} \qquad\qquad Var[Y_{ij}] = \phi\, \mu_{ij}$$

$$\ln \mu_{ij} = \ln(thooks_{ij}) + \beta_0 + \beta_1 cluster_{ij} + \beta_2 flag_{ij} + f_1(year_{ij}) + f_2(HBF_{ij}) + f_3(SST_{ij})$$

where Y_{ij} denotes observed catch rate (individuals per thousand hooks), subscripts i and j refer to observer trip and set number respectively, f_n represent natural cubic splines and ϕ is a variance inflation parameter.

The specification of the delta-lognormal models was:

(presence-absence component)

$$E[P_{ij}] = \gamma_{ij} \qquad\qquad Var[P_{ij}] = \phi\, \gamma_{ij}(1-\gamma_{ij})$$

$$\ln\left(\frac{\gamma_{ij}}{1-\gamma_{ij}}\right) = \beta_0 + \beta_1 cluster_{ij} + \beta_2 flag_{ij} + f_1(year_{ij}) + f_2(HBF_{ij}) + f_3(SST_{ij})$$

(positives component i.e. catch rate when present)

$$E[N_{ij}] = \eta_{ij} \qquad\qquad Var[N_{ij}] = \sigma^2$$
$$\ln(\eta_{ij}) = \beta_0 + \beta_1 cluster_{ij} + \beta_2 flag_{ij} + f_1(year_{ij}) + f_2(HBF_{ij}) + f_3(SST_{ij})$$

where P_{ij} denotes whether individuals (of the species concerned) were caught, N_{ij} denotes the observed catch rate (numbers per '000 hooks), and the overall estimated mean catch rate ζ_{ij} is given by $\zeta_{ij} = \gamma_{ij}\, \eta_{ij}$.

All explanatory variables were retained in catch rate models regardless of statistical significance, though noting that all terms were significant for most models. We did not include, or test for, interactions between explanatory variables. Other variables have been demonstrated to have a strong effect on catch rates of species caught in longline fisheries, including *inter alia* the diurnal phase when gear is set or soaking, and the shape and size of hooks (e.g. Bigelow et al., 2006; Gilman et al., 2006, 2008). However, explanatory variables could only be included if they were available in aggregate catch and effort datasets held by SPC, or available in external datasets that could be linked back to aggregate data (*e.g.* oceanographic variables).

2.2. Catch estimation

A simulation modelling framework was used to estimate catches. The WCPFC Convention Area was split into three regions to allow spatially disaggregated summaries of estimated catches: north, >= 10°N; tropical >= 10°S and < 10°N; and, south, < 10°S. First, the effort dataset for catch estimation was generated by aggregating HBF-specific effort surfaces to a resolution of year, SST, HBF, catch composition cluster, flag and region. SSTs were mean monthly values per 5° grid, rounded to the nearest ⅓ °C. For each catch rate model, 1,000 random draws of parameters were taken from the multivariate normal distribution defined by the vector of mean parameter values $\boldsymbol{\beta}$ and their covariance matrix $\boldsymbol{\Sigma}$, $N_k(\boldsymbol{\beta}, \boldsymbol{\Sigma})$ where k is the number of estimated parameters. The random draws of parameter values were then used to generate 1,000 estimated catch rates for each record in the effort dataset. Estimated catches were then obtained by taking the product of the catch rates and the effort. The estimated catches were then aggregated to a variety of resolutions, and summary statistics computed, e.g. medians and 95 % confidence intervals. Reported catches were assumed to be known without error.

The natural catch unit for the estimation of longline catches is numbers of individuals. Estimated catch numbers were also converted to weight using estimates of average weight (see Peatman et al. 2018 for more information). The estimates of average weight were based on either direct measurements of whole weight (where available), or using length measurements and length weight parameters to estimate weight. It is not clear to what extent available length measurements are representative of catches. For example, downwards bias in length measurements might be expected if larger individuals are cut off the line. As such, the estimates of catch numbers are likely to be more reliable than catch weight estimates.

2.3. Simulations to explore precision of estimated catch rates at differing levels of monitoring coverage

Lawson (2003, 2004) used a combination of stratified sub-sampling approaches and sampling theory to explore the precision of estimated catch rates with differing levels of observer coverage. In this study, simulations were used to explore differing levels of coverage using a similar method to the stratified sub-sampling approach used by Lawson (2003, 2004). There are a range of options available for allocating electronic and/or observer monitoring coverage within a longline fleet. Two approaches were used here: a target coverage rate of 5 %, 10 % or 20 % of trips, with full coverage of sets within a trip; and, partial coverage of all trips, with a target coverage rate of 10 %, 20 % or 50 % of sets for each trip.

Simulations were undertaken separately for two broad regions within the WCPFC Convention Area: the area from 10°S to 30°S, primarily vessels targeting South Pacific albacore tuna; and the area from 10°S to 20°N, primarily vessels targeting yellowfin and/or bigeye tuna. Following Lawson (2003, 2004), a subset of eleven species were selected for each region, covering a range of species including target species, bycatch species and SSIs.

The overall approach was to randomly sample without replacement from available observer data with a specified target coverage rate. This process was done 1,000 times for each target coverage rate. The 'observed' effort and catches (individuals) of each species were then aggregated to a resolution of either binned departure year, or combinations of binned departure year and flag, and the nominal CPUE calculated in units of numbers per '000 hooks. This resulted in 1,000 estimates of nominal CPUE for each strata, from which coefficients of variation were extracted.

Simulations were stratified by flag and binned departure year, where departure year bins were: 2003 to 2006; 2007 to 2009; 2010 to 2012; 2013 to 2015; and, 2016 to 2018. This approach was used to reflect to the extent possible a flag-specific target coverage rate per year, noting that there were insufficient observer data available to stratify by flag and year.

By way of example, when simulating a target coverage rate of 10 % of trips, 10 % of available observer trips were selected at random for each combination of flag and departure year bin. When simulating a target coverage rate of 10 % of sets, 10 % of observed sets were selected at random for each observer trip. It was rarely possible to precisely achieve the target coverage rate, either for trips or for sets. Instead, the closest possible coverage rate to the target rate was used. As such, the coverage rates of trips for each combination of flag and binned departure year will have generally been slightly higher or lower than the target rate, and the same when defining coverage rates on the basis of % of sets per trip.

Shallow-sets were excluded from simulations for the tropical region, as these largely reflected shark targeted effort in fisheries that are now closed. For both regions, observer trips were excluded with 5 observed sets or fewer. Additionally, flag and binned departure year combinations with fewer than 15 observer trips were excluded for both regions. These data filtering steps were necessary to allow meaningful inclusion of target coverage rates of 5 % of trips, and 10 % of sets.

3. Coverage of available data

From 2003 to 2006, coverage of L_BEST_HBF varied between 25% and 35% of total aggregate effort (Figure 1). From 2006 onwards the coverage of L_BEST_HBF increased, and since 2014 has remained above 75 %.

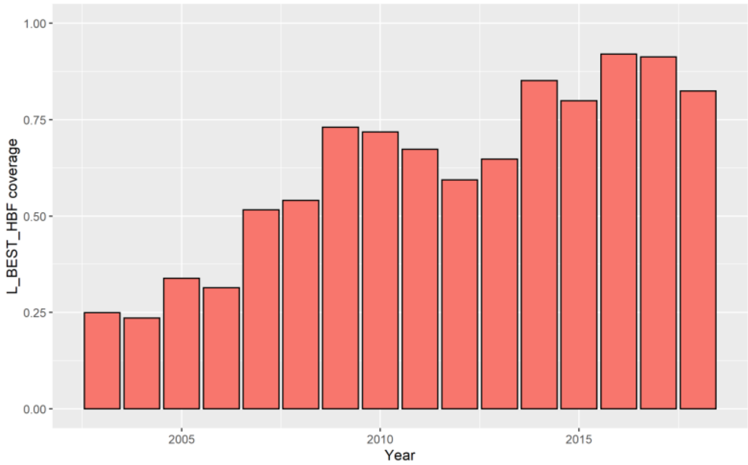


Figure 1 Overall annual coverage of L_BEST_HBF aggregate data (proportion of number of hooks) across the WCPFC-CA from 2003 to 2018. Effort from west-tropical domestic fisheries was excluded.

CCMs were required by the 30th of June 2012 to achieve 5% coverage in each longline fishery under the jurisdiction of the Commission as stipulated in WCPFC CMM 2007-01. In this study observer coverage is defined as the proportion of total reported hooks accounted for by trips with an observer onboard, and for which observer data are available in SPC observer data holdings. Observer coverage over the whole Convention Area was relatively consistent at approximately 1 % from 2003 to 2010 (Figure 2). Observer coverage increased from 2011 onwards, reaching 6 % in 2018. Longline fishing effort was deployed widely throughout the WCPFC-CA from 2003 to 2018 (Figure 3). However, observer coverage has not been distributed evenly across the WCPFC-CA. From 2003 to 2018, observer coverage was generally highest in the region around Hawaii, and generally lowest in the north-west Pacific (Figure 4). Observer coverage was more widespread from 2015 to 2018 (Figure 4).

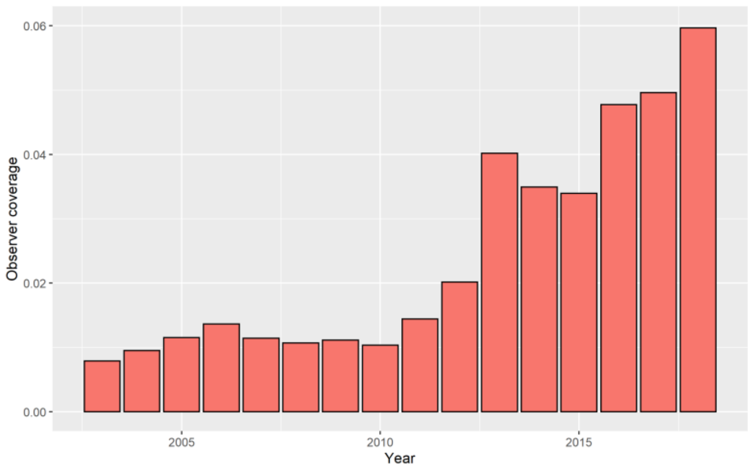
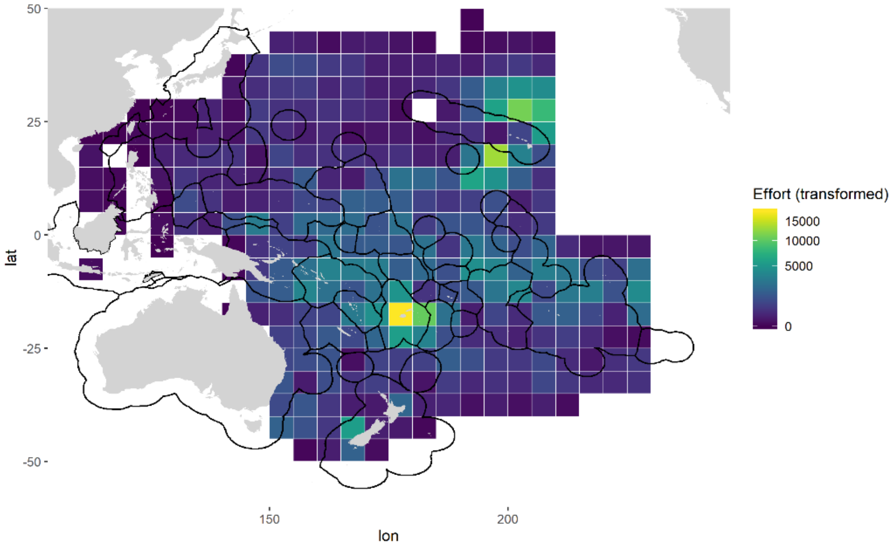


Figure 2 Overall annual observer coverage (proportion of number of hooks) of longline fleets in the WCPFC-CA, excluding effort from west-tropical domestic fisheries.

(a) Observed effort



(b) Reported effort

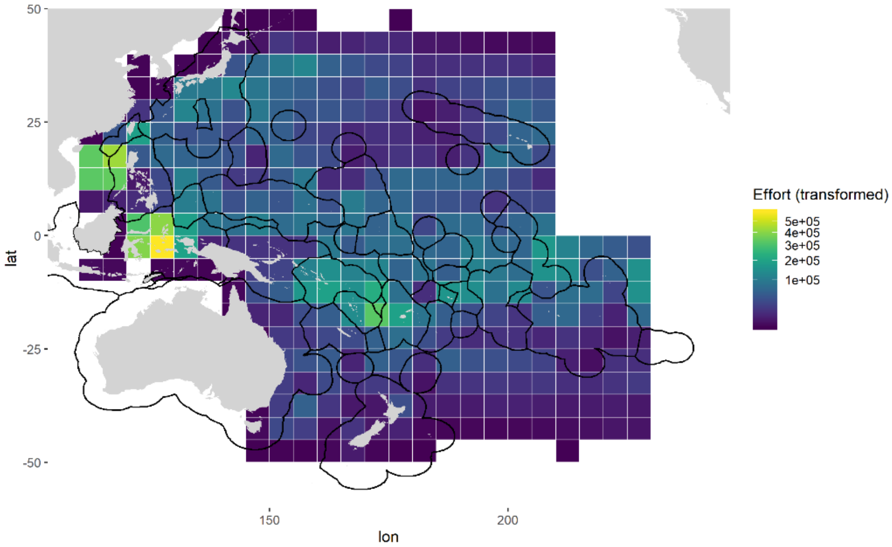
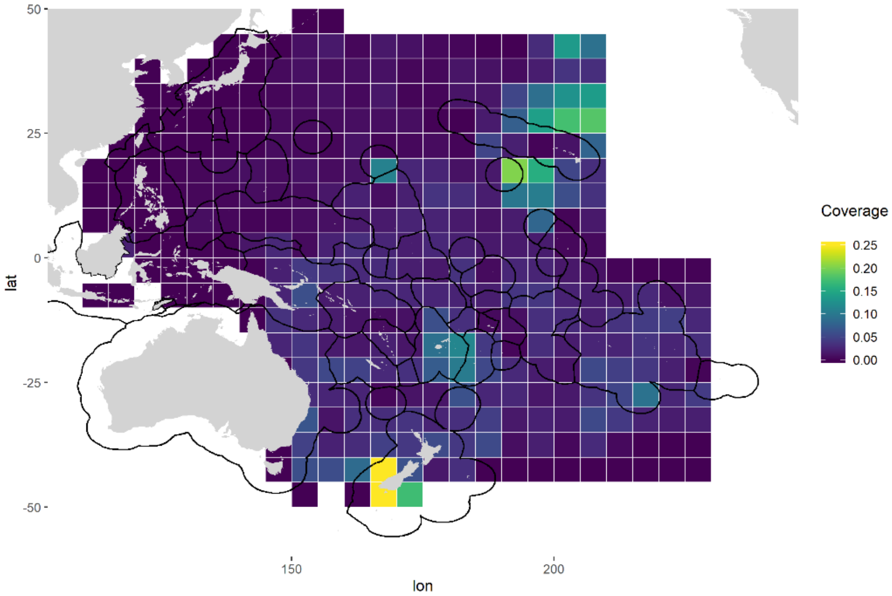


Figure 3 (a) Observed and (b) total reported longline fishing effort (bottom) in '000 hooks from 2003 to 2018 in the WCPFC-CA. Note that colour scales are different for the 2 figures, and a square root transformation was applied.

(a) 2003 - 2018



(b) 2015 - 2018

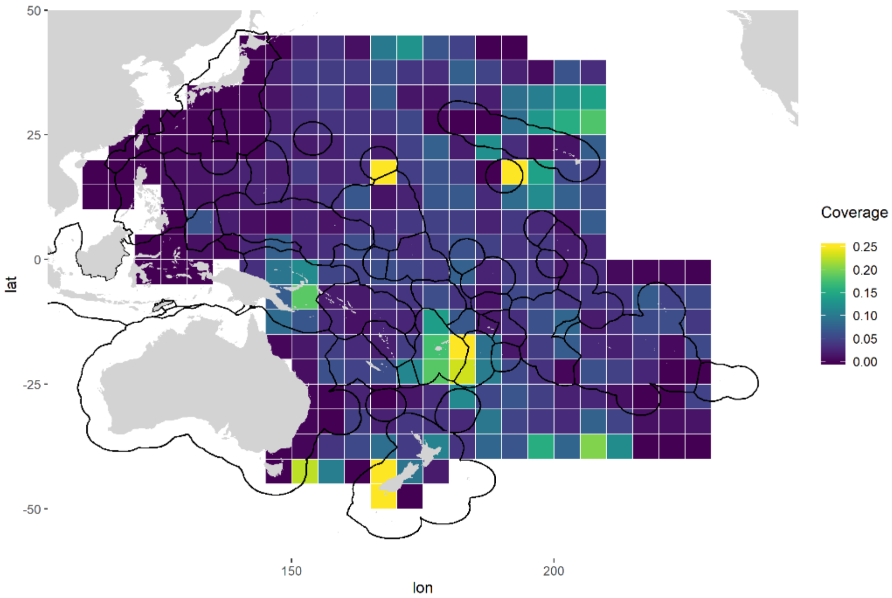


Figure 4 Observer coverage (proportion of hooks) of longline fleets in the WCPFC-CA from a) 2003 to 2018 and b) 2015 to 2018. Cells with coverage above 25 % were capped at 25 % to facilitate interpretation.

4. Catch estimates

Annual catch estimates for finfish (excluding billfish), billfish, sharks and rays, marine mammals and turtles are provided in Table 1. It is important to note that these catch estimates do not include catches of the west-tropical domestic fisheries, or shark fisheries that are not covered in aggregate longline effort data (see Section 2). Species or species group specific catches, including uncertainty, are provided in APPENDIX A, Table 10 to Table 17, with regional breakdowns provided in APPENDIX A, Table 17 to Table 25.

Table 1 Estimated annual longline catch ('000s individuals). Median catch (med), and lower (low) and upper (high) 95 % confidence intervals are provided for finfish (excluding billfish), billfish, sharks and rays, marine mammals and turtles.

