The catch of SBT by the Indonesian Longline Fishery Operating Out of Benoa, Bali in 2003

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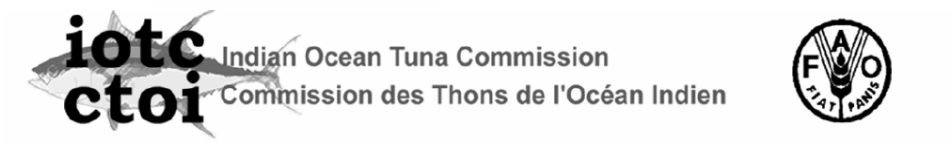

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Abstract

This paper reports on the longline catch of southern bluefin and other tuna and billfish species landed at the Port of Benoa, Bali in 2003. The IOTC method of raising monitored landings to estimate total catch by species and month is described.

The estimated landings in 2003 for southern bluefin, bigeye and yellowfin tuna were 555.6, 5,610.7, and 7,339.3 tonnes (round weight), respectively. The catch of SBT in 2003 is 32.9% of the 2002 estimate. Bigeye also dropped to 50.7% and yellowfin to 75.6% of the 2002 estimates. Part of the drop in catch of southern bluefin tuna between years (21%) could be attributed to changes in the method of raising monitored catches from using Dinas export data to vessel activity data. The remainder of the drop in catch appeared to be a combination of a lower fishing effort due to weather restrictions and fleet dynamics, a possible drop in CPUE, and a shift in environmental conditions delaying the arrival of spawners on the fishing ground in the 2003-2004 spawning season.

Preliminary analysis of the January to May 2004 catch data indicates a further drop in the catch of yellowfin, SBT and bigeye to ~64-68% of the corresponding period in 2003. This would suggest a further reduction in fishing effort in 2004. The catch of all three tuna species in the 2004 spawning season was the lowest so far recorded by this monitoring program, and the percentage of SBT in the catch was the lowest since 1995. The most likely causes of a reduced catch of SBT in the 2003 calendar year and the 2004 spawning season are unusual environmental conditions which affected the availability of SBT on the fishing grounds, a drop in CPUE (in part a consequence of environmental conditions), and a reduction in effort in the fishery.

Introduction

A collaborative project between Indonesia's Research Centre for Capture Fisheries/Research Institute for Marine Fisheries (RCCF/RIMF) and Directorate General for Capture Fisheries (DGCF), CSIRO, AFFA, ACIAR, IOTC and OFCF has established an integrated monitoring program at three major ports where tuna and billfish caught by longline fleets operating in the Indian Ocean are landed and processed. SBT are landed in the most eastern port of Benoa which services longline vessels fishing on the SBT spawning grounds south and east of Central Java. This program started operating in July 2002, expanding on the RCCF/RIMF/CSIRO catch monitoring that has operated since 1993. This paper describes the catch estimation procedure and the subsequent estimated catch of SBT, other tuna, and billfish landed in Benoa in 2003, and provides perspective for the changes between 2002 and 2003.

Methods

Monitoring at Benoa

Catches are monitored by seven enumerators at the fourteen processing plants at Benoa where tuna and billfish landings are processed for export. A target of >30% coverage of landings at each processor each month is maintained. The information is entered on to IOTC's WinTuna database by staff at the Gondol Research Institute of Mariculture, Bali. The resulting data are sent to IOTC after each month's data entry is complete. After data checking, the total catch by species and month is estimated by IOTC.

Estimation of catches

The catch is estimated from a monitored subsample of catches unloaded at all processing plants. The basic estimator is:

$\hat{C} = L_w \bar{C}_l$

It is a simple product of two estimates: 1) an estimate of the number of unloadings (or landings), as a measure of activity of the fleet during the period, and 2) the average catch unloaded during a landing.

1) Vessel Activity Data

Required Data: The number of tuna longline landings per month and processing plant. All fish unloaded from a vessel after its arrival to port, and irrespective of the source of the fish unloaded, constitutes a landing or unloading, and a sampling unit according to the sampling design. In Benoa, unloading can be carried by:

1. Longliners acting as fishing vessels – all the fish unloaded were caught by the unloading vessel.
2. Longliners acting as fishing and carrier vessels – all fish unloaded were caught by the unloading vessel, or caught by other vessels and transshipped at sea to the unloading vessel.

The estimation procedure remains valid irrespective of the unloading vessel operating, or not, as a carrier.

