REPORT OF THE 2008 ICCAT
YELLOWFIN AND SKIPJACK STOCK ASSESSMENTS MEETING

(Florianópolis, Brazil – July 21 to 29, 2008)

1. Opening, adoption of Agenda and meeting arrangements

The meeting was opened by Mr. Papa Kebe on behalf of Mr. Driss Meski, ICCAT Executive Secretary. Mr. Kebe thanked the Brazilian government for hosting the meeting and providing all the logistical arrangements. Dr. Joao G. Pereira, General Rapporteur of the Tropical Species Group chaired the meeting.

The Agenda (**Appendix 1**) was adopted with minor modifications. The List of Participants is included in **Appendix 2**. The List of Documents presented at the meeting is attached as **Appendix 3**. The following served as rapporteurs:

P. Pallarés	Items 1, 9 and 10
H. Murua, L.V. González-Ania,	
P. Kebe, G. Scott	Item 2
A. Delgado de Molina, J. Ariz,	
P. Bannerman, E. Chassot	Item 3
H. A. Andrade, K. Ramírez	Item 4
S. Cass-Calay, K. Satoh	Items 5.1, 6.1 and 7.1
V. Restrepo, P. De Bruyn,	
J. Walters, E. Chassot	Items 5.2, 6.2 and 7.2
G. Scott and G. Díaz	Item 8

2. Review of biological information

2.1 Yellowfin

Yellowfin tuna is a tropical and subtropical species distributed mainly in the epipelagic oceanic waters of the three oceans. The sizes exploited range from 30 cm to over 170 cm; maturity occurs at about 100 cm. Smaller fish (juveniles) form mixed schools with skipjack and juvenile bigeye, and are mainly limited to surface waters, while larger fish form schools in surface and sub-surface waters. Reproductive output among females has been shown to be highly variable. The main spawning ground is the equatorial zone of the Gulf of Guinea, with spawning primarily occurring from January to April. Juveniles are generally found in coastal waters off Africa. In addition, spawning occurs in the Gulf of Mexico, in the southeastern Caribbean Sea, and off Cape Verde, although the relative importance of these spawning grounds is unknown. Although such separate spawning areas might imply separate stocks or substantial heterogeneity in the distribution of yellowfin tuna, a single stock for the entire Atlantic is assumed as a working hypothesis, taking into account data that indicates yellowfin are distributed continuously throughout the entire tropical Atlantic Ocean and west to east recovery of tags on a regular base. Males are predominant in the catches of larger sized fish.

Natural mortality is assumed to be higher for juveniles than for adults as showed from tagging studies in other oceans. The natural mortality rates have been showed to be size-dependant in bigeye, skipjack and yellowfin tuna in the western tropical Pacific Ocean using tagging data (Hampton, 2000). In summary, this work demonstrated that M was an order of magnitude higher in the smallest size-class in comparison to fish of midsized. Moreover, it showed that mortality changed from high to low around 40 cm FL, approximately the size at which the three species recruit to the PS fishery in the western Pacific. The results of this work underline the importance of accounting for size- or age-specific natural mortality rates. In that sense, variable mortality for yellowfin was discussed by the group and it was agreed to continue using variable M in the assessment.

Growth rates have been described as relatively slow initially, increasing at the time the fish leave the nursery grounds. Nevertheless, questions remain concerning the most appropriate growth model for Atlantic yellowfin tuna. A recent study (Shuford *et al.*, 2007) developed a new growth curve using daily growth increment counts from otoliths. The results of this study, along with other recent hard part analyses, did not support the concept of the two-stanza growth model (initial slow growth) which is currently used for ICCAT yellowfin tuna stock assessments. This discrepancy can be addressed in future analyses. However, various background documents pertaining to biological information for tropical tunas were distributed with very valuable information about the growth, ecology and behavior of skipjack. These documents were basically peer-reviewed articles and working documents presented to the IOTC Working Party on Tagging Data Analysis and they contained new data in relation to tagging and growth studies of yellowfin. Papers made available from the IOTC Working Party on Tagging Data Analysis were mainly focused on skipjack and yellowfin growth curves in the Indian Ocean. Although the papers were not presented during the meeting, they provided a valuable source of information to compare growth rates between areas and other methods in use. For example, most of the papers considered that yellowfin has a two- or multiple- stanza growth whereas skipjack growth does not present such a pattern.

A document was presented to the Group (SCRS/2008/111) with new information for the western South Atlantic on sizes, sex ratio, and catch rates of yellowfin, collected by the Uruguayan Longline Tuna Fleet Observer Program during 1998-2007. Geographic and seasonal patterns in the proportion of subadults and adults were analyzed, as well as the relationship with sea surface temperature (SST). The highest catches were recorded in Uruguayan territorial waters, associated with the continental slope, especially sub-adult class fish (<100 cm). Higher CPUE occurred in southern latitudes between 35ºS and 37ºS for both adults and sub-adults, with a maximum at 36ºS (1.6 and 4.7 fish/1000 hooks for sub-adults and adults, respectively). The higher CPUE values were also associated to SST between 19º and 21ºC, with the maximum at 21ºC (2.0 and 7.1 fishes/1000 hooks for subadults and adults, respectively) and the minimum for both classes at SST higher than 25ºC. Sex composition was 1.3 males per female. Mean fork length for the whole period was 111.2 ± 16.7 cm (range: 52-180 cm), with minor differences between males (116.9 ±15.4 cm; range: 65-180 cm) and females (117.1 ±14.0 cm; range: 65-162 cm). Lower sizes were recorded between May and August, with a minimum in August (99.0 ± 14.7 cm) and a maximum in December (144.5 ± 12.9 cm). Changes in mean weight or length of fish landed in the fishery can be useful indicators of patterns of exploitation. However, much in the same way that nominal CPUE can be a misleading indicator of stock abundance due to changes in catchability, changes in nominal mean weight may not necessarily be an indicator of population-level changes in the mean weight. Standardization methods similar to those used for CPUE datasets should be considered to separate population-level changes in mean weight from changes in fishing location, timing or selectivity.

2.2 Skipjack

Skipjack tuna is a gregarious species that is found in schools in the tropical and subtropical waters of the three oceans. Skipjack is a species showing an early maturity (around the first or second year of life), high fecundity and spawns opportunistically throughout the year in warm waters above 25ºC (Cayré and Farrugio, 1986). Skipjack is also thought to be a faster-maturing and shorter lived species than yellowfin tuna (Maunder, 2001). Moreover, some works have shown that its growth varies according to latitude (Gaertner *et al.*, 2008 in press).

Skipjack is the predominant species aggregated to FADs where it is caught in association with juvenile yellowfin tuna, bigeye tuna and with other species of epipelagic fauna. The increasing use of fish aggregation devices (FADs) since the early 1990s may have changed the behavior of the tuna schools. In this sense, Fonteneau (2000) noted that the free schools of mixed species were considerably more common prior to the introduction of FADs. Furthermore, the association with FADs may also have acted as an “ecological trap” which, in turn, affected negatively the growth, plumpness of skipjack tuna and may change the movement patterns of this species (Hallier and Gaertner, 2008).

No documents containing new biological information for skipjack were presented at the meeting.

Gaertner *et al.* 2008 (in press) investigated latitudinal variability in growth rates of eastern Atlantic skipjack tuna. They reanalyzed conventional tagging data collected by ICCAT since the 1960s. The results of this study suggest that the growth parameters of skipjack tuna vary with latitude. The estimated L_∞ for skipjack tagged and recovered north of 10°N was lower than the L_∞ estimated for skipjack tagged and recovered south of 10°N (89.4 cm vs. 112.3 cm, respectively), whereas the estimated growth rate coefficient was greater in the northern region of the eastern Atlantic Ocean than in the equatorial areas (K = 0.376 and 0.135, respectively). The growth parameters estimated during this study are consistent with the range of growth estimates obtained in the Atlantic Ocean and in other oceans. However, the estimates of L_∞ and K in the Senegalese region in the 1980s within the framework of the Skipjack Year Program, and traditionally applied in ICCAT assessments, are not supported by this study.

The latitudinal variability in the growth rates would complicate age-structured assessment techniques because the size-at-age would be dependant on geographic location and movement patterns. These authors suggested possible alternatives to standard age-structured models including the use of catch-at-size models and growthtransition matrices by large geographic areas. The Group considered the implications of these results into the assessment. Taking into account the uncertainties associated to the growth curves, the variability in growth between areas and fish movements, no age slicing was performed during this meeting using the available growth curves. It was concluded that a better understanding of skipjack growth patterns is a high priority.

The Group was concerned about the low number of working papers presented during the meeting pertaining to biological information both for yellowfin and skipjack. Moreover, the Group underlined the importance of conducting biological (growth, maturation, reproduction, etc.) and ecological studies for the tropical tuna species for which this information is considered to be poor. This, apart from allowing a more comprehensive knowledge of the processes occurring in the population, will allow using more updated information in the assessment of the tropical tuna species.

The table below summarizes the biological parameters adopted by the SCRS and used in the 2008 Atlantic yellowfin and skipjack (East & West) assessments.

Parameter	*Yellowfin*
Natural mortality	Assumed to be 0.8 for ages 0 and 1, and 0.6 for ages 2+
Assumed "birth date" of age 0 fish	February 14 (approximate mid-point of the peak spawning season).
Plus group	Age 5+
Growth rates	Length at age was calculated from the Gascuel *et al.* (1992) equation: $FL\ (cm) = 37.8 + 8.93 * t + (137.0 - 8.93 * t) * [1 - \exp(-0.808 * t)]^{7.49}$
Weights -at-age	Average weights-at-age were based on the Gascuel *et al.* (1992) growth equation and the Caveriviere (1975) length-weight relationship: $W(kg) = 2.1527 \times 10^{-5} * L(cm)^{2.976}$
Maturity schedule	Assumed to be knife-edge at the beginning of age 3.
Partial recruitment	Based on output from age-structured VPA (see section addressing yield-per-recruit).
	Skipjack (East & West)
Natural mortality	Assumed to be 0.8 for all ages
Assumed "birth date" of age 0 fish	February 14 (approximate mid-point of the peak spawning season)
Plus group	Age 5+
Growth rates	$L\ (cm) = 94.9 * [1 - \exp(-0.340 * t)]$ (West) - Pagavino and Gaertner (1995) $L\ (cm) = 97.258 * [1 - \exp(-0.251 * t)]$ (East) - Hallier and Gaertner (2006)
Weights -at-age	$W(kg) = 7.480 \times 10^{-6} * FL\ (cm)^{3.253}$ (Entire Atlantic)
Maturity schedule	Assumed to be knife-edge at the beginning of age 2.

3. Review of fishery statistics: Effort, and catch data, including size frequencies and fisheries trends

3.1 Description of fisheries

Yellowfin tuna are caught in the entire tropical Atlantic between 45ºN and 40ºS by surface gears (purse seine, baitboat and handline) and by longline **(Figure 1)**. **Table 1** presents the yellowfin landings by flag and gear.

Skipjack are caught almost exclusively by surface gears throughout the Atlantic, although some minor catches are made by longline as by-catch **(Figure 2)**. **Table 2** presents the skipjack landings by flag and gear.

3.1.1 Baitboat

In the East Atlantic, the baitboat fisheries exploit concentrations of juvenile yellowfin in schools mixed with bigeye and skipjack. There are several baitboat fisheries that operate along the African coast.

The most important, in terms of catch, is the Ghanaian baitboat fishery based at Tema. This fleet began to use Fads (fish aggregating device/floating object, which can be natural or artificial) in the early 1990's to enhance the capture of the species together with other tunas. Over 70-80% of these catches in the past five years are off FADs; the mean weight of the captured fishes has remained relatively stable at around 2 kg (mode around 48 cm).

There is another baitboat fishery based in Dakar that began operation in 1956 in the coastal areas off Senegal and Mauritania. Other baitboat fisheries operate in the various archipelagos in the Atlantic (Azores, Madeira, Canary Islands and Cape Verde), which target different species of tuna, including yellowfin and skipjack, according to the season. The average weight of yellowfin tuna taken by these fleets is highly variable (between 7 and 30 kg); lengths range from 38 cm to 80 cm with the mode around 48 cm. The average weight of skipjack taken by Dakar and Canary Island baitboat is 2.5 kg and 3 kg, respectively, with lengths ranging from 35 to 70 cm (mode near 45cm) for Dakar baitboat and from 38 cm to 72 cm (mode at 57 cm) for the Canary Island baitboat fleet. Since the early 1990s, the fleets in Dakar and the Canary Islands have operated using a different method, using the boat itself as a FAD, under which various species of tuna accumulate, including yellowfin tuna. These changes have resulted in an increase in the exploitable biomass of the skipjack stock (due to the expansion of the fishing area) and of its catchability.

In the West Atlantic, Venezuelan and Brazilian baitboats target yellowfin together with skipjack and other small tuna. The sizes for Venezuelan yellowfin are between 45cm and 175 cm and for Brazil between 45 to 115, with the mode at 65 cm.

3.1.2 Purse seine

The East Atlantic purse seine fisheries began in 1963 and developed rapidly in the mid-1970s. They initially operated in coastal areas and gradually extended to the high seas. Purse seiners catch large yellowfin in the equatorial region in the first quarter of the year, coinciding with the spawning season and area. They also catch small yellowfin in association with skipjack and bigeye. Since the early 1990s, several purse seine fleets (France, Spain and NEI) have operated fisheries using objects, with between 45 and 55% of the total catch being taken by this method, whilst before this the proportion of the catch taken by this fishing method was 15% of the total. The Ghanaian purse seine fleet predominantly fishes off floating objects (80%-85%). Frequently, FADs with accumulations of fish are first located by baitboats, who call in a purse seiner to make the set if the accumulation is large. In this situation, the catch is shared between the purse seiner and the baitboat.

Fishing with floating objects takes place mainly in the first and fourth quarters of the year, with skipjack as the dominant species together with lesser quantities of yellowfin and bigeye. The species composition of the schools associated with floating objects is very different from that of free schools. Yellowfin catches from floating objects comprised between 15% and 26% of the total catch in the years between 1991 and 2006 (22% in 2006 for the French, Spanish and NEI fleets) and between 52% and 86% for skipjack for the same period (86% in 2006 for the French, Spanish and NEI fleets).

The East Atlantic purse seine fishery shows a bimodal distribution in the size classes for yellowfin, with modes near 50 cm and 150 cm but with very few intermediate sizes and a high proportion of large fish (more than 160 cm). The average weight of yellowfin tuna caught by the European and NEI purse seine fleets was 13.4 kg in 2006 (4.2 kg with FADs and 30.5 kg unassociated fish). The sizes of yellowfin caught by the Ghanaian purse seiners have ranged around 48-52 cm for the past decade. The average weight of skipjack caught by the European and NEI purse seine fleets was 2.5 kg in 2006 (2.0 kg on FADs and 2.5 kg on free schools), with sizes between 30 cm and 65 cm, with the mode around 45 cm.

The Task I catch series available for these stock assessments includes, for the first time, catches of "*faux poisson*" (fish sold in the local markets of the landing ports, which are not reported in the logbooks). The "*faux poisson*" catches made by the European purse seine fleets have been calculated since 1981.

Between 1997 and 2004, new developments in the purse seine fishery which affect yellowfin catches arose from the establishment of a closed season/area for fishing with artificial FADs, for a period of three months in a wide area of the equatorial Atlantic. Starting in 2005, those restrictions were discontinued, and instead a new closed season/area was established with a smaller area (Piccolo) and only for one month (November).

In the West Atlantic, the purse seine fisheries, which were sporadic between 1970 and 1980, have operated in coastal areas since 1980 to the North of the Venezuelan coast and in the south of Brazil. Sizes are in a smaller range than that of fish taken in the east (from 40 to 140 cm), with the majority being of intermediate size. Yellowfin is not the target species of these fleets.

Purse seine skipjack fisheries, with much lower catches than the baitboat fleets, one only operated by Venezuela and Brazil. The sizes of fish from those fisheries are between 35 cm and 65 cm with the mode around 55 cm for Venezuela and for Brazil between 35cm and 75 cm, with a mode around 40 cm.

3.1.3 Longline

The longline fishery began in the late 1950s and soon became important, with significant catches being taken by the early 1960s. Since then, the catches have gradually decreased. Longline fisheries capturing yellowfin tuna are found throughout the Atlantic **(Figure 1)**. The degree of targeting yellowfin varies across the longline fleets. In the Gulf of Mexico, both U.S. and Mexican longline vessels target yellowfin (the average weight of yellowfin has remained between 32 and 39 kg during the period from 1994 to 2006). Venezuelan vessels also target yellowfin, at least seasonally. In contrast, Japanese and Chinese Taipei vessels began in the early 1980s to shift targeting away from albacore and yellowfin toward bigeye tuna through the use of deep longline. Uruguayan longliners also catch yellowfin in the Southwest Atlantic, together with other target species. Yellowfin FL sizes ranged from 52 to 180 cm with a mode of 110 cm. (SCRS/2008/111).

3.2 Catch

3.2.1 Yellowfin

Table 1 and **Figure 3** show the development of yellowfin catches in the East Atlantic, West Atlantic and total Atlantic. Total yellowfin catches in 2006 amounted to 108,623 t. Task I catches for 2007 shown are informative only, since they are preliminary and incomplete (important fleets are missing) figures.

In overall, the total Atlantic Task I yellowfin catches have imperceptibly changed since the 2007 SCRS. Although, minor updates have been made to the historical Task I nominal catch series that will slightly change the catch composition of both, Atlantic East and West Atlantic management units. The revisions made were:

- "Unclassified" Atlantic (not split by eastern and western management units) longline catch series of Chinese Taipei (1962-65), NEI (Flags related) (1983-03), Panama (1986-99) and EC. Spain (2005-2006), was split into eastern and western geographic units using the corresponding geographical information of Task II catch and effort (except the NEI fleets and Panama for which Chinese Taipei was used). Details are shown in **Table 3**.

- The historical Task I catch series of Sao Tomé & Principe (1988-1903), disaggregated by species (those catches existed in Task I as tuna unclassified since 1970), were presented and discussed at the end of the 2007 SCRS meeting and incorporated into the Task I catches.

- Cape Verde carryovers from 2004 onwards were replaced by official catch statistics reported before the current meeting.

- An estimate of the "*faux poisson*" caught by the European purse seine fleets (1981-1907) was presented during the meeting by French scientists and consequently incorporated into Task I as "Mix.FR+ES" fleet.

Yellowfin catches increased from the 1950s to reach an average of 150,000 t in the 1980s, and in 1990 reached their highest value (193,448 t). Since then, the catches had shown a gradual decline, and in recent years are at a similar level to those in the early 1970s.

Baitboat: Total catch by this gear for the whole Atlantic was 13,129 t in 2006 although in 1993 the catch was nearly 25,000 t **(Figure 4)**. The development is different for the various fisheries.

In the East Atlantic, boats from Angola, Cape Verde and Japan, which took significant catches in the early period of the fishery, have decreased their catches, while other fisheries have increased theirs. In 2006 the catch was 10,434 t **(Figure 5)**, with a record catch in 1968 of 22,135 t. Documents SCRS/2008/105, SCRS/2008/106 and SCRS/2008/124 show the various statistical data for the Spanish tropical, Canary Islands and total European and NEI fisheries, respectively.

In the West Atlantic **(Figure 6)** baitboat catches started in 1974, increasing regularly from 1,300 t. in 1974 to 7,000 t in 1994, and later decreasing to about 2,695 t in 2006.

Purse seine: Yellowfin catches by this fleet reached 62,761 t for the entire Atlantic in 2006. In the East Atlantic, catches increased spectacularly in the early years of the fishery **(Figure 4)**, from 10,000 t in the 1960s to 100,000 t in 1980, stabilizing at this level until 1983 before decreasing by half in 1984. This occurred as a result of the drastic decrease in effort which took place following the drop in yield of large sized yellowfin, mainly due to the French, Spanish and NEI purse seine fleets abandoning the fishery. Catches later increased again, with a record catch in 1990 of over 129,000 t, followed by a decreasing trend in subsequent years, reaching, 58,319 t in 2006. Documents SCRS/2008/105 and SCRS/2008/124 present statistical data for the Spanish and European and NEI purse seine fisheries. For the "*faux poisson*", the estimates corresponding to yellowfin show that the highest figure was 2,750 t in 1993, with 1,063 t in 2006.

Estimates of discards and by-catch in the French purse seine fishery of the eastern Atlantic Ocean were derived from observer trips conducted during 2005-2008 (SCRS/2008/117). Results showed that there were almost no discards observed on free schools during this period and that skipjack and little tunny (*Euthynnus alletteratus*) composed the bulk of the discards that were essentially made under fishing aggregating devices (FADs). In 2007, the average discard rates of skipjack and yellowfin tunas under FADs were estimated at 42.9 kg and 1.3 kg per ton landed, respectively. Data samples on size of "*faux poisson*" collected at the fishing port of Abidjan showed that there was no significant difference between discard and "*faux poisson*" size distributions for skipjack, yellowfin, and bigeye tunas. Small skipjack have dominated the "*faux poisson*" tuna landings in Abidjan since the early 1980s and the annual average landings on the local market during 2004-2007 were higher than 9,500 kg while the total landings in Abidjan for the canneries were about 40,000 t each year during the same period. Hence, the average rate of "*faux poisson*" in recent years was about 235 kg per ton of skipjack landed. For yellowfin, the annual average biomass of "*faux poisson*" landed was about 1,900 t during 2004-2007 compared to 37,000 t of commercial landings in Abidjan. The average rate of "*faux poisson*" was then of about 50 kg per ton of yellowfin landed for the canneries. Quantities of juvenile tunas sold as "*faux poisson*" could then largely exceed discards for skipjack, emphasizing the need to improve sampling of "*faux poisson*" that are currently missing from official statistics and not included in stock assessment models.

In the West Atlantic **(Figure 6)** catches increased since the beginning of the fishery in the early 1960s to 1983, when they reached 25,000 t. Catches in the following years showed considerable variation as a part of this fleet shifted its fishery to the Pacific Ocean. Caches in 2006 were 4,442 t. The most important catches in the West Atlantic are taken by the Venezuelan purse seine fishery (in some years being 100% of the total catch).

Longline: After a maximum of over 50,000 t reached in the 1959-1961 period, longline catches decreased to a level of around 30,000 t in the early 1970s, and to about 25,000 t in the 1990s. Longline catches in 2006 reached 22,238 t. The main fisheries are those of Brazil, Chinese Taipei, Japan, Mexico and the United States. The appearance of important catches, beginning in 1985, by NEI fleets in unknown areas is of concern as it is uncertain to what extent these catches actually occurred in the Atlantic. Document SCRS/2008/125 presents statistical data for the longline Mexican fishery in the Gulf of Mexico.

3.2.2. Skipjack

Table 2 and **Figure 7** (catch by area) show the development of skipjack catches in the East Atlantic, West Atlantic and total Atlantic. Total skipjack catches in 2006 amounted about 142,200 t (about 115,700 t in the East and about 26,500 in the West). This catch level has remained relatively stable in the last 11 years, although it is notably lower than that of 1991 and 1993 when the highest level in catches of this species was reached (approximately 200,000 t). Task I catches shown for 2007 shown are informative only as they are preliminary and incomplete (important fleets are missing).

As for yellowfin, minor revisions have been made to the skipjack Task I historical catches since the 2007 SCRS. Nevertheless, this only affects the eastern stock. The revisions made were:

- The historical Task I catch series of S. Tomé e Principe (1988-2003) disaggregated by species (those catches existed in Task I as "Tuna Unclassified" since 1970) presented and discussed at the 2007 SCRS meeting incorporated into the Task I catches.

- Cape Verde carryovers from 2004 onwards were replaced by official catch statistics reported before the current meeting.

- An estimate of the “faux poisson” caught by the European purse seine fleets (1981-1907) was presented during the meeting by French scientists and consequently incorporated into Task I as “Mix.FR+ES” fleet.

The breakdown of “unclassified” Atlantic catches into East and West stocks was already made during the 2007 Inter-sessional Meeting of Tropical Tunas (Recife, Brazil, April 11 to 16, 2007) (Anon. 2008).

In the East Atlantic **(Figure 8)**, currently the most important fisheries are those of the purse seine fleets, mainly those of France, Ghana, the NEI fleet (Belize, Guinea, Netherlands Antilles, Panama, Malta, Morocco, St. Vincent and Vanuatu), and Spain followed by the baitboat fleets of France, Ghana, Portugal and Spain.

In the West Atlantic **(Figure 9)**, the most important fisheries are the Brazilian and Venezuelan baitboat fisheries.

Baitboat: Total catch by this gear for the whole Atlantic was 64,924 t in 2006.

In the East Atlantic, the most important baitboat fleets are the Ghanaian, Senegal and North Islands (Canarias, Madeira and Azores). In 2006 the catches reached 41,175 t, the same level from the end of 1980s. Documents SCRS/2008/105, SCRS/2008/106 and SCRS/2008/124 show the various statistical data for the Spanish tropical, Canary Island and total European and NEI fisheries, respectively.

In the West Atlantic, baitboat catches reached 20,000 t in 1982 and from then remain at the same level, between 18,000 t and 28,000 t **(Figure 9)**. In 2006 the catches in these fisheries reached 23,749 t. The most important fishery is the Brazilian baitboat fishery, the target species of which is only skipjack. Cuban and Venezuelan baitboats have also participated in the fishery.

Purse seine: Total catch by this gear for the whole Atlantic was 71,215 t in 2006.

In the East Atlantic, the purse seine fishery was developed in the 1960s, originally as a coastal fishery, but eventually, became more high seas orientated. In the early 1970s the catches of skipjack reached 50,000 t **(Figure 8)**. At the beginning of the 1980s, the catches reached 70,000 t. In 1985, there was a considerable decline in the catches of purse seiners, due to the displacement of a large part of the French and Spanish fleets to the Indian Ocean. This situation changed in the years immediately following, skipjack catches then reaching 142,000 t in 1991. From this time there was a marked decline in catches, which dropped to 66,819 t in 2002 and in 2006 reached 69,170 t.

Documents SCRS/2008/105 and SCRS/2008/124 present statistical data for the Spanish and European and NEI purse seine fisheries.

For the “*faux poisson*”, the estimates corresponding to skipjack (the main species of tunas inside this group) show that the highest figure was 13,750 t in 1993, reaching 5,313 t in 2006.

In the West Atlantic, the purse seine fisheries that developed in the 1960s (USA fleet) had much lower catches than the baitboat fleets; currently, the only purse seine operations are conducted by Venezuela and Brazil. By the end of the 1970s, annual catches reached 3,000 t, and in the 1980s they soon reached 18,000 t (1984), with catches fluctuating in the 1990s between 12,800 t (1993) and 2,100 t (1995). Catches in 2006 were 2,045 t. The most important catches in the West Atlantic are taken by the Venezuelan purse seine fishery (in some years being 100% of the total catch).

3.3 Fishing effort

In general, the fisheries that target tropical tunas are fisheries where it is extremely difficult to discriminate the effective fishing effort by species. However, exceptions do exist among those are several longline fisheries that target yellowfin and the Brazilian baitboat fishery that has skipjack as a target species.

Beginning in the 1990s, important changes have taken place in the East Atlantic main surface fisheries that further complicate the estimation of effective effort, including the greatly increased use of floating objects by purse seiners and baitboats, as well as the use of baitboats as FADs in Dakar and other baitboat fisheries.

As indicators of the nominal effort in the East Atlantic, the carrying capacity of the purse seiner and baitboat fleets has traditionally been used. **Figure 10** shows the development of the carrying capacity of the surface fleets in the East Atlantic for the 1972-2006 period. The baitboat carrying capacity has remained stable since the late

1970s at around 10,000 t. The carrying capacity of the purse seine fleet, on the other hand, has undergone significant changes during the whole period being reviewed, with a constant increase from the start of the fishery until 1983, when carrying capacity exceeded 70,000 t. After that, until 1990, the carrying capacity decreased considerably to 37,000 t, due to part of the fleet abandoning this fishery. There was a slight recuperation in the following two years (1991 and 1992) followed since then by a progressive decline, with capacity at around 29,700 t in the last year (2006).

Document SCRS/2008/124 shows the development of both nominal fishing effort measures for EC and NEI purse seiners: the number of 1-degree rectangles explored and the number with effort greater than 1 fishing day, and total purse seiners fishing days (1991-2007). It can be observed that, while the searching area remains at the same level during these periods, the number of fishing days has diminished considerably.

For the West Atlantic, there have been substantial recent changes in the amount and distribution of fishing effort in the Brazilian longline fishery. Until 1995, sharks were the primary target species (58% of the total catches). However, since 1993, the proportion of sharks has declined, being replaced by swordfish as the dominant species in this fishery (swordfish now represent 48% of the total catches). Effort in the Venezuelan surface fisheries has been high since 1992 (more than 8,000 t vessel carrying capacity). Effort in the U.S. longline fishery, which is active in the northwestern Atlantic and in the Gulf of Mexico, has declined somewhat in the last few years. Japanese longline effort for yellowfin tuna has also declined in recent years. This fleet mainly targets other species (bigeye and bluefin).

Venezuelan and Mexican longline effort for yellowfin tuna has increased in recent years.

3.4 Task II size frequencies

The updated catalogues of Task II size frequencies available in the ICCAT database (observed samples and extrapolated size frequencies reported), for both yellowfin and skipjack, are shown in **Tables 4** and **5**, respectively. They contain a set of metadata information (time and space stratification, number of fish in the dataset, type of size frequencies, etc.) which allows having a clear picture of the level of heterogeneity in the size data.

When comparing the current catalogues with the ones published for revision on the ICCAT web (May 2008) one can verify that:

- Revisions before 2006, were only reported by Japan (2003-05, size and catch-at-size data) for yellowfin only, and Chinese Taipei (2005 size samples) for both species.

- New size information (2006 onwards) has been reported by various countries: Canada (2007); Chinese Taipei (2006-07); Japan (2006); USA (2006-07); EC-Spain (2007, tropical and Canary based fleets); EC-France (2007, tropical fleet); EC-Portugal (2007); Cape Verde (2007); and Ghana (2007);

Details about the species covered and type of size frequencies can be obtained on the corresponding tables.

3.5 Catch-at-size and catch-at-age

At the beginning of the meeting the Secretariat presented, the updated catch-at-size (CAS) data sets for yellowfin (1970-1907) and skipjack (1969-07), together with their corresponding substitution tables. The substitution rules, as also the size datasets used in the estimations were revised by the Group, and updated accordingly. Year 2007 was discarded for both species due to the lack of size information (and Task I catches) of important fisheries.

3.5.1 Yellowfin

The yellowfin CAS includes the complete rebuild of 2005 (considerably incomplete in previous estimations) and 2006. The historical CAS series (1970-2004) was left exactly the same as in previous assessment. After revising the substitution tables, the Group decided to include in the revised CAS:

- the new "*faux poissons*" series (1981-06) estimated by the European purse seine fleet (a reference file with samples from April 2007 to February 2008, stored in the ICCAT-DB as being from EC-France an EC-Spain)

- the carry over (from 2005) figures for Task I to 2006 for Colombia, Cuba, Dominican Republic, EC-Latvia, Gabon, and Libya.

No changes have been made to the substitution criteria.

A problem identified later by Japan had to do with discrepancies between reported Japanese CAS revision (2003-2004) which has not been included in the historical CAS, and also, a discrepancy in the number of fish found in 2005 (only 65% of the size information has been incorporated in ICCAT database, due to a problem of incompleteness in the ICCAT Form-5 reported, and a corresponding weakness on the code that automatically reads the forms and omits these possibilities). At the same time, Japan also presented a complete (all quarters) CAS revision for 2006. The Group considered that, it was too late to change the revised CAS again and decided to keep the incomplete CAS series of 2006 (first quarter only). The Group determined that these updates should be made before the next SCRS meeting.

The Secretariat also informed about the inconsistencies (small for the overall Atlantic CAS) existent between Task I and CAS at the fleet/gear discrimination level in the period 1975-1983, which could have implications when selecting various fleet related indexes for VPA analyses. During that period CAS has various fleet catches aggregated (longline, baitboat and purse seine fisheries) without a strait correspondence with Task I figures. The Group considered that this revision of historical CAS should be made for the next assessment.

After the creation of a revised CAS version, the corresponding CAA matrices have been obtained by the Secretariat (overall and also fishery based matrices).

A comparison between Task I and CAS is shown in **Figure 11**. Catch-at-age distribution is shown in **Figure 12**. **Tables 6** and **9** show the overall CAS and CAA matrices.

The details of the final yellowfin CAS estimations shall be recollected in a SCRS document (SCRS/2008/128) and presented at the SCRS by the Secretariat.

3.5.2 Skipjack

The skipjack CAS includes the complete rebuilt of 2005 (incomplete in previous estimations) and 2006. The historical CAS series (1969-2004) has been slightly adjusted with the inclusion of Sao Tomé and Cape Verde. After revising the substitution tables, the Group decided to include in the revised CAS:

- the new "*faux poissons*" series (1981-1906) estimated by the European purse seine fleet (a reference file with samples from April 2007 to February 2008, stored in the ICCAT-DB as being from EC-France and Spain)

- the carryover (from 2005) figures for Task I to 2006 for Cape Verde and EC-Ireland.

No changes to the criteria of substitution have been made.

A comparison between Task I and CAS is shown in **Figure 13**. **Tables 7** and **8** show the CAS matrix for eastern and western stocks.

The details of the final skipjack CAS estimations shall be recollected in a SCRS document (SCRS/2008/126) and presented at the SCRS by the Secretariat.

3.5.2 Catch at age

The yellowfin catch at size data in ICCAT variable format was used to create catch at age following the cohort slicing parameters (**Table 10**) by length class used in a previous assessment. The catch at age in number of fish for selected fisheries and the total amount was presented by the Secretariat and used further in the assessment (**Figure 13** and **Table 9**). The catch at age in weight for the same fisheries was also created using the same cohort slicing and the following length weight relationship:

1) Kevin Davis (1991) (RWT = 0.000000089 * FL**2.88) where RWT is in pounds and fork length in mm.
2) Gaertner *et al.* (1992) RWT = 0.00006611 * FL**2.7148 and;
3) Caveriviere (1975) RWT =0.00002153*FL**2.976

A new cohort slicing from Shuford *et al.* (2007) was also raised and the group felt that further investigation should be carried out to test possible discrepancies with earlier calculations.

3.6 Multifan data preparations

Prior to the assessment session, it was agreed to attempt to conduct Multifan-CL (MFCL) analyses of skipjack and yellowfin at the 2008 assessment meeting, in order to improve the account for spatial and fishery dynamics related to these species throughout the Atlantic.

For skipjack, the preliminary fishery definitions are given in **Table 11** and those for yellowfin in **Table 12**. Intersessionally, the Secretariat prepared catch data through 2006 by area (5x5) and quarter as well as the available Task II size and catch/effort information. National scientists prepared CPUE indices for specific fisheries by quarter (see Section 4), and the ICCAT Task II data were examined to produce catch rate indicators for the remaining fisheries.

The temporal time-step agreed for the MFCL applications was quarterly. As such, catch and effort and size frequency information by fishery and quarter were compiled from the ICCAT CATDIS, and Task II size and catch effort information. Quarterly effort data by fishery were estimated from the Task II data applying Generalized Linear Models controlling for Fleet, Gear Type, and Effort Type within each Fishery Definition recorded in the Task II database. **Appendix 4** documents the procedures used to generate the time-series CPUE, which was then divided into the fishery specific catch information to estimate effort patterns for MFCL. In all cases, where detailed, standardized CPUE was available from National Scientists or based on work conducted by the Group at the assessment meeting, those CPUE patterns were used to compute quarterly effort patterns for use in MFCL. The resulting catch and effort time-series by fishery are shown in **Figures 14** and **15** and in **Appendix 4**.

Size frequency data held in the ICCAT Task II data set were also organized by MFCL fishery definition and quarter for skipjack and yellowfin tunas. A criterion of at least 50 size observations per fishery/quarter was used to filter the data for use (**Figures 16** and **17)**. The SAS code used for summarizing the data are given in **Appendix 4**.

In support of the MFCL data preparations, for the European and associated purse seine fleet annual skipjack standardized CPUEs, for both FAD and free school fishing modes, were obtained using GLM (see Section 4 for more details). In order to incorporate these indices to the MFCL runs, some adjustments were needed to obtain quarterly standardized CPUEs. During the meeting, it was not possible to obtain new standardized indices by quarter. Therefore, a procedure was established to split the annual standardized CPUE by quarter. In the case of the skipjack free school CPUE the partial residuals corresponding to the factor quarter were used as criteria to split CPUEs. From the graphic of partial residuals, a multiplier was obtained relative to the average value and then quarterly CPUE were obtained multiplying the annual value by these multipliers. In the case of the skipjack, FAD standardized CPUE, partial residuals were not available; hence, the same annual value was considered for each of the four quarters.

Yellowfin

For the European and associated purse seine fleet annual yellowfin tuna <10 kg. standardized CPUEs, for FADs fishing mode and first quarter standardized catch rate for spawner yellowfin (>30 kg) were obtained using GLM (see Section 4 for more details). The information available on the index of small yellowfin, and skipjack, did not allow establishing any criteria to split the index by quarter. Therefore, the same annual value was considered for all quarters.

Appendix 4 contains the preliminary FRQ files prepared for skipjack and yellowfin and are available at the Secretariat on request.

4. Relative abundance indices and other fishery indicators

4.1 Skipjack

4.1.1 Fishery indicators

Eastern Atlantic

The Group examined several general indicators of the purse seine and baitboat fisheries. The carrying capacity of EU purseseines and the number of baitboats has decreased (**Figure 10**). However, in the Dakar-based fisheries the carrying capacity increased, while the number of baitboats decreased in the Dakar-based fisheries (**Figure 18**). The total number of sets and the percentage of successful sets by fishing mode (**Figure 19**) and total areas visited and fished (**Figures 20** and 2**1**) were also used as indicators of effort.

Catch-at-size data of eastern Atlantic skipjack were used in document SCRS/2008/114 to estimate changes in total mortality and in selectivity patterns for two surface fisheries (the pole and line fishery operating from Dakar, Senegal and the purse seine fleets, omitting Ghanaian vessels) from 1971 to 2005. The general pattern depicted by Z (**Figure 22**) is in agreement with previous knowledge on this fishery: a state at, or close to, full exploitation during the 1990s, followed by a decrease since the mid-1990s, likely due to a combined result of the decrease in purse seine nominal fishing effort, and the adoption of the seasonal moratorium for fishing under FADs. Even if the total selectivity pattern remains relatively stable over the years, the decreasing trend in selectivity observed for purse seiners since the early 1990s suggests that these fleets have shifted from targeting small fish. This is in agreement with the development of the FADs fishing operations since the same period.

Regarding the European baitboats based in Dakar (Senegal), the nominal catch rates of skipjack have increased regularly over the entire time series. When analyzing these data it must be kept in mind that since the beginning of the 1990s these baitboats have developed a fishing technique (mainly for targeting bigeye) in which the baitboat is used as the floating object, fixing the school (comprised of bigeye, yellowfin and skipjack) during the entire fishing season in waters off Senegal and Mauritania. As a consequence, it makes sense to assume that the adoption of this fishing technique has increased the overall catchability of tunas. Note, however, that the pattern described for skipjack contrasts with the decreasing trends in CPUEs observed for the other two tropical tuna species.

4.1.2 Catch rates

During the Group’s Meeting held in Séte (France) in 2006 (Anon. 2007), it was recommended that analyses of the CPUE trends for fisheries along the fringes of species distribution be conducted by scientists from various Contracting Parties. The results of the standardization of the CPUEs for the Azorean baitboats were presented and discussed during the Species Group. As expected, due to the location of this fishing area with respect to the distribution range of skipjack, the standardized index showed high variability, but without significant trend (**Figure 23**).

The Group stressed the importance of updating the catch rates of the main fisheries reporting catches of skipjack. It must be stressed that skipjack tuna are often a secondary species, depending on the price differential and on the catchability of other target species. Consequently, estimation of the effective effort exerted on skipjack (e.g. effort proportional to fishing mortality) remains problematic and catch rates may sometimes depict a different trend than abundance.

For purse seiners, fishing alternatively on free schools and on FADs, it was considered that search time may be the best measure of basic effort on free schools. It was also suggested that the analysis data set might be further restricted to effort associated with free school sets by assuming that vessels that travel longer distances overnight are moving between FADs, as they can not be searching for free schools at night. However, this approach would likely require further study, including the incorporation of VMS data, to determine if it is both feasible and appropriate. A new EU-funded CEDER Project (Catch, Effort and Discards Estimates in Real Time), which started in 2006, will deal in part with this question. The basic objective developed within the framework of this project is to analyze the individual trajectory of purse seiners in order to characterize fishing behavior reflecting searching time for un-associated schools or moving towards FADs previously detected by radio range beacon (bearing in mind, however, that whatever the fishing mode researched, every tuna school detected by chance can be set on). Other factors which might be considered include the changes over time, which have resulted in a reduction of the time necessary to make sets and to offload catches (increasing efficiency of fishing effort over time).

For continuity with the previous assessment the catch rates of the European purse seine fleet (France and Spain), obtained after standardizing nominal fishing effort to category 5 (450-750 TRB) FIS purse seiners and assuming a 3% annual increase in fishing efficiency of the fleet from 1981, were updated. The objective of incorporating an increase in efficiency was to take account of the changes that have occurred in the purse seine fleet during these years. The estimate of a 3% annual increase in efficiency is derived from a study by Gascuel *et al.* (1993). The Group discussed the convenience of maintaining this assumption when the vessels fishing in the Atlantic are old (on average more than 20 years old) and their skippers and crews have a low profile compared with those fishing in other oceans (e.g. Indian Ocean). Considering that the estimate of the 3% increase was made 15 years ago, the Group decided to conduct a new estimate of changes in catchability of purse seiners. These new estimates showed a higher increase in efficiency of the fleet, an average annual increase of about a 5% (all three species combined). Nevertheless, the Group decided to use the index estimated with a 3% increase for continuity with the last two assessments.

Standardized indices for juvenile yellowfin and skipjack for the European and associated purse seine fleets fishing on FADs were presented to the Group (SCRS/2008/116). Logbook set by set on FADs data as well as fleet characteristics were used. Indices were developed using a delta-lognormal model. In this case, the model was formulated different to the general use to take into account the problem related with the species composition of the purse seine catch of small fish (>10 kg). These catches are estimated from sampling to correct the bias detected in the logbook data. Therefore, the model included two distinct generalized linear models: a lognormal model which describes the variability in the non-zero catch of species less than 10 kg, and a data and binomial model which describes the proportion of each of the three species in the catch. The results of this approach are different, depending on the species, and the skipjack catch rates showed a U shape with a minimum in 1998 during the whole period.

In addition, a standardized index for skipjack for the Spanish fleet, fishing on free schools, was presented (SCRS/2008/118). This index corresponds to the seasonal fishery on free schools developed by the Spanish fleet offshore Senegal mainly during the second and third quarters of the year. This fishery mainly targets skipjack. Logbook set by set data as well as fleet characteristics were used. In this model, only the free school sets were included for the period (1991-2006) during which the extension of the FADs fishery started and information on fishing mode exists. For the historical period it was assumed that free school was the fishing mode. Data were also limited to the off Senegal area. An index was developed using a delta-lognormal model. The variables considered were *year*, *quarter* and *vessel category* (volume of wells). The series covered the period 1980 to 2006. Also a threshold of 120 fishing days by vessel and year was established. The standardized catch rates showed an increasing trend in the 1980s, followed by a decrease in the early 1990s and high variability since then. The Group considered that the availability of skipjack in this area could be related to environmental factors and that this index would be more representative of changes in catchability than in abundance.

All the standardized catch rates estimated by the Group for the east stock are shown in **Figure 24**. Some of the data series are not complete. For example, there are no estimations for Ghana baitboat after 1992. Estimations that were not used in assessment analyses (purse seine on free schools-EC) are not included in the figure. Estimations as calculated for the Portugal and Canada database showed large variations with several peaks and plunges. Estimations of standardized catch rates of Dakar purse seines increased until the early-1990s but there is no clear time trend since 1992.

Western Atlantic

In contrast with the large fishing areas observed in the eastern part of the Atlantic Ocean, the fishing grounds in the western Atlantic are generally more coastal. Most of skipjack landed in the west have been caught by Brazilian baitboats. Actually skipjack is the main target species in this case. Note that the catch rates reported for this fishery are higher than the CPUEs observed in all the eastern baitboat fisheries. For the Venezuelan purse seiners fishing mainly in the Caribbean Sea, no new information has been provided since the 2007 SCRS meeting.

Standardized catch rates were calculated for west stock. In most of the papers, Generalized Linear Model and Delta-lognormal distribution were used to calculate the relative abundance indices. Generalized Linear Mixed models were used to analyze catch and effort data from the U.S. Marine Recreational Fisheries Statistical Survey (MFRSS) of the Atlantic coast and Gulf of Mexico (SCRS/2008/122). Positive data were modeled using a lognormal model, while the proportion of positive catches was modeled with a binomial distribution. Geographic area, season and fishing mode (charter or private fishing boat) were the factors considered in the model.

Standardized catch rates calculated using the delta-lognormal model varied annually showing no clear trend.

Standardized catch rates of skipjack caught by U.S. pelagic longline fleets in the Gulf of Mexico calculated using GLM were presented in SCRS/2008/121. Response variables considered for skipjack were the CPUEs for the period 1992-2007. In the analysis, the delta-lognormal models with the following explanatory variables were used: year, area, season, gear characteristics and fishing characteristics. Overall, there appears to be an increasing trend in skipjack catch rates in 2006 and 2007 though this may be explained by increasing rates of observer coverage. Currently, skipjack tuna is not a target species for the U.S. longline fleet and there are few reports of positive sets in logbooks.

Most of skipjack landed in the West Atlantic are caught by the Brazilian baitboat fleet. In order to obtain standardized catch rates per year and quarter two approaches were used (SCRS/2008/113). In the first, catches equal to zero were discarded and a model (lognormal) was selected to analyze the positive dataset. In the second approach, the zero catches (< 2% of the total database) were also considered and a delta-lognormal model was used to estimate standardized catch rates. Indices showed large variations across the years but there was no trend.

All the standardized catch rates used in the assessment analyses are in **Figure 25**. Estimations gathered in the analysis of Brazilian and U.S. datasets showed no trend. Estimations calculated for the Venezuelan database showed dropped abruptly in the early-1980s but showed a slight decreasing trend since 1983.

4.1.3 Fishery-specific patterns for skipjack

The fishery definitions used are shown in the following table and generally follow the definitions used for MULTIFAN CL assessment modeling of bigeye tuna.

Fishery definitions proposed for use in further analysis for skipjack.

Stock	*Fishery*	*Flags*	*Gear*	*Period*
Atlantic East	1E	EC-France, EC-Spain and Others	PS	1969-1979
Atlantic East	2E	EC-France, EC-Spain and Others	PS	1980-1990
Atlantic East	3E	EC-France, EC-Spain and Others-Free School	PS	1991-2005
Atlantic East	4E	EC-France, EC-Spain and Others-FADs	PS	1991-2005
Atlantic East	5E	Ghana	PS & BB	1973-2005
Atlantic East	6E	EC-France, EC-Spain (Dakar Based), Senegal	BB	1965-1983
Atlantic East	7E	EC-France, EC-Spain (Dakar Based), Senegal	BB	1984-2005
Atlantic East	8E	Azores, Madeira, Canaries	BB	1965-2005
Atlantic East	9E	Others	BB	1965-2005
Atlantic East	10E	Others	Others	1965-2005
Atlantic West	1W	Brazil	BB	1965-2005
Atlantic West	2W	Venezuela	PS+BB	1965-2005
Atlantic West	3W	All	Others	1965-2005

Selection of the abundance indices for skipjack

To select among the candidate fisheries the most appropriate series of CPUEs in terms of representativeness of changes in the abundance of skipjack in both parts of the Atlantic Ocean, attention has been paid to criteria such as the average total catch, the surface of the fishing grounds and the size of the time series.

In the eastern Atlantic, the baitboat fisheries depicting changes over time of the abundance of different size classes of skipjack were selected as follows:

- Portuguese-Azorean fleet (standardized index after omitting the smallest boats fishing in coastal Azorean waters): 1970-2006;

- Spanish Canary Islands vessels (a non-standardized series, divided for periods of time, prior to and following the adoption of the associated school fishing technique in 1992): 1980-1991; 1992-2006;

- Baitboat fleets (EC-France, EC-Spain, FIS, Senegal) operating from Dakar (Senegal), (standardized for the whole time series, then broken down prior to and following the adoption of the associated school fishing technique in 1984): 1969-1983; 1984-2006; and

- Ghanaian vessels (non-standardized CPUE); from 1969 to 1982 (Wise 1986).

Two purse seine series were used:

- The Spanish and associated purse seiners, targeting free schools of skipjack off Senegal during the second quarter of the year from 1980 to 2006. The advantage of using purse seine CPUE in this region is the possibility to calculate an index of apparent abundance for school fishing operations only, which is not the case in other areas.

- The EC-purse seiners fishing on FADs mainly in equatorial areas: 1991-2006.

For the western stock, three indices of catch rates were used:

- The Brazilian baitboat fishery, known to target specifically skipjack (standardized index): 1981-2006;

- The Venezuelan purse seiners, operating in general with the assistance of the bait boats (non standardized index, corrected by accounting for a moderate annual 1% increase in efficiency): 1982-2005; and

- The U.S. recreational fishery (standardized series): 1986-2006.

4.1.4 Average weight

Figure 26 shows average weight of skipjack for the eastern and western Atlantic. The average weight of fish landed showed no trend in the most recent period. Since the early 1980s the average weight of fish landed in the western part doubled the weight of fish landed in the East Atlantic.

4.2 Yellowfin

4.2.1 Average weight

The average weight of yellowfin showed some variability but a decreasing trend is evident since the early 1970s (**Figure 27**). When analyzing the information separated by gear it is apparent that the decreasing trend is mainly due to longline and purse seine.

4.2.2 Catch rates

Purse seine

Standardized catch rates for adult yellowfin caught by purse seiners fishing during the period 1980-2006 in the tropical Atlantic Ocean were presented in SCRS/2008/115. Two approaches were used to obtain the indices from the results of the generalized linear model: (a) least-square means; and (b) average of the fitted values. Estimations of variance made with the second approach were lower. Nevertheless, standardized catch rates did not show a trend.

In document SCRS/2008/116 information on logbook set by set on FADs was also analyzed in order to obtain standardized catch rates for juvenile yellowfin. A delta-lognormal model and GLM were used to estimate the indices. Explanatory variables included in the model were *year*, *region*, *quarter* and *vessel category*. Standardized catch rates for yellowfin showed a flat trend during the period 1991-2006.

Catch rates available in this meeting were contradictory (**Figure 29**). Estimates calculated for Venezuelan indices showed three peaks but a decreasing trend. Nevertheless, tropical purse seine indices peaked in 1989 but did not show many changes after 1992. Standardized catch rates as calculated for the EC database appear flat in the period 1991-2005.

Baitboat

Nominal catch rates for the Canary Islands fleet show several peaks and plunges (**Figure 30**). Estimated values gathered with the Brazilian database dropped abruptly from 1981 to 1982 and then showed a slightly decreasing trend. The nominal catch rates of Dakar peaked in 1993 and then showed a decreasing trend.

Recreational fisheries

Generalized Linear Mixed and delta-lognormal distribution were used to analyze the catch rates of yellowfin caught in the Atlantic and Gulf of Mexico as reported in the U.S. Marine Recreational Fisheries Statistical Survey (MFRSS) database (SCRS/2008/122). Geographic area, season and fishing mode (charter or private fishing boat) were the factors considered in the model. Standardized catch rates vary annually but without trend (**Figure 31**). There were some peaks in 1984, 1994 and 1999, as well as plunges at the end of the 1980s and in the mid-1990s. A decreasing trend is apparent after 1999.

Longline

Several CPUE indices were presented at the meeting from fisheries other than purse seine. All the indices were standardized using GLM, differing in the assumption of the error distribution (log-normal or Poisson). They had the same basic factors in common, such as year, season and area, along with other factors particular to each case.

Standardized catch rates for yellowfin tuna caught by Japanese longline fleet from 1965 to 2006 were estimated using a generalized linear model (GLM) (SCRS/2008/108). Factors considered in the model were year, quarter, SST (sea surface temperature), number of hooks between floats and kind of main and branch lines. Main effects and interactions were included in the analysis. Catch rates were modeled using a lognormal density distribution and a positive constant were added to catch rate in order to deal with catches equal to zero. Standardized catch rates as estimated in year and quarter base decreased through mid 1970s. Estimations were close to 1.7 (fish/1000 hooks) until early 1990s when it dropped to 0.6 (fish/1000 hooks). After that plunge standardized catch rates variation showed not trends. Variations of standardized indices as calculated in weight were similar to those gathered in calculations based in number of fish. Nominal catch rates for the 1960s and the early 1970s as reported for Japanese as well as for all other longline fleets were considered doubtful in an earlier meeting. Therefore, the Group decided not to use the estimations for the very early years.

In the southwest Atlantic, yellowfin tuna are caught mainly by the fleets operating drifting pelagic longline. SCRS/2008/109 presented the CPUE of yellowfin tuna caught by the longline fleets of Brazil and Uruguay in the Atlantic Ocean for the period 1980-2006 standardized using General Linear Models with a Delta Lognormal approximation. There number of analyzed hauls was 76,521, with a total effort of 136,947,483 hooks between 7ºN-45ºS and 57º-20ºW. The response variables considered in the model were CPUE and a nominal CPUE weighted by total catch (CPUEp). There were considered as explanatory variables for the models the year, quarter, area, water surface temperature and type of fishing gear. Both CPUE and standardized CPUEp show oscillations along all the period with a downward trend in the last seven years and a moderate peak in 2005. Standardized catch rates showed large variations all across the years with a decrease from 2000 to 2006. In a companion paper, only the Uruguayan database was considered (SCRS/2008/110). The results were similar to those mentioned above.

A GLM was also used to analyze the CPUE of yellowfin caught by the Brazilian longline fleet but the catch rate (number of fish/100 hooks) was assumed to follow Poisson and Tweedie densities distributions (SCRS/2008/112). The four factors considered when analyzing data from 1986 to 2007 were year, area, quarter and target. Cluster analysis of species compositions caught in the fishing sets was used to define the levels of the "target" factor. Estimations gathered with Poisson and Tweedie models were similar. Standardized catch rates were large between 1988 and 1990, decreased through 1993 and did not show any trends at the end of the time series.

For the Mexican and U.S. longline fishery in the Gulf of Mexico (1992-2006) a combined index was presented (SCRS/2008/119), based on available observer data. The variables included by year and quarter, fleet, quarter, sets, temperature and bait type.

In document SCRS/2008/120 yellowfin CPUE were in weight and number for the period 1987-2007. Standardized catch rates for yellowfin have declined since 1987 but appear to be increasing since 2003. Overall the standardized indices show a decrease since 1986 but a rather flat trend since 1992. The proportion of positive catches and the catch rate of positive datasets for yellowfin showed contradictory trends in some of the fishing grounds. That issue was discussed but there were no agreement on the explanation for those contradictory patterns.

For this assessment, datasets from Japan, Brazil, Uruguay, United States and a combined index between Mexico and United States were used. Most of the standardized catch rate time series showed a continuous decreasing trend **(Figure 32)**. The exceptions were the indices calculated for Chinese Taipei and for the Uruguayan databases. Estimations for Chinese Taipei data dropped in the early 1970s and appeared flat after 1974, while estimations for Uruguayan data showed large variability but no trend.

Indices used in the analysis

After evaluating all catch rate indices available during the meeting the Group decided to use some of them for virtual population analysis but not for production models. Some of the indices showed unreliable time trends. Catch rate indices selected for the assessment analysis are included in **Appendix 7.**

Combined indexes

Combined indexes were estimated for both species using a GLM approach (see **Appendix 5**). For yellowfin, the model included the Japanese longline, the combined Mexico and U.S. longline in the Gulf of Mexico, U.S. rod and reel, Brazilian longline, Chinese Taipei longline, Canadian baitboat, Venezuelan purse seine, Brazilian baitboat, EC Dakar-based baitboat, Venezuelan longline, and EC purse seine assuming a constant annual increase in catchability of 3%. The estimated unweighted and weighted combined indices are presented in **Table 13** and **Figure 33**. Both the unweighted and weighted index showed similar trends with a sharp decrease in the late 1960s followed by a relatively stable period until about 1990. From 1990 onward both indexes showed a continuous declining trend.

For skipjack, the fisheries used to estimate the combined index for the ATE stock where the EU-Dakar and EU-FAD purse seine fisheries and the Ghana, Canary Islands, Portugal and EC Dakar-based baitboat fisheries. In the case of the western Atlantic skipjack stock they were the Venezuelan purse seine, the U.S. rod and reel and the Brazilian baitboat. The combined index for the eastern Atlantic skipjack stock showed a variable but constant increasing trend from the beginning of the time series in 1965 to the end in 2006. The western Atlantic stock series started in 1981 and also showed a series with highly variable values but with a relatively constant trend. Values of the estimated combined indexes for each stocks and matrices of weighting factors are shown in **Table 13** and **Figure 33**.

5. Methods and other data relevant to the assessment

5.1 Methods – Yellowfin

5.1.1 ADAPT-VPA

The parameter specifications used in the 2008 VPA base model were generally the same as those used in the 2003 base-case VPA model (Mérida, Mexico, July 2003) (Anon. 2004). A summary of the model control settings and parameters appears below and in **Tables 14** (Control Settings) and **15** (Parameters).

VPA models require the estimation or assumption of terminal year fishing mortality rates (F). Like the previous assessment, the 2008 base cases (Runs 5 and 8) allowed terminal F values to be estimated for Ages 0-4. The oldest age class represents a plus group (ages 5 and older) and the corresponding terminal fishing mortality rate is specified as the product of $F_{age\ 4}$ and an estimated 'F-ratio' parameter that represents the ratio of $F_{age\ 5}$ to $F_{age\ 4}$. For Runs 5 and 10 the initial F-Ratio (1970) was estimated as a frequentist parameter, and then allowed to vary annually using a random walk with a standard deviation equal to 0.2 and a prior expectation equal to the previous annual estimate.

The indices of abundance were fitted assuming a lognormal error structure and equal weighting (i.e., the coefficient of variation was represented by a single estimated parameter for all years and indices). The catchability (scaling) coefficients for each index were assumed constant over the duration of that index and estimated by the corresponding concentrated likelihood formula.

The natural mortality rate was assumed to be age-dependent (Ages 0 and 1 = 0.8 yr^{-1}; Ages 2+ = 0.6 yr^{-1}) as in previous assessments.

Description of model runs

The indices used during the various model runs are summarized in **Table 16**. Methods used to estimate index selectivities are described in **Table 17**. A general description of the model runs follows.

− **Continuity Run:** The "continuity run" was performed to determine the 2008 stock status using model settings and structure identical to the 2003 base assessment (i.e. identical parameter settings, constraints and indices of abundance). It is intended to facilitate comparison of the 2008 and 2003 assessment results. Indices of abundance and catch data were updated and extended through 2008.

− **Runs 5** and **10** were chosen as "base runs" and were combined to develop management advice.

− **Run 5:** Run 5 differs from the "continuity" and 2003 model runs in that:

1) All indices recommend by the 2008 assessment working group were used.
2) A penalty was applied to restrict deviations in vulnerability-at-age (Penalty applied to 2004-2006, Ages 0-5+, Standard Deviation = 0.4)
3) The peak of the spawning season was set at February 14. Weight-at-age of spawners was also calculated from the growth curve using that date.

− **Run 10:** This run is identical to Run 5 except that the LONGLINE and TROP_PS indices were assumed to have fixed "flat-topped" selectivity patterns rather than the steeply "dome-shaped" patterns estimated by Run 5. To accommodate this assumption, the selectivity patterns estimated during RUN 5 were used until full selectivity was reached. Then, full selection (1.0) was retained for older ages.

5.1.2 ASPIC

The yellowfin stock was also assessed with a Surplus Production Model (ASPIC v. 5.16) using landings for the period 1950-2006. Three different sets of fisheries were considered in the runs:

1) A combined fleet with a combined index for the period 1965-2007. This case used a weighted combined index (see Section 4) for the Japanese longline, the combined Mexico and U.S. longline in the Gulf of Mexico, the US rod and reel, the Brazilian longline, the Chinese Taipei longline, the Canary Islands baitboat, the Venezuelan purse seine, the Brazilian baitboat, the EC Dakar-based baitboat, the Venezuelan longline, and the EC-purse seine assuming a constant annual increase of 3% in catchability.

2) Ten separate fleets with indexes that cover some portions of the period 1965-2007. This case used separate landings and indexes of abundance for the Japanese longline, the U.S. rod and reel, the Brazilian longline, the U.S. longline, the Uruguayan longline, the Venezuelan purse seine, the Brazilian baitboat, and the EU-Dakar baitboat fleets. A tenth fleet included all other landings and it did not have a corresponding index of abundance.

3) A combined fleet with a combined index for the period 1956-2006. This case used 1965 to 2006 combined index extended back to 1956 using Task II data.

Table 18 shows the indexes of abundance used in each case while **Table 19** provides de catches. These three scenarios tested different combinations of different model forms (logistic vs. Generalized), weighted or unweighted indexes, and fix or estimated value of B_1/K. A total of ten initial cases were considered which are summarized in **Table 20**.

5.2 Methods - Skipjack

5.2.1 Catch-only model

The catch-only model combines a Schaefer biomass dynamics model with a logistic exploitation dynamics model (Vasconcellos and Cochrane, 2005). The model assumes that the fisheries harvest follows a logistic curve that depends on two parameters. The model predicts the total catches, which are fitted to the observed catches using Bayesian methods (Gelman *et al.,* 2004). The fits are done using a Bayesian framework in order to allow the use of prior information, which could boost the information extraction from catches. Preliminary simulation testing (Minte-Vera *et al.* in prep) showed that, for artificial data sets, catch data combined with informative priors on some parameters could produce acceptable management quantities.

Catch only model is given by

$$C_{t+1} = P_t \left[1 + x \left(\frac{B_t}{aK} - 1 \right) \right] \left[B_t + rB_t (1 - \frac{B_t}{K}) - C_t \right]$$

where:

C_{t+1} is catch in at time *t;*

P_t is the proportion of biomass caught at time *t*;

B_t is the population biomass at time *t*;
K is the carrying capacity, or biomass at which the growth of the population is zero;
r is the intrinsic rate of population biomass change;
x is a multiplier that defines the increase in fishing mortality over time;
a ($0<a<1$) is the bio-economic equilibrium as a proportion of *K*.

In this model, four parameters are estimated: *r, K, a* and *x*. The population was assumed to be lightly fished at the beginning of the time-series (so $B_0 = K$), and that the first catch (C_0) was measured without error (so $P_0 = C_0/B_0$).

The parameters were estimated using Bayesian techniques. Several combinations of priors were used. For the Western stock, priors for K were set as *K*~U(100 000,1 000 000), ln(*K*)~U(ln(100 000), ln(1 000 000)) or a lognormal distribution with mean 350 000 t and CV=0.5. For the eastern stock, priors for K were set as *K*~U(200 000, 2 000 000), ln(*K*)~U(ln(200 000), ln(2 000 000)) or a lognormal distribution with mean 700 000 t and CV=0.5. Priors for *r* were set as *r*~U(0.4, 2.0) or a prior based on demographic methods (see **Appendix 6**, McAllister *et al* 2001). The priors for *a* were set as uniform on the possible range of the parameter *a*~U(0,1). Sensitity for the priors for *x* were done, because some combinations of *a* and *x* values may generate unrealistic oscilations on the harvest rate and consequently on the biomass. Initially, priors on x were set as *x*~U(0,10), then the range was restricted to *x*~U(0,1) or *x*~U(0, 1.1) for the eastern and western stocks, respectively.

The observed catches were assumed to follow a log-normal likelihood function (Casella and Berger 2002) with expected value equal to the catches predicted by the models:

$$L(\phi \mid w) = \prod_{t=1}^{n} \frac{1}{\sigma C_t \sqrt{2\pi}} \exp\left[-\frac{1}{2\sigma^2} \left(\ln C_t - \mu \right)^2 \right]$$

Where:

$$\mu = \ln E(C_t) - \frac{\sigma^2}{2}$$

n is the length of the catch time-series

C_t is the observed catch in year *t*

$\hat{C}_t$ is the expected catch for year *t* predicted by the model

σ is the variability parameter assumed known and equal to 0.4.

The parameters were estimated using SIR-Sampling Importance Resampling (McAllister *et al.* 1994; Gelman *et al.* 2004). The importance function was equal to the joint prior function, and thus the importance ratio is equal to the likelihood. One million parameter vectors were randomly sampled from the joint prior distribution; of those 20 000 samples were taken with replacement with probability proportional to the importance ratio. Punt and Hilborn (1997) found that the resampling need to be done until no vector is assigned more than 1% of the posterior probability (MSD-maximum single density). In our case, the MSD was monitored and no vector occurred in more than 1% of the resamples. Other diagnostics for convergence were also used such as the coefficient of variation in the average importance weight (McAllister and Kirchner, 2002) and the maximum importance ratio (McAllister and Pikitch, 1997).

The data used in the first set of runs were the time series of total catches from 1950 to 2006 for the eastern stock and 1976 to 2006 for the western stock. Although, the catches for the western skipjack stock start at 1953, they stay very low until mid-1970s. Preliminary runs using the whole catch series would not run because the model was unable to find a combination of parameters that would produce a trajectory with a small harvest rate for almost 30 years. For the second set of runs, the model was fit to a restricted catch series for the eastern stock in order to have only catches coming from a more homogeneous fishery (see section 3.2). The series was divided in two periods, from 1965 to 1984 and from 1985 to 2006.