	Finfish ('000s)			Billfish ('000s)			Sharks ('000s)			Turtles ('000s)			Marine mammals ('000s)		
Year	Low	Med	High	Low	Med	High	Low	Med	High	Low	Med	High	Low	Med	High
2003	13,241.3	13,621.3	14,290.6	639.5	641.3	645.8	1,816.0	1,983.1	2,169.1	7.6	14.1	29.7	0.8	1.8	3.9
2004	14,166.5	14,358.3	14,620.2	857.7	858.8	861.1	1,965.7	2,126.8	2,319.3	9.8	14.6	23.5	0.8	1.5	2.8
2005	12,877.0	13,008.1	13,174.0	847.3	848.3	850.1	1,698.3	1,804.0	1,924.4	11.1	15.1	22.2	0.7	1.1	1.8
2006	12,777.5	12,924.2	13,105.9	695.0	696.2	700.2	1,703.4	1,827.3	1,970.4	13.1	18.5	26.8	0.8	1.2	1.9
2007	12,161.7	12,341.1	12,565.7	887.6	889.2	894.2	1,681.8	1,798.9	1,948.0	20.7	31.7	59.3	1.1	1.6	2.5
2008	11,394.8	11,591.2	11,831.2	718.8	720.1	725.1	1,590.1	1,709.7	1,846.7	18.6	28.9	50.7	1.0	1.7	3.0
2009	13,893.0	14,136.6	14,435.5	764.1	765.0	766.6	1,906.8	2,083.8	2,307.1	22.1	33.2	54.9	0.8	1.4	2.3
2010	14,868.1	15,173.4	15,563.3	702.5	703.3	704.9	1,955.0	2,179.2	2,534.9	18.2	26.9	44.3	0.7	1.2	2.0
2011	13,063.1	13,338.4	13,691.0	764.9	765.7	767.4	1,942.3	2,161.2	2,482.4	13.5	18.8	28.8	1.1	1.6	2.4
2012	14,517.4	14,753.8	15,046.2	834.4	835.7	837.9	1,749.8	1,940.2	2,207.2	14.4	21.0	32.2	1.7	2.6	4.0
2013	12,988.5	13,141.5	13,313.4	865.8	867.5	870.5	1,361.4	1,450.0	1,550.7	13.9	17.9	24.3	1.9	2.6	3.7
2014	14,121.4	14,283.8	14,445.0	870.5	872.9	877.9	1,476.6	1,586.2	1,713.3	18.6	23.6	31.2	2.1	2.8	3.9
2015	14,533.2	14,644.4	14,772.2	863.7	865.6	869.2	1,608.9	1,705.1	1,819.2	20.6	25.5	32.6	2.0	2.7	3.6
2016	12,106.9	12,207.5	12,321.2	732.7	733.9	736.0	1,391.7	1,481.4	1,583.1	16.2	19.8	26.8	1.4	1.8	2.4
2017	13,227.6	13,304.0	13,381.0	583.2	584.2	586.4	1,381.1	1,452.4	1,528.6	16.1	19.6	24.8	1.3	1.7	2.5
2018	12,296.7	12,428.7	12,610.0	620.3	621.6	623.8	1,492.3	1,601.2	1,727.4	11.4	15.5	22.6	1.2	1.7	2.6

Note: turtle catch estimates are likely unreliable (see discussion in Section 6).

5. Precision of catch rate estimates for varying levels of observer coverage

The number of observer trips by flag and departure year bin in the filtered datasets are provided in Table 2 and Table 3. There was strong variation in the number of available trips between flags. It is important to note that patchy availability of observer data through time can result both from temporal gaps in observer coverage and low numbers of trips in departure year bins that were excluded through the data filtering process. The selected species for simulations, and their total observed captures and nominal CPUE, are provided in Table 4 and Table 5. Nominal CPUEs ranged from < 0.001 individuals per '000 hooks for sea turtle species, through to 3 + individuals per '000 hooks for bigeye and yellowfin, and > 10 individuals per '000 hooks for albacore.

Table 2 Total observer trips by departure year bin and flag for the filtered dataset for simulations of longline effort 10°S to 20°N.

Departure year	US	CN	TW	JP	FM	MH	KR	SB	PG
2003-2006	371	81	0	0	26	0	0	27	16
2007-2009	205	75	0	0	0	0	0	0	0
2010-2012	220	0	38	0	0	0	0	0	0
2013-2015	200	18	64	30	17	0	27	0	0
2016-2018	215	42	114	77	27	63	32	0	0
Total	**1211**	**216**	**216**	**107**	**70**	**63**	**59**	**27**	**16**

Table 3 Total observer trips by departure year bin and flag for the filtered dataset for simulations of longline effort 30°S to 10°S.

Departure year	FJ	PF	NC	AU	TW	VU	CN	TO	SB	CK	JP
2003-2006	87	59	29	81	0	0	0	23	21	0	0
2007-2009	70	73	41	65	0	0	0	21	0	0	0
2010-2012	51	106	63	45	30	27	0	0	0	0	0
2013-2015	302	103	42	33	65	46	22	0	18	0	0
2016-2018	454	78	70	0	100	0	31	0	0	15	17
Total	964	419	245	224	195	73	53	44	39	15	17

Table 4 Total observed number of individuals caught and nominal CPUE (numbers per '000 hooks) for the selected species for simulations for longline effort 10°S to 20°N.

Common name	Scientific name	Species code	Individuals	CPUE
Bigeye	*Thunnus obesus*	BET	333,842	4.1
Yellowfin	*Thunnus albacares*	YFT	271,577	3.31
Blue shark	*Prionace glauca*	BSH	95,527	1.164
Mahi mahi	*Coryphaena hippurus*	DOL	56,046	0.683
Wahoo	*Acanthocybium solandri*	WAH	49,709	0.606
Blue marlin	*Makaira nigricans*	BUM	24,501	0.299
Silky shark	*Carcharhinus falciformis*	FAL	22,719	0.2768
Striped marlin	*Tetrapturus audax*	MLS	13,128	0.1600
Oceanic whitetip shark	*Carcharhinus longimanus*	OCS	5,096	0.0621
Olive ridley turtle	*Lepidochelys olivacea*	LKV	616	0.00751
Leatherback turtle	*Dermochelys coriacea*	DKK	65	0.000792

Table 5 Total observed number of individuals caught and nominal CPUE (numbers per '000 hooks) for the selected species for simulations for longline effort 30°S to 10°S.

Common name	Scientific name	Species code	Individuals	CPUE
Albacore	*Thunnus alalunga*	ALB	739,716	10.4
Mahi mahi	*Coryphaena hippurus*	DOL	87,139	1.23
Wahoo	*Acanthocybium solandri*	WAH	49,519	0.698
Blue shark	*Prionace glauca*	BSH	25,378	0.358
Opah	*Lampris guttatus*	LAG	13,056	0.184
Blue marlin	*Makaira nigricans*	BUM	7,935	0.112
Silky shark	*Carcharhinus falciformis*	FAL	6,599	0.0931
Striped marlin	*Tetrapturus audax*	MLS	6,516	0.0919
Oceanic whitetip shark	*Carcharhinus longimanus*	OCS	4,207	0.0593
Green turtle	*Chelonia mydas*	TUG	104	0.00147
Leatherback turtle	*Dermochelys coriacea*	DKK	45	0.000635

Coefficients of variation (CVs) were generally higher in years with lower numbers of observed sets, i.e. earlier years, and for species that were more rarely caught (Table 6 to Table 9). Coefficients of variation demonstrated strong between-species variation for a given target coverage rate. Coefficients of variation at a departure year bin resolution for a target coverage rate of 10 % of sets (and partial coverage of all trips) were generally lower or equivalent to those for a target coverage rate of 20 % of trips. Exceptions to this were leatherback and green turtle, the rarest observed species considered, for which coefficients of variation for a target coverage rate of 10 % of sets (and partial coverage of all trips) were more consistent with those for a target coverage rate of 10 % of trips. Coefficients of variation at a resolution of departure year bin and flag were higher, and more variable, than at a resolution of departure year bin.

Table 6 Coefficients of variation by species and binned departure year for longline effort 10°S to 20°N and target coverage rates of a) 5 % of trips, b) 10 % of trips and c) 20 % of trips with full coverage of sets.

a) 5 % trips

Species	2003 - 2006	2007 - 2009	2010 - 2012	2013 - 2015	2016 - 2018
BET	12.1%	13.5%	18.3%	16.6%	13.9%
YFT	21.9%	26.6%	47.8%	32.4%	21.2%
BSH	16.9%	25.8%	30.2%	24.2%	24.2%
DOL	31.3%	34.9%	50.9%	38.2%	39.7%
WAH	15.1%	19.6%	26.4%	18.1%	21.3%
FAL	36.8%	37.6%	66.7%	51.8%	42.0%
BUM	19.8%	23.4%	37.3%	24.9%	25.3%
MLS	21.7%	33.8%	49.0%	27.2%	35.1%
OCS	27.8%	46.8%	47.0%	40.1%	42.5%
LKV	118.7%	105.5%	163.9%	117.4%	114.7%
DKK	143.8%	209.3%	165.4%	98.7%	155.1%

a) 10 % trips

Species	2003 - 2006	2007 - 2009	2010 - 2012	2013 - 2015	2016 - 2018
BET	8.1%	9.0%	12.5%	11.7%	10.0%
YFT	14.2%	19.3%	35.4%	22.2%	14.8%
BSH	11.5%	18.6%	20.1%	16.9%	17.4%
DOL	22.3%	25.1%	36.7%	25.7%	26.2%
WAH	11.0%	13.1%	18.6%	12.1%	15.2%
FAL	24.3%	26.8%	44.4%	33.1%	31.5%
BUM	13.8%	16.2%	26.6%	17.3%	17.7%
MLS	14.8%	22.0%	33.7%	18.4%	23.4%
OCS	20.2%	31.6%	32.2%	25.2%	30.2%
LKV	77.1%	69.5%	118.8%	80.8%	76.2%
DKK	102.8%	146.8%	104.5%	62.2%	101.6%

a) 20 % trips

Species	2003 - 2006	2007 - 2009	2010 - 2012	2013 - 2015	2016 - 2018
BET	5.4%	6.3%	8.2%	8.2%	6.3%
YFT	9.6%	12.5%	23.3%	15.6%	9.9%
BSH	7.8%	11.9%	14.1%	10.8%	11.1%
DOL	15.3%	16.5%	23.6%	17.8%	18.6%
WAH	7.3%	8.7%	13.0%	8.4%	10.1%
FAL	16.7%	17.6%	31.4%	23.1%	19.6%
BUM	9.3%	10.3%	17.7%	11.3%	12.6%
MLS	10.2%	15.4%	22.2%	12.7%	15.3%
OCS	13.9%	20.4%	21.5%	17.2%	19.7%
LKV	52.6%	46.3%	77.9%	54.1%	53.1%
DKK	72.2%	100.8%	71.6%	42.3%	71.7%

Table 7 Coefficients of variation by species and binned departure year for longline effort 10°S to 20°N and target coverage rates of a) 10 % of sets, b) 20 % of sets and c) 50 % of sets, and partial coverage of all trips.

a) 10 % of sets

Species	2003 - 2006	2007 - 2009	2010 - 2012	2013 - 2015	2016 - 2018
BET	3.2%	3.9%	3.0%	2.4%	2.0%
YFT	5.5%	8.4%	6.4%	4.5%	2.9%
BSH	3.0%	4.0%	3.1%	3.0%	2.7%
DOL	4.7%	6.3%	5.7%	5.2%	4.5%
WAH	3.7%	5.3%	4.7%	3.4%	3.0%
FAL	12.0%	11.5%	9.7%	8.8%	6.9%
BUM	6.3%	7.3%	6.2%	4.3%	3.9%
MLS	5.6%	10.0%	7.9%	6.5%	6.3%
OCS	10.1%	13.2%	13.8%	10.3%	8.8%
LKV	48.5%	55.1%	48.1%	28.0%	18.4%
DKK	111.3%	154.3%	112.1%	69.5%	59.8%

a) 20 % of sets

Species	2003 - 2006	2007 - 2009	2010 - 2012	2013 - 2015	2016 - 2018
BET	2.2%	2.5%	2.1%	1.7%	1.3%
YFT	4.0%	5.5%	4.4%	3.0%	1.8%
BSH	2.1%	2.7%	2.3%	2.1%	1.9%
DOL	3.2%	4.2%	4.1%	3.9%	3.0%
WAH	2.5%	3.4%	3.1%	2.4%	2.0%
FAL	8.2%	7.5%	6.7%	5.9%	4.5%
BUM	4.1%	4.9%	4.3%	2.9%	2.5%
MLS	3.8%	6.8%	5.3%	4.7%	4.4%
OCS	6.4%	9.0%	9.5%	7.0%	6.0%
LKV	32.5%	34.7%	33.4%	18.9%	12.6%
DKK	73.2%	99.2%	74.4%	43.8%	41.9%

a) 50 % of sets

Species	2003 - 2006	2007 - 2009	2010 - 2012	2013 - 2015	2016 - 2018
BET	1.1%	1.3%	1.0%	0.8%	0.7%
YFT	1.8%	2.8%	2.2%	1.6%	1.0%
BSH	1.0%	1.4%	1.1%	1.1%	0.9%
DOL	1.6%	2.1%	2.0%	1.9%	1.6%
WAH	1.2%	1.7%	1.6%	1.2%	1.0%
FAL	4.0%	3.8%	3.1%	3.1%	2.3%
BUM	2.0%	2.5%	2.1%	1.5%	1.3%
MLS	1.9%	3.6%	2.7%	2.3%	2.2%
OCS	3.2%	4.3%	4.3%	3.5%	3.1%
LKV	16.7%	18.6%	16.2%	9.5%	6.4%
DKK	34.2%	47.6%	37.3%	22.4%	20.8%

Table 8 Coefficients of variation by species and binned departure year for longline effort 30°S to 10°S and target coverage rates of a) 5 % of trips, b) 10 % of trips and c) 20 % of trips with full coverage of sets.

a) 5 % trips

Species	2003 - 2006	2007 - 2009	2010 - 2012	2013 - 2015	2016 - 2018
ALB	23.3%	15.7%	22.6%	16.6%	12.6%
DOL	31.2%	30.6%	37.7%	29.5%	31.0%
WAH	25.4%	21.3%	33.3%	18.3%	14.2%
BSH	37.8%	36.1%	34.1%	32.4%	22.3%
LAG	37.5%	36.9%	32.1%	27.8%	24.5%
BUM	49.0%	41.0%	53.3%	31.3%	25.6%
FAL	60.7%	60.4%	81.3%	39.0%	37.4%
MLS	36.4%	32.8%	39.3%	30.5%	24.9%
OCS	46.7%	68.7%	105.9%	50.8%	50.3%
TUG	224.6%	243.8%	202.9%	93.1%	78.7%
DKK	220.4%	431.6%	173.0%	117.7%	131.7%

a) 10 % trips

Species	2003 - 2006	2007 - 2009	2010 - 2012	2013 - 2015	2016 - 2018
ALB	15.7%	11.4%	15.1%	11.1%	8.7%
DOL	19.8%	23.0%	25.0%	19.2%	21.9%
WAH	16.4%	16.2%	21.7%	13.1%	9.6%
BSH	25.9%	26.6%	24.4%	22.3%	15.3%
LAG	24.9%	26.7%	22.4%	18.7%	16.9%
BUM	32.1%	29.9%	35.3%	22.0%	17.3%
FAL	41.2%	42.8%	53.7%	26.3%	26.9%
MLS	24.8%	21.3%	26.1%	21.4%	17.8%
OCS	30.2%	47.4%	75.3%	35.6%	33.2%
TUG	151.4%	170.6%	140.2%	62.4%	54.4%
DKK	147.1%	293.5%	111.8%	82.4%	93.4%

a) 20 % trips

Species	2003 - 2006	2007 - 2009	2010 - 2012	2013 - 2015	2016 - 2018
ALB	10.4%	7.8%	10.3%	7.5%	6.0%
DOL	12.8%	14.7%	17.3%	13.1%	15.2%
WAH	11.1%	10.6%	15.4%	8.2%	6.9%
BSH	16.9%	16.8%	15.9%	14.8%	10.3%
LAG	17.1%	18.1%	15.1%	12.3%	11.5%
BUM	21.9%	18.9%	24.0%	14.8%	12.3%
FAL	28.3%	29.2%	38.3%	17.0%	17.7%
MLS	16.3%	14.1%	18.3%	13.9%	12.0%
OCS	19.8%	30.9%	50.0%	23.0%	21.0%
TUG	100.6%	112.1%	92.0%	42.5%	35.0%
DKK	101.5%	197.5%	74.6%	54.2%	64.6%

Table 9 Coefficients of variation by species and binned departure year for longline effort 30°S to 10°S and target coverage rates of a) 10 % of sets, b) 20 % of sets and c) 50 % of sets, and partial coverage of all trips.

a) 10 % of sets

Species	2003 - 2006	2007 - 2009	2010 - 2012	2013 - 2015	2016 - 2018
ALB	3.6%	3.6%	3.3%	2.1%	1.7%
DOL	6.1%	6.2%	4.9%	4.0%	3.4%
WAH	4.9%	5.3%	4.5%	3.0%	2.9%
BSH	7.5%	8.8%	7.0%	4.8%	3.6%
LAG	9.5%	10.3%	9.7%	5.9%	5.5%
BUM	11.6%	11.9%	9.1%	6.3%	6.1%
FAL	17.5%	18.6%	13.1%	12.5%	9.0%
MLS	10.6%	10.5%	9.6%	7.0%	6.9%
OCS	12.1%	15.9%	15.4%	12.7%	11.4%
TUG	140.4%	144.2%	81.6%	49.9%	41.0%
DKK	134.9%	229.2%	99.5%	70.5%	79.2%

a) 20 % of sets

Species	2003 - 2006	2007 - 2009	2010 - 2012	2013 - 2015	2016 - 2018
ALB	2.6%	2.6%	2.1%	1.4%	1.2%
DOL	4.4%	4.8%	3.5%	3.0%	2.6%
WAH	3.7%	3.9%	3.4%	2.1%	1.9%
BSH	5.5%	6.5%	5.0%	3.2%	2.4%
LAG	7.0%	7.3%	6.6%	4.3%	3.9%
BUM	8.1%	8.6%	6.6%	4.2%	4.0%
FAL	12.3%	13.7%	9.1%	8.7%	6.3%
MLS	8.0%	8.0%	6.7%	5.1%	4.8%
OCS	8.6%	12.3%	10.4%	8.9%	7.9%
TUG	103.7%	123.9%	57.3%	37.3%	31.3%
DKK	101.7%	231.8%	73.7%	52.0%	58.3%

a) 50 % of sets

Species	2003 - 2006	2007 - 2009	2010 - 2012	2013 - 2015	2016 - 2018
ALB	1.3%	1.3%	1.1%	0.7%	0.6%
DOL	2.2%	2.5%	1.7%	1.4%	1.2%
WAH	1.8%	1.9%	1.7%	1.0%	1.0%
BSH	2.7%	3.1%	2.6%	1.7%	1.2%
LAG	3.2%	3.7%	3.3%	2.1%	1.9%
BUM	3.9%	4.0%	3.3%	2.1%	2.1%
FAL	5.9%	6.8%	4.7%	4.2%	3.2%
MLS	3.9%	3.8%	3.3%	2.6%	2.3%
OCS	4.3%	5.7%	5.5%	4.4%	4.0%
TUG	49.5%	60.4%	28.8%	18.2%	15.4%
DKK	52.2%	96.9%	36.8%	25.1%	26.4%

6. Discussion

This report presents updated estimates of longline catches across the full range of finfish, sharks and rays, sea turtles and marine mammals caught in WCPFC-CA longline fisheries. The analysis was complicated by the coverage of available observer data, and for some years the coverage of HBF-specific aggregate data. The catch estimates presented here must be viewed in the context of the limitations of the dataset, and the methodology used to obtain the estimates.