The fish may be target species which include mainly yellowfin, bigeye and southern bluefin tunas and, less frequently, swordfish and marlins (mainly striped marlin) or by-catch which includes mainly billfish species and sharks. Fish are graded and classified into export (packed and air freighted) and reject (sold locally or processed into toro, loin etc. for export) according to its quality.

1. Target species may be unloaded to a single plant or unloaded to two or more plants.
2. By-catch fish are always unloaded to fish auction halls or local markets and never go through processing plants.

The estimation procedure requires an estimate of the **total catch unloaded during a landing**. If there are partial unloadings to more than one processing plant it is necessary to obtain an estimate of the fraction of the catch unloaded actually monitored by the sampling team. Note also that estimates of by-catch are obtained through an independent procedure that does not require an estimate of average catch per landing.

Vessel activity was originally obtained through WASKI[1] who recorded details of the unloading vessel and the date of unloading. However, it eventually became clear that not all unloadings were recorded, and that in situations where a carrier vessel unloaded, WASKI also entered a record for each of the vessels that had contributed to the catch. The former underestimated and the latter overestimated fleet activity.

In order to resolve this problem in Benoa, a revised method of recording vessel activity was developed. The enumerators visit each processing plant daily and record the number of

[1] *Pengawas Kapal Ikan* = Office of Control and Surveillance of Fishing Vessels

landings by longline vessels to those plants. The type of information collected by the enumerators has changed over time:
June 2002-September 2003: Total number of landings per processing plant and day recorded and data aggregated by month.
October 2003 to date: Name of the vessel unloading the fish, name of the processing plant and date of landing are recorded. Since October two enumerators are assigned to collect this information in order to have a more detailed and accurate record of the number of landings as required by the estimating procedure.

2) Average catch per landing data

All fish from the vessel unloaded to the plant selected for sampling are monitored by the sampling team. The following data are collected routinely by enumerators:

Type of landing: Landings of vessels acting as fishing and/or carriers and single fishing vessels are recorded separately.

Classification Variables:
Port: name of the port; sampling is currently conducted in Benoa, Jakarta and Cilacap
Plant: name of the plant where the sample is taken (name of the plant where the sample of target species took place for by-catch fish). When there are partial unloadings to two or more plants, one form is completed for each partial unloading monitored.
Fish Destination: the destination of the fish after grading, i.e. export, reject (target species) or by-catch.
Vessel name: the name of the unloading vessel.
Sampler's name: the name of the sampler recording the information. Sampling teams are usually made up of two or three enumerators and therefore only the name of one of them is recorded.
Date Sampling Started: The date the sampling of the landing selected started
Date Sampling Ended: The date the sampling of the landing selected finished
The following applies only to carrier vessels:
Total vessels: number of vessels whose catches are unloaded by the carrier (including the carrier if it is unloading its own catch)
Vessels Sampled: number of vessels represented in the portion of the landing monitored. The enumerators can obtain information on the number of vessels that contributed to the landing from the vessel skippers or the plant managers. In some cases, the individual names of the vessels are also available.

Sampling Variables:
Vessel number (applies only to carrier vessels): Each fish unloaded from a carrier vessel is labeled according to the vessel that caught it, making it possible for enumerators to identify catches that come from different vessels. Therefore, each fish is numbered from 1 to n (n being the number of vessels sampled) according to its label.
Species: The name of the species.
Fish Count: The number of specimens measured; fish are measured and recorded individually whenever it is possible. Specimens weighed in groups (usually by-catch) are sometimes difficult to monitor individually; total number of specimens and total weight are recorded in these cases.
Weight: Weight of the specimen/s.
Weight Units: the weight units used (set to kilograms).

Fish Processing: The type of processing the fish undergoes.
Fish Length1: Length of the specimen (obligatory when fish weight is not available).
Measurement Type1: Type of measurement.
Length Units: The length units used (set to cm).

3) Catch Estimation Process

The weight of each specimen is converted to round (whole) weight according to species and type of processing using the appropriate conversion value. Where weight is not recorded, the length of each specimen is converted into round weight according to the species and type of measurement and a formula specific to each case (weights are available for all export and reject specimens in Benoa, so conversion is not needed).