5.2.2 PROCEAN

The PROCEAN (Production Catch/Effort ANalysis) model is a multi-fleet surplus production model developed in a Bayesian framework to conduct stock assessments based on catch and effort time series data (Maury, 2001; Maury and Chassot, 2001). PROCEAN is a biomass dynamics model based on the generalized surplus production model (Pella and Tomlinson, 1969) that includes process error for fishing fleet catchability, stock carrying capacity, and a robust process error on fishing mortality.

The eight independent time series of abundance indices defined during the Working Group were used as well as the combined abundance index weighted by fishing area (see Section 4).

Preliminary runs showed that there was not enough information in the data to estimate the shape parameter (m) regarding the typical one-way trip of the eastern Atlantic skipjack fishery so it was fixed when running the model. The initial biomass of the stock in 1969 (B0) was also difficult to estimate and assumed equal to a fixed proportion of the carrying capacity (K). Informative prior distributions were considered for the growth rate parameter (r) and the maximum sustainable yield (MSY). Normal distributions with mean 1.17 (S.D. = 0.26) and 150,000 (S.D. = 20,000) were assumed for the intrinsic growth rate (Section 5.3.2) and MSY, respectively. A sensitivity analysis was conducted to account for uncertainty in some input parameters and to assess the impact of the prior distributions on posterior estimates (see Section 6.2.4).

5.2.3 Bayesian Surplus Production Model methods

The Bayesian Surplus Production model (McAllister *et al.* 2001) is a non-equilibrium surplus production model that allows prior distributions on intrinsic rate of population increase (*r*), carrying capacity (*K*), biomass in the first modeled year defined as a ratio (*alpha.b0*) of *K,* average annual catch before data were recorded as well as variance, the shape parameter (n) for a Fletcher/Scheafer model and catchability parameters for each time series. The model uses a sampling importance resampling algorithm (SIR, McAllister and Kirkwood 1998) and can fit either a Scheafer or a Fletcher/Scheafer type production model. The BSP model has been accepted into the ICCAT catalog and has been applied to several previous ICCAT species (white marlin, bluefin tuna, billfishes, bigeye tuna) however this is the first time that the model has been applied to skipjack tuna.

In this application we use the logistic Schaefer formulation of the model and estimate r and k and alpha.b0 using prior distributions. A lognormal(mean= 1, sd=0.01) prior distribution for alpha.b0 was assumed on the basis that biomass in the first year of the model year (1950 for eastern skipjack and 1952 for western skipjack) was at or close to carrying capacity. Prior distributions for r were determined on the basis of demographic modeling described in Section 5.3.2. Priors for K were initially estimated to be uniform on either K or log K with maximum bounds equal to 10 times the maximum observed catch and minimum bounds equal to the maximum observed catch but were subsequently decreased to ~ 5 times the maximum catch. In this formulation of the BSP model we input prior distributions for the parameters r and K and assumed that K was equal to the biomass at the starting point for each of recorded catch for each model.

Initial model fitting and parameterization was necessarily to find suitable starting values for the input parameters r and K to get the model to estimate modal values which are either the maximum likelihood estimates for the non-Bayesian parameters or the mode of the posterior for the Bayesian parameters. This is performed during the 'estimate mode' component of the model fit procedure and often different starting values where necessary for different runs. Starting values for the various parameters are given in **Tables 21** and **22** for western and eastern skipjack, respectively. Indices used for western skipjack are given in **Table 23** and for eastern skipjack in **Tables 24** and **25**.

For each model run, the convergence diagnostics were examined during the 'importance sample' stage of modeling according to the methodology described in McAllister and Kirkwood (1998). Further, given the non-informative or contradictory nature of many of the input indices, examination of the diagnostics was particularly critical because of the potential bias that the importance function can impart on the posterior modes. It is recommended that the CV of the weights CV(wts) of the importance draws should be less than the CV of the likelihood times the priors CV(L*P) for the same draws. As a diagnostic of convergence for the SIR algorithm, the we used the ratio of the CV(wts)/CV(L*P) assumed that ratios greater than 2 were unacceptable, ratios between 1 and 2 were marginal and ratios less then 1, acceptable.

5.3 Other methods

5.3.1 Estimation of potential trends in catchability in the European purse seine fleet

The Group noted than in various past analyses it has been assumed that the catchability associated with the EC tropical purse seine fleet has increased about 3% per year since 1980. The Group conducted additional analyses to determine if perhaps changes in catchability have not occurred at a constant rate since 1980.

The data used, see **Figures 34** and **35** (for the three tropical species separately and combined) were: 1950-2006 total catch; 1969-2006 catch and nominal effort (fishing days) of the EC and associated purse seine fleets. No attempt was made to separate FAD and free school sets. The 1983 and 1984 effort values seemed anomalously high and were excluded from the analyses.

The approach used can be summarized as follows: Conditional on the total catches, biomass trajectories were computed based on a deterministic Fox production model with assumed parameter values (these are explained below). From these biomass values and the total and purse seine catches and fishing effort, it is possible to derive values of fishing mortality and catchability by purse seine fleet. The trends in the resulting catchability values were then examined. The following equations explain the method used:

1) Assume values for *MSY* and *K*.
2) Assume that $B_{1949} = K$
3) Project the population forward using Fletcher's parameterization of the Fox model given the above values and the time series of known total catches:

$$B_{t+1} = B_t - e^1 \mathrm{MSY} \frac{B_t}{K} \ln\left(\frac{B_t}{K}\right) - {}^{T}C_t$$

4) Estimate total fishing mortality:

$$F_t = \frac{{}^{T}C_t}{(B_t + B_{t+1})/2}$$

5) Estimate purse seine fishing mortality based on the ratio of purse seine catch (P) to total catch:

$${}^{P}F_t = \frac{{}^{P}C_t}{{}^{T}C_t} F_t$$

6) Estimate purse seine catchability using the nominal effort:

$$q_t = \frac{{}^{P}F_t}{f_t}$$

The values assumed for *MSY* for bigeye and yellowfin were 90,000 t and 150,000 t, as estimated from the previous assessments. An *MSY* of 150,000 t was assumed for skipjack in the eastern Atlantic. When the three stocks were analyzed together, the overall *MSY* used was 390,000 t.

The values of *K* for bigeye and yellowfin were calculated such that the projected B_{2006}/B_{MSY} ratios were 0.9 and 1.0, respectively. The value of *K* for skipjack was fixed arbitrarily to 700,000 t, which is similar in magnitude to the values calculated for yellowfin and bigeye. The value of *K* for the analyses of the three species combined was the sum of the three individual *K* values.

The group calculated average percent changes in catchability by regressing $\ln(q_t)$ against time for different time periods. These were 1969-1979, 1980-1990 and 1991-2006, i.e. the same periods being considered to split the series for the Multifan analyses. In addition, the time period 2002-2006 was examined to investigate more recent trends.

Results

The projected biomass trends are shown in **Figure 36**. The models show steeper declines for bigeye and yellowfin than they do for skipjack or for the three species combined.

Table 26 provides the assumed population dynamics parameters and the resulting slopes of the regression of ln(*q*) against time for different time periods. The values of ln(*q*) for the entire time period are shown in **Figure 37**. These results suggest that during some time periods, catchability may have changed by more than 10% per year. This is evident primarily in the 1970s and 1980s. For the more recent five years, these analyses suggest that catchability continues to increase rapidly for skipjack, is decreasing for yellowfin, and is increasing slowly for bigeye.

Figure 38 and **39** show the input (nominal) fishing effort as well as the effort adjusted by the catchability estimates by species. Note that the largest impact of adjusting effort by catchability is for bigeye tuna, followed by skipjack and then yellowfin.

Figure 39 compares the nominal effort series with two adjusted series for yellowfin tuna. The blue line is adjusted using the catchability changes estimated in the present analyses. The red line was obtained following the same approach that was applied during the yellowfin session held in Cumana, Venezuela in 2000 (Anon. 2001), which assumes a 3% annual increase in *q* after 1980. (Note that the input effort series used for both analyses are different). The two adjusted series are similar in magnitude, although in some years the adjusted effort from the current analysis can be up to 60% higher than the effort adjusted by the 3% annual change in *q*.

In discussing the results obtained, the Group agreed that the approach used to calculate changes in *q* has strengths and weaknesses. One strength is that the rate at which *q* changes over time is not fixed. Another strength is that it is linked to a population dynamics model. In terms of weaknesses, the deterministic nature of the Fox model used is rather inflexible. A more flexible approach would be, for instance, to estimate catchability changes as random walks within a stock assessment framework such as Multifan-CL. Finally, the group did not examine in detail the effect that changes in assumed values of *MSY* and *K* would have on the results, although limited runs suggested that the trends in q were relatively insensitive to these.

For the stock assessment analyses, the Group concluded that both the effort series adjusted for a 3% increase in q per year, as well as adjusted by the catchability changes estimated in these analyses, should be used (see **Table 27**).

6. Stock status results

6.1 Stock status – Yellowfin

6.1.1 VPA Results

This section summarizes the results from VPA analyses explained in Section 5.1. The report file output by the VPA-2BOX software for the base VPA models (Runs 5 and 10) is included as **Appendix 7** This appendix contains a complete description of the VPA results, including the matrix of estimated fishing mortality rates, abundance at age, stock biomass, recruitment, fits to indices, estimated index selectivities, F-ratios and Terminal Fs-at-age.

Diagnostics

Fits to the CPUE series for the VPA continuity and base models are summarized in **Figures 40** and **41**. The fits to the base models (Runs 5 and 10) are very similar, and show a substantial lack of fit to many indices (**Figure 41**).

Retrospectives

A retrospective analysis was completed by sequentially removing inputs of catch and abundance indices from the 2008 base case model, back to 2003. **Figure 42** shows the trends of spawning biomass and recruits for the base cases. SSB trends were scaled to the maximum value of the series to facilitate comparison. The SSB trends are sensitive to the sequential removal of data and show no convergence back in time. Instead, some series indicate a steeper decline in biomass. The estimated recruitment is fairly insensitive to the retrospective removal of data. In recent years, the recruitment estimates fluctuate with no obvious pattern.

Retrospective patterns in fishing mortality-at-age (FAA) and numbers-at-age (NAA) are summarized in **Figure 43** and **44**, respectively. Some substantial retrospective pattern in FAA is noted, particularly for Ages 4 and 5+ between 1990 and 2006. Retrospective pattern in NAA are less apparent. The model results are generally convergent until the most recent years, and then vary without obvious pattern.

Comparison of 2003 and 2008 VPA base models

The 2008 continuity run was constructed to examine the implications of adding recent years (2002-2006) to the VPA model without changing the indices used or the model settings. Trends in apical fishing mortality, spawning stock biomass (SSB), abundance (Ages 0-5+), recruitment (Age 0) and the annual F-Ratio (F5+/F4) for the 2003 base and 2008 continuity models are shown in **Figure 45**. The 2003 base and 2008 continuity stock assessment results are similar, but some differences are evident in the recruitment, abundance and fishing mortality estimates, particularly between 1999 and 2001. These inconsistencies are likely to be caused by differences in the estimated F-Ratios during those years. The SSB estimates are quite similar throughout the time series.

VPA Base Models

Two models (Runs 5 and 10) were chosen by the working group to provide management advice. Annual trends in yield, total biomass, apical fishing mortality, recruits (Age 0), spawning stock biomass (SSB) and SSB relative to SSB at Fmax are shown in **Figure 46** (Run 5) and **Figure 47** (Run 10). Uncertainty in the annual values was estimated using 500 bootstraps runs of the index residuals.

The two runs are very similar, although run 10 estimates a slightly more optimistic stock status in 2006.

Sensitivity Runs

Several sensitivity runs were conducted to examine model sensitivity to:

1) The application/removal of penalties on deviations in recent recruitment.
2) The application/removal of penalties on deviations in recent estimates of vulnerability at age.
3) Changes in the timing applied to indices of abundance.
4) Various assumptions about the catch-at-age of the Japanese longline in 2006.
5) Estimating a single F-Ratio for all years (1970-2006).
6) Fixing the F-Ratio for all years at various values.

The Group considered these models during the development of the base run, but ultimately decided that these runs would not be used to develop management advice.

Stock status

The Working Group could not choose between the two VPA base cases, and since the model results were so similar (**Figures 46** and **47**), the Group recommended combining the model results into a single joint distribution. This joint distribution was used to determine stock status and develop management advice. Management references were calculated using the medians of the joint distribution, and assuming constant recruitment equal to the mean of the observed recruitments during 1970-2006. All management benchmarks and reference points are summarized in **Table 28**.

The trajectory of stock status during the time series is summarized in **Figure 48**. According to the joint distribution of the 2008 base models, yellowfin tuna have never been overfished, although overfishing has occurred (**Figure 48**; yellow symbols). Current stock status was estimated using SSB_{2006}/SSB_{MAX} and $F_{Current}/F_{MAX}$. According to the results of the joint distribution, the stock is not currently overfished ($SSB_{2006}/SSB_{MAX} = 1.09$) or undergoing overfishing ($F_{Current}/F_{MAX} = 0.84$) (**Figure 49**). Uncertainty in the stock status was estimated by bootstrapping the index residuals. 500 bootstraps were run from each VPA base model (**Figure 49**) Histograms of the bootstrap estimates of 2006 stock status from the joint distribution were constructed to examine the normality of the distribution. There is no evidence of a strong bias in the results (**Figure 50)**.

The conclusions of this assessment do not capture the full degree of uncertainty in the assessments and projections. An important factor contributing to uncertainty is the accuracy of the growth curve and the age-slicing procedure. Age-slicing procedures are sensitive to small changes in slicing limits. Improved methods to estimate catch-at-age (e.g. stochastic approaches and/or directly observed age composition) have the potential to improve the reliability of age-structured models. Another important source of uncertainty is recruitment, both in terms of recent levels (which estimated with low precision in the assessment), and potential future levels. These models assumed recruitment would continue at the level observed during 1970-2006. It is possible that changes in fishing pressure or environment could invalidate this assumption.

6.1.2 ASPIC

Table 29 shows the initial results of the 10 runs. Estimated trajectories of relative biomass and relative fishing mortality for each of the 10 cases are presented in **Figure 51**. In the case of relative biomass, cases 1, 3, 7, and 9 showed very different trends compared to the other cases. For relative fishing mortality, cases 1, 3, 9, and 10 clearly showed trajectories with different trends. After initial examination of the results, the Group decided to run bootstraps for cases 2, 4, 6, and 8. The estimated deterministic trajectories for the 4 bootstrap cases are shown in **Figure 52**. The four cases showed the same trends with an increase in fishing mortality and a reduction of biomass that resulted in a period where the stock was overfished and undergoing overfishing, followed for a period of recovery. The present condition of the stock is overfished but not experiencing overfishing any longer. **Figure 53** shows the phase plots of each of the 4 bootstrap runs (500 bootstraps) for year 2006 (i.e., current condition). **Figures 54** and **55** show the relative biomass and relative F trajectories and the 80% CI estimated from 500 bootstraps. Results of bootstraps runs for cases 2, 4, 6, and 8 are summarized in **Table 30**.

6.2 Stock status – Skipjack

6.2.1 Multifan-CL model

The Group attempted several analyses of the eastern and western stocks combined. All of these showed very poor convergence, as expected because the tagging data were not judged to be very informative on ocean wide spatial scale. Subsequently, the Group made separate analyses for the eastern and western stocks. These are described below.

6.2.1.1 Eastern Atlantic

The eastern model included 10 separate fisheries (see Section 4.1.3), was divided into yearly and quarterly time frames and assumed four recruitment events, each occurring at the beginning of each quarter. Natural mortality was fixed at 0.2.quarter^{-1}. The options for the base case eastern model which included all catch data from 1950 to 2006, were similar to those for the base case model simulated for the western region The major differences however, were that the model for the eastern region included a cubic spline selectivity function with three nodes (later increased to 5) and the penalties for the effort deviations were set to be the same for all the fisheries.

The model had great difficulty estimating the biomass at the beginning of the fishing period (**Figure 56**). The model estimate of biomass fluctuated greatly for the initial model years, repeatedly reducing to zero. The estimates of MSY and F_{MSY} were consequently nonsensical (**Figures 57** and **58**). As a result of the poor model estimation, another model run was carried out including data only from 1970-2006. The model was set to estimate the initial population age structure based on Z averaged over the last 20 time periods (quarters in this case). Also, the cubic spline selectivity option was removed and instead selectivity was set to be length dependant for all fisheries. Although these changes removed the occurrence of biomass reducing to zero in the initial years of the model run, it still resulted in an increase in biomass over time (**Figure 59**). MSY and F_{MSY} estimates (**Figures 60 and 61**) were superficially more plausible than the previous model run, but clearly unrealistic due to the strange biomass estimates.

Although several ad hoc variations and model options were simulated for this stock in order to improve the model outputs, they all resulted in similar unrealistic patterns for biomass. As a result, further analysis was discontinued. It is clear that at this stage, the data for the eastern region were unsuitable for Multifan-CL simulation within the time limitations of the working group meeting. Further modeling should be carried out inter-sessionally and possibly include tagging data once fully verified.

6.2.1.2 Western Atlantic

The basic run for the western stock used data from 1952 to 2006 for three fisheries (1=Brazil BB, 2= Venezuela BB+PS, and 3=Others) and the following assumptions/constraints:

- Assume starting population at equilibrium based on M
- Assume M=0.2 per quarter
- Estimate 4 annual recruitment events
- Allow higher variability in effort deviations for fisheries 2 and 3 (weights = 10, 3 and 3)
- Divide length frequencies by 10 (fishery 1) or 20 (fisheries 2 and 3)
- Estimate separate selectivities by fishery; assume constant selectivity after age 14 (quarters)
- Estimate the growth curve, starting from the one assumed by ICCAT (see Manual)

− Allow for random walks in the catchabilities of the 3 fisheries
− Fit a stock-recruitment relationship to estimate MSY-related statistics (steepness prior = 0.9)

An additional sensitivity run was made estimating natural mortality.

Summary fit diagnostics are plotted in **Figure 62**. The estimated selectivity patterns are shown in **Figure 63** and the recruitment and SSB trajectories are shown in **Figure 64**. Overall the model estimates dome-shaped selectivity patterns and substantial fluctuations in recruitment and spawning biomass. The model fit was imprecise. It was not possible to obtain variance estimates of all quantities of interest. Approximate 90% confidence intervals for recruitment and SSB are given in **Figure 65**.

In terms of benchmarks, the model estimated an MSY of 30,660 t per year, and current (2006) ratios of B/B_{MSY}=2.04 and F/F_{MSY}=0.51. A plot of relative B and relative F is given in **Figure 66**. When the sensitivity run estimating M was made (M was estimated at 0.32 per quarter), the benchmarks were estimated as follows: MSY=35,960 t, B/B_{MSY}=2.31, F/ F_{MSY} =0.47.

The group was encouraged by these preliminary results and recommended that more work be undertaken in the future to refine the Multifan-CL model analyses for the stock.

6. 2.2 Bayesian Surplus Production model results

6.2.2.1 Western skipjack

The indices used for the western Atlantic skipjack production model assessment gave quite contradictory information, particularly the sharp decline of the Venezuelan purse seine index (**Figure 67**) and the high fluctuations in the Brazilian baitboat and U.S. rod and reel index. There is little spatial overlap in the coverage of these indices and given the high viscosity of skipjack, these indices may reflect more local conditions rather than the overall western stock. It is, therefore, not unlikely that these indices could show contradictory trends.

Likely due to these contradictory trends, the BSP model runs for the western Atlantic stock of skipjack had initial problems with convergence indicated by very high CV of the weights of the importance draws relative to the CV of the likelihood times the priors cv(wts)/cv(lp). Such a situation can occur when the input indices either are contradictory or uninformative as occurred in several shark stock assessments (McAllister and Kirkwood 1998), resulting in a very narrow importance function. As a remedy, McAllister recommended increasing the width importance function to allow for greater sampling variability with the parameter setting *expand.imp* or by decreasing the degrees of freedom for the multivariate t importance function (the importance function used for these models). The Group explored a series of runs (5-9) either expanding the importance function or increasing the degrees of freedom where each successive expansion improved the convergence criteria cv(wts)/cv(lp) and widened the posterior for *r (***Figure 68***)*. It is highly likely that runs 1-6 are unreasonable given the lack of achieving the convergence criteria. Runs 1-8 also were run with a very wide prior for r (sd=.5) rather than the originally desired 0.25. To correct this an additional run 9 with the correctly specified prior N(1.17, 0.25) was conducted.

The results of Runs 7 and 8 both achieve reasonable but not great convergence criteria (cv(wts)/cv(lp) ~1.6) (**Table 31**). Runs 1-8 also were run with a very wide prior for r (sd=.5) rather than the originally desired 0.25. To correct this an additional Run 9 with the correctly specified prior N(1.17, 0.25) was conducted, however it should be noted that the posterior for r was very wide (**Figure 68).** The fit to the indices for Run 9 was rather poor and not unexpected given the different trajectories of the indices (**Figure 69)** and the equal weighting given to them. The intrinsic rate of population increase, *r*, for Run 9 was estimated to be slightly lower than the prior mean and at a value of 1.159 with a standard deviation of 0.278.

Figure 70 shows the Biomass, B/B_{MSY}, F, and F/F_{MSY} trajectory with projections of 25,000 t starting in 2007 for SKJW-RUN9 showing the initial steep increase in fishing mortality with the creation of the fisheries and a current status assessment of B above B_{MSY} and F below F_{MSY}. It is important to note that expanding the importance function tends to let the model estimate a lower K and higher fishing mortality rates so that if there is a bias introduced by the lack of convergence of the earlier runs, it tends to give more optimistic results for this particular model set up (**Table 31)**.

6.2.2.2 Eastern skipjack

The BSP model for eastern Atlantic skipjack production model assessment used eight indices (**Figure 71)**, two a weighted combined and an unweighted combined index by area and two additional indices obtained from an analysis of the time series of nominal EC purse seine fishing effort with catchability changes estimated by year (**Table 27**). Despite the rather contradictory nature of some of the indices the BSP model runs for the eastern Atlantic stock of skipjack showed more acceptable convergence criteria than for the SKJ-W.

Nineteen runs using various combinations of indices, bounds on K, and with standard deviations for the priors for r (**Tables 32** and **33)**. Many of the runs used the same data and should actually be considered as 'ranging' runs to determine appropriate boundary conditions for the further models. There was a strong effect of the bounds on the uniform prior for K (**Figure 72)**. Decreasing the upper bound from 2 million metric tons (t) to 1 million metric tons (a value similar to 5 times the maximum observed catch) reduced the K values from approximately 1.2-1.3 million metric tons to values around 720-790 thousand metric tons. Given the extremely high K values predicted by using the higher bound on K (1.3 million t) it is likely more plausible to use a bound close to commonly used bounds such as 5 times the maximum observed catch.

Note that the prior distributions for *r* were originally run with a variance of 0.09 where N~(mean=1.17, sd=0.3). This was slightly different from the demographic analysis standard deviation which estimated a sd of 0.25, however the results are likely very comparable to using a N~(1.17, sd=0.3) prior. An input of the standard deviation rather than the variance as the mean for the prior distribution facilitated an impromptu sensitivity analysis of the effects of using a narrow (sd=0.25) or wide (sd=0.5) prior for r. This set of runs indicated that there was little effect on the posterior modes (**Tables 32** and **33**) resulting in little actual affect on the status results for each run. The resulting posterior distributions were, however, much broader with the wide or uninformative prior, resulting in wider coefficients of variation around the mode of the posterior distributions for status results (**Tables 32** and **33)**. In addition, the higher r values of the posterior suggest that freeing the prior on r allows the model to estimate a higher posterior value for r (~1.3-1.7) than for the informative priors. Based on earlier demographic modeling (section 5.3.2) these higher values seem unlikely for skipjack tuna.

As such, RUN5BZ with using a uniform (250000, 1000000) prior on ln K, a N~(1.17, 0.3) prior on r and all indices weighted equally may be considered the best model incorporating all of the data, though the fits to the indices were generally poor (**Figure 73)**. Trajectories of Biomass, B/Bmsy, F, and F/Fmsy with projections of 100,000 t starting in 2007 for SKJE-RUN5BZ (**Figure 74)**, indicate the relatively high B/Bmsy status and low F/Fmsy status predicted by the model.

6.2.3 Catch-only model

Western skipjack

Two sets of runs were conducted for the western stock (**Table 34**). For both sets, the catch series used ranged from the year 1976 to 2006, in order to include the years when the catches start to increase (see **Figure 7**). For the first set (A), the prior on x was set as wide values *x*~U(0,10). Explorations of the behaviour of the model for combinations of *a, x* parameters showed that for high *x* and low *a* the model predictions for biomass and harvest had wide unrealistic oscillations. A second set (B) of runs with a narrow prior on *x* was also conducted. When narrower prior on *x* were assumed, the model was able to gain more information from the catches than for a wider prior on *x*. **Figure 75** has the results only for run 1 of the two sets, which were similar for the other runs within each set (see **Appendix 8** for full results).

The estimations were sensitive to the prior on *x*. The first set of runs (A) included less information from the catches as suggested by the wider posteriors when compared to the priors (**Figures 75** and 7**6**). For the first set of runs the median of the posterior for MSY ranged from 54,000 to 83,000 t. The second set of runs (B) were able to incorporate more information from the catches that the first set of runs, as suggested by narrower posteriors on the parameters and derived quantities, when compared to the priors (**Figure 75**), and were selected for inference. For the second set of runs, the median of the posteriors for MSY were around 30,000 t.

Eastern skipjack

For the eastern stock of skipjack, three sets of runs were performed (**Table 35**). For first set (A) the catch series of 1950 to 2006 was used as well as a wider prior on *x*. The catch series showed a decline in the mid 1980 when there was displacement of a large part of the French and Spanish purse seiners fleets to the Indian Ocean. The catch-only model assumes that the harvest rate increases and levels off following a logistic curve. It was suggested by the Group to run the model only with the catches from 1985 to 2006, in order to fulfill the assumptions of the catch-only model. Two other sets of runs were conducted. Set B included runs fit to the catches from 1965 to 1984 and set C included runs fit to catches from 1985 to 2006. For those two sets the prior on *x* was narrower (**Table 35**).

Similarly to the SKJ-W, the results appear sensitive to priors on *x*, and the first set of runs (A) included less information from the catches than the set C as suggested by the wider posteriors (**Figure 77**). The set C of runs was considered the best fit because no posterior concentrated towards the bounds as for set A and B (**Figure 77** and see **Appendix 8**). For the set A of runs, the medians of the posterior distributions for MSY ranged from 200,000 t to 275,000 t. For the set C of runs, the medians of the posterior distributions for MSY ranged from 143,000 t to 156,000 t.

6.2.4 PROCEAN

6.2.4.1 *Eastern skipjack*

The model generally fitted well the data for the different runs although European and Senegalese baitboat fisheries and European purse seiners based in Dakar showed increasing trends in the residuals. In all runs, it was shown that informative priors were required for convergence of the model. Maximum posterior estimates of MSY were in the range 154,000-185,000 t and appeared quite sensitive to the mean of the MSY prior (**Table 36**). F_{MSY} appeared robust to the changes made in input parameters and prior distributions, the value of 0.48 for m = 2 being related to the shape of the production curve and leading to a value of F/F_{MSY} in 2006 close to the other runs.

For the standard run, catches observed and predicted were close to the equilibrium production curve (**Figure 78**). This might be due to the relatively short time span of the skipjack that are mainly caught before age 4 and to their high growth rate. The stock appeared underexploited in 2006 with the fishing mortality below the fishing mortality at MSY, i.e. F/F_{MSY} = 0.32 in 2006, and the biomass above the biomass at MSY, i.e. B/B_{MSY} = 1.79.

The model run conducted with the combined abundance index led to similar results in terms of diagnostic of the stock, although the MSY was estimated about 10,000 t lower than in the standard run (**Table 36**). The quality of the fit was however quite poor and results showed an increasing trend in the residuals, indicating that the data did not conform to the assumption of lognormal error. The inclusion of process error on catchability for the standard run parameter settings improved the fit of the model by removing trend in the residuals and allowed tracking the changes in catchability through time (**Figure 79**).

In particular, results suggested that the catchability of baitboat fishing fleets based in Dakar would have continuously increased by about 4% each year since the 1970s. This could be related in the 1980s to the introduction and development of associated-school fishing (Fonteneau and Diouf, 1994). Despite the 3% increase already accounted for in the abundance indices, the European purse seine fishing fleet based in Dakar fishing on free schools showed a step-increase in catchability around 1990 followed by a relative stability (**Figure 79**). This would suggest that technological improvements in the late 1980s and early 1990s would have led to a larger increase in catchability than generally assumed (see section 5.3.1).

7. Projections

7.1 Projections – Yellowfin

7.1.1 VPA model projections

Specifications

The projections for yellowfin tuna (Runs 5 and 10) were based on the bootstrap replicates of the fishing mortality-at-age and numbers-at-age matrices produced by the VPA-2BOX software. The Group agreed that projections and benchmarks should be computed using a resampling of observed recruitments during 1970-2006. This resulted in an essentially constant recruitment at the mean value of the time series. This is in contrast with the approach used during the 2003 assessment which used a fixed Beverton and Holt S-R relationship estimated externally to the model. The extent of recruitment variability, σ_R, for each bootstrap replicate was modeled using a standard deviation of 0.5 with no autocorrelation.

Because no management changes occurred during 2007 and 2008 (projected by the VPA model because data is not yet available), these years were projected at F Current[1]. Projections were made at various levels of constant catch or constant F, including:

1) Catch = 50,000 t	2009-2016
2) Catch = 70,000 t	2009-2016
3) Catch = 90,000 t	2009-2016
4) Catch = 110,000 t	2009-2016
5) Catch = 130,000 t	2009-2016
6) Catch = 150,000 t	2009-2016
7) Fishing mortality = F0.1	2009-2016
8) Fishing mortality = F_{max}	2009-2016
9) Fishing mortality = $F_{Current}$	2009-2016
10) Fishing mortality = F1992	2009-2016

Projections that used various levels of constant catch employed a restriction that the fully-selected *F* was constrained not to exceed 3 yr^{-1}.

Results

The Working Group recommended that management advice be constructed using the joint distribution of VPA runs 5 and 10. Therefore, the projections reflect the median outcome of both base runs.

Projection of total biomass, yield, fishing mortality, SSB and recruitment are shown in **Figures 80** and **81** SSB and F are also plotted relative to the management benchmarks (SSB @ Fmax and Fmax). Projections of constant catch (**Figure 81**) indicate that catches of 130,000 t or less are sustainable during the projection interval. Catches in excess of 130,000 t cause an overfished and overfishing condition during the projection interval. Projections of constant fishing mortality (**Figure 81**) indicate that current (2003-2006) fishing mortality levels allow the spawning biomass to gradually increase during the projection interval. Increasing fishing pressure to 1992 levels causes the stock status to deteriorate to an overfished and overfishing condition during the projection interval.

7.1.2 ASPIC

ASPIC projections (**Figure 82**) for each of the 4 cases were run for the following catch scenarios: 108,263 t (2006 catch level), 80,000 t, 100,000 t, 120,000 t, 140,000 t, and 160,000 t. All runs indicated that catch levels of 120,000 t or less will recover the stock from the overfished condition. A catch level of 140,000 t will not recover the stock according to the results of the case 6, but it will recover it for the other three cases. All 4 cases showed that the stock will not recover if the catch levels are 160,000 t or more.

7.2 Projections – Skipjack

8. Recommendations

- The Group agreed that the level of landings of "*faux poisons*" in Abidjan (on the order of 10,000 t for skipjack) and the small size of the fish landed was important enough to potentially affect the results of stock assessments. Therefore, the Group recommends the development and implementation of sampling protocols to collect detailed information on the amounts of landings, the species composition and the size composition of false fish landings.

- As it has been already implemented by other RFMOs, carefully design extensive conventional tagging studies should be implemented by ICCAT to complement the use of fishery dependent data used to estimate indexes of abundance.

- Although there have been improvements, the Group agree there is a need to increase efforts towards biological studies of the three tropical tuna species: yellowfin, skipjack and bigeye.

- The Group was encouraged by the preliminary results obtained for the western skipjack stock and recommended that more work be undertaken in the future to refine the Multifan-CL model analyses for this

[1] F current was calculated as the maximum value (apical) of the geometric mean F-at-age. The geometric mean was calculated for the years 2003-2006.

stock. Regarding the eastern stock, the Group recommended to carry out further modeling inter-sessionally and possibly include tagging data once fully verified.

- The Secretariat needs sufficient resources to prepare available data files (table of substitutions, catch-at-size, catch-at-age, tagging) at least two weeks before the meeting and National Scientists need to devote sufficient resources to review those files before the start of the meeting and request any necessary modifications, if applicable. Note that this issue should be addressed to the Sub-Committee on Statistics and revised in the SCRS plenary and the use of modern web conferencing techniques should be considered.

9. Other matters

The Group reviewed the 2007 Report of Panel 1, which included as part of the discussions, the suggestion that *the SCRS analyze and present a range of options to the Commission in time for consideration at the 2008 Special Meeting to increase the yield per recruit and MSY of bigeye tuna by reducing mortality on small bigeye tuna through the use of closed areas (i.e. total closure of all surface fisheries) and moratoriums on the use of fish aggregating devices (FADs).* In addition it was also suggested that the SCRS *analyze the impacts of such measures on the catches of yellowfin tuna and skipjack tuna as well* (ICCAT 2008). The Group considered that the Panel suggestion was addressed to the analyses conducted in 2005, which included a wide range of management scenarios as well as different approaches to assess the effect of the moratorium and other alternative measures. Nonetheless, the Group considered it useful to analyze the effect of the time-area closure established by [Rec. 04-01], because at the time of the 2005 meeting there were no observation data to conduct such analyses, since the Recommendation had only recently been agreed at that time. However, these analyses could not be conducted at the assessment meeting as the main thrust of the assessment meeting was to update the evaluations of the status of the skipjack and yellowfin stocks. Discussions were held to plan analyses to be conducted between the assessment meeting and the Species Group discussions in September, 2008.

As for previous analyses, the Group discussed which period of reference to consider in the analyses. Taking into account that the compliance during the first time-area closure was only partial, considering the period prior to 2004 as reference would likely lead to and overestimate of the effects of the current time-area closure. On the other hand, considering years prior (1993-1996) to the first moratorium would make it difficult to separate the effect of the continuous decrease of effort by the European and associated fleets since this period. As an alternative, the Group decided to limit the analyses to the European and associated fleets assuming that these fleets have fully implemented the different time-area closures.

In addition to these analyses, the Group considered that some general scenarios of reduction in effort for different fleet components, as suggested by Panel 1, and its effects on yield per recruit, could be carried out. These analyses could provide the range of options requested by Panel 1.

In order to facilitate the work of the Group in September, during the Species Group meeting, it was suggested that scientists conduct these analyses in advance to the Species Group meeting and present the results as SCRS documents.

The results of the analyses conducted prior and during the Species Group meeting are included as **Appendix 9**.

10. Report adoption and closure

The Chairman again thanked the local hosts for the organization of the meeting. The report was adopted and the meeting adjourned.

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Table.1 Task I - Estimated catches (t) of yellowfin tuna (*Thunnus albacares*) by major area, gear and flag.

			1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
TOTAL			145361	136265	162247	193448	166901	163760	162753	172551	153246	153040	137211	148564	140366	136235	164650	140279	125515	119936	107322	108623	75156
	ATE		113379	101671	125345	160717	130004	126048	124009	124336	117973	119984	104871	117644	109656	101725	124363	110619	100595	88794	81344	80225	62697
	ATW		31982	34594	36902	32731	36897	37712	38745	48215	35274	33056	32341	30919	30710	34510	40287	29660	24920	31143	25979	28398	12459
Landings	ATE	Bait boat	16750	16020	12168	19560	17772	15095	18471	15652	13496	13804	12907	17330	19256	13267	19071	13432	11513	15354	12012	10434	7498
		Longline	6624	8956	7566	10253	9082	6516	8537	14605	13718	14233	10488	13869	13561	11364	7570	5790	9075	11501	7494	7857	2851
		Other surf.	2932	2646	2586	2175	3748	2450	2122	2030	1989	2065	2136	1674	1580	2424	2074	1826	2540	2928	3062	3615	1456
		Purse seine	87074	74049	103025	128729	99402	101987	94880	92050	88770	89882	79339	84771	75260	74670	95648	89572	77468	59011	58776	58319	50892
	ATW	Bait boat	5468	5822	4834	4718	5359	6276	6383	7094	5297	4560	4275	5511	5349	5649	5315	6009	3764	4868	3867	2695	
		Longline	14291	19046	17128	18851	13667	16594	11439	11343	10059	11111	11554	11671	13326	15760	14872	11922	10136	15953	14409	14376	9108
		Other surf.	5557	3692	3293	2362	3457	3483	4842	10166	13580	6601	4801	4581	5345	5231	7027	3763	6413	7104	5069	6880	3345
		Purse seine	6665	6034	11647	6800	14414	11359	16081	19612	6338	10784	11710	9157	6523	7870	13072	7966	4607	3217	2634	4442	
Discards	ATW	Longline	0	0	0	0	0	0	0	0	0	0	0	0	167	0	0	0	0	0	0	5	6
Landings	ATE	Angola	51	246	67	292	510	441	211	137	216	78	70	115	170	35	34	34	34	34	111	0	
		Benin	3	2	7	1	1	1	1	1	1	1	3	1	1	1	1	0	0	0	0	0	
		Cambodia	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	
		Canada	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Cape Verde	2675	2468	2870	2136	1932	1426	1536	1727	1781	1448	1721	1418	1663	1851	1684	1802	1855	3236	2127	2179	1355
		Cayman Islands	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		China P.R.	0	0	0	0	0	0	139	156	200	124	84	71	1535	1652	586	262	1033	1030	1112	1017	
		Chinese Taipei	193	207	96	2244	2163	1554	1301	3851	2681	3985	2993	3643	3389	4014	2787	3363	4946	4145	2327	830	1791
		Congo	15	15	21	22	17	18	17	14	13	12	0	0	0	0	0	0	0	0	0	0	
		Côte D'Ivoire	0	0	0	0	0	0	0	0	0	0	2	0	0	673	213	99	302	565	175	482	216
		Cuba	1295	1694	703	798	658	653	541	238	212	257	269	0	0	0	0	0	0	0	0	0	
		EC.España	66093	50167	61649	68603	53464	49902	40403	40612	38278	34879	24550	31337	19947	24681	31105	31469	24884	21414	11795	11606	13417
		EC.Estonia	0	0	0	0	234	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		EC.France	17491	21323	30807	45684	34840	33964	36064	35468	29567	33819	29966	30739	31246	29789	32211	32753	32429	23949	22672	18940	13263
		EC.Ireland	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	
		EC.Latvia	0	0	0	0	255	54	16	0	55	151	223	97	25	36	72	334	334	334	334	334	
		EC.Lithuania	0	0	0	0	332	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		EC.Poland	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		EC.Portugal	278	188	182	179	328	195	128	126	231	288	176	267	177	194	4	6	4	5	16	274	854
		Faroe Islands	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	
		Gabon	0	0	0	0	0	0	12	88	218	225	225	295	225	162	270	245	44	44	44	44	
		Gambia	0	0	0	2	16	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Georgia	0	0	0	0	25	22	10	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Ghana	10830	8555	7035	11988	9254	9331	13283	9984	9268	11720	15437	17657	25268	17662	33546	23674	18457	15054	17493	11931	12954
		Guatemala	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2906	6560	
		Guinea Ecuatorial	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	
		Japan	4521	5808	5882	5887	4467	2961	2627	4194	4770	4246	2733	4092	2101	2286	1550	1534	1999	5066	3137	4840	

	Korea Rep.	1221	1248	1480	324	259	174	169	436	453	297	101	23	94	142	3	8	209	984	95	4	
	Libya	0	0	0	0	0	0	0	0	0	0	0	0	0	0	208	73	73	73	73	73	
	Maroc	1529	0	0	0	0	0	0	0	0	0	0	0	0	0	0	79	108	95	183	95	
	Mixed flags (FR+ES)	933	932	825	1056	2220	2455	2750	1898	1172	1166	981	1124	1369	1892	1427	599	992	1052	933	1063	655
	Namibia	0	0	0	0	0	0	0	2	14	72	69	3	147	59	165	89	139	85	135	59	
	NEI (ETRO)	2077	3140	5436	12513	4856	10921	9875	8544	8970	9567	6706	7225	5418	5448	10205	8209	5396	4294	6808	6151	6163
	NEI (Flag related)	285	206	280	1115	2310	1315	1157	2524	2975	3588	3368	5464	5679	3072	2090	133	466	0	0	0	
	Netherlands Antilles	0	0	0	0	0	0	0	0	0	3183	6082	6110	3962	5441	4793	4035	6185	4161	0	1939	1429
	Norway	418	493	1787	1790	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	Panama	1858	1239	901	1498	7976	8338	10973	12066	13442	7713	4293	2111	1315	1103	574	1022	0	1887	6170	8557	9363
	Philippines	0	0	0	0	0	0	0	0	0	0	0	126	173	86	0	50	9	68	69	30	
	Russian Federation	0	0	0	0	3200	1862	2160	1503	2936	2696	4275	4931	4359	737	0	0	0	0	4	42	211
	S. Tomé e Príncipe	178	298	299	164	187	170	181	125	135	120	109	124	114	122	122	122	122	134	145	137	
	Senegal	0	0	2	90	132	40	19	6	20	41	208	251	834	252	295	447	279	681	1301	1262	816
	Seychelles	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	
	Seychelles (foreign obs.)	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	
	South Africa	68	137	671	624	52	69	266	486	183	157	116	240	320	191	342	152	298	402	1156	1187	
	St. Vincent and Grenadines	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	101	209
	U.S.A.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	U.S.S.R.	1275	3207	4246	3615	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	UK.Sta Helena	93	98	100	92	100	166	171	150	181	151	109	181	116	136	72	9	0	0	0	344	
	Ukraine	0	0	0	0	215	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	Vanuatu	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	24	145	
	Venezuela	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
ATW	Argentina	18	66	33	23	34	1	0	0	0	0	0	0	0	0	0	0	0	327	327	0	
	Barbados	57	236	62	89	108	179	161	156	255	160	149	150	155	155	142	115	116	116	116	197	
	Belize	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	143	1164
	Brasil	2266	2512	2533	1758	1838	4228	5131	4169	4021	2767	2705	2514	4127	6145	6239	6172	3503	6985	7223	3790	
	Canada	40	30	7	7	29	25	71	52	174	155	100	57	22	105	125	70	73	304	240	293	276
	China P.R.	0	0	0	0	0	0	0	0	0	0	0	628	655	22	470	435	17	275	74	68	
	Chinese Taipei	709	1641	762	5221	2009	2974	2895	2809	2017	2668	1473	1685	1022	1647	2018	1296	1540	1679	1269	430	156
	Colombia	258	206	136	237	92	95	2404	3418	7172	238	46	46	46	46	46	46	46	46	46	46	
	Cuba	1062	98	91	53	18	11	1	14	54	40	40	15	15	0	0	65	65	65	65	65	
	Dominica	0	0	0	18	12	23	30	31	9	0	0	0	80	78	120	169	119	81	119	65	103
	Dominican Republic	0	0	0	0	0	0	0	0	0	0	0	89	220	226	226	226	226	226	226	226	
	EC.España	0	1	3	2	1462	1314	989	7	4	36	34	46	30	171	0	0	0	0	0	1	
	EC.France	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	EC.Portugal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	151	60	14
	Grenada	186	215	235	530	620	595	858	385	410	523	302	484	430	403	759	593	749	460	492	502	633

		Jamaica	0	0	0	0	0	0	0	0	0	21	21	0	0	0	0	0	0	0	0	0	
		Japan	1647	2395	3178	1734	1698	1591	469	589	457	1004	806	1081	1304	1775	1141	571	755	1194	1176	494	
		Korea Rep.	236	120	1055	484	1	45	11	0	0	84	156	0	0	0	0	0	0	0	580	279	
		Mexico	33	283	345	112	433	742	855	1093	1126	771	826	788	1283	1390	1084	1133	1313	1208	1050	938	890
		NEI (Flag related)	1012	2118	2500	2985	2008	2521	1514	1880	1227	2374	2732	2875	1730	2197	793	42	112	0	0	0	
		Netherlands Antilles	160	170	170	170	150	160	170	155	140	130	130	130	130	130	0	0	0	0	0	0	
		Panama	3289	2192	1595	2651	2249	2297	0	0	0	0	0	0	5	0	0	0	0	0	0	2804	
		Philippines	0	0	0	0	0	0	0	0	0	0	0	36	106	78	12	79	145	299	299	234	
		Seychelles	0	0	0	0	0	0	0	0	0	0	0	0	0	32	0	0	0	0	0	0	
		St. Vincent and Grenadines	0	0	1	40	48	22	65	16	43	37	35	48	38	1989	1365	1160	568	4251	0	2680	2989
		Sta. Lucia	76	97	70	58	49	58	92	130	144	110	110	276	123	134	145	94	139	147	172	103	82
		Trinidad and Tobago	0	1	11	304	543	4	4	120	79	183	223	213	163	112	122	125	186	224	295	459	615
		U.S.A.	9661	11064	8462	5666	6914	6938	6283	8298	8131	7745	7674	5621	7567	7051	6703	5710	7695	6516	5568	7091	5529
		UK.Bermuda	25	23	22	15	17	42	58	44	44	67	55	53	59	31	37	48	47	82	61	31	
		UK.British Virgin Islands	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	
		UK.Turks and Caicos	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
		Uruguay	109	177	64	18	62	74	20	59	53	171	53	88	45	45	90	91	95	204	644	218	
		Vanuatu	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	681	689	661	
		Venezuela	11137	10949	15567	10556	16503	13773	16663	24789	9714	13772	14671	13995	11187	10549	18651	11421	7411	5774	5097	6514	
Discards	ATW	Mexico	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	6
		U.S.A.	0	0	0	0	0	0	0	0	0	0	0	0	167	0	0	0	0	0	0	0	

Table 2 Task I-Estimated catches (t) of skipjack tuna (*Katsuwonus pelamis*) by major area, gear and flag.

			1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
TOTAL			119229	144796	120419	144118	219733	170708	205685	185014	167381	154127	146082	151699	166488	148598	155767	116781	145293	158707	162241	142177	124546
	ATE		95052	121060	94037	118008	186329	140554	172462	155065	145479	126557	114367	122436	139079	119202	124239	95144	120412	131085	133597	115704	124234
	ATW		24164	23736	26382	26110	33404	30155	33221	29949	21859	27562	31712	29087	27356	29307	31451	21600	24749	27461	28517	26454	313
	MED		13	0	0	0	0	0	2	0	43	9	4	176	53	90	77	37	132	161	127	20	
Landings	ATE	Bait boat	38803	48015	41000	36569	41611	35660	31656	37817	33691	32047	37293	42045	37696	29967	46281	27590	29847	39539	43603	41175	26321
		Longline	6	4	9	0	5	3	2	10	3	7	47	85	42	48	53	56	66	316	458	2957	8454
		Other surf.	1027	1506	1643	1357	2067	1602	1223	501	445	501	304	923	417	2423	764	681	551	816	1898	2402	1817
		Purse seine	55216	71535	51385	80082	142646	103288	139581	116737	111340	94002	76722	79383	100925	86763	77142	66817	89948	90414	87638	69170	87642
	ATW	Bait boat	18675	21057	23292	22246	23972	20852	19697	22645	17744	23741	26797	24724	23881	25754	25142	18737	21990	24082	26028	23749	
		Longline	6	9	25	23	33	29	20	16	33	19	12	21	58	23	60	349	95	206	207	287	38
		Other surf.	518	355	600	600	872	764	710	1577	2023	452	556	516	481	466	951	398	367	404	316	372	275
		Purse seine	4964	2315	2466	3241	8527	8509	12794	5712	2059	3349	4347	3826	2936	3063	5297	2116	2296	2769	1967	2045	
	MED	Bait boat	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Longline	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	17	21	13	8	
		Other surf.	13	0	0	0	0	0	2	0	43	9	4	176	53	90	77	32	12	40	16	12	

		Purse seine	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	103	101	99	0	
Discards	ATW	Longline	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Landings	ATE	Angola	80	30	85	69	66	41	13	7	3	15	52	2	32	14	14	14	14	10	0	0	
		Benin	5	3	7	2	2	2	2	2	2	2	7	3	2	2	0	0	0	0	0	0	
		Canada	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Cape Verde	2076	1456	971	806	1333	864	860	1007	1314	470	591	684	962	789	794	398	343	1097	637	929	325
		Cayman Islands	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		China P.R.	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	
		Chinese Taipei	0	1	3	0	5	3	2	10	3	5	47	73	39	41	24	23	26	16	10	8	14
		Congo	8	8	11	12	9	9	10	7	7	6	0	0	0	0	0	0	0	0	0	0	
		Côte D'Ivoire	0	0	0	0	0	0	0	0	0	0	0	0	0	1173	259	292	143	559	1259	1565	1817
		Cuba	81	206	331	86	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	
		EC.Bulgaria	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		EC.España	33076	47643	35300	47834	79908	53319	63660	50538	51594	38538	38513	36008	44520	37226	30954	25456	44837	38725	28139	22206	23621
		EC.Estonia	0	0	0	0	102	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		EC.France	17114	16504	15211	17099	33271	21890	33735	32779	25188	23107	17023	18382	20344	18183	16593	16615	19899	21879	14850	7034	5782
		EC.Germany	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	
		EC.Ireland	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	14	14	
		EC.Latvia	0	0	0	0	92	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		EC.Lithuania	0	0	0	0	221	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		EC.Portugal	8420	14257	7725	3987	8059	7477	5651	7528	4996	8297	4399	4544	1810	1302	2167	2958	4315	8504	4735	11158	8962
		Gabon	0	0	0	0	0	0	1	11	51	26	0	59	76	21	101	0	0	0	0	0	
		Ghana	24347	26597	22751	24251	25052	18967	20225	21258	18607	19602	26336	34183	40216	28974	42489	30499	24597	25727	44671	30236	45709
		Guatemala	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6389	5162	
		Japan	1982	3200	2243	2566	4792	2378	0	0	0	0	0	0	0	0	1	0	0	0	0	0	
		Korea Rep.	6	3	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Maroc	1028	428	295	1197	254	559	310	248	4981	675	4509	2481	848	1198	268	280	523	807	1893	3779	
		Mixed flags (FR+ES)	4663	4660	4125	5280	11101	12273	13750	9492	5862	5831	4905	5621	6845	9461	7137	2995	4959	5262	4666	5313	3275
		Namibia	0	0	0	0	0	0	0	2	15	0	1	0	0	0	8	0	0	0	0	0	
		NEI (ETRO)	791	2994	2263	10516	11335	12409	20291	17418	16235	16211	6161	6748	8893	7127	8122	8550	9688	11137	9740	7629	11247
		Netherlands Antilles	0	0	0	0	0	0	0	0	0	7096	8444	8553	9932	10008	13370	5427	10092	8708	0	3042	1252
		Norway	581	738	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Panama	0	0	0	0	8312	8719	13027	12978	14853	5855	1300	572	1308	1559	281	342	0	7126	11490	13468	18821
		Rumania	0	0	59	142	349	73	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Russian Federation	0	0	0	0	1175	1110	540	1471	1450	381	1146	2086	1426	374	0	0	0	0	0	392	1130
		S. Tomé e Príncipe	20	195	196	204	201	178	212	190	180	187	178	169	181	179	179	179	179	117	166	143	
		Senegal	0	0	47	134	652	260	95	59	18	163	455	1963	1631	1506	1271	1053	733	1333	4874	3534	2278
		South Africa	88	157	96	17	15	7	6	4	4	1	6	2	1	0	1	0	2	2	1	0	
		St. Vincent and	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0

		Grenadines																					
		U.S.A.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		U.S.S.R.	547	1822	1915	3635	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		UK.Sta Helena	139	158	397	171	24	16	65	55	115	86	294	298	13	64	205	63	63	63	63	88	
		Venezuela	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	ATW	Argentina	90	7	111	106	272	123	50	1	0	1	0	2	0	1	0	0	0	30	0	0	
		Barbados	21	3	9	11	14	5	6	6	6	5	5	10	3	3	0	0	0	0	0	0	
		Brasil	16286	17316	20750	20130	20548	18535	17771	20588	16560	22528	26564	23789	23188	25164	24146	18338	20416	23037	26388	23270	
		Canada	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Chinese Taipei	2	7	19	0	32	26	9	7	2	10	1	2	1	0	1	16	14	27	28	30	2
		Colombia	0	0	0	0	0	0	2074	789	1583	0	0	0	0	0	0	0	0	0	0	0	
		Cuba	1101	1631	1449	1443	1596	1638	1017	1268	886	1000	1000	651	651	651	0	0	624	545	514	536	
		Dominica	0	0	0	60	38	41	24	43	33	33	33	33	85	86	45	55	51	30	20	28	32
		Dominican Republic	62	63	117	110	156	135	143	257	146	146	0	0	0	0	0	0	0	0	0	0	
		EC.España	0	0	0	0	1592	1120	397	0	0	0	0	0	1	1	0	0	0	0	0	0	
		EC.France	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		EC.Portugal	0	0	0	0	0	0	0	0	0	0	0	0	0	4	1	0	3	3	5	21	1
		Grenada	5	22	11	23	25	30	25	11	12	11	15	23	23	23	15	14	16	21	22	15	26
		Jamaica	0	0	0	0	0	0	0	0	0	62	0	0	0	0	0	0	0	0	0	0	
		Japan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	
		Korea Rep.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Mexico	13	10	14	4	9	8	1	1	0	2	3	6	51	13	54	71	75	9	7	10	7
		Netherlands Antilles	40	40	40	40	40	40	45	40	35	30	30	30	30	30	0	0	0	0	0	0	
		Panama	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		St. Vincent and Grenadines	0	17	28	29	27	20	66	56	53	37	42	57	37	68	97	357	92	251	251	355	90
		Sta. Lucia	60	53	38	37	51	39	53	86	72	38	100	263	153	216	151	106	132	137	159	120	89
		Trinidad and Tobago	0	1	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	
		U.S.A.	734	57	73	304	858	560	367	99	81	85	84	106	152	44	70	88	79	103	30	61	66
		UK.Bermuda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	
		Venezuela	5750	4509	3723	3813	8146	7834	11172	6697	2387	3574	3834	4114	2981	3003	6870	2554	3247	3270	1093	2008	
	MED	Algerie	0	0	0	0	0	0	0	0	0	0	0	171	43	89	77	0	0	0	0	0	
		EC.España	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	26	10	15	
		EC.France	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22	0	0	0	0	
		EC.Greece	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	102	99	99	0	
		EC.Italy	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	29	34	17	0	
		Maroc	13	0	0	0	0	0	2	0	43	9	4	5	10	1	0	1	1	2	1	5	
Discards	ATW	Mexico	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 3. Breakdown of Task I yellowfin "unclassified" Atlantic catches into eastern and western management units using Task II catch and effort geographic information.

Task-1	Stock	Flag	FleetCode	1962	1963	1964	1965	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2005	2006
Task-1 before area breakdown (UNK = all Atlantic)	UNK	Chinese Taipei	TAI	278	399	396	183																							
		EC.España	EC.ESP-ES-SWO																										18	226
		NEI (Flag related)	NEI.007																							23				
			NEI.028																							72	118			
			NEI.040											137	162	78	68	18	174	143	223	48	41		11	29				
			NEI.042																							4				
			NEI.071					754	406	526	956	1297	2324	2643	3938	4240	3768	2555	3626	2913	3970	4155	4057	3453	2646	332				
			NEI.079																						77	54				
			NEI.081																		20	393	1263	1396	951	762				
			NEI.094																		34	46	22							
			NEI.105																	284	400	59	62							
			NEI.111																					649						
			NEI.134															98	604	862	1315	1399	2894	1911	1584	1471	22	578		
			NEI.144																							26	35			
			NEI.166																							110				
		Panama	PAN								7222	5147	3431	2496	4149	3519	3594	3134	3422	2588	1954	1156	358	385						
	TOTAL			*278*	*399*	*396*	*183*	*754*	*406*	*526*	*8178*	*6444*	*5755*	*5276*	*8249*	*7837*	*7430*	*5805*	*7826*	*6790*	*7916*	*7256*	*8697*	*7794*	*5269*	*2883*	*175*	*578*	*18*	*226*
Task-1 Atlantic catches broken down into ATE and ATW management units	ATE	Chinese Taipei	TAI	66	95	94	44																							
		EC.España	EC.ESP-ES-SWO																										18	226
		NEI (Flag related)	NEI.007																							17				
			NEI.028																							52	90			
			NEI.040											14	44	42	23	8	100	101	134	27	27		6	21				
			NEI.042																							3				
			NEI.071					103	54	76	150	285	206	266	1071	2268	1292	1106	2078	2063	2389	2294	2658	2647	1543	241				
			NEI.079																						45	39				
			NEI.081																		12	217	828	1070	555	553				
			NEI.094																		20	25	14							
			NEI.105																	201	241	33	41							
			NEI.111																					497						
			NEI.134															42	346	610	791	772	1896	1465	924	1067	17	466		
			NEI.144																							19	27			
			NEI.166																							80				
		Panama	PAN								1944	1858	1239	901	1498	1270	1297	3134	3422	2588	1954	1156	358	385						
	ATW	Chinese Taipei	TAI	212	304	302	139																							
		NEI (Flag related)	NEI.007																							6				
			NEI.028																							20	28			
			NEI.040											123	118	36	45	10	74	42	89	21	14		5	8				
			NEI.042																							1				
			NEI.071					651	352	450	806	1012	2118	2377	2867	1972	2476	1449	1548	850	1581	1861	1399	806	1103	91				
			NEI.079																						32	15				
			NEI.081																		8	176	435	326	396	209				
			NEI.094																		14	21	8							
			NEI.105																	83	159	26	21							
			NEI.111																					152						
			NEI.134															56	258	252	524	627	998	446	660	404	5	112		
			NEI.144																							7	8			
			NEI.166																							30				
		Panama	PAN								5278	3289	2192	1595	2651	2249	2297													
	TOTAL			*278*	*399*	*396*	*183*	*754*	*406*	*526*	*8178*	*6444*	*5755*	*5276*	*8249*	*7837*	*7430*	*5805*	*7826*	*6790*	*7916*	*7256*	*8697*	*7794*	*5269*	*2883*	*175*	*578*	*18*	*226*

Table 4. Task II size data catalog of yellowfin tuna in the ICCAT database.

Species	Flag	GearGrp	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
YFT	Angola	BB																	X	X	X	X	X	X	X		X											X	X											
YFT	Barbados	LL																																								X							
YFT	Brasil	BB																								X	X	X	X	X	X	X	X	X	X	X													
YFT	Brasil	HL																																		X													
YFT	Brasil	LL									X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X			X	X		X					X	X	X	X	X	X	X	X	
YFT	Brasil	UN																																														X	
YFT	Canada	HP																																									X			X			
YFT	Canada	LL																										X	X	X	X									X	X	X	X	X	X	X	X	
YFT	Canada	PS							X	X	X	X								X																													
YFT	Canada	RR																																						X						X		
YFT	Canada	TL																																						X								
YFT	Canada	TR																																								X	X	X	X	X	X	
YFT	Cape Verde	BB																					X	X	X	X		X	X		X	X						X											
YFT	Cape Verde	HL																										X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X		
YFT	Cape Verde	PS																																											X		X	
YFT	Cayman Islands	PS																								X																					
YFT	China (ICCAT program)	LL															X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																		
YFT	China P.R.	LL																																													X	
YFT	Chinese Taipei	LL																			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
YFT	Congo	PS																				X																									
YFT	Côte D'Ivoire	GN																																													X	
YFT	Cuba	LL													X	X	X																									X					
YFT	Cuba (ICCAT program)	LL																									X	X																			
YFT	EC.España	BB												X	X	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
YFT	EC.España	LL																							X	X	X				X	X	X	X	X	X	X	X											
YFT	EC.España	PS														X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
YFT	EC.France	BB																														X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
YFT	EC.France	PS																														X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
YFT	EC.Portugal	BB																			X	X	X	X	X	X	X	X	X	X				X	X	X	X		X		X	X					X		
YFT	EC.Portugal	HL																							X	X																					
YFT	EC.Portugal	PS																						X	X																						
YFT	Ghana	BB											X	X	X	X	X	X	X	X	X	X	X	X					X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
YFT	Ghana	PS											X	X							X	X	X	X													X	X	X	X	X	X	X	X	X	X	X	
YFT	Ghana (ICCAT program)	BB																							X	X	X	X	X	X																		
YFT	Japan	BB					X		X	X							X	X	X	X	X		X																										
YFT	Japan	LL		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
YFT	Japan	PS							X	X	X	X	X	X	X	X	X																																
YFT	Japan (foreign obs.)	LL																					X	X	X	X	X	X	X	X																			
YFT	Japan (ICCAT program)	BB													X	X	X	X	X	X	X	X	X	X	X																								
YFT	Japan (ICCAT program)	LL																										X																			
YFT	Korea Rep.	BB																			X	X	X	X	X	X																							
YFT	Korea Rep.	LL										X			X		X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X															
YFT	Mexico	LL																																	X							X			X		X	
YFT	Mixed flags (FIS)	BB									X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																	
YFT	Mixed flags (FIS)	PS									X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																	
YFT	Mixed flags (FIS)	SU													X	X	X	X	X	X																													
YFT	Mixed flags (KR+PA)	BB														X	X	X	X	X	X	X	X	X	X																								
YFT	Mixed flags (KR+PA)	LL															X	X	X	X	X	X	X	X	X	X	X	X	X																				
YFT	Namibia	LL																																													X	
YFT	NEI (ETRO)	BB																														X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
YFT	NEI (ETRO)	PS																														X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
YFT	Panama	BB														X	X	X	X	X					X	X																							
YFT	Russian Federation	PS																															X		X	X		X	X									
YFT	Senegal	BB																																			X										
YFT	South Africa	BB																			X																		X	X	X	X	X	X				
YFT	South Africa	LL																																						X	X	X	X		X	X	X	
YFT	South Africa	PS												X	X			X	X	X																												
YFT	U.S.A.	GN																									X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X					
YFT	U.S.A.	HL																														X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
YFT	U.S.A.	HP																																									X					
YFT	U.S.A.	LL																									X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	
YFT	U.S.A.	PS								X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	X																
YFT	U.S.A.	RR																							X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	
YFT	U.S.A.	SP											X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																
YFT	U.S.A.	TW																														X		X	X	X	X	X	X	X	X	X	X			X	X	
YFT	U.S.S.R.	LL					X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X		X	X	X	X	X																			
YFT	U.S.S.R.	PS																				X	X	X	X	X	X	X	X	X	X																		
YFT	UK.Bermuda	RR																																		X	X											
YFT	UK.Sta Helena	HL																								X	X	X																			
YFT	Uruguay	LL																						X	X	X	X	X	X																		X	
YFT	Venezuela	BB														X											X	X	X	X				X	X	X	X	X	X	X	X	X	X	X	X	X	X	
YFT	Venezuela	LL									X	X	X	X	X	X												X	X	X	X	X			X				X	X									
YFT	Venezuela	PS																								X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	

Table 5. Task II size data catalog of skipjack tuna in the ICCAT database.

Species	Flag	GearGrp
SKJ	Angola	BB
SKJ	Brasil	BB
SKJ	Brasil	LL
SKJ	Brasil	PS
SKJ	Brasil	SU
SKJ	Brasil	UN
SKJ	Canada	PS
SKJ	Cape Verde	BB
SKJ	Cape Verde	HL
SKJ	Cape Verde	PS
SKJ	Cayman Islands	PS
SKJ	China (ICCAT program)	LL
SKJ	Chinese Taipei	LL
SKJ	Congo	PS
SKJ	Côte D'Ivoire	GN
SKJ	Cuba	BB
SKJ	Cuba (ICCAT program)	LL
SKJ	EC.Bulgaria	TW
SKJ	EC.España	BB
SKJ	EC.España	GN
SKJ	EC.España	LL
SKJ	EC.España	PS
SKJ	EC.France	BB
SKJ	EC.France	PS
SKJ	EC.France	TR
SKJ	EC.Portugal	BB
SKJ	EC.Portugal	HL
SKJ	EC.Portugal	PS
SKJ	EC.Portugal	SU
SKJ	EC.Portugal	TP
SKJ	Ghana	BB
SKJ	Ghana	PS
SKJ	Ghana (ICCAT program)	BB
SKJ	Japan	BB
SKJ	Japan	LL
SKJ	Japan	PS
SKJ	Japan (foreign obs.)	LL
SKJ	Japan (ICCAT program)	BB
SKJ	Korea Rep.	BB
SKJ	Maroc	PS
SKJ	Mexico	LL
SKJ	Mixed flags (FIS)	BB
SKJ	Mixed flags (FIS)	PS
SKJ	Mixed flags (FIS)	SU
SKJ	Mixed flags (KR+PA)	BB
SKJ	Mixed flags (KR+PA)	LL
SKJ	NEI (ETRO)	BB
SKJ	NEI (ETRO)	PS
SKJ	Panama	BB
SKJ	Russian Federation	PS
SKJ	Senegal	BB
SKJ	South Africa	BB
SKJ	South Africa	LL
SKJ	South Africa	PS
SKJ	U.S.A.	GN
SKJ	U.S.A.	HL
SKJ	U.S.A.	LL
SKJ	U.S.A.	PS
SKJ	U.S.A.	RR
SKJ	U.S.S.R.	PS
SKJ	U.S.S.R.	SU
SKJ	U.S.S.R.	TW
SKJ	UK.Sta Helena	HL
SKJ	Venezuela	BB
SKJ	Venezuela	LL
SKJ	Venezuela	PS

Table 6. Overall yellowfin catch-at-size matrix (number of fish) obtained for the overall Atlantic.