As discussed in the equivalent 2018 study, observer coverage for some key longline fleets has been limited for the time period considered, with particularly low available observer coverage in the north west Pacific. As such, the catch estimates for the region north of 10°N, and consequently the catch estimates for the WCPFC Convention Area as a whole, are unlikely to be reliable.

Reported catches from aggregate longline catch data were used in this study where available, i.e. for albacore, bigeye, yellowfin, skipjack and billfish species. The reported catches are included in tables of catch estimates to give context to estimated catches of other species. We also compared reported catches to estimates generated using the modelling approach outlined in Section 2, to provide context to the likely reliability of catch estimates presented here (APPENDIX A, Figure 7 to Figure 10). The accuracy of the catch estimates varied between species, though catches tended to be overestimated for billfish species and underestimated for tuna species. However, for most species, the trends in estimated annual catches were comparable to the trends in reported catches. This suggests that, more generally, the trends in predicted catches through time may be more accurate than the magnitude of those predicted catches.

The approach used to generate uncertainty in catch estimates is more statistically robust than that used in the 2018 study. However, it is still the case that the uncertainty in catch estimates does not include uncertainty in the estimated proportions of effort by hooks between float category. The number of hooks between floats, a proxy for the depth of fishing gear, has a large impact on the catch rates for a wide range of the species considered here. As such, the uncertainty in catch estimates is likely underestimated between 2003 and 2009, i.e. those years with less L_BEST_HBF effort coverage (Figure 1). Additionally, it is reasonable to expect that catch estimates will be biased if available L_BEST_HBF data are not representative. It should also be noted that reported catches were assumed to be known without error. This results in relatively tight confidence intervals for total catches of finfish and billfish, where large proportions of the catch are accounted for by reported rather than estimated catches.

Olive ridley turtle catch estimates had a peak of ~ 25,000 individuals in 2009, and represented 62 % of total estimated catches of olive ridley, green, loggerhead and leatherback turtles. This is almost double the estimate of 35 %, obtained from the Common Oceans (2017) initiative focussing on sea turtle mitigation effectiveness. It would appear likely that the proportional contribution of olive ridley to overall sea turtle catch presented here is overestimated. The increase in 'sea turtles nei' from 2013 onwards is a new feature that was not present in the previous estimates (Peatman et al., 2018), and is driven by the recent increase in the usage of the 'TTX' species code, i.e. unidentified sea turtles, in specific observer programmes.

Introduction of flag effects to the catch rate models, suggested in discussion of the 2018 analysis at SC14, improved the model fits. However residual diagnostics indicated a lack of fit for a range of log-normal components of catch rate models, and relatively strong spatial patterns in residuals for a range of both delta-lognormal and Poisson models. This appears to reflect the inability of the catch rate models to adequately capture both targeting behaviour and spatial variation in catch rates more generally. The catch rate models presented here represent a modest extension of those developed in the beginning of 2018 (and reported in Peatman et al., 2018). Observer coverage in the longline fishery has been increasing in recent years, coupled with an increase in spatial coverage both in general and for some of the key longline fleets operating in the region. There may be sufficient observer data to consider explicitly capturing spatial variation in catch rate models in the next iteration of this work. There may also be value in considering other ways of accounting for targeting, for example by subjectively splitting observer data and aggregate data spatially, e.g. fitting separate catch rate models for effort south of 10°S to reflect effort targeting South Pacific albacore, and applying these catch rates to all effort in the same area.

Catch indices do not necessarily provide an accurate proxy for trends and/or absolute levels of mortalities resulting from the catch and release of individuals. Time series of catches may be particularly misleading for species with no-retention policies either through domestic or regional measures, for example shark species. Catch indices could be converted to time series of mortalities using available observer data and assumptions regarding discard mortality (e.g. see Harley et al., 2015; Tremblay-Boyer et al., 2019).

The simulations indicate that the precision of estimated catch rates is generally higher for species that are more frequently caught, and higher in years where true observed effort was higher, consistent with the results of similar earlier studies (Lawson, 2003 and 2004). The simulations also indicate that for most species, more precise estimates of catch rates are obtained by covering a proportion of sets from all trips, rather than having full coverage of the same proportion of trips, e.g. having 10 % coverage of sets from all trips, rather than covering all sets from 10 % of trips. For frequently caught species, coverage of 10 % of sets from all trips obtained more precise estimates than full coverage of 20 % of trips. However, for the most rarely caught species, coverage of 10 % of sets from all trips gave similar, or slightly higher, precision in catch rates to full coverage of 10 % of trips. This would reflect higher between-trip variation in catch rates relative to within-trip variation for the frequently caught species, compared with the rare-event species. However, the more precise estimation of catch rates for some species would need to viewed in the context of the additional costs required with respect to overheads associated with the sampling approach. Additionally, the simulation exercise looked exclusively on the effects of coverage rates on precision of estimated catch rates. Similar simulations could be undertaken to look at the precision of other quantities of interest, which may lead to differing conclusions on the relative merits of alternative approaches to allocating coverage amongst trips.

It is reasonable to expect that partial coverage of all trips would be a better approach than full coverage of a subset of trips, as coverage will be more likely to be representative, e.g. in terms of coverage of different vessels, or different areas of operation. It should be noted that the simulations assume that observed longline effort is representative of all effort in the regions considered. This assumption may not hold given the relatively low coverage rates of WCPFC longline effort. For example, observer coverage for specific flags may not have been distributed evenly in time and space, or distributed evenly across vessels. It appears likely that this would act to reduce the strength of apparent between-trip variability.

It is important to note that it is more appropriate to view the results in a relative sense, e.g. relative changes in CVs with increasing coverage rates, rather than in absolute terms, e.g. the coverage rate required to obtain a specific CV. This is due to the fact that the CVs are a function of the amount of observed effort in the dataset used as the basis of the simulations (Lawson, 2003). For example, the estimated CVs for a given coverage rate would be lower if there had been more observed effort historically, all else being equal. There is also the question of what is the appropriate resolution to calculate and compare CVs. In this study comparisons of catch rate precisions were mainly focussed on comparisons by year, which would be appropriate when considering the impact of coverage rates on uncertainty in total catches and catch rates through time. However, a finer-scale resolution may be more relevant, for example if the quantity of interest is catch rates by sub-area.

The Scientific Committee is invited to:

- Note the difficulties in robust estimation of longline catches from observer data, particularly for rarely caught species, given the low levels and imbalanced nature of observer coverage, and for some years the low coverage of available L_BEST_HBF data;
- Note that simulations indicate that partial coverage of all trips would provide more precise estimates of catch rates than full coverage of some trips, with the exception of species that are rarely caught. This has implications on how best to allocate resources to collect and process monitoring from longline vessels in the region (including the application of electronic monitoring);
- Note that updating the longline bycatch estimates in 4-5 years would likely result in sufficient available observer data to enable a substantive revision of the catch rate models;
- Consider whether the time-series of catches, in combination with estimated effects from the fitted catch rate models, have utility in identifying species of potential concern that may warrant additional investigation.

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APPENDIX A

Additional tables of catch estimates

Table 10 Annual finfish catch estimates ('000s individuals, 95% CIs in parentheses where applicable) by species/species group for the WCPFC Convention area.

Year	Albacore*	Yellowfin*	Bigeye*	Skipjack*	Longsnouted lancetfish	Mahi mahi	Wahoo	Opah	Pomfrets	Escolars	Others
2003	5342.5	2685.5	2489.0	128.4	255.3 (213.8-306.7)	518.2 (425.6-635.3)	477.3 (410.4-561.2)	146.2 (130.0-164.4)	134.7 (114.7-157.0)	361.2 (314.9-416.0)	1021.9 (700.6-1659.7)
2004	5748.2	2675.9	3139.9	148.8	233.8 (201.4-268.1)	503.0 (430.7-598.1)	401.7 (357.3-455.8)	129.4 (116.2-144.3)	184.9 (165.0-207.5)	377.6 (338.4-418.3)	755.7 (602.3-990.7)
2005	6084.0	2346.9	2174.8	104.4	248.5 (220.2-279.4)	459.1 (397.8-535.3)	413.5 (365.7-466.8)	111.8 (101.6-122.9)	151.5 (137.6-166.5)	345.1 (315.5-377.4)	510.7 (413.4-637.8)
2006	6159.2	1933.8	2339.0	139.3	328.7 (286.0-372.7)	489.4 (412.1-588.5)	470.6 (421.0-536.4)	123.3 (113.1-135.2)	137.1 (125.3-151.1)	312.0 (286.8-340.9)	415.9 (330.7-553.2)
2007	5596.7	1983.5	2153.4	109.3	327.7 (294.7-362.2)	705.4 (578.1-870.4)	457.6 (407.6-520.1)	110.4 (102.7-119.4)	126.0 (116.1-136.7)	316.5 (294.0-342.9)	356.0 (285.2-492.7)
2008	5067.5	1984.1	1946.8	107.3	309.9 (274.9-345.5)	739.1 (605.5-925.0)	362.0 (319.6-416.2)	106.2 (97.6-115.7)	121.9 (110.5-134.6)	375.3 (342.2-408.5)	345.8 (265.0-488.8)
2009	6784.3	2339.9	1913.4	133.9	340.5 (307.5-378.5)	918.5 (735.2-1174.4)	358.0 (310.4-417.9)	109.9 (101.7-119.0)	108.0 (98.8-118.5)	471.1 (434.8-511.6)	499.1 (375.0-669.1)
2010	7376.0	2398.0	1749.4	188.4	386.0 (331.8-449.9)	946.0 (766.3-1180.9)	358.6 (304.7-423.2)	126.5 (115.8-139.4)	100.6 (88.6-114.8)	591.8 (536.4-652.6)	723.3 (494.0-1047.7)
2011	5471.7	2256.8	1931.8	158.1	407.1 (363.1-453.0)	1099.8 (887.6-1380.2)	344.3 (299.7-396.1)	126.3 (115.1-138.2)	123.4 (112.0-136.4)	585.5 (539.8-637.0)	597.4 (470.7-776.7)
2012	6861.9	2223.0	2028.0	345.9	413.2 (361.3-473.2)	1016.5 (837.0-1249.3)	391.4 (347.3-447.1)	123.2 (109.3-138.0)	160.6 (142.4-180.5)	527.7 (482.0-579.3)	427.0 (344.1-547.8)
2013	6561.6	1862.3	1701.4	219.4	409.8 (365.4-459.9)	773.8 (666.3-904.9)	395.9 (361.8-434.2)	118.0 (107.8-128.6)	170.0 (153.9-188.0)	447.3 (414.3-483.2)	311.9 (263.5-386.6)
2014	6188.9	2702.2	2181.4	274.3	429.2 (385.4-481.7)	730.5 (625.1-859.9)	488.2 (435.7-548.1)	120.5 (110.2-133.1)	192.9 (174.9-212.8)	493.9 (456.5-533.9)	296.0 (251.2-366.0)
2015	6169.0	3205.3	2226.9	289.7	403.3 (364.1-444.8)	558.0 (488.0-650.2)	519.9 (468.2-576.0)	113.1 (104.6-123.0)	203.5 (187.4-220.9)	537.6 (499.7-577.8)	255.6 (225.7-305.6)
2016	5454.5	2499.5	1669.8	290.4	382.1 (333.8-436.9)	387.6 (337.1-457.9)	411.5 (371.6-456.7)	95.9 (88.4-103.4)	182.4 (163.0-204.0)	491.4 (443.9-536.0)	225.7 (202.7-258.4)
2017	6539.0	2581.2	1559.7	319.8	427.6 (396.7-459.7)	337.0 (297.4-383.8)	430.0 (392.5-470.5)	92.9 (86.5-99.9)	175.1 (164.7-188.4)	487.5 (459.4-514.5)	241.2 (217.5-273.6)
2018	5314.5	2415.2	1825.4	310.7	542.9 (443.6-672.2)	335.0 (296.4-382.3)	454.8 (403.0-520.8)	85.6 (78.8-93.0)	171.7 (148.8-201.4)	492.4 (438.5-555.1)	375.6 (327.2-437.8)

** Reported catches were used for these species*

Table 11 Annual finfish catch estimates ('000 metric tonnes, 95% CIs in parentheses where applicable) by species/species group for the WCPFC Convention area.

Year	Albacore*	Yellowfin*	Bigeye*	Skipjack*	Longsnouted lancetfish	Mahi mahi	Wahoo	Opah	Pomfrets	Escolars	Others
2003	80.3	66.4	82.0	1.0	0.9 (0.7-1.0)	3.3 (2.8-4.0)	5.1 (4.4-6.0)	4.6 (4.1-5.1)	0.2 (0.2-0.3)	2.1 (1.9-2.5)	8.7 (6.9-11.1)
2004	84.0	68.0	95.2	1.0	0.8 (0.7-0.9)	3.1 (2.7-3.7)	4.3 (3.8-4.9)	4.0 (3.6-4.5)	0.3 (0.3-0.3)	2.2 (2.0-2.4)	7.7 (6.4-9.3)
2005	86.8	57.2	79.0	0.7	0.8 (0.7-0.9)	2.8 (2.5-3.2)	4.4 (3.9-5.0)	3.5 (3.2-3.8)	0.2 (0.2-0.3)	2.0 (1.8-2.2)	4.6 (3.9-5.4)
2006	87.7	54.3	81.5	0.8	1.1 (1.0-1.3)	3.0 (2.5-3.5)	5.0 (4.5-5.8)	3.8 (3.5-4.2)	0.2 (0.2-0.3)	1.8 (1.7-2.0)	3.3 (2.8-3.9)
2007	85.0	52.2	77.8	0.6	1.1 (1.0-1.2)	4.3 (3.5-5.2)	4.9 (4.3-5.6)	3.4 (3.2-3.7)	0.2 (0.2-0.2)	1.9 (1.8-2.1)	3.1 (2.6-3.7)
2008	83.8	52.6	73.9	0.6	1.0 (0.9-1.2)	4.3 (3.6-5.3)	3.9 (3.4-4.5)	3.3 (3.0-3.6)	0.2 (0.2-0.2)	2.2 (2.0-2.4)	3.4 (2.9-4.1)
2009	105.	65.7	72.5	0.7	1.1 (1.0-1.3)	5.5 (4.4-6.8)	3.9 (3.3-4.6)	3.4 (3.2-3.7)	0.2 (0.2-0.2)	3.0 (2.8-3.3)	4.8 (4.0-6.1)
2010	110.	64.7	67.6	1.0	1.3 (1.1-1.5)	5.8 (4.8-7.2)	3.9 (3.3-4.6)	4.0 (3.6-4.4)	0.2 (0.1-0.2)	3.8 (3.5-4.2)	5.9 (4.6-8.4)
2011	82.9	62.2	72.9	1.1	1.4 (1.2-1.5)	6.7 (5.5-8.2)	3.7 (3.2-4.3)	4.0 (3.6-4.3)	0.2 (0.2-0.2)	3.6 (3.3-3.9)	5.9 (5.0-7.4)
2012	102.	58.7	81.4	2.0	1.4 (1.2-1.6)	6.3 (5.3-7.7)	4.1 (3.7-4.7)	3.9 (3.4-4.3)	0.3 (0.2-0.3)	3.3 (3.0-3.6)	5.1 (4.4-6.0)
2013	97.0	46.1	63.8	1.2	1.4 (1.2-1.5)	4.9 (4.2-5.7)	4.2 (3.8-4.6)	3.7 (3.4-4.0)	0.3 (0.2-0.3)	2.8 (2.5-3.0)	3.8 (3.4-4.4)
2014	87.0	62.4	75.1	1.5	1.4 (1.3-1.6)	4.5 (3.9-5.2)	5.2 (4.6-5.9)	3.8 (3.5-4.2)	0.3 (0.3-0.3)	3.1 (2.8-3.3)	4.3 (3.7-5.0)
2015	88.7	72.9	76.5	1.6	1.4 (1.2-1.5)	3.4 (3.0-3.9)	5.5 (5.0-6.1)	3.5 (3.3-3.9)	0.3 (0.3-0.4)	3.2 (3.0-3.5)	5.7 (5.1-6.6)
2016	80.3	59.6	59.6	1.7	1.3 (1.1-1.5)	2.3 (2.0-2.7)	4.4 (4.0-4.9)	3.0 (2.8-3.2)	0.3 (0.3-0.3)	2.9 (2.6-3.1)	6.9 (6.2-7.9)
2017	99.5	65.9	58.9	2.2	1.4 (1.3-1.5)	2.1 (1.9-2.3)	4.6 (4.2-5.1)	2.9 (2.7-3.1)	0.3 (0.2-0.3)	3.0 (2.8-3.1)	6.8 (6.0-7.8)
2018	85.3	64.8	69.6	1.9	1.8 (1.5-2.3)	2.1 (1.9-2.4)	4.8 (4.3-5.5)	2.7 (2.5-2.9)	0.3 (0.2-0.3)	2.9 (2.5-3.2)	5.5 (4.8-6.4)

** Reported catches were used for these species*

Table 12 Annual billfish catch estimates ('000s individuals, 95% CIs in parentheses where applicable) by species/species group for the WCPFC Convention area.