When enumerators are unable to monitor catches of carrier vessels going through several plants, the proportion of catches sampled is assessed from the number of vessels whose catches were unloaded from the carrier through the plant/s where the sample/s occurred (see classification variables, *Vessels Sampled*) and the total number of vessels whose catches are unloaded from the carrier (*Total vessels*). This is used to raise the catches when necessary: Thus, *Total RoundWeight = RoundWeight*TotalVessels/VesselsSampled.*

These data are then aggregated by strata – year, month, plant and species. Total catches for all strata covered through sampling are then raised by the coverage rates recorded by the enumerators for each stratum. Total catches for strata not covered through sampling are estimated according to the total catches estimated per month and year from all plants covered through sampling (only three cases have occurred).

Results

The estimated monthly landings of tuna and billfish at Benoa in 2003 are shown in Table 1. There was excellent coverage of all processing plants throughout the year. Based on records by the enumerators, 42% of landings were monitored in 2003.

Catches for all tuna species in 2003 were down from the previous year (Table 2). SBT estimated landings of 555.6 tonnes showed the most dramatic change being only 32.9% of the 2002 estimate and the lowest catch estimate since monitoring began in 1993 (Figure 1). Bigeye and yellowfin tuna landings also declined in 2003 but not quite to the same extent as SBT. Bigeye dropped to 50.7% of 2002 estimates and yellowfin dropped to 75.6% of 2002 estimates.

The estimated catch of SBT for the 2002 spawning season (July 2001 to June 2002) was the highest on record (2,444.8 tonnes), whereas the 2003 spawning season estimate was one of the lowest at 740.8 tonnes (Figure 2).

The 2002 spawning season had two very large peaks in catches which is a little unusual, although not significantly so. The second peak tends to be a lot smaller than the first, if the latter is large (Figure 3). Two large peaks resulted in an exceptionally high 2002 spawning season catch.

It was reported that the estimate for February to April 2002 was probably too high based on the low coverage (<3%) and the magnitude of the raised catch in these months (Davis and Andamari, 2003a). However, this did not take into account that overall catches for the 2002 spawning season were high. The percentage of the estimated catch taken in February to March was 36.5% of the catch for the whole of the 2002 spawning season (Figure 2). This does not stand out as an outlier when compared to a mean of 31.04% (SD=12.01) for all 9 seasons. Also, there is not any large trend in this percentage over time (Figure 4). Based on this, we would conclude that there is no reason to suggest that the estimates in February to March 2002 are biased, although it is clearly more uncertain than in some other years, and that no corrections to these months should be applied.

Discussion

The southern bluefin tuna catch landed in Benoa is very much lower in 2003 than in previous years and a number of points need to be considered to put this change in context.

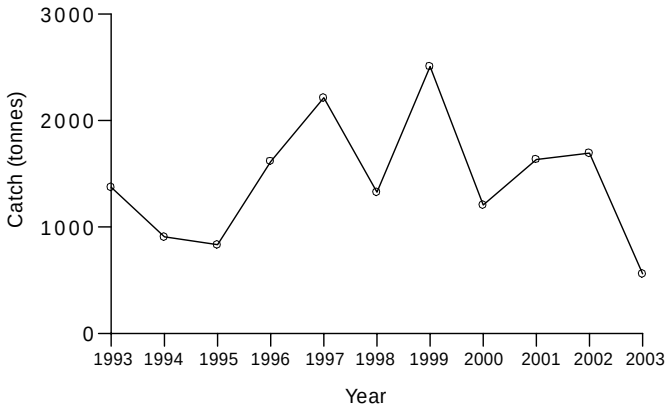

Figure 1. The estimated catch (round weight) of SBT by year.

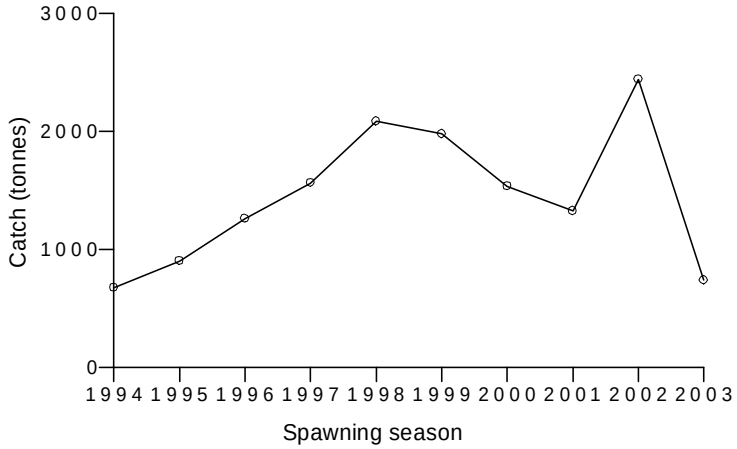

Figure 2. The estimated catch (round weight) of SBT by spawning season. A spawning season is defined as July 1 of the previous year to June 30 of the given year.