Li 2cm	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
<22	1607											80	85	121	27	18	35	233	232	206	263	554	612	686	474	292	291	245	43968	342	517	356	149	251	1578	585	789
24	985		1771																							28			8066		170		61	155	1912	636	707
26	1866		2232								1291	605	638	906	206	134	259	1745	1744	1543	1976	4154	4592	5154	3552	2229	2182	2652	7966	3013	5033	3365	2387	2145	4305	2247	5336
28	3007	450	12394								2406	3183	3403	4829	1098	713	1382	9306	9299	8232	10537	22154	24492	27440	19644	18875	11849	14060	16129	13660	19976	16712	8110	13049	22664	13541	17379
30	1296	56	2155			263				3316	1641	12656	13908	21312	4622	6824	9094	43572	37785	33779	55739	98507	102501	112733	76078	51260	47616	58775	65824	66764	91174	73002	38141	93645	82240	58126	59803
32	4441	175	7620	1652	5993	147903	860	1780	43887	8222	15245	40446	37007	59216	15947	19944	16042	119576	114252	100412	141060	262990	287888	308776	208159	145201	142301	173178	184543	220895	263659	238857	97172	207745	209206	160851	166792
34	8507	1364	13780	5444	29511	220744	10805	12849	53200	18810	51409	139621	82953	147640	59705	62533	60543	250092	240744	254430	264454	474338	580284	594714	381615	266854	258522	382716	332005	416182	508319	408197	175185	420326	436596	315893	303761
36	9832	4173	10205	6388	62432	133220	101307	55739	87313	71848	224504	536910	172540	330715	172337	309089	123017	461247	417689	463939	502792	707673	879860	906542	521642	369988	342621	439705	481968	663076	690983	700661	299686	692162	720717	490467	400003
38	11958	13439	24646	13852	124539	147843	213961	111239	63577	96733	335399	840525	248606	473408	376583	594336	258526	707254	516376	658335	616295	683286	985893	947411	485985	382886	374470	468765	442493	661480	759955	1188952	375065	814022	662626	525917	352745
40	29399	31028	42251	36380	163090	221688	350279	190719	178892	310749	498581	1030771	391632	746150	511907	680072	478871	983665	617928	967635	1023705	903003	1059812	1053057	437917	452299	423097	475345	481598	765470	939564	1219511	563956	956906	866493	712325	447350
42	44712	58978	65707	56492	171891	228408	400813	294207	302865	397166	644009	1153633	568562	950624	614460	675340	676713	1160446	875385	1294966	1146528	906365	1019357	1663461	687085	737631	717799	636297	672446	960959	1241718	1919516	855512	1118316	972358	928459	555374
44	48771	74372	72792	57420	157627	334081	388319	395952	357486	462724	667407	1351147	583280	762324	565445	835511	738342	1137953	1004704	1168744	1827219	1402854	941290	2504768	933904	1218277	1143265	771245	980691	1878730	1609840	1827633	1626199	1325771	1364952	1134989	763083
46	172947	188800	153234	125782	241511	517076	500914	576631	504713	586732	834200	1567408	1188526	1153668	724788	964318	1091055	1236237	1413318	1569952	1818506	1385515	1050194	1322417	1353556	1472103	1643147	1116050	1255592	2521692	1823021	1533326	2332152	1748318	1852388	1552010	1335586
48	233785	209271	200333	164292	324331	554524	464925	487371	490891	503571	682722	1188230	1180635	1026863	741217	816978	1083794	995092	1283118	1261035	1371124	1044915	1140024	1304153	1682101	1587953	1718657	1526297	1305393	2841577	1643116	1713524	2714981	1781689	1847144	1624609	1129445
50	247495	179032	187952	131124	287881	380819	347420	372384	370535	418287	436238	509690	720997	448904	584025	520044	597778	493455	592079	467739	913852	688960	679743	620281	1043778	950052	1031703	1150042	1230834	2436569	1240278	1241525	2188697	1364356	1291398	1441449	678431
52	286509	195494	182606	127218	275551	294766	297718	326528	293821	461491	450103	454457	679255	399969	570315	448431	419306	465264	516468	355435	564759	506702	500776	508236	880953	623772	826726	1295190	1245825	1520917	1035758	1381902	1456301	1063085	779414	974345	545988
54	310215	224121	204254	131939	244152	249346	337146	326302	332493	440252	446237	361292	610244	319293	635431	395327	320639	363779	365091	238677	366353	396419	320924	421738	342426	262661	429251	569452	1001238	943604	538716	1044965	783787	749790	671096	724237	286814
56	316292	281540	284481	179463	259496	268331	446059	507446	414661	499992	441036	348476	657912	358013	653091	323264	378652	395198	346719	291483	328187	396050	231059	398925	379972	221681	296700	375412	669235	546955	423901	956824	450751	440472	388830	572627	355770
58	243182	267474	276574	194238	254620	219752	495881	473878	448146	459853	400409	327909	579217	336414	507386	287484	335213	387654	307175	238048	272859	336403	206210	305196	326409	158018	275801	339705	441530	307239	239477	659227	251393	265112	179443	255591	240606
60	188666	209454	227028	172248	213321	167358	438599	410064	380955	350533	284365	269688	417744	329598	541515	269710	367517	329758	266830	108580	248963	297189	182116	273034	260648	156228	212280	210051	265855	203968	310904	475358	172402	210848	159776	219861	207986
62	122056	137151	156963	133778	167831	176802	333479	332756	274558	228496	180483	222312	243521	266334	424266	243846	323936	199993	213869	68196	162550	209001	159037	203263	171432	132438	148809	163874	234970	160770	246119	339065	121152	114019	75032	134430	169685
64	85695	100357	127089	114159	148119	128268	258733	267473	193467	140834	108926	160577	205525	190060	394129	168729	210956	144577	211564	76004	196851	177750	159004	215898	264935	199419	198782	195622	313551	243275	229976	286277	160098	187128	106873	221520	165187
66	66801	71047	94586	80908	98071	106557	193029	177706	133970	92614	86737	124576	150604	151323	468584	162186	151676	122385	169468	55334	199273	155355	164555	174728	195422	137885	129746	138644	195756	131198	110234	125708	73370	94506	50750	164139	82671
68	46311	52274	73819	59951	61159	64199	112802	103325	95121	69581	69990	86124	168770	141863	309650	164103	104152	114969	145141	56202	150769	106692	154515	191664	224409	125055	118631	131069	168182	117399	109618	155971	102654	113401	86701	160239	97842
70	50034	63543	70318	65883	67878	60862	124833	76704	124852	66157	68150	77330	174719	98163	338289	203456	121677	130940	134582	49405	206447	122023	168505	146711	147437	110022	100516	104426	155633	103101	47042	113955	77426	80553	61480	74608	51643
72	47905	73986	69790	62377	73037	65907	120882	65268	126146	74708	63426	76968	145960	86406	214634	149174	91589	124995	110181	57202	175720	101703	157931	164558	169067	137065	118695	145589	155796	139732	55505	115484	96376	79287	80002	93314	67530
74	44241	72806	62804	52266	66872	44989	95964	61029	116364	58190	54298	68220	163272	80073	265684	133119	85489	103749	86721	44173	116424	104144	117823	109238	84621	94429	84051	105997	145394	123410	50445	70898	89362	71025	40108	71256	48275
76	36878	65179	52672	44390	47739	43604	75443	61029	109838	56281	64128	79880	166113	59920	186651	124478	72448	89020	76379	35339	114252	97748	110953	123567	190079	114894	104384	117656	106500	121364	79858	137611	144881	123863	75520	73243	59224
78	36306	56785	42728	36255	37215	53715	66260	65147	95526	47964	51904	59385	127512	73649	163256	75434	65430	96089	71806	56535	61974	166000	54128	127263	141150	120285	104646	119135	176671	103416	63937	86269	76019	96888	54211	67129	59617
80	25874	47563	39446	35189	34778	57784	62885	59017	69005	43840	67719	63533	66224	82519	151567	88752	68252	91711	58928	66246	57836	95092	46722	50823	91513	69226	69260	71867	54400	145778	60115	86950	49989	48727	24026	58756	53638
82	23828	42786	36684	33850	34816	49741	58897	65128	64692	49708	76602	65954	71740	96975	167557	77823	60466	84505	52034	43290	44741	65091	26988	45681	87064	60981	55643	48581	46985	67538	63428	117295	88435	96485	60978	66982	80979
84	26138	44180	39540	38392	36793	38093	54544	68138	59240	53927	68280	60759	60725	130185	109669	77246	69979	89244	53690	39176	48254	56889	42853	37500	65321	50833	51667	49592	54380	79797	49475	60930	45250	51715	37180	39690	56261
86	27731	53574	50632	53097	57329	47041	68608	82541	68902	38751	56762	68287	56550	71020	146787	88614	70254	98357	59936	42822	32421	81885	36770	52208	96645	73579	66018	60524	132695	69901	68585	60121	63648	60344	61154	48361	64607
88	36711	55515	60951	63038	65555	56429	65260	84620	77073	48090	84149	85544	52405	86845	106607	88229	60491	72646	57134	43985	44582	61123	39424	35272	67722	52062	45318	57884	48075	121511	56866	64224	61915	61622	58535	40618	60716
90	43175	66835	75324	79721	82068	63686	65369	91019	83727	51513	104163	82979	60222	65151	113277	96306	72252	82043	66933	43612	38074	60707	46777	46240	110957	61162	57709	54552	55077	78350	83130	83375	69991	51625	80702	53385	68449
92	36861	58401	69628	69215	74964	66662	60394	86940	82433	43608	77408	65259	67026	66221	78894	105881	79724	77440	61924	42300	38611	60941	44726	40349	84459	54967	42617	32187	40233	73466	48242	58064	48641	39777	53270	36864	53700
94	29764	47463	62085	52568	50080	101589	65138	80368	84543	41170	73928	63217	84815	68126	74931	99795	73766	93248	62251	42649	40075	61436	61783	45867	124938	91240	69077	58502	74739	60939	68916	50551	46986	41771	63224	46943	62973
96	31368	51362	67967	54092	51977	85384	58157	76155	93820	40052	69567	65033	75613	73015	102403	122648	107425	86897	67794	39548	42901	52355	52039	47532	172296	72590	48356	37528	38599	86347	47647	44132	45149	32024	50212	33840	52585
98	30505	53692	72574	46368	45469	93641	56901	77896	118890	42890	71552	60452	81276	78783	75597	115925	75011	80953	52583	42959	47760	61486	56288	45171	204314	74646	49960	40748	28085	55216	70024	65439	67919	37363	60101	40404	75049
100	28550	55579	82466	52571	50856	114507	57569	76741	117677	53987	75276	66158	70423	74232	81062	110814	61445	65305	58084	46521	56169	45820	63526	39043	148608	67204	54100	50811	40469	56902	53588	59774	37844	42679	40325	38747	72742
102	26558	60896	79616	51679	47955	104899	57062	78590	106758	45889	68250	56475	57216	67116	68718	107700	57910	73374	59251	57646	53056	53557	77550	54099	134024	62237	59187	58223	69358	51495	101990	70389	62988	54692	86655	61757	94094
104	30888	67810	90526	55116	52400	100294	48412	79295	96947	57702	87421	62847	71517	101558	55414	98776	55706	87485	57836	61488	65407	57279	70103	58846	116229	57793	57985	53094	46816	100364	57364	47992	40190	36648	43752	27747	100116
106	26875	62943	84411	55330	58310	100141	59469	92500	83211	64519	70481	57072	53957	93928	64122	97140	40830	71058	50382	61070	52251	48103	67992	61522	125806	60524	63698	67501	29954	45540	121589	71751	50855	48296	58943	44348	117242
108	30824	63691	88185	62438	73011	89372	49630	78565	83996	54922	58446	63719	48572	74572	81488	103572	48407	75396	60505	59474	43186	72706	71887	74136	87802	61046	58397	46749	30947	51389	62601	56863	39591	48311	54056	35377	63164
110	29633	59939	72977	66086	80345	92155	43686	75741	76892	57075	61620	67780	50689	76401	88248	91926	49010	71630	56467	51424	43939	75444	75192	73526	106842	93411	88909	78287	66926	53779	146564	70561	54044	69303	75247	45482	83401
112	29648	54007	64658	63224	70305	79384	41966	59144	68430	47140	50983	63551	48352	70898	91160	114865	48214	67634	56298	52732	43710	74848	77507	64373	82028	64198	57220	37854	27572	63606	48507	52713	42908	54168	55689	21243	61494
114	32356	46637	57732	64481	71656	76675	31723	55312	63063	44625	52784	67760	56636	105844	53766	76911	51381	63874	55085	47463	36647	56527	55929	78659	87119	81502	79752	59899	50609	40880	118798	55184	42815	54153	58032	31708	58377
116	23152	36141	47206	56274	66005	72932	25186	55349	62082	40201	49798	59596	71024	80887	76853	79384	64127	55776	73835	53914	36143	63373	53612	54800	59051	64363	48039	38823	32616	38697	43337	65687	42353	33257	42786	21745	29200
118	29124	32666	50653	60571	77362	80887	35161	67465	71987	51126	57680	64657	84221	76600	68785	75637	60775	62000	77239	55239	48128	79510	79453	96969	98993	114197	95885	84043	69426	48216	107375	79451	54891	43269	54523	28589	35066
120	33790	35792	54441	58284	72189	72972	35855	74479	77014	46018	69064	76286	73924	136643	72674	68831	79464	65350	80251	72084	55364	58206	85133	49449	84130	98788	84997	76646	70968	73492	50194	68449	50097	41447	53933	20797	46041
122	34553	39718	58792	57641	69962	73392	43804	79547	77234	53024	53336	56037	71277	157976	59834	60004	90162	61172	92993	81672	51484	74928	70351	69120	51805	61975	62412	42085	37949	40892	44625	60641	44729	38941	48175	20960	32604
124	40580	38746	60811	59445	71713	67671	50976	86972	82771	58229	66333	64456	72160	165038	74148	72391	105538	68993	103184	82278	73489	80222	87696	101674	80848	87683	86501	70381	64926	57706	88307	81854	51057	45868	57014	32129	58924
126	34027	30562	48787	48423	54547	51449	45313	80738	76854	56369	46770	46749	60164	93235	63668	70462	89939	55955	94111	79378	69579	79134	85896	71631	73251	68113	76012	54220	52145	43585	58693	66934	44291	41967	53719	26210	38147
128	37319	29116	52193	50682	61663	56511	61006	79592	82488	68123	51867	53196	73508	104328	55936	69396	98249	63736	104460	107664	89805	93364	97856	101457	78124	80358	90967	60720	62907	51493	77965	90195	51994	41120	52705	27844	35578
130	46231	27274	54853	50663	53220	55335	57361	73866	81797	72599	57383	58441	87255	90221	75831	88606	109102	69989	108674	106106	108499	81175	98634	70367	67578	72304	86440	55870	58344	60262	65715	89094	55060	40364	47209	31189	33865
132	49804	27258	50846	53764	60875	63168	72505	81637	97620	97702	59839	69791	97341	105031	64986	92753	112236	81413	122206	111342	125595	84911	105624	84834	75094	81154	89869	58555	61408	51431	84530	95398	62266	47113	54606	39764	40891
134	49571	26578	61368	60038	58683	60693	71855	73206	99534	96176	61318	79401	104325	103652	66526	92988	117282	87809	111996	108065	135972	99184	100054	97737	83235	94603	104722	70348	69390	64846	65357	99350	72562	54491	51433	43820	40585
136	54278	28295	57948	55930	60085	62239	79724	74064	110614	110571	69688	87039	112118	112447	59946	115286	112453	104662	114031	115557	162687	138343	108511	99234	90703	99721	107202	76505	76165	72236	75508	105712	79426	65888	60951	51998	44331
138	47489	30567	57218	57171	59384	72377	87830	82531	113326	113494	79324	93843	115347	101707	60275	114851	115430	109050	110369	134423	167556	113168	109701	114492	97217	109913	121916	85962	82474	68763	76046	99085	89865	71828	62643	55753	42369
140	62091	35276	48894	56477	57453	71091	85480	78827	103757	115870	90630	102478	114909	109952	48075	117247	107691	110519	96345	127626	173534	108901	114844	110469	101642	108634	115854	89898	87147	73436	79131	95153	93019	73107	58593	61733	50434
142	48073	30638	43169	53768	56556	68800	82839	79769	97831	112413	86700	100005	111267	128044	45026	115222	104465	112549	92757	130582	162740	115904	108903	110464	97818	106187	113744	89285	88478	70077	67913	86887	89989	67415	56363	63711	46117
144	41011	31809	42934	52688	57288	66192	71043	67610	78000	94916	81343	88340	98886	96630	35564	108284	94778	99806	82781	118274	129665	104963	98759	107481	100940	104130	105501	89801	92488	73287	64146	86361	87771	62540	53492	60780	47981
146	42303	30926	37906	47096	49480	66648	74632	70491	76797	90591	81510	93698	93167	86377	33467	98481	92300	94587	86383	123185	136651	103554	97000	108282	98359	95900	96898	84385	88818	72937	61381	77766	82923	62692	50946	57108	46128
148	42403	38989	42709	52322	56803	85187	83684	78199	74023	91182	89035	104316	98761	90860	32839	97126	89467	92907	70312	126215	147175	107747	104038	111804	109381	98157	100560	92438	93496	71939	63322	75995	85300	69296	55736	60504	50954
150	51206	41775	44427	61751	68897	94031	89518	86688	78559	99717	96227	115394	101767	90737	32811	103846	94272	95432	67538	132366	126960	116477	114463	118103	116554	102001	97090	92883	102190	73971	62580	72973	85181	72121	54402	63578	57552
152	39130	35799	34864	49981	58449	86629	81147	73079	61908	82756	80621	107573	91757	80587	29578	83191	84704	80482	58190	118276	138344	110003	110369	110294	106367	91154	90908	83239	96423	65995	57933	68633	75619	66945	49620	62171	58213
154	36964	36908	37619	49071	53312	78980	67296	60971	46242	61429	64416	88322	76860	65457	22675	64289	63479	59333	43163	96785	110689	87536	91322	87195	84764	73474	69607	67587	82762	58079	48418	53498	61042	58569	44239	49618	48911
156	30690	31764	31037	39083	39598	64460	58383	50403	35815	47640	48253	71390	62053	57185	17837	49170	48155	44525	32212	75261	88215	72479	71238	64572	62786	53622	51417	55725	62700	43878	39949	44156	47267	49782	34702	40530	44160
158	27815	27123	29150	35687	39323	59671	50740	37510	24173	34427	41005	55749	52559	42106	14197	33118	34869	32213	23722	56721	69295	54301	55693	44541	49708	38516	37815	35603	49695	35257	32885	31970	34629	37824	30117	33311	35447
160	25333	22922	24136	28794	32661	47306	38730	27866	19326	22798	33167	39952	41917	33687	9957	22114	23143	22831	15008	36383	47129	37923	37216	26738	29949	26738	25361	28180	37147	26888	24814	22755	24318	26326	21223	23649	27713
162	24271	17835	20824	24419	25102	36246	33167	21535	13701	18375	22822	33896	30045	24538	7485	17955	16998	16880	11257	28528	37714	26167	24856	16888	19764	17321	17359	17396	25555	19827	20520	14493	16574	21100	17468	16907	22532
164	16345	15014	16914	21494	20572	29989	26477	16599	9846	14120	18216	24442	25082	17832	4989	10961	11808	11471	7077	19347	26768	19420	18317	12610	15514	13258	11989	12390	20617	15188	15583	11606	11865	15876	15428	13710	18275
166	14848	13172	13796	16591	18459	27498	23872	15871	8958	12268	15623	21683	21356	16277	4219	9754	10163	9629	4892	16897	24196	15562	15647	11557	10770	10416	9997	9357	15357	12042	13421	10801	10044	15158	15308	13368	18133
168	12620	11830	14222	15703	16638	20843	18544	12659	7721	9199	11893	14801	15155	11560	3680	6221	6550	7235	3399	12259	16959	13279	13259	8726	10357	7757	6608	11725	12672	9077	9732	7514	7073	12512	11685	9651	12670
170	9864	8249	9588	12510	12935	15871	14956	11080	5360	8658	11421	9753	14323	10878	2219	3695	4346	4069	1954	7897	12018	8983	8099	6364	6235	5215	4534	4612	9690	7013	7255	18170	4982	9933	9758	6439	9312
172	5148	4750	5330	8620	8674	9590	9782	7609	4389	4876	6238	6924	6973	6506	1703	2049	2907	2272	1064	5337	7378	6715	5042	3618	3641	3006	2456	2550	5374	3846	4967	3379	3129	7711	8897	4828	8254
174	4529	3571	3382	5285	6249	5183	6316	4708	3304	2886	4661	3519	3834	4203	910	816	1431	1727	514	2612	3904	3625	2483	2525	2229	1905	1494	1684	3426	2332	2953	2107	1821	5503	6194	2695	4611
176	1544	1275	1343	2728	3782	2578	3023	2367	2059	1185	1532	1677	880	2637	338	402	521	274	139	1198	1591	1568	1642	983	1534	868	332	579	1478	1024	1594	1116	1053	3490	4033	1266	2747
178	993	785	1223	1852	1787	1757	1810	1370	800	649	1324	1454	944	1342	197	252	271	592	800	890	933	947	787	574	485	1778	449	378	1456	679	1488	4779	548	4202	8752	1351	2086
180	1330	172	452	672	362	818	587	366	739	225	1246	769	1802	1692	31	36	63	19	12	341	418	797	125	137	468	320	289	112	503	718	960	351	317	1607	2718	656	628
182	349	274	782	537	964	441	285	359	92	43	227	384	40	222	29	26	4	7	21	24	54	1245	12	12	23	34	72	5	68	162	278	26469	42	268	376	269	636
184	690	497	1071	410	481	330	43	74	65	18	284	544	336	689	10	1	6				108	451	473	5	86	4	28		46	126	344	13	64	181	456	608	72
186	52		190		143	10		117		8		523	6	83								24		213	8		116	6	15	91	359	42	15	106	293	381	495
188	155		114				62	69	27	82	51	261	3	5	1						17	33			4	56	15	15	12	42	137	6		40	43	67	18
190+	418	363	4132	689	692	671	106	691		8	730	216	166	51	4					2		491		866	10	2	4	3	13	232	318	1236	4	41	616	937	195
tot	4269080	4449654	5083506	4357470	6074879	7978945	8771201	8837567	8879391	8594480	10052207	14176035	12904608	12809049	12903823	12342365	11381800	13886309	13086650	13210691	16311810	15064353	14635243	17763240	15577557	13452611	14096869	13835570	15437913	20929317	17226274	21031034	17815764	16469040	15419053	14591521	11026888

Table 7. Overall skipjack catch-at-size matrix (number of fish) obtained for the eastern stock.

Li (cm)	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
<24	215	651	7353					67468				3408	36	38	54	12	8	15	104	104	92	118	248	274	307	212	131	130	110	126	153	211	160	67	111	1474	141	1081
24	215	1952	19302	2661								6817	143	152	216	49	32	62	417	417	369	472	993	1097	1234	849	524	528	439	503	612	1356	638	268	443	470	417	1049
25	215	3903	14706	1330						1495		6817	36	38	54	12	8	15	104	104	92	118	248	274	312	212	131	137	334	126	153	232	160	67	111	4946	584	1657
26	108	4554	14706	887						1495		3408	17791	381	541	123	80	155	1042	1042	922	1180	2482	2743	3074	2152	2167	1303	1104	1257	1530	2156	2976	670	1108	3429	4002	2619
27	1183	8457	30792	3548						1495		3408	18718	1372	1947	443	457	557	3753	3750	3319	4249	8933	9876	11262	8257	7227	4692	3983	4524	6988	7655	9068	2917	3990	4234	7208	6998
28	753	6505	25736	10643	810	7274	1016	803		1495		5112	101900	13293	4706	1070	865	1347	9069	9062	8022	10268	21589	23867	26740	18460	11906	11346	11047	14138	13312	20319	20709	7606	9644	15505	9437	13762
29	1505	13661	72613	29712		6986		803		2475	3167	5112	105394	17028	10008	2274	2965	2864	19285	19269	17409	21835	45908	50752	56862	39875	25771	25226	32889	36229	31516	42104	43083	26362	20507	35244	25695	35474
30	1183	7806	14247	1330	820	13395	1573	29651	3403	23918	13830	31717	88357	40244	38010	10924	8146	8822	49315	54584	47920	68393	130718	134587	165050	102982	68500	66095	86161	97011	100159	115519	104283	58412	81313	121637	81747	93072
31	2150	9758	10556	2661	5678	26430	9178	29651	4331	25389	12949	45463	102033	52428	60753	16247	13372	13950	86420	91312	80549	104051	217867	229857	271446	185083	116345	125545	162188	153814	159114	214961	178599	116050	147157	288778	131368	148881
32	1720	9107	25722	17295	3970	23276	9016	39353	24461	26859	60064	91970	128264	95531	116757	29954	20251	29456	184519	192586	173768	227881	463268	491629	554791	407252	261726	269704	317989	323549	351418	446530	398003	204834	309964	517430	279714	302107
33	1183	7333	2298	887	5934	39261	6984	34592	42843	29361	142801	131995	185705	124025	161835	51692	33328	38995	239518	276899	238822	311483	619813	651886	738553	556748	374795	390435	461902	413808	508336	611703	508418	277037	467625	851820	377008	459710
34	15836	28344	44316	50158	49338	103702	22124	65293	92538	62721	131284	234260	322533	227792	247857	91380	71662	74627	369276	409983	369065	439039	901306	946104	1102434	832537	563152	620058	645861	567314	776195	921663	707954	424152	697997	1132809	695295	626929
35	14976	28952	43489	42475	82277	174323	31021	100505	108689	132824	171113	424303	344246	355491	396385	149019	138775	126441	544986	671798	572753	719360	1240586	1246256	1456676	1162833	762291	946007	988709	814384	1141465	1201522	986287	567701	933717	1425355	1110067	832036
36	34005	41126	60101	71470	137249	348841	108372	165406	199632	302075	393204	897308	372543	499280	568305	248280	244608	248779	690502	821579	672933	854365	1581089	1572283	1902174	1462078	1067968	1461493	1336745	1007278	1447546	1569777	1337417	821185	1244471	1671743	1343630	1033412
37	39292	70224	100942	94459	221737	400316	141188	211683	292020	390309	462085	1210916	663326	798315	691479	362602	391688	409440	751841	953020	732568	933783	1796534	1668939	1962217	1637617	1262451	1584421	1512984	1145961	1543288	1849722	1649163	1031387	1518058	1916878	1655751	1150452
38	116523	169932	271248	389939	439474	886059	303255	502272	582204	673233	775304	1646355	1274781	1118183	991020	494042	559024	561511	850115	1247729	1076490	1417186	2366208	1977176	2360206	2120955	1743395	1854926	1842288	1354276	1948962	2081676	1994383	1259705	1870363	1985875	1910063	1551142
39	123339	205986	435029	509485	574053	1198467	347786	806175	779080	902919	868974	1516664	1707253	1540150	1251063	702464	764038	703250	886003	1452413	1097063	1459893	2479451	1986806	2681611	2163376	2251848	1960101	1874331	1455823	1878438	2219588	2310936	1609023	2060197	2163209	2151424	1613629
40	229600	406258	790001	855136	1197426	2416226	656379	1377159	1459300	1581692	1299867	2238624	2453689	2271533	1793548	1134604	1219576	909929	1300878	2154106	1746953	2139464	3677003	2866013	3747778	2743853	3121918	2562192	2339748	1836059	2850025	2909917	3007550	1992571	2683742	2649705	3042852	2268866
41	235778	426866	976623	985328	1383229	3085153	743077	1729841	1548177	1885796	1374783	2365078	3353163	2963166	2453382	1626215	1684327	1054874	1572421	2460663	1770983	2165791	3822612	3145404	4369470	3177782	4028464	3145774	2692530	2148763	3345320	3354343	3332945	2178825	2971823	2763531	3089321	2625145
42	423390	753996	1509236	1528159	2254286	4185033	1046304	1984934	2054328	2330482	1715964	2994350	3802800	3491992	3384854	2343385	2253957	1540576	2249740	3704093	2576689	3185285	5466980	4299021	5551883	4519004	5858281	4475558	3762455	2965294	4455032	3826021	4158522	2705833	3838042	3567475	4462579	3323578
43	445291	927553	1743772	1580105	2564792	4365511	1134258	1998015	2274317	2676550	1984944	3059270	4757821	4114400	4315887	2859901	2612920	2141595	2839020	4404580	2911567	3430266	6545842	4995788	6218178	5207458	6356782	4888884	3945448	3335897	5278979	4019986	4401076	2920666	4459257	3725662	4300660	3351355
44	771092	1492009	2568192	2445328	3659805	4818428	1401624	2350049	2482795	3066611	2433419	3136131	4769117	4339963	4306553	2995842	2569564	2823283	2977498	4793117	2763604	3366052	7230412	5499007	6732046	5847163	7319037	5623958	4265586	3927299	5796220	4050163	4854603	3231380	4704853	4193732	4723633	3535905
45	781099	1803024	2489906	2375631	3732101	4552430	1333835	2285969	2903619	3521418	2602114	3229125	5094078	5169502	4779775	3360697	2704169	3837503	3693497	6468500	4215240	5021871	7692540	6074922	7725977	6958536	7294307	5556626	4567266	5098181	6335593	4052057	4604820	3446986	5016620	4420535	4843646	4244331
46	631367	1698826	2150198	1866827	3154657	4406804	1398302	2111211	2980303	3631017	3001842	3204334	4190087	5578322	5120994	3045745	2416855	4263646	3796391	5774561	4218403	5227978	7888205	6469215	8804386	7934317	7660770	6994116	6245562	5509336	6177689	3958539	4392917	3577786	4515350	4445044	4520494	3967906
47	663213	1481100	1961540	2042365	2782746	3776548	1354908	1899894	3357855	3498277	2998611	2864535	4027249	5560412	4615384	2929172	2276118	4376213	3762959	5360414	3589523	4625354	7774928	5740910	7339294	6159303	5648823	4544575	3884181	5078584	5379204	3774866	3935701	3435705	4092120	4541690	4433168	3579021
48	512536	1339821	1637316	1774242	1991939	3242856	1072462	1740787	3450953	3166805	2550998	2916545	2876586	4153417	4025330	2721567	2077369	3918772	3199935	4677220	3452905	4515011	7067811	5139648	6590713	6588220	5886098	5223030	5565495	4876197	4642068	3442664	3618227	3270232	3556063	4332374	3875077	3372297
49	550969	1239082	1900972	1959914	1663610	2813024	1057748	1643065	3218508	2724144	2165395	2501066	2575156	3110807	2897498	2504225	1877860	3193792	2824553	3379508	2750524	3416359	5247130	3333082	5164494	4460010	3274461	2842398	2309097	3767813	3439626	2954905	3193715	2835529	2940749	3723010	3314833	2854858
50	497806	963283	1713407	1729143	1170822	2115683	986783	1514461	3134530	2237682	1802342	2187594	2251691	2734641	2374038	2588861	1794240	2683558	2414366	2647752	2378280	3080014	4746669	2954385	3493957	3558020	2864428	2329485	2907084	3088825	3324107	2600816	2632096	2384811	2607280	3417618	3143427	2683725
51	474876	798912	1557886	1575321	965679	1892249	967131	1311659	2687108	1753586	1543019	1634373	1460075	1768113	1464519	2169388	1344141	1760090	1828717	1635457	1848443	2023103	3275127	1905704	2276679	2035591	1453698	1330544	1296604	2196285	2337431	2011351	2318762	1739075	1941097	2274134	2239865	2014074
52	563143	928689	1700883	1590173	999790	1347907	885548	1038783	2131789	1429318	1144375	1600696	1443827	1679936	1427801	2014868	1387167	1705965	1778441	1549956	1526746	1815099	2615688	1617472	1723295	2295468	1478742	1287621	1708072	2092495	1807274	1561471	1736466	1413215	1516456	2118125	1923230	1742555
53	578866	841362	1510953	1456184	934667	1202702	896334	781754	1705872	1192187	914245	1237525	1213609	1379311	1056976	1635309	1145525	1151765	1372280	1062263	1134525	1249328	1826123	1095433	1235866	1287162	772979	838751	930951	1434069	1243277	1184592	1376752	1087649	1138410	1335699	1345700	1458349
54	582491	791056	1482605	1376282	964971	911862	683066	832422	1279561	1017423	750661	1021804	935148	1091602	754735	1250703	993818	902070	964054	815635	802499	1020684	1474187	880418	1068830	964294	598941	750637	643985	961540	987315	1026407	982903	851286	856152	1103140	1032509	1163563
55	549865	827931	1281304	1261073	937185	838957	755522	682035	1217096	976637	679689	845912	786070	952292	639118	909684	829156	705048	693110	650311	597115	881163	1028274	636389	744327	675310	452454	591366	484749	752482	827418	1036521	849097	609135	692908	885684	923459	1123037
56	396384	559343	855605	860131	644411	625234	608278	597154	846920	804903	560843	615455	534534	873811	410800	653829	676031	489490	537208	473828	477784	639861	751322	509994	637393	582991	362133	508537	384209	530975	505137	700077	507499	502914	544337	749323	782849	956266
57	395424	556998	817770	805427	684425	455744	548731	467266	823594	773777	415728	490882	424737	683141	312775	404034	505046	382943	405235	413433	312609	411363	619246	382479	492652	421836	314683	427250	306057	434406	482468	543201	492379	384915	478272	552814	626277	703297
58	259516	332729	483505	437934	396030	298604	285394	292449	652754	593954	364834	357245	319018	536928	230452	255265	402918	259921	298933	321852	247678	348278	499508	363712	396201	361271	293307	345633	262211	373952	338817	480658	411422	340372	423368	436757	501612	750066
59	234342	270255	439490	395204	364615	351145	286106	338708	460587	554992	292848	273813	258899	374957	192580	214780	350699	193189	223515	226940	168824	201117	355352	234480	302929	262540	285590	293589	226448	308030	283144	386586	298522	243850	321717	330649	397854	342752
60	158931	174758	290647	189964	154846	289776	264400	229104	476395	382502	323933	300684	207746	284425	176540	134397	307907	117817	229831	207756	154544	211012	273561	279971	313737	289978	263453	272936	212787	275624	246374	337927	308047	221284	340332	329947	391746	324972
61	112598	139094	165703	155617	132597	319269	266644	156503	274413	221997	254222	232827	155767	218058	140065	89528	187003	89857	167887	154740	117324	174384	191229	194214	189464	148586	203461	183289	132618	158797	140781	213939	207760	159226	222868	217778	287247	192370
62	65761	67811	84729	113628	83789	150898	106609	86626	225267	259257	252322	202111	170928	121707	107644	92825	192705	68283	136470	121770	116633	162874	179467	223667	216471	147643	206638	172360	139067	133797	127296	203881	167653	123911	212329	203269	237520	144519
63	47767	65786	112281	77679	77534	149456	125378	87455	164097	182690	246122	167294	161990	102633	68654	101766	152893	71949	113530	118517	89425	110701	123862	163839	117900	119163	147038	123816	106969	101657	87743	125423	169520	99126	137131	181768	256872	150777
64	19901	41706	66314	41620	34133	68459	105150	61964	117339	125921	228544	123121	72850	59809	69270	78850	108619	35278	88356	66349	71370	110207	103238	168582	91231	111016	123210	85040	62156	79919	82956	74386	130005	73759	115088	146191	191265	79779
65	8208	20672	44549	46930	43108	34364	101535	32862	118955	75903	116164	99286	73543	56803	52200	78276	93236	37519	59625	61092	45811	106261	84486	160599	65929	82052	95875	87520	66520	67759	85248	74458	87857	40869	96477	120925	136040	50533
66	4995	15671	21610	28433	28841	34413	114751	29099	64761	79480	98801	82818	58139	48470	31829	62692	55168	19972	55175	31046	20104	78759	73320	131487	61919	62272	78355	62623	26223	44607	68690	38712	65314	26799	98496	79530	116035	37764
67	2998	8035	15441	13467	21395	91198	107517	15573	53343	68597	102360	68700	52940	43926	23399	59357	47295	19288	35277	13681	21613	58785	58283	119317	34348	65935	53776	46091	20427	29194	36851	38340	48130	26618	74180	49204	40843	37685
68	3569	4312	14554	9247	17076	22378	56315	8491	54424	56434	92661	65010	31208	24602	18416	36793	26235	5832	21402	10465	8608	40407	51107	107296	58826	52579	53387	51016	17833	11884	11704	26764	49834	16563	56492	33337	83968	31055
69	4714	3615	9182	9691	17616	18006	51665	12908	38546	49583	84244	55916	34474	11432	14619	37020	30089	4576	8577	3665	10209	35833	27871	58465	34337	44425	23837	24538	19448	11276	27734	11519	28050	14484	31473	21531	25364	24674
70	290	115	45	2287	5193	17647	41820	12900	23285	42317	40959	36857	21600	14315	5709	20755	14186	690	5667	3571	13280	14524	18440	56860	22882	27946	22575	25208	10025	12260	11653	36524	13024	10120	27576	14397	15292	16738
71	870	171		3991	2366	9329	28908	8774	12237	32735	20011	31815	13492	6959	1897	13551	8518	1664	2870	1188	18690	9375	15804	42234	14577	10200	14724	5084	2180	6712	7420	14612	6361	5695	16484	8544	8567	14923
72	139	115		956	712	2582	19451	4814	2047	21187	18502	20085	16118	5950	5803	5404	4173	259	991	2106	13147	7722	5942	15669	2860	18004	15600	3986	4156	3157	2668	11342	5438	4096	15104	3373	7872	5427
73	548	171			712		14710	1267	2047	12308	10690	13783	11929	3103	5664	2543	2742	514	1557	1865	13389	1569	7212	10049	6015	7293	7852	887	518	5070	7956	9145	1544	7821	11299	6466	5561	7633
74	2188	3266	5179	6449	4120	1729	12146	1731	1079	6123	11148	3376	5570	3066	463	3435	1711	243	490	4045	5586	596	710	7854	3809	6111	4728	410	144	250	673	1067	765	5674	7063	5135	3726	2185
75	1757	3266	5179	6006	4120	865	10635	1267	1079	2560	1180	893	2482	2323	463	2473	1234		305	1823	3640	364		5429	3011	1416	2433	244	144	1158	583	2178	1516	4025	4755	159	2417	3446
76			45			865	3360	464	3237	747	1187	1322	1634	987	309	906	430		438	3485	295	246		4361	3239	680	517	10	2974	1411	120	1910	761	1523	557	210	918	1153
77						865	3360		3237	795		1003		197	154	403			376	3485	934		183	17			141	10	52	727	2534	932	1369	2629	1866	1719	5707	9898
78						865	1609	928	7836	747		203	936	592	695	504	704	70	250	6273	195		96	2581	2		136	6	68	98	16	674	2218	1784	814	2231	1986	4133
79				443		4324	12		3245	3866				197	154	201	75		397	3412	934	30			2		70	3	350	98	16	41	1091	1229	3196	182	1868	3923
80							3360	1392	4591			1143		577	309	504	430		397	1213	97				4		17		77	189	32	21	289	633	1336	36	182	287
81							3360							759					501	1418					4		3		77	774	910	21	68	144	463	75	359	311
82									5130					197	77	101	430		702	167					4				146	332	24	82		466	880	17975	276	350
83									4212	336	190	385	211	1473	341				522	1262					4		14		2786	332	24	82		68	82	54	167	157
84									918							101			1044	1249					9		3	6	184	290	16	21		82	118	125	207	239
85									1836	4485	13071				386				835	36					9		3	6	184	290	16	21	150	383	118	125	125	241
86									3672	4485	13071				77				689	36									23	84		41		11	30	90	104	157
87									1836	4485	13071				77				543										2663	84		41		11	30	90	104	157
88									4591	4485	13071								647							118	12		2678	67	8			23	44	215	219	562
89		651					12		4591	4485	13071								284	36		5				118	12		38	67	8				44	215	146	471
90+		651				231732			5509										230						26	532	46	19	3515	1645	379	247	1159	91	925	1026	1586	4399
Total	10566682	19607214	31599775	30835257	34596683	52379449	20526007	29785391	44482923	43643825	35599889	46548021	54053970	58724551	51823208	40601046	34606548	40988321	44305383	60005588	45308876	56460771	92697009	70890373	89151912	77937674	75164143	65027779	58843831	59056212	70695763	60406190	62656134	46409323	60143044	65153462	65130882	55085876

Table 8. Overall skipjack catch-at-size matrix (number of fish) obtained for the western stock.

Li (cm)	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
<24	4	20	59	76	203	249	305	77	18	90	17	427	332	300	134		854	730			440	556										346						
24									21	974		827																										
25	483	713	641	570	606	725			5	225	91	827		88	134						547	692			1774		275									453		
26	322	475	428	380	404	483	547	637	560	1273		414		221	403				279	118	301	118	344				549											
27	644	950	855	760	808	966			5	225	182	414		177	268				279	118	301	118	344		0	1155	275											
28	322	475	428	380	404	483	821	956	797		91	621		221	805				1117	473	1203	473	1375		1289	3466	549									453	676	
29	1127	1663	1497	1330	1413	1743	274	319	282	749	91	621		221	671				1117	473	1203	473	1375			2031	158	349				346				453	2028	
30	807	1198	1099	988	1111	1332	700	676	585	2067	371	4014	622	1284	560	302	5181	5372	1592	413	1053	413	2527		1472	1943	713	370					1756		1453	4531	1352	3400
31	968	1435	1312	1178	1313	1574	973	995	846	1842	411	3736	492	903	387	353	7274	9437	977	413	1053	413	1297	16	15942	7910	1588	466	2122		2193		1756	356	234	5890	4732	
32	2414	3563	3207	2855	3029	3624	3557	4143	3684	3370	1024	7729	391	599	721	488	8002	19587	2123	3042	2180	992	2794	258	29377	10998	2293	1750	2817	1284	709	2520	6146		3719	8156	5408	
33	2253	3326	2993	2661	2827	3434	3010	3506	3226	6740	3786	6617	195	569	353	1109	7231	13531	2123	1031	2180	992	10637	323	26468	19773	1790	338	155	101	1924	5285	4390	1912	141	8156	4056	
34	1770	2619	2358	2245	2252	2750	10434	12118	10901	8484	4212	8089	782	206	602	3201	5565	7743	2094	1741	2987	1614	10878	924	38662	22821	5667	4314	4752	1190	4715	12769	19316	3505	3715	10887	5518	153
35	2897	4282	3854	3576	3665	4547	15360	17855	15671	8117	7016	9555	1165	623	2029	6315	8474	16275	2709	3150	2987	1614	18698	21212	87993	11945	5636	3190	5800	3985	6723	16478	32485	4461	5961	23118	10625	134
36	3058	4573	4121	3893	4220	6163	25467	29394	25693	12016	10367	9683	1614	802	4973	11209	14681	32208	3963	6128	25379	22069	32117	32702	121996	24886	12244	14418	21826	5012	11972	18652	35119	5736	4657	14238	18842	479
37	3541	5285	4763	4463	5004	7179	13743	15371	13963	12768	13868	13414	2851	2539	11967	18226	59750	29720	11766	8413	9841	11111	16498	44651	183489	33519	20161	12849	12636	4591	14776	14598	50923	9879	7513	9888	15268	1238
38	6116	9224	8321	9055	8916	12270	22010	22872	21566	20054	23239	16400	4133	3042	15165	24924	11315	52162	10326	15922	53505	26605	69798	38700	276873	68162	35699	32880	47276	26269	38035	44607	74088	13204	14981	24974	23772	6572
39	16416	24426	22003	21488	21839	34580	44024	47412	42197	31038	31179	27197	3937	2521	12103	32220	47854	68623	65097	20071	22246	21757	59602	29493	234938	80305	43192	32437	27554	21717	36658	52155	70239	15833	14739	21620	20994	1959
40	13199	19798	17870	19107	19157	34613	58514	65118	58566	53310	51803	41303	7036	3522	11750	52019	276853	164059	48439	21776	32885	23785	82777	62505	285312	136183	52593	82724	119909	70391	84636	86294	132004	12572	26359	33061	37517	9176
41	12072	18135	16373	18331	19619	47024	48759	52052	47538	60595	45302	49986	22652	30377	43753	114419	416841	141177	56132	40775	52933	42897	118758	58345	300636	144507	61747	69770	54143	48605	62036	61373	161886	32092	58059	34143	64638	20703
42	13889	20996	18917	23021	25188	56256	52369	52282	49827	76886	55505	72483	33091	81059	97512	212843	521398	188292	48096	45657	61420	55753	171350	110281	368683	167481	80148	93171	92112	73287	67994	81635	169273	33533	68706	51772	107810	28937
43	19458	29169	26210	31428	35612	66680	58526	57402	54118	90605	64052	113063	85769	260951	287982	493612	525137	194418	44775	61967	59158	45340	221592	111021	318797	158531	66001	80036	74579	66740	57154	74706	180743	39995	106302	76609	139016	75663
44	26442	39709	35777	42775	46082	84294	76906	66421	63764	92729	71545	151872	122949	346608	373160	615415	628391	173199	130393	80470	99233	63468	235193	148612	469746	282476	94554	101775	85959	90714	63914	98897	177733	40696	126494	136691	183819	155740
45	23369	35103	31537	37471	45100	81590	85441	80792	76025	124509	81319	121585	88074	209784	226628	400596	471842	233868	180244	148152	135879	83447	282677	208445	424568	229534	109426	106408	101386	86695	67797	116905	247144	62181	192537	244839	274057	182498
46	30806	45930	40858	46730	55745	94537	79259	74412	69576	130048	84593	138867	125018	165331	228794	329846	513528	273077	198012	163769	207007	154626	351013	251770	468301	349754	139083	147938	135364	126786	75820	93782	206448	72504	204878	348363	270855	209301
47	27700	41368	36784	43759	55205	84197	81583	74721	70022	145262	90371	126812	105902	87393	143868	217611	431583	278230	187217	224893	211809	202675	413286	278676	386364	365913	143625	172151	166663	169469	108938	101054	206371	115152	268214	552989	363144	267597
48	24788	37078	32836	43642	52735	82899	69327	65605	64203	148906	85081	142956	133329	133611	175679	224977	516459	371470	308833	282227	253753	325719	497651	336831	426828	446919	221297	267911	238368	195224	152425	128389	275002	156820	297382	619878	413285	386125
49	29841	44583	39653	50524	58511	86606	84868	88851	83681	140726	86139	130845	166711	155169	204377	250377	524198	338543	338797	365228	329609	429972	572454	370516	366247	390351	212980	242099	227843	204632	191373	188011	302271	172087	269207	608143	495921	513044
50	37195	55390	49404	62447	71290	82830	78802	78306	72917	150775	110654	134596	196760	209460	286219	301171	888732	467267	361156	458005	487550	567107	598241	365397	458858	510573	250344	285481	338222	227473	235694	249759	367512	239163	306450	779360	656597	592056
51	16733	23247	19751	38238	39042	48588	50429	51846	49719	111312	96809	106169	264555	226092	302166	280818	748650	454533	367480	460833	470454	691285	605556	375796	374210	470603	280478	293602	393897	294321	281721	271344	433502	286908	307100	537075	680331	615392
52	19802	26853	23062	43408	39757	45819	54349	57046	46204	102658	75058	94503	335237	325697	345442	393167	818402	544473	349720	491442	590191	767785	607368	430795	428721	536686	283357	298536	463705	386923	302915	324885	444832	335325	337297	473192	745103	658986
53	23112	28943	24974	51720	37183	40787	55439	63249	48858	94048	69166	97090	456612	521704	531634	592339	629447	566138	350923	437466	592791	705412	683727	390686	455970	483527	338078	391317	536601	439239	393980	413130	490169	353615	338034	431296	740921	647445
54	14368	19339	16163	38668	27105	33179	42548	44233	35685	76690	57894	92567	327809	464937	423940	556954	674922	621990	378571	383244	590957	762865	591135	449963	639989	465016	294895	359205	558362	468680	385665	410608	502952	365282	370555	393967	757599	706306
55	15970	19833	15978	41926	25344	28864	42758	42283	33209	80423	58641	104705	381877	559938	508582	564778	761959	665884	416833	394606	537732	674399	622940	413279	572715	448808	311666	380040	622065	494098	435736	487280	510156	359890	368990	414784	668086	620660
56	13391	16925	12930	39374	18688	21476	40808	42842	34078	70767	55159	97266	334639	463611	420030	440336	712462	703751	451649	383326	508816	624895	598403	423469	544428	475667	275272	370189	623447	450174	425952	449624	487146	370437	380010	381990	624183	466337
57	15587	19197	13652	29230	20614	19839	25457	29560	23604	55489	72081	117615	348901	468459	390677	383169	587541	619353	402723	359476	443381	442544	494364	427556	446628	423344	290643	405042	582345	485111	472370	511812	464973	343306	364923	343984	467155	488595
58	13742	17117	11628	21962	15745	16035	20648	23864	22037	54138	60002	125022	239354	373215	355979	373378	568255	545821	389790	315413	448249	323409	505818	418460	418789	404369	293391	402272	562511	511807	499271	533819	410865	313666	333319	318977	328909	390161
59	17007	17304	10285	21625	13794	14035	21632	32034	26570	50513	67065	152719	227540	303107	286903	264255	486049	457492	402231	366198	381818	241457	349616	371838	478802	393253	333101	447762	500649	491767	485563	533841	406168	306471	350854	249108	214369	332755
60	20482	22596	15297	23680	21653	19547	25170	37478	30991	42122	60970	149474	255411	297512	300320	270850	412159	419926	300419	290597	239835	148582	327286	330061	399719	341127	272459	378024	413640	472151	460588	493140	321159	240399	266495	302189	207510	223083
61	16199	18596	11981	17705	16956	13741	19343	24042	21456	37044	53476	139270	240133	252810	228682	255939	268574	270783	227636	218069	183825	138551	260385	264452	153702	306229	265432	364805	368089	407666	400822	422629	230194	166393	190345	168807	126597	132947
62	11716	14279	9168	13072	14068	10887	10971	14054	13471	32506	47060	121521	203694	271013	226476	261382	220115	199821	144694	179714	155147	112049	206777	203779	205412	236887	234769	322730	289573	333627	322357	348395	247975	184160	209318	179470	102121	103634
63	9235	11032	6812	13658	13218	8035	9705	12280	11584	23630	39176	119649	196709	308954	264885	330140	169538	169302	106214	146042	110041	75129	166222	195396	156097	182627	200777	261027	219369	235373	233743	253166	200687	137023	161449	193002	72611	84160
64	9056	11760	8025	11698	12582	10590	9259	9433	9527	26409	40740	89473	157589	225765	168641	197419	121749	91763	82526	110603	62434	40723	92924	155234	117472	131684	156218	208790	168216	167005	164228	176506	175568	124287	137562	140014	61576	55443
65	11594	12618	8702	13807	12780	10593	8008	13765	10756	25355	32308	97382	155816	234945	190825	224404	62325	76490	72376	78734	58829	26800	88660	126765	153610	87412	99462	130842	123401	130049	126833	144281	151671	105500	118447	125045	45202	46508
66	6700	5993	3564	6946	5833	4433	7973	14171	10875	27189	23491	76132	143141	239514	204057	253757	53329	51367	52774	56362	40668	25452	66621	90298	48547	49997	58816	82757	103234	104309	102339	113830	126329	91667	99525	57158	22307	32686
67	4488	4277	2209	6063	3981	2440	5025	7976	6808	22665	22560	60002	110262	180979	150153	165108	42027	35127	50427	40592	42598	23188	52691	68227	48443	36270	54853	74594	89533	89919	87704	94299	141457	103978	114738	52041	16643	16625
68	2114	2561	1169	2474	3026	1690	2618	2648	3318	22045	16462	54277	72435	195480	180920	186907	31601	22303	55132	20339	27561	13792	28390	76438	25448	22692	37341	51190	57304	60856	59715	60374	120639	86273	95131	18354	8360	7579
69	5686	7972	6228	6151	7017	7426	2789	2906	3360	16660	17451	34395	48869	84408	88158	67950	22381	20075	35307	19392	23066	5336	20966	50279	15427	20156	26437	33924	42052	42007	44458	43407	76292	49689	53941	18199	10764	3976
70	7691	11203	9706	8848	11276	13010	4019	2359	2423	16183	15185	41982	51033	149712	152635	178853	17473	19823	28067	9462	33095	7134	15070	31001	61278	19559	32035	43572	28384	30821	29399	26586	43131	34309	35488	13875	8670	259
71	8317	12289	10904	9904	12348	14083	4242	2607	2386	9807	6273	22079	31599	60866	76365	58727	15274	14194	23303	9974	22438	1896	3565	50034	4249	15910	25356	29564	12655	15959	16573	14256	13620	13906	11987	2730	12817	288
72	6664	9901	8757	8191	10182	10868	2763	1701	1649	6916	5904	16951	25942	56795	69184	59752	17940	13008	35584	6434	4854	3112	15368	53716	3020	16025	28655	31114	8121	6373	7046	6720	28465	23844	24308	10941	10827	142
73	3476	5335	4836	4427	6411	6447	2215	1004	941	5823	6281	7706	23916	21821	32953	19001	12441	8171	17818	9143	8759	1924	15368	31271	14562	11864	20361	22407	4674	4014	4875	3737	21888	16655	16372	2904	7997	153
74	1188	1993	1929	1820	3303	3158	2484	1500	1259	4647	3349	7989	12670	12907	22540	13244	8499	6479	16062	10543	9205	7463	9689	27356	17791	13552	13462	13200	6543	6354	5051	4900	15083	12753	12363	3335	3880	6162
75	979	1707	1703	1618	2974	2861	1937	853	662	2456	3245	7946	23350	13275	25126	8279	3000	3929	13319	8788	5118	5097	5637	11498	3592	13735	12067	12360	4755	2352	3572	2472	15787	11939	13345	4138	4440	5945
76	163	385	381	365	1110	734	519	209	244	2729	2153	7171	15148	10837	20759	5785	1131	2499	6006	2762	2362	2352	9168	24000	1661	5052	6729	3851	2167	2923	1235	1786	18345	9863	10688	5794	2603	3117
77	163	385	381	365	985	734	519	209	223	1757	1555	4808	9124	7289	20009	5872	804	1694	4293	3974	2362	2352	5888	9566	28163	7538	5127	3895	1630	1764	1061	1299	6980	5647	5742	1731	1454	3117
78		47	47	47	358	160	118	58	96	2518	2911	2805	6397	4118	10035	3257	1939	1422	2049	6658	5719	5677	6282	19808	4026	5102	7312	4344	3968	2552	2552	2586	2005	1732	1825	2891	3764	3117
79	161	284	261	237	434	610	118	58	102	3393	4201	582	3663	1510	6065	3599	188	931	1225	8394	5719	5677	6281	18240	4026	5102	8687	8925	3968	2552	2552	2632	333	573	508	2891	985	3743
80		50	50	50	374	115	147	62	87	1387	6968	306		2	1407	3281	188	811	965	197	169	168	3489	2748	1687	533	2108	2417	116	76	76	141	3090	1892	5335	5386	2762	85
81		50	50	50	248	115	147	62	98	2374	1442	28	28	632	2463	1833	956	541	335	1108	169	168	1466	355	2035	703	1368	2122	116	76	76	176	415	611	585		441	18
82		50	50	50	248	115	126	62	130	5413	2823	28	28	632	1457	5915		743	460	365	112	112	124	7772	1075	98	873	1015	78	836	51	82	1997	1583	1772		84	1499
83		50	50	50	248	115	126	66	106	3287	1442	28			201	4851		406	251	132	10486	7351	16205	2870	607	571	69	687	78	304	51	111	251	327	352		84	1499
84		53	53	53	263	122	134	66	111	3293	4209	30				1177	253	170	42					5136	1855		88	33		266	5	39	131	172	199		227	18
85		53	53	53	263	122	134	66	104	2455	217	30				724	253	238	84				1260	467		6972	88	33		13	5	26	78	152	126		3028	7
86		16	16	16	77	36	39	19	36	1169	1554	9				475			864	1349			10	24	387	1847	2777	3821				10	41	88	80		5	7
87		16	16	16	77	36	39	19	22	31	2935	9				113		135	316				10	24	17	635						34	140	217	217		5	7
88		12	12	12	62	29	31	15	18	25	168	7				362		348	42						1181	916	88	33				5	21	27	28		76	7
89		12	12	12	62	29	31	15	18	25	168	7						280								1538	88	33				7	29	38	40	1592	191	83
90+	4	20	59	76	203	249	305	77	18	90	17	13	332	300	0	227			864	438			151	28192	628	1242	526	133		553	214	325	75	7945	673	2891	342	98
Total	577685	795839	665059	952797	942147	1295375	1390706	1449090	1303097	2371821	1960877	3384698	5807616	8036418	8140664	9749614	13362967	9691203	6797031	6786594	7677599	7978937	10258156	8057520	11130584	9115984	5837893	7193038	8554731	7567034	7045839	7602865	8837245	5500218	6721767	8478418	9084957	8117427

Table 9. Yellowfin catch-at-age matrix.

Year	***0***	***1***	***2***	***3***	***4***	***5+***
1970	361290	2229482	607301	650369	335068	85575
1971	344448	1977021	1287353	474486	293744	72602
1972	370595	2052767	1492978	786068	289931	91172
1973	243206	1577104	1251198	811921	370436	103603
1974	886952	2496615	1274896	897957	403301	115146
1975	1850686	2801854	1719568	842170	602660	162022
1976	2183572	3635133	1388487	867883	547868	148267
1977	1488116	4057058	1711726	970685	504842	105140
1978	1592943	3664928	1963323	1155362	441937	60903
1979	2028285	3775358	1022740	1156845	537482	73775
1980	3200008	4016663	1247358	972350	532110	83719
1981	6758071	4062149	1479983	926044	810154	139639
1982	2657563	6800765	1379253	1214320	710570	142131
1983	4323476	4680819	1680974	1290371	704840	128569
1984	2901125	6946804	1953147	861417	211065	30274
1985	4268983	4165569	2143130	957578	738008	69106
1986	3706439	4362541	1306129	1351567	586169	68951
1987	6280192	4318997	1513905	1055188	652139	65881
1988	5045170	5018133	1138051	1362108	479093	44092
1989	5844442	4139343	946698	1212904	945449	121843
1990	6840077	5910204	977104	1354542	1052048	177816
1991	6313402	5500947	1181880	1108701	832673	126849
1992	6170239	5029419	1236534	1294467	780051	124612
1993	8654594	5382283	1528458	1371075	745384	81507
1994	4983084	6443400	2198100	1089902	762615	100493
1995	5210909	4889679	1543835	1000446	724878	82982
1996	5415623	5453178	1306456	1144517	699652	77460
1997	5109588	6051401	1090160	805058	697640	81796
1998	5261746	7237372	1260581	828678	716679	132870
1999	6104314	11684800	1722161	797909	524019	96085
2000	8362333	5878954	1274923	1133947	475691	100301
2001	7465211	10065910	1576328	1271341	534448	117632
2002	7175201	8115388	952183	882558	613958	76429
2003	6879341	7202107	1008228	764832	507098	107459
2004	7118910	5801751	1149694	874474	360014	114175
2005	5792990	6796869	895413	573610	446518	86079
2006	4628314	3926747	1232116	759365	382044	98240

Table 10. Yellowfin upper size limits used for slicing.

Upper Slicing limits

	Quarter				
Age	*1*	*2*	*3*	*4*	
0	42	45	48	53	Current and past
1	60	69	78	89	
2	100	110	120	128	
3	136	143	148	153	
4	157	161	163	166	
0	30	44	58	71	Shuford *et al.*
1	83	100	104	114	
2	122	131	139	146	
3	153	159	165	170	
4	175	180	185	189	

Table 11. Fishery definitions used for skipjack MFCL analyses preparations.

Definition of fisheries

Region	*Fishery*	*Nation/Gear*		*Years*	*Fishery #*
#East	1E	EC-France, EC-Spain and Others	PS	1956-1979	1
#East	2E	EC-France, EC-Spain and Others	PS	1980-1990	2
#East	3E	EC-France, EC-Spain and Others-Free School	PS	1991-2005	3
#East	4E	EC-France, EC-Spain and Others-FADs	PS	1991-2005	4
#East	5E	Ghana	PS & BB	1973-2005	5
#East	6E	EC-France, EC-Spain (Dakar Based), Senegal	BB	1956-1983	6
#East	7E	EC-France, EC-Spain (Dakar Based), Senegal	BB	1984-2005	7
#East	8E	Azores, Madeira, Canaries	BB	1956-2005	8
#East	9E	Others	BB	1956-2005	9
#East	10E	Others	Others	1956-2005	10
#West	1W	Brazil	BB	1956-2005	11
#West	2W	Venezuela	PS+BB	1956-2005	12
#West	3W	All	Others	1956-2005	13

Table 12. Fishery definitions used for yellowfin MFCL analyses preparations.

	Fishery	*Gear*	*Nation*	*Years*	*Region*
#	1	PS	EC-France, EC-Spain, Others	1956-1979	E
#	2	PS	EC-France, EC-Spain, Others	1980-1990	E
#	3	PS	EC-France, EC Spain, Others, free schools Qtr 2-4	1991 - 2006	E
#	4	PS	EC-France, EC-Spain, Others, FADS	1991 - 2006	E
#	5	PS&BB	Ghana (1973 - 2005)	1956 - 2006	E
#	6	BB	EC-France, EC-Spain (Dakar based), Senegal	1965 - 1983	E
#	7	BB	EC-France, EC-Spain (Dakar based), Senegal	1984 - 2006	E
#	8	BB	Azores, Madeira, Canaries	1956 - 2005	E
#	9	BB	Others	1956 - 2006	E
#	10	LL	ALL	1956 - 1975	E
#	11	LL	ALL	1976 - 2006	E
#	12	OTH	Others	1956 - 2006	E
#	13	PS	EC-France, EC-Spain, Others, free schools Qtr 1	1991 - 2006	E
#	14	BB	Brazil	1956 - 2006	W
#	15	PS&BB	Venezuela	1956 - 2006	W
#	16	LL	All	1956 - 1975	W
#	17	LL	All	1976 - 2006	W
#	18	Others	Others	1956 - 2006	W

Table 13. Estimated yellowfin and skipjack weighted and unweigthed combined indexes. Refer to text for explanation of the fleets used in the GLM procedure.

	YELLOWFIN		*SKIPJACK - ATE*		*SKIPJACK - ATW*	
Year	Unweighted	Weighted	Unweighted	Weighted	Unweighted	Weighted
1965	2.5708	2.5708	0.1476	0.220		
1966	1.7311	1.7311	0.1985	0.142		
1967	3.4049	3.4049	0.3608	0.582		
1968	3.2299	3.2299	0.3063	0.438		
1969	1.9136	1.9136	0.2339	0.279		
1970	1.5549	1.5549	0.2681	0.226		
1971	1.2247	1.2247	0.1230	0.102		
1972	1.3862	1.3862	0.2730	0.345		
1973	1.2904	1.2904	0.3052	0.492		
1974	1.2970	1.2970	0.4099	0.593		
1975	0.9611	0.9611	0.5716	0.752		
1976	1.0211	1.0211	0.4586	0.594		
1977	1.0334	1.0334	0.7638	0.994		
1978	0.8556	0.8556	0.7091	1.067		
1979	1.0593	1.0593	0.2645	0.227		
1980	0.5871	0.5871	0.5238	0.694		
1981	1.1711	1.1711	0.4980	0.674	1.1371	1.160
1982	1.0718	1.0718	0.7100	0.677	2.5823	2.420
1983	1.3095	1.3095	0.8498	0.956	1.0104	0.934
1984	1.1961	1.1961	1.1888	1.344	0.8831	0.918
1985	1.1660	1.1660	0.7824	0.953	1.1639	1.170
1986	1.2742	1.2742	0.8196	0.685	1.0632	1.152
1987	1.3523	1.3523	1.1653	0.667	0.7874	0.719
1988	1.4114	1.4114	0.8892	0.532	0.8940	0.929
1989	1.1496	1.1496	1.1556	0.651	0.9410	0.930
1990	1.4176	1.4176	1.0684	0.890	1.0947	1.064
1991	1.2238	1.2238	0.8047	0.387	1.0400	0.992
1992	1.1837	1.1837	1.1339	1.283	0.7074	0.636
1993	0.9902	0.9902	0.9468	1.458	1.2769	1.315
1994	1.0952	1.0952	0.9560	1.548	0.7491	0.763
1995	0.7577	0.7577	0.9832	1.097	0.6162	0.597
1996	1.1553	1.1553	1.0552	0.884	0.8227	0.733
1997	0.7201	0.7201	0.8262	0.643	1.2126	1.073
1998	0.8519	0.8519	0.8533	0.484	1.1828	1.141
1999	0.8140	0.8140	1.2205	1.255	0.8910	1.200
2000	0.6015	0.6015	1.3322	1.161	0.5497	0.532
2001	0.5274	0.5274	1.2468	0.956	1.2446	1.297
2002	0.8007	0.8007	1.1831	1.305	0.8448	0.937
2003	0.8928	0.8928	0.1476	0.220	1.0310	1.202
2004	0.7589	0.7589	0.1985	0.142	0.7431	0.769
2005	0.5288	0.5288	0.3608	0.582	0.3078	0.449
2006	0.6980	0.6980	0.3063	0.438	0.6849	0.592

Table 14. Control file specifications used for VPA model runs.