Year	Swordfish*	Blue marlin*	Striped marlin*	Shortbill spearfish*	Indo-Pacific sailfish*	Black marlin*	Billfishes nei
2003	242.4	217.7	115.6	29.7	13.5	18.5	3.9 (2.1-8.4)
2004	365.0	323.8	102.6	29.0	9.5	26.4	2.5 (1.5-4.9)
2005	343.2	356.5	78.3	28.7	15.6	23.6	2.4 (1.4-4.3)
2006	357.3	203.2	73.1	30.3	12.9	16.3	3.1 (1.9-7.1)
2007	427.0	316.8	64.1	20.9	31.0	25.1	4.3 (2.7-9.3)
2008	333.0	243.2	73.5	24.7	20.7	21.6	3.3 (2.0-8.3)
2009	336.9	276.2	59.9	17.5	51.8	20.4	2.4 (1.5-4.0)
2010	280.5	298.2	58.7	20.0	19.5	24.3	2.0 (1.2-3.6)
2011	315.2	283.0	92.0	30.3	14.4	28.4	2.4 (1.6-4.1)
2012	344.8	287.5	82.6	25.1	65.1	27.1	3.6 (2.3-5.8)
2013	327.2	319.9	77.6	33.3	83.0	21.7	4.7 (3.0-7.7)
2014	323.3	330.2	77.0	40.3	72.7	23.9	5.4 (3.0-10.5)
2015	348.7	319.5	79.7	34.1	55.9	22.6	5.2 (3.2-8.7)
2016	267.8	287.3	60.7	33.3	61.9	18.9	4.0 (2.8-6.0)
2017	234.2	220.5	54.6	29.9	30.9	10.4	3.8 (2.8-6.0)
2018	279.7	209.7	58.6	25.6	33.8	9.9	4.3 (3.1-6.5)

** Reported catches were used for these species*

Table 13 Annual billfish catch estimates ('000s metric tonnes, 95% CIs in parentheses where applicable) by species/species group for the WCPFC Convention area.

Year	Swordfish*	Blue marlin*	Striped marlin*	Shortbill spearfish*	Indo-Pacific sailfish*	Black marlin*	Billfishes nei
2003	13.9	12.1	5.1	0.4	0.3	0.8	0.2 (0.1-0.4)
2004	20.3	18.8	4.6	0.4	0.2	1.4	0.1 (0.1-0.2)
2005	18.9	20.8	3.7	0.4	0.3	1.3	0.1 (0.1-0.2)
2006	20.5	12.9	3.5	0.4	0.2	0.8	0.1 (0.1-0.3)
2007	24.3	17.1	3.1	0.3	0.8	1.1	0.2 (0.1-0.4)
2008	19.8	13.0	3.5	0.3	0.5	1.0	0.1 (0.1-0.4)
2009	18.3	14.2	2.7	0.2	0.9	1.0	0.1 (0.1-0.2)
2010	16.1	15.0	2.7	0.3	0.3	1.2	0.1 (0.1-0.2)
2011	17.2	14.5	3.6	0.4	0.3	1.1	0.1 (0.1-0.2)
2012	19.7	14.5	3.8	0.3	1.1	1.2	0.1 (0.1-0.2)
2013	17.7	15.1	3.2	0.5	1.2	1.0	0.2 (0.1-0.3)
2014	18.3	15.6	3.1	0.5	1.0	1.1	0.2 (0.1-0.4)
2015	20.1	15.7	3.4	0.5	0.9	1.0	0.2 (0.1-0.4)
2016	16.5	13.5	2.6	0.5	1.1	0.8	0.2 (0.1-0.3)
2017	15.9	12.3	2.5	0.4	0.6	0.5	0.2 (0.1-0.3)
2018	18.1	11.6	2.4	0.4	0.6	0.5	0.2 (0.1-0.3)

** Reported catches were used for these species*

Table 14 Annual shark and ray catch estimates (‘000s individuals, 95% CIs in parentheses) by species/species group for the WCPFC Convention area.

Year	Blue shark	Silky shark	Pelagic stingray	Shortfin mako	Oceanic whitetip shark	Bigeye thresher	Thresher sharks nei	Mantas, devil rays	Elasmobranchs nei	Others
2003	1137.1 (993.0-1316.4)	178.0 (129.9-246.8)	278.9 (232.1-326.8)	89.2 (67.3-116.5)	111.0 (87.1-144.4)	31.8 (25.5-40.2)	42.5 (31.2-58.4)	1.5 (0.4-6.9)	57.9 (44.1-75.0)	46.0 (34.3-66.6)
2004	1264.4 (1120.2-1441.7)	187.6 (145.1-247.7)	220.0 (193.2-253.3)	129.7 (101.5-164.9)	102.7 (81.6-131.4)	40.2 (34.0-47.7)	46.8 (36.3-60.2)	26.6 (13.6-51.7)	64.7 (51.8-78.6)	37.2 (28.6-49.7)
2005	1057.5 (960.7-1172.1)	166.4 (137.5-199.8)	205.6 (179.3-232.8)	128.7 (104.1-158.8)	71.9 (59.7-89.0)	37.9 (32.0-44.5)	36.4 (28.8-45.0)	20.1 (12.3-32.5)	51.7 (41.8-64.0)	26.7 (21.1-34.2)
2006	1096.1 (981.5-1224.6)	183.4 (154.4-220.5)	189.9 (165.5-215.5)	127.7 (103.5-154.9)	59.7 (47.7-76.8)	51.2 (43.7-59.5)	46.9 (37.1-58.1)	4.3 (2.4-8.2)	38.2 (31.2-47.5)	26.9 (21.9-33.7)
2007	1001.2 (886.5-1140.3)	233.5 (200.7-269.7)	178.4 (156.9-202.9)	145.4 (117.2-173.8)	57.4 (47.3-69.2)	52.4 (45.2-60.7)	58.7 (49.0-69.7)	3.0 (1.8-5.5)	36.0 (30.5-43.8)	35.0 (28.4-43.5)
2008	880.1 (776.1-1011.3)	250.4 (206.8-298.3)	155.8 (135.0-180.6)	145.9 (117.0-184.4)	58.9 (46.8-73.9)	54.4 (44.8-65.9)	64.0 (52.4-78.3)	4.2 (2.5-7.6)	47.0 (38.7-59.2)	45.9 (34.8-61.9)
2009	989.9 (883.6-1129.5)	390.1 (274.8-572.1)	228.0 (198.6-259.7)	158.6 (128.7-197.0)	70.7 (50.7-100.0)	53.2 (44.7-62.8)	63.9 (48.6-85.9)	8.3 (5.2-13.3)	55.8 (46.2-67.3)	52.0 (39.6-70.3)
2010	991.6 (881.1-1128.3)	394.3 (235.8-744.5)	313.8 (259.4-382.8)	152.6 (123.0-193.5)	68.8 (42.2-111.6)	52.4 (43.0-63.1)	55.1 (37.2-83.7)	12.0 (7.1-20.6)	64.8 (51.5-80.2)	51.3 (38.9-69.9)
2011	1012.4 (904.1-1142.7)	382.6 (232.7-686.1)	275.0 (240.1-313.5)	135.2 (111.2-165.6)	68.7 (46.6-103.2)	72.3 (60.2-85.3)	56.9 (38.2-87.5)	12.3 (8.2-18.6)	72.5 (58.3-88.7)	54.9 (44.2-70.4)
2012	829.8 (747.5-929.6)	385.9 (247.4-632.1)	250.6 (215.2-293.5)	122.6 (99.8-149.9)	69.2 (49.1-101.0)	80.6 (68.2-95.6)	59.7 (40.8-88.2)	13.2 (8.6-20.5)	65.0 (52.7-80.9)	51.0 (40.1-65.1)
2013	694.6 (630.9-763.4)	182.3 (136.9-262.1)	203.3 (177.3-233.1)	125.6 (103.1-150.3)	49.0 (37.6-65.4)	60.1 (51.6-69.6)	33.2 (25.3-44.8)	11.7 (7.9-18.3)	46.3 (37.8-57.1)	38.6 (32.3-46.6)
2014	835.9 (735.1-947.0)	136.7 (108.2-180.9)	254.4 (222.3-288.1)	132.7 (108.8-161.1)	42.8 (34.1-55.3)	53.7 (45.9-63.6)	24.7 (19.4-32.4)	12.5 (8.8-17.6)	52.8 (41.2-65.5)	35.9 (28.9-46.2)
2015	900.3 (821.8-986.9)	187.5 (151.1-254.4)	266.3 (234.6-297.7)	89.5 (75.4-106.2)	49.7 (39.1-65.4)	61.6 (53.7-71.7)	29.2 (23.6-38.5)	10.2 (7.5-14.4)	73.7 (62.5-89.1)	32.4 (27.4-38.4)
2016	810.9 (737.4-897.7)	169.6 (141.7-213.2)	205.6 (180.2-237.0)	57.1 (47.5-68.8)	37.7 (30.8-46.9)	54.8 (47.7-63.2)	30.8 (25.1-38.4)	4.9 (3.6-6.9)	82.3 (68.2-101.1)	23.5 (20.4-27.2)
2017	765.7 (710.2-832.3)	154.9 (132.4-187.3)	239.8 (218.7-265.2)	57.2 (49.5-66.1)	32.3 (27.2-38.9)	51.6 (45.8-58.5)	35.1 (29.1-42.9)	4.8 (3.8-6.1)	84.5 (72.9-99.2)	22.5 (19.7-25.9)
2018	809.2 (722.1-921.3)	129.3 (105.8-162.5)	349.7 (305.7-402.3)	77.1 (65.9-90.1)	27.6 (22.2-34.3)	50.3 (42.0-61.7)	37.0 (28.7-48.1)	7.2 (5.1-10.4)	85.2 (63.9-117.4)	22.7 (18.4-28.1)

Table 15 Annual shark and ray catch estimates (‘000 metric tonnes, 95% CIs in parentheses) by species/species group for the WCPFC Convention area.

Year	Blue shark	Silky shark	Pelagic stingray	Shortfin mako	Oceanic whitetip shark	Bigeye thresher	Thresher sharks nei	Mantas, devil rays	Elasmobranchs nei	Others
2003	33.2 (29.3-37.9)	2.6 (1.9-3.6)	0.6 (0.5-0.8)	3.2 (2.4-4.1)	4.3 (3.4-5.6)	0.2 (0.2-0.2)	1.2 (0.9-1.7)	0.2 (0.1-0.9)	1.6 (1.2-2.1)	2.1 (1.4-3.5)
2004	37.0 (32.9-41.8)	2.6 (2.1-3.4)	0.5 (0.4-0.6)	4.6 (3.6-5.8)	3.8 (3.1-4.8)	0.2 (0.2-0.3)	1.0 (0.8-1.3)	3.3 (1.7-6.4)	1.7 (1.4-2.1)	1.6 (1.2-2.4)
2005	30.9 (28.3-33.9)	2.4 (2.0-2.8)	0.5 (0.4-0.5)	4.5 (3.6-5.5)	2.7 (2.3-3.3)	0.2 (0.2-0.3)	0.9 (0.7-1.1)	2.6 (1.6-4.1)	1.4 (1.1-1.7)	1.3 (1.0-1.8)
2006	31.9 (28.9-35.3)	2.7 (2.2-3.2)	0.4 (0.4-0.5)	4.4 (3.6-5.3)	2.3 (1.8-2.8)	0.3 (0.3-0.4)	1.1 (0.9-1.3)	0.6 (0.3-1.1)	1.0 (0.9-1.3)	1.4 (1.1-1.8)
2007	28.5 (25.7-31.9)	3.4 (2.9-3.9)	0.4 (0.4-0.5)	5.0 (4.0-6.0)	2.2 (1.9-2.7)	0.3 (0.3-0.4)	1.4 (1.1-1.7)	0.4 (0.2-0.7)	1.0 (0.8-1.2)	2.0 (1.5-2.6)
2008	24.9 (22.2-28.1)	3.7 (3.0-4.4)	0.4 (0.3-0.4)	5.0 (4.0-6.3)	2.3 (1.8-2.9)	0.3 (0.3-0.4)	1.8 (1.5-2.3)	0.6 (0.3-1.0)	1.3 (1.0-1.5)	2.6 (1.9-3.6)
2009	28.0 (25.2-31.2)	5.6 (4.0-8.1)	0.6 (0.5-0.6)	5.4 (4.4-6.7)	2.8 (2.0-3.9)	0.3 (0.3-0.4)	1.8 (1.4-2.4)	1.1 (0.7-1.8)	1.5 (1.3-1.8)	3.0 (2.2-4.3)
2010	29.2 (26.2-32.7)	5.9 (3.6-11.0)	0.8 (0.7-1.0)	5.2 (4.2-6.6)	2.8 (1.7-4.4)	0.3 (0.3-0.4)	1.6 (1.1-2.4)	1.6 (0.9-2.7)	1.8 (1.5-2.2)	3.0 (2.2-4.3)
2011	29.8 (26.9-33.2)	5.6 (3.4-9.9)	0.7 (0.6-0.8)	4.6 (3.8-5.7)	2.7 (1.9-4.0)	0.5 (0.4-0.5)	1.5 (1.0-2.2)	1.6 (1.1-2.4)	2.0 (1.6-2.4)	3.0 (2.4-3.9)
2012	25.0 (22.8-27.7)	5.7 (3.6-9.2)	0.6 (0.5-0.7)	4.2 (3.4-5.1)	2.7 (1.9-3.8)	0.5 (0.4-0.6)	1.8 (1.2-2.6)	1.7 (1.1-2.7)	1.8 (1.5-2.2)	2.8 (2.2-3.8)
2013	21.5 (19.7-23.5)	2.7 (2.0-3.8)	0.5 (0.4-0.6)	4.3 (3.5-5.1)	1.9 (1.5-2.5)	0.4 (0.3-0.4)	1.1 (0.8-1.4)	1.6 (1.0-2.4)	1.3 (1.1-1.6)	2.2 (1.8-2.8)
2014	25.2 (22.3-28.3)	1.9 (1.5-2.5)	0.6 (0.5-0.7)	4.5 (3.7-5.5)	1.6 (1.3-2.1)	0.3 (0.3-0.4)	0.7 (0.5-0.9)	1.6 (1.1-2.3)	1.5 (1.2-1.9)	2.0 (1.6-2.8)
2015	27.4 (25.2-29.8)	2.6 (2.1-3.5)	0.6 (0.5-0.7)	3.0 (2.6-3.6)	1.8 (1.4-2.3)	0.4 (0.3-0.4)	0.7 (0.6-0.9)	1.2 (0.9-1.7)	2.1 (1.8-2.5)	1.7 (1.4-2.0)
2016	24.8 (22.7-27.3)	2.4 (2.0-3.0)	0.5 (0.4-0.6)	1.9 (1.6-2.3)	1.4 (1.2-1.7)	0.3 (0.3-0.4)	1.0 (0.8-1.2)	0.6 (0.5-0.9)	2.3 (1.9-2.9)	1.2 (1.0-1.4)
2017	23.7 (22.1-25.6)	2.3 (2.0-2.8)	0.6 (0.5-0.7)	1.9 (1.7-2.2)	1.3 (1.1-1.5)	0.3 (0.3-0.4)	1.2 (1.0-1.6)	0.6 (0.5-0.8)	2.5 (2.2-2.9)	1.1 (1.0-1.4)
2018	25.8 (23.2-29.1)	1.9 (1.5-2.3)	0.8 (0.7-0.9)	2.6 (2.2-3.0)	1.0 (0.8-1.3)	0.3 (0.2-0.4)	1.1 (0.9-1.4)	0.9 (0.6-1.3)	2.4 (1.8-3.3)	1.2 (1.0-1.6)

Table 16 Annual sea turtle catch estimates ('000s individuals, 95% CIs in parentheses) by species/species group for the WCPFC Convention area.

Year	Olive ridley turtle	Green turtle	Loggerhead turtle	Leatherback turtle	Hawksbill turtle	Marine turtles nei
2003	7.3 (3.4-16.1)	0.8 (0.2-4.0)	0.1 (0.0-5.8)	0.7 (0.2-2.4)	0.4 (0.1-3.5)	2.9 (0.7-12.2)
2004	6.4 (3.2-12.4)	1.9 (0.8-4.3)	0.8 (0.2-3.2)	0.6 (0.2-1.6)	0.3 (0.1-1.2)	3.7 (1.5-10.0)
2005	5.5 (3.2-9.4)	1.3 (0.7-2.6)	4.0 (1.8-9.1)	0.7 (0.4-1.4)	0.3 (0.1-1.1)	2.7 (1.3-5.5)
2006	6.2 (3.2-12.7)	0.8 (0.4-1.6)	8.2 (4.5-14.3)	0.8 (0.4-1.6)	0.5 (0.2-1.8)	1.3 (0.6-2.6)
2007	19.6 (9.5-46.8)	2.7 (1.5-5.0)	6.2 (3.4-11.3)	0.8 (0.4-1.6)	0.8 (0.3-2.6)	1.0 (0.4-2.7)
2008	19.1 (9.7-40.7)	4.4 (2.3-9.3)	3.0 (1.5-6.0)	0.6 (0.3-1.3)	0.6 (0.2-1.9)	0.2 (0.1-0.9)
2009	24.2 (13.8-44.8)	4.0 (2.1-7.7)	1.7 (0.8-3.5)	0.9 (0.4-1.7)	1.5 (0.5-4.3)	0.1 (0.0-0.5)
2010	17.5 (10.0-33.1)	2.1 (1.0-4.6)	1.9 (0.8-4.7)	1.4 (0.7-2.9)	2.6 (0.8-9.6)	0.1 (0.0-0.4)
2011	10.3 (6.0-19.1)	2.0 (1.1-3.8)	2.6 (1.4-5.1)	1.6 (0.9-2.9)	1.3 (0.5-4.2)	0.1 (0.0-0.6)
2012	10.7 (5.1-21.7)	3.1 (1.9-5.2)	3.5 (1.8-7.1)	1.9 (1.2-2.9)	0.8 (0.2-2.9)	0.2 (0.1-0.7)
2013	8.1 (5.1-14.0)	3.3 (2.2-5.4)	3.0 (1.9-5.1)	1.8 (1.2-2.6)	0.6 (0.3-1.6)	0.5 (0.3-1.1)
2014	10.8 (7.2-16.6)	4.0 (2.5-7.0)	2.8 (1.9-4.4)	1.8 (1.2-2.9)	1.4 (0.6-3.6)	2.1 (1.2-4.3)
2015	10.9 (7.5-16.7)	3.5 (2.3-5.5)	3.4 (2.6-4.6)	1.8 (1.2-2.8)	1.2 (0.6-3.0)	4.0 (2.3-8.0)
2016	7.2 (5.2-10.2)	2.1 (1.4-3.3)	2.9 (2.1-4.2)	1.0 (0.6-1.6)	0.7 (0.4-1.3)	5.4 (3.2-11.2)
2017	8.2 (6.0-11.6)	1.9 (1.4-2.8)	2.6 (1.9-3.7)	0.8 (0.5-1.2)	0.6 (0.4-1.7)	5.0 (3.2-9.0)
2018	5.7 (3.2-11.1)	1.5 (1.0-2.2)	2.0 (1.3-3.0)	0.6 (0.3-1.1)	0.6 (0.3-1.4)	4.6 (2.5-9.3)

Note: refer to Section 6 for discussion regarding of olive ridley catch estimates.