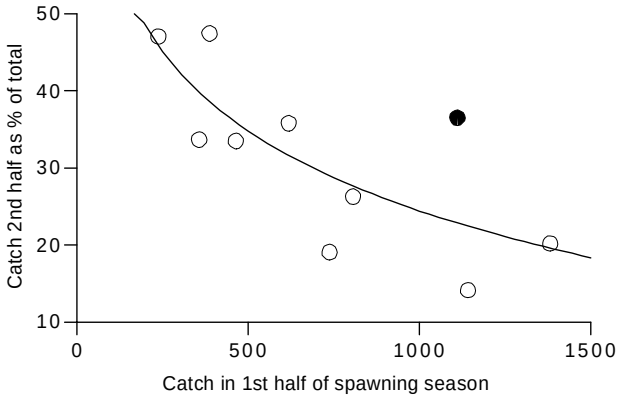

Figure 3. Catch in the second half of the spawning season expressed as a percentage of the total catch in the spawning season plotted against the catch (tonnes round) in the first half of the spawning season. The 2002 spawning season is the solid point. A spawning season is defined as July 1 of the previous year to June 30 of the given year. Line fitted to all points is a log smoother.

The most obvious question is whether the method of raising catches used by IOTC has caused the dramatic change in estimated catch of SBT between years. To investigate this, the IOTC monitored catch was raised by the method used in previous years by the RCCF/RIMF/CSIRO catch monitoring program. This was based on monitored export grade tuna and Dinas[2] statistics for fresh and frozen export whole tuna[3]. Details are provided in Davis and Andamari (2003b). This resulted in Dinas raised whole round weights for southern bluefin of 757.8 tonnes (Table 3). So the transition from Dinas export raising to vessel activity raising could account for a drop of 26.7%. As the Dinas export raising was only applied to the first half of 2002 (January-June 2002) in which 78.9% of the 2002 annual catch was landed, the drop between 2002 and 2003 due to the change in raising method would be 78.9% of that estimated in Table 3 – namely 21%. This assumes that there had been no changes in the nature or recording of exports between years. So, about 1/3 of the 67.1% drop in southern bluefin tuna landings between 2002 and 2003 could be attributed to the effect of changing raising from Dinas export data to vessel activity data. The remainder of the change must have been due to a drop in CPUE and/or a drop in effort.

Interviews with representatives of the Association of Tuna Longliners Indonesia (ATLI), WASKI, and the senior enumerator uncovered the following points:

- Hook rate for bigeye tuna by a fishing company targeting bigeye has dropped from 6.2 fish/1000 hooks in 2002 to 4.0 in 2003. So CPUE has dropped for bigeye and probably has also dropped for southern bluefin tuna.
- There were two weeks of bad fishing weather in February 2003 and also in October 2003 that would have affected catches of southern bluefin tuna which normally peak in those periods.
- In August 2003 around 100 boats changed from tuna longlining to grouper and squid fishing. So tuna fishing effort has declined and would impact more on southern

[2] Full title: *Dinas Perikanan dan Kelautan Propinsi Bali* = Office of Fisheries and Marine Affairs for Province of Bali

[3] A large single consignment of frozen tuna in December (5,340 tonnes) was not included as it was an accumulation over the year of tuna frozen at sea which bypassed the export processing plants and the monitoring. Many boats (>60) fitted freezers on board in 2003.

bluefin tuna than the other species because it occurred just prior to the peak catch months of the 2003-2004 spawning season.

- Also, in December 2003, 60 boats moved to Sri Lanka and 50 boats moved to the Maldives – these boats came from Jakarta and Benoa. One processor has closed due to this movement. Both the change in fishing to species other than tuna, and exodus from the Port of Benoa appears to be due to low profitability in the tuna longline fishery caused by a marked increase in fuel costs in 2003, lower catch rates, and smaller profit margins on export due to low prices and increasing airfreight costs.
- Albacore continued to be caught in October and November which is unusual. This might indicate that unusual environmental conditions occurred which may have resulted in the low catches of southern bluefin tuna in October – normally a month when catches peak. There were larger than usual catches of southern bluefin tuna in December, which is exceptional, as it is normally a quiet month. This probably indicates that the movement of SBT onto the spawning ground may be later than usual in the 2003-2004 spawning season.