SEARCH ALGORITHM CONTROLS (USED FOR ALL RUNS)

-911 RANDOM NUMBER SEED

50 MAXIMUM NUMBER OF AMOEBA SIMPLEX SEARCH RESTARTS

3 NUMBER OF CONSECUTIVE RESTARTS THAT MUST VARY BY LESS THAN 1% TO STOP SEARCH

0.4 PDEV (standard deviation controlling vertices for Initial simplex of each restart)

INDEX WEIGHTING CONTROLS (USED FOR ALL RUNS)

1 SCALE (DIVIDE INDEX VALUES BY THEIR MEAN)- ANY VALUE > 0 = YES

1.0 INDEX WEIGHTING:(0)INPUT CV's, (+)DEFAULT CV, (-)DEFAULT STD. DEV., (999)MLE

0 (0) MULTIPLICATIVE VARIANCE SCALING FACTOR or (1) ADDITIVE VARIANCE SCALING FACTOR

CONSTRAINT ON VULNERABILITY (PARTIAL RECRUITMENT) - LINKS THE VULNERABILITIES IN THE LAST N YEARS. (Number of years affected, Standard Deviation, First Age, Last Age)

0 0.4 0 5 (CONTINUITY RUN) – NO PENALTY USED

3 0.4 0 5 (BASE RUNS 5 and 10) – PENALTY APPLIED

CONSTRAINTS ON RECRUITMENT - LINKS THE RECRUITMENTS IN THE LAST N YEARS (N Years,

4 0.4 (CONTINUITY AND BASE RUNS 5 and 10) – PENALTY APPLIED

PARAMETER ESTIMATION OPTIONS

1 USE F'S AS TERMINAL YEAR PARAMETERS (ALL RUNS)

-1 ESTIMATE Q BY CONCENTRATED MLE's (ALL RUNS)

Table 15. Parameter file specifications used for VPA model Runs.

```
# TERMINAL F PARAMETERS: (lower bound, best estimate, upper bound, indicator, reference age)
#(USED FOR CONTINUITY AND BASE RUNS 5 and 10)
#_________________________________________X__________________________________________
$    1    0    0.2    2    1    0.1    first age (AGE 0 in this case)
$    1    0    0.8    2    1    0.1
$    1    0    0.3    2    1    0.1
$    1    0    0.3    2    1    0.1
$    1    0    0.5    2    1    0.1    next to last age
#_________________________________________X__________________________________________
```

```
# F-RATIO PARAMETERS F{oldest}/F{oldest-1} (lower bound, best estimate, upper bound, indicator, std. dev. of prior)
#   one parameter (set of specifications) for each year
#(USED FOR CONTINUITY AND BASE RUNS 5 and 10)
#_________________________________________X__________________________________________
$    1     0.1    0.2    5    1    0.2    1970    estimated
$    36    0.1    0.2    5    3    0.2    1971-2006 random walk
#_________________________________________X__________________________________________
```

```
# NATURAL MORTALITY PARAMETERS: (lower bound, best estimate, upper bound, indicator, std. dev. of prior)
#   one parameter (set of specifications) for each age
#(USED FOR CONTINUITY AND BASE RUNS 5 and 10)
#_________________________________________X__________________________________________
$    1    0    0.8    1    0    0.1
$    1    0    0.8    1    0    0.1
$    1    0    0.6    1    0    0.1
$    1    0    0.6    1    0    0.1
$    1    0    0.6    1    0    0.1
$    1    0    0.6    1    0    0.1
#_________________________________________X__________________________________________
# MIXING PARAMETERS: (lower bound, best estimate, upper bound, indicator, std. dev. of prior)
#   one parameter (set of specifications) for each age :not used here!
#(NO MIXING WAS USED FOR ANY 2008 YFT VPA RUN)
#_________________________________________X__________________________________________
$    6    0    0    0    0    0
#_________________________________________X__________________________________________
# STOCK-RECRUITMENT PARAMETERS: (lower bound, best estimate, upper bound, indicator, std. dev. of prior)
#   five parameters so 5 sets of specifications  : not used here!
#(THESE SETTINGS ARE USED TO CONTRAINT ON THE ESTIMATED S-R RELATIONSHIP. THIS WAS NOT DONE FOR ANY 2008 YFT VPA RUN)
#_________________________________________X__________________________________________
0    0    0    0    0    maximum recruitment
0    0    0    0    0    spawning biomass scaling parameter
0    0    0    0    0    extra parameter (not used yet)
0    0    0    0    0    autocorrelation parameter
0    0    0    0    0    variance for penalty function
#_________________________________________X__________________________________________
# VARIANCE SCALING PARAMETER (lower bound, best estimate, upper bound, indicator, std. dev.)
#(USED FOR CONTINUITY AND BASE RUNS 5 and 10. THESE SETTINGS ESTIMATE A SINGLE VARIANCE SCALAR FOR ALL INDICES. THE SAME SCALAR IS USED FOR THE INTERANNUAL VARIANCE OF EACH INDEX. (EQUAL WEIGHTING ACROSS YEARS AND INDICES).
#_________________________________________X__________________________________________
$ 1    0    0.5    1.0     1     0.1
$ 17  0    1.0    1.0    -0.1    0.1
```

Table 16. Indices of abundance used for VPA model runs.

Index	*Continuity Run*	*Runs 5 & 10*
Brazilian Bait Boat	Used	Used
Brazilian Longline	Used	Used
Japanese Longline	Used	Used
USA-Mexico Longline (GOM)	Used	Used
USA Rod and Reel	Not Used	Used
USA Pelagic Longline (ATL)	Used	Used
Venezuela Longline	Used	Used
Venezuela Purse Seine	Used	Used
EU FAD Purse Seine	Not Available in 2003	Used
EU PS 3% Annual Increase in Q	Used 1970-2006	Used (1970-1979) ***
EU TROP Purse Seine	Not Available in 2003	Used
EU Dakar Purse Seine	Not Available in 2003	Used
Uruguay Longline	Not Available in 2003	Used
Chinese Taipei Longline	Not Available in 2003	Used
Canary Islands Bait Boat	Not Available in 2003	Used

*** No increase in catchability was applied during this period. The EU indices for juveniles (EU-FAD_PS) and adults (EU-TROP-PS) were used when available. They cannot be used with the EU-PS 3% index during overlapping time periods because they were developing using the same datasets.

Table 17. Methods used to estimate index selectivities for VPA models. (B&G = Butterworth and Geromont, 1999).

<table>
<tr><th></th><th colspan="3">Estimation of Index Selectivities</th></tr>
<tr><th>Index</th><th>Continuity Run</th><th>Run 5</th><th>Run 10</th></tr>
<tr><td>Brazilian Bait Boat</td><td>Partial Catches (B&G) Ages 0-4</td><td>Partial Catches (B&G) Ages 0-4</td><td rowspan="15">Identical to Run 5 except that for all LONGLINE INDICES, the selectivity was estimated as in Run 5, then for all ages older than the first fully selected age, the selectivity was fixed at 1.0. Using this method, the selectivity vectors of the longline fleets were assumed to be logistic (flat-topped) rather than dome shaped (as in Run 5).</td></tr>
<tr><td>Brazilian Longline</td><td>Partial Catches (B&G) Ages 0-5</td><td>Partial Catches (B&G) Ages 0-5</td></tr>
<tr><td>Japanese Longline</td><td>Partial Catches (B&G) Ages 0-5</td><td>Partial Catches (B&G) Ages 0-5</td></tr>
<tr><td>USA-Mexico Longline (GOM)</td><td>Partial Catches (B&G) Ages 0-5</td><td>Partial Catches (B&G) Ages 0-5</td></tr>
<tr><td>USA Rod and Reel</td><td>Not Used</td><td>Partial Catches (B&G) Ages 0-5</td></tr>
<tr><td>USA Pelagic Longline (ATL)</td><td>Partial Catches (B&G) Ages 0-5</td><td>Partial Catches (B&G) Ages 0-5</td></tr>
<tr><td>Venezuela Longline</td><td>Partial Catches (B&G) Ages 0-5</td><td>Partial Catches (B&G) Ages 0-5</td></tr>
<tr><td>Venezuela Purse Seine</td><td>Partial Catches (B&G) Ages 0-4</td><td>Partial Catches (B&G) Ages 0-4</td></tr>
<tr><td>EU FAD Purse Seine</td><td>Not Used</td><td>Partial Catches EU-PS (B&G) Ages 0-1</td></tr>
<tr><td>EU PS 3% Annual Increase in Q</td><td>Partial Catches (B&G) Ages 0-5</td><td>Partial Catches EU-PS (B&G) Ages 0-5</td></tr>
<tr><td>EU TROP Purse Seine</td><td>Not Used</td><td>Fixed at Fecudity Proxy Ages 3-5</td></tr>
<tr><td>EU Dakar Purse Seine</td><td>Not Used</td><td>Partial Catches (B&G) Ages 0-4</td></tr>
<tr><td>Uruguay Longline</td><td>Not Used</td><td>Partial Catches (B&G) Ages 0-5</td></tr>
<tr><td>Chinese Taipei Longline</td><td>Not Used</td><td>Partial Catches (B&G) Ages 0-5</td></tr>
<tr><td>Canary Islands Bait Boat</td><td>Not Used</td><td>Partial Catches (B&G) Ages 0-4</td></tr>
</table>

Table 18. Estimated indexes of abundance used in ASPIC runs.

YEAR	*YFT-JPN-LL(w)*	*YFT-USA-RR(n)*	*YFT-BRZ-LL(n)*	*YFT-USA-LL(w)*	*YFT-URU-LL(n)*	*YFT-VEN-PS(w)*	*YFT-BRZ-BB(w)*	*YFT-EUDKR-BB(w)*	*EU PS 3% incQ*	*combined index (from 1965 to 2006)*	*combined index (from 1956 to 2006)*
1950											
1951											
1952											
1953											
1954											
1955											
1956											72.909
1957											43.752
1958											31.410
1959											32.821
1960											20.334
1961											12.884
1962											4.283
1963											4.027
1964											2.367
1965	2.355									2.537	1.222
1966	1.586									1.708	0.823
1967	3.119									3.360	1.618
1968	2.580									3.128	1.507
1969	2.270							0.659		2.715	1.308
1970	1.690							0.644	5.061	2.099	1.011
1971	1.357							0.636	4.318	1.469	0.707
1972	1.834							0.640	4.795	1.776	0.856
1973	1.288							0.589	4.833	1.560	0.751
1974	1.778							0.925	4.405	1.367	0.658
1975	1.321							0.405	4.744	1.121	0.540
1976	1.297							0.448	4.693	1.169	0.563
1977	1.006							0.684	4.610	1.026	0.494
1978	1.478							0.264	4.195	1.084	0.522
1979	1.783							0.498	4.171	1.246	0.600
1980	1.102								3.457	0.965	0.465
1981	1.390				144.960		1.391	1.024	3.709	1.133	0.546
1982	1.228				196.750		0.212	0.976	3.166	0.915	0.441
1983	1.222				84.811	13.589	0.576	0.994	2.748	1.068	0.514
1984	1.315				42.077	6.027	0.280	1.420	2.172	1.021	0.492
1985	0.840				75.434	10.170	0.209	1.091	3.732	0.909	0.438
1986	1.053	32.756	5.035		116.428	5.977	0.209	1.647	4.026	1.098	0.529
1987	1.110	15.564	6.355	1.766	112.292	4.574	0.295	1.858	3.527	1.141	0.549
1988	1.102	7.789	5.276	1.861	142.612	6.304	0.327	1.798	3.340	1.341	0.646
1989	0.863	12.821	5.342	1.626	56.755	13.656	0.299	0.433	4.162	1.091	0.525
1990	1.169	5.746	9.045	1.371	51.864	7.002	0.620	1.658	4.531	1.323	0.637

1991	0.891	9.236	4.962	1.053	186.624	7.151	0.187	1.200	3.605	1.020	0.491
1992	1.003	6.298	2.069	1.257	293.019	4.812	0.295	2.340	3.290	0.935	0.450
1993	0.478	14.332	2.402	0.716	55.948	5.511	0.350	1.899	3.256	0.766	0.369
1994	0.813	34.744	2.668	0.695	214.310	6.720	0.210	1.414	3.123	0.951	0.458
1995	0.560	47.164	1.810	0.835	88.011	3.025	0.104	0.845	3.192	0.796	0.383
1996	0.613	14.731	4.648	0.824	166.935	6.777	0.289	1.381	3.116	0.864	0.416
1997	0.465	6.324	3.678	0.888	54.748	4.569	0.422	0.586	2.887	0.703	0.339
1998	0.557	10.750	4.685	0.650	62.019	3.704	0.323	0.223	2.589	0.730	0.351
1999	0.563	21.224	4.392	0.982	125.597	5.434	0.112	0.639	2.329	0.729	0.351
2000	0.625	22.736	4.583	0.853	165.542	6.624		0.301	2.983	0.765	0.368
2001	0.421	24.172	3.676	0.771	0.000	13.243	0.681	0.482	3.290	0.621	0.299
2002	0.430	19.716	2.908	0.606	100.350	8.181	0.291	0.731	3.723	0.707	0.340
2003	0.507	17.978	6.166	0.513	152.398	3.999	0.238	0.835	3.175	0.882	0.425
2004	0.657	17.585	7.536	0.868	109.591	2.393	0.091	0.636	2.906	0.905	0.436
2005	0.499	13.211	0.918	0.869	231.081	1.226	0.103	0.519	3.146	0.636	0.306
2006	0.693	19.888	2.305	0.891	90.832		0.376	0.588	3.838	0.749	0.361

Table 19. Series of catches used in ASPIC runs.

YEAR	*YFT-JPN-LL(w)*	*YFT-USA-RR(n)*	*YFT-BRZ-LL(n)*	*YFT-USA-LL(w)*	*YFT-URU-LL(n)*	*YFT-VEN-PS(w)*	*YFT-BRZ-BB(w)*	*YFT-EUDKR-BB(w)*	*EU PS (PILAR) 3% incQ*	*others*	*Total*
1950	0	0	0	0	0	0	0	0	0	1200	1200
1951	0	0	0	0	0	0	0	0	0	1358	1358
1952	0	0	0	0	0	0	0	0	0	2787	2787
1953	0	0	0	0	0	0	0	0	0	3600	3600
1954	0	0	0	0	0	0	0	0	0	3407	3407
1955	0	0	0	0	0	0	0	0	0	4300	4300
1956	612	0	0	0	0	0	0	0	0	5985	6597
1957	13198	0	0	0	0	0	0	0	0	10500	23698
1958	27159	0	1740	0	0	0	0	0	0	11682	40581
1959	44071	0	5920	111	0	0	0	0	0	7667	57769
1960	50822	0	4700	0	0	0	0	0	0	12971	68493
1961	42609	0	4400	0	0	0	0	0	0	11794	58803
1962	41973	0	1400	17	0	0	0	0	0	14133	57523
1963	37717	0	2400	8	0	0	0	0	88	24384	64598
1964	35106	0	1624	0	0	0	0	0	637	31561	68928
1965	36918	0	696	0	0	0	0	0	718	29390	67721
1966	22354	0	464	0	0	0	0	0	983	34639	58439
1967	12824	0	812	0	0	0	0	0	994	45163	59793
1968	13913	0	812	0	0	0	0	0	1402	68196	84323
1969	9966	0	464	0	0	0	0	14269	1595	68277	94571
1970	6809	0	812	0	0	0	0	7556	4309	54969	74455
1971	10629	0	347	0	0	0	0	7570	3014	52887	74448
1972	6497	0	233	0	0	0	0	7539	5017	75342	94628
1973	3803	0	153	0	0	0	0	5542	5297	80332	95127
1974	3475	0	232	0	0	0	0	6353	12498	84583	107141
1975	4192	0	260	0	0	0	0	2881	27309	90154	124796
1976	3366	0	681	0	0	0	0	3718	17720	99475	124960
1977	1467	0	928	0	0	0	0	3380	22329	102909	131013
1978	1923	0	795	0	0	0	0	2783	24669	103874	134044
1979	1986	0	1076	0	0	0	117	2141	22199	99998	127517
1980	2839	0	521	52	0	4397	392	0	22398	100097	130696
1981	4145	1275	1159	45	67	2500	917	2766	40976	102287	156137
1982	6062	912	935	65	214	12030	1036	2907	35639	105542	165342
1983	2069	2196	887	165	357	23503	1778	2690	39808	92404	165857
1984	3967	404	484	593	368	17814	1298	3460	10972	74690	114050
1985	5308	3393	515	738	354	16241	2176	2874	32339	92680	156619
1986	3405	4836	1057	3975	270	9175	751	3797	32462	86945	146673
1987	3365	3952	653	4888	109	6583	1560	3778	31498	88975	145361
1988	5982	1899	898	8644	177	5992	1596	4420	28618	78039	136265
1989	6970	1930	1126	6247	64	11612	1376	2809	47539	82574	162247

1990	5919	545	661	4474	18	6533	953	3805	50053	120487	193448
1991	4718	1418	582	4141	62	11967	1169	4824	30805	107214	166901
1992	3715	957	1248	5337	74	9693	2660	3359	30426	106290	163760
1993	3096	1898	1518	3886	20	12659	3087	3002	26500	107088	162753
1994	4783	4523	1084	3246	59	19587	2744	3155	30473	102896	172551
1995	5227	4053	1312	3645	53	6338	2613	2152	28324	99529	153246
1996	5250	4032	734	3320	171	10777	1956	2190	26181	98428	153040
1997	3539	3569	849	3773	53	11653	1643	1478	26761	83893	137211
1998	5173	2927	1014	2449	88	9157	1229	569	27255	98703	148564
1999	3405	3967	2930	3541	45	6523	1197	1857	19442	97459	140366
2000	4061	3862	2754	2901	45	7572	3093	872	15627	95447	136235
2001	2691	4185	4883	2200	90	13064	1276	1172	18756	116333	164650
2002	2105	2887	3323	2573	91	7961	2843	2242	23166	93088	140279
2003	2754	5328	1941	2164	95	4607	1289	1963	14816	90558	125515
2004	6260	3759	1968	2492	204	3185	2838	1664	14077	83488	119936
2005	4488	3657	4695	1746	644	2634	2236	1288	10077	75857	107322
2006	5334	4908	1329	2010	218	0	1214	2483	4430	86697	108623

Table 20. Summarized scenarios for yellowfin ASPIC runs.

Run	*Model*	*Abundance indicators*	*Weighting of indexes*	*B1/K*	*Time period*
1	GENFIT	combined (from 1965 - 2006)	none	fix as 1	1950 -2006
2	LOGISTIC				
3	GENFIT			estimate	
4	LOGISTIC				
5	GENFIT	10 separate series	equal	fix as 1	
6	LOGISTIC				
7	GENFIT		weighting by ratio of area convergence		
8	LOGISTIC				
9	GENFIT	combined (from 1956 –	none		
10	LOGISTIC				

Table 21. Western skipjack BSP starting parameter inputs and technical inputs for all runs.

param.out file		
parameter	starting guess	Comment
K	100000	close to mode
B1950/K	1	close to mode
r	1.2	close to mode

Techinputs file	
Fmin	0.0000001
stepsize	0.000001
eps	0.0000001
maxlikefunc	10000

Table 22. Eastern skipjack BSP starting parameter inputs and technical inputs for all runs.

Low variance on r prior

Runs 1-3

param.out file		
parameter	starting guess	Comment
K	1500000	close to mode
B1950/K	1	close to mode
r	1.1	close to mode

Run 4

param.out file		
parameter	starting guess	Comment
K	700000	close to mode
B1950/K	1	close to mode
r	1.1	close to mode

Runs 5-8

param.out file		
parameter	starting guess	Comment
K	700000	close to mode
B1950/K	1	close to mode
r	1.3	close to mode

High variance on r prior

Runs 1-3

param.out file		
parameter	starting guess	Comment
K	1500000	close to mode
B1950/K	1	close to mode
r	1.1	close to mode

Run 4

param.out file		
parameter	starting guess	Comment
K	700000	close to mode
B1950/K	1	close to mode
r	1.1	close to mode

Runs 5-8

param.out file		
parameter	starting guess	Comment
K	700000	close to mode
B1950/K	1	close to mode
r	1.3	close to mode

Same for all runs

Techinputs file	
Fmin	1.00E-07
stepsize	1.00E-06
eps	1.00E-07
maxlikefunc	1.00E+04

Run 5B

param.out file		
parameter	starting guess	Comment
K	600000	close to mode
B1950/K	1	close to mode
r	1.2	close to mode

Table 23. Western skipjack BSP indices.

year	Brazilian Baitboat	VZ ourse seine	US rod and reel	Combined Weighted by area	Combined unweighted
1981	1.171	NA	NA	1.160	1.137
1982	1.577	4.083	NA	2.420	2.582
1983	0.624	1.581	NA	0.934	1.010
1984	0.646	1.167	NA	0.918	0.883
1985	0.928	1.409	1.516	1.170	1.164
1986	0.935	0.848	0.652	1.152	1.063
1987	0.716	1.046	1.018	0.719	0.787
1988	0.827	0.849	0.957	0.929	0.894
1989	0.763	1.142	0.947	0.930	0.941
1990	1.341	1.033	1.090	1.064	1.095
1991	0.834	1.237	0.434	0.992	1.040
1992	0.935	0.872	1.640	0.636	0.707
1993	1.334	0.952	0.795	1.315	1.277
1994	0.822	0.643	0.439	0.763	0.749
1995	1.063	0.501	0.528	0.597	0.616
1996	0.923	1.144	0.710	0.733	0.823
1997	1.257	1.999	1.380	1.073	1.213
1998	0.807	1.487	2.209	1.141	1.183
1999	0.624	0.514	0.525	1.200	0.891
2000	NA	0.559	1.602	0.532	0.550
2001	0.927	1.298	1.289	1.297	1.245
2002	0.777	0.602	1.623	0.937	0.845
2003	1.372	0.492	0.827	1.202	1.031
2004	0.967	0.514	0.455	0.769	0.743
2005	1.409	0.046	0.366	0.449	0.308
2006	1.368	NA	NA	0.592	0.685

Table 24. Eastern skipjack - Eight indices used in the BSP model. Weights are determined by the inverse of the fraction of the total fished area that the index accounts for in each year[1]. Weights are used in the BSP model as CVs so that the higher the value, the lower its influence.

year	SKJ-GHN-BB	Weight	Area	SKJ-CAN1-BB	Weight	Area	SKJ-CAN2-BB	Weight	Area	SKJ-POR-BB(w)	Weight	Area	SKJ-EUDK R1-BB	Weight	Area	SKJ-EUDK R2-BB	Weight	Area	SKJ-EC-PS-FAD	Weight	Area	SKJ-EUDK R-PS	Weight	Area	Total area
1969	1.138	4.75	4										0.121	1.27	15										19
1970	1.612	6	4							0.0188	12.0	2	0.213	1.33	18										24
1971	1.865	5.75	4							0.793	11.5	2	0.299	1.35	17										23
1972	1.581	5.25	4							0.4535	10.5	2	0.263	1.40	15										21
1973	1.138	4.5	4							0.1962	9.0	2	0.219	1.50	12										18
1974	1.233	4.25	4							0.0655	8.5	2	0.319	1.55	11										17
1975	0.664	4	3							0.0205	6.0	2	0.175	1.71	7										12
1976	0.917	4	3							0.3899	6.0	2	0.257	1.71	7										12
1977	1.201	2.13	8							0.9981	8.5	2	0.224	2.43	7										17
1978	1.296	3.33	3							1.2161	5.0	2	0.296	2.00	5										10
1979	2.308	4.33	3							0.8233	6.5	2	0.503	1.63	8										13
1980	1.771	4	5	1.439	20.0	1				0.6778	10.0	2	0.518	2.50	8							0.147	5.0	4	20
1981	2.340	4.75	4	2.035	19.0	1				0.9066	9.5	2	0.651	2.37	8							0.612	4.7	4	19
1982	2.055	2.87	8	2.105	23.0	1				1.4974	11.5	2	0.620	2.87	8							0.610	5.8	4	23
1983				0.265	16.0	1				0.1333	8.0	2	0.376	1.78	9							0.098	4.0	4	16
1984				0.883	15.0	1				1.5574	7.5	2				0.273	1.88	8				0.363	3.7	4	15
1985				2.471	13.0	1				0.6045	6.5	2				0.311	2.17	6				0.260	3.2	4	13
1986				0.405	13.0	1				1.1491	6.5	2				0.380	2.17	6				0.696	3.2	4	13
1987				1.191	12.0	1				1.8142	6.0	2				0.576	2.40	5				0.395	3.0	4	12
1988				1.260	18.0	1				3.2581	6.0	3				0.663	2.00	9				0.704	3.6	5	18
1989				1.105	15.0	1				1.8214	7.5	2				0.444	1.88	8				0.541	3.7	4	15
1990				0.811	3.8	5				0.2639	9.5	2				0.790	2.37	8				0.765	4.7	4	19
1991				0.146	29.0	1				0.693	14.5	2				0.505	4.14	7	1.2985	1.81	16	1.061	9.7	3	29
1992							0.160	33.0	1	0.2577	16.5	2				0.516	5.50	6	0.8376	1.65	20	0.688	8.3	4	33
1993							0.153	27.0	1	0.2547	13.5	2				1.028	5.40	5	1.0758	1.59	17	0.786	13.5	2	27
1994							0.676	33.0	1	0.4754	16.5	2				0.966	6.60	5	0.8534	1.65	20	0.608	6.6	5	33
1995							0.379	35.0	1	0.0295	17.5	2				0.381	5.00	7	0.9468	1.67	21	0.622	8.8	4	35
1996							1.376	32.0	1	1.5686	16.0	2				2.118	6.40	5	0.7653	1.60	20	0.286	8.0	4	32
1997							3.208	34.0	1	1.3652	17.0	2				1.037	5.67	6	0.5449	1.62	21	0.767	8.5	4	34
1998							4.821	34.0	1	0.7329	17.0	2				1.732	4.86	7	0.474	1.62	21	0.883	11.3	3	34
1999							0.808	37.0	1	0.6019	18.5	2				1.260	5.29	7	0.5722	1.61	23	1.307	9.3	4	37
2000							0.901	35.0	1	0.2085	11.7	3				1.198	4.37	8	0.8031	1.84	19	0.861	8.8	4	35
2001							0.263	32.0	1	0.2975	10.7	3				1.100	8.00	4	0.6577	1.60	20	0.558	8.0	4	32
2002							0.041	33.0	1	0.827	11.0	3				1.230	5.50	6	0.6683	1.65	20	0.272	11.0	3	33
2003							1.232	34.0	1	0.9712	17.0	2				1.169	5.67	6	0.864	1.62	21	0.742	8.5	4	34
2004							0.605	37.0	1	1.0496	18.5	2				1.148	6.17	6	1.0084	1.54	24	0.825	9.3	4	37
2005							0.555	33.0	1	0.6505	16.5	2				1.383	5.50	6	0.9809	1.57	21	0.469	11.0	3	33
2006							0.904	28.0	1	2.7102	14.0	2				1.376	5.60	5	0.8057	1.75	16	0.401	7.0	4	28

[1] For 1960, weight for SKJ-GHN-BB = 1/% total area fished=1/(4/19)=4.75

Table 25. Eastern skipjack combined indices and EU-PS indices constructed with variable q or a 3% increase in q by year. used for BSP model.

year	Combined, Weighted by area	Combined unweighted	EU-PS CPUE variable q	EU-PS CPUE 3% change in q
1969	0.220	0.148	4.568	
1970	0.142	0.198	4.953	3.253
1971	0.582	0.361	4.249	4.473
1972	0.438	0.306	2.891	3.791
1973	0.279	0.234	3.760	3.835
1974	0.226	0.268	2.641	4.679
1975	0.102	0.123	2.339	1.994
1976	0.345	0.273	2.755	2.463
1977	0.492	0.305	2.658	3.773
1978	0.593	0.410	2.453	3.158
1979	0.752	0.572	2.931	2.719
1980	0.594	0.459	2.490	2.607
1981	0.994	0.764	2.263	2.608
1982	1.067	0.709	2.171	2.381
1983	0.227	0.265	NA	1.752
1984	0.694	0.524	NA	1.749
1985	0.674	0.498	2.202	1.878
1986	0.677	0.710	2.075	2.492
1987	0.956	0.850	2.434	2.321
1988	1.344	1.189	2.254	2.990
1989	0.953	0.782	2.448	2.426
1990	0.685	0.820	1.935	2.778
1991	0.667	1.165	1.458	4.025
1992	0.532	0.889	1.419	2.823
1993	0.651	1.156	1.152	3.450
1994	0.890	1.068	1.142	2.806
1995	0.387	0.805	1.116	3.032
1996	1.283	1.134	1.174	2.577
1997	1.458	0.947	1.576	2.407
1998	1.548	0.956	1.898	2.137
1999	1.097	0.983	1.623	2.308
2000	0.884	1.055	1.594	2.612
2001	0.643	0.826	1.862	2.484
2002	0.484	0.853	1.912	2.526
2003	1.255	1.220	1.640	3.050
2004	1.161	1.332	1.677	3.180
2005	0.956	1.247	2.206	3.919
2006	1.305	1.183	2.252	4.089

Table 26. Summary results from the analyses of catchability trends in the purse seine fishery. The regression slope values can be used to infer average annual percent change in catchability for different time periods.

						q Regression slopes			
	MSY	*k*	*Bmsy*	*B/k*	*B/Bmsy*	*1969-79*	*1980-90*	*1991-06*	*2002-06*
SKJ	150000	700000	257516	0.61	1.66	0.04	0.10	0.01	0.13
YFT	150000	644588	237131	0.37	1.00	0.09	0.11	0.05	-0.07
BET	90000	839523	308843	0.33	0.90	0.07	0.06	0.08	0.03
All	390000	2184112	803490	0.55	1.50	0.07	0.10	0.03	0.03

Table 27. Time series of nominal EC-purse seine fishing effort, estimates of catchability trends by species (and species combined), and effort adjusted for catchability changes estimated by year. The last column shows adjusted yellowfin effort assuming a 3% change per year following the method applied in 2000.

	Effort	*Catchability*				*Adjusted Effort*				*Adj. Effort*
Year	*Nominal*	*SKJ*	*YFT*	*BET*	*All*	*SKJ*	*YFT*	*BET*	*All*	*3%/year*
1969	6010	2.3E-06	6.6E-06	3.5E-07	2.7E-06	6010	6010	6010	6010	--
1970	8970	2.4E-06	5.2E-06	4.4E-07	2.4E-06	9647	7063	11308	8060	14686
1971	11708	3.5E-06	4.4E-06	3.7E-07	2.5E-06	17990	7875	12234	11155	17091
1972	13322	4.4E-06	5.3E-06	4.1E-07	3.1E-06	25736	10869	15699	15586	19624
1973	15041	3.0E-06	5.6E-06	4.4E-07	2.8E-06	20076	12961	18768	15566	19683
1974	17491	5.6E-06	5.6E-06	4.8E-07	3.6E-06	43084	15015	23994	23665	24322
1975	19179	2.7E-06	8.0E-06	4.2E-07	3.3E-06	22432	23385	23092	23450	26305
1976	19726	2.7E-06	9.6E-06	5.4E-07	3.7E-06	23797	29052	30327	27424	26624
1977	17065	5.4E-06	1.2E-05	1.0E-06	5.3E-06	40346	30575	49899	33874	28420
1978	19950	4.7E-06	1.1E-05	6.6E-07	4.7E-06	41134	33857	37439	35156	31950
1979	21138	3.1E-06	1.1E-05	5.7E-07	3.9E-06	28357	34101	34399	31223	30570
1980	24732	3.7E-06	9.6E-06	5.2E-07	3.9E-06	39676	36302	36932	36008	37884
1981	25660	4.3E-06	1.1E-05	8.4E-07	4.6E-06	48412	43247	61599	43894	42010
1982	27674	4.7E-06	1.1E-05	7.8E-07	4.5E-06	57154	45305	61622	46823	52118
1983										60175
1984										52468
1985	14362	5.7E-06	1.6E-05	7.2E-07	6.1E-06	35788	35561	29479	32877	41949
1986	11397	8.7E-06	2.1E-05	1.3E-06	8.5E-06	43727	36563	42421	36319	36401
1987	13390	6.6E-06	1.9E-05	8.6E-07	7.1E-06	39055	39317	32772	35475	40951
1988	11647	1.0E-05	1.9E-05	1.1E-06	8.4E-06	53716	33406	35072	36829	40486
1989	13050	6.7E-06	2.4E-05	8.4E-07	8.1E-06	38409	47275	31284	39481	38756
1990	12006	1.2E-05	3.7E-05	1.4E-06	1.3E-05	60990	67900	47327	56488	42480
1991	12109	2.4E-05	3.2E-05	2.2E-06	1.6E-05	127784	60056	77349	72834	46291
1992	12700	1.8E-05	3.5E-05	2.9E-06	1.4E-05	99020	67029	103537	67849	49781
1993	12462	2.7E-05	3.5E-05	5.2E-06	1.9E-05	149726	66026	186500	86770	49990
1994	11679	2.6E-05	4.0E-05	6.5E-06	2.0E-05	135785	70805	215071	86298	55253
1995	10969	2.7E-05	4.4E-05	6.0E-06	2.1E-05	130382	73872	187096	84939	48003
1996	10544	2.3E-05	4.7E-05	6.9E-06	2.0E-05	107790	75714	206154	80148	49115
1997	8506	1.9E-05	4.9E-05	5.8E-06	1.9E-05	72590	63849	141217	60017	47521
1998	8581	1.7E-05	5.3E-05	4.9E-06	1.8E-05	64594	68904	119406	58124	57373
1999	7909	2.5E-05	4.6E-05	6.8E-06	2.1E-05	85731	56112	154479	61369	60271
2000	7337	2.3E-05	5.5E-05	7.8E-06	2.2E-05	74841	61312	163285	59859	45663
2001	7661	2.0E-05	6.6E-05	7.7E-06	2.1E-05	66769	77093	168851	61472	50044
2002	6397	1.8E-05	8.3E-05	9.3E-06	2.2E-05	49771	81084	169902	52767	37675
2003	6366	2.6E-05	7.3E-05	9.3E-06	2.4E-05	73525	71136	168495	56257	39529
2004	5430	3.3E-05	6.3E-05	9.4E-06	2.5E-05	78281	52485	146129	50267	41268
2005	4600	3.0E-05	5.9E-05	8.4E-06	2.3E-05	60619	41337	109729	39417	34118
2006	3675	3.2E-05	6.5E-05	1.1E-05	2.6E-05	51387	36505	117368	35942	28299

Table 28. Management benchmarks and references calculated from the joint distribution of yellowfin VPA Runs 5 and 10.

[redacted]

Table 29. Non-bootstrap results of initial ASPIC runs.

Run	MSY (mt)	K (mt)	B_{MSY} (mt)	F_{MSY}	B_{2006}/B_{MSY}	F_{2006}/F_{MSY}	Equilibrium yield (mt)
1	170,200	2,151,000	215,100	0.792	3.581	0.175	135,700
2	146,600	852,700	426,400	0.344	0.834	0.845	145,600
3	1,173,000	39,120,000	13,270,000	0.088	3.034	0.031	-73,060
4	146,600	853,000	426,400	0.344	0.834	0.845	145,600
5	111,900	4,027,000	2,014,000	0.056	0.957	1.013	111,700
6	119,800	3,320,000	1,667,000	0.072	0.944	0.955	119,500
7	137,100	1,521,000	459,300	0.299	0.940	0.815	137,100
8	150,400	631,500	315,800	0.476	0.707	0.948	145,100
9	69,460	4,377,000	547,100	0.127	0.811	2.022	68,940
10	8,723	6,179,000	3,089,000	0.003	0.216	62.800	2,882

Table 30. ASPIC bootstraps results of cases 2, 4, 6, and 8.

		run02	*run04*	*run06*	*run08*
MSY (MT)	point estimate	1.47E+05	1.47E+05	1.20E+05	1.50E+05
	80% lower	1.20E+05	9.62E+04	9.88E+04	1.44E+05
	80% upper	1.54E+05	1.53E+05	1.42E+05	1.54E+05
K (MT)	point estimate	8.53E+05	8.53E+05	3.32E+06	6.32E+05
	80% lower	4.60E+05	5.17E+05	1.20E+06	4.65E+05
	80% upper	2.63E+06	3.99E+06	4.63E+06	9.82E+05
B_{MSY} (MT)	point estimate	4.26E+05	4.26E+05	1.67E+06	3.16E+05
	80% lower	2.30E+05	2.58E+05	5.99E+05	2.32E+05
	80% upper	1.31E+06	2.00E+06	2.31E+06	4.91E+05
F_{MSY}	point estimate	0.344	0.344	0.072	0.476
	80% lower	0.089	0.049	0.040	0.292
	80% upper	0.671	0.590	2.205	0.664
$B_{current}/B_{MSY}$	point estimate	0.834	0.834	0.944	0.707
	80% lower	0.745	0.733	0.871	0.669
	80% upper	0.965	0.963	1.044	0.764
$F_{current}/F_{MSY}$	point estimate	0.845	0.845	0.955	0.948
	80% lower	0.615	0.631	0.749	0.828
	80% upper	1.149	1.206	1.308	1.105
Equilibrium yield (MT)	point estimate	1.46E+05	1.46E+05	1.20E+05	1.45E+05
	80% lower	1.31E+05	1.25E+05	9.64E+04	1.33E+05
	80% upper	1.54E+05	1.53E+05	1.42E+05	1.53E+05

Table 31. BSP model runs, convergence criteria and model results for western skipjack.

			limits of uniform prior on ln(K) in 1000 MT		parameter settings for importance function width		status results (marginal posterior distributions of each parameter)						convergence criteria good convergence is achieved if CV(wts)/CV(lp) <2	
RUN	Indices	prior on r	Kmin	Kmax	degf	expand _imp	K	r	MSY	F(2006)/Fmsy	B(2006)/Bmsy	Bmsy	cv(wts)/cv(lp)	comments
RUN1	3 equal	~N(1.17,.5)	ln(500)	ln(2500)	1E-05	2	159,322 (55,374)	1.372 (0.372)	52,064 (14,488)	0.381 (0.461)	1.625 (0.208)	79,661 (27,687)	18.74	CV(wts)/CV(lp)>2
RUN2	combined eq wt	~N(1.17,.5)	ln(500)	ln(2500)	1E-05	2	164,549 (48,812)	1.392 (0.361)	54,159 (10,465)	0.304 (0.08)	1.69 (0.08)	82,274 (24,406)	60.46	CV(wts)/CV(lp)>2
RUN3	combined sep wt	~N(1.17,.5)	ln(500)	ln(2500)	1E-05	2	187,037 (48,041)	1.328 (0.329)	59,334 (10,548)	0.271 (0.07)	1.724 (0.071)	93,519 (24,020)	58.51	CV(wts)/CV(lp)>2
RUN4	3 equal	~U(0.01, 3)	ln(500)	ln(2500)	1E-05	2	159,322 (55,374)	1.372 (0.372)	52,064 (14,488)	0.381 (0.461)	1.625 (0.208)	79,661 (27,687)	18.74	CV(wts)/CV(lp)>2
RUN5	3 equal	~N(1.17,.5)	ln(500)	ln(2500)	1E-05	4	147,037 (53,860)	1.342 (0.341)	47,596 (15,286)	0.449 (0.615)	1.565 (0.232)	73,519 (26,930)	12.95	CV(wts)/CV(lp)>2
RUN6	3 equal	~N(1.17,.5)	ln(500)	ln(2500)	1E-05	10	132,316 (34,320)	1.19 (0.344)	38,471 (11,216)	0.596 (0.663)	1.427 (0.271)	66,158 (17,160)	3.79	CV(wts)/CV(lp)>2
RUN7	3 equal	~N(1.17,.5)	ln(500)	ln(2500)	1E-08	15	124,907 (14,181)	1.097 (0.154)	33,972 (4607)	0.664 (0.798)	1.369 (0.249)	62,453 (7,090)	1.66	marginal
RUN8	3 equal	~N(1.17,.5)	ln(500)	ln(2500)	1E-09	20	127,373 (14,677)	1.107 (0.172)	34,912 (5037)	0.624 (0.662)	1.395 (0.244)	63,686 (7,338)	1.56	marginal
RUN9	3 equal	~N(1.17,.25)	ln(500)	ln(2500)	1E-09	20	200104 (35297)	1.159 (0.278)	57815 (17229)	0.326 (0.262)	1.672 (0.189)	100052 (17649)	1.22	acceptable

Table 32. BSP model runs, convergence criteria and model results for eastern skipjack for priors on *r* with narrower standard deviations (0.3 or 0.25). Note that the only the sd= 0.25 was as originally specified from the demographic analysis.

RUN	Indices		limits of uniform prior on K or ln(K) in 1000 MT		parameter settings for importance function width		status results (marginal posterior distributions of each parameter)						convergence criteria	
		prior on r	Kmin	Kmax	degf	expand _imp	K	r	MSY	F(2006)/ Fmsy	B(2006)/ Bmsy	Bmsy	cv(wt)/cv(I*p)	comments
RUN1	8 equal	~normal (1.17,sd=.3)	200	2000	0.00001	2	1,393,053 (392,931)	1.351 (0.296)	465,834 (162,805)	0.159 (0.074)	1.834 (0.078)	696,527 (196,466)	1.1578	marginal
RUN2	8 equal	~normal (1.17,sd=.3)	ln(200)	ln(2000)	0.00001	2	1,293,317 (410,825)	1.285 (0.275)	465,834 (162,805)	0.183 (0.082)	1.808 (0.087)	646,658 (205,413)	0.9627	acceptable
RUN3	combined eq wt	~normal (1.17,sd=.3)	ln(200)	ln(2000)	0.00001	2	1,316,538 (406,767)	1.326 (0.332)	408,830 (148,173)	0.176 (0.081)	1.816 (0.086)	658,269 (203,383)	0.7832	acceptable
RUN4	combined sep wt	~normal (1.17,sd=.3)	ln(200)	ln(2000)	0.00001	2	1,278,930 (425,336)	1.305 (0.335)	428,418 (162,252)	0.19 (0.092)	1.801 (0.098)	639,465 (212,668)	0.7667	acceptable
RUN5	8 equal	~normal (1.17,sd=.3)	200	1000	0.00001	2	724,475 (146,955)	1.422 (0.281)	407,960 (161,318)	0.261 (0.081)	1.727 (0.087)	395,034 (73,477)	0.9344	acceptable
RUN5B	8 equal	~normal (1.17,sd=.3)	ln(200)	ln(1000)	0.00001	2	762,831 (154,416)	1.416 (0.263)	278,228 (69,645)	0.273 (0.083)	1.713 (0.089)	381,416 (77,208)	0.8815	acceptable
RUN6	8 separate weighting	~normal (1.17,sd=.3)	ln(200)	ln(1000)	0.00001	2	849,344 (115,140)	1.497 (0.316)	267,019 (66,345)	0.221 (0.064)	1.769 (0.069)	424,672 (57,570)	1.4983	marginal
RUN7	1 EU-PS, variable q	~normal (1.17,sd=.3)	ln(200)	ln(1000)	0.00001	2	543,400 (106,018)	1.237 (0.273)	316,192 (74,752)	0.523 (0.151)	1.443 (0.161)	271,700 (53,009)	1.3096	marginal
RUN8	1 EU-PS, 3% per year	~normal (1.17,sd=.3)	ln(200)	ln(1000)	0.00001	2	731,404 (175,105)	1.286 (0.312)	163,313 (31,388)	0.344 (0.13)	1.637 (0.14)	365,702 (87,553)	0.7225	acceptable
RUN8Z	1 EU-PS, 3% per year	~normal (1.17,sd=.25)	ln(200)	ln(1000)	0.00001	2	735,623 (169,249)	1.25 (0.269)	229,727 (66,596)	0.347 (0.125)	1.633 (0.135)	367,812 (84,624)	0.99	acceptable
RUN5BZ	8 equal	~normal (1.17,sd=.25)	ln(200)	ln(1000)	0.00001	2	768,318 (150,650)	1.371 (0.243)	225,796 (61,501)	0.279 (0.082)	1.707 (0.088)	384,159 (75,325)	0.8185	comments

Table 33. BSP model runs, convergence criteria and model results for eastern skipjack with wide standard deviations (0.5) on r prior.

			limits of uniform prior on K or ln(K) in 1000 MT		parameter settings for importance function width		status results (marginal posterior distributions of each parameter)						convergence criteria	
RUN	Indices	prior on r	Kmin	Kmax	degf	expand _imp	K	r	MSY	F(2006)/ Fmsy	B(2006)/ Bmsy	Bmsy	cv(wt)/cv(l*p)	comments
RUN1	8 equal	~normal (1.17,sd=.5)	200	2000	0.00001	2	1,382,655 (408,971)	1.487 (0.444)	504,319 (207,639)	0.153 (0.078)	1.84 (0.083)	691,327 (204,486)	1.1058	marginal
RUN2	8 equal	~normal (1.17,sd=.5)	ln(200)	ln(2000)	0.00001	2	1,248,077 (449,897)	1.538 (0.483)	461,961 (206,136)	0.172 (0.089)	1.821 (0.094)	624,038 (224,949)	0.9333	acceptable
RUN3	combined eq wt	~normal (1.17,sd=.5)	ln(200)	ln(2000)	0.00001	2	1,266,776 (435,154)	1.581 (0.502)	485,205 (216,089)	0.163 (0.085)	1.83 (0.09)	633,388 (217,577)	0.8496	acceptable
RUN4	combined sep wt	~normal (1.17,sd=.5)	ln(200)	ln(2000)	0.00001	2	1,243,952 (451,127)	1.518 (0.499)	453,691 (207,983)	0.178 (0.096)	1.814 (0.102)	621,976 (225,563)	0.932	acceptable
RUN5	8 equal	~normal (1.17,sd=.5)	200	1000	0.00001	2	790,069 (146,955)	1.422 (0.281)	278,228 (69,645)	0.261 (0.081)	1.727 (0.087)	395,034 (73,477)	0.852	acceptable
RUN5B	8 equal	~normal (1.17,sd=.5)	ln(200)	ln(2000)	0.00001	2	724,475 (174,418)	1.685 (0.369)	300,485 (90,125)	0.246 (0.089)	1.743 (0.095)	362,238 (87,209)	1.0382	marginal
RUN6	8 separate weighting	~normal (1.17,sd=.5)	ln(200)	ln(2000)	0.00001	2	827,685 (127,400)	1.681 (0.352)	345,673 (84,803)	0.201 (0.061)	1.79 (0.065)	413,843 (63,700)	1.2219	marginal
RUN7	1 EU-PS, variable q	~normal (1.17,sd=.5)	ln(200)	ln(2000)	0.00001	2	577,890 (157,188)	1.309 (0.434)	177,892 (52,233)	0.495 (0.197)	1.475 (0.194)	288,945 (78,594)	1.1259	marginal
RUN8	1 EU-PS, 3% per year	~normal (1.17,sd=.5)	ln(200)	ln(2000)	0.00001	2	661,461 (195,584)	1.516 (0.454)	241,380 (89,412)	0.343 (0.145)	1.639 (0.156)	330,730 (97,792)	0.7676	acceptable

Table 34. Summary table of the model runs for the catch-only model for SKJ-W. Abreviations: lnK is ln(*K*)~U(ln(100),ln(1000)), U is *K*~U(100,1000), logN is *K*~logN(mean=350000,CV=0.5), u is *r*~U(0.4,2.0), D is *r*~demographic, L is *x*~ U(0,10), s is *x*~ U(0,1.1). The catch data used ranged from 1976 to 2006.

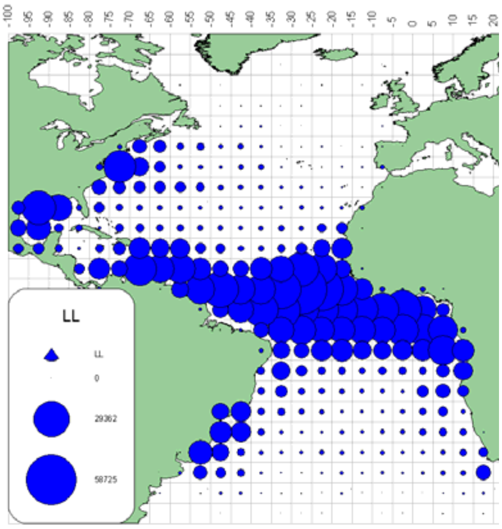
Model	*Priors* *K*	*r*	*x*	*Posteriors* *K*	*r*	*MSY*	F_{2006}/F_{MSY}	B_{2006}/B_{MSY}	B_{MSY}	$P(MSY<C_{2006})$	*Obs*
A. 1	lnK	u	L	239 193	0.97	58 234	0.31	1.71	119 596	0.01	Wide posterior on x
A. 2	logN	u	L	316 597	0.89	69 561	0.25	1.77	158 299	0.00	
A. 3	U	u	L	399 328	0.82	83 646	0.20	1.81	199 664	0.00	
A. 4	lnK	D	L	202 204	1.09	54 887	0.34	1.69	101 102	0.01	
A. 5	logN	D	L	295 618	1.05	77 250	0.22	1.79	147 809	0.00	
A. 6	U	D	L	312 610	1.04	83 012	0.21	1.80	156 305	0.00	
B. 1	lnK	u	s	129 023	0.93	30 520	0.98	1.22	64 512	0.08	
B. 2	logN	u	s	165 843	0.75	31 069	0.86	1.26	82 921	0.06	
B. 3	U	u	s	140 755	0.85	30 702	0.93	1.24	70 377	0.07	
B. 4	lnK	D	s	116 808	1.04	30 601	1.02	1.20	58 404	0.06	Posterior probability increasing towards the upper limit of the prior
B. 5	logN	D	s	127 264	0.98	30 986	0.97	1.23	63 632	0.05	
B. 6	U	D	s	120 434	1.02	30 892	0.99	1.22	60 217	0.05	

Table 35. Summary table of the model runs for the catch-only model for eastern skipjack. Abbreviations: lnK is ln(*K*)~U(ln(200),ln(2000)), U is *K*~U(200,2000), logN is *K*~logN(mean=350000,CV=0.5), u is *r*~U(0.4,2.0), D is *r*~demographic, L is *x*~ U(0,10), s is *x*~ U(0,1.1). The runs were fit to the following catch series: A- 1950 ro 2006, B – 1965 to 1984, C- 1985 to 2006.

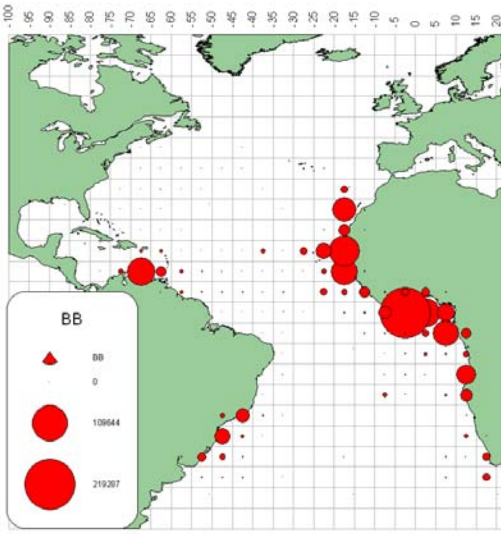
	Priors			*Results – median of the posteriors*							*Obs*
Model	*K*	*r*	*x*	*K*	*r*	*MSY*	F_{2006}/F_{MSY}	B_{2006}/B_{MSY}	B_{MSY}	$P(MSY<C_{2006})$	
A. 1	lnK	u	L	827 839	1.37	223 930	0.37	1.66	413 919	0.03	The fishery was not homogeneous over the whole time series
A. 2	logN	u	L	722 445	1.27	204 349	0.43	1.62	361 222	0.02	
A. 3	U	u	L	1 187 158	1.20	275 904	0.28	1.74	593 579	0.01	
A. 4	lnK	D	L	759 226	1.15	204 510	0.42	1.62	295 061	0.03	
A. 5	logN	D	L	698 803	1.17	198 995	0.45	1.60	349 401	0.03	
A. 6	U	D	L	1 121 772	1.15	308 717	0.24	1.77	560 886	0.02	
B. 1	lnK	u	s	229 516	1.51	88 195			114 758	1.00	The posteriors for K were concentrated on the lower bound
B. 2	logN	u	s	231 966	1.52	87 194			115 983	1.00	
B. 3	U	u	s	234 421	1.49	89 199			117 210	1.00	
B. 4	lnK	D	s	255 996	1.32	85 573			127 998	1.00	
B. 5	logN	D	s	288 006	1.21	87 830			144 003	1.00	
B. 6	U	D	s	266 596	1.28	86 827			133 298	1.00	
C. 1	lnK	u	s	618 746	1.05	143 632	0.94	1.20	309 373	0.06	
C. 2	logN	u	s	663 628	0.95	145 004	0.92	1.24	331 814	0.06	
C. 3	U	u	s	871 930	0.81	155 552	0.71	1.37	435 965	0.05	
C. 4	lnK	D	s	534 309	1.12	142 865	1.10	1.17	267 155	0.06	
C. 5	logN	D	s	569 172	1.09	146 103	1.01	1.21	284 586	0.04	
C. 6	U	D	s	629 915	1.09	156 326	0.82	1.32	314 957	0.04	

Table 36. Maximum posterior estimates of the parameters and reference points based on the different runs conducted with PROCEAN. SD = standard deviation; q = catchability.

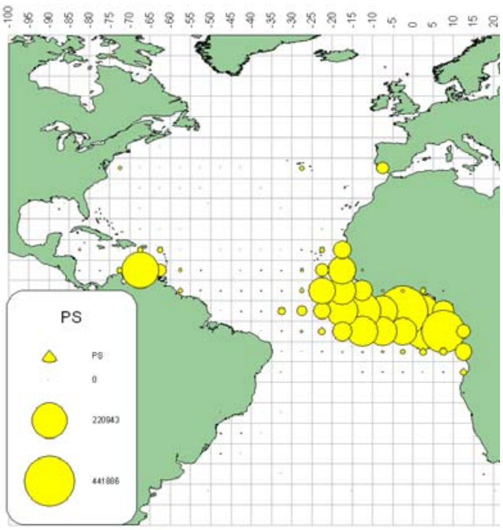
	m	*r*	*B0/K*	*K*	*MSY*	F_{MSY}
Standard run	1.2	1.169	0.9	2173530	170200	0.19
Sensitivity m	1.7	1.174	0.9	740914	167798	0.48
Sensitivity B0/K	1.2	1.114	0.7	2265240	169055	0.19
Sensitivity mean prior MSY = 130,000	1.2	1.164	0.9	2020000	157090	0.19
Sensitivity mean prior MSY = 170,000	1.2	1.172	0.9	2360080	185192	0.20
Sensitivity SD prior r = 0.7	1.2	1.161	0.9	2189580	170195	0.19
Combined abundance index	1.2	1.212	0.9	1978800	160653	0.20
Standard run with random walk on q	1.2	1.234	0.9	1860000	153986	0.21



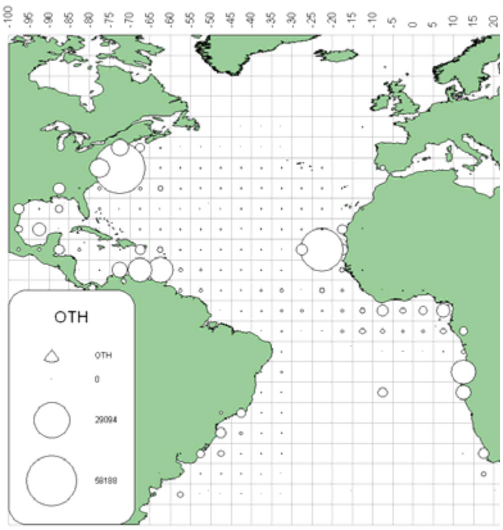
a. YFT (LL)



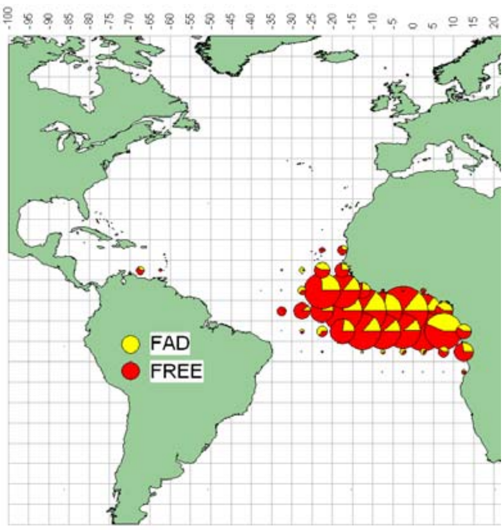
b. YFT (BB)



c. YFT (PS)



d. YFT (OTH)



e. YFT (FAD/FREE 1991-2006)

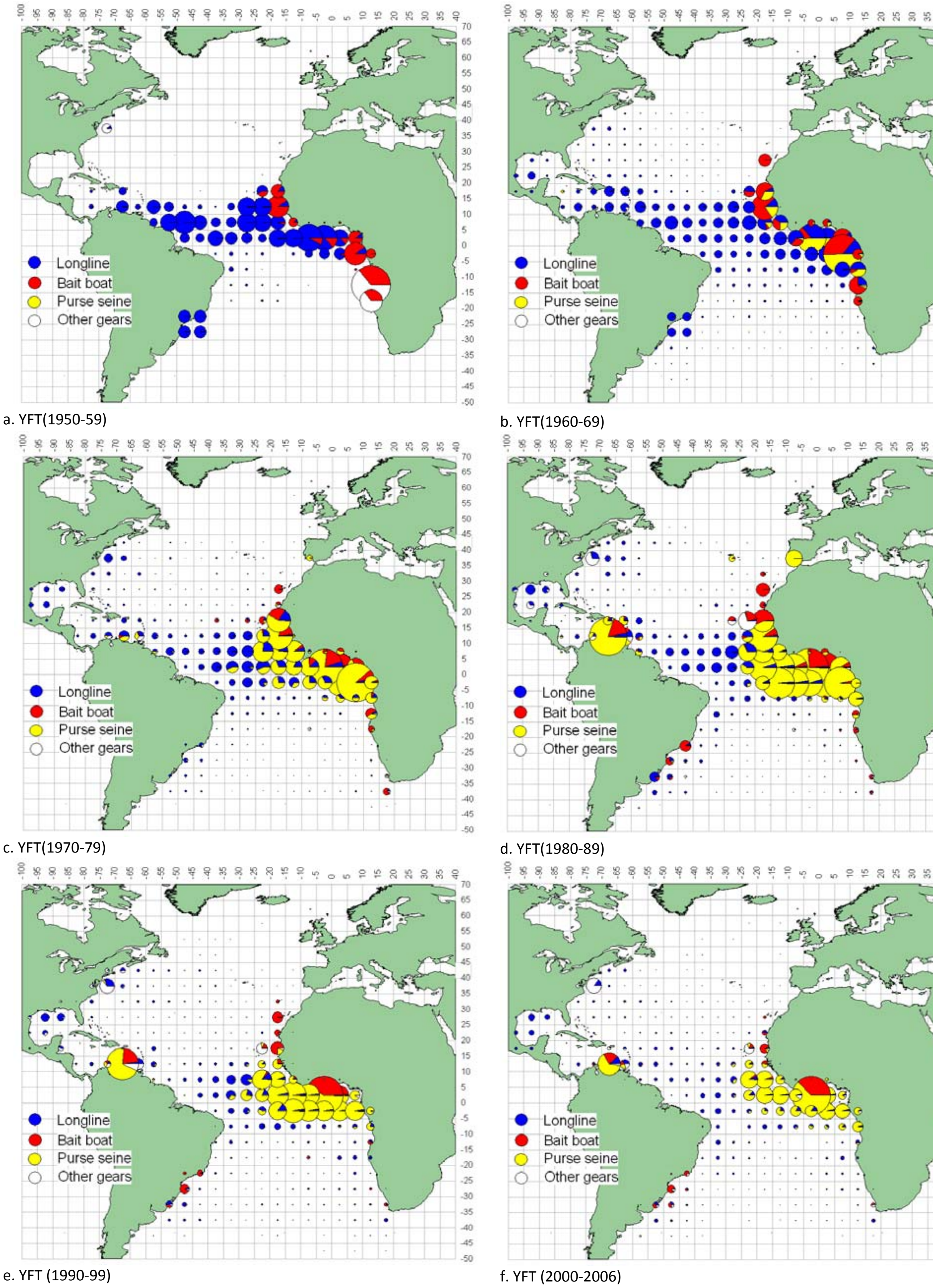
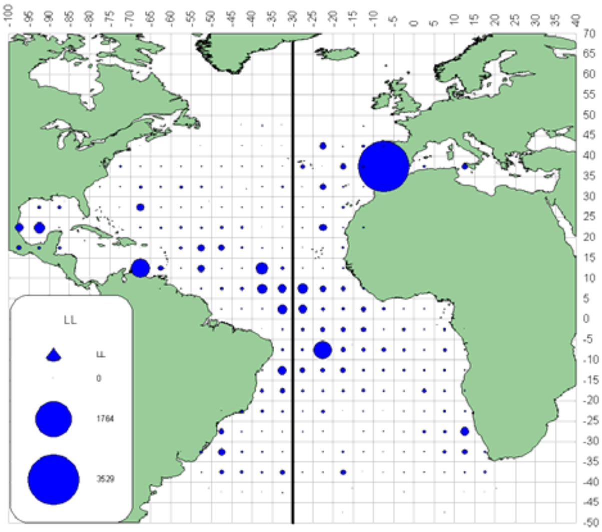
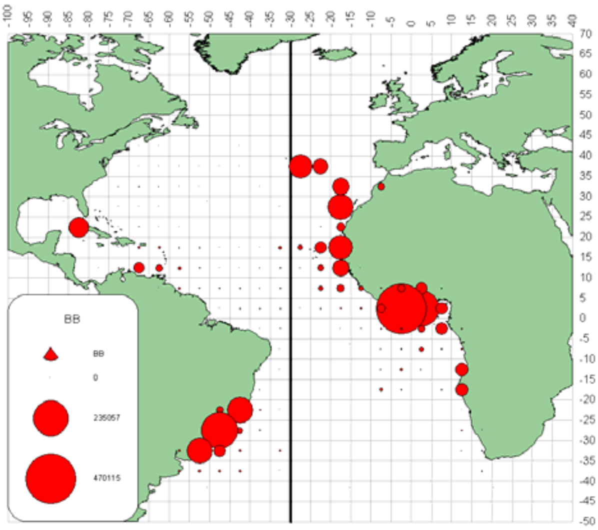


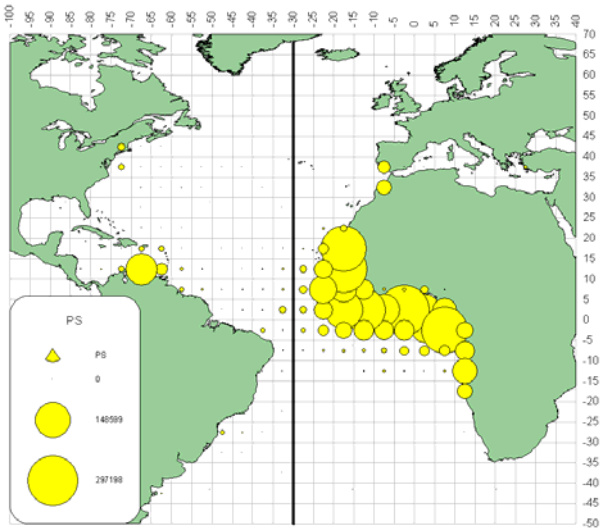
Figure 1. Geographic distribution of yellowfin catch by gear and decade.