Table 17 Annual marine mammal catch estimates ('000s individuals, 95% CIs in parentheses) north of 10°N, 10°S to 10°N, south of 10°S, and for WCPFC Convention area.

Year	north of 10N	10S to 10N	south of 10S	Total
2003	0.6 (0.3-1.3)	0.5 (0.2-1.1)	0.7 (0.3-1.6)	1.8 (0.8-3.9)
2004	0.5 (0.3-1.0)	0.4 (0.2-0.8)	0.6 (0.3-1.0)	1.5 (0.8-2.8)
2005	0.4 (0.3-0.8)	0.3 (0.2-0.5)	0.4 (0.2-0.6)	1.1 (0.7-1.8)
2006	0.5 (0.3-0.8)	0.3 (0.2-0.5)	0.4 (0.3-0.7)	1.2 (0.8-1.9)
2007	0.7 (0.4-1.1)	0.4 (0.3-0.7)	0.5 (0.3-0.9)	1.6 (1.1-2.5)
2008	0.8 (0.4-1.3)	0.4 (0.2-0.7)	0.5 (0.3-1.0)	1.7 (1.0-3.0)
2009	0.5 (0.3-0.9)	0.4 (0.2-0.6)	0.4 (0.3-0.9)	1.4 (0.8-2.3)
2010	0.4 (0.2-0.6)	0.4 (0.2-0.6)	0.5 (0.3-0.9)	1.2 (0.7-2.0)
2011	0.5 (0.3-0.8)	0.5 (0.3-0.8)	0.5 (0.4-0.8)	1.6 (1.1-2.4)
2012	0.8 (0.5-1.3)	0.9 (0.6-1.5)	0.9 (0.6-1.5)	2.6 (1.7-4.0)
2013	0.8 (0.6-1.2)	0.8 (0.6-1.1)	0.9 (0.7-1.6)	2.6 (1.9-3.7)
2014	0.9 (0.6-1.3)	0.9 (0.6-1.4)	1.0 (0.7-1.5)	2.8 (2.1-3.9)
2015	0.8 (0.6-1.0)	1.0 (0.7-1.5)	0.9 (0.6-1.3)	2.7 (2.0-3.6)
2016	0.6 (0.5-0.8)	0.6 (0.4-0.8)	0.6 (0.4-0.9)	1.8 (1.4-2.4)
2017	0.6 (0.4-0.8)	0.5 (0.3-0.7)	0.7 (0.5-1.2)	1.7 (1.3-2.5)
2018	0.5 (0.4-0.7)	0.6 (0.4-0.9)	0.6 (0.4-1.0)	1.7 (1.2-2.6)

Table 18 Annual finfish catch estimates (‘000s individuals, 95% CIs in parentheses where applicable) by species/species group for longline effort north of 10°N.

Year	Albacore*	Yellowfin*	Bigeye*	Skipjack*	Longsnouted lancetfish	Mahi mahi	Wahoo	Opah	Pomfrets	Escolars	Others
2003	1757.2	608.9	688.6	32.9	126.6 (106.7-149.3)	232.0 (178.4-308.4)	110.6 (90.4-139.3)	64.0 (57.3-71.5)	50.6 (44.2-58.3)	117.5 (103.5-133.5)	459.1 (281.8-817.2)
2004	1763.7	369.8	677.0	25.6	120.9 (105.0-138.1)	242.9 (192.8-317.8)	90.9 (76.2-110.4)	64.7 (58.3-71.7)	70.0 (63.5-77.7)	139.2 (124.6-154.5)	265.1 (195.1-375.4)
2005	1777.7	376.7	669.5	20.7	138.0 (122.6-155.6)	248.9 (202.1-310.6)	109.2 (90.1-136.1)	58.3 (53.3-64.2)	63.5 (58.3-69.3)	137.6 (125.6-150.5)	203.6 (153.6-274.6)
2006	1989.7	354.5	735.5	11.8	180.8 (158.2-205.3)	255.0 (195.9-343.8)	110.6 (89.1-139.4)	66.6 (61.3-73.3)	57.9 (53.2-63.3)	131.8 (120.3-145.8)	183.8 (132.2-268.3)
2007	1902.7	243.3	582.0	18.8	177.9 (159.0-196.7)	380.0 (288.1-514.9)	114.6 (91.2-147.6)	60.2 (55.6-65.6)	54.3 (50.2-58.6)	139.5 (128.0-153.6)	156.6 (114.2-241.8)
2008	1660.1	349.1	564.2	20.9	170.4 (151.5-190.8)	442.9 (329.8-604.2)	102.9 (79.8-136.1)	59.4 (54.2-64.9)	51.4 (46.8-56.2)	170.5 (155.2-188.3)	154.4 (111.9-234.2)
2009	1686.9	356.5	405.1	14.7	178.9 (161.3-198.7)	545.8 (405.0-751.4)	94.3 (70.8-127.2)	56.7 (52.4-62.0)	44.6 (41.2-48.6)	193.8 (176.7-213.1)	205.6 (149.8-307.4)
2010	1694.8	410.0	377.1	17.1	181.3 (158.7-209.3)	501.8 (376.5-678.8)	77.8 (59.7-102.4)	56.1 (51.2-61.8)	37.7 (33.9-42.2)	199.0 (180.1-219.6)	267.4 (181.0-407.1)
2011	1838.4	363.4	500.2	31.9	204.2 (184.5-225.5)	563.2 (418.3-790.0)	78.7 (61.0-105.1)	61.4 (55.7-67.2)	47.8 (43.6-52.2)	216.2 (198.0-237.7)	228.8 (175.0-307.9)
2012	2061.0	227.8	476.8	46.3	211.6 (187.3-241.6)	437.3 (338.3-592.4)	78.0 (62.4-101.5)	60.0 (53.5-67.3)	60.6 (54.3-66.8)	187.8 (171.7-207.7)	146.5 (112.0-202.3)
2013	1780.1	261.6	413.7	66.8	213.8 (191.4-238.2)	311.8 (254.8-394.1)	78.6 (66.0-94.9)	58.1 (53.1-63.3)	66.5 (61.3-72.9)	159.8 (147.5-173.2)	112.5 (85.7-155.9)
2014	1780.3	232.7	530.4	46.2	233.8 (211.3-261.0)	351.7 (276.8-453.5)	113.4 (91.7-143.8)	56.7 (51.8-62.5)	83.1 (76.4-90.9)	182.9 (168.5-197.8)	106.2 (84.8-142.4)
2015	2005.8	374.1	548.9	50.5	216.2 (197.6-234.7)	289.7 (234.0-368.2)	134.7 (110.3-169.8)	52.2 (48.6-56.3)	85.8 (80.2-91.7)	203.8 (191.3-218.1)	85.9 (77.0-98.3)
2016	1477.8	430.1	515.8	48.6	226.0 (199.2-254.6)	220.8 (180.2-278.3)	128.7 (106.4-159.2)	52.2 (48.1-56.7)	91.1 (82.8-100.6)	222.7 (202.2-241.8)	96.1 (86.3-107.7)
2017	1437.5	582.9	554.0	71.2	235.0 (219.4-251.9)	162.3 (133.9-197.7)	116.6 (97.3-141.8)	46.5 (43.3-49.8)	84.6 (80.0-89.7)	201.6 (190.5-212.5)	97.2 (87.5-109.4)
2018	1088.9	442.2	607.3	55.1	304.0 (249.3-372.6)	141.1 (118.2-172.0)	112.7 (93.1-140.9)	39.7 (36.6-43.0)	83.0 (73.2-95.4)	194.1 (173.5-218.8)	151.0 (124.5-186.4)

** Reported catches were used for these species*

Table 19 Annual finfish catch estimates (‘000s individuals, 95% CIs in parentheses where applicable) by species/species group for longline effort from 10°S to 10°N.

Year	Albacore*	Yellowfin*	Bigeye*	Skipjack*	Longsnouted lancetfish	Mahi mahi	Wahoo	Opah	Pomfrets	Escolars	Others
2003	411.8	1298.4	1383.0	8.9	44.6 (33.4-57.7)	112.9 (90.6-141.0)	182.3 (150.8-220.1)	21.1 (17.7-25.3)	41.0 (32.6-50.6)	125.3 (106.4-148.5)	317.0 (208.8-537.9)
2004	409.4	1547.0	2107.1	20.5	46.0 (36.8-55.6)	103.1 (85.9-121.8)	162.5 (140.9-188.1)	18.5 (15.8-21.8)	59.0 (49.6-70.2)	130.1 (113.4-149.7)	306.1 (222.8-439.2)
2005	507.7	1484.2	1245.3	13.1	42.1 (34.2-52.1)	70.4 (59.6-82.0)	150.4 (130.4-173.9)	15.2 (13.2-17.6)	48.3 (41.8-55.4)	112.9 (99.5-129.1)	191.6 (150.1-256.1)
2006	349.9	1019.2	1354.2	10.4	60.6 (48.9-73.5)	96.9 (81.7-113.6)	165.9 (145.2-189.7)	17.8 (15.4-20.3)	42.4 (36.2-48.7)	91.8 (82.5-103.9)	146.2 (112.9-198.4)
2007	366.0	1106.0	1337.9	11.5	62.4 (52.8-73.6)	177.4 (148.5-210.1)	173.7 (151.9-198.7)	17.3 (15.2-19.6)	38.5 (33.5-43.4)	94.8 (85.7-104.2)	131.2 (102.9-176.6)
2008	229.4	936.8	1144.1	7.3	55.3 (46.2-66.7)	157.5 (133.6-184.8)	119.4 (102.8-138.4)	15.1 (12.9-17.6)	35.6 (30.1-41.6)	110.3 (97.5-124.0)	117.2 (83.2-170.1)
2009	394.0	1254.2	1249.6	12.6	56.2 (46.2-68.2)	196.6 (161.3-242.4)	119.4 (101.6-140.6)	13.7 (12.0-15.7)	27.4 (23.2-31.9)	137.3 (122.3-153.8)	176.5 (122.7-260.2)
2010	467.3	1135.2	1090.5	16.5	73.6 (57.7-93.3)	199.8 (163.9-243.8)	109.6 (93.4-128.6)	18.5 (16.2-21.0)	29.5 (24.4-35.1)	183.7 (163.1-207.2)	257.1 (168.2-408.1)
2011	408.4	1166.3	1114.9	16.7	79.1 (65.4-94.6)	276.9 (230.3-328.4)	123.2 (106.8-140.8)	20.1 (17.6-23.2)	39.4 (34.1-45.7)	200.9 (180.9-224.2)	216.8 (161.1-304.4)
2012	700.1	1382.4	1246.4	121.3	75.2 (61.4-91.5)	350.7 (284.6-433.8)	156.4 (133.8-183.5)	17.3 (14.8-20.3)	49.4 (42.0-58.2)	177.5 (158.9-199.2)	160.8 (125.1-217.7)
2013	636.3	1134.0	1001.7	81.9	66.9 (56.2-79.4)	243.5 (205.1-290.4)	141.2 (124.5-159.1)	15.4 (13.5-17.4)	49.0 (42.6-56.3)	134.4 (122.6-148.1)	102.0 (82.9-132.0)
2014	463.4	1681.1	1401.3	74.7	73.2 (60.8-87.1)	182.0 (155.9-210.5)	163.2 (142.7-183.1)	16.6 (14.1-19.2)	51.9 (43.9-60.4)	144.5 (130.2-159.4)	92.0 (73.7-123.5)
2015	760.3	2033.4	1430.1	83.5	77.3 (64.2-90.6)	128.6 (111.6-148.4)	205.2 (180.4-230.7)	18.4 (15.8-21.0)	60.6 (52.4-68.9)	175.9 (159.3-195.3)	81.1 (64.2-113.2)
2016	766.8	1412.8	913.8	140.6	57.8 (47.3-70.3)	65.5 (56.7-75.8)	135.5 (119.8-152.2)	11.6 (10.2-13.2)	44.7 (38.2-52.5)	133.4 (117.2-150.4)	51.4 (42.0-67.3)
2017	452.1	1089.5	758.6	72.2	61.1 (52.1-69.6)	65.1 (56.6-75.1)	124.2 (111.6-136.9)	9.5 (8.5-10.6)	37.9 (34.4-42.2)	114.2 (104.9-123.4)	51.8 (43.3-66.0)
2018	480.2	1359.4	1017.1	127.2	90.4 (71.7-116.7)	88.8 (75.8-102.3)	168.4 (148.2-193.4)	11.7 (10.4-13.3)	45.5 (38.1-55.3)	149.7 (131.4-170.6)	124.6 (105.2-155.4)

** Reported catches were used for these species*

Table 20 Annual finfish catch estimates ('000s individuals, 95% CIs in parentheses where applicable) by species/species group for longline effort south of 10°S.

Year	Albacore*	Yellowfin*	Bigeye*	Skipjack*	Longsnouted lancetfish	Mahi mahi	Wahoo	Opah	Pomfrets	Escolars	Others
2003	3173.5	778.2	417.4	86.7	84.3 (70.5-101.5)	173.2 (150.1-198.1)	184.3 (158.8-213.4)	61.1 (53.3-70.0)	42.9 (35.4-51.0)	117.9 (101.4-139.0)	242.5 (187.9-338.9)
2004	3575.1	759.0	355.9	102.7	66.5 (57.9-76.3)	158.0 (140.1-176.2)	148.7 (132.1-167.2)	46.1 (40.3-52.7)	55.4 (48.4-64.6)	108.0 (95.3-120.6)	184.6 (157.1-220.4)
2005	3798.6	486.0	260.0	70.6	67.7 (60.7-76.5)	138.8 (126.3-151.8)	153.9 (137.6-172.5)	38.2 (34.0-43.0)	39.3 (34.7-44.9)	94.5 (85.3-103.6)	114.4 (98.8-135.3)
2006	3819.6	560.1	249.3	117.0	87.7 (77.2-99.3)	136.4 (123.6-150.5)	193.2 (173.3-219.0)	39.0 (35.2-43.5)	37.0 (33.1-41.8)	88.0 (79.8-97.3)	85.9 (73.2-104.0)
2007	3328.1	634.3	233.5	79.0	86.9 (78.9-96.7)	148.1 (134.0-163.8)	168.9 (152.2-189.1)	32.9 (30.1-36.1)	33.4 (29.7-37.3)	82.4 (75.6-90.1)	66.2 (56.7-80.1)
2008	3178.0	698.2	238.5	79.1	83.9 (75.2-93.9)	140.2 (126.9-152.9)	139.3 (126.2-153.2)	31.9 (29.0-35.1)	34.9 (30.9-39.5)	93.8 (85.8-102.3)	73.0 (61.7-91.0)
2009	4703.4	729.2	258.7	106.5	105.3 (95.1-116.5)	173.7 (158.2-190.5)	144.0 (127.7-161.1)	39.6 (36.0-43.8)	35.9 (31.8-40.5)	140.5 (129.2-154.3)	115.0 (94.7-148.5)
2010	5213.9	852.8	281.9	154.8	131.3 (111.7-153.4)	245.6 (217.9-277.3)	171.4 (145.6-199.1)	52.0 (46.9-58.3)	33.7 (29.0-39.1)	209.0 (188.2-231.7)	192.7 (143.3-265.2)
2011	3225.0	727.1	316.6	109.5	123.3 (110.6-137.9)	259.3 (231.7-287.5)	141.6 (126.1-158.3)	44.8 (40.8-49.3)	36.2 (32.6-40.3)	168.1 (155.3-183.3)	149.0 (125.1-181.6)
2012	4100.8	612.9	304.7	178.3	126.5 (108.4-148.1)	224.4 (199.6-251.9)	156.3 (140.3-174.0)	45.8 (40.0-52.2)	50.5 (43.5-57.9)	161.6 (146.2-179.9)	118.4 (100.3-143.5)
2013	4145.2	466.7	286.0	70.6	129.6 (113.8-148.3)	216.5 (197.7-236.9)	175.9 (161.4-191.8)	44.6 (40.1-49.9)	54.2 (48.1-60.8)	152.6 (139.3-167.8)	96.7 (84.7-113.3)
2014	3945.2	788.4	249.8	153.4	123.3 (107.1-140.9)	195.4 (176.8-216.1)	210.8 (187.7-241.0)	47.2 (42.2-53.4)	57.6 (50.8-65.2)	166.2 (150.9-183.7)	97.2 (84.3-114.0)
2015	3402.9	797.8	247.8	155.6	110.0 (96.8-124.6)	138.7 (128.1-150.5)	178.5 (161.7-199.8)	42.5 (38.6-47.2)	56.8 (51.1-63.3)	157.6 (143.1-172.7)	87.8 (78.8-100.7)
2016	3209.9	656.7	240.1	101.2	98.1 (83.6-115.0)	100.6 (92.8-108.9)	146.8 (134.8-159.5)	32.0 (29.1-35.3)	46.4 (40.8-53.1)	134.9 (120.9-147.9)	77.1 (69.5-89.1)
2017	4649.4	908.8	247.1	176.4	130.8 (117.0-144.9)	109.0 (101.3-117.9)	188.6 (174.9-202.9)	37.0 (33.7-40.8)	52.4 (47.4-58.2)	171.5 (158.7-185.5)	91.2 (81.7-105.9)
2018	3745.5	613.6	201.0	128.4	148.9 (121.8-184.5)	105.3 (96.0-115.5)	172.7 (155.6-192.3)	34.1 (30.9-37.8)	43.1 (36.2-51.5)	148.4 (131.5-168.1)	99.6 (87.9-114.2)

** Reported catches were used for these species*

Table 21 Annual billfish catch estimates ('000s individuals, 95% CIs in parentheses where applicable) by species/species group for longline effort a) north of 10°N, b) 10°S to 10°N, and c) south of 10°S.

a) north of 10°N

Year	Swordfish*	Blue marlin*	Striped marlin*	Shortbill spearfish*	Indo-Pacific sailfish*	Black marlin*	Billfishes nei
2003	74.3	37.3	70.7	18.6	1.2	1.5	1.4 (0.8-3.0)
2004	171.8	175.8	63.3	14.5	1.5	11.2	1.1 (0.6-2.0)
2005	203.9	188.5	48.2	16.5	1.4	6.9	1.1 (0.6-2.1)
2006	173.3	81.5	45.1	14.9	1.6	1.2	1.3 (0.8-2.3)
2007	216.7	152.1	40.6	10.5	22.0	9.6	1.8 (1.1-3.1)
2008	136.0	103.6	44.1	16.4	12.8	3.4	1.7 (1.0-3.0)
2009	125.5	100.7	32.1	8.1	30.2	2.5	1.1 (0.7-2.1)
2010	97.5	105.7	30.1	6.7	2.6	4.7	0.8 (0.5-1.6)
2011	97.0	100.0	53.3	14.8	2.3	8.0	1.0 (0.6-1.8)
2012	102.5	87.3	50.6	13.0	34.5	3.4	1.6 (1.0-2.8)
2013	93.4	98.9	55.5	15.3	26.7	6.2	2.3 (1.3-4.0)
2014	98.2	119.9	48.7	16.6	13.0	6.6	3.0 (1.6-6.2)
2015	108.9	111.2	54.2	16.0	23.7	4.0	3.1 (1.8-5.6)
2016	108.4	99.1	41.4	23.1	11.8	3.2	2.3 (1.6-3.7)
2017	91.4	81.1	35.8	18.9	7.5	0.6	2.0 (1.5-3.0)
2018	94.8	79.0	36.1	14.8	8.6	0.6	2.4 (1.7-3.5)