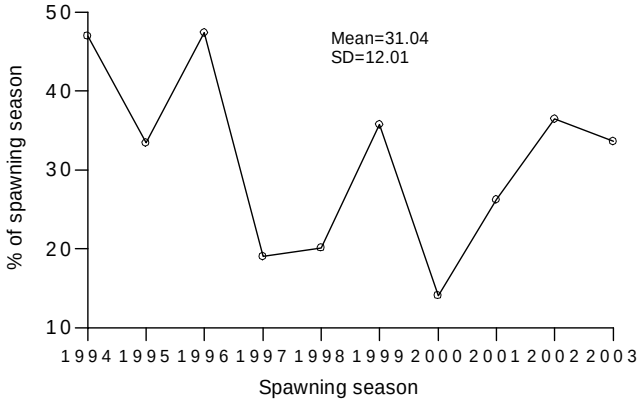

Figure 4. The estimated catch (round weight) of SBT from February to April expressed as a percentage of the total estimated catch in that spawning season. A spawning season is defined as July 1 of the previous year to June 30 of the given year.

As the dramatic drop in catch of SBT between 2002 and 2003 might indicate a "collapse" in the SBT spawning stock it is important to provide an indication of how the fishery is performing in 2004. We have used uncorrected data from the January to May 2004 monitoring at Benoa to produce a preliminary catch estimate for bigeye, SBT and yellowfin during this period (Table 4). In comparison with the catch for the same period in 2003 the catch of all species is further reduced to 64-68% of the previous year. As this reduction is consistent across all species, it is likely that it represents an effort reduction in the fishery rather than an identical decline in CPUE for three species with different population dynamics. There has been an increase in catch of SBT in the second half of the 2004 spawning season (January-May 2002) to 260 tonnes compared to the 172 tonnes caught in the first half (July-December 2003). The percentage composition of the three species in January to May has not changed between 2003 and 2004 and is higher than 2000 and 2001(Table 5). January to May 2002, on the other hand, appears to be the outlier with an unusually high percentage of SBT in landings.

The estimated landings of the three main species of tuna and % species composition by spawning season are shown in Tables 6 and 7, although 2004 is preliminary and does not include June data. The observed decline in SBT catch in the 2003 spawning season is exacerbated by the unusually high catch of SBT in the 2002 season. Catches of bigeye, SBT

and yellowfin continued to decline in the 2004 season with the lowest catches for all three species since monitoring began and the percentage of SBT in the tuna catch being the lowest since 1995. The most likely causes of a reduced catch of SBT in the 2003 calendar year and the 2004 spawning season are unusual environmental conditions which affected the availability of SBT on the fishing grounds, a drop in CPUE (in part a consequence of environmental conditions), and a reduction in effort in the fishery.

Acknowledgements

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References

Davis, T.L.O. and Andamari. R. 2003a. The catch of SBT by the Indonesian longline fishery operating out of Benoa, Bali in 2002. Report for the Eight Scientific Meeting of the Commission for the Conservation of Southern Bluefin Tuna, 1-4 September 2003, Christchurch, New Zealand. CCSBT-ESC/0309/17.

Davis, T.L.O. and Andamari. R. 2003b. The CSIRO/RIMF Monitoring Systems Used To Determine The Catch Of SBT By The Indonesian Longline Fishery. Commission for the Conservation of Southern Bluefin Tuna, Indonesian Catch Monitoring Review Workshop, 10-11 April 2003, Queenstown, New Zealand. CCSBT-ICM/03/04/06.

Table 1. Estimated landings (tonnes round weight) by species by month for Benoa in 2003.

	1	2	3	4	5	6	7	8	9	10	11	12	Total
Albacore	21.74	104.85	123.11	248.27	234.24	504.06	375.27	602.58	775.43	333.75	77.10	7.41	**3,407.82**
Bigeye	493.99	476.61	336.98	506.61	400.50	523.52	446.45	427.56	420.53	533.56	596.80	447.62	**5,610.73**
Marlins	194.13	135.50	138.11	174.70	114.14	82.06	73.07	90.80	59.80	90.08	118.01	168.40	**1,438.81**
Southern bluefin	128.06	135.24	70.81	43.01	4.97	1.53	0.33	0.66	23.12	48.30	43.73	55.87	**555.62**
Swordfish	138.94	67.63	62.73	57.90	105.92	142.70	79.06	180.36	102.49	57.99	72.07	62.06	**1,129.86**
Yellowfin	810.20	568.96	568.60	743.98	502.78	670.90	650.57	319.40	455.41	475.97	587.23	1,045.28	**7,399.29**
Total	**1,787.07**	**1,488.79**	**1,300.36**	**1,774.47**	**1,362.55**	**1,924.78**	**1,624.75**	**1,621.35**	**1,836.77**	**1,539.65**	**1,494.94**	**1,786.65**	**19,542.14**

Table 2. Comparison of the landings of tunas (tonnes round weight) at Benoa in 2002 and 2003.