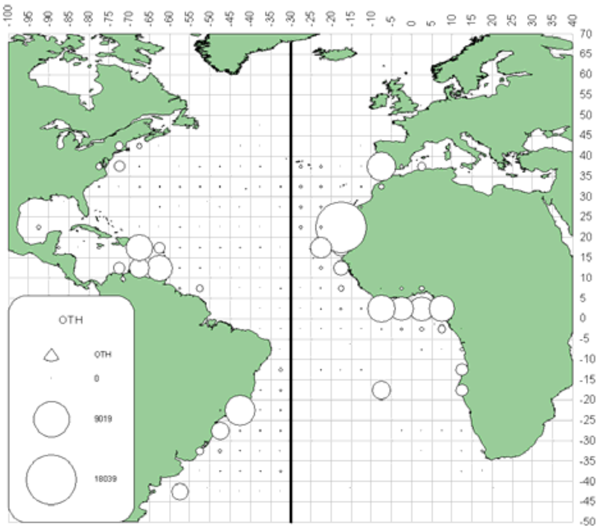
a. SKJ (LL)



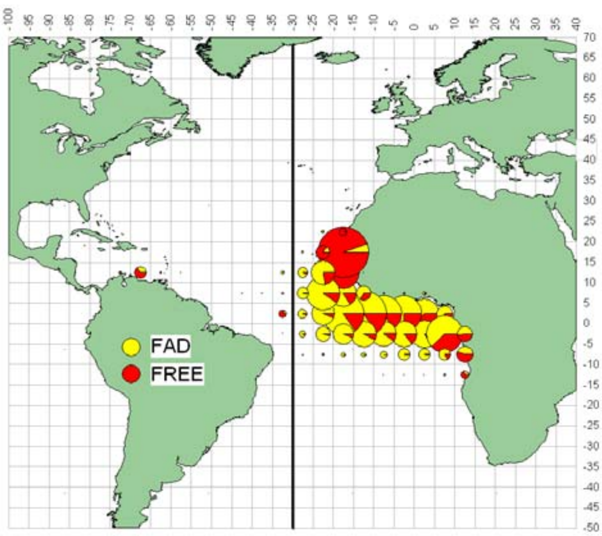
b. SKJ (BB)



c. SKJ (PS)



d. SKJ (OTH)



e. SKJ (FAD/FREE 1991-2006)

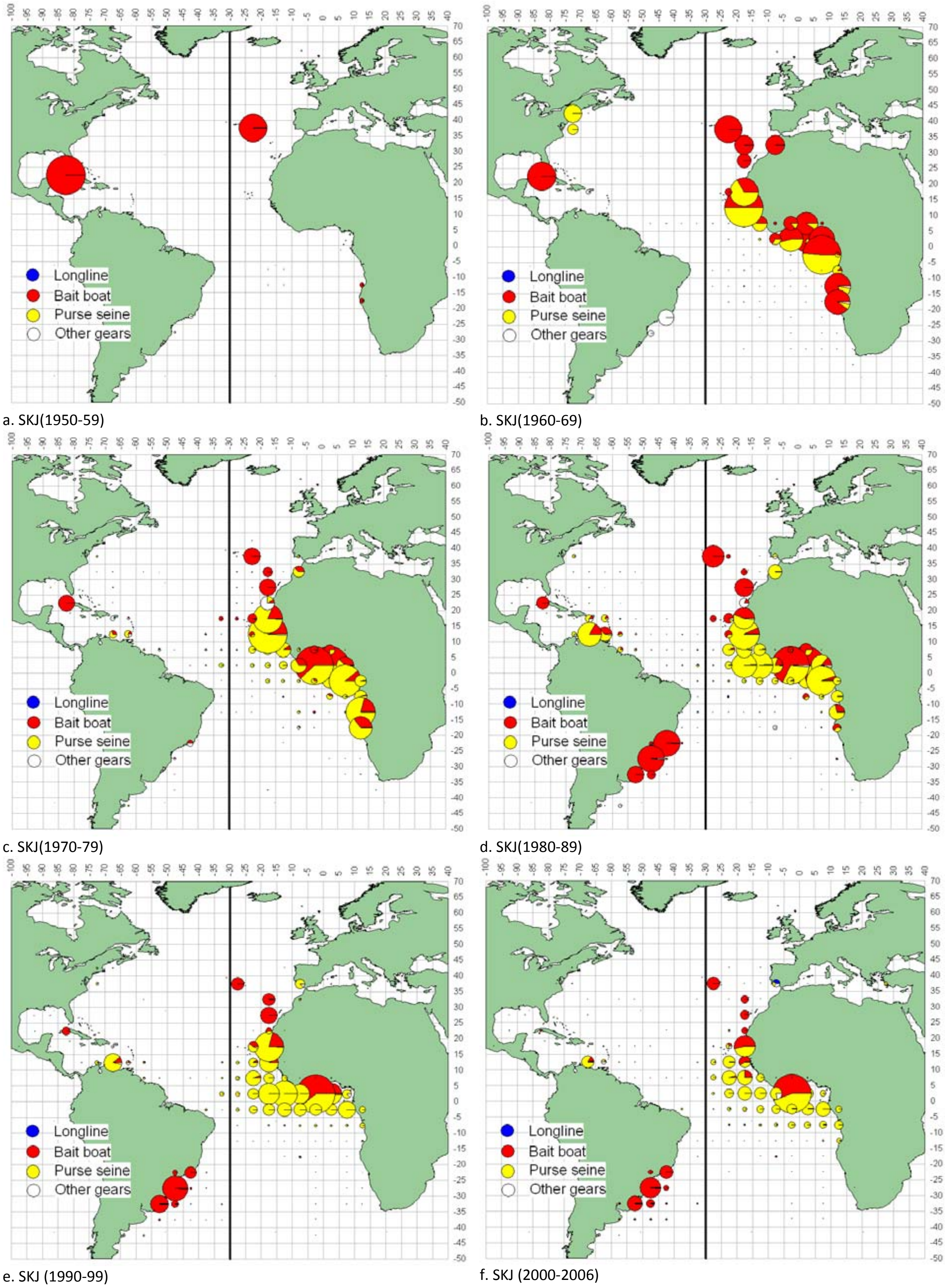


Figure 2. Geographic distribution of skipjack catch by gear and decade.

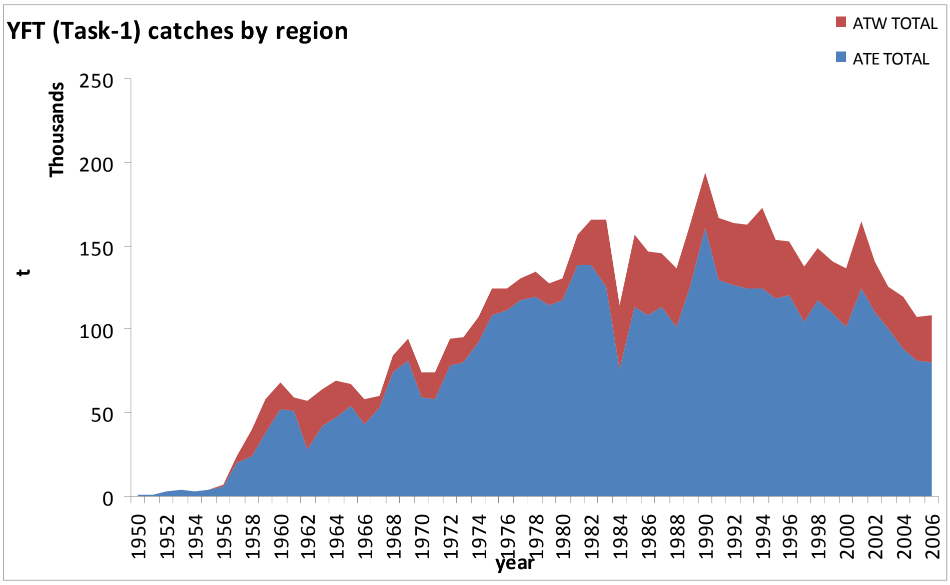


Figure 3. Atlantic yellowfin tuna catch by area.

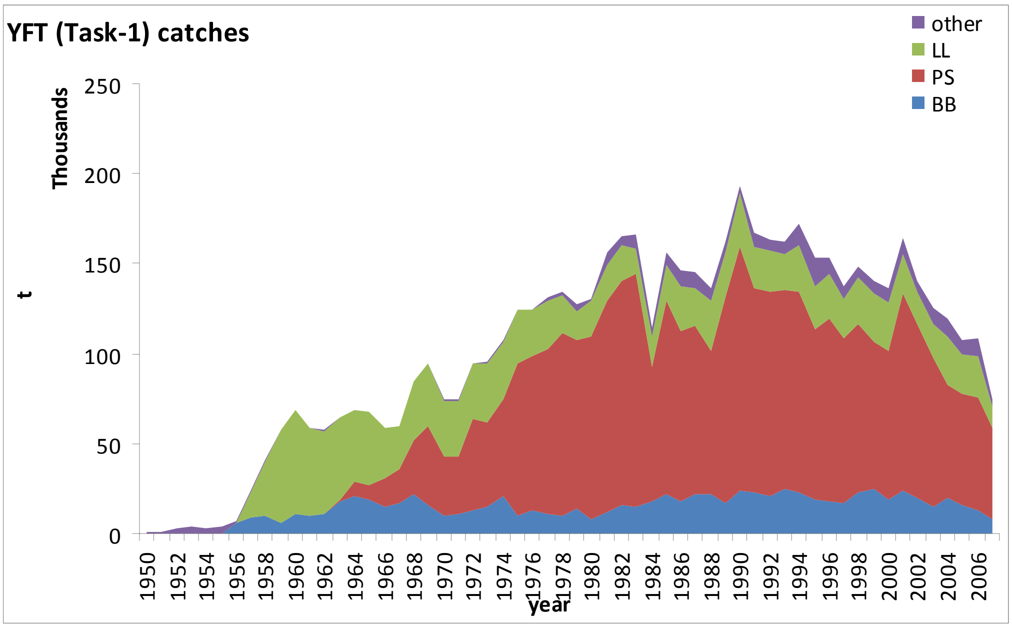


Figure 4. Atlantic yellowfin tuna catch by gear.

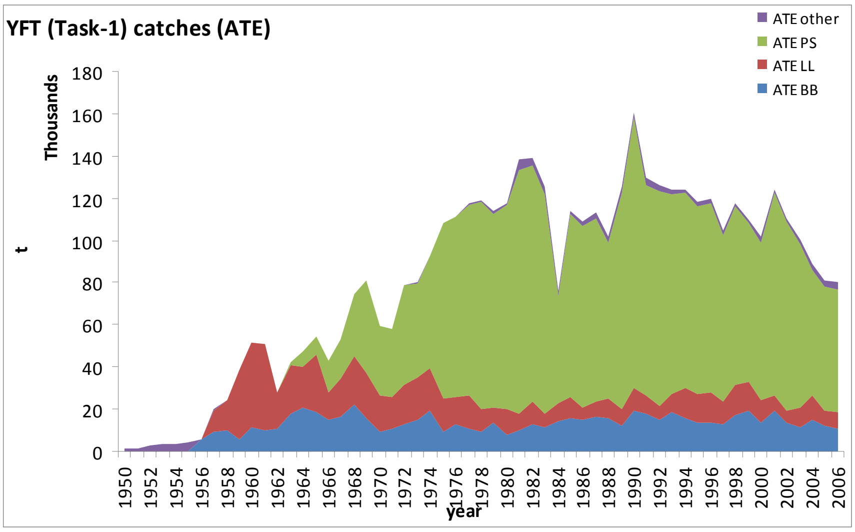


Figure 5. Yellowfin catch by gear – east.

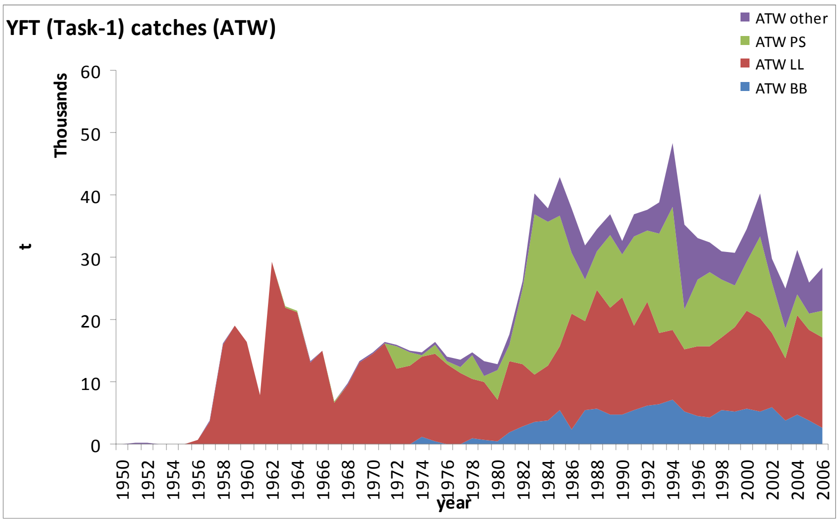


Figure 6. Yellowfin catch by gear – west.

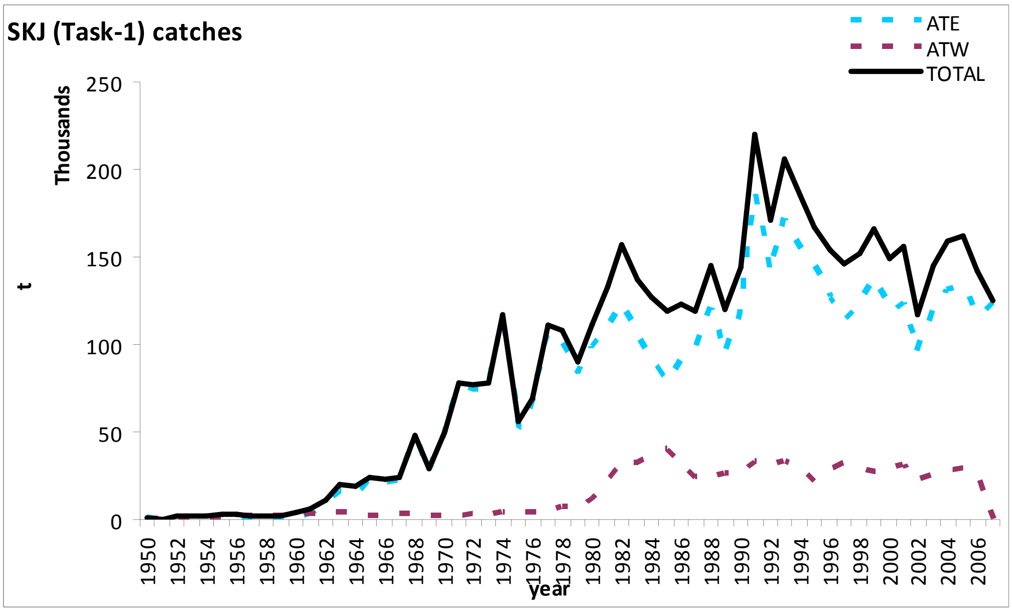


Figure 7. Atlantic skipjack catch by area.

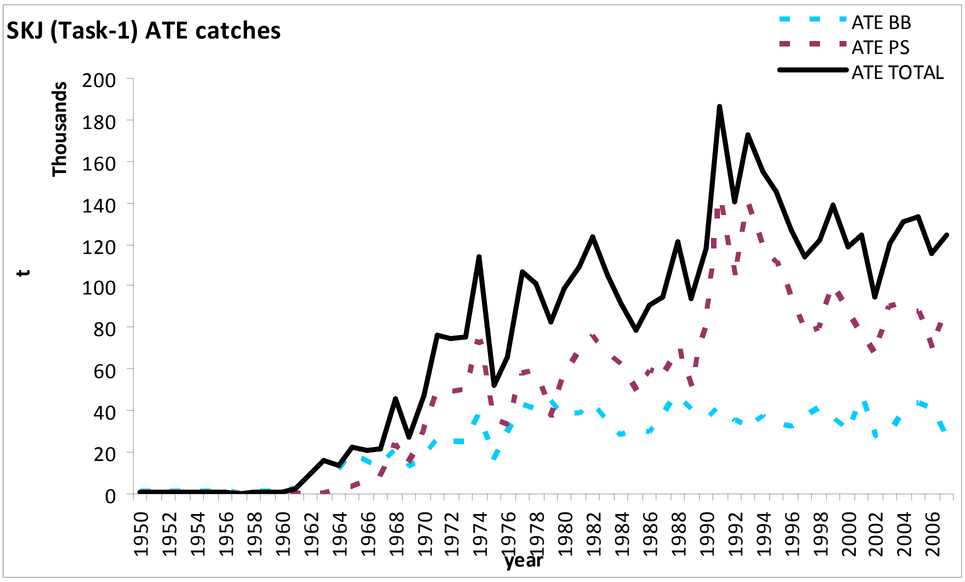


Figure 8. Skipjack catch by gear in the eastern Atlantic.

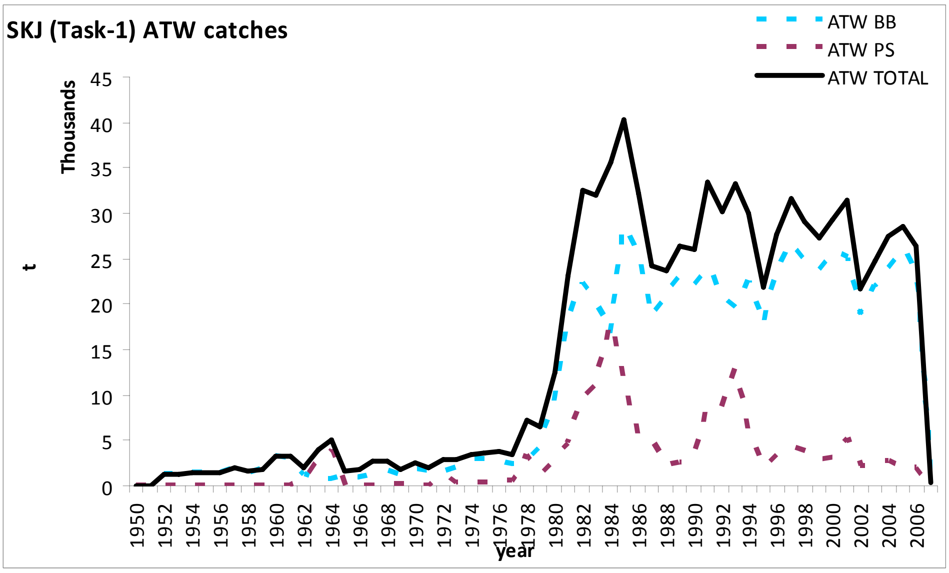


Figure 9. Skipjack catch by gear in the western Atlantic.

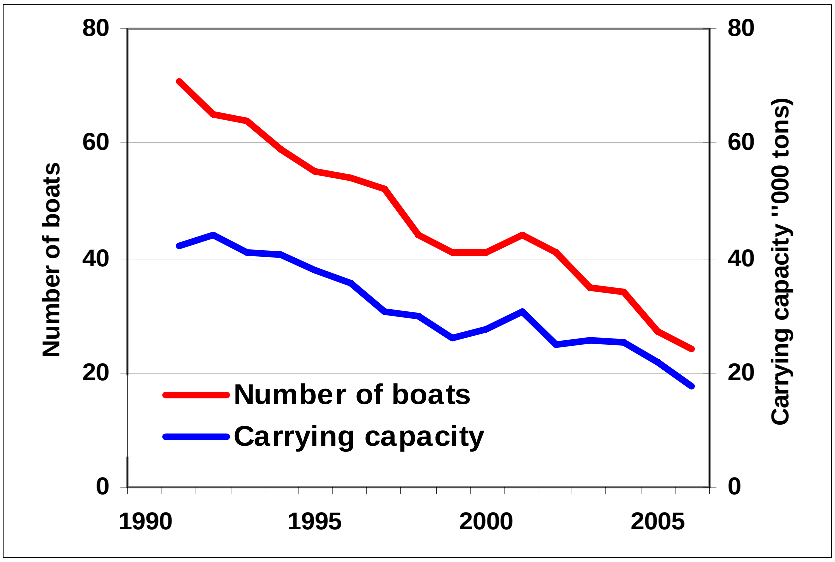


Figure 10. Change over time of the carrying capacity of the European and associated purse seine fleet.

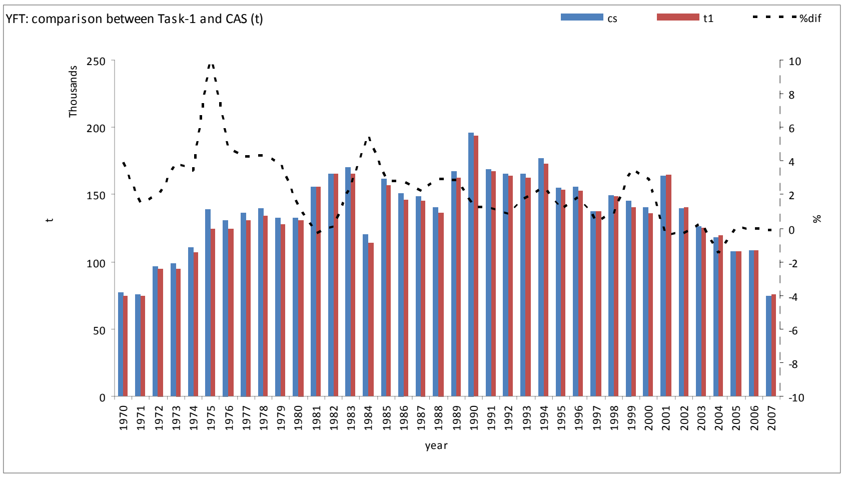


Figure 11. Comparison of Task II catch at size and Task I (t) for Atlantic yellowfin.

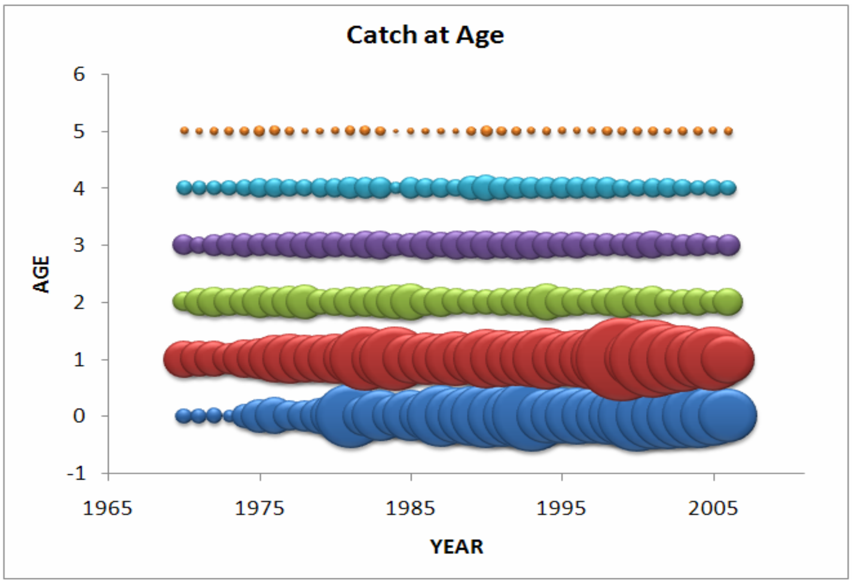


Figure 12. Relative distribution of Atlantic yellowfin catches by age (0-5+) and year (bubble size is proportional to total catches).

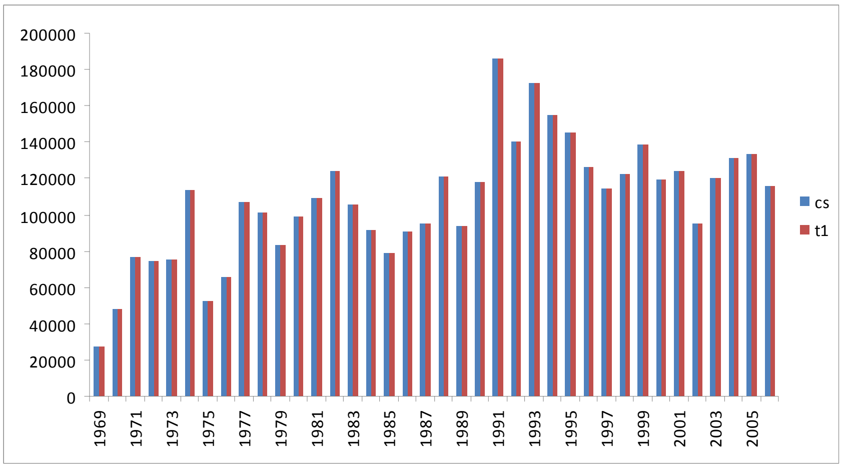
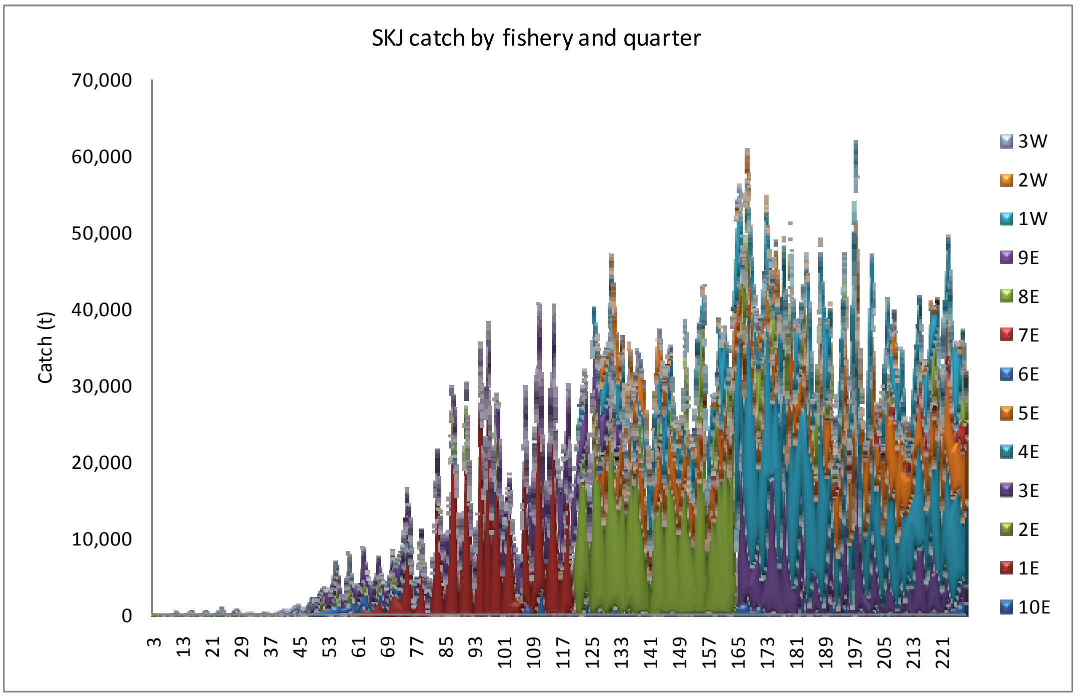


Figure 13. Comparison of Task II catch at size and Task I (t.) for skipjack.



.
Figure 14. Skipjack quarterly catch by cumulative quarter starting in 1956 through 2006, by MFCL fishery definitions (**Table 11**).

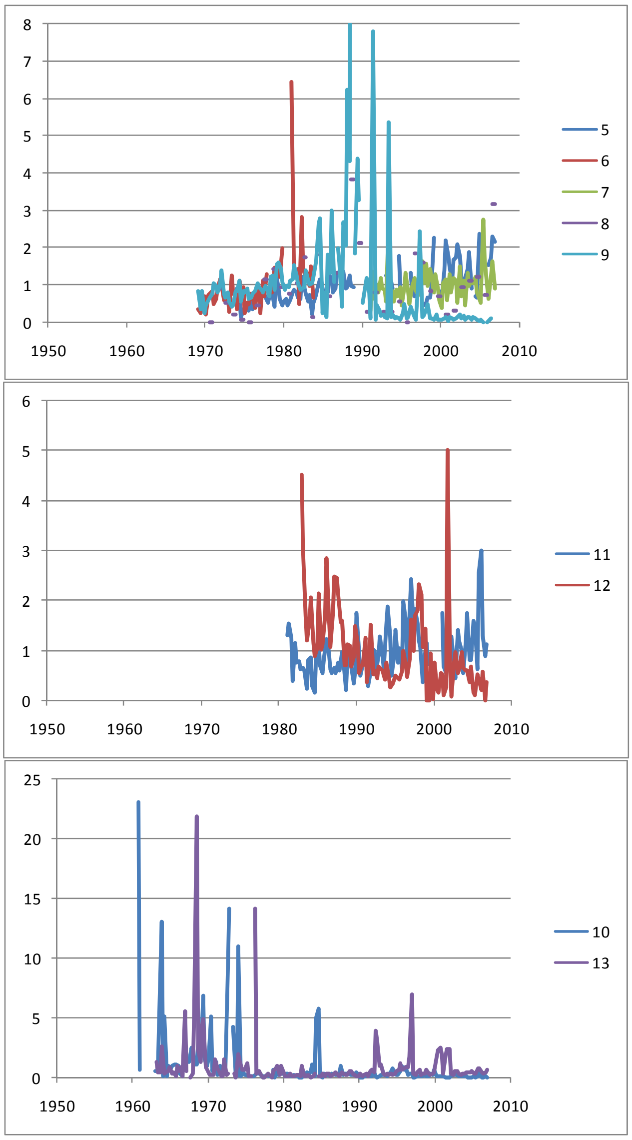


Figure 15. Quarterly catch rate patterns by fishery prepared for skipjack (**Table 11**).

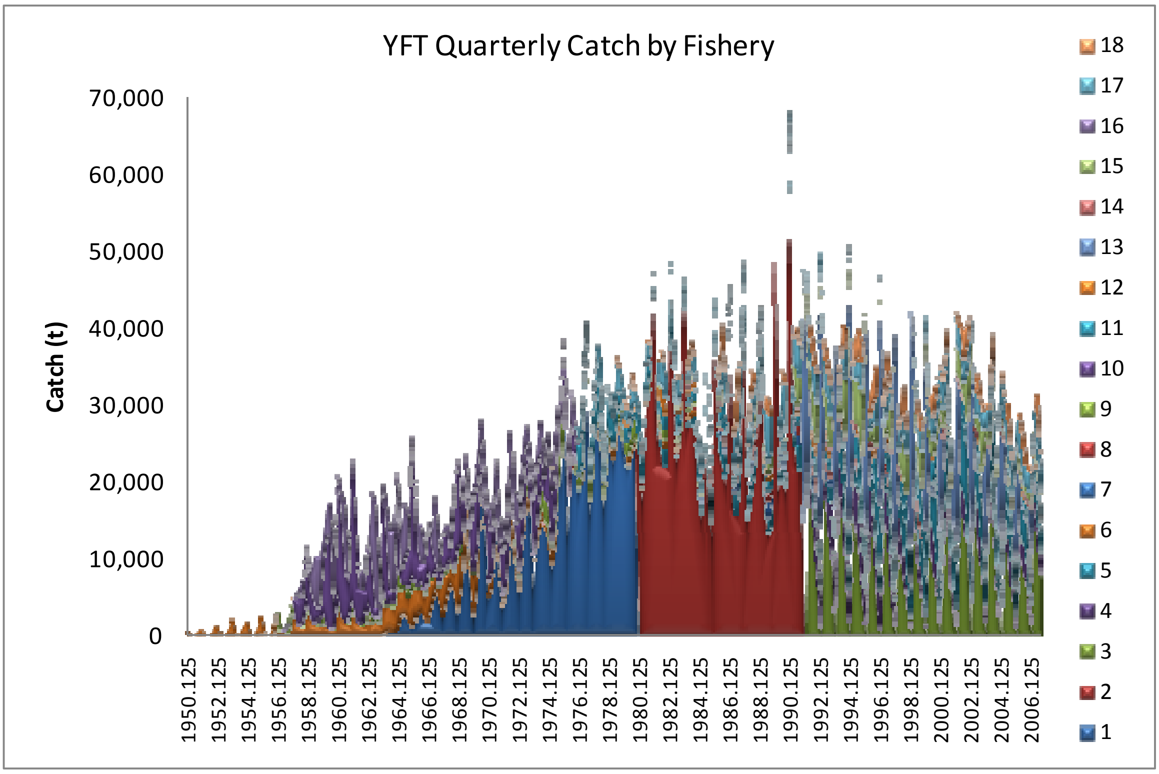


Figure 16. Yellowfin quarterly catch by cumulative quarter starting in 1956 through 2006, by MFCL fishery definitions (**Table 12**).

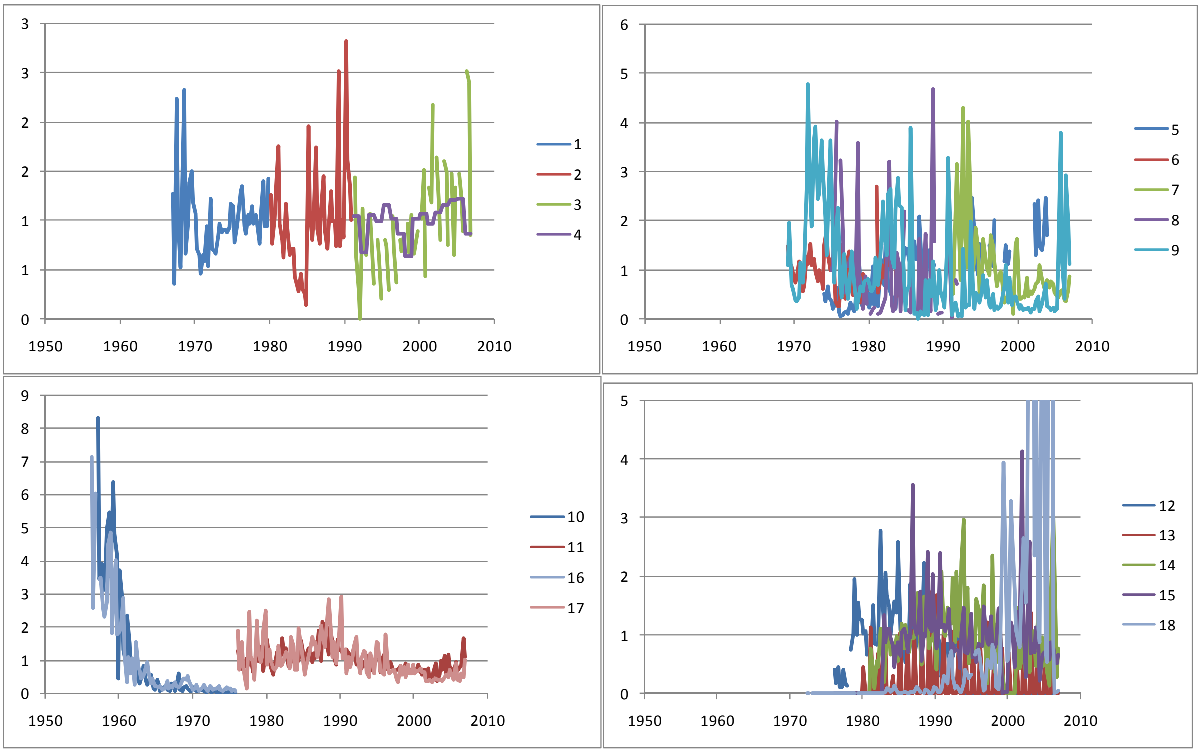


Figure 17. Quarterly catch rate patterns by fishery prepared for yellowfin (**Table 12**).

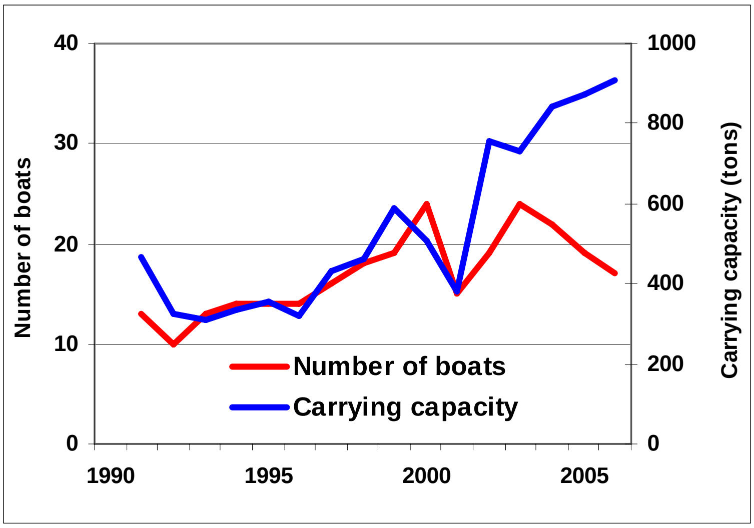


Figure 18. Change over time of the carrying capacity of the Dakar based baitboats.

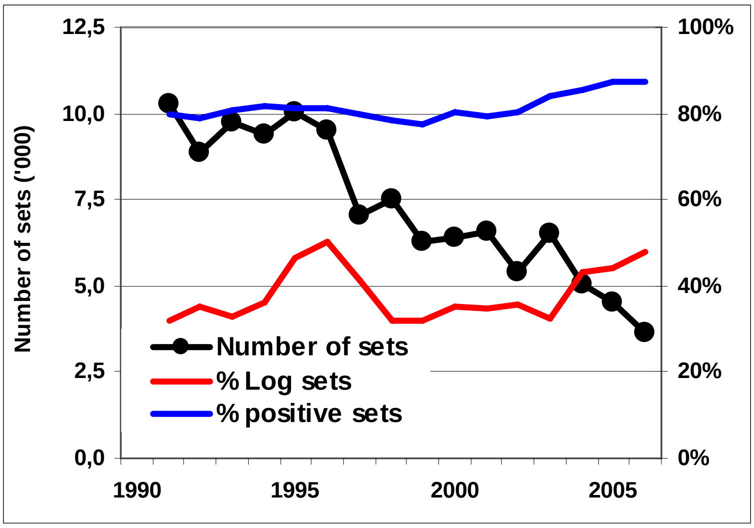


Figure 19. Proportion of FADs sets, % of successful sets and total number of sets for the EC-purse seiners in the eastern Atlantic.

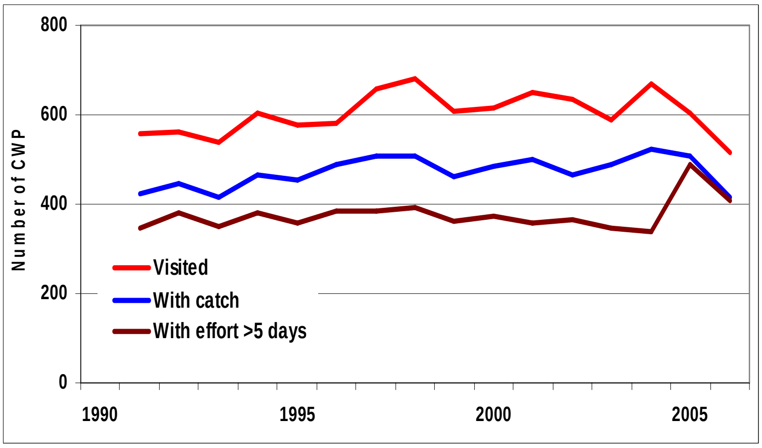


Figure 20. Change over time of the total area visited and fished by the EC purse seiners.

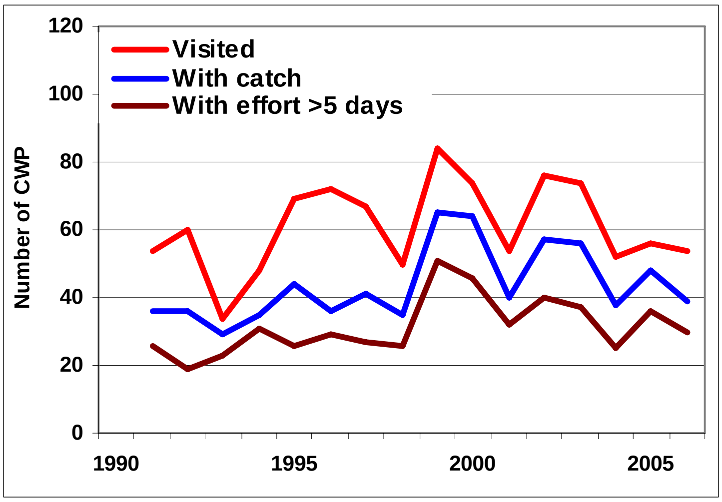


Figure 21. Change over time of the total area visited and fished by the Dakar based baitboats.

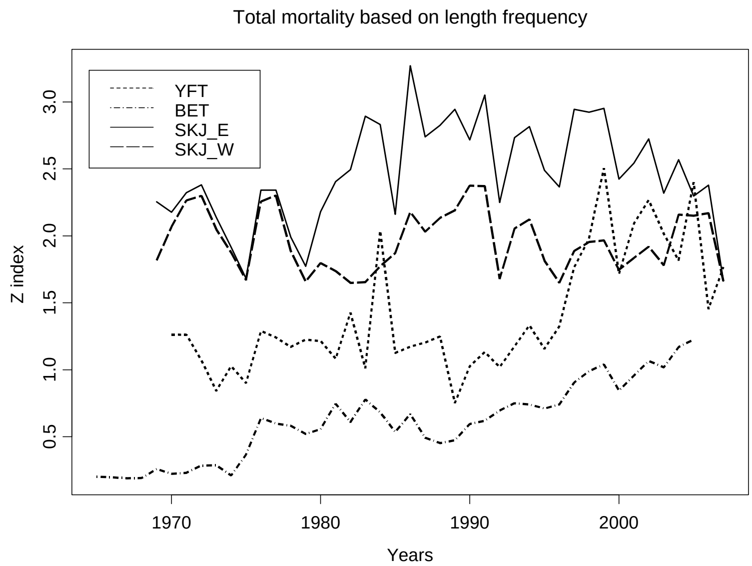


Figure 22. Changes over the years in the apparent total mortality *Z* , based on Beverton and Holt's equation, for the three tropical tuna species in the Atlantic Ocean. YFT = yellowfin, BET = bigeye, SKJ = skipjack (eastern and western stock). The size of full recruitment was fixed at 50 cm (FL).

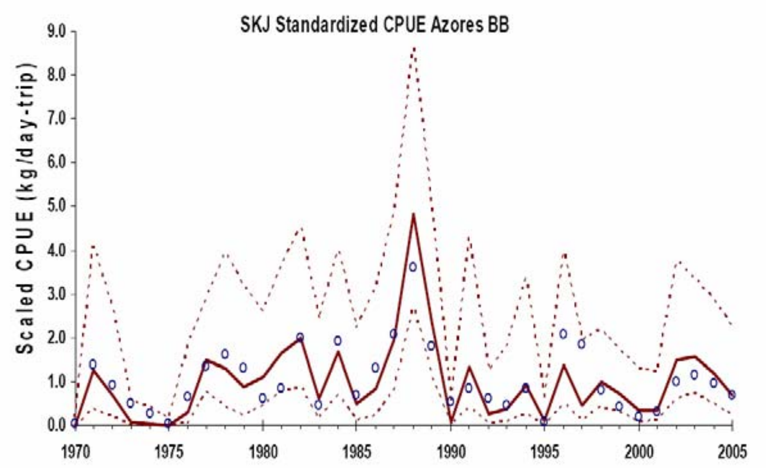


Figure 23. Standardized CPUE for skipjack for the Azorean baitboat fishery. The index was obtained by fitting a delta-lognormal GLM to daily catch records. Open symbols: observed CPUE. Lines: predicted CPUE and approximate 95% confidence intervals.

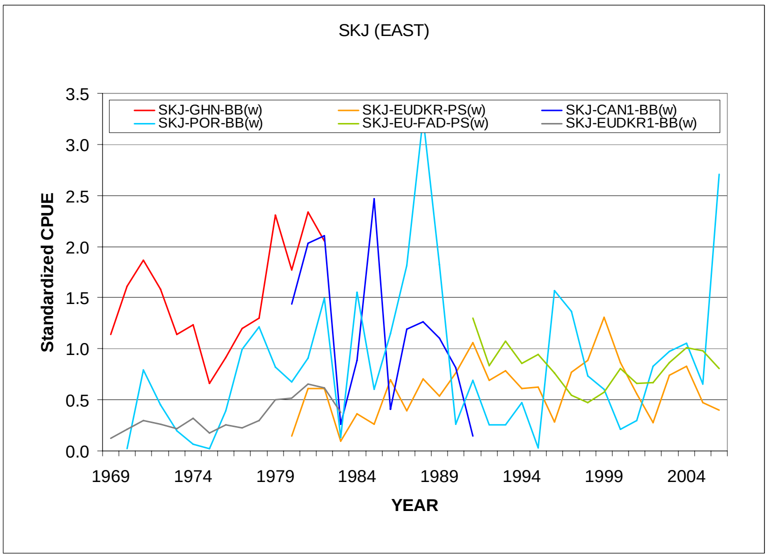


Figure 24. Standardized CPUEs for the east Atlantic stock (1969-2006).

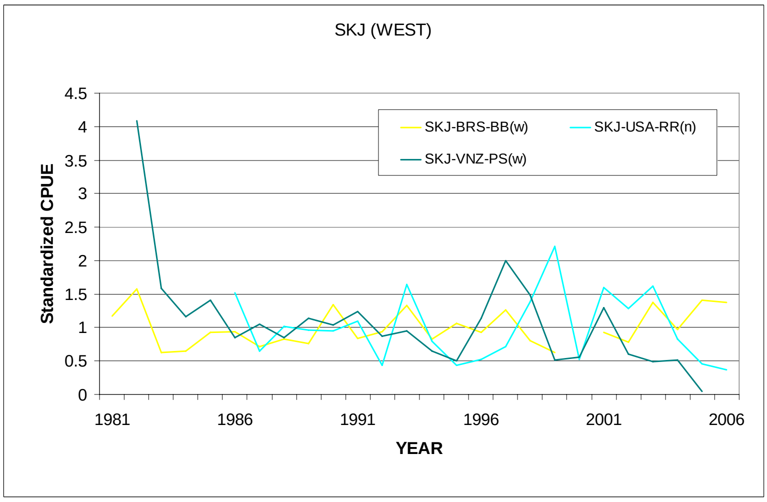


Figure 25. Standardized CPUEs for the western Atlantic stock (1981-2006). Letters w and n indicate estimations gathered in analysis of catch in weight and number, respectively.

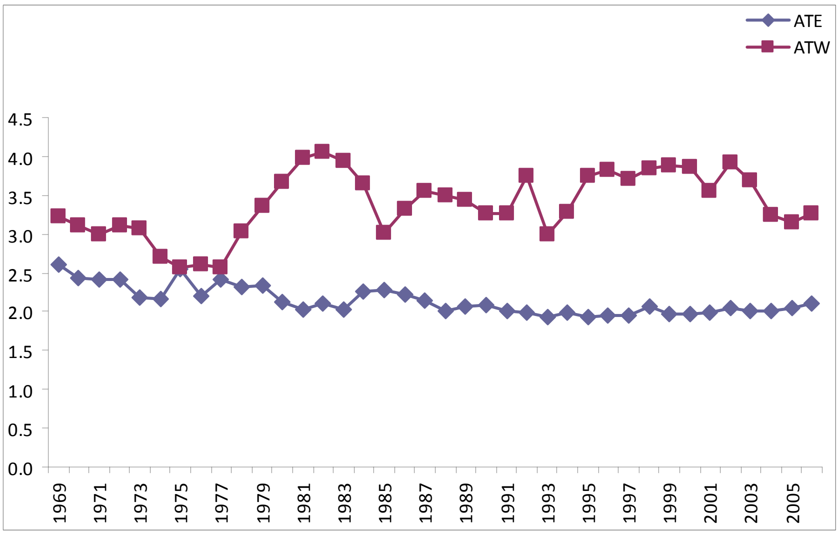


Figure 26. Average weight of skipjack landed in the East and West Atlantic Ocean.

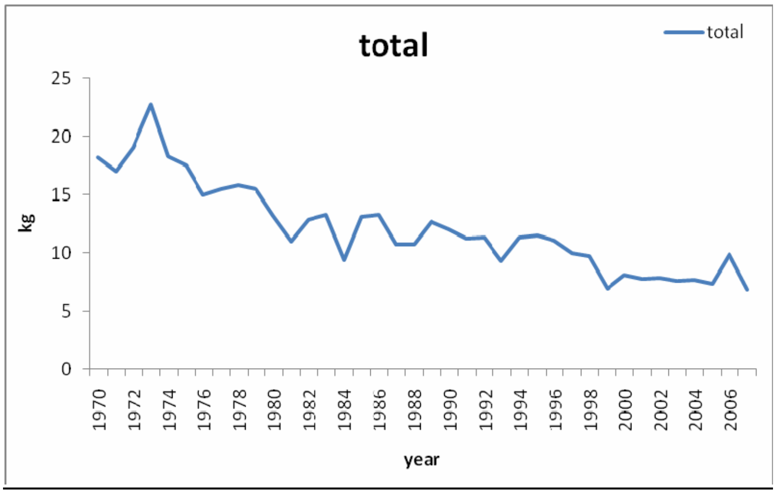


Figure 27. Average weight of yellowfin landed in the Atlantic Ocean.

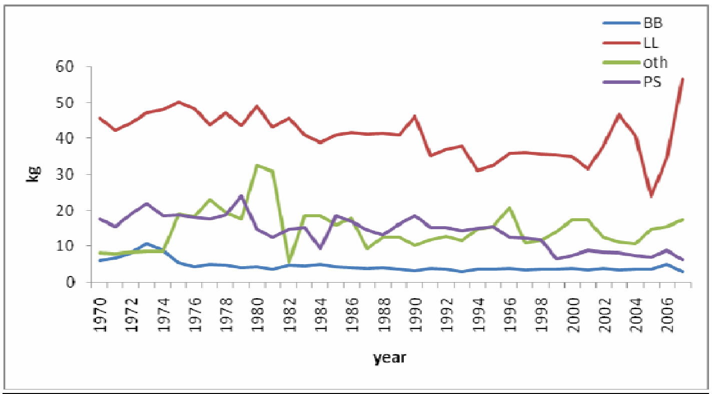


Figure 28. Average weight of yellowfin landed by fishing fleet.

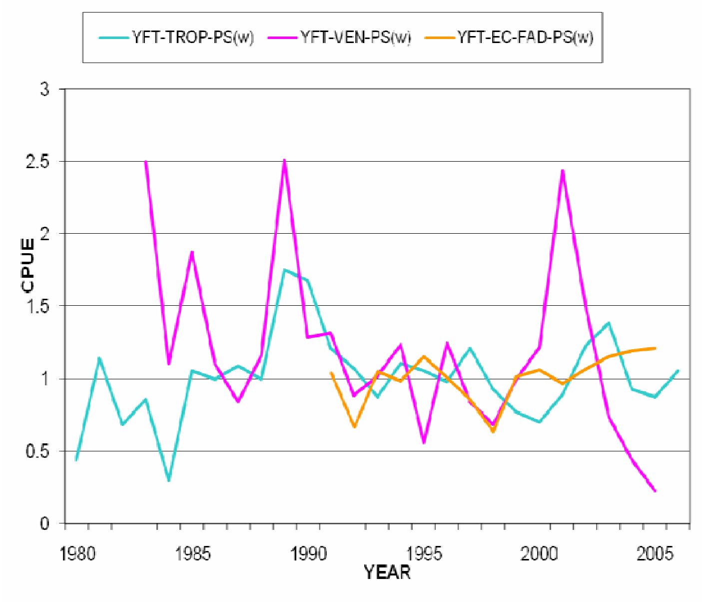


Figure 29. Standardized CPUE for yellowfin tuna caught by purse seine fleets.

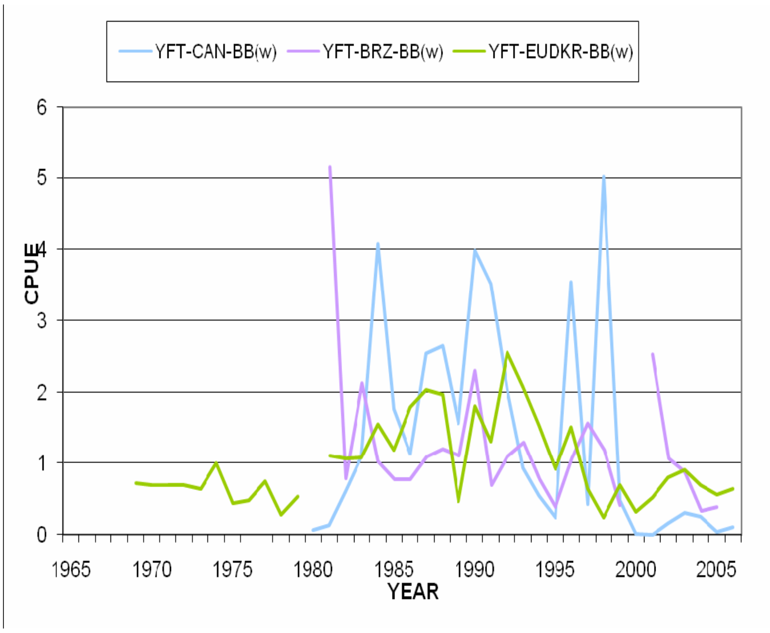


Figure 30. Nominal CPUE for yellowfin tuna caught by baitboat fleets.

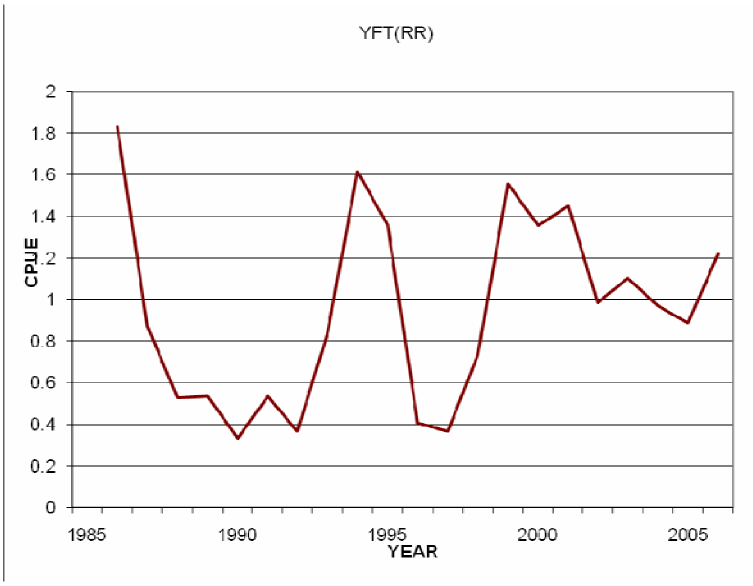


Figure 31. Standardized CPUE for yellowfin tuna caught by the U.S. rod and reel fleet.

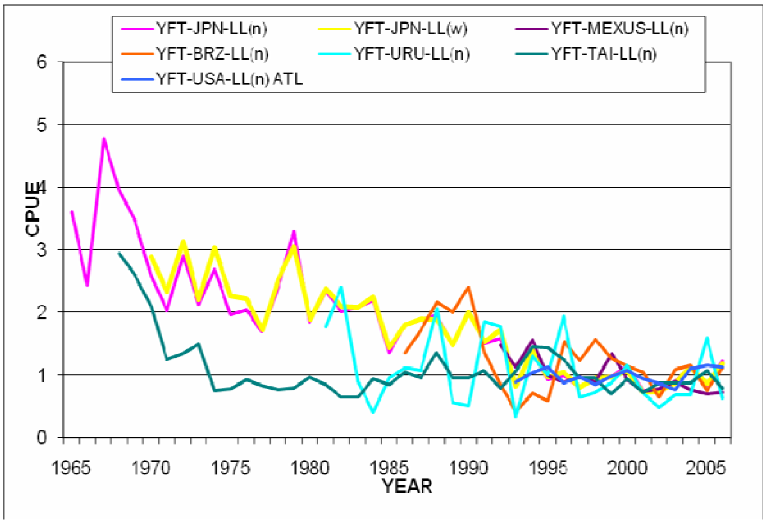


Figure 32. Standardized CPUE for yellowfin tuna caught by longline fleets.

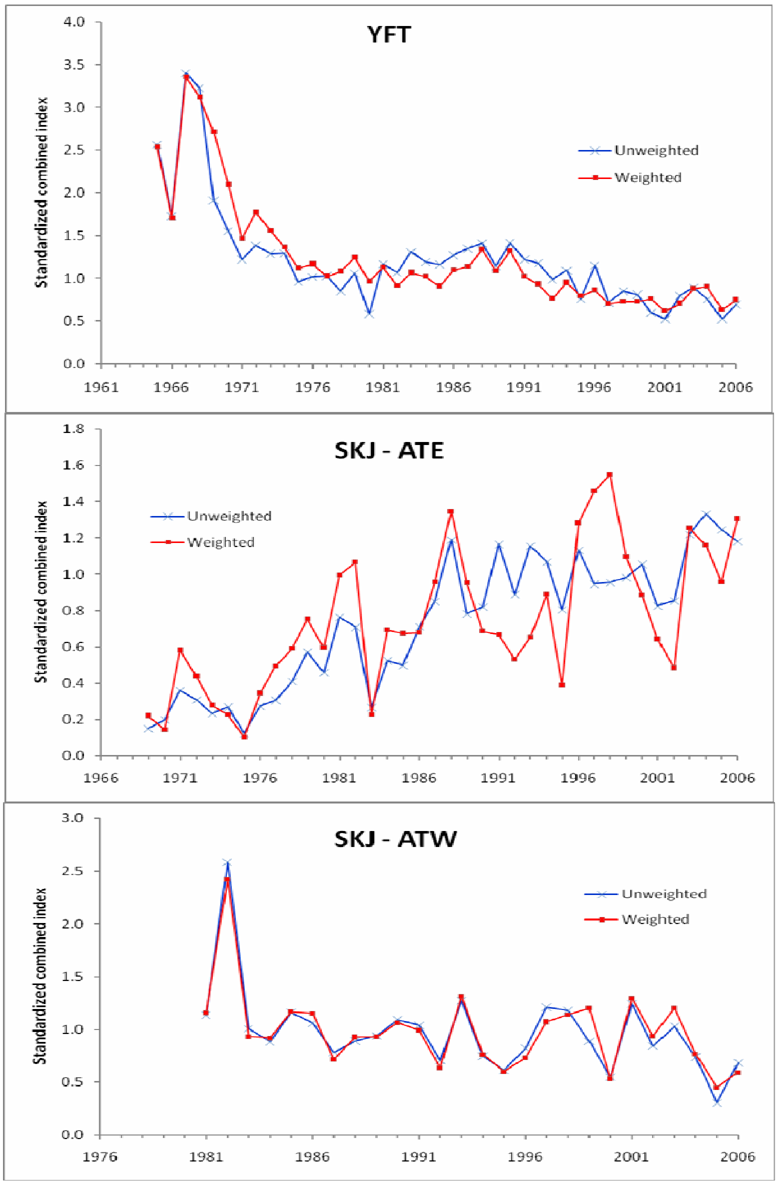


Figure 33. Estimated combined weighted and unweighted indexes of abundances for yellowfin and the two skipjack stocks.

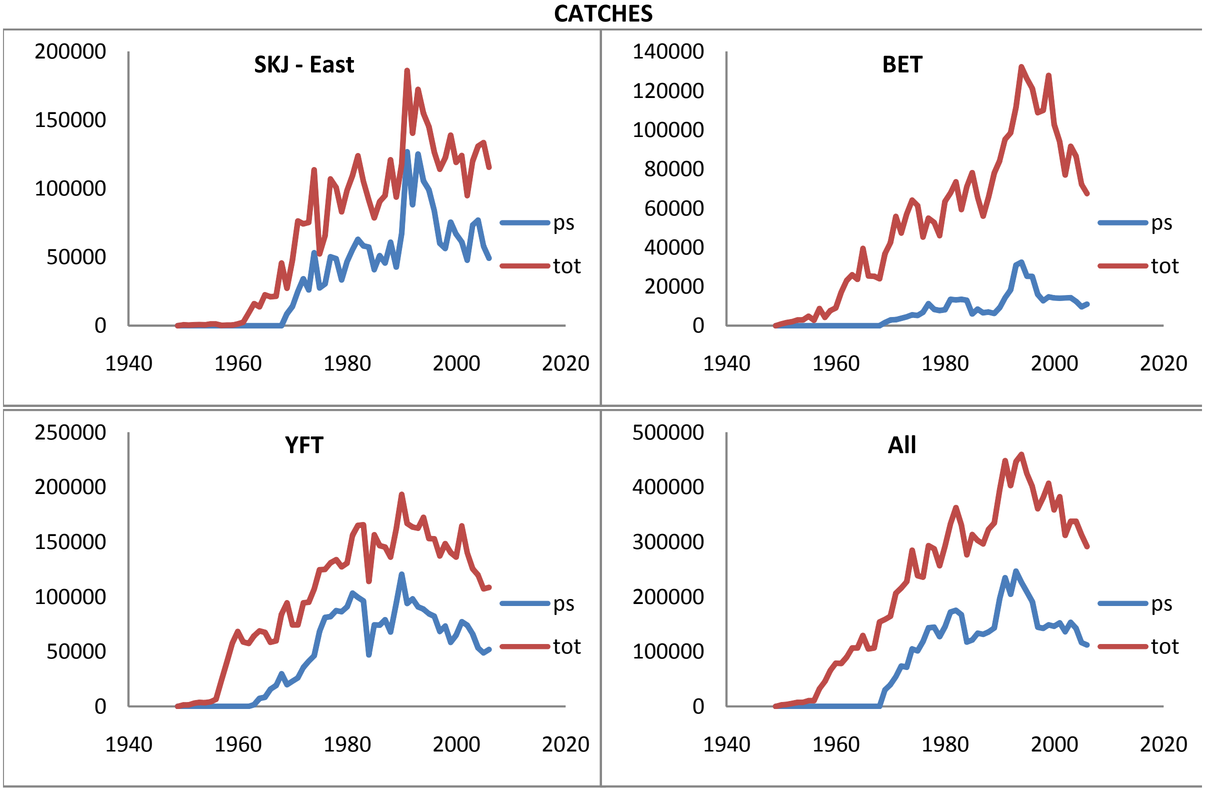


Figure 34. Input catch series used in the analyses of catchability trends.

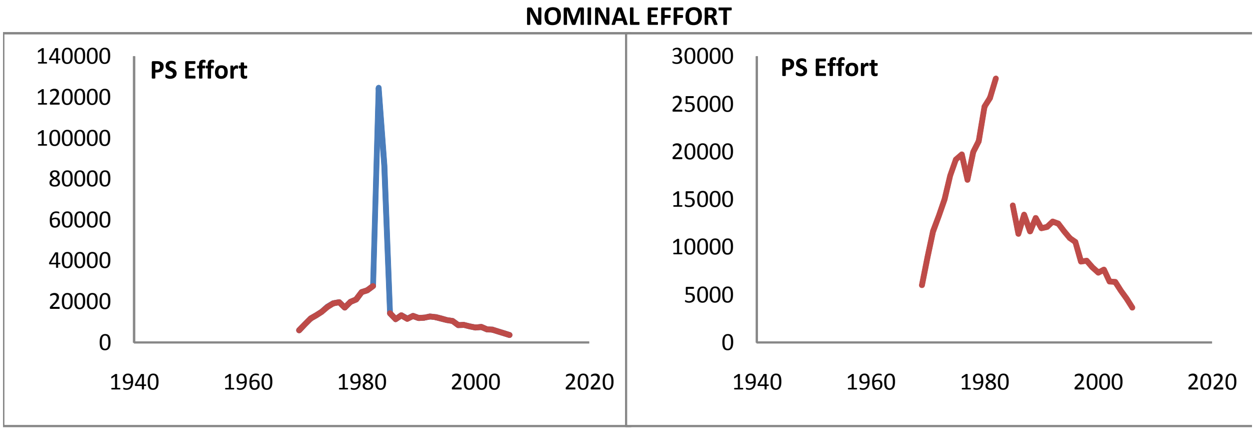


Figure 35. Input nominal effort series used in the analysis of catchability trends. The figure on the right excludes the 1983 and 1984 data points.

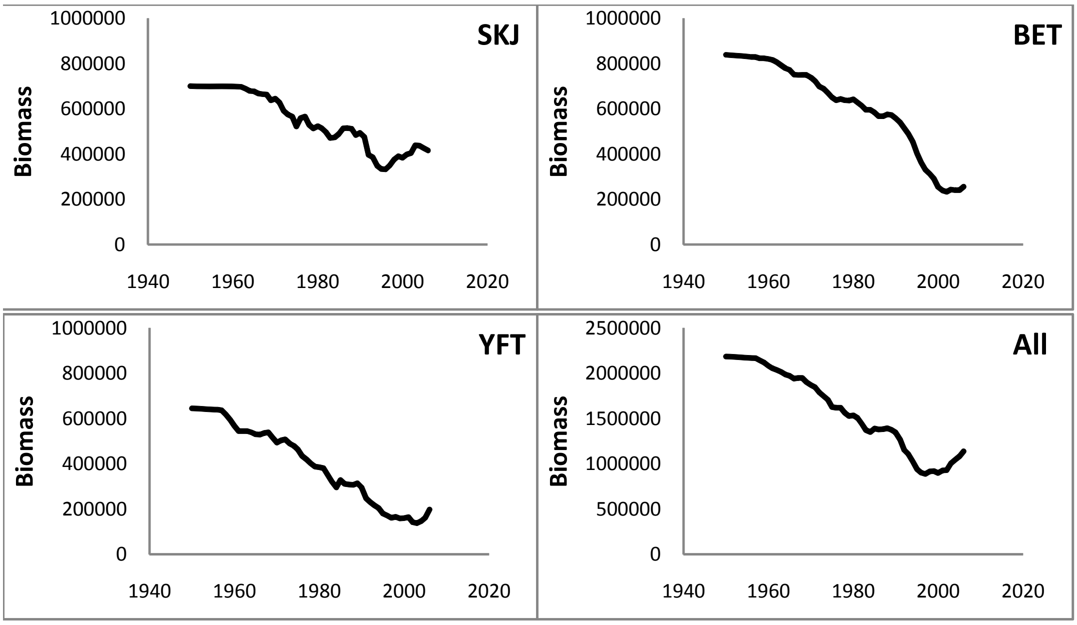


Figure 36. Biomass trajectories that result from the catchability trend analyses.