** Reported catches were used for these species*

b) 10°S to 10°N

Year	Swordfish*	Blue marlin*	Striped marlin*	Shortbill spearfish*	Indo-Pacific sailfish*	Black marlin*	Billfishes nei
2003	78.8	142.6	14.3	2.0	5.5	11.6	1.0 (0.5-2.6)
2004	104.5	121.8	15.6	2.7	3.7	10.8	0.7 (0.4-1.4)
2005	58.2	140.7	11.9	1.8	7.7	10.8	0.6 (0.3-1.2)
2006	84.5	97.7	11.7	2.9	6.1	8.5	0.7 (0.4-2.5)
2007	99.4	135.9	7.1	2.5	4.4	9.1	1.1 (0.7-3.8)
2008	102.4	108.7	8.5	2.3	4.6	12.0	0.8 (0.5-5.4)
2009	118.6	140.0	9.4	3.8	13.3	12.6	0.6 (0.4-1.0)
2010	102.2	150.8	12.2	3.7	8.5	12.6	0.5 (0.3-0.9)
2011	120.1	138.6	20.2	4.4	5.1	13.6	0.7 (0.4-1.1)
2012	137.8	150.1	13.9	3.9	24.1	13.0	1.1 (0.7-1.8)
2013	132.2	174.6	9.9	7.1	45.8	10.0	1.1 (0.7-1.8)
2014	129.0	163.4	10.0	8.9	42.6	7.5	1.2 (0.6-2.2)
2015	146.3	167.5	9.9	6.3	20.2	9.6	1.1 (0.7-1.8)
2016	79.0	149.8	7.0	1.2	35.6	8.0	0.7 (0.4-1.1)
2017	74.9	100.9	7.1	1.1	13.2	2.1	0.8 (0.5-1.3)
2018	124.0	96.2	10.2	2.1	16.0	2.9	1.0 (0.7-1.8)

** Reported catches were used for these species*

c) south of 10°S

Year	Swordfish*	Blue marlin*	Striped marlin*	Shortbill spearfish*	Indo-Pacific sailfish*	Black marlin*	Billfishes nei
2003	89.2	37.9	30.5	9.2	6.9	5.4	1.3 (0.6-3.4)
2004	88.8	26.2	23.6	11.9	4.2	4.4	0.8 (0.4-1.8)
2005	81.1	27.4	18.2	10.3	6.6	5.9	0.6 (0.3-1.2)
2006	99.5	24.0	16.4	12.5	5.2	6.5	1.0 (0.6-3.0)
2007	110.9	28.7	16.4	7.9	4.6	6.4	1.3 (0.8-3.5)
2008	94.6	30.9	20.9	6.1	3.3	6.2	0.8 (0.4-1.7)
2009	92.8	35.5	18.4	5.6	8.2	5.3	0.6 (0.3-1.2)
2010	80.8	41.7	16.4	9.6	8.4	7.0	0.7 (0.4-1.4)
2011	98.1	44.3	18.5	11.2	7.0	6.8	0.8 (0.5-1.4)
2012	104.5	50.1	18.1	8.1	6.5	10.7	0.8 (0.5-1.6)
2013	101.6	46.4	12.2	10.8	10.5	5.6	1.2 (0.8-2.3)
2014	96.2	47.0	18.4	14.9	17.1	9.7	1.1 (0.7-2.4)
2015	93.6	40.8	15.6	11.8	12.1	8.9	0.9 (0.6-2.0)
2016	80.4	38.3	12.3	9.0	14.4	7.7	0.9 (0.6-1.8)
2017	67.9	38.5	11.7	9.9	10.2	7.6	1.0 (0.6-2.4)
2018	60.9	34.5	12.3	8.7	9.2	6.5	0.8 (0.5-2.1)

** Reported catches were used for these species*

Table 22 Annual shark and ray catch estimates (‘000s individuals, 95% CIs in parentheses) by species/species group for longline effort north of 10°N.

Year	Blue shark	Silky shark	Pelagic stingray	Shortfin mako	Oceanic whitetip shark	Bigeye thresher	Thresher sharks nei	Mantas, devil rays	Elasmobranchs nei	Others
2003	619.9 (517.4-751.1)	31.6 (23.4-43.4)	76.6 (61.5-95.3)	53.9 (38.1-75.4)	18.4 (14.2-24.2)	7.5 (6.0-9.5)	13.0 (9.5-17.8)	0.3 (0.1-1.1)	11.9 (9.0-15.9)	7.8 (4.8-12.8)
2004	748.2 (637.6-907.1)	17.5 (13.3-23.6)	56.8 (47.4-69.1)	86.2 (63.7-114.8)	16.6 (12.8-21.7)	11.1 (9.3-13.7)	12.3 (9.2-16.2)	3.9 (2.0-8.1)	14.2 (10.7-18.5)	6.9 (4.6-11.2)
2005	692.7 (610.0-808.3)	20.4 (15.4-27.5)	54.6 (45.8-65.8)	89.4 (68.4-115.3)	15.6 (11.7-21.1)	13.3 (10.7-16.4)	10.8 (8.3-14.4)	3.7 (2.1-6.9)	12.6 (9.8-16.1)	6.0 (4.2-9.1)
2006	760.8 (658.4-884.3)	22.3 (16.7-30.8)	52.2 (43.6-63.1)	92.8 (72.0-117.4)	12.3 (8.8-18.1)	17.2 (13.4-22.5)	12.9 (9.8-17.1)	0.7 (0.4-1.5)	11.2 (8.7-15.0)	6.6 (4.8-9.1)
2007	737.8 (631.4-873.0)	34.8 (25.4-49.7)	53.0 (44.1-65.3)	110.1 (84.3-136.0)	13.7 (9.7-20.1)	18.3 (14.4-24.0)	15.6 (12.0-20.2)	0.6 (0.3-1.3)	11.5 (9.0-15.7)	9.9 (7.1-13.8)
2008	671.8 (577.7-801.0)	50.4 (36.8-72.7)	51.3 (42.6-62.7)	112.1 (87.3-146.3)	16.1 (11.0-23.8)	19.0 (14.1-25.7)	17.0 (12.8-22.4)	0.9 (0.5-1.9)	15.9 (12.3-21.6)	14.4 (9.8-20.7)
2009	711.0 (614.8-842.0)	59.4 (43.0-80.6)	60.5 (49.6-74.5)	114.5 (88.6-148.0)	16.8 (11.3-25.3)	18.2 (13.7-24.6)	12.9 (9.9-16.8)	1.3 (0.7-2.5)	16.7 (12.5-23.0)	15.8 (10.8-23.2)
2010	630.6 (541.8-750.2)	61.9 (40.6-98.1)	77.2 (61.5-96.6)	100.4 (78.2-132.5)	13.3 (8.1-20.4)	14.6 (11.3-18.9)	11.6 (8.3-16.7)	1.8 (0.9-3.4)	15.7 (11.6-21.4)	13.8 (9.7-20.6)
2011	670.6 (580.8-790.8)	64.5 (42.4-103.6)	71.5 (59.5-87.3)	89.0 (70.9-113.1)	16.3 (10.5-25.5)	24.3 (18.4-33.0)	12.6 (8.8-17.9)	2.0 (1.1-3.3)	20.3 (15.3-27.9)	16.2 (11.5-23.8)
2012	516.2 (449.9-598.7)	47.0 (32.0-69.4)	54.8 (45.3-66.2)	78.7 (61.5-99.8)	11.9 (8.1-18.0)	24.4 (19.0-32.3)	12.7 (9.1-17.8)	1.6 (0.9-2.7)	16.0 (12.4-21.8)	11.8 (8.3-17.2)
2013	406.5 (359.9-460.3)	19.9 (15.5-25.7)	48.9 (41.0-57.8)	78.4 (60.9-98.6)	6.8 (5.1-9.3)	15.3 (12.8-18.6)	7.3 (5.8-9.5)	1.5 (0.9-2.7)	10.6 (8.5-13.5)	7.3 (5.5-9.9)
2014	556.8 (476.4-647.4)	19.7 (15.2-26.3)	51.0 (43.2-59.6)	86.6 (67.4-110.5)	8.7 (6.5-11.6)	19.1 (15.7-23.3)	6.2 (4.9-8.1)	1.8 (1.1-3.0)	14.2 (10.7-18.7)	7.7 (5.6-11.2)
2015	573.2 (507.8-648.3)	24.0 (19.4-30.6)	51.2 (44.3-58.5)	57.2 (46.4-71.4)	9.4 (7.4-12.0)	22.2 (18.8-26.4)	7.3 (6.1-8.9)	1.3 (0.8-2.0)	20.3 (16.6-25.9)	6.3 (4.9-8.4)
2016	550.9 (490.4-628.1)	32.3 (26.8-39.4)	56.5 (48.8-65.8)	39.2 (31.4-48.6)	8.5 (6.8-10.7)	22.7 (19.6-27.3)	10.6 (8.9-12.7)	0.9 (0.6-1.3)	28.9 (23.6-36.5)	5.0 (4.0-6.5)
2017	470.1 (428.0-524.1)	32.4 (27.8-37.8)	69.6 (62.7-77.6)	35.6 (29.9-42.7)	6.7 (5.6-8.1)	19.2 (17.4-21.5)	10.5 (8.9-12.3)	1.0 (0.8-1.4)	29.3 (25.2-35.1)	4.4 (3.7-5.4)
2018	475.1 (416.8-552.3)	21.3 (17.7-26.3)	85.2 (72.1-100.1)	45.7 (37.5-55.4)	5.4 (4.4-6.7)	17.1 (14.4-20.4)	9.9 (7.8-13.0)	1.2 (0.8-1.8)	26.5 (19.8-36.5)	4.5 (3.5-5.9)

** Reported catches were used for these species*

Table 23 Annual shark and ray catch estimates (‘000s individuals, 95% CIs in parentheses) by species/species group for longline effort from 10°S to 10°N.

Year	Blue shark	Silky shark	Pelagic stingray	Shortfin mako	Oceanic whitetip shark	Bigeye thresher	Thresher sharks nei	Mantas, devil rays	Elasmobranchs nei	Others
2003	183.2 (160.6-208.2)	114.4 (81.6-163.2)	144.0 (118.7-172.0)	6.1 (4.6-8.1)	60.7 (45.3-83.7)	19.6 (15.4-25.4)	23.6 (17.0-33.1)	0.9 (0.2-4.3)	32.5 (24.5-43.0)	13.2 (8.5-20.7)
2004	202.7 (179.5-227.3)	145.3 (109.0-198.0)	121.8 (104.8-142.8)	8.9 (7.1-11.4)	62.5 (45.2-87.9)	25.8 (21.3-31.9)	30.6 (23.6-40.8)	17.8 (8.5-35.9)	38.1 (29.4-48.1)	10.8 (7.1-17.3)
2005	147.3 (131.6-162.4)	119.6 (98.2-147.8)	109.7 (93.9-126.7)	7.6 (6.1-9.5)	38.0 (28.8-51.7)	20.8 (17.1-25.6)	21.9 (17.0-27.2)	12.2 (7.3-19.9)	30.5 (23.6-39.3)	8.4 (5.8-11.8)
2006	142.7 (127.3-158.7)	128.6 (104.2-163.8)	94.6 (81.1-108.5)	8.2 (6.7-10.1)	30.9 (22.1-45.0)	29.2 (24.4-35.2)	29.4 (23.1-37.6)	2.7 (1.5-4.8)	20.2 (15.8-25.4)	8.8 (6.6-11.8)
2007	131.0 (117.6-146.2)	161.3 (137.9-186.6)	86.4 (76.0-98.5)	11.1 (9.1-13.5)	29.0 (22.7-38.3)	29.5 (25.2-34.6)	37.2 (31.0-44.3)	1.8 (1.1-3.3)	18.6 (15.2-22.9)	13.0 (10.0-17.0)
2008	99.5 (88.6-111.8)	154.3 (124.5-190.2)	68.9 (58.4-81.0)	10.4 (8.3-13.0)	26.7 (19.5-36.6)	28.3 (23.2-34.1)	36.6 (29.5-46.2)	2.3 (1.4-4.3)	24.3 (18.9-31.9)	16.1 (11.4-23.3)
2009	125.7 (113.0-139.8)	268.5 (182.8-415.6)	113.8 (97.1-131.6)	13.0 (10.5-16.0)	34.7 (22.3-53.7)	27.0 (22.1-32.5)	39.9 (29.4-56.2)	5.0 (3.0-8.3)	29.4 (23.6-36.8)	18.9 (13.5-27.8)
2010	170.9 (151.4-191.9)	245.8 (137.1-495.2)	141.6 (115.4-173.0)	14.8 (11.9-18.2)	33.2 (18.8-57.4)	29.8 (24.0-36.6)	33.3 (22.2-52.3)	6.9 (3.8-12.2)	35.0 (26.9-44.1)	19.4 (13.8-28.4)
2011	176.0 (159.0-194.4)	246.5 (140.3-474.2)	129.3 (110.7-148.5)	14.6 (12.0-18.0)	34.1 (21.6-55.1)	39.1 (32.3-47.3)	35.5 (23.2-56.4)	7.5 (4.8-12.1)	39.3 (31.3-49.0)	20.9 (16.1-27.1)
2012	155.2 (139.8-173.1)	267.0 (167.6-453.5)	130.2 (110.8-155.1)	14.8 (12.0-18.3)	37.4 (25.3-57.9)	42.5 (35.4-51.2)	34.9 (23.5-53.8)	8.0 (5.3-12.5)	36.4 (28.6-45.6)	20.6 (15.6-26.8)
2013	125.2 (113.3-137.7)	125.4 (90.2-190.7)	97.8 (85.5-113.5)	13.5 (11.0-16.2)	25.6 (18.4-37.3)	33.2 (27.7-40.4)	18.5 (13.6-25.7)	7.0 (4.8-11.0)	25.3 (20.2-32.2)	15.0 (12.3-18.8)
2014	113.7 (100.1-127.9)	97.3 (74.0-136.5)	130.6 (113.1-148.2)	12.3 (9.8-15.3)	22.2 (15.9-32.4)	27.3 (22.6-34.0)	14.3 (10.9-19.5)	7.9 (5.6-11.5)	27.4 (21.3-34.9)	13.6 (10.1-18.8)
2015	141.0 (127.4-156.1)	142.6 (110.3-205.1)	150.1 (129.6-171.0)	8.7 (7.1-10.6)	29.4 (21.1-43.2)	33.4 (28.0-40.5)	18.2 (13.8-25.7)	7.3 (5.3-10.9)	38.2 (31.1-47.6)	12.2 (9.4-16.1)
2016	102.6 (92.0-115.0)	111.5 (90.3-149.6)	99.3 (84.4-118.0)	4.4 (3.5-5.4)	18.6 (14.1-25.3)	24.7 (20.9-29.0)	15.0 (11.5-20.2)	3.1 (2.2-4.5)	36.5 (29.0-45.8)	7.0 (5.6-8.8)
2017	101.0 (92.8-110.3)	89.9 (76.0-111.5)	98.9 (88.5-112.6)	4.4 (3.7-5.2)	13.1 (10.4-16.9)	22.0 (18.8-25.9)	16.2 (13.0-20.5)	2.5 (1.9-3.3)	33.4 (28.0-40.2)	5.9 (4.9-7.3)
2018	153.8 (134.6-177.1)	89.6 (72.3-114.5)	177.0 (153.9-205.2)	8.5 (7.2-10.3)	14.2 (10.8-18.8)	27.1 (22.0-34.6)	21.4 (16.4-27.9)	4.7 (3.2-7.0)	41.7 (30.9-58.1)	8.5 (6.5-11.5)

** Reported catches were used for these species*

Table 24 Annual shark and ray catch estimates ('000s individuals, 95% CIs in parentheses) by species/species group for longline effort south of 10°S.