Species	2002	2003	% of previous year
Bigeye	11,070.79	5,610.73	50.7
Southern bluefin	1,690.66	555.62	32.9
Yellowfin	9,789.28	7,399.29	75.6
Total	**22,550.74**	**13,565.64**	**60.2**

Table 3. Comparison of monthly estimated landings (tonnes round weight) of southern bluefin in 2003 using raising by Dinas exports (old RCCF/RIMF/CSIRO method) and vessel activity (new IOTC method)[4].

Month	1	2	3	4	5	6	7	8	9	10	11	12	Total	% Drop
Dinas	184.5	263.9	106.1	40.1	5.2	2.1	0.5	0.8	14.7	36.8	45.3	57.7	**757.8**	
IOTC	128.06	135.24	70.81	43.01	4.97	1.53	0.33	0.66	23.12	48.30	43.73	55.87	**555.6**	26.7

[4] The two types of raising give comparable estimates for all months except January to February 2003. The difference in January to February is not due to a transition in raising methods by IOTC as the enumerator estimated coverage, not WASKI vessel activity, has been used since IOTC monitoring started in July 2002.

Table 4. Landings of tunas (tonnes round weight) at Benoa during January to May for the years 2000-2004. The catch estimates for 2004 are preliminary and uncorrected, and should only be considered a guide as to the final estimate. The right hand column is the 2004 catch expressed as a fraction of the 2003 catch.

Species	2000	2001	2002	2003	2004	2004/2003
Bigeye	3814.44	3621.08	6073.62	2214.69	1415.50	0.64
Southern bluefin	395.79	520.43	1323.17	382.09	260.70	0.68
Yellowfin	7305.29	5433.55	5236.30	3194.52	2128.10	0.67
Total	11515.52	9575.06	12633.09	5791.31	3804.30	0.66

Table 5. Percent species composition of tuna landings at Benoa during January to May for the years 2000-2004. The catch estimates for 2004 are preliminary and uncorrected, and should only be considered a guide as to the final estimate.

Species	2000	2001	2002	2003	2004
Bigeye	33.1	37.8	48.1	38.2	37.2
Southern bluefin	3.4	5.4	10.5	6.6	6.9
Yellowfin	63.4	56.7	41.4	55.2	55.9
Total	100.0	100.0	100.0	100.0	100.0

Table 6. Estimated landings of tunas (tonnes round weight) at Benoa by spawning season. A spawning season is defined as July 1 of the previous year to June 30 of the given year. The catch estimates for 2004 are preliminary and do not include June data.

Species	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Bigeye	6,021.2	7,266.6	9,245.3	11,906.3	10,829.8	13,473.0	9,904.8	9,207.3	13,470.4	6,181.8	4,288.0
Southern bluefin	677.5	906.1	1,263.7	1,566.1	2,087.3	1,981.3	1,538.1	1,327.2	2,444.8	740.8	432.7
Yellowfin	13,911.9	12,923.3	10,243.3	13,458.5	13,139.1	20,532.1	15,825.6	11,397.2	12,892.3	7,262.0	5,662.0
Total	20,610.6	21,096.1	20,752.3	26,930.9	26,056.2	35,986.4	27,268.4	21,931.8	28,807.5	14,184.6	10,382.7

Table 7. Species composition (%) of tuna landings at Benoa by spawning season. A spawning season is defined as July 1 of the previous year to June 30 of the given year. The catch estimates for 2004 are preliminary and do not include June data.

Species	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Bigeye	29.2	34.4	44.6	44.2	41.6	37.4	36.3	42.0	46.8	43.6	41.3
Southern bluefin	3.3	4.3	6.1	5.8	8.0	5.5	5.6	6.1	8.5	5.2	4.2
Yellowfin	67.5	61.3	49.4	50.0	50.4	57.1	58.0	52.0	44.8	51.2	54.5