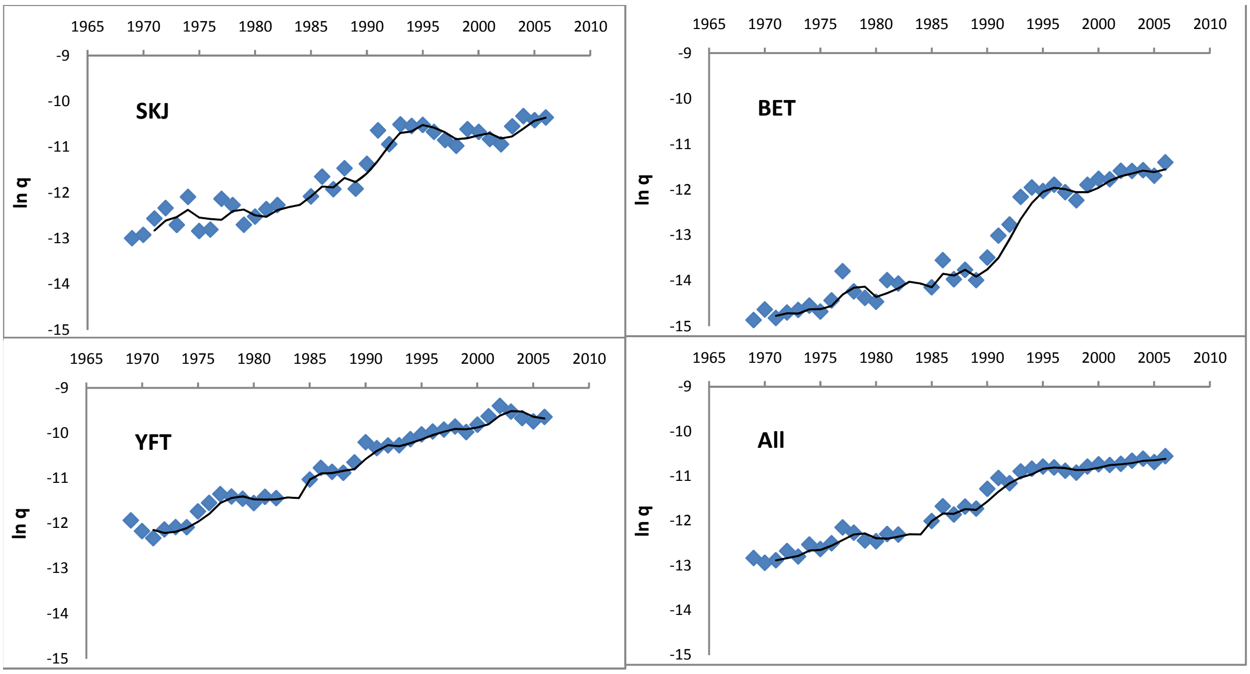


Figure 37. Trends in estimated catchability (in logarithmic units) for the three stocks individually and combined. The solid line is a running average.

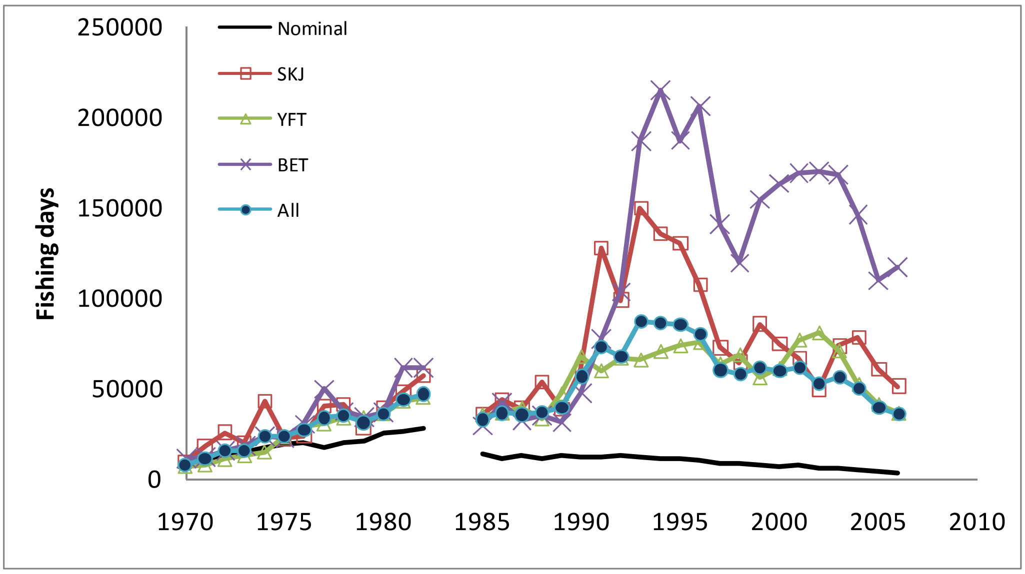


Figure 38. EC and associated purse seine fishing effort (fishing days). The solid black line is the nominal series. The lines with symbols represent fishing effort adjusted for potential catchability changes. All series are scaled so that they start at the same value in 1969.

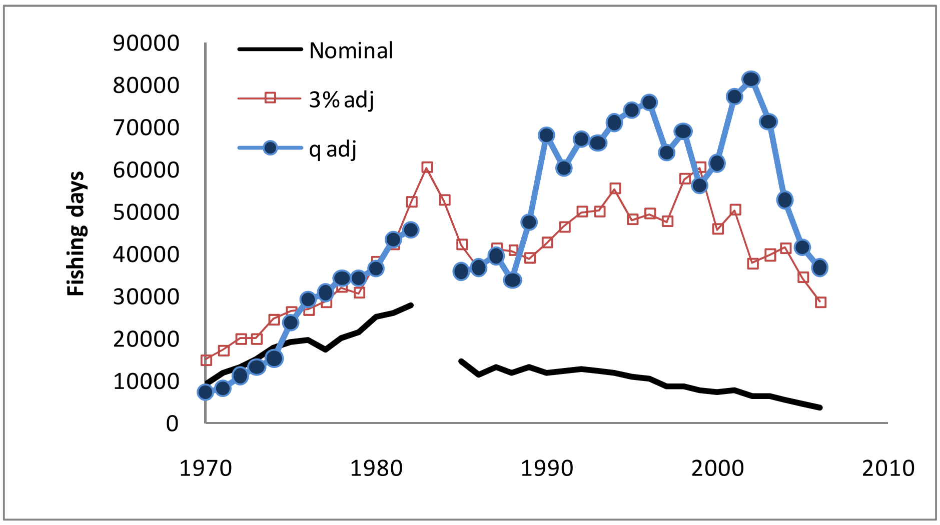


Figure 39. EC and associated purse seine fishing effort (fishing days). The solid black line is the nominal series. The lines with symbols represent fishing effort adjusted for potential catchability changes for yellowfin tuna: The red line with open squares assumes a 3% per year change in q starting in 1980; the blue line with solid circles is adjusted for catchability changes estimated in the present analysis.

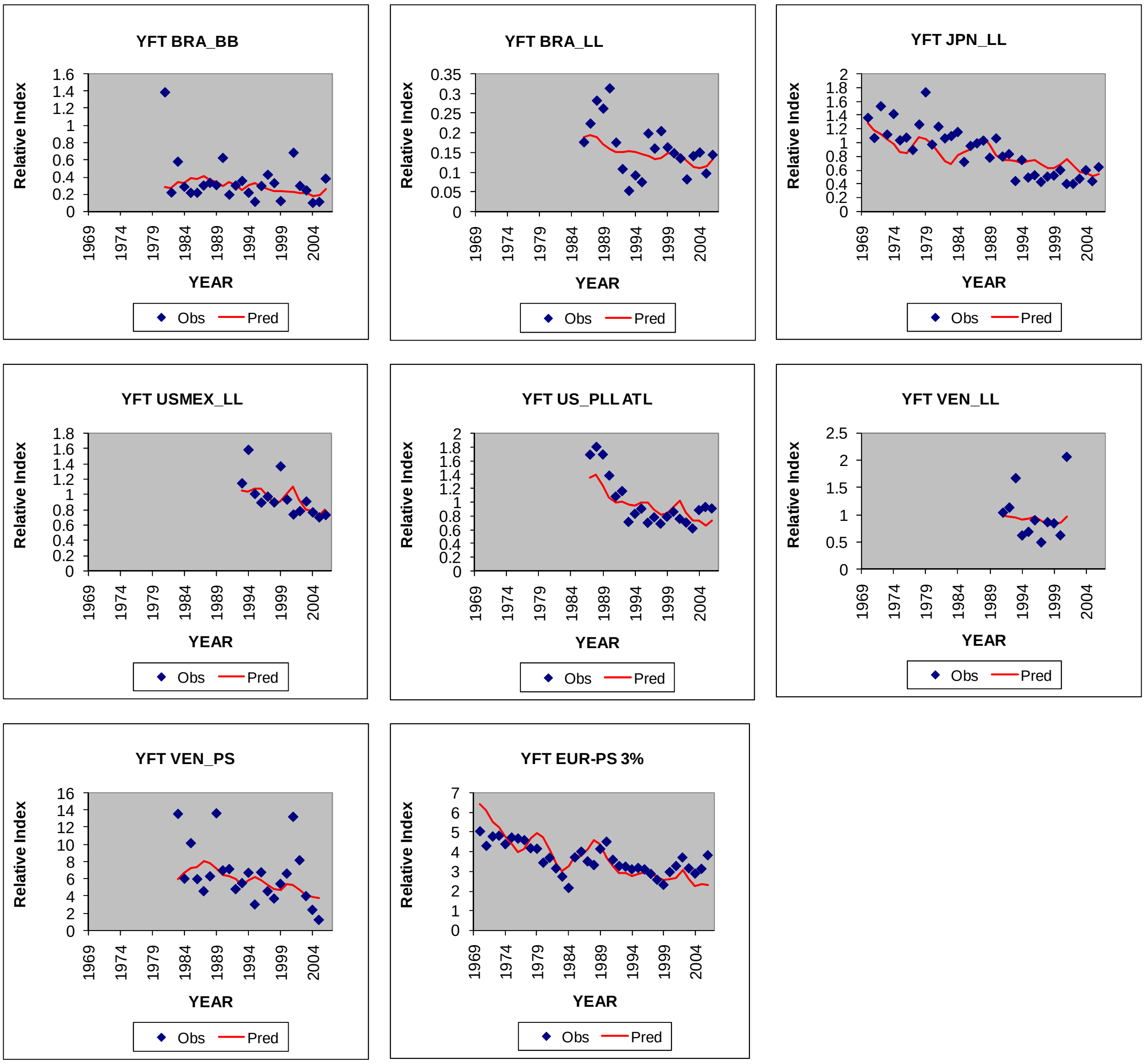


Figure 40. Fits to the CPUE indices for yellowfin VPA continuity model.

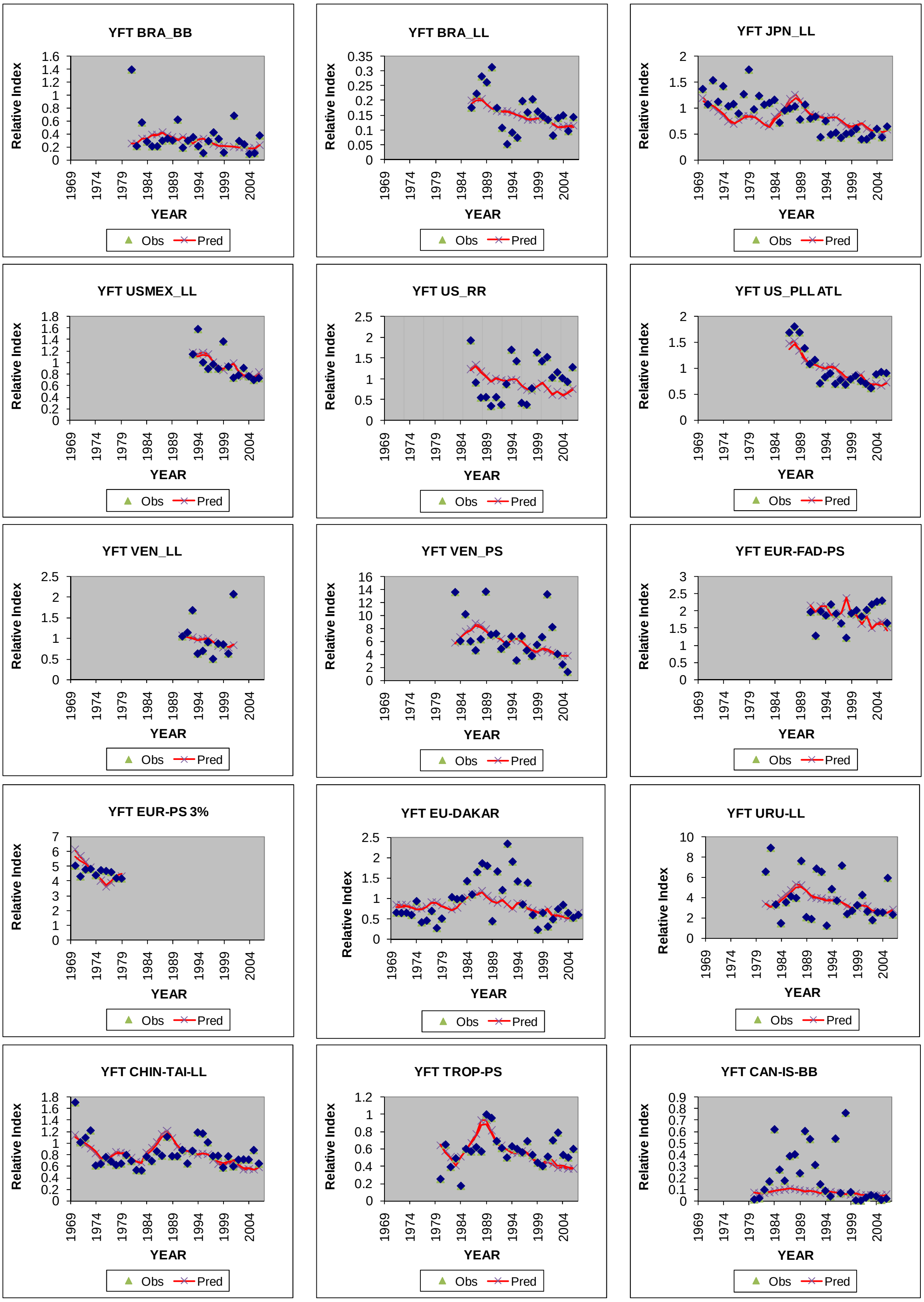
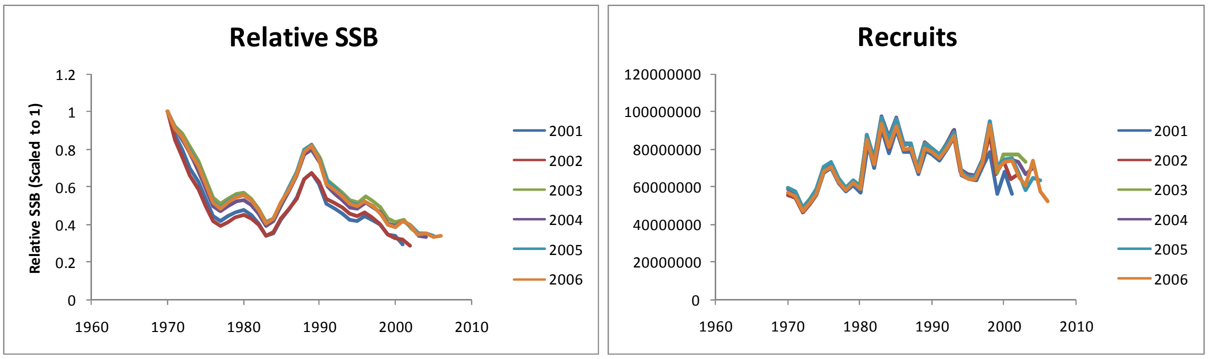


Figure 41. Fits to the CPUE indices for YFT VPA Runs 5 and 8. The blue diamonds are the observed values. The red line and the “X” symbol are the predicted values from Run 5 and Run 10, respectively.

RUN 5



RUN 10

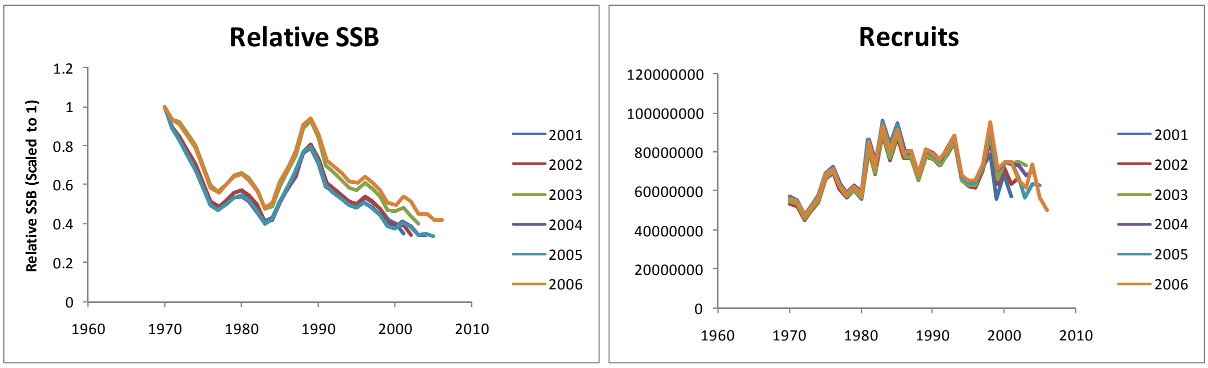


Figure 42. Retrospective trends of spawning biomass (mt) and recruits (numbers at Age 0) from the yellowfin VPA base cases. The legend indicates the terminal year of the analysis.

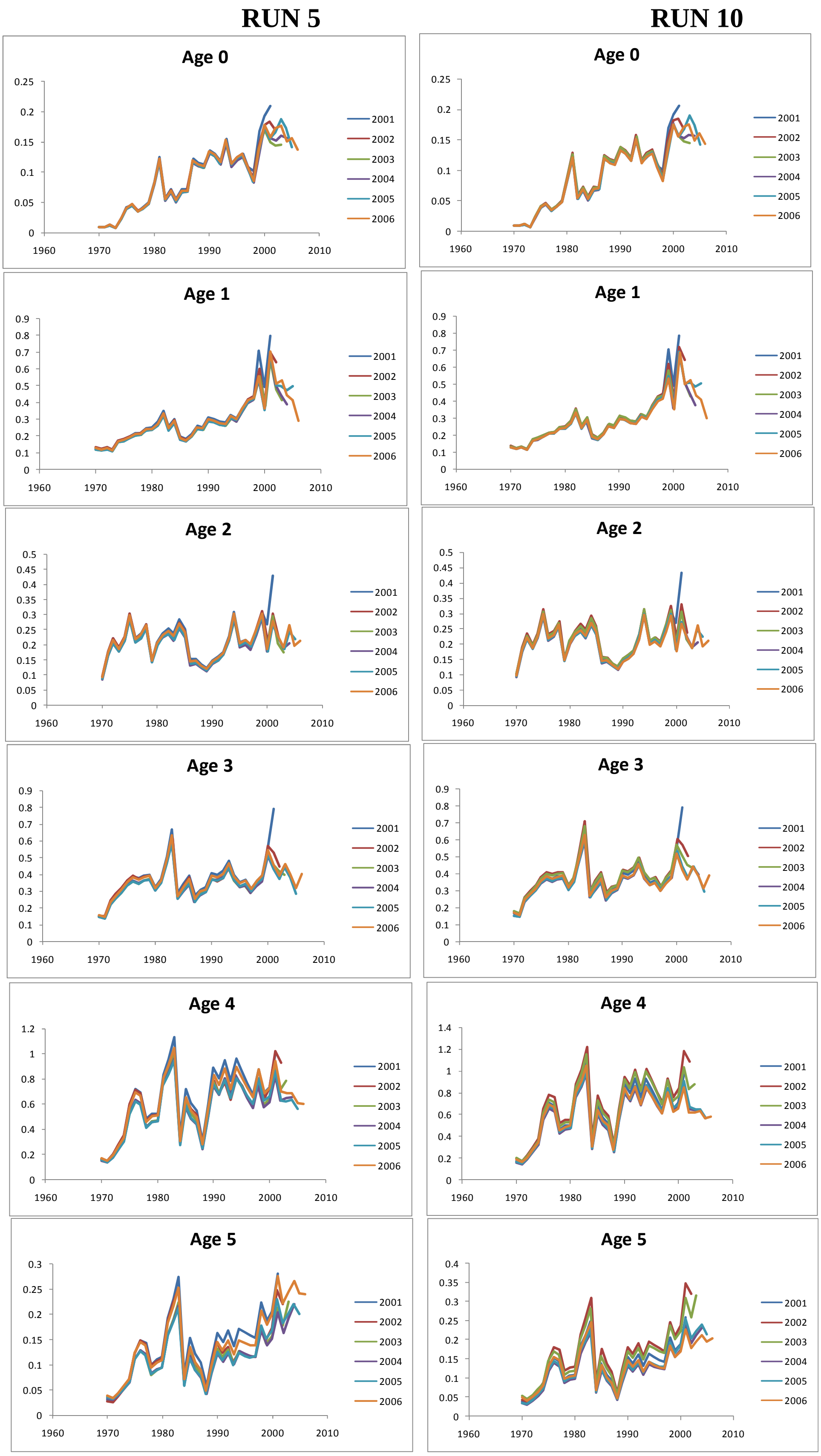


Figure 43. Retrospective patterns in fishing mortality at age (FAA) from the yellowfin base models. The legend indicates the terminal year of the analysis.

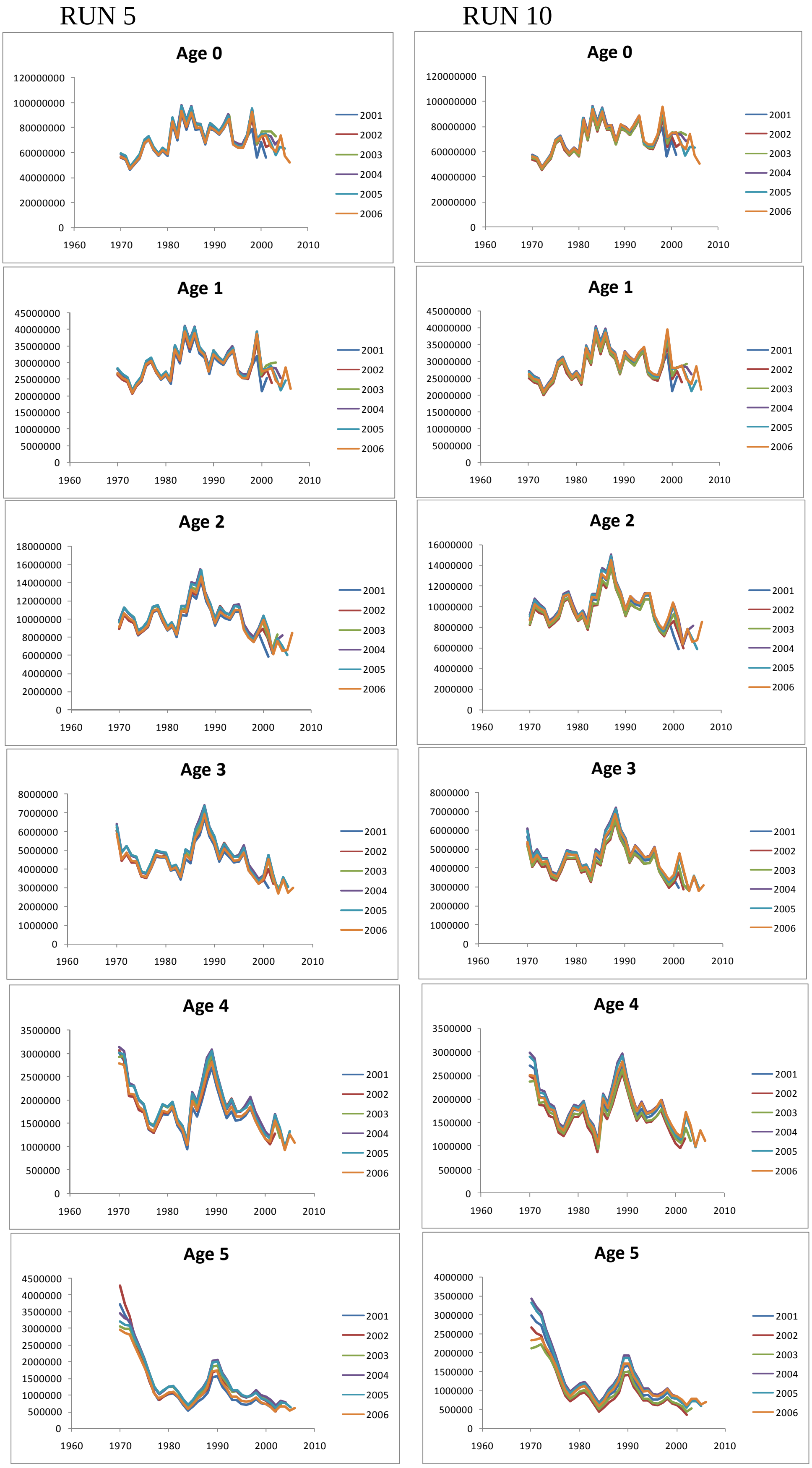


Figure 44. Retrospective patterns in numbers at age (NAA) from the yellowfin base models. The legend indicates the terminal year of the analysis.

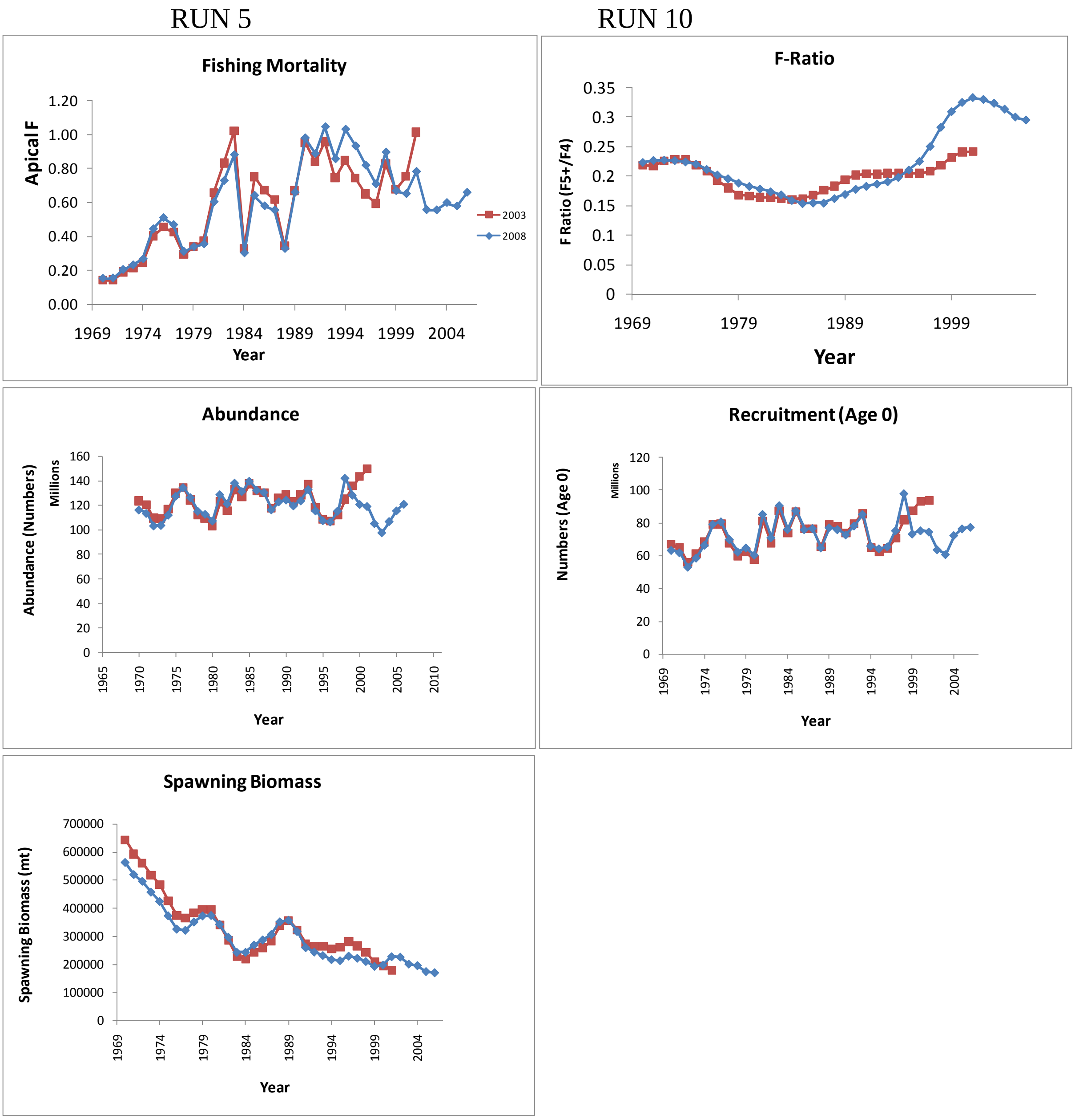


Figure 45. Annual estimates of average fishing mortality by age group, spawning stock biomass (SSB), recruitment and F-Ratio for the 2003 base (red line) and 2008 continuity (blue line) VPA runs.

RUN 5

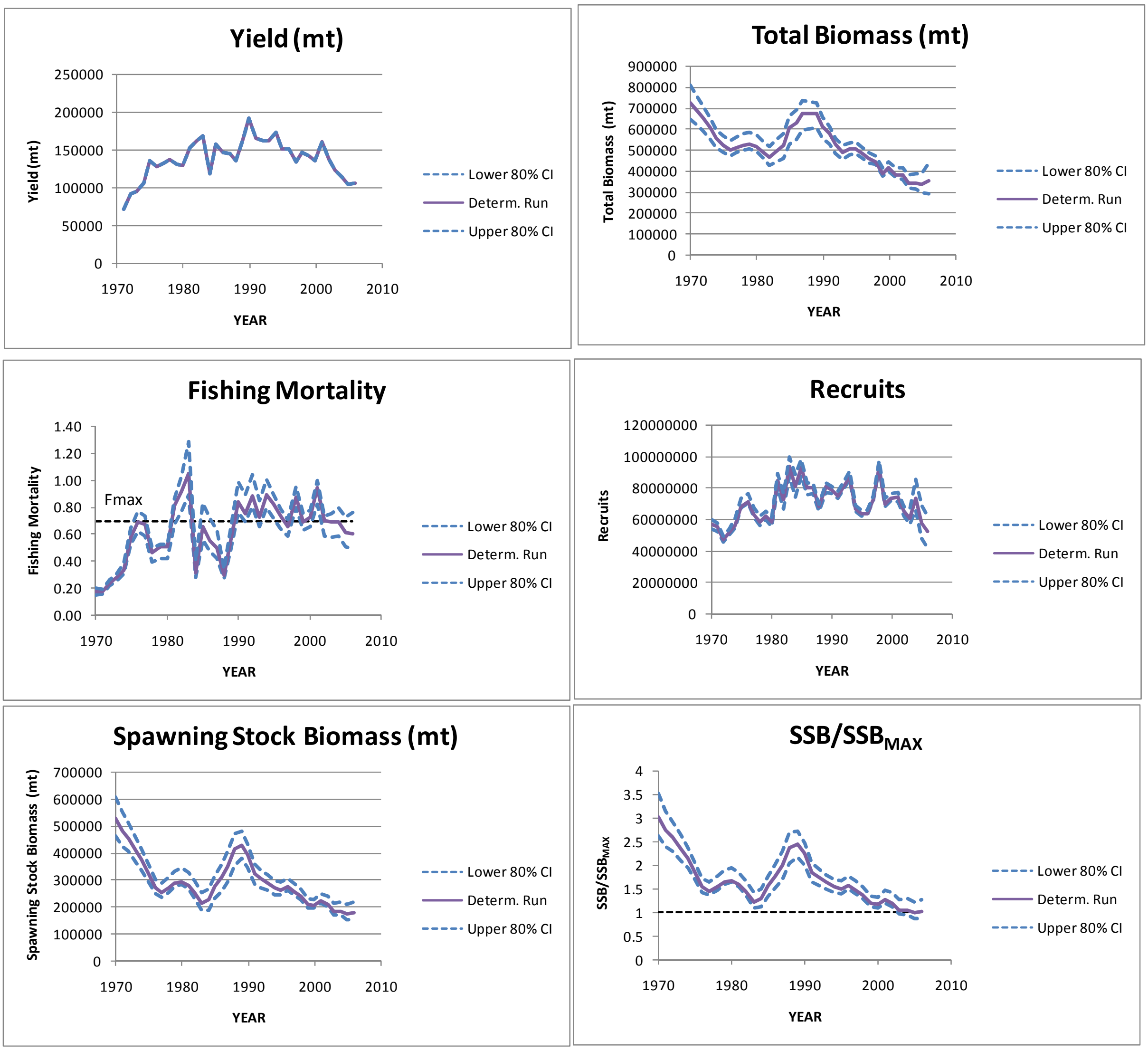


Figure 46. Run 5 - Annual estimates of yield, total biomass, apical fishing mortality, recruits (Age 0), spawning stock biomass (SSB) and SSB relative to SSB at F_{MAX}. The dashed lines are the 80% confidence intervals obtained from 500 bootstrap runs.

RUN 10

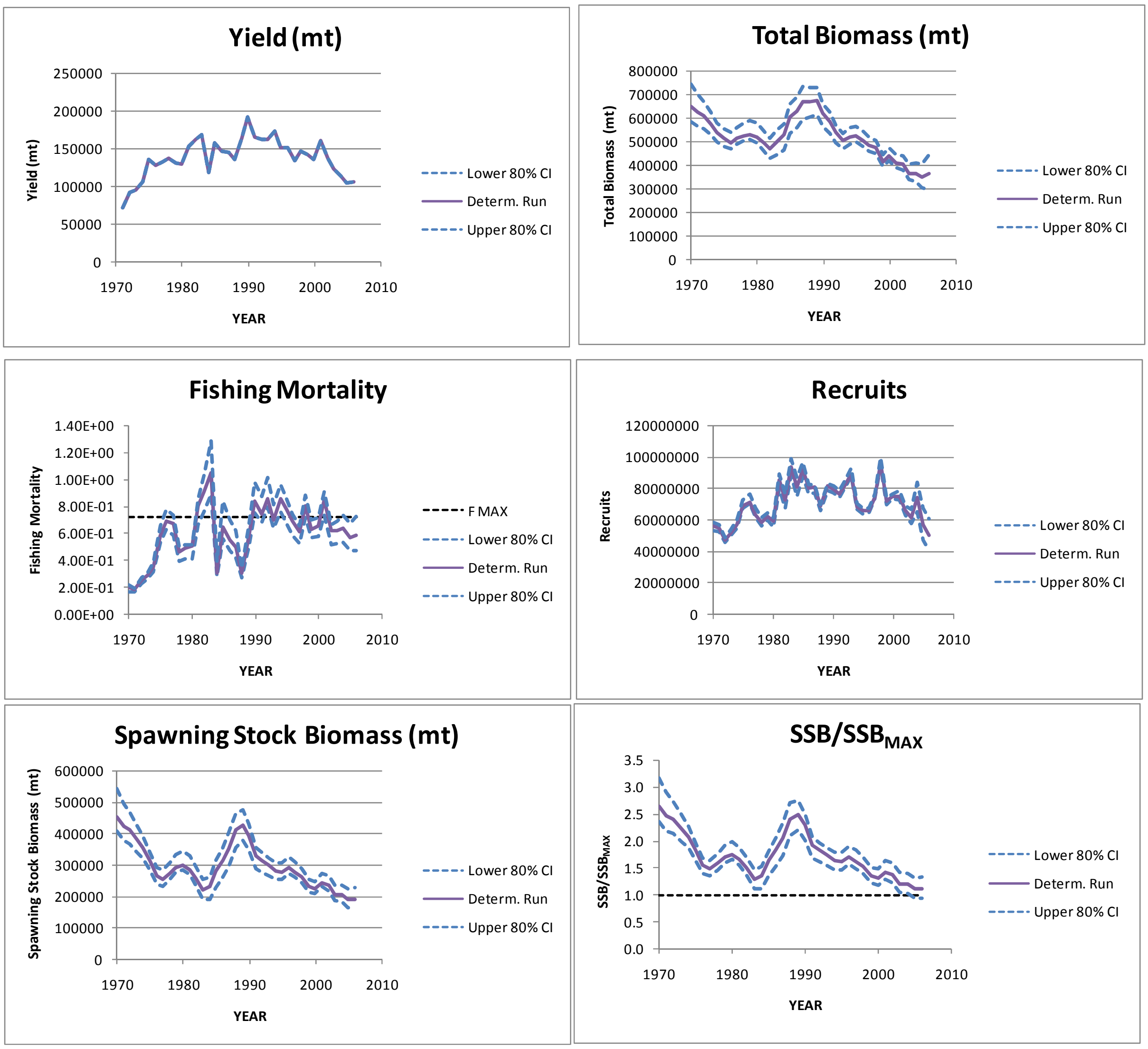


Figure 47. Run 10 - Annual estimates of yield, total biomass, apical fishing mortality, recruits (Age 0), spawning stock biomass (SSB) and SSB relative to SSB at F_{MAX}. The dashed lines are the 80% confidence intervals obtained from 500 bootstrap runs.

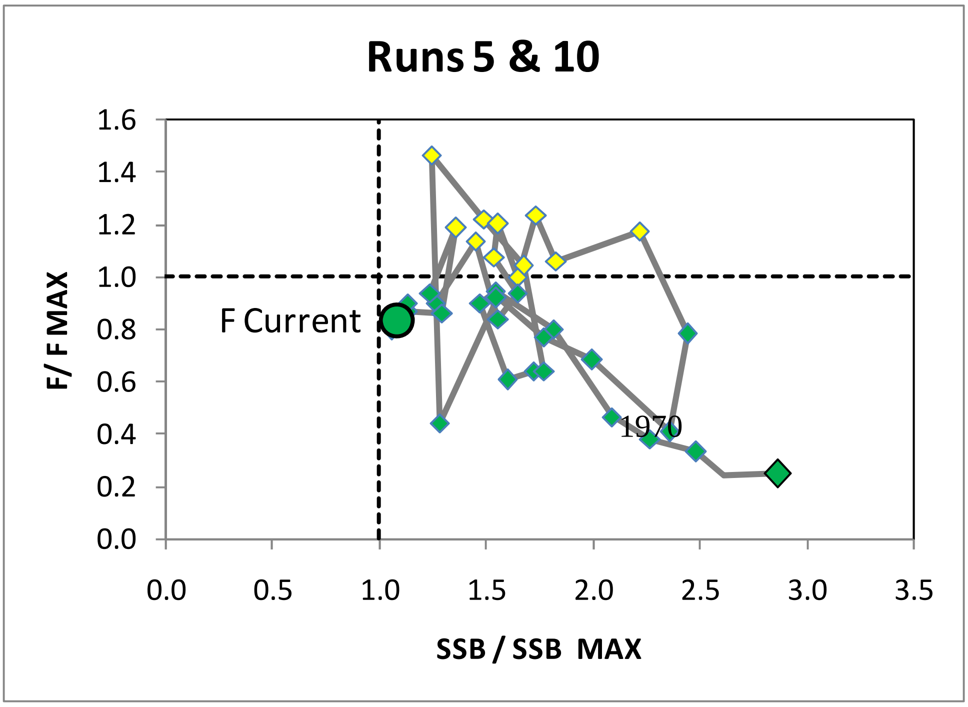


Figure 48. Trajectory of stock status from 1970 to 2006. Stock status in 2006 (large circle) was estimated using SSB_{2006}/SSB_{MAX} and $F_{Current}/F_{MAX}$. Yellow points indicate that overfishing was occurring. Green points indicate that the population is neither overfished nor undergoing overfishing.

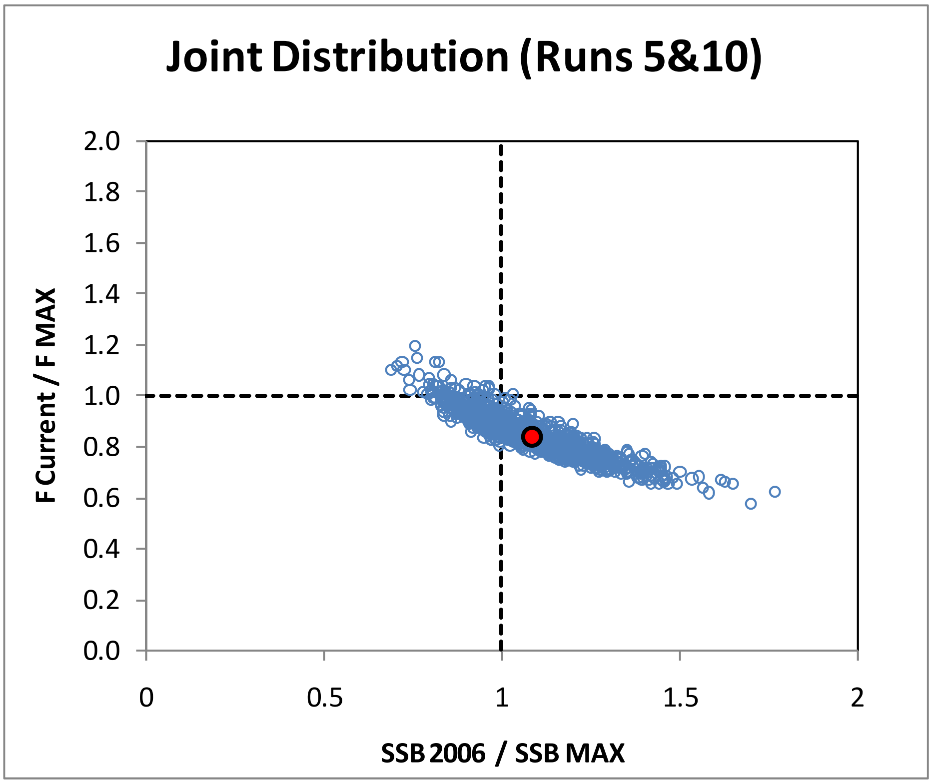


Figure 49. Phase plot showing the 2006 stock status (filled symbol) obtained using the median of the joint distribution of VPA models 5 and 10. The open circles show 500 bootstrap runs of each VPA model.

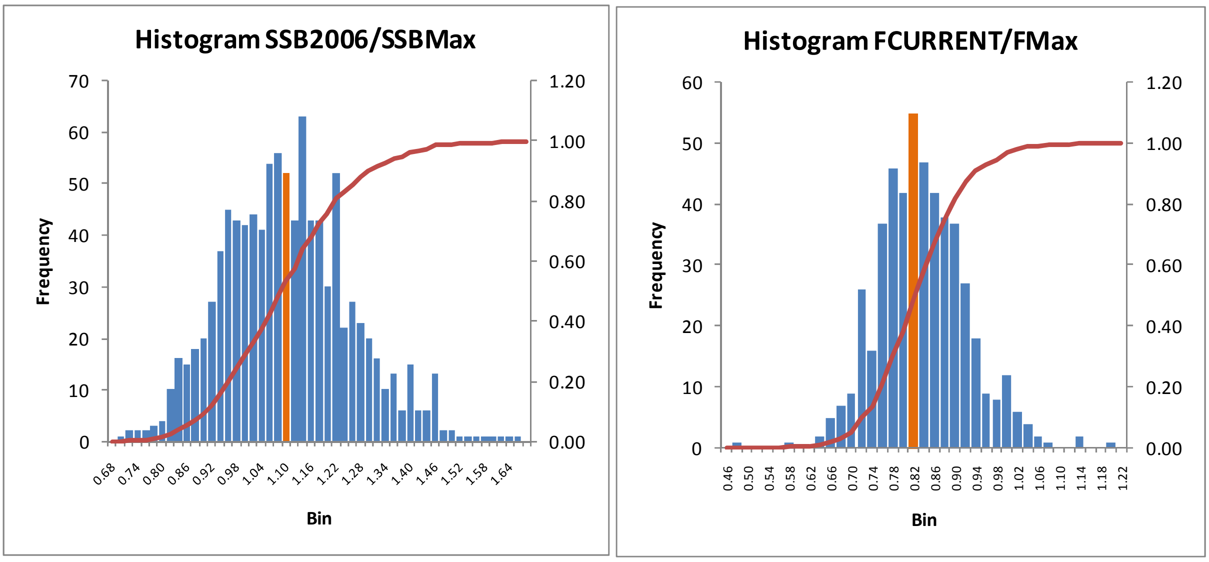
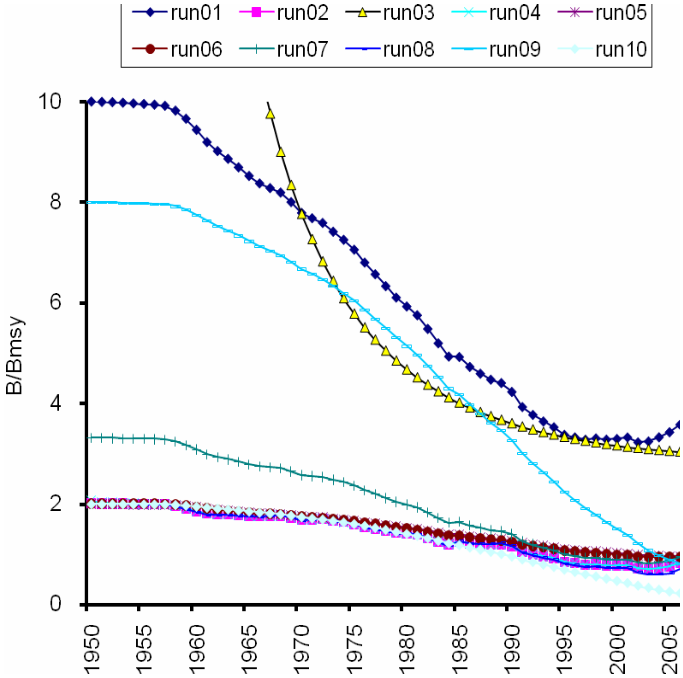


Figure 50. Histograms of bootstrap estimates of 2006 stock status. These were constructed to examine bias and normality.



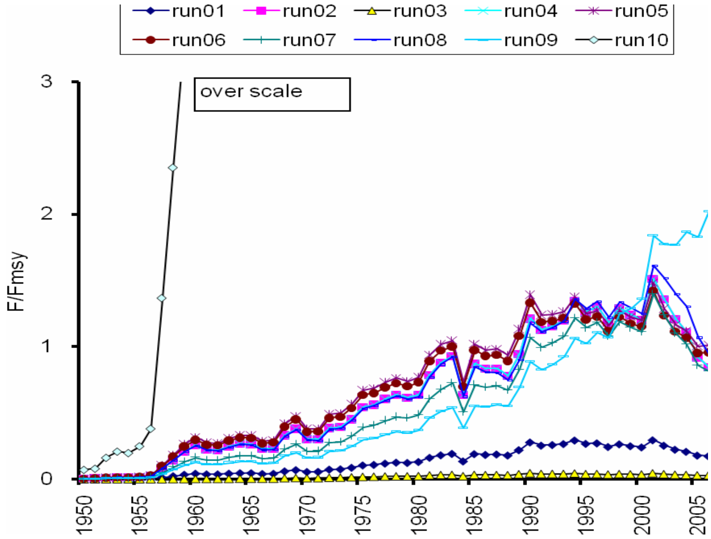


Figure 51. Estimated relative biomass (B/Bmsy) and relative fishing mortality (F/Fmsy) for 10 ASPIC runs. Refer to text for detail explanation of each run setting.

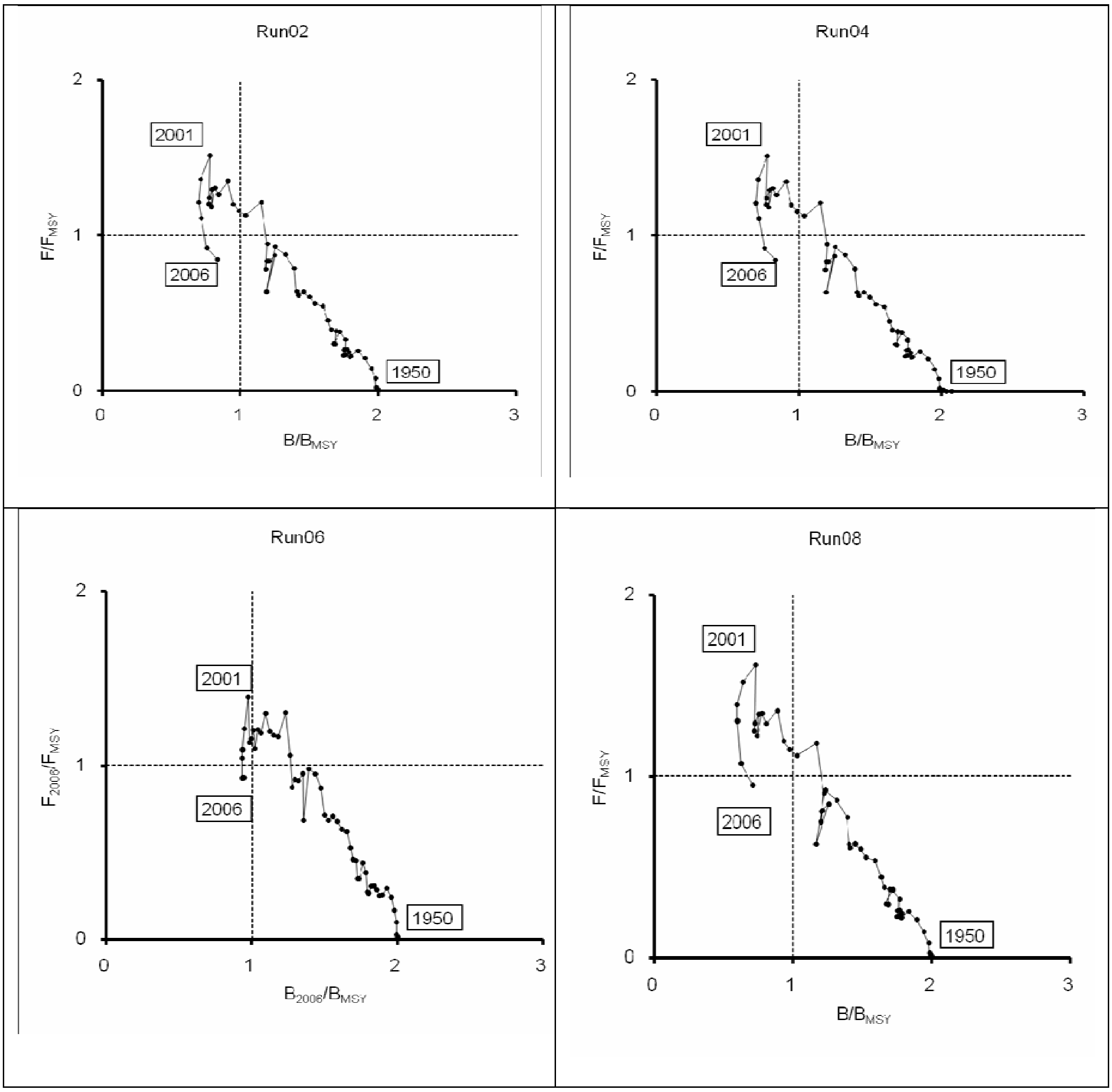


Figure 52. Relative Biomass – Relative F trajectories ('snail tracks') for 4 cases of ASPIC.

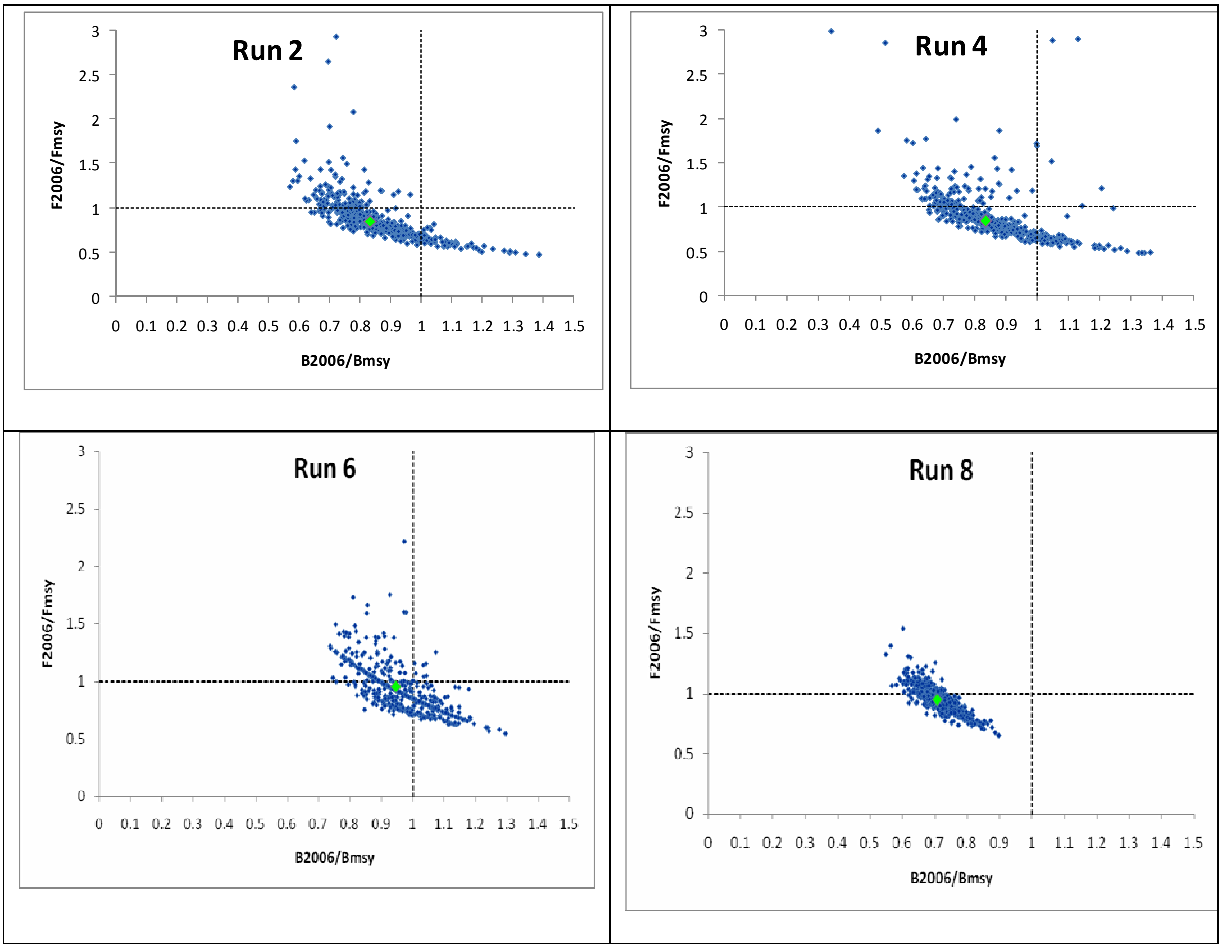


Figure 53. Phase plots of 2006 conditions from bootstraps runs for 4 runs of ASPIC. Green diamond indicates deterministic results.

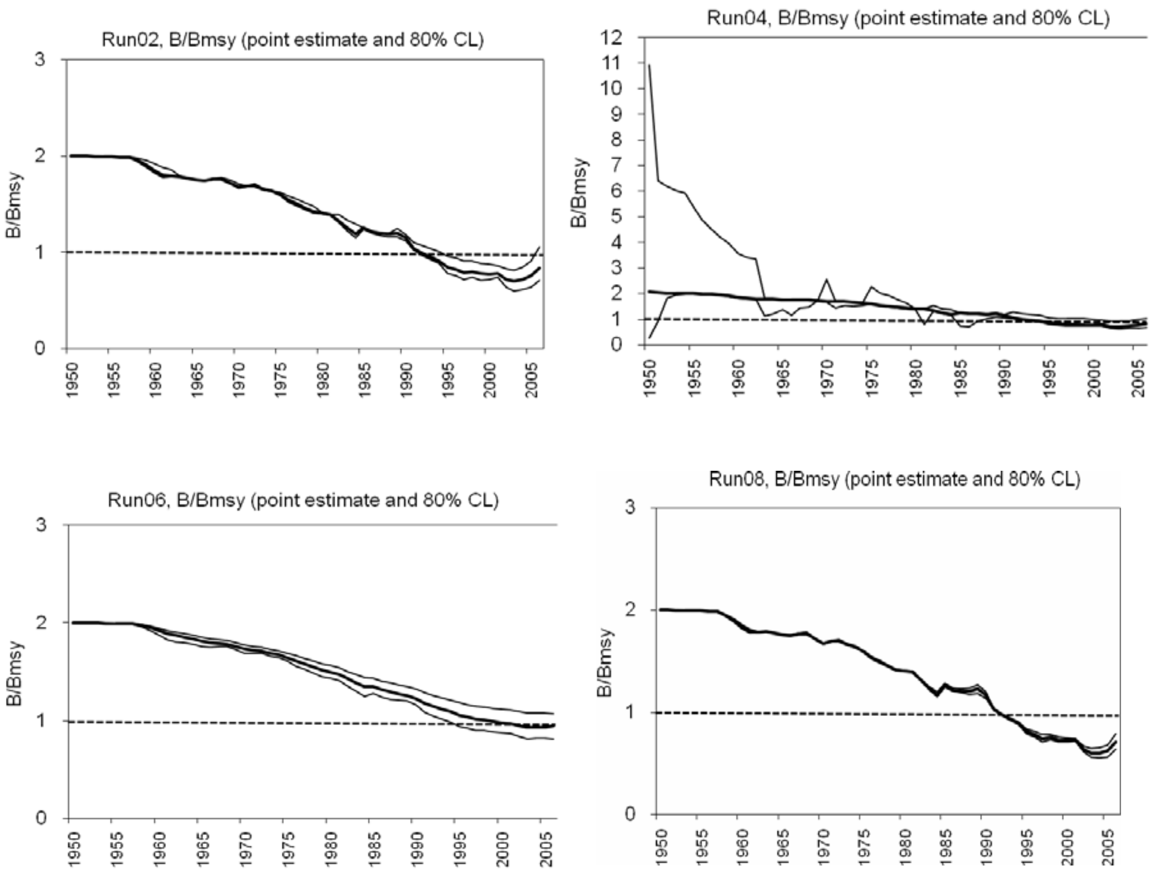


Figure 54. Estimated relative biomass trajectories and 80% confidence intervals estimated from 500 bootstraps.

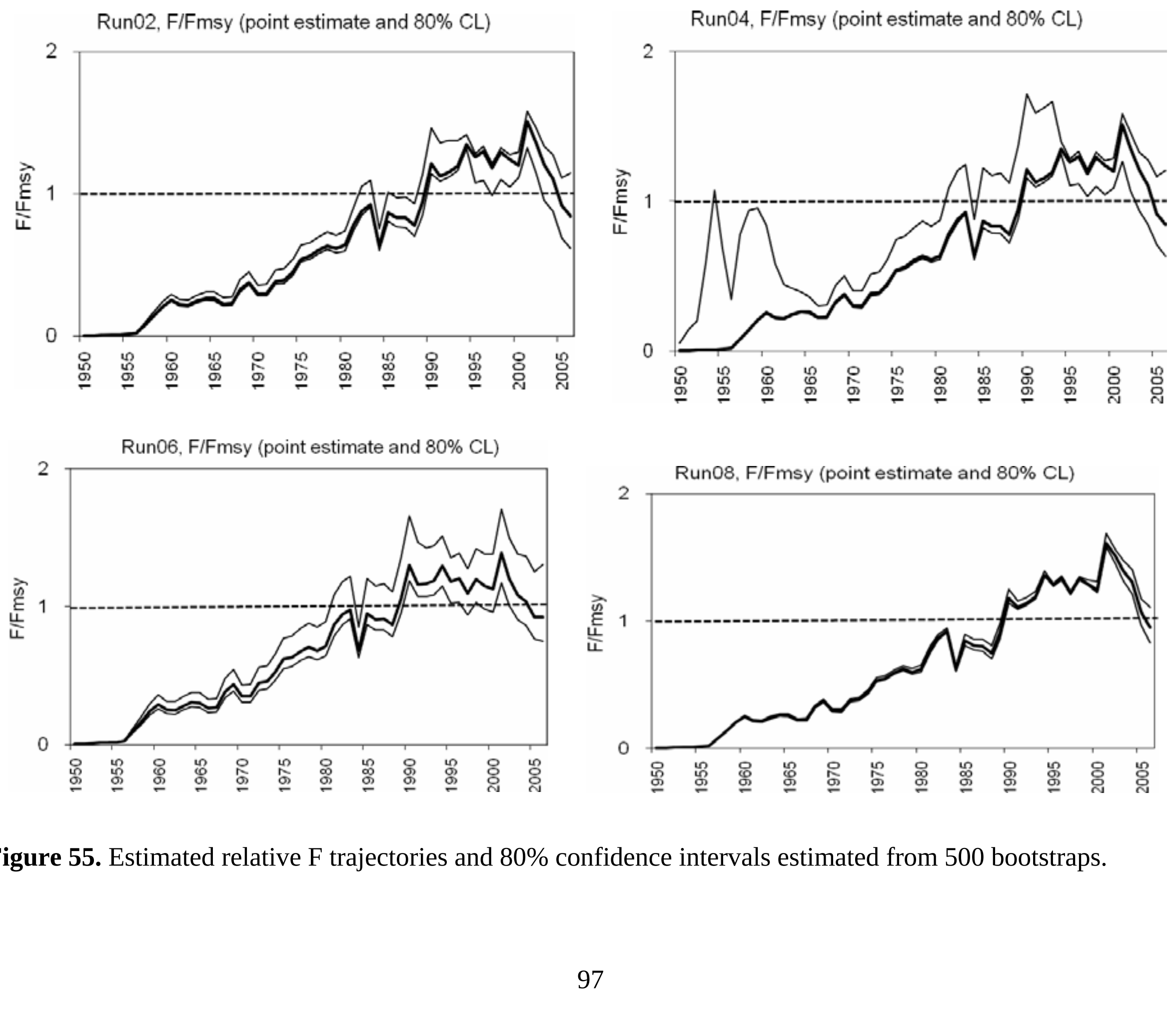


Figure 55. Estimated relative F trajectories and 80% confidence intervals estimated from 500 bootstraps.

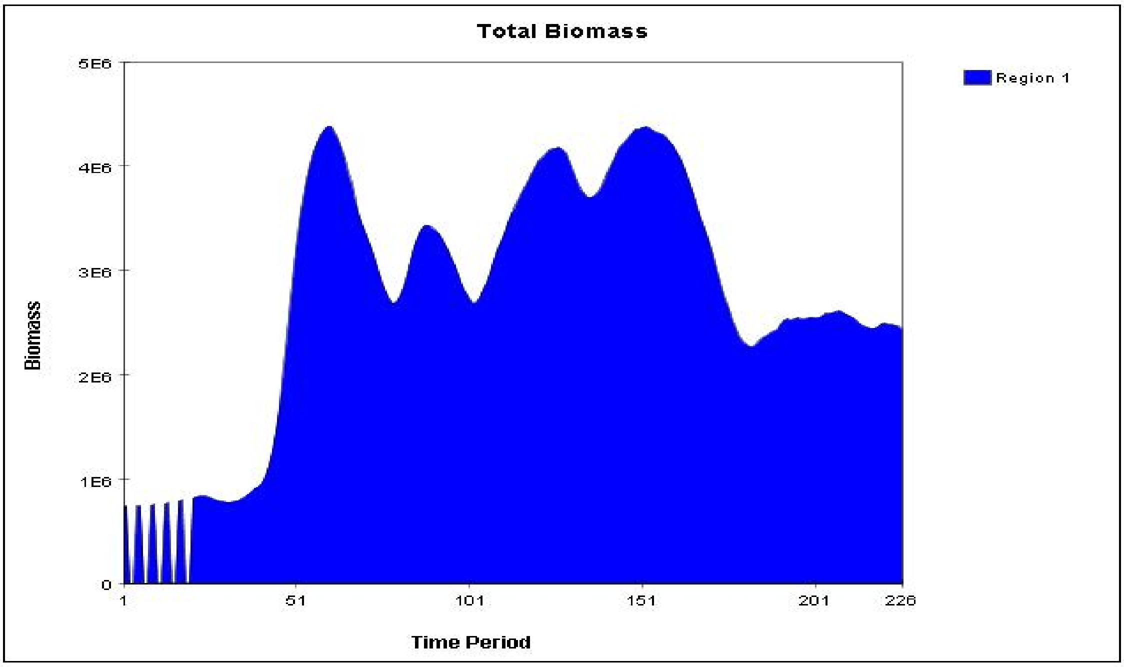


Figure 56. Multifan-CL biomass estimates for the eastern Atlantic region using data from 1950 to 2006.

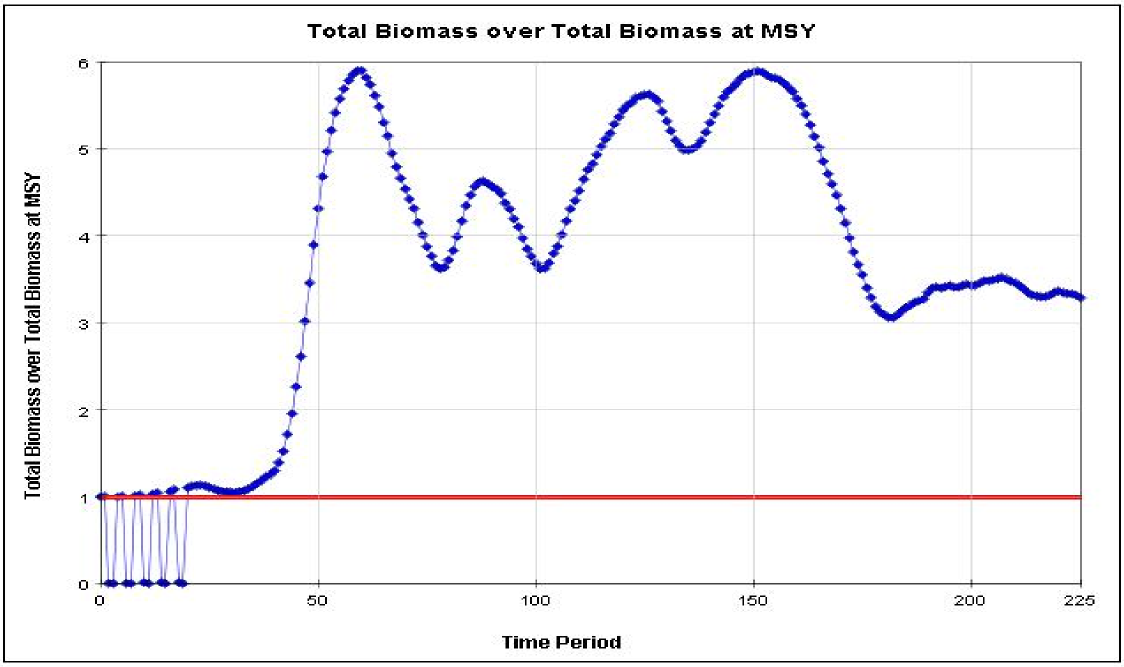


Figure 57. Multifan-CL biomass over MSY estimates for the eastern Atlantic region using data from 1950 to 2006.