Year	Blue shark	Silky shark	Pelagic stingray	Shortfin mako	Oceanic whitetip shark	Bigeye thresher	Thresher sharks nei	Mantas, devil rays	Elasmobranchs nei	Others
2003	331.1 (292.0-376.7)	31.5 (22.8-44.0)	57.6 (47.2-68.4)	29.1 (22.8-36.5)	31.6 (25.5-38.6)	4.7 (3.7-5.9)	5.8 (4.2-8.1)	0.3 (0.1-1.6)	13.4 (10.4-17.4)	24.7 (18.0-39.4)
2004	311.0 (274.7-351.3)	24.7 (19.3-31.5)	41.4 (36.1-47.7)	34.5 (28.5-42.0)	23.6 (19.9-28.4)	3.2 (2.7-3.8)	3.9 (3.0-5.2)	4.8 (2.6-9.2)	12.1 (9.8-15.0)	19.2 (15.2-24.0)
2005	215.0 (194.6-237.2)	25.9 (21.1-31.7)	40.9 (36.2-46.0)	31.7 (26.8-37.5)	18.2 (15.5-21.4)	3.6 (3.0-4.2)	3.7 (2.9-4.6)	4.0 (2.4-7.0)	8.8 (7.3-10.7)	12.2 (9.8-15.7)
2006	193.7 (174.1-215.6)	31.8 (26.3-39.0)	42.6 (37.1-48.5)	26.7 (22.7-31.9)	16.0 (13.4-18.9)	4.6 (3.9-5.6)	4.5 (3.6-5.8)	1.0 (0.5-2.2)	6.8 (5.4-8.6)	11.5 (8.9-14.3)
2007	131.2 (119.2-145.3)	36.8 (29.8-45.5)	38.4 (34.1-43.2)	23.9 (20.8-27.3)	14.0 (11.9-16.9)	4.3 (3.7-5.1)	5.6 (4.5-7.0)	0.6 (0.3-1.3)	5.9 (4.9-7.2)	12.1 (9.5-15.1)
2008	107.1 (96.2-118.2)	44.6 (36.9-54.0)	35.5 (30.9-40.4)	23.6 (20.5-27.0)	15.9 (12.8-19.3)	6.7 (5.4-8.1)	10.2 (8.1-13.0)	1.0 (0.6-1.8)	6.6 (5.6-7.9)	15.3 (12.1-19.4)
2009	154.4 (141.4-168.5)	60.8 (44.2-86.0)	53.9 (48.1-60.6)	31.2 (27.4-35.4)	19.1 (14.4-25.1)	7.9 (6.2-10.0)	11.3 (8.2-16.0)	1.9 (1.2-3.1)	9.4 (7.8-11.5)	17.0 (13.9-21.5)
2010	190.6 (171.4-211.3)	85.1 (53.0-149.9)	95.5 (80.1-116.0)	37.1 (31.8-44.1)	22.0 (14.1-32.9)	7.7 (6.1-9.8)	10.0 (6.5-16.1)	3.3 (1.9-5.7)	13.9 (11.1-17.6)	17.8 (14.0-23.4)
2011	164.4 (150.7-178.7)	70.9 (46.3-117.7)	73.7 (66.1-82.1)	31.2 (27.2-36.4)	17.9 (13.0-25.0)	8.4 (7.1-10.2)	8.8 (5.7-13.6)	2.7 (1.9-4.0)	12.6 (10.6-15.0)	17.7 (14.7-21.7)
2012	157.5 (142.5-172.8)	71.9 (46.2-116.4)	65.3 (55.3-76.3)	29.1 (25.1-34.1)	20.0 (14.4-28.8)	13.5 (10.9-16.9)	11.8 (7.4-18.5)	3.6 (2.2-5.8)	12.4 (10.0-15.3)	18.4 (14.5-23.2)
2013	162.1 (148.2-175.9)	36.6 (27.4-51.2)	56.4 (48.5-64.6)	33.8 (29.3-38.7)	16.3 (13.0-20.8)	11.3 (9.0-13.9)	7.4 (5.1-10.7)	3.2 (2.0-5.2)	10.2 (8.4-12.4)	16.4 (13.5-19.9)
2014	165.2 (148.2-183.7)	19.0 (15.4-24.3)	72.4 (61.5-86.3)	34.0 (29.5-39.5)	11.7 (9.4-14.8)	7.2 (5.8-9.0)	4.0 (2.9-6.1)	2.6 (1.7-4.2)	11.0 (8.4-14.6)	14.4 (12.1-17.6)
2015	184.9 (168.8-202.8)	20.0 (16.6-25.0)	64.3 (55.4-74.8)	23.1 (20.1-26.7)	10.7 (8.8-13.1)	6.1 (5.0-7.4)	3.5 (2.7-5.4)	1.6 (1.1-2.3)	14.9 (12.5-18.7)	13.8 (12.0-16.1)
2016	158.0 (143.6-173.2)	25.3 (20.8-31.1)	50.1 (43.8-57.2)	13.6 (11.4-16.0)	10.5 (8.8-12.5)	7.1 (5.9-8.6)	5.1 (4.0-6.8)	0.9 (0.7-1.4)	17.0 (14.0-20.9)	11.4 (9.6-13.6)
2017	193.9 (178.6-211.3)	32.4 (25.7-41.9)	71.0 (63.9-79.1)	17.0 (14.6-19.8)	12.5 (10.3-15.1)	10.2 (8.3-12.6)	8.4 (6.3-11.3)	1.3 (0.9-1.8)	21.8 (18.2-26.1)	12.1 (10.1-14.4)
2018	179.5 (160.1-202.7)	18.1 (14.6-22.9)	87.1 (76.2-100.8)	22.7 (19.3-27.3)	7.9 (6.5-9.7)	6.2 (5.0-7.9)	5.5 (4.1-7.8)	1.4 (0.9-1.9)	16.8 (12.4-22.6)	9.7 (7.6-12.4)

** Reported catches were used for these species*

Table 25 Annual sea turtle catch estimates (‘000s individuals, 95% CIs in parentheses where applicable) by species/species group for longline effort a) north of 10°N, b) 10°S to 10°N, and c) south of 10°S.

a) north of 10°N

Year	Olive ridley turtle	Green turtle	Loggerhead turtle	Leatherback turtle	Hawksbill turtle	Marine turtles nei
2003	3.3 (1.3-8.8)	0.3 (0.0-1.5)	0.1 (0.0-4.5)	0.2 (0.1-0.7)	0.0 (0.0-0.5)	2.3 (0.5-10.8)
2004	1.5 (0.7-3.7)	0.5 (0.2-1.7)	0.6 (0.1-2.3)	0.2 (0.1-0.6)	0.0 (0.0-0.2)	3.1 (1.2-9.1)
2005	1.7 (0.8-4.0)	0.5 (0.2-1.4)	3.2 (1.4-7.4)	0.3 (0.1-0.7)	0.0 (0.0-0.3)	2.3 (1.1-4.9)
2006	1.2 (0.5-3.6)	0.2 (0.1-0.7)	6.4 (3.4-11.8)	0.3 (0.1-0.6)	0.1 (0.0-0.3)	1.1 (0.5-2.2)
2007	4.6 (1.6-15.6)	1.0 (0.4-2.5)	4.6 (2.5-8.7)	0.3 (0.2-0.8)	0.1 (0.0-0.4)	0.8 (0.3-2.4)
2008	5.3 (2.2-14.8)	1.7 (0.7-4.4)	2.4 (1.2-4.8)	0.3 (0.1-0.6)	0.1 (0.0-0.4)	0.2 (0.1-0.7)
2009	5.4 (2.5-13.9)	1.3 (0.6-3.4)	1.2 (0.6-2.6)	0.3 (0.1-0.7)	0.2 (0.1-0.9)	0.1 (0.0-0.4)
2010	4.9 (2.5-11.1)	0.6 (0.2-1.6)	1.3 (0.5-3.0)	0.4 (0.2-1.0)	0.4 (0.1-1.8)	0.1 (0.0-0.3)
2011	2.6 (1.2-6.3)	0.6 (0.2-1.5)	1.6 (0.8-3.1)	0.5 (0.2-1.1)	0.2 (0.0-0.9)	0.1 (0.0-0.5)
2012	1.3 (0.6-3.1)	0.5 (0.2-1.4)	2.1 (1.0-4.3)	0.4 (0.2-0.8)	0.1 (0.0-0.6)	0.2 (0.1-0.5)
2013	1.3 (0.8-2.6)	0.6 (0.3-1.3)	2.1 (1.3-3.6)	0.4 (0.3-0.8)	0.1 (0.0-0.3)	0.4 (0.2-0.9)
2014	2.6 (1.5-4.8)	0.9 (0.4-2.3)	1.6 (1.1-2.4)	0.5 (0.3-0.9)	0.1 (0.1-0.5)	1.7 (0.9-3.8)
2015	2.8 (1.7-4.9)	0.8 (0.4-1.9)	2.3 (1.7-3.0)	0.5 (0.3-0.8)	0.1 (0.1-0.4)	3.0 (1.6-6.9)
2016	2.4 (1.5-3.9)	0.6 (0.3-1.3)	2.1 (1.4-3.2)	0.3 (0.2-0.6)	0.1 (0.0-0.3)	4.5 (2.4-10.2)
2017	3.0 (2.1-4.6)	0.5 (0.3-0.9)	1.9 (1.3-2.7)	0.2 (0.2-0.4)	0.1 (0.0-0.2)	3.7 (2.2-7.6)
2018	1.1 (0.6-2.0)	0.3 (0.2-0.4)	1.3 (0.8-2.0)	0.1 (0.1-0.3)	0.1 (0.0-0.1)	3.3 (1.6-7.5)

b) 10°S to 10°N

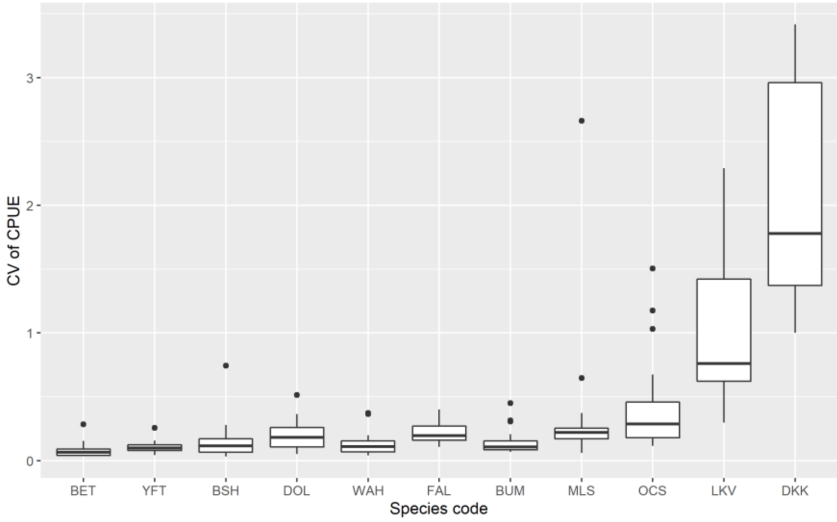
Year	Olive ridley turtle	Green turtle	Loggerhead turtle	Leatherback turtle	Hawksbill turtle	Marine turtles nei
2003	3.3 (1.7-7.7)	0.3 (0.1-1.6)	0.0 (0.0-0.8)	0.4 (0.1-1.3)	0.1 (0.0-1.2)	0.2 (0.1-0.9)
2004	4.2 (2.1-8.6)	0.8 (0.3-1.8)	0.1 (0.0-0.5)	0.3 (0.1-0.8)	0.1 (0.0-0.5)	0.3 (0.1-0.7)
2005	3.1 (1.9-5.2)	0.4 (0.2-0.8)	0.4 (0.2-0.8)	0.2 (0.1-0.4)	0.1 (0.0-0.4)	0.2 (0.1-0.4)
2006	4.1 (2.2-8.6)	0.3 (0.1-0.6)	0.9 (0.5-1.6)	0.3 (0.1-0.6)	0.2 (0.1-0.6)	0.1 (0.0-0.3)
2007	13.4 (6.8-29.7)	1.1 (0.6-2.0)	0.8 (0.5-1.5)	0.3 (0.2-0.6)	0.2 (0.1-0.7)	0.1 (0.0-0.2)
2008	12.1 (6.4-25.8)	1.7 (0.9-3.5)	0.4 (0.2-0.8)	0.2 (0.1-0.5)	0.2 (0.1-0.8)	0.0 (0.0-0.1)
2009	17.2 (10.2-30.6)	1.9 (1.0-3.6)	0.3 (0.1-0.6)	0.3 (0.2-0.7)	0.6 (0.2-1.9)	0.0 (0.0-0.1)
2010	10.7 (6.2-20.1)	1.0 (0.4-2.1)	0.4 (0.2-1.0)	0.6 (0.3-1.2)	1.1 (0.3-4.2)	0.0 (0.0-0.1)
2011	6.7 (4.0-11.8)	1.0 (0.5-1.8)	0.7 (0.4-1.4)	0.7 (0.4-1.3)	0.7 (0.2-2.1)	0.0 (0.0-0.1)
2012	8.8 (4.2-17.5)	1.9 (1.2-3.1)	1.0 (0.5-2.3)	0.9 (0.6-1.6)	0.4 (0.1-1.5)	0.0 (0.0-0.1)
2013	6.3 (3.9-10.8)	1.9 (1.3-3.2)	0.6 (0.4-1.1)	0.9 (0.6-1.3)	0.3 (0.1-0.8)	0.1 (0.0-0.2)
2014	7.4 (4.7-11.7)	2.3 (1.4-3.9)	0.8 (0.4-1.6)	0.9 (0.5-1.5)	0.8 (0.3-2.5)	0.2 (0.1-0.3)
2015	7.2 (4.8-11.3)	1.9 (1.3-3.0)	0.7 (0.4-1.2)	0.9 (0.6-1.6)	0.6 (0.3-1.9)	0.5 (0.3-0.9)
2016	4.2 (3.0-6.0)	1.0 (0.6-1.5)	0.4 (0.2-0.6)	0.4 (0.2-0.7)	0.3 (0.2-0.6)	0.4 (0.3-0.7)
2017	4.6 (3.3-6.8)	0.8 (0.6-1.2)	0.3 (0.2-0.5)	0.3 (0.2-0.4)	0.2 (0.1-0.5)	0.5 (0.4-0.7)
2018	4.3 (2.3-8.6)	0.9 (0.6-1.3)	0.4 (0.3-0.7)	0.3 (0.2-0.6)	0.3 (0.2-0.7)	0.6 (0.4-1.0)

c) south of 10°S

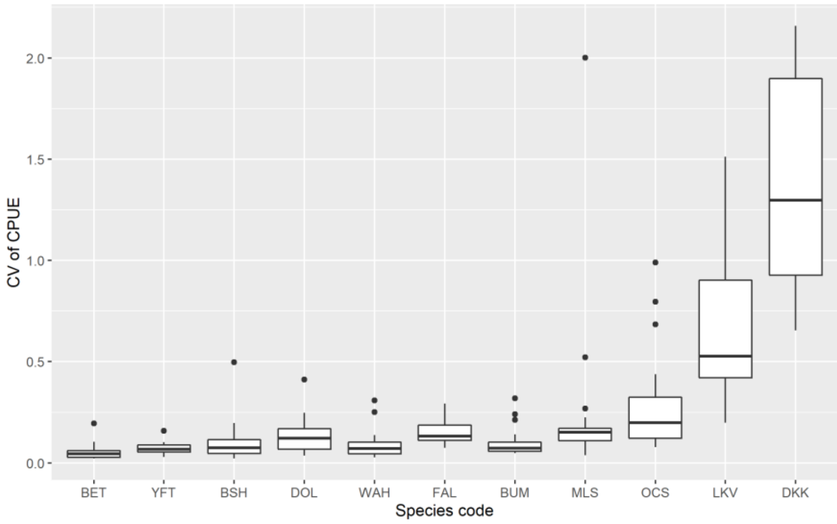
Year	Olive ridley turtle	Green turtle	Loggerhead turtle	Leatherback turtle	Hawksbill turtle	Marine turtles nei
2003	0.4 (0.2-0.9)	0.2 (0.0-0.9)	0.0 (0.0-0.9)	0.1 (0.0-0.5)	0.2 (0.0-1.7)	0.3 (0.1-1.0)
2004	0.5 (0.2-1.0)	0.5 (0.2-1.2)	0.1 (0.0-0.5)	0.1 (0.0-0.4)	0.1 (0.0-0.6)	0.3 (0.1-0.6)
2005	0.6 (0.3-1.0)	0.4 (0.2-0.7)	0.4 (0.2-1.1)	0.2 (0.1-0.4)	0.1 (0.0-0.6)	0.2 (0.1-0.5)
2006	0.8 (0.4-1.5)	0.2 (0.1-0.5)	0.8 (0.4-1.8)	0.2 (0.1-0.4)	0.2 (0.1-1.0)	0.1 (0.0-0.3)
2007	1.4 (0.8-2.5)	0.5 (0.3-1.1)	0.7 (0.4-1.5)	0.2 (0.1-0.4)	0.5 (0.2-2.0)	0.0 (0.0-0.1)
2008	1.2 (0.7-2.2)	0.9 (0.5-1.9)	0.2 (0.1-0.5)	0.1 (0.1-0.3)	0.3 (0.1-0.9)	0.0 (0.0-0.1)
2009	1.3 (0.9-2.1)	0.8 (0.4-1.7)	0.2 (0.1-0.3)	0.2 (0.1-0.5)	0.6 (0.2-2.1)	0.0 (0.0-0.0)
2010	1.7 (1.0-3.2)	0.5 (0.2-1.2)	0.2 (0.1-0.6)	0.4 (0.2-0.8)	1.0 (0.3-4.3)	0.0 (0.0-0.1)
2011	1.0 (0.6-1.7)	0.4 (0.2-0.8)	0.3 (0.2-0.6)	0.3 (0.2-0.7)	0.5 (0.2-1.5)	0.0 (0.0-0.1)
2012	0.6 (0.3-1.1)	0.7 (0.4-1.2)	0.4 (0.2-0.8)	0.5 (0.3-0.8)	0.2 (0.1-0.9)	0.0 (0.0-0.1)
2013	0.5 (0.3-0.7)	0.7 (0.5-1.3)	0.4 (0.2-0.6)	0.5 (0.3-0.7)	0.2 (0.1-0.7)	0.1 (0.0-0.1)
2014	0.8 (0.5-1.4)	0.8 (0.5-1.3)	0.4 (0.2-0.7)	0.4 (0.3-0.7)	0.4 (0.2-1.0)	0.2 (0.1-0.3)
2015	0.8 (0.5-1.6)	0.7 (0.4-1.1)	0.4 (0.3-0.7)	0.4 (0.2-0.6)	0.4 (0.2-1.1)	0.4 (0.3-0.7)
2016	0.6 (0.4-0.8)	0.5 (0.3-1.0)	0.4 (0.3-0.7)	0.2 (0.1-0.4)	0.3 (0.1-0.7)	0.5 (0.3-0.7)
2017	0.5 (0.4-0.8)	0.6 (0.4-1.1)	0.4 (0.3-0.8)	0.2 (0.1-0.5)	0.3 (0.1-1.2)	0.7 (0.5-1.1)
2018	0.3 (0.2-0.6)	0.4 (0.2-0.7)	0.3 (0.2-0.5)	0.1 (0.1-0.3)	0.2 (0.1-0.8)	0.6 (0.4-1.1)