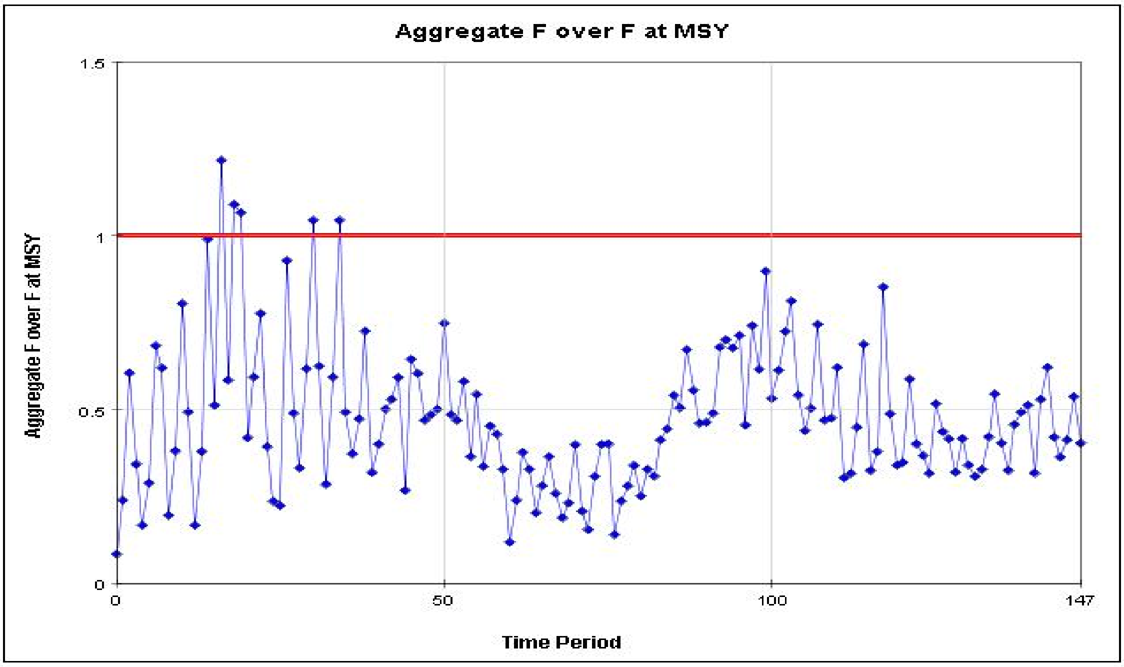


Figure 58. Multifan-CL F over F_{MSY} estimates for the eastern Atlantic region using data from 1950 to 2006.

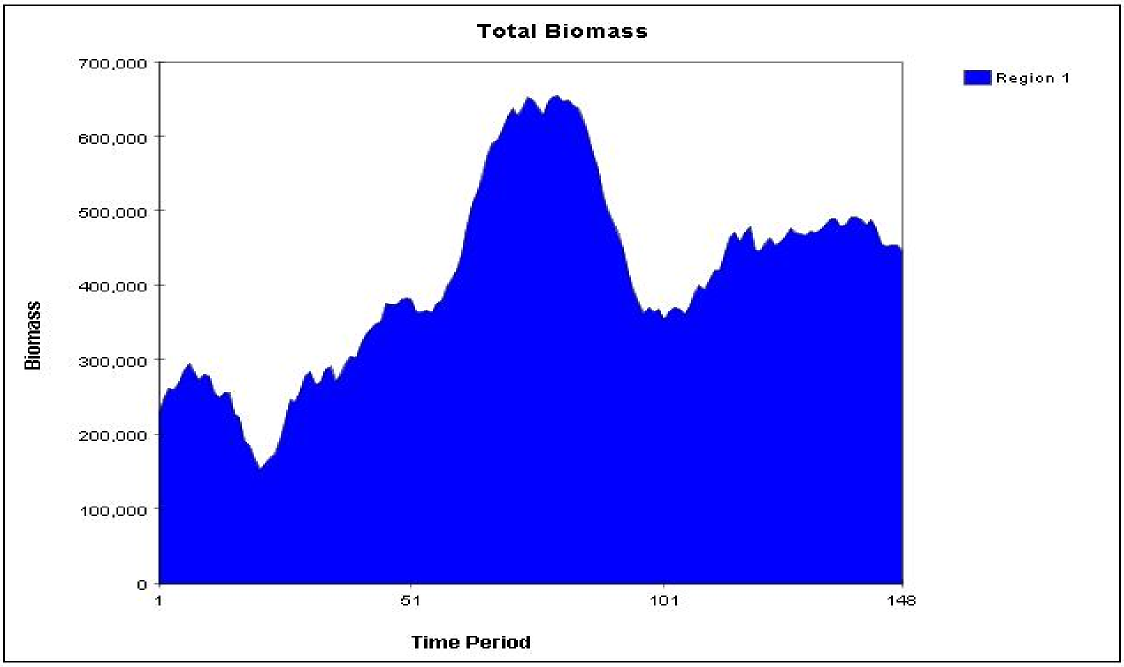


Figure 59. Multifan-CL biomass estimation for the eastern Atlantic region using data from 1970 to 2006.

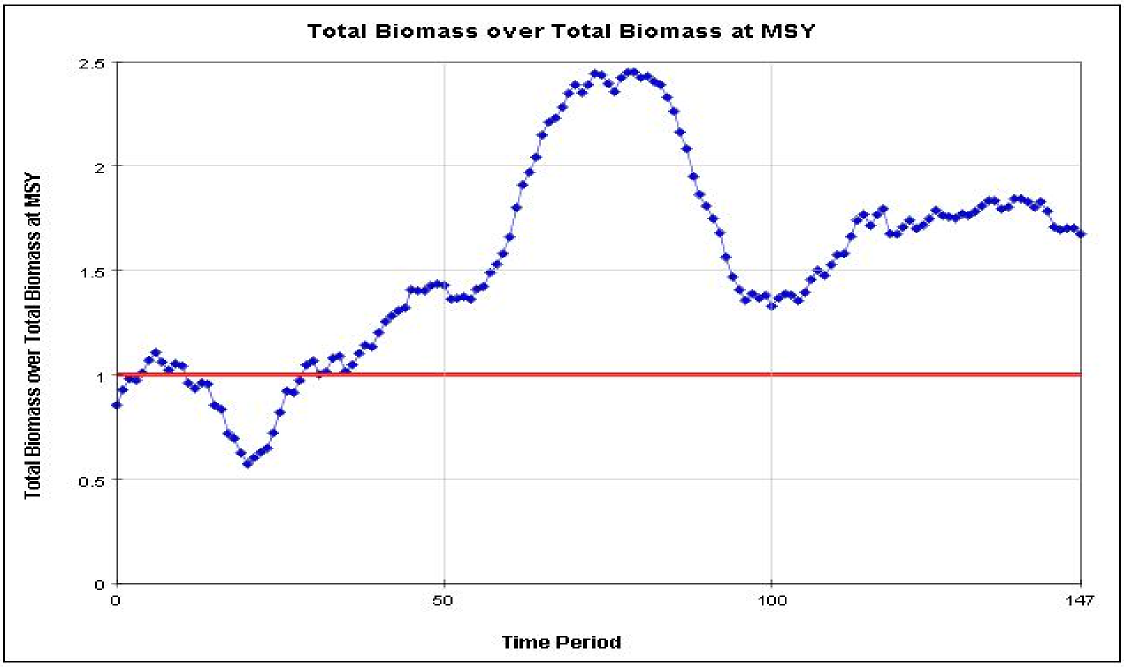


Figure 60. Multifan-CL biomass over MSY estimates for the eastern Atlantic region using data from 1970 to 2006.

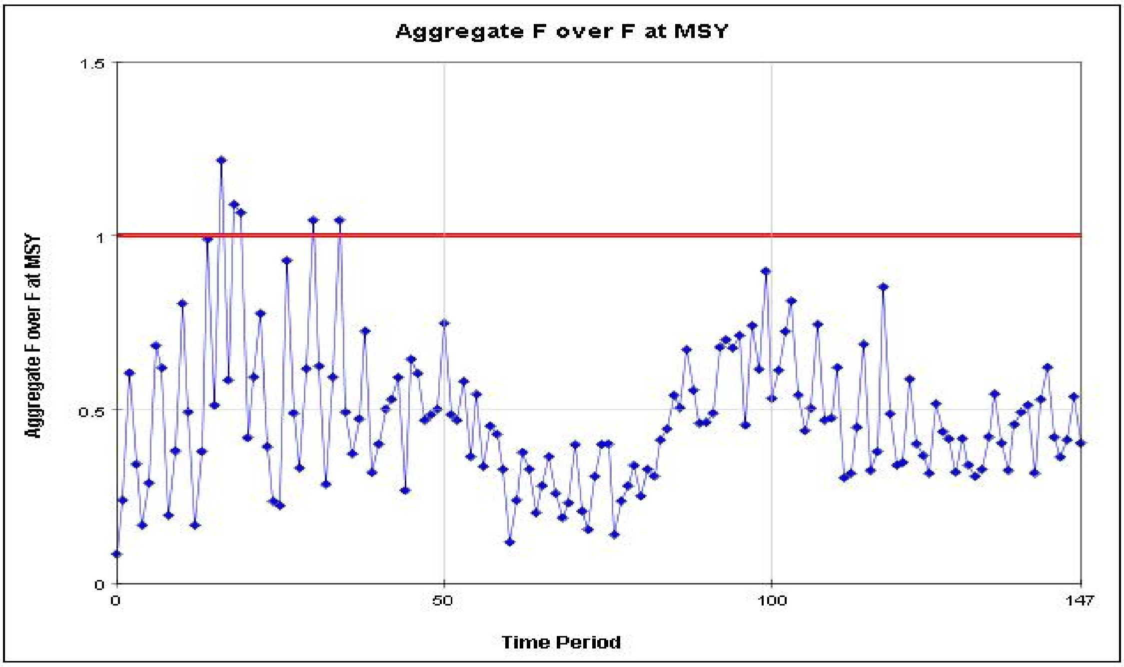


Figure 61. Multifan-CL F over F_{MSY} estimates for the eastern Atlantic region using data from 1970 to 2006.

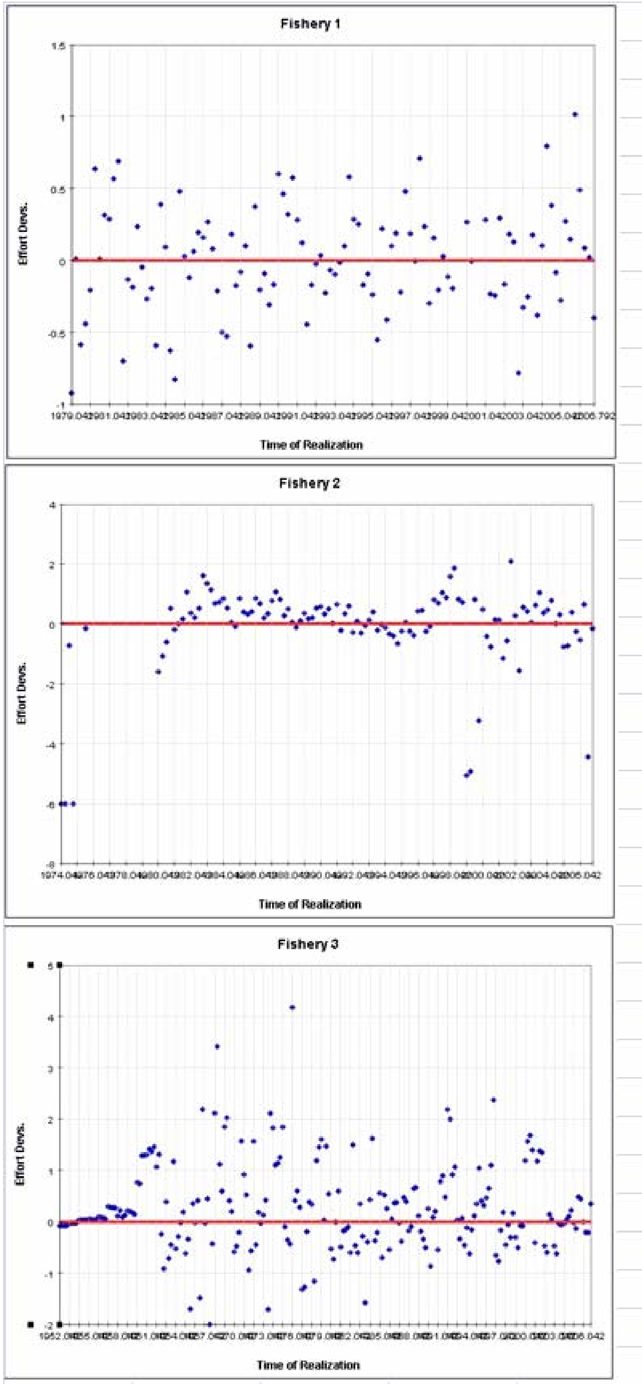


Figure 62a. Effort deviations estimated from the Multifan-CL application to western skipjack for the three fisheries.

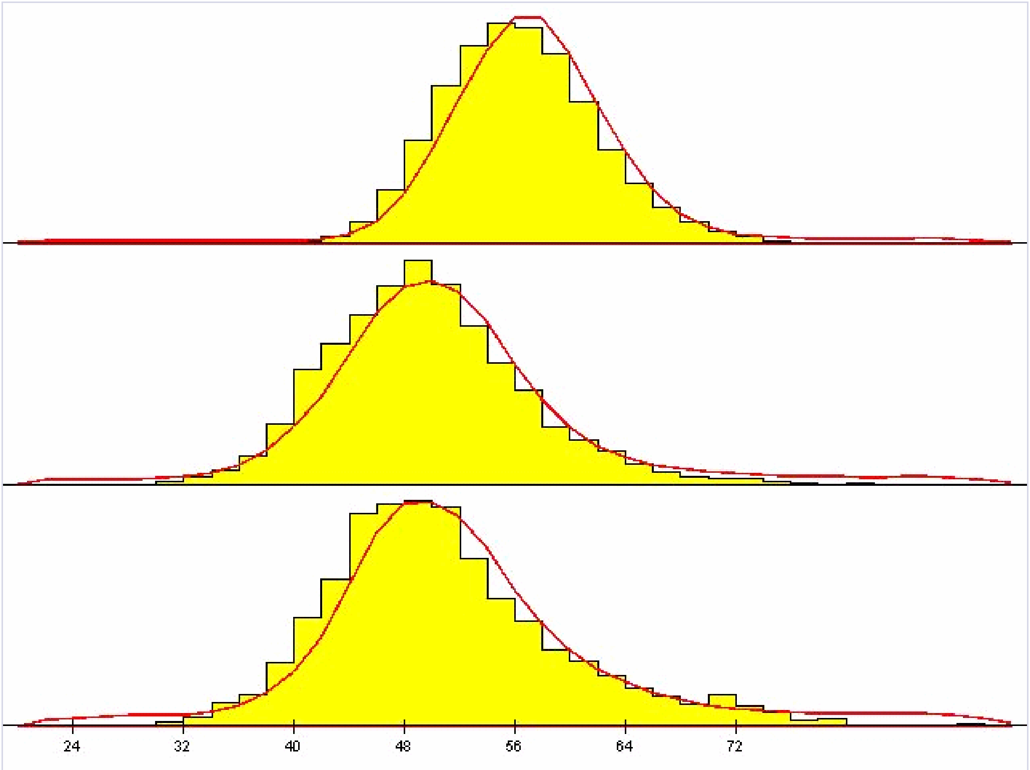


Figure 62b. Overall size frequencies fitted in the Multifan-CL application to western skipjack for the three fisheries.

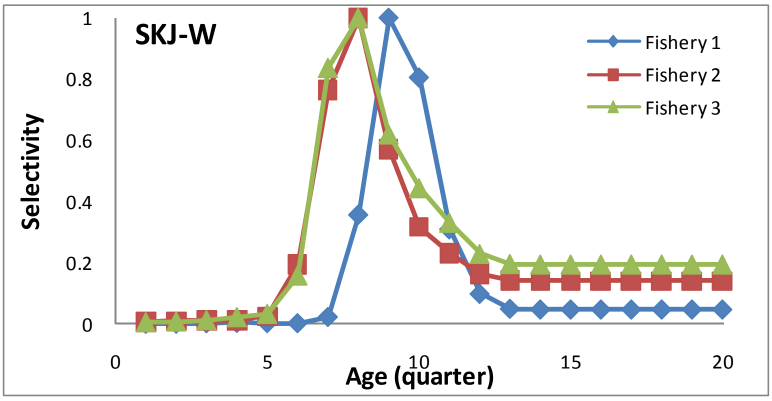


Figure 63. Selectivities estimated by the Multifan-CL application to western skipjack for the three fisheries.

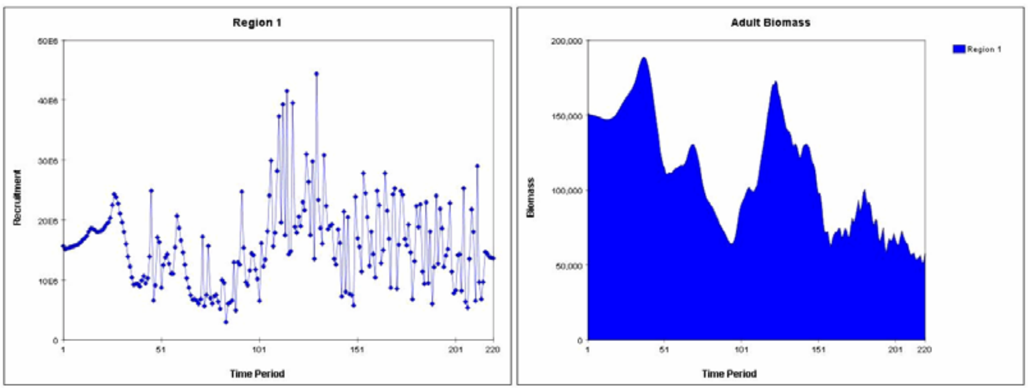


Figure 64. Recruitment and spawning biomass trends estimated by the Multifan-CL application to western skipjack.

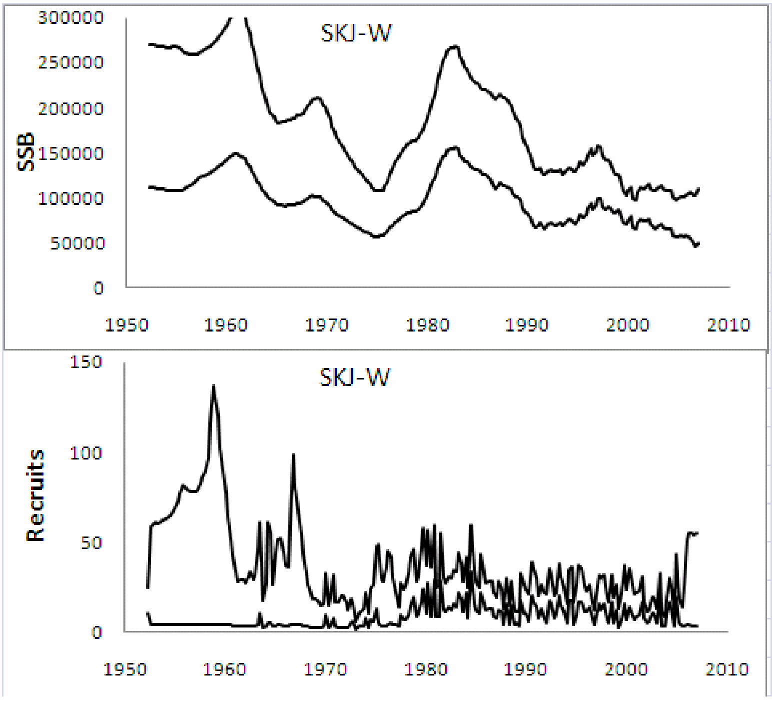


Figure 65. Approximate 95% confidence intervals for SSB and recruitment estimated by the Multifan-CL application to western skipjack.

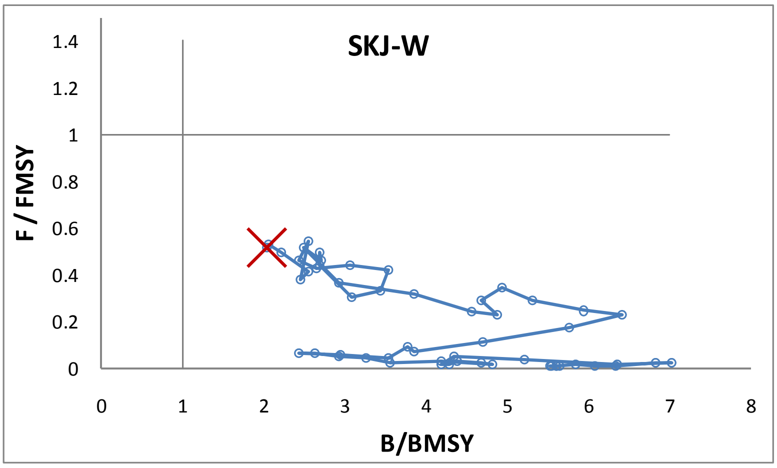


Figure 66. Joint trajectory of biomass and fishing mortality relative to MSY levels, estimated by the Multifan-CL application to western skipjack.

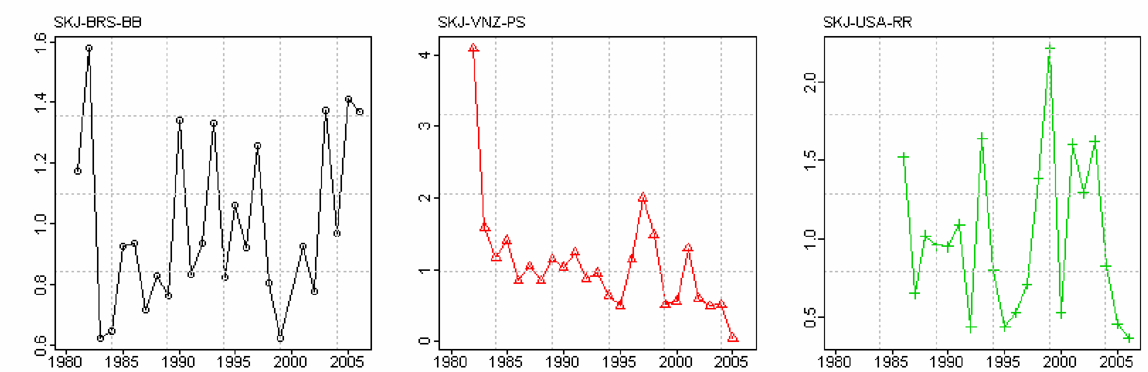


Figure 67. Plot of indices of abundance used for BSP projection models for western skipjack.

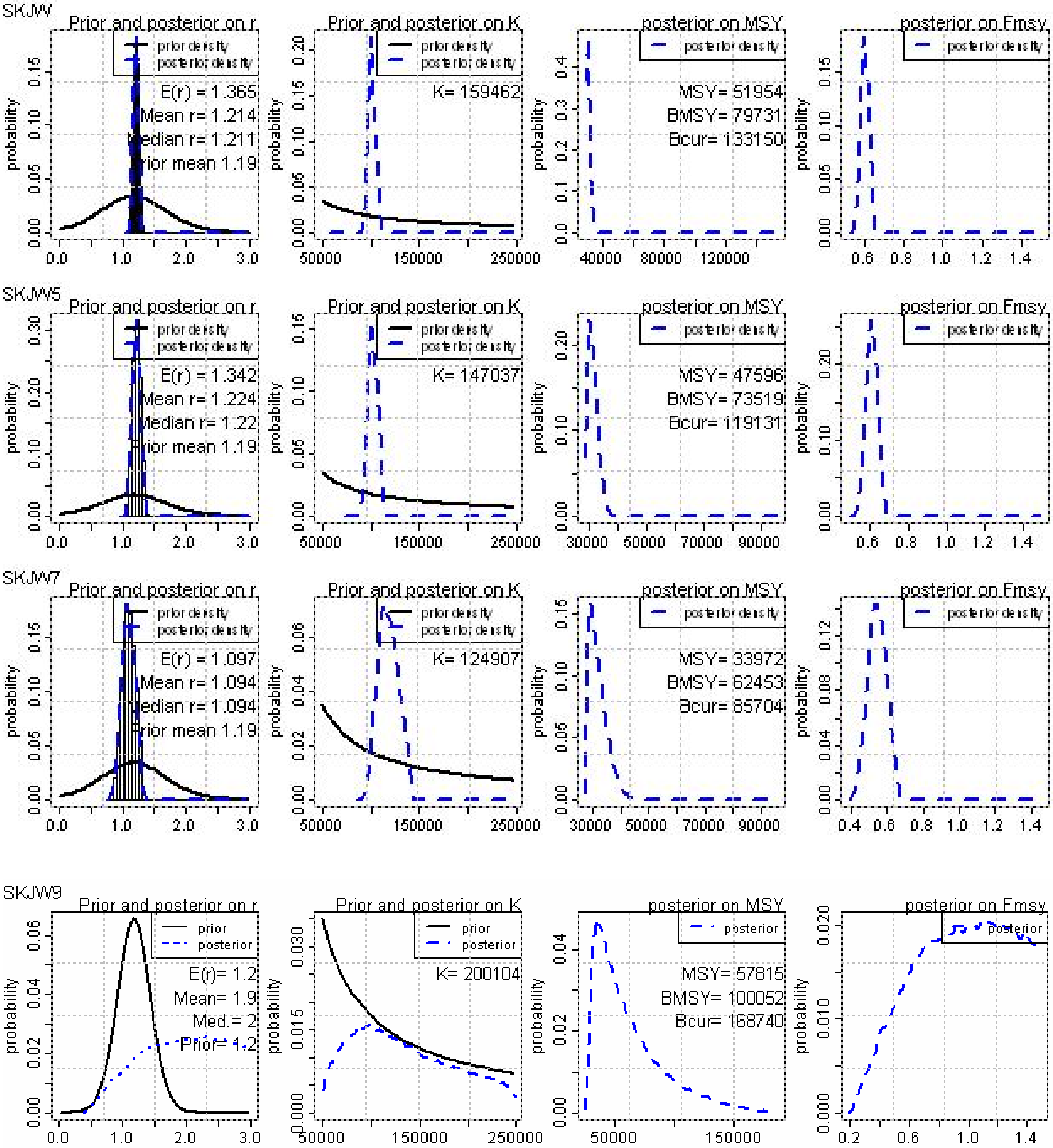


Figure 68. Prior and posteriors for r, K and posteriors for MSY and F_{MSY} for BSP runs 1, 5, 7 and 9 showing the expansion of the posterior for r and the migration of K to lower values. Note that for run 9 the prior for r was N(1.17, 0.25) and N(1.17, 0.5) for all others.

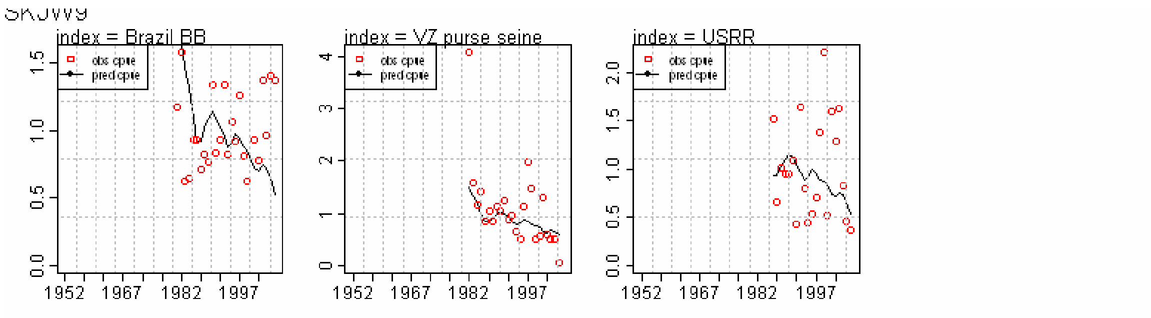


Figure 69. Fits to the indices for BSP SKJW-RUN9.

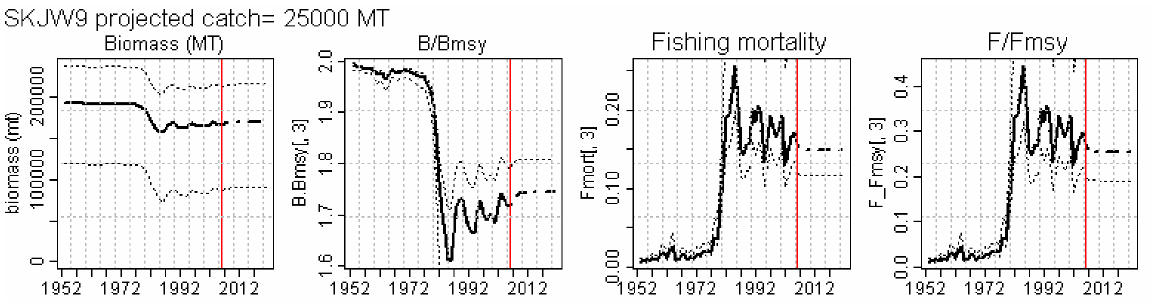


Figure 70. Biomass, B/B_{MSY}, F, and F/F_{MSY} trajectory with projections of 25,000 MT starting in 2007 for SKJW-RUN9. Dashed lines are 90% confidence intervals based on importance samples.

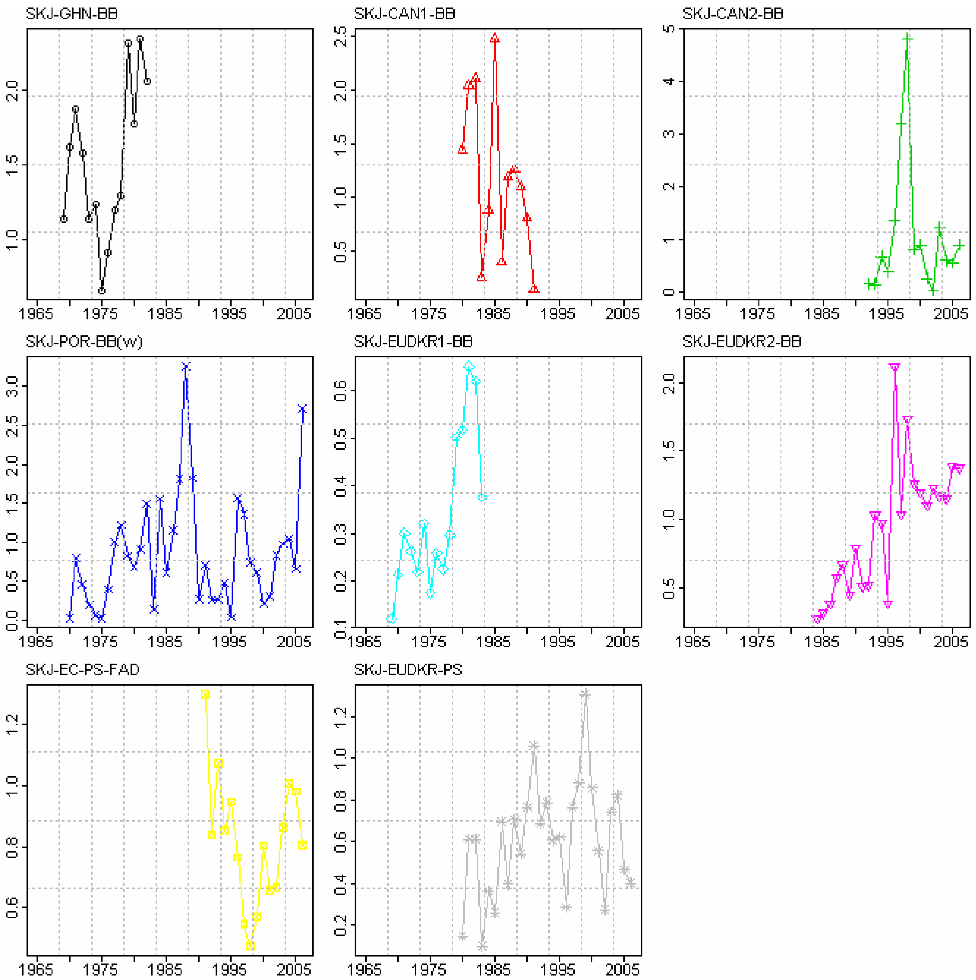


Figure 71. Plot of indices of abundance used for BSP projection models for eastern skipjack.

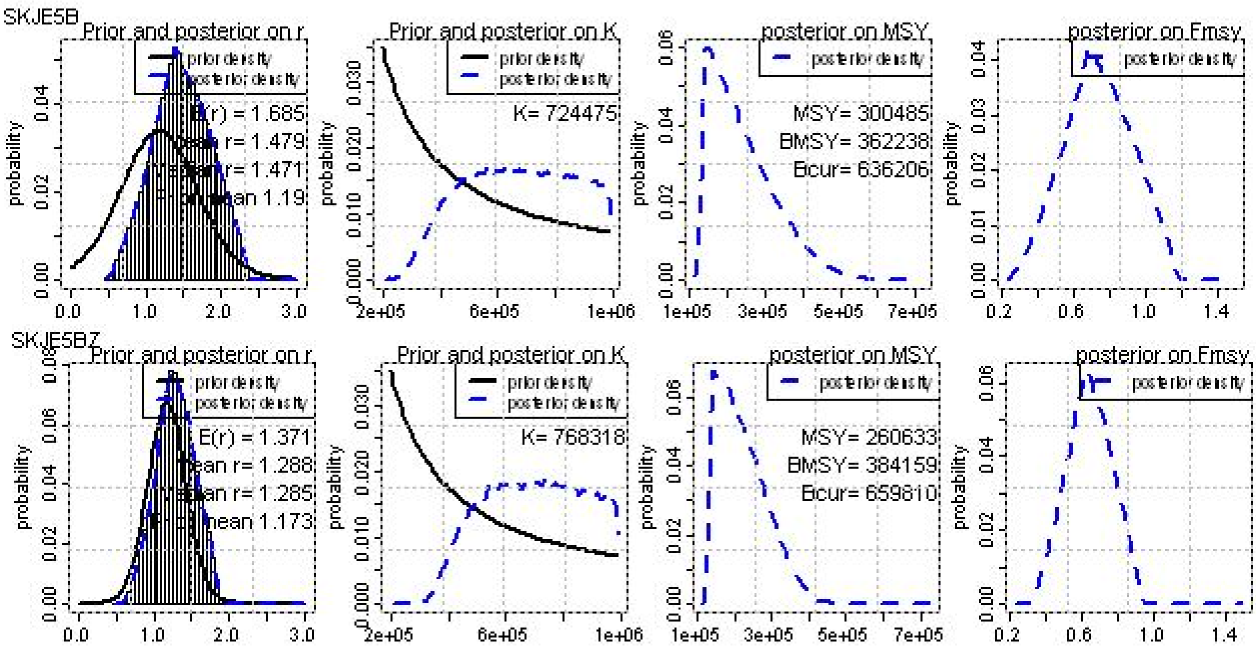


Figure 72. Comparison of SKJE A. Run 5B with a loose prior on r (sd=0.5) and B. Run 5BZ with a tight prior on r (sd =0.25).

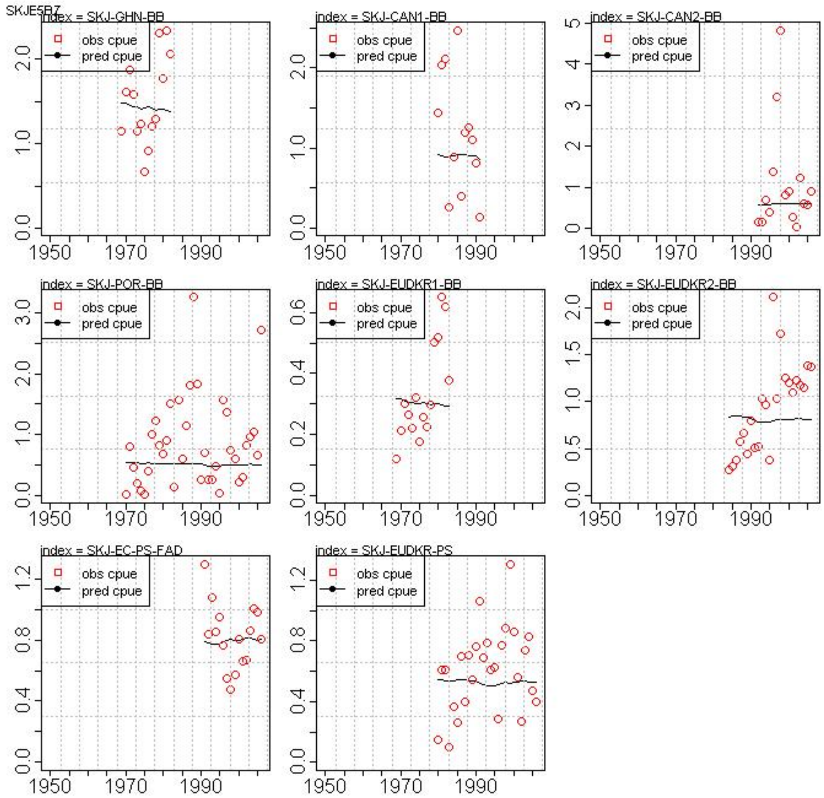


Figure 73. Fits to the indices for BSP RUN5BZ for with low variance r prior.

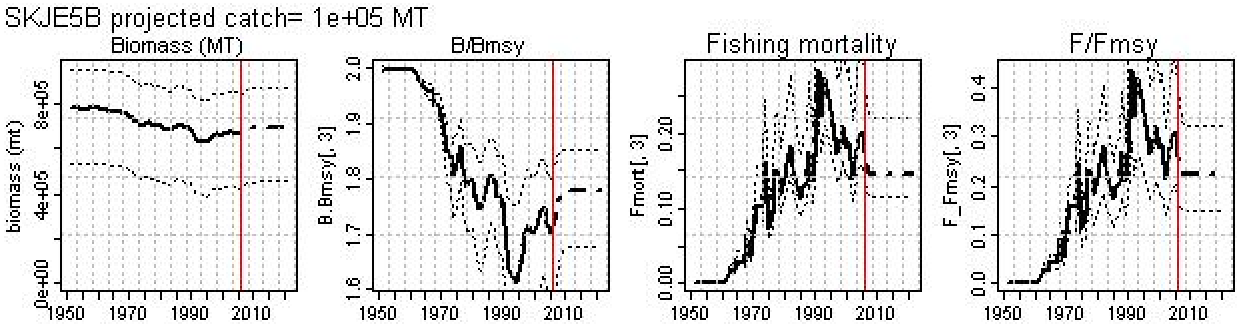


Figure 74. Biomass, B/B_{MSY}, F, and F/F_{MSY} trajectory with projections of 100,000 MT starting in 2007 for SKJE-RUN5BZ, low variance on r. Dashed lines are 90% confidence intervals based on importance samples.

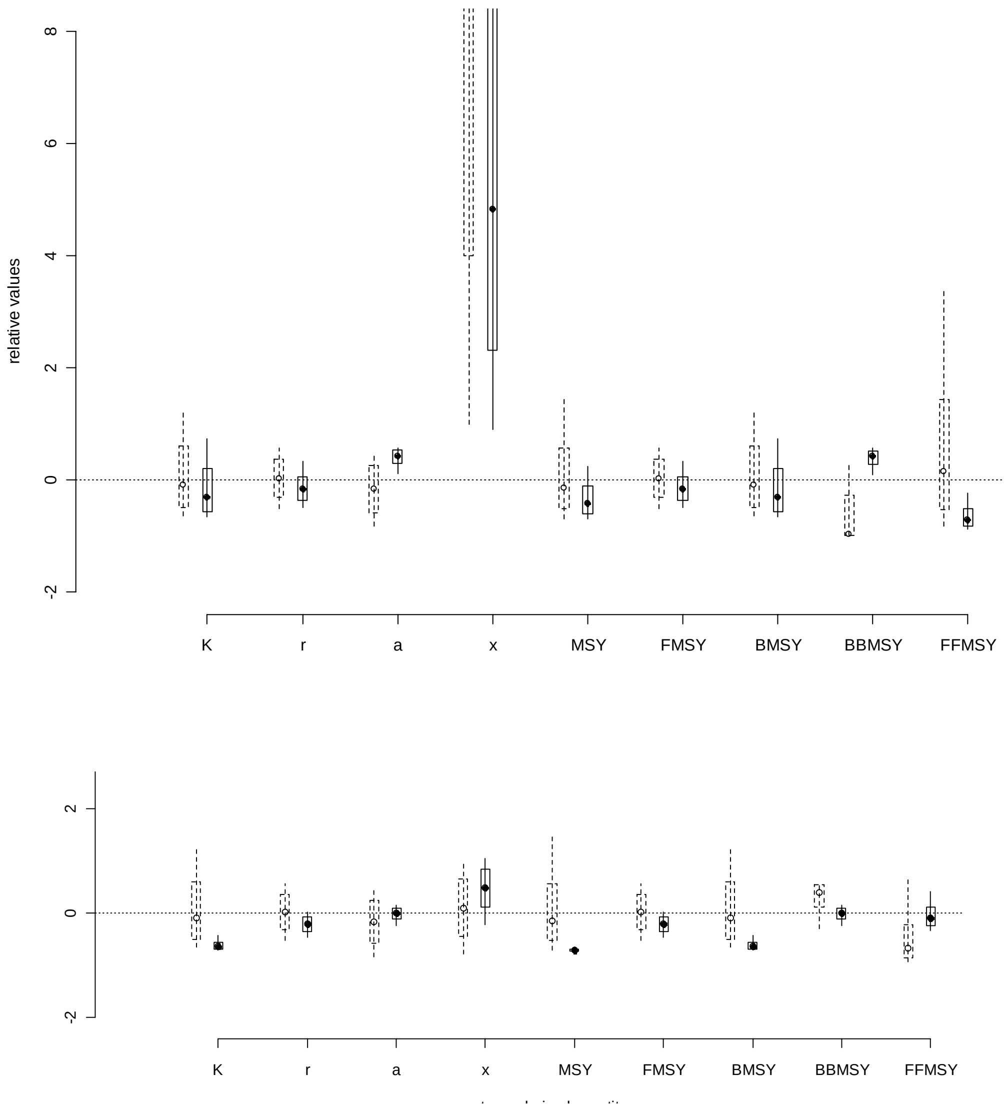


Figure 75. Priors and posteriors for runs A.1 and B.1 for the western skipjack stock. The priors (dashed boxes) and posteriors (solid boxes) were relativised to be in the same scale. The dashed boxes for management quantities are the values obtained by running the model only with the priors.

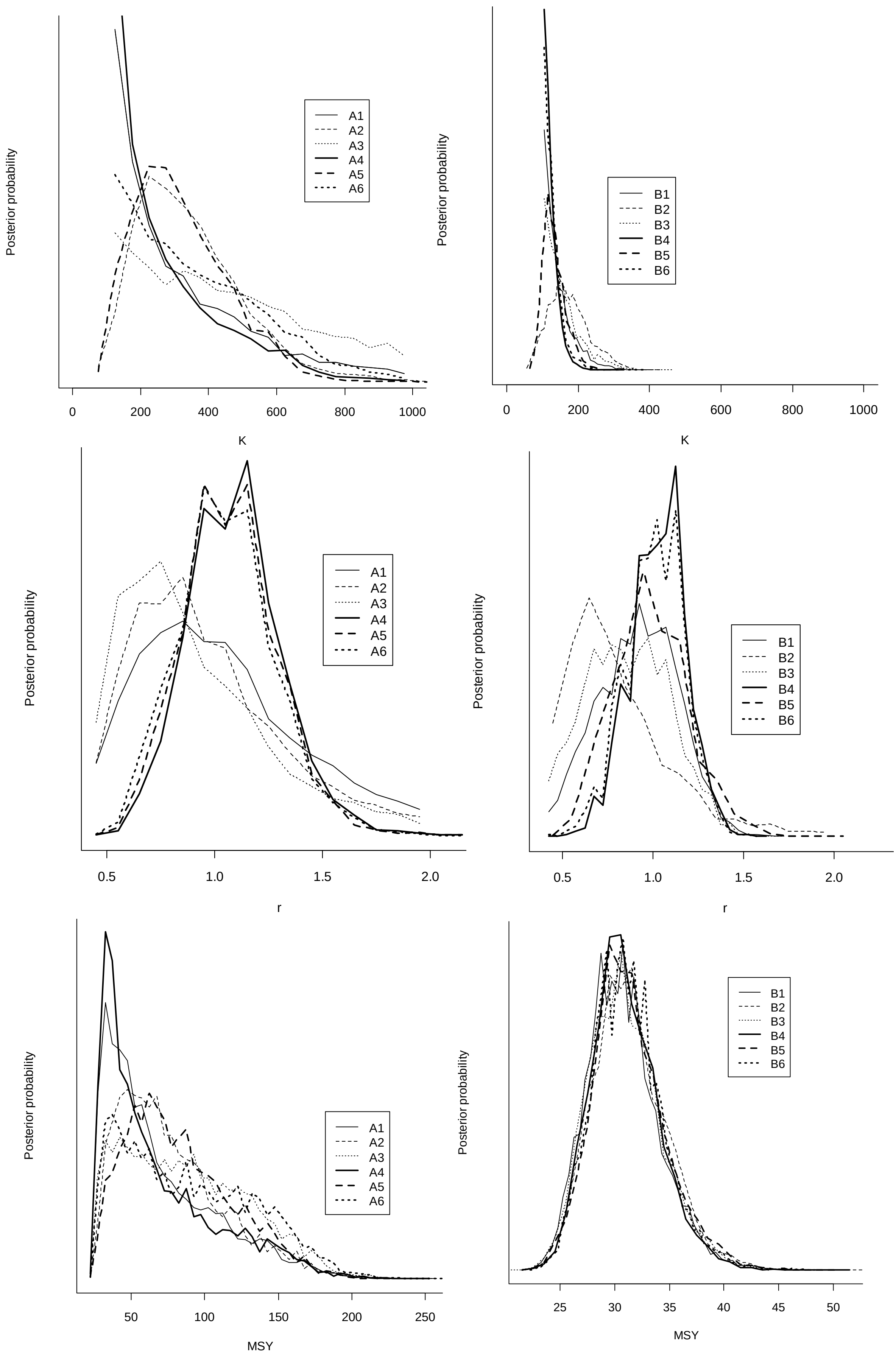


Figure 76. Posteriors for *K*, *r* and *MSY* for runs A1 to A6 (left) and B1 to B6 (right) for the western skipjack stock. (Units for *K* and MSY are in 1,000 t).

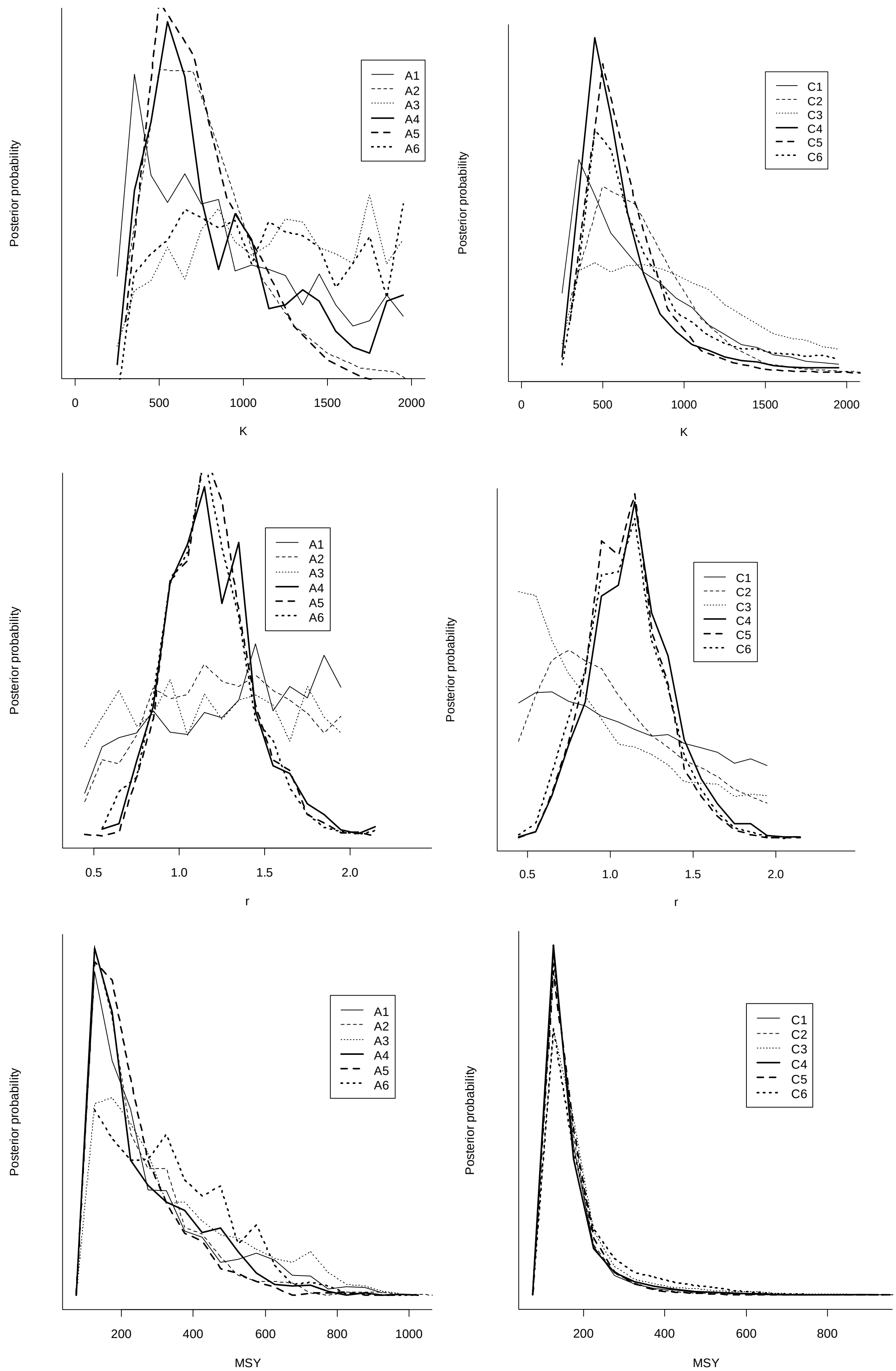


Figure 77. Posteriors for K, r and MSY for runs A1 to A6 (left) and C1 to C6 (right) for the eastern SKJ stock (units for K and MSY are in 1000 t).

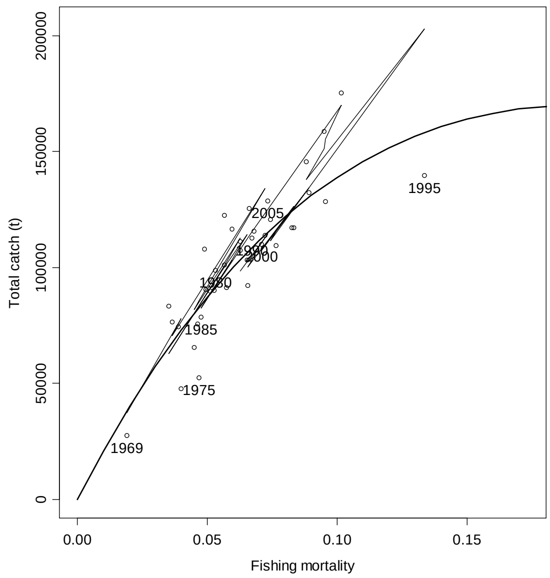


Figure 78. Total catches observed (circles), predicted (solid line) and equilibrium production curve estimated in the standard run.

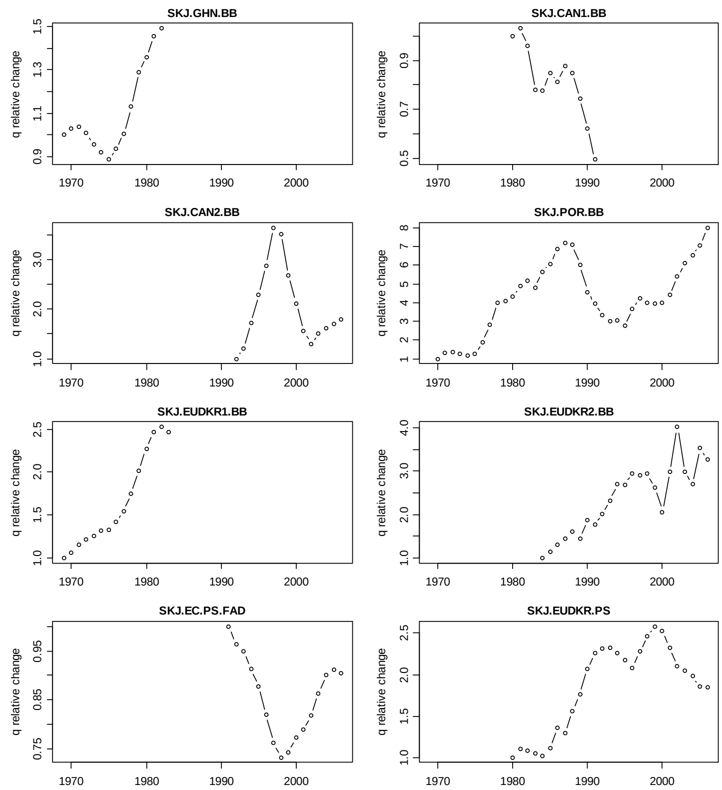


Figure 79. Relative changes in catchability estimated with a process error on catchability for the 8 fishing fleets considered in the standard run. GHN.BB = Ghanean baitboats; CAN.BB = Canarian baitboats; POR.BB = Azorean baitboats; EUDKR.BB = European and Senegalese baitboats; EC.PS.FAD = European purse seiners fishing on fishing aggregating devices; EUDKR.PS = Spanish purse seiners fishing off Senegal.

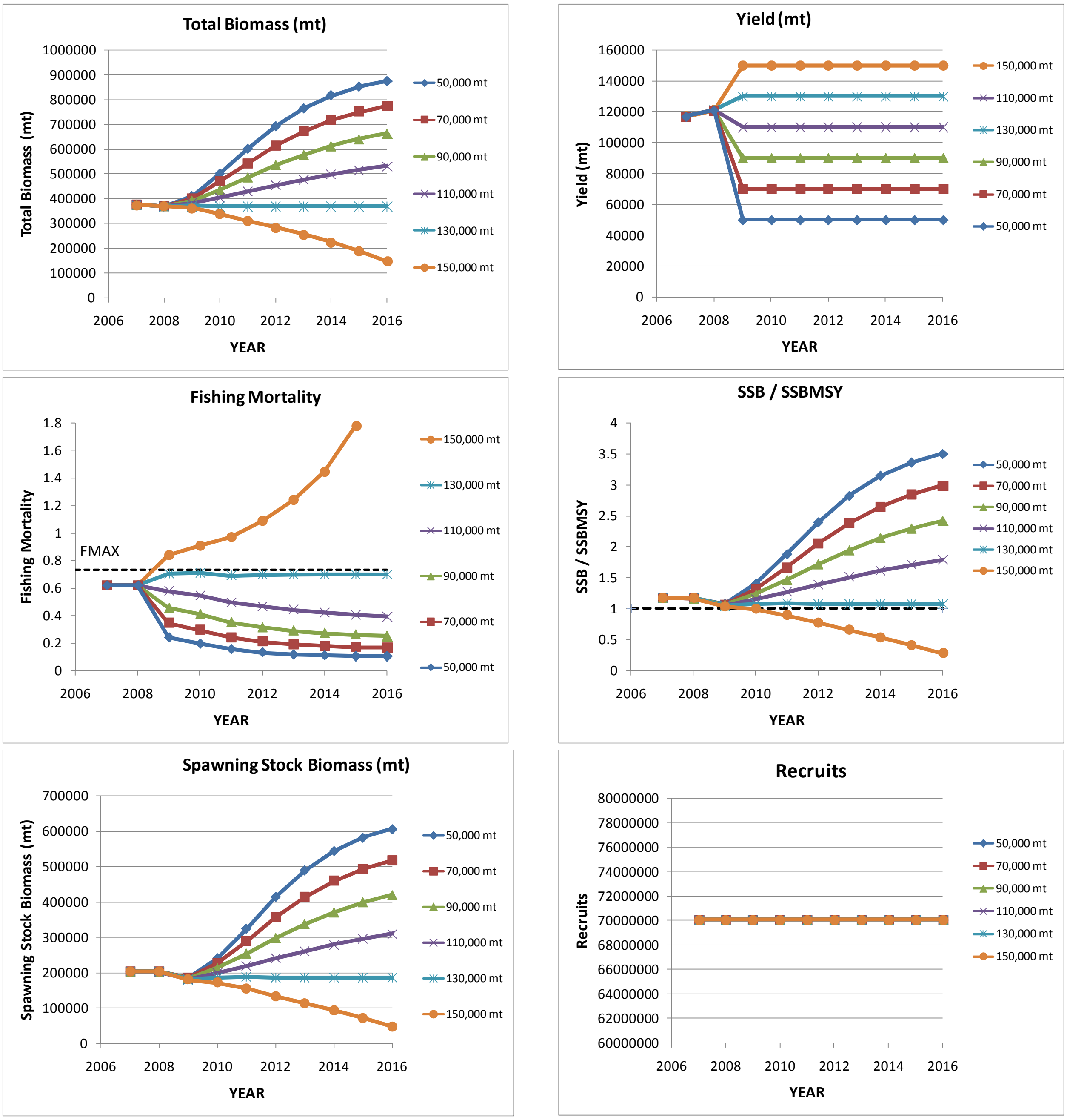


Figure 80. Constant catch projection results using the joint distribution of YFT VPA runs 5 and 10.

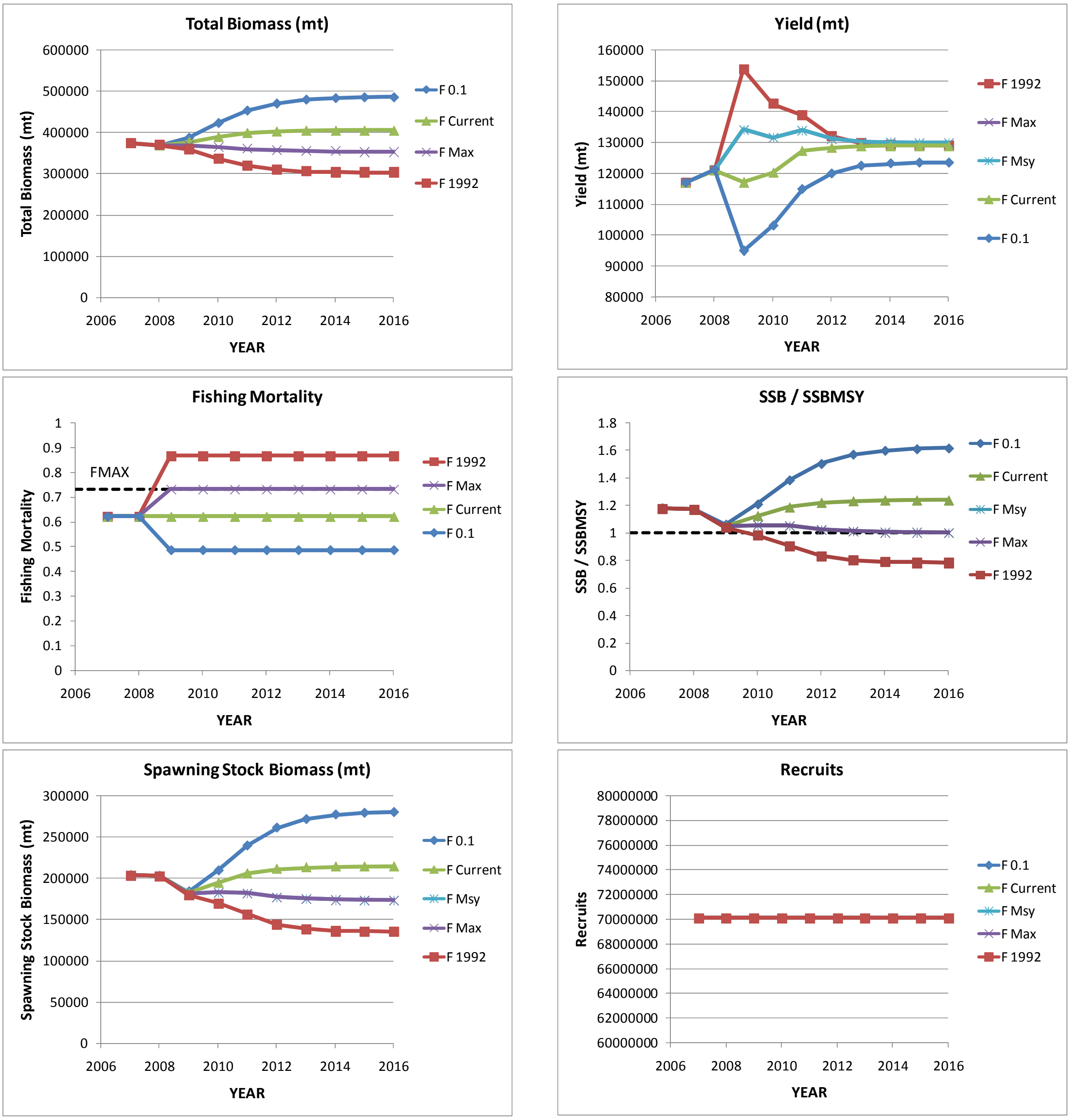


Figure 81. Constant F projection results using the joint distribution of YFT VPA runs 5 and 10.

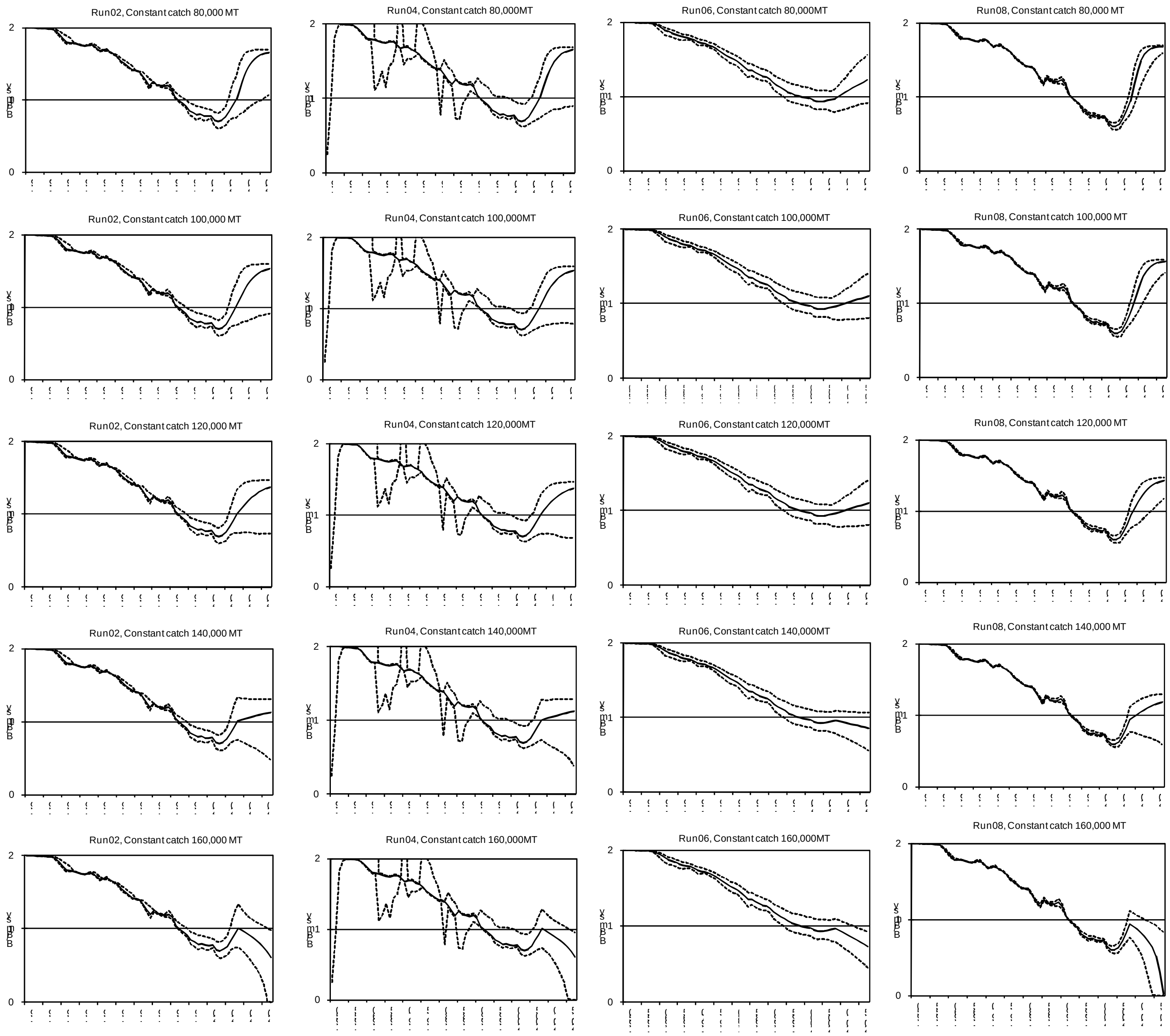


Figure 82. Biomass projections for catch levels of 80,000 t, 100,000 t, 120,000 t, 140,000 t and 160,000 t for each of the 4 ASPIC cases.