Additional figures

a) 10 % of sets



b) 20 % of sets



b) 50 % of sets

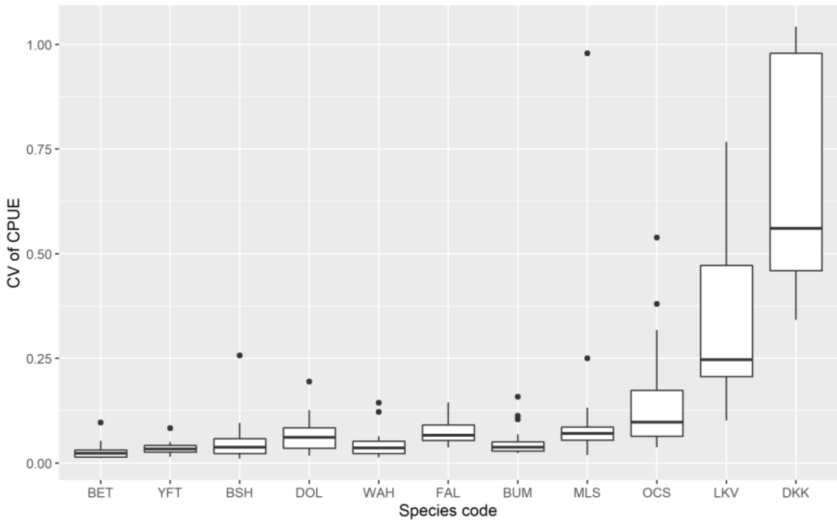
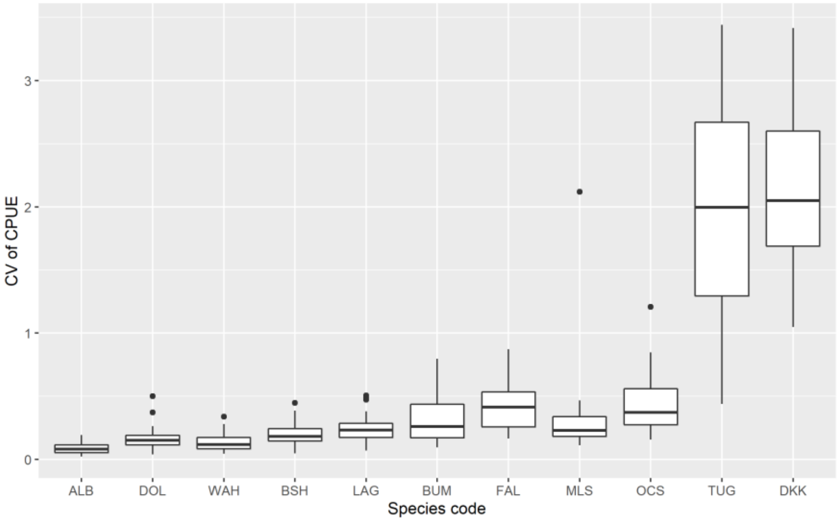
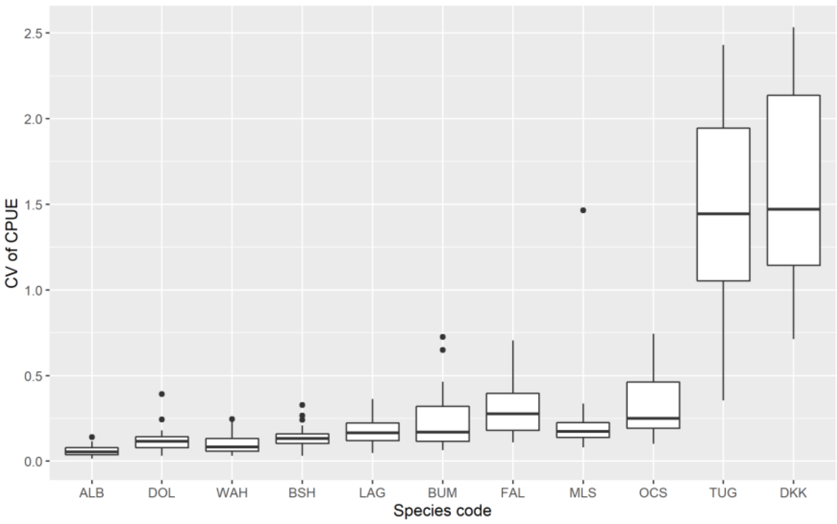


Figure 5 Estimated coefficients of variation of catch rates by species for longline effort 10°S to 20°N, with a target coverage rate of a) 10 % of sets, b) 20 % of sets and c) 50 % of sets, and partial coverage of all trips. Note that the scale of the y-axis varies between panels.

a) 10 % of sets



b) 20 % of sets



b) 50 % of sets

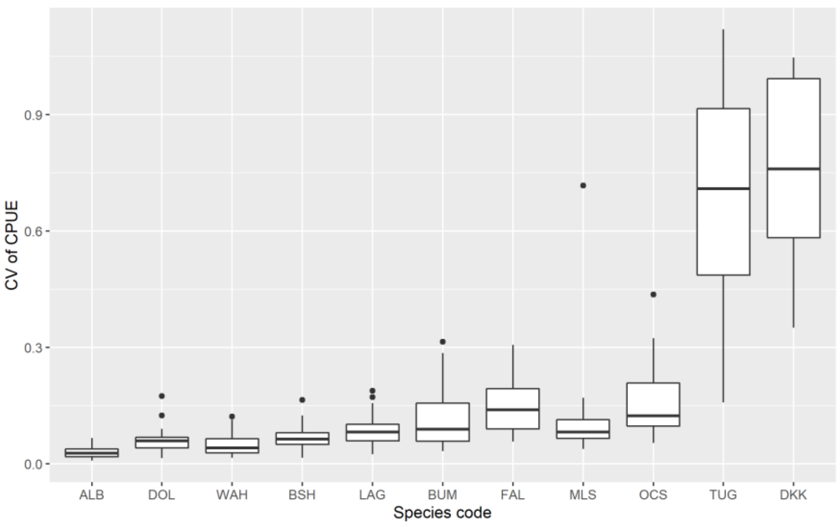
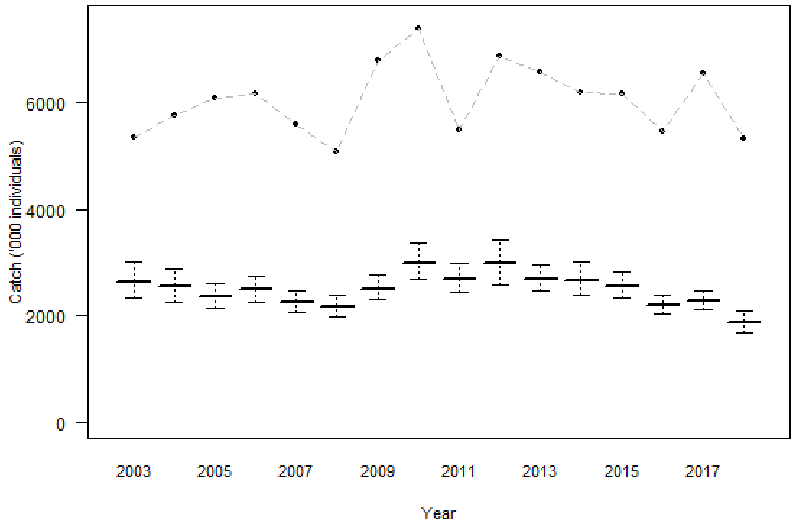
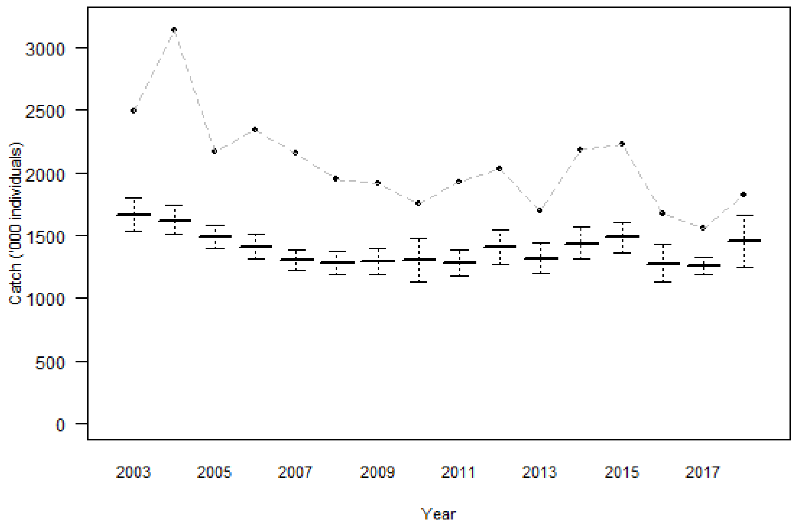


Figure 6 Estimated coefficients of variation of catch rates by species for longline effort 30°S to 10°S, with a target coverage rate of a) 10 % of sets and b) 20 % of sets, and partial coverage of all trips. Note that the scale of the y-axis varies between panels.

a) Albacore



b) Bigeye



c) Yellowfin

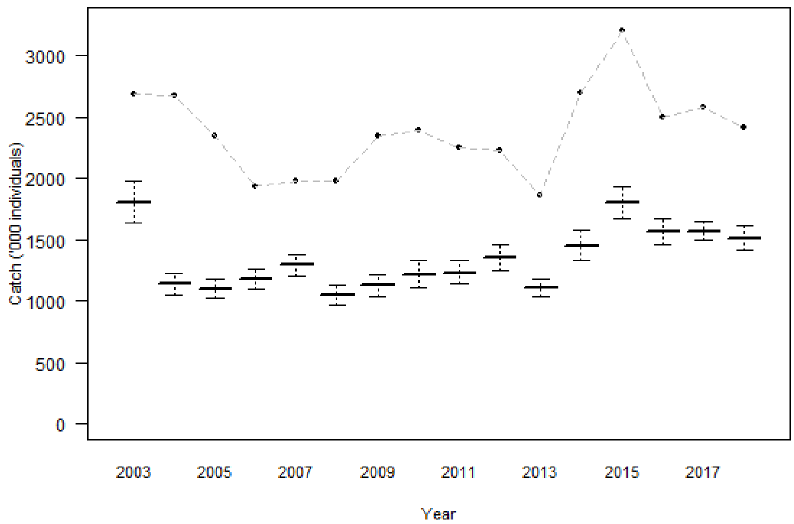


Figure 7 Annual reported (black points) and estimated catches for a) albacore, b) bigeye and c) yellowfin. The median estimated catch is given by the thick black line, with the thin black lines giving 95 % CIs.

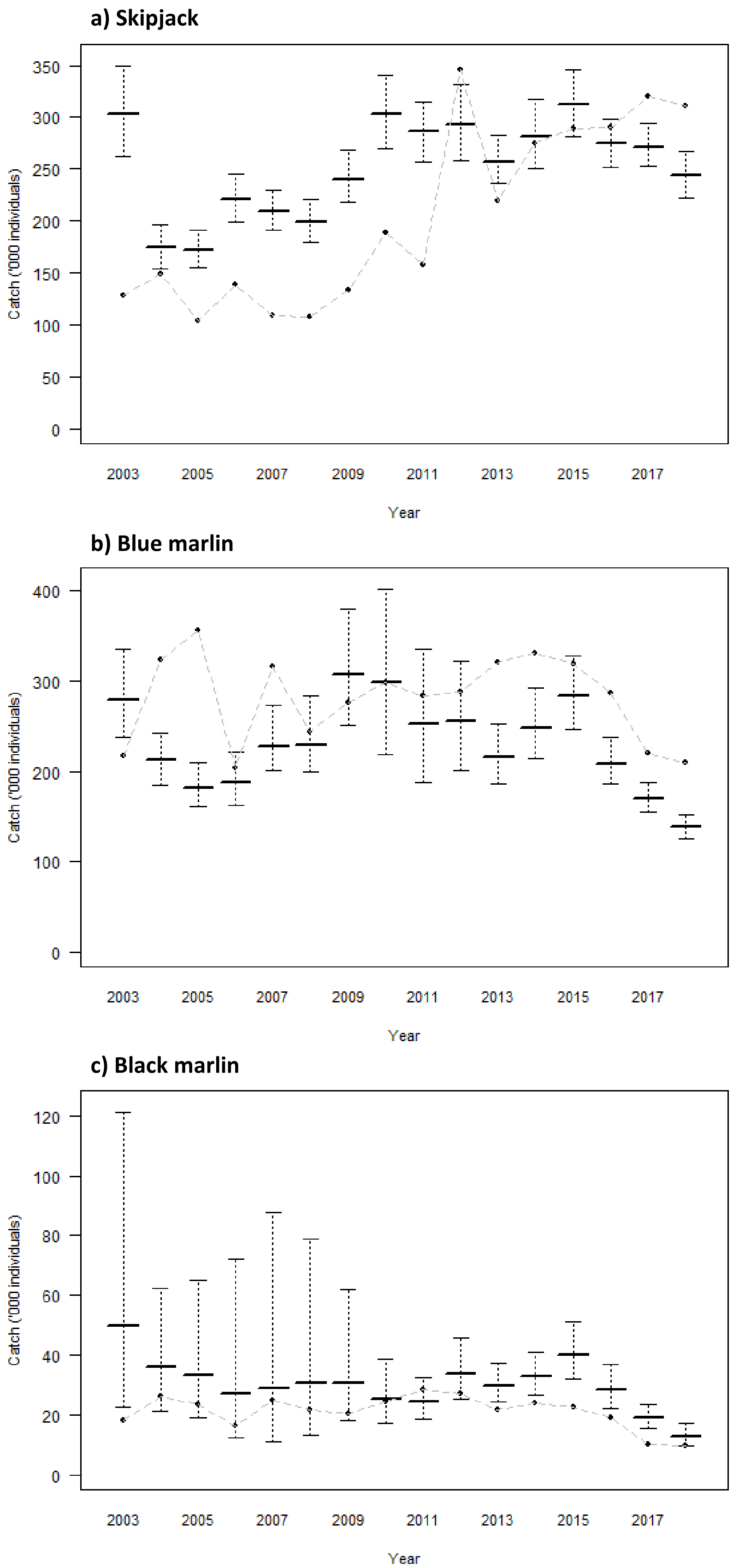


Figure 8 Annual reported (black points) and estimated catches for a) skipjack, b) blue marlin and c) black marlin. The median estimated catch is given by the thick black line, with the thin black lines giving 95 % CIs.

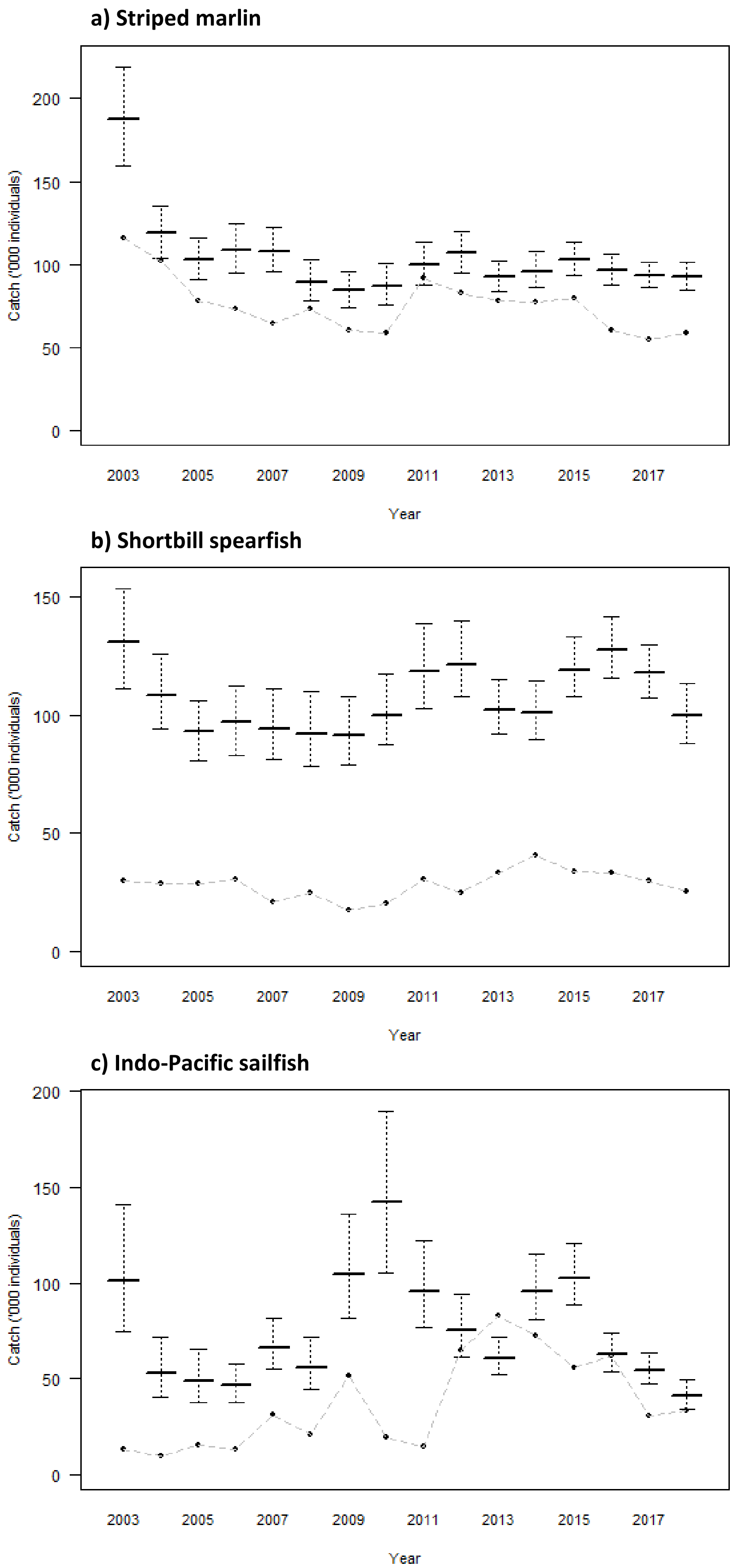


Figure 9 Annual reported (black points) and estimated catches for a) skipjack, b) blue marlin and c) black marlin. The median estimated catch is given by the thick black line, with the thin black lines giving 95 % CIs.

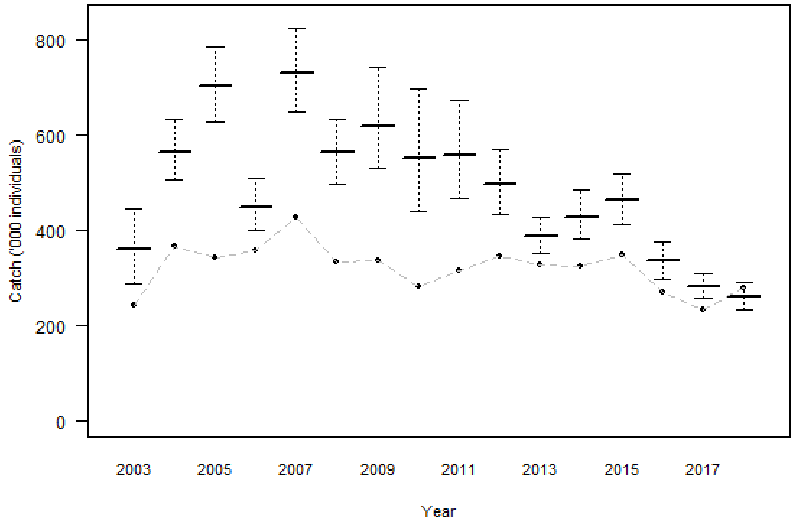


Figure 10 Annual reported (black points) and estimated catches for swordfish. The median estimated catch is given by the thick black line, with the thin black lines giving 95 % CIs.