Appendix 1

Agenda

1. Opening, adoption of the Agenda and meeting arrangements.
2. Review of Biological Information, including results from tagging, growth & reproductive studies, and other studies pertinent to the assessment
3. Review of fishery statistics: Effort and Catch data, including size frequencies and fisheries trends
4. Relative abundance indices and other fishery indicators
5. Methods and other data relevant to the assessment
   5.1 Methods – Yellowfin
   5.2 Methods – Skipjack
6. Stock status results
   6.1 Stock status – Yellowfin
   6.2 Stock status – Skipjack
7. Projections
   7.1 Projections – Yellowfin
   7.2 Projections – Skipjack
8. Recommendations
   8.1 Research and Statistics – Yellowfin
   8.2 Research and Statistics – Skipjack
   8.3 Management – Yellowfin
   8.4 Management – Skipjack
9. Other matters
10. Adoption of the report and closure

Appendix 2

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Appendix 3

List of Documents

SCRS/2008/105	Estadísticas españolas de la pesquería atunera tropical, en el Océano Atlántico, hasta 2007. DELGADO DE MOLINA, A., J.C. Santana and J. Ariz.
SCRS/2008/106	Datos estadísticos de la pesquería de túnidos de las Islas Canarias durante el periodo 1975 a 2007. DELGADO DE MOLINA, A., J. Ariz, R. Delgado de Molina and J. C. Santana.
SCRS/2008/108	Japanese longline CPUE for yellowfin tuna (*Thunnus albacares*) in the Atlantic Ocean standardized using GLM up to 2006. OKAMOTO, H.

SCRS/2008/109 Estandarización de la CPUE del atún aleta amarilla (*Thunnus albacares*) capturados por las flotas de palangre de Brasil y Uruguay (1980-2006). PONS, M., P. Travassos, A. Domingo, H. Hazin and F. Hazin.

SCRS/2008/110 Estandarización de la CPUE del atún aleta amarilla de la flota palangrera uruguaya (1982-2007). PONS, M. and A. Domingo.

SCRS/2008/111 Distribución espacio temporal, composición de tallas y relaciones ambientales del atún aleta amarilla (*Thunnus albacares)* en el Atlantico SW. DOMINGO, A., M. Rios and M. Pons.

SCRS/2008/112 Standardization of (*Thunnus albacares*) CPUE series caught by Brazilian longliners in the Atlantic Ocean. TRAVASSOS, P., H. Hazin, F. Hazin, B. Mourato and F. Carvalho.

SCRS/2008/113 Standardized catch rate of skipjack tuna (*Katsuwonus pelamis*) caught in the southwest of the South Atlantic Ocean. ANDRADE, H.A.

SCRS/2008/114 Estimates of total mortality and selectivity for eastern Atlantic skipjack (*Katsuwonus pelamis*) from catch curves based on length composition data (1971-2005). GAERTNER, D.

SCRS/2008/115 Actualización de la CPUE estandarizada de rabil de la flota de cerco tropical en el océano Atlántico de 1980 a 2006. SOTO, M., P. Pallarés, A. Delgado de Molina and D. Gaertner.

SCRS/2008/116 Stardardized CPUE for juvenile Atlantic yellowfin and bigeye and skipjack tunas caught by the purse seine fleet fishing with FADs. SOTO, M., D. Gaertner, A. Delgado de Molina and P. Pallarés.

SCRS/2008/117 A preliminary attempt to estimate tuna discards and by-catch in the French purse seine fishery of the eastern Atlantic Ocean. CHASSOT, E., M.J. Amande, R. Pianet, P. Chavance and R. Dedo.

SCRS/2008/118 Stardardized CPUE for eastern Atlantic skipjack tuna caught in free school by the purse seine fleet. SOTO, M., D. Gaertner, J. Ariz and P. Pallarés.

SCRS/2008/119 Standardized catch rates for yellowfin tuna (*Thunnus albacares*) in the Gulf of Mexico longline fishery for 1992-2007 based upon observer programs from Mexico and the United States. BROWN, C.A. and K. Ramírez-López.

SCRS/2008/120 Standardized catch rate in number and weight of yellowfin tuna (*Thunnus albacares*) from the United States pelagic longline fishery 1986-2007. WALTER, J.

SCRS/2008/121 Standardized catch rate of skipjack tuna (*Katsuwonus pelamis*) from the United States pelagic longline fishery 1991-2007. WALTER, J.

SCRS/2008/122 Catch rate indices of yellowfin (*Thunnus albacares*) and skipjack (*Katsuwonus pelamis*) tunas from the United States recreational fishery in the western North Atlantic Ocean, 1986-2007. CASS-CALAY, S. L.

SCRS/2008/124 Statistiques de la pêcherie thonière Europeenne et assimilée durant la période 1991-2007. PIANET, R., V. Nordström , P. Dewals , A. Delgado, J. Ariz , R. Saralde, R. Gnegoury Dédo and Y. Diatta.

SCRS/2008/125 Datos estadisticos de la flota palangrera mexicana dedicada a la pesca del atun aleta amarilla en el Golfo de México durante el periodo 1994 a 2007. RAMIREZ LOPEZ, K.

SCRS/2008/126 Recollection (historical years, 1969-2004) and update (new years, 2005-07) of the skipjack (*Katsuwonus pelamis*) catch-at size for the Atlantic eastern and western stocks.PALMA, C. and P. Kebe.

SCRS/2008/127 Update (years 2005-06) of yellowfin tuna (*Thunnus albacares*) catch-at-size for the overall Atlantic stock. PALMA, C. and P. Kebe.

Appendix 4

Appendices MFCL

Available from the ICCAT Secretariat upon request.

Appendix 5

Estimation of Combined Indices for Yellowfin and Skipjack

Combined indexes were estimated for both species using a GLM approach with the following model formulation:

Log(index) = Year + Source + ε

Where 'Source' identifies the index (fleet) included in the model and ε is the error term. Indexes expressed as number of fish per unit of effort were transformed into biomass by multiplying the index value times the average weight of the fish. Average weights were estimated from the yield-at-age and weight at age matrices for each specific fishery:

$$\overline{W}_{y,g} = \frac{\sum_a C_{y,a,g} * W_{y,a}}{\sum_a C_{y,a,g}}$$

Where y, a, and g indentify the year, age, and fishery, respectively. Prior to estimating the combined indexes, individual indexes were scaled to their mean value of the overlapping years. Annual weighting factors were estimated for each fleet by counting the number of 5^ox5^o squares where each fishery operated and estimating the proportion to the total number of squares fished for each year. This approach allowed to capture the spatial expansion/contraction experienced by different fleets over time. The index weights were re-scaled so that they would add up to 1.0 each year.

$$\phi_{y,g} = \frac{Y_{y,g}}{\sum_g Y_{y,g}}$$

Yellowfin tuna

Table Appendix 5.1 shows the values of the indexes used in the GLM to estimate the combined index. The fleets included in the model were the Japanese longline, the combined Mexico and US longline in the Gulf of Mexico, the US rod and reel, the Brazilian longline, the Chinese-Taipei longline, the Canadian baitboat, the Venezuelan purse seine, the Brazilian baitboat, the EC-Dakar baitboat, the Venezuelan longline, and the EC-purse seine assuming a constant annual increase in catchability of 3%. The estimated weighting factos are shown in **Table Appendix 5.2** and the estimated unweighted and weighted combined indexes are presented in **Table Appendix 5.5** and **Figure Appendix 5.1**. Both the unweighted and weighted index showed similar trends with a sharp decrease in the late 1960s followed by a relatively stable period until about 1990. From 1990 onward both indexes showed a continuous declining trend.

Skipjack tuna

Table Appendix 5.3 presents the values of the indexes used in the GLM to estimated combined indexes for each skipjack stock. The fisheries used to estimate the combined index for the ATE stock where the EC-Dakar and EC-FAD purse seine fisheries and the Ghana, Canarian, Portugal and EC-Dakar baitboat fisheries. In the case of the ATW stock they were the Venezuelan purse seine, the US rod and reel and the Brazilian baitboat. The combined index for the skipjack eastern Atlantic stock (ATE) showed a variable but constant increasing trend from the beginning of the time series in 1965 to the end in 2006. The western Atlantic stock (ATW) series started in 1981 and also showed a series with highly variable values but with a relatively constant trend. The weighting factors for each fishery/year are shown in the **Table Appendix 5.4**. Values of the estimated combined indexes for each stocks and matrices of weighting factors are shown in **Table Appendix 5.5** and **Figure Appendix 5.1**.

Table Appendix 5.1 Yellowfin scaled indexes of abundance used in the GLM to estimate a combined index. The indexes included were the Japanse longline (jp_ll), the combined Mexico and US longline in the Gulf of Mexico (mxus_ll), the US rod and reel (US_rr), the Brazilian longline (br_ll), the Chinese-Taipei longline (tai_ll), the Canarian baitboat (can_bb), the Venezuelan purse seine (ven_ps), the Brazilian baitboat (br_bb), the EC-Dakar baitboat (eudkr_bb), the Venezuelan longline (ven_ll) and the EC-purse seine assuming an constant annual increase in catchability of 3% (ec_ps_3perc).

YEAR	*jp_ll*	*mx_ll*	*us_rr*	*br_ll*	*uru_ll*	*tai_ll*	*ca_bb*	*ve_ps*	*br_bb*	*us_ll_atl*	*Eudkr_bb*	*ven_ll*	*ec_ps_3perc*
1965	4.16												
1966	2.801												
1967	5.509												
1968	4.557					4.303							
1969	4.01					3.787					0.763		
1970	2.985					3.066					0.746		1.702
1971	2.396					1.745					0.737		1.452
1972	3.24					1.895					0.741		1.612
1973	2.275					2.185					0.682		1.625
1974	3.141					1.128					1.071		1.481
1975	2.334					0.971					0.469		1.595
1976	2.291					1.152					0.519		1.578
1977	1.778					1.038					0.792		1.55
1978	2.611					0.946					0.306		1.411
1979	3.149					0.982					0.577		1.403
1980	1.946					0.918	0.051						1.162
1981	2.456				1.256	0.953	0.103		4.468		1.186		1.247
1982	2.169				1.705	0.716	0.499		0.68		1.131		1.065
1983	2.158				0.735	0.917	0.878	2.199	1.85		1.151		0.924
1984	2.322				0.365	0.916	3.274	0.975	0.9		1.645		0.73
1985	1.484				0.654	0.901	1.422	1.646	0.673		1.264		1.255
1986	1.86		1.503	1.392	1.009	1.046	0.915	0.967	0.673		1.908		1.354
1987	1.961		0.714	1.758	0.973	0.953	2.043	0.74	0.947	2.567	2.152		1.186
1988	1.947		0.357	1.459	1.236	1.835	2.126	1.02	1.05	2.799	2.083		1.123
1989	1.524		0.588	1.477	0.492	1.328	1.257	2.21	0.96	2.218	0.502		1.4
1990	2.064		0.264	2.502	0.449	1.468	3.199	1.133	1.993	1.897	1.92		1.523
1991	1.573		0.424	1.373	1.617	1.233	2.827	1.157	0.602	1.41	1.39	1.114	1.212
1992	1.773		0.289	0.572	2.539	0.925	1.638	0.779	0.947	1.569	2.71	1.634	1.106
1993	0.845	1.124	0.658	0.664	0.485	1.082	0.748	0.892	1.124	0.953	2.2	2.352	1.095
1994	1.437	1.44	1.594	0.738	1.857	1.158	0.445	1.088	0.673	0.995	1.638	1.118	1.05
1995	0.99	0.92	2.164	0.501	0.763	1.283	0.189	0.49	0.333	1.134	0.979	0.765	1.073
1996	1.082	0.868	0.676	1.285	1.446	1.249	2.851	1.097	0.929	0.932	1.6	0.976	1.048
1997	0.821	0.936	0.29	1.017	0.474	0.971	0.341	0.74	1.355	0.999	0.679	0.597	0.971
1998	0.984	0.789	0.493	1.296	0.537	0.978	4.03	0.6	1.038	0.829	0.258	1.021	0.871
1999	0.995	1.198	0.974	1.215	1.088	0.721	0.384	0.879	0.359	0.949	0.74	0.932	0.783
2000	1.104	0.899	1.043	1.268	1.434	0.936	0.012	1.072		1.137	0.349	0.289	1.003
2001	0.743	0.825	1.109	1.017	0.916	0.623	0	2.143	2.189	1.072	0.558	0.95	1.106
2002	0.759	0.817	0.905	0.804	0.869	0.949	0.13	1.324	0.934	1.005	0.847		1.252
2003	0.895	1.02	0.825	1.705	1.32	1.283	0.244	0.647	0.764	0.868	0.967		1.068
2004	1.16	0.809	0.807	2.084	0.95	1.178	0.201	0.387	0.291	1.163	0.737		0.977
2005	0.881	0.766	0.606	0.254	2.002	1.475	0.027	0.198	0.332	1.252	0.601		1.058
2006	1.224	0.738	0.912	0.638	0.787	1.411	0.085		0.376	1.121	0.681		1.291

Table Appendix 5.2 Weighting factors (by fleet and year) used to estimate the yellowfin weighted combined index.

YEAR	*jp_ll*	*mxus_ll*	*us_rr*	*br_ll*	*usu_ll*	*tai_ll*	*ve_ps*	*br_bb*	*us_ll_atl*	*ven_ll*	*ec_ps_3perc*	*can_bb*	*eudkr_bb*
1965	1	0	0	0	0	0	0	0	0	0	0	0	0
1966	1	0	0	0	0	0	0	0	0	0	0	0	0
1967	1	0	0	0	0	0	0	0	0	0	0	0	0
1968	0.65	0	0	0	0	0.35	0	0	0	0	0	0	0
1969	0.47	0	0	0	0	0.46	0	0	0	0	0	0	0.07
1970	0.46	0	0	0	0	0.43	0	0	0	0	0.04	0	0.06
1971	0.53	0	0	0	0	0.37	0	0	0	0	0.04	0	0.06
1972	0.49	0	0	0	0	0.41	0	0	0	0	0.03	0	0.06
1973	0.47	0	0	0	0	0.4	0	0	0	0	0.05	0	0.08
1974	0.4	0	0	0	0	0.48	0	0	0	0	0.05	0	0.06
1975	0.48	0	0	0	0	0.42	0	0	0	0	0.06	0	0.05
1976	0.37	0	0	0	0	0.52	0	0	0	0	0.07	0	0.04
1977	0.34	0	0	0	0	0.53	0	0	0	0	0.09	0	0.04
1978	0.35	0	0	0	0	0.52	0	0	0	0	0.1	0	0.02
1979	0.41	0	0	0	0	0.47	0	0	0	0	0.08	0	0.04
1980	0.41	0	0	0	0	0.5	0	0	0	0	0.08	0	
1981	0.44	0	0	0	0.01	0.46	0	0.01	0	0	0.08	0	0
1982	0.43	0	0	0	0	0.47	0	0.02	0	0	0.07	0	0
1983	0.38	0	0	0	0.01	0.42	0.03	0.02	0	0	0.09	0	0.04
1984	0.37	0	0	0	0.03	0.39	0.06	0.03	0	0	0.08	0	0.03
1985	0.43	0	0	0	0.03	0.39	0.04	0.02	0	0	0.06	0	0.02
1986	0.36	0	0.03	0.06	0.03	0.4	0.02	0.02	0	0	0.06	0	0.02
1987	0.33	0	0.03	0.06	0.01	0.32	0.01	0.02	0.15	0	0.05	0	0.02
1988	0.4	0	0.03	0.06	0.01	0.16	0.01	0.01	0.19	0	0.08	0	0.03
1989	0.43	0	0.04	0.04	0	0.16	0.01	0.01	0.22	0	0.05	0	0.03
1990	0.4	0	0.03	0.05	0	0.2	0.02	0.02	0.19	0	0.05	0.02	0.03
1991	0.37	0	0.03	0.05	0	0.31	0.01	0.02	0.14	0.01	0.05	0	0.02
1992	0.35	0	0.03	0.1	0	0.23	0.01	0.02	0.16	0.01	0.06	0	0.03
1993	0.28	0.02	0.03	0.09	0	0.35	0.02	0.02	0.12	0.01	0.05	0	0.01
1994	0.31	0.02	0.03	0.07	0	0.37	0.01	0.01	0.11	0.01	0.04	0	0.01
1995	0.33	0.01	0.02	0.07	0	0.32	0.01	0.02	0.13	0	0.05	0	0.02
1996	0.28	0.02	0.03	0.11	0	0.33	0.02	0.01	0.13	0.01	0.06	0	0.02
1997	0.3	0.02	0.03	0.11	0	0.31	0.01	0.01	0.14	0.01	0.04	0	0.02
1998	0.3	0.02	0.03	0.1	0	0.33	0.01	0.02	0.13	0.01	0.05	0	0.01
1999	0.27	0.01	0.02	0.13	0	0.36	0.01	0.01	0.1	0.02	0.04	0	0.01
2000	0.31	0.01	0.02	0.07	0	0.38	0.01	0.01	0.09	0.03	0.05	0	0.01
2001	0.3	0.01	0.02	0.11	0	0.34	0.01	0.01	0.09	0.03	0.05	0	0.01
2002	0.27	0.01	0.02	0.12	0	0.4	0.01	0.02	0.09	0	0.04	0	0.01
2003	0.3	0.02	0.03	0.12	0	0.37	0.01	0.01	0.07	0	0.06	0	0.02
2004	0.3	0.01	0.02	0.11	0	0.38	0.01	0.01	0.07	0	0.07	0	0.01
2005	0.3	0.02	0.03	0.15	0	0.29	0.02	0.04	0.08	0	0.05	0	0.01
2006	0.41	0.02	0.04	0.19	0	0.11	0	0.03	0.1	0	0.07	0	0.02

Table Appendix 5.3 Skipjack indices of abundance values used in the GLM to estimate a combined indexes. The indexes used included for the Eastern Atlantic stock (ATE) the baitboat fisheries from Ghana (ghn_bb), Canary Islands (can1_bb and can2_bb), Portugal (por_bb), and EC-Dakar (eudkr1_bb and eudkr2_bb) and the purse seine fisheries from EC-Dakar (eudkr_ps) and the EC on FADs (ec_ps_fad). In the case of the western stock (ATW) the fisheries were the Brazilian baitboat (br_bb), the Venezuelan purse seine (ven_ps) and the US rod and reel (us_rr).

	SKJ - ATE								SKJ - ATW		
Year	*ghn*	*can1_b*	*can2_b*	*por_b*	*eudkr1_b*	*eudkr2_b*	*ec_ps_fa*	*eudkr_p*	*br_b*	*ven_p*	*us_r*
1969	1.13				0.121						
1970	1.612			0.019	0.213						
1971	1.865			0.793	0.299						
1972	1.581			0.453	0.263						
1973	1.138			0.196	0.219						
1974	1.233			0.066	0.319						
1975	0.664			0.02	0.175						
1976	0.917			0.39	0.257						
1977	1.201			0.998	0.224						
1978	1.296			1.216	0.296						
1979	2.308			0.823	0.503						
1980	1.771	1.439		0.678	0.518			0.147			
1981	2.34	2.035		0.907	0.651			0.612	1.17		
1982	2.055	2.105		1.497	0.62			0.61	1.58	4.08	
1983		0.265		0.133	0.376			0.098	0.62	1.58	
1984		0.883		1.557		0.273		0.363	0.65	1.17	
1985		2.471		0.605		0.311		0.26	0.93	1.41	
1986		0.405		1.149		0.38		0.696	0.94	0.85	1.52
1987		1.191		1.814		0.576		0.395	0.72	1.05	0.65
1988		1.26		3.258		0.663		0.704	0.83	0.85	1.02
1989		1.105		1.821		0.444		0.541	0.76	1.14	0.96
1990		0.811		0.264		0.79		0.765	1.34	1.03	0.95
1991		0.146		0.693		0.505	1.298	1.061	0.83	1.24	1.09
1992			0.16	0.258		0.516	0.838	0.688	0.94	0.87	0.43
1993			0.153	0.255		1.028	1.076	0.786	1.33	0.95	1.64
1994			0.676	0.475		0.966	0.853	0.608	0.82	0.64	0.8
1995			0.379	0.029		0.381	0.947	0.622	1.06	0.5	0.44
1996			1.376	1.569		2.118	0.765	0.286	0.92	1.14	0.53
1997			3.208	1.365		1.037	0.545	0.767	1.26	2	0.71
1998			4.821	0.733		1.732	0.474	0.883	0.81	1.49	1.38
1999			0.808	0.602		1.26	0.572	1.307	0.62	0.51	2.21
2000			0.901	0.208		1.198	0.803	0.861		0.56	0.52
2001			0.263	0.298		1.1	0.658	0.558	0.93	1.3	1.6
2002			0.041	0.827		1.23	0.668	0.272	0.78	0.6	1.29
2003			1.232	0.971		1.169	0.864	0.742	1.37	0.49	1.62
2004			0.605	1.05		1.148	1.008	0.825	0.97	0.51	0.83
2005			0.555	0.651		1.383	0.981	0.469	1.41	0.05	0.45
2006			0.904	2.71		1.376	0.806	0.401	1.37		0.37

Table Appendix 5.4 Weighting factors (by fleet and year) used to estimate the skipjack weighted combined indexes.

	SKJ - ATE								*SKJ - ATW*		
Year	*ghn_bb*	*can1_bb*	*can2_bb*	*por_bb*	*eudkr1_bb*	*eudkr2_bb*	*ec_ps_fad*	*eudkr_ps*	*br_bb*	*ven_ps*	*us_rr*
1969	0.21	0.00	0.00	0.00	0.79	0.00	0.00	0.00			
1970	0.17	0.00	0.00	0.08	0.75	0.00	0.00	0.00			
1971	0.17	0.00	0.00	0.09	0.74	0.00	0.00	0.00			
1972	0.19	0.00	0.00	0.10	0.71	0.00	0.00	0.00			
1973	0.22	0.00	0.00	0.11	0.67	0.00	0.00	0.00			
1974	0.24	0.00	0.00	0.12	0.65	0.00	0.00	0.00			
1975	0.25	0.00	0.00	0.17	0.58	0.00	0.00	0.00			
1976	0.25	0.00	0.00	0.17	0.58	0.00	0.00	0.00			
1977	0.47	0.00	0.00	0.12	0.41	0.00	0.00	0.00			
1978	0.30	0.00	0.00	0.20	0.50	0.00	0.00	0.00			
1979	0.23	0.00	0.00	0.15	0.62	0.00	0.00	0.00			
1980	0.25	0.05	0.00	0.10	0.40	0.00	0.00	0.20			
1981	0.21	0.05	0.00	0.11	0.42	0.00	0.00	0.21	1.00	0.00	0.00
1982	0.35	0.04	0.00	0.09	0.35	0.00	0.00	0.17	0.56	0.44	0.00
1983	0.00	0.06	0.00	0.13	0.56	0.00	0.00	0.25	0.57	0.43	0.00
1984	0.00	0.07	0.00	0.13	0.00	0.53	0.00	0.27	0.42	0.58	0.00
1985	0.00	0.08	0.00	0.15	0.00	0.46	0.00	0.31	0.47	0.53	0.00
1986	0.00	0.08	0.00	0.15	0.00	0.46	0.00	0.31	0.38	0.14	0.48
1987	0.00	0.08	0.00	0.17	0.00	0.42	0.00	0.33	0.32	0.16	0.53
1988	0.00	0.06	0.00	0.17	0.00	0.50	0.00	0.28	0.22	0.22	0.56
1989	0.00	0.07	0.00	0.13	0.00	0.53	0.00	0.27	0.24	0.18	0.59
1990	0.00	0.26	0.00	0.11	0.00	0.42	0.00	0.21	0.29	0.24	0.48
1991	0.00	0.03	0.00	0.07	0.00	0.24	0.55	0.10	0.37	0.11	0.53
1992	0.00	0.00	0.03	0.06	0.00	0.18	0.61	0.12	0.29	0.24	0.48
1993	0.00	0.00	0.04	0.07	0.00	0.19	0.63	0.07	0.32	0.28	0.40
1994	0.00	0.00	0.03	0.06	0.00	0.15	0.61	0.15	0.26	0.21	0.53
1995	0.00	0.00	0.03	0.06	0.00	0.20	0.60	0.11	0.32	0.23	0.45
1996	0.00	0.00	0.03	0.06	0.00	0.16	0.63	0.13	0.33	0.19	0.48
1997	0.00	0.00	0.03	0.06	0.00	0.18	0.62	0.12	0.32	0.23	0.45
1998	0.00	0.00	0.03	0.06	0.00	0.21	0.62	0.09	0.38	0.21	0.42
1999	0.00	0.00	0.03	0.05	0.00	0.19	0.62	0.11	0.22	0.22	0.56
2000	0.00	0.00	0.03	0.09	0.00	0.23	0.54	0.11	0.22	0.22	0.56
2001	0.00	0.00	0.03	0.09	0.00	0.13	0.63	0.13	0.30	0.20	0.50
2002	0.00	0.00	0.03	0.09	0.00	0.18	0.61	0.09	0.33	0.19	0.48
2003	0.00	0.00	0.03	0.06	0.00	0.18	0.62	0.12	0.26	0.21	0.53
2004	0.00	0.00	0.03	0.05	0.00	0.16	0.65	0.11	0.29	0.24	0.48
2005	0.00	0.00	0.03	0.06	0.00	0.18	0.64	0.09	0.47	0.24	0.29
2006	0.00	0.00	0.04	0.07	0.00	0.18	0.57	0.14	0.38	0.00	0.63

Table Appendix 5.5 Estimated yellowfin and skipjack weighted and unweigthed combined indexes. Refer to text for explanation of the fleets used in the GLM procedure.

	Yellowfin		*Skipjack - ATE*		*Skipjack - ATW*	
Year	*Unweighted*	*Weighted*	*Unweighted*	*Weighted*	*Unweighted*	*Weighted*
1965	2.5708	2.5708	0.1476	0.220		
1966	1.7311	1.7311	0.1985	0.142		
1967	3.4049	3.4049	0.3608	0.582		
1968	3.2299	3.2299	0.3063	0.438		
1969	1.9136	1.9136	0.2339	0.279		
1970	1.5549	1.5549	0.2681	0.226		
1971	1.2247	1.2247	0.1230	0.102		
1972	1.3862	1.3862	0.2730	0.345		
1973	1.2904	1.2904	0.3052	0.492		
1974	1.2970	1.2970	0.4099	0.593		
1975	0.9611	0.9611	0.5716	0.752		
1976	1.0211	1.0211	0.4586	0.594		
1977	1.0334	1.0334	0.7638	0.994		
1978	0.8556	0.8556	0.7091	1.067		
1979	1.0593	1.0593	0.2645	0.227		
1980	0.5871	0.5871	0.5238	0.694		
1981	1.1711	1.1711	0.4980	0.674	1.1371	1.160
1982	1.0718	1.0718	0.7100	0.677	2.5823	2.420
1983	1.3095	1.3095	0.8498	0.956	1.0104	0.934
1984	1.1961	1.1961	1.1888	1.344	0.8831	0.918
1985	1.1660	1.1660	0.7824	0.953	1.1639	1.170
1986	1.2742	1.2742	0.8196	0.685	1.0632	1.152
1987	1.3523	1.3523	1.1653	0.667	0.7874	0.719
1988	1.4114	1.4114	0.8892	0.532	0.8940	0.929
1989	1.1496	1.1496	1.1556	0.651	0.9410	0.930
1990	1.4176	1.4176	1.0684	0.890	1.0947	1.064
1991	1.2238	1.2238	0.8047	0.387	1.0400	0.992
1992	1.1837	1.1837	1.1339	1.283	0.7074	0.636
1993	0.9902	0.9902	0.9468	1.458	1.2769	1.315
1994	1.0952	1.0952	0.9560	1.548	0.7491	0.763
1995	0.7577	0.7577	0.9832	1.097	0.6162	0.597
1996	1.1553	1.1553	1.0552	0.884	0.8227	0.733
1997	0.7201	0.7201	0.8262	0.643	1.2126	1.073
1998	0.8519	0.8519	0.8533	0.484	1.1828	1.141
1999	0.8140	0.8140	1.2205	1.255	0.8910	1.200
2000	0.6015	0.6015	1.3322	1.161	0.5497	0.532
2001	0.5274	0.5274	1.2468	0.956	1.2446	1.297
2002	0.8007	0.8007	1.1831	1.305	0.8448	0.937
2003	0.8928	0.8928	0.1476	0.220	1.0310	1.202
2004	0.7589	0.7589	0.1985	0.142	0.7431	0.769
2005	0.5288	0.5288	0.3608	0.582	0.3078	0.449
2006	0.6980	0.6980	0.3063	0.438	0.6849	0.592

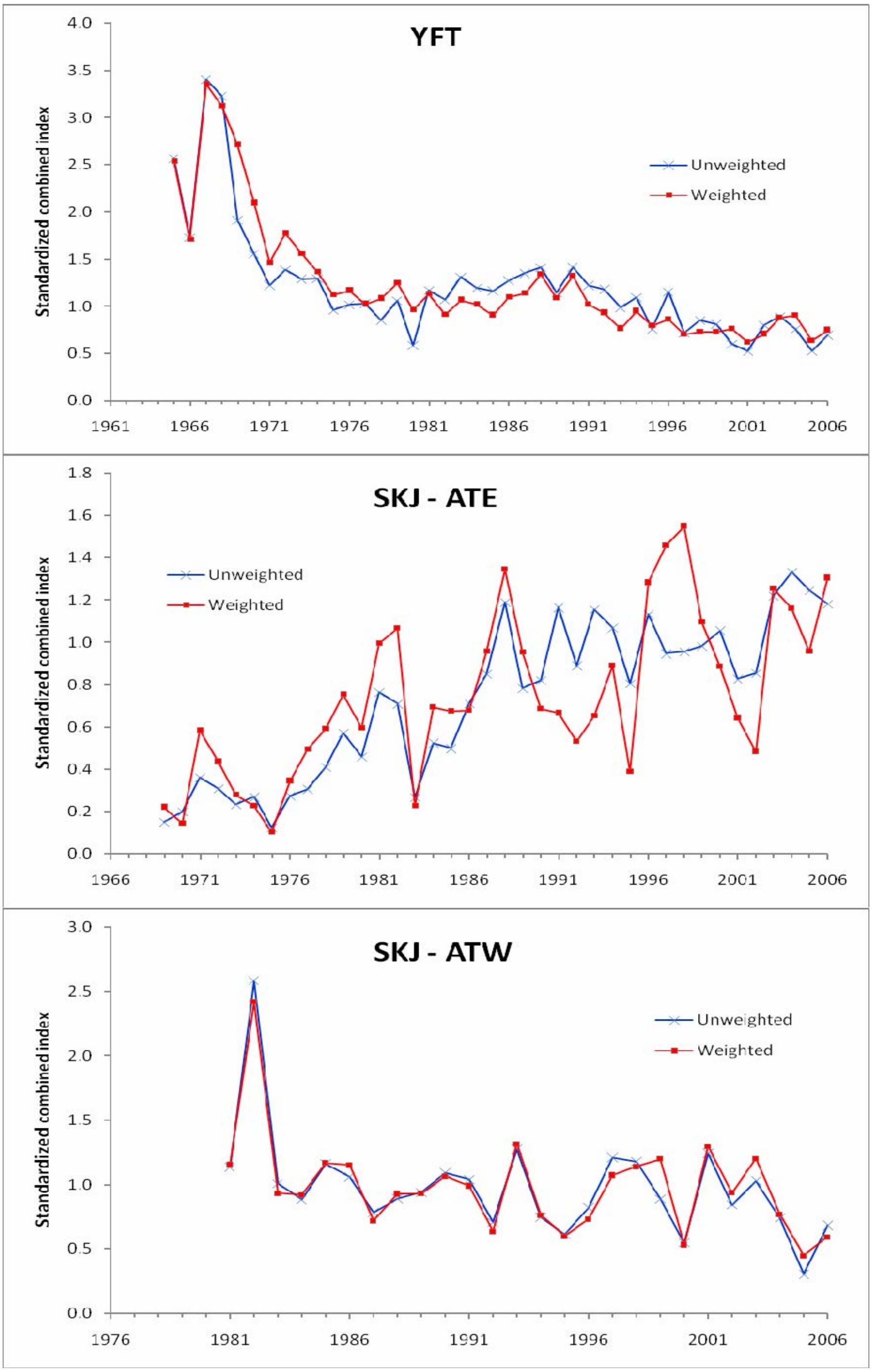

Figure Appendix 5.1 Estimated combined weighted and unweighted indexes of abundances for yellowfin and the two stocks of skipjack.

Appendix 6

Developing Demographic Priors for Yellowfin and Skipjack Tuna

Demographic priors for ***r*** for both yellowfin and skipjack tuna were obtained using methods described in McAllister *et al* (2001) whereby estimates of ***r*** are obtained by repeatedly sampling from distributions of basic life history inputs. This method operates by recasting the intrinsic rate of population increase into component parts for which we either have greater knowledge of than ***r*** or for which we can place reasonable distributions around. Prior distributions for ***r*** were obtained through Monte Carlo sampling of inputs and then numerically solving the Euler-Lotka population growth equation using methods outlined in originally in McAllister (2001) and McAllister & Carruthers (2007). The method proceeds by numerically solving for ***r*** from the Euler-Lotka equation (Lotka 1907) with the integration over ages starting at age 0:

$$1 = \int_{a=0}^{\infty} l_a m_a \exp(-a \times r) da \qquad \text{(a1)}$$

where l_a is the fraction of animals surviving from age 0 to age *a* where the fraction is set at 1 for l_0, and m_a is the number of age 0 offspring expected to be produced by an individual of age *a*. Equation (a1) can be approximated by the discrete equation below:

$$1 = \sum_{a=0}^{\infty} l_a m_a \exp(-a \times r) \qquad \text{(a2)}$$

Survivorship (l_a) or the fraction of the initial population surviving to age *a* can be obtained as follows:

$$l_a = l_0 \exp\left(-\sum_{i=0}^{a-1} M_i \right) \qquad \text{(a3)}$$

Where M_i is natural mortality at age. McAllister & Carruthers (2008) make a particularly useful advancement by starting the integration (or summation if using (a2)) of equation (a1) at age 1 and setting l_1 equal to 1. What follows is a description of this method. Provided that there is no reproduction in the first year of the life (m_0=0) and m_a can be specified in terms of age 1 recruits, this bypasses the need to obtain estimates of larval survival and production of larval fish per spawner, making the solution of equation (a1) or (a2) far more tractable.

Estimates of the expected number of recruits produced per adult female of age *a*, m_a, were obtained by:

$$m_a = \widetilde{R}_S W_a G_a \qquad \text{(a4)}$$

where $\widetilde{R}_S$ is the number of age 1 recruits produced per unit of spawning potential at spawner abundance approaching zero $\widetilde{R}_S$), W_a is the mass per fish of age *a* in grams, and G_a is the fraction of animals of age *a* that are mature. ($\widetilde{R}_S$) was computed using an assumed Beverton-Holt stock recruitment relationship for both skipjack and yellowfin tuna:

$$\widetilde{R}_S = \frac{4h}{\widetilde{S}\,(1-h)} \qquad \text{(a5)}$$

Where steepness (h) was obtained from a sample from the beta() distributions indicated below in Inputs. Estimates of the spawner biomass produced per single age 1 recruit ($\widetilde{S}$) were obtained as follows:

$$\widetilde{S} = \left(\sum_{a=1}^{a_p-1} \left(W_a G_a \exp(-(a-1)\, M_a) \right) \right) + W_{a_p} G_{a_p} \frac{\exp(-a_p M_a)}{1-\exp(-M_a)} \qquad \text{(a6)}$$

Where W_a and G_a were defined as above, *Ma* is natural mortality at age, a_p is the age of the plus group. However, as no plus group was used for either species the right side equation (a6) was dropped and a_p equals the last age (10). It is likely more correct to include a plus group on the last age, however, given the high mortality rates for both species including a plus group likely would have little impact upon the resulting *r* values.

Inputs

Inputs into the Euler-Lotka equation take the form of a standard life table representing survivorship, or a natural mortality at age schedule, a fecundity and maturity schedule, lengths at age and weights at age derived from lengths **(Table Appendix 6.1 and Table Appendix 6.2)** (Gotelli & Ellison, 2001). Inputs into the life tables are maturity, survival, weight and reproductive output. Weights at age were computed from lengths using ICCAT length-weight conversions (skipjack: RWT = $7.480*10^{-6}(FL)^{3.2526}$ (Cayré-Laloe, 1986); yellowfin: RWT = $2.1527*10^{-5} * FL^{2.976}$ (Caveriviere, 1976)) where the lengths at age were determined from sampling from distributions of Von Bertalanffy growth equation parameters as shown below. Maturity at age for skipjack was assumed to be 50% at age 2 and 100% at age 3 based on an assumed size at first maturity of either 41 cm (Entire Atlantic: Cayré & Farrugio, 1986), or 51 cm (Southwestern Atlantic: Vilela & Castello, 1993). For yellowfin maturity was assumed to be knife-edged at age 3 (Anon 2003).

1. prior distribution on steepness (*h*) was chosen to be distributed according to a beta( ) function with a mode of 0.9. This is based upon examination of the prior distribution for h used in the western Pacific skipjack and yellowfin tuna assessments (Hampton, 2002; Langley *et al.* 2003) but allowing a greater density towards lower values of steepness**.** This chosen beta(18, 4) distribution was used for both yellowfin and skipjack tuna.

2. prior distributions of mortality at age The vector of mortality at age for skipjack was assumed to be constant at 0.8 for all ages (Anon. 1984) which is close to the value (0.77) estimated Vilela & Castello (1993) using the equation of Rikhter and Efanov (1976). Each mortality at age value was assumed to be distributed as a normal (*u*, 0.04) random variable and a single value for mortality at age was chosen from these distributions for each Monte Carlo simulation. For yellowfin tuna mortality natural mortality was assumed to be 0.8 for ages 1 and 2, and 0.6 for ages 3-10. The life tables were extended out to a maximum age of 10 with no plus group for both yellowfin and skipjack tuna.

3. prior distributions on growth rate paramters. For skipjack prior values of K and L_{inf} were chosen from von Bertalannfy K and L_{inf} pairs obtained from a meta-analysis (Gaertner *et al.* 2008) of skipjack growth rates. For each iteration a single pair of K and L_{inf} was chosen. For yellowfin tuna, an empirical bivariate normal distribution (R code: *rmvnorm (n, mean = c(191.30,0.47), sigma= matrix(c(617.4366667, -3.683830769, -3.683830769,0.033582936)* ,ncol=2))) was constructed from the set of 26 Von Bertalannfy K and L_{inf} values found in FISH-BASE. From this distribution a random set of von Bertalannfy K and L_{inf} pairs was chosen for each Monto Carlo run. For all samples for yellowfin t_o was set to zero.

For both species 1000 estimates of ***r*** were obtained by numerically solving for *r* from random combinations of *h*, M_i, and the von Bertalannfy growth rate parameters using the R function "nlminb". Histograms of the prior distributions are shown in **Figure Appendix 6.1** for both yellowfin and skipjack tunas with mean values equal to 0.76 and 1.17, respectively. For input into the catch-free models the empirical histogram values were input into as prior distributions for r. For the BSP and PROCEAN model a N(1.17, 0.25) distribution was used as a prior for ***r***. While the BSP model was not applied to yellowfin tuna during this assessment, the construction of demographic priors for the species will facilitate further analyses that require or can benefit from demographic priors.

Table Appendix 6.1. Life table analysis for skipjack tuna. Description of inputs are given in the text.

Age	*Maturity (G_a)*	*Mortality (M_a)*	*Survival (exp(-M_a))*	*Survivor-ship (l_a)*	*length from Von Bert. K= .294 L_{inf}=91*	*Weight (kg) = 0.00000748* length^3.2526 Cayré & Laloê, 1983*
1	0	0.8	0.449	1.000	23.180	0.2061
2	0.5	0.8	0.449	0.449	40.455	1.2611
3	1	0.8	0.449	0.202	53.330	3.0978
4	1	0.8	0.449	0.091	62.926	5.3060
5	1	0.8	0.449	0.041	70.077	7.5304
6	1	0.8	0.449	0.018	75.406	9.5578
7	1	0.8	0.449	0.008	79.378	11.2947
8	1	0.8	0.449	0.004	82.339	12.7232
9	1	0.8	0.449	0.002	84.545	13.8659
10	1	0.8	0.449	0.001	86.189	14.7624

Table Appendix 6.2 Life table analysis for yellowfin tuna. Description of inputs are given in the text. Note that the Von Bertalannfy parameters for this table are from Lessa & Duarte-Neto (2004) but for the Monte-Carlo sampling are chosen from the bivariate normal distribution.

Age	*Maturity (G_a)*	*Mortality (M_a)*	*Survival (exp(-M_a))*	*Survivor-ship (l_a)*	*length from Von Bert. t_o= 0.042, K= .281 L_{inf}=245*	*Weight (kg) = $2.153*10^{-5} * FL^{2.98}$ (Caveriviere, 1976)*
1	0	0.8	0.449	1.000	57.66	3.74
2	0	0.8	0.449	0.449	98.05	18.18
3	1	0.6	0.549	0.247	128.97	41.09
4	1	0.6	0.549	0.135	152.64	67.86
5	1	0.6	0.549	0.074	170.77	94.76
6	1	0.6	0.549	0.041	184.65	119.57
7	1	0.6	0.549	0.022	195.28	141.24
8	1	0.6	0.549	0.012	203.41	159.48
9	1	0.6	0.549	0.007	209.64	174.46
10	1	0.6	0.549	0.004	214.41	186.55

Table Appendix 6.3 Compilation if L_{inf} and K pairs randomly chosen to obtain lengths at age obtained from a metanalysis of skipjack tuna growth (Gaertner 2008). For each Monte Carlo simulation, a single L_{inf} and K pair was chosen randomly. Rows indicated with an asterisk were not used in the simulations as they were deemed to be outliers.

Linf	K	PhiPrime	Method
62	2.08	3.903	Tagging*
66.5	1.806	3.902	Tagging*
60	1.537	3.743	Tagging*
61.3	1.25	3.672	Tagging
80	0.95	3.784	Length
65.5	0.945	3.608	Tagging
60.6	0.93	3.533	Length
73	0.82	3.64	Tagging
75.5	0.77	3.642	Tagging
60	0.75	3.431	Length
79	0.64	3.601	Tagging
85	0.62	3.651	Length
80	0.601	3.585	Tagging
76.6	0.6	3.547	Length
64.3	0.55	3.357	Tagging
102.2	0.55	3.759	Reading
77	0.52	3.489	Length
96.3	0.515	3.679	Tagging
74.8	0.515	3.46	Length
90	0.49	3.599	Length
82	0.45	3.481	Length
93.6	0.43	3.576	Reading
107	0.42	3.682	Length
94.9	0.34	3.486	Length
80	0.322	3.314	Tagging
86.7	0.307	3.363	Reading
103.6	0.302	3.511	Reading
97.26	0.251	3.376	Tagging
87.12	0.219	3.221	Reading

*Not used

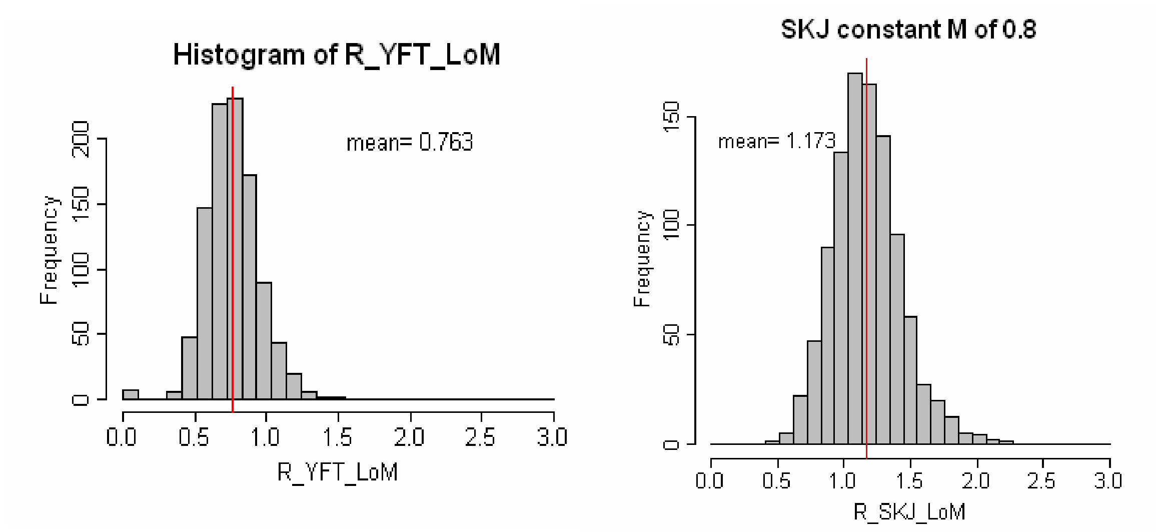

Figure Appendix 6.1 Histograms of prior distributions for r for yellowfin and skipjack obtained from demographic analysis.

Appendix 7

VPA Results. Report Files for YFT VPA Base Runs 5 and 10

Run 5. This file contains basic model inputs and results.

```
                ****************************************
                                VPA-2BOX
                SUMMARY STATISTICS AND DIAGNOSTIC OUTPUT
                ****************************************

YFT 1970-2006 RUN 5
12:48, 26      July 2008

=======================================================================
Total objective function =       -25.06
      (with constants)   =       297.49
Number of parameters (P) =           58
Number of data points (D)=          351
AIC : 2*objective+2P     =       710.98
AICc: 2*objective+2P(...)=       734.42
BIC : 2*objective+Plog(D)=       934.91
Chi-square discrepancy   =       421.37

Loglikelihoods (deviance)=       -44.11 (      350.36)
   effort data           =       -44.11 (      350.36)

Log-posteriors           =        56.58
   catchability          =         0.00
   f-ratio               =        56.58
   natural mortality     =         0.00
   mixing coeff.       =        0.00

Constraints              =        12.59
   terminal F            =        10.17
   stock-rec./sex ratio  =         2.42

Out of bounds penalty    =         0.00
=======================================================================
```

TABLE 1. FISHING MORTALITY RATE FOR Yellowfin Tuna 2008

	0	1	2	3	4	5
1970	0.009	0.128	0.093	0.158	0.172	0.039
1971	0.009	0.120	0.174	0.149	0.151	0.034
1972	0.012	0.128	0.217	0.237	0.196	0.044
1973	0.007	0.115	0.186	0.273	0.261	0.058
1974	0.023	0.169	0.224	0.310	0.333	0.073
1975	0.040	0.178	0.298	0.356	0.576	0.124
1976	0.046	0.195	0.219	0.383	0.691	0.146
1977	0.035	0.212	0.232	0.370	0.669	0.139
1978	0.040	0.214	0.265	0.384	0.461	0.095
1979	0.048	0.242	0.147	0.391	0.502	0.105
1980	0.082	0.243	0.205	0.318	0.508	0.109
1981	0.122	0.273	0.233	0.364	0.810	0.183
1982	0.055	0.337	0.247	0.489	0.912	0.217
1983	0.069	0.246	0.228	0.632	1.047	0.253
1984	0.053	0.291	0.271	0.272	0.310	0.071
1985	0.069	0.190	0.240	0.325	0.654	0.136
1986	0.069	0.176	0.144	0.371	0.550	0.106
1987	0.119	0.204	0.147	0.258	0.498	0.090
1988	0.113	0.253	0.131	0.298	0.279	0.049
1989	0.110	0.245	0.119	0.312	0.567	0.099
1990	0.134	0.300	0.145	0.392	0.833	0.146
1991	0.129	0.293	0.156	0.384	0.750	0.129
1992	0.117	0.277	0.172	0.404	0.881	0.148
1993	0.154	0.273	0.222	0.467	0.723	0.120
1994	0.114	0.319	0.303	0.386	0.894	0.149
1995	0.125	0.303	0.205	0.347	0.820	0.143
1996	0.130	0.365	0.216	0.364	0.731	0.138
1997	0.107	0.415	0.201	0.315	0.657	0.138
1998	0.085	0.427	0.250	0.364	0.876	0.208
1999	0.135	0.556	0.303	0.394	0.690	0.179
2000	0.178	0.365	0.186	0.545	0.726	0.201
2001	0.157	0.703	0.278	0.456	0.944	0.276
2002	0.173	0.514	0.228	0.393	0.699	0.222
2003	0.177	0.530	0.192	0.462	0.688	0.245
2004	0.150	0.442	0.264	0.401	0.688	0.266
2005	0.156	0.412	0.196	0.320	0.606	0.242
2006	0.137	0.290	0.212	0.402	0.602	0.240

TABLE 2. ABUNDANCE AT THE BEGINNING OF THE YEAR [BY AREA] FOR Yellowfin Tuna 2008

	0	1	2	3	4	5
1970	56827076.	26816375.	9071802.	5884865.	2793144.	2966660.
1971	55106729.	25298304.	10606195.	4537515.	2758725.	2856222.
1972	47054028.	24536455.	10086825.	4889354.	2146497.	2815868.
1973	51632776.	20900939.	9696256.	4457788.	2116338.	2447425.
1974	56299245.	23041404.	8369699.	4416666.	1861879.	2162395.
1975	68100480.	24718895.	8741493.	3673188.	1778511.	1835313.
1976	70980976.	29394694.	9299178.	3560807.	1411955.	1438214.
1977	62688538.	30472596.	10865238.	4101046.	1332649.	1070197.
1978	58214208.	27198591.	11080421.	4727969.	1555082.	885900.

1979	62168958.	25120192.	9862202.	4666806.	1767372.	980099.
1980	58551869.	26614566.	8861610.	4671485.	1733012.	1071574.
1981	84969788.	24231497.	9378199.	3962195.	1865189.	1099634.
1982	72220041.	33803026.	8283350.	4079113.	1510692.	957699.
1983	93618531.	30722104.	10846076.	3551608.	1373457.	755870.
1984	81032660.	39255938.	10797621.	4739407.	1036099.	586785.
1985	92594770.	34523286.	13189634.	4519391.	1980767.	716953.
1986	80000485.	38831521.	12826872.	5693023.	1792549.	908768.
1987	80414113.	33537951.	14633132.	6093126.	2155891.	1016047.
1988	67810039.	32064870.	12287775.	6933962.	2583632.	1228496.
1989	80687185.	27200090.	11185917.	5918445.	2825847.	1715199.
1990	78485573.	32467672.	9562891.	5452106.	2376462.	1732600.
1991	75078726.	30840093.	10805767.	4540212.	2022515.	1388887.
1992	80528069.	29648712.	10334831.	5074422.	1697735.	1194334.
1993	87100552.	32186810.	10098026.	4777056.	1858795.	951405.
1994	66443625.	33544313.	11011292.	4438584.	1643773.	957994.
1995	63832247.	26626621.	10953309.	4462745.	1655519.	822078.
1996	63898099.	25308041.	8835028.	4895966.	1731451.	791223.
1997	72830487.	25206331.	7895838.	3905446.	1866539.	835581.
1998	93078749.	29412868.	7481199.	3545574.	1564866.	930587.
1999	69538085.	38407535.	8621467.	3197076.	1351838.	772262.
2000	73582135.	27295975.	9900397.	3493399.	1183460.	726455.
2001	73830946.	27667459.	8517649.	4511530.	1111479.	640601.
2002	64995513.	28351317.	6152743.	3539845.	1568726.	504214.
2003	60926366.	24573507.	7615827.	2689564.	1310971.	649440.
2004	73658093.	22937269.	6499403.	3450777.	930406.	640551.
2005	57823827.	28495271.	6626683.	2738768.	1268101.	525862.
2006	52099904.	22238924.	8484458.	2989618.	1091007.	606128.
2007		20415829.	7477540.	3766537.	1097412.	589827.

TABLE 3. CATCH OF Yellowfin Tuna 2008

	0	1	2	3	4	5
1970	361290.	2229482.	607301.	650369.	335068.	85575.
1971	344448.	1977021.	1287353.	474486.	293744.	72602.
1972	370595.	2052767.	1492978.	786068.	289931.	91172.
1973	243206.	1577104.	1251198.	811921.	370436.	103603.
1974	886952.	2496615.	1274896.	897957.	403301.	115146.
1975	1850686.	2801854.	1719568.	842170.	602660.	162022.
1976	2183572.	3635133.	1388487.	867883.	547868.	148267.
1977	1488116.	4057058.	1711726.	970685.	504842.	105140.
1978	1592943.	3664928.	1963323.	1155362.	441937.	60903.
1979	2028285.	3775358.	1022740.	1156845.	537482.	73775.
1980	3200008.	4016663.	1247358.	972350.	532110.	83719.
1981	6758071.	4062149.	1479983.	926044.	810154.	139639.
1982	2657563.	6800765.	1379253.	1214320.	710570.	142131.
1983	4323476.	4680819.	1680974.	1290371.	704840.	128569.
1984	2901125.	6946804.	1953147.	861417.	211065.	30274.
1985	4268983.	4165569.	2143130.	957578.	738008.	69106.
1986	3706439.	4362541.	1306129.	1351567.	586169.	68951.
1987	6280192.	4318997.	1513905.	1055188.	652139.	65881.
1988	5045170.	5018133.	1138051.	1362108.	479093.	44092.
1989	5844442.	4139343.	946698.	1212904.	945449.	121843.
1990	6840077.	5910204.	977104.	1354542.	1052048.	177816.
1991	6313402.	5500947.	1181880.	1108701.	832673.	126849.
1992	6170239.	5029419.	1236534.	1294467.	780051.	124612.
1993	8654594.	5382283.	1528458.	1371075.	745384.	81507.
1994	4983084.	6443400.	2198100.	1089902.	762615.	100493.
1995	5210909.	4889679.	1543835.	1000446.	724878.	82982.
1996	5415623.	5453178.	1306456.	1144517.	699652.	77460.
1997	5109588.	6051401.	1090160.	805058.	697640.	81796.
1998	5261746.	7237372.	1260581.	828678.	716679.	132870.
1999	6104314.	11684800.	1722161.	797909.	524019.	96085.
2000	8362333.	5878954.	1274923.	1133947.	475691.	100301.
2001	7465211.	10065910.	1576328.	1271341.	534448.	117632.
2002	7175201.	8115388.	952183.	882558.	613958.	76429.
2003	6879341.	7202107.	1008228.	764832.	507098.	107459.
2004	7118910.	5801751.	1149694.	874474.	360014.	114175.
2005	5792990.	6796869.	895413.	573610.	446518.	86079.
2006	4628314.	3926747.	1232116.	759365.	382044.	98240.

TABLE 4. SPAWNING STOCK FECUNDITY AND RECRUITMENT OF Yellowfin Tuna 2008

year	spawning biomass	recruits from VPA
1970	527927.	56827076.
1971	481016.	55106729.
1972	454589.	47054028.
1973	412567.	51632776.
1974	376086.	56299245.
1975	324436.	68100480.
1976	272667.	70980976.
1977	256577.	62688538.
1978	272458.	58214208.
1979	288027.	62168958.
1980	293904.	58551869.
1981	279967.	84969788.
1982	253417.	72220041.
1983	215698.	93618531.
1984	226445.	81032660.
1985	274518.	92594770.
1986	311782.	80000485.
1987	350898.	80414113.
1988	413286.	67810039.
1989	429900.	80687185.
1990	391943.	78485573.
1991	325441.	75078726.

1992	308360.	80528069.
1993	290867.	87100552.
1994	271127.	66443625.
1995	263249.	63832247.
1996	276953.	63898099.
1997	260906.	72830487.
1998	240945.	93078749.
1999	210427.	69538085.
2000	205339.	73582135.
2001	222426.	73830946.
2002	210526.	64995513.
2003	184918.	60926366.
2004	186435.	73658093.
2005	176398.	57823827.
2006	179806.	52099904.

===

TABLE 5. FITS TO INDEX DATA FOR Yellowfin Tuna 2008

===

5.1 BRA_BB

Lognormal dist.
month 6 biomass
Ages 0 - 4
log-likelihood = -1.51
deviance = 21.69
Chi-sq. discrepancy= 29.46

Year	Observed	Predicted	Residuals (Obs-pred)	Standard Deviation	Q Catchabil.	Untransfrmd Observed	Untransfrmd Predicted	Chi-square Discrepancy
1981	1.614	-0.079	1.693	0.688	0.163E-08	1.391	0.256	17.865
1982	-0.269	-0.076	-0.193	0.688	0.163E-08	0.212	0.257	0.201
1983	0.732	0.185	0.547	0.688	0.163E-08	0.576	0.333	0.218
1984	0.012	0.185	-0.173	0.688	0.163E-08	0.280	0.333	0.187
1985	-0.279	0.359	-0.638	0.688	0.163E-08	0.209	0.396	0.561
1986	-0.279	0.347	-0.626	0.688	0.163E-08	0.209	0.392	0.551
1987	0.063	0.444	-0.381	0.688	0.163E-08	0.295	0.432	0.351
1988	0.165	0.327	-0.162	0.688	0.163E-08	0.327	0.384	0.178
1989	0.076	0.265	-0.189	0.688	0.163E-08	0.299	0.361	0.199
1990	0.807	0.121	0.686	0.688	0.163E-08	0.620	0.312	0.530
1991	-0.390	0.245	-0.635	0.688	0.163E-08	0.187	0.354	0.558
1992	0.062	0.120	-0.058	0.688	0.163E-08	0.295	0.312	0.107
1993	0.234	-0.093	0.327	0.688	0.163E-08	0.350	0.252	0.015
1994	-0.278	0.131	-0.410	0.688	0.163E-08	0.210	0.316	0.374
1995	-0.983	0.172	-1.155	0.688	0.163E-08	0.104	0.329	0.931
1996	0.044	-0.002	0.045	0.688	0.163E-08	0.289	0.276	0.050
1997	0.421	-0.113	0.533	0.688	0.163E-08	0.422	0.247	0.196
1998	0.154	-0.247	0.401	0.688	0.163E-08	0.323	0.216	0.052
1999	-0.906	-0.256	-0.650	0.688	0.163E-08	0.112	0.214	0.570
2001	0.900	-0.310	1.210	0.688	0.163E-08	0.681	0.203	4.475
2002	0.049	-0.362	0.411	0.688	0.163E-08	0.291	0.193	0.060
2003	-0.151	-0.338	0.187	0.688	0.163E-08	0.238	0.197	0.004
2004	-1.118	-0.444	-0.674	0.688	0.163E-08	0.091	0.178	0.589
2005	-0.985	-0.408	-0.577	0.688	0.163E-08	0.103	0.184	0.511
2006	0.305	-0.174	0.479	0.688	0.163E-08	0.376	0.233	0.124

Selectivities by age

Year	0	1	2	3	4
1981	0.007	0.621	1.000	0.196	0.011
1982	0.007	0.621	1.000	0.196	0.011
1983	0.007	0.621	1.000	0.196	0.011
1984	0.007	0.621	1.000	0.196	0.011
1985	0.007	0.621	1.000	0.196	0.011
1986	0.007	0.621	1.000	0.196	0.011
1987	0.007	0.621	1.000	0.196	0.011
1988	0.007	0.621	1.000	0.196	0.011
1989	0.007	0.621	1.000	0.196	0.011
1990	0.007	0.621	1.000	0.196	0.011
1991	0.007	0.621	1.000	0.196	0.011
1992	0.007	0.621	1.000	0.196	0.011
1993	0.007	0.621	1.000	0.196	0.011
1994	0.007	0.621	1.000	0.196	0.011
1995	0.007	0.621	1.000	0.196	0.011
1996	0.007	0.621	1.000	0.196	0.011
1997	0.007	0.621	1.000	0.196	0.011
1998	0.007	0.621	1.000	0.196	0.011
1999	0.007	0.621	1.000	0.196	0.011
2001	0.007	0.621	1.000	0.196	0.011
2002	0.007	0.621	1.000	0.196	0.011
2003	0.007	0.621	1.000	0.196	0.011
2004	0.007	0.621	1.000	0.196	0.011
2005	0.007	0.621	1.000	0.196	0.011
2006	0.007	0.621	1.000	0.196	0.011

5.2 BRA_LL

Lognormal dist.
month 6 numbers
Ages 0 - 5
log-likelihood = 4.15
deviance = 7.39
Chi-sq. discrepancy= 3.63

Year	Observed	Predicted	Residuals (Obs-pred)	Standard Deviation	Q Catchabil.	Untransfrmd Observed	Untransfrmd Predicted	Chi-square Discrepancy

1986	0.178	0.310	-0.132	0.688	0.156E-07	0.177	0.201	0.157
1987	0.416	0.348	0.068	0.688	0.156E-07	0.224	0.209	0.040
1988	0.645	0.330	0.315	0.688	0.156E-07	0.282	0.206	0.011
1989	0.571	0.227	0.344	0.688	0.156E-07	0.262	0.185	0.021
1990	0.752	0.159	0.592	0.688	0.156E-07	0.313	0.173	0.301
1991	0.177	0.110	0.067	0.688	0.156E-07	0.176	0.165	0.040
1992	-0.300	0.104	-0.405	0.688	0.156E-07	0.109	0.164	0.370
1993	-1.013	0.102	-1.115	0.688	0.156E-07	0.054	0.164	0.906
1994	-0.468	0.079	-0.548	0.688	0.156E-07	0.093	0.160	0.488
1995	-0.661	0.030	-0.690	0.688	0.156E-07	0.076	0.152	0.603
1996	0.299	-0.024	0.323	0.688	0.156E-07	0.199	0.144	0.013
1997	0.085	-0.100	0.185	0.688	0.156E-07	0.161	0.134	0.004
1998	0.327	-0.097	0.424	0.688	0.156E-07	0.205	0.134	0.070
1999	0.104	-0.065	0.169	0.688	0.156E-07	0.164	0.139	0.007
2000	0.008	-0.095	0.103	0.688	0.156E-07	0.149	0.134	0.026
2001	-0.086	-0.123	0.037	0.688	0.156E-07	0.136	0.131	0.054
2002	-0.573	-0.215	-0.358	0.688	0.156E-07	0.083	0.119	0.332
2003	-0.043	-0.297	0.254	0.688	0.156E-07	0.142	0.110	0.000
2004	0.020	-0.282	0.302	0.688	0.156E-07	0.151	0.112	0.007
2005	-0.415	-0.251	-0.164	0.688	0.156E-07	0.098	0.115	0.180
2006	-0.022	-0.250	0.228	0.688	0.156E-07	0.145	0.115	0.000

Selectivities by age

Year	0	1	2	3	4	5
1986	0.018	0.172	0.407	1.000	0.624	0.237
1987	0.018	0.172	0.407	1.000	0.624	0.237
1988	0.018	0.172	0.407	1.000	0.624	0.237
1989	0.018	0.172	0.407	1.000	0.624	0.237
1990	0.018	0.172	0.407	1.000	0.624	0.237
1991	0.018	0.172	0.407	1.000	0.624	0.237
1992	0.018	0.172	0.407	1.000	0.624	0.237
1993	0.018	0.172	0.407	1.000	0.624	0.237
1994	0.018	0.172	0.407	1.000	0.624	0.237
1995	0.018	0.172	0.407	1.000	0.624	0.237
1996	0.018	0.172	0.407	1.000	0.624	0.237
1997	0.018	0.172	0.407	1.000	0.624	0.237
1998	0.018	0.172	0.407	1.000	0.624	0.237
1999	0.018	0.172	0.407	1.000	0.624	0.237
2000	0.018	0.172	0.407	1.000	0.624	0.237
2001	0.018	0.172	0.407	1.000	0.624	0.237
2002	0.018	0.172	0.407	1.000	0.624	0.237
2003	0.018	0.172	0.407	1.000	0.624	0.237
2004	0.018	0.172	0.407	1.000	0.624	0.237
2005	0.018	0.172	0.407	1.000	0.624	0.237
2006	0.018	0.172	0.407	1.000	0.624	0.237

5.3 JPN_LL

Lognormal dist.
month 6 numbers
Ages 0 - 5
log-likelihood = 9.12
deviance = 9.39
Chi-sq. discrepancy= 6.80

Year	Observed	Predicted	Residuals (Obs-pred)	Standard Deviation	Q Catchabil.	Untransfrmd Observed	Untransfrmd Predicted	Chi-square Discrepancy
1970	0.526	0.399	0.127	0.688	0.153E-06	1.364	1.201	0.018
1971	0.283	0.299	-0.016	0.688	0.153E-06	1.069	1.087	0.083
1972	0.643	0.231	0.411	0.688	0.153E-06	1.533	1.016	0.060
1973	0.329	0.153	0.176	0.688	0.153E-06	1.119	0.939	0.006
1974	0.566	0.058	0.508	0.688	0.153E-06	1.420	0.854	0.160
1975	0.250	-0.085	0.334	0.688	0.153E-06	1.034	0.740	0.017
1976	0.288	-0.138	0.426	0.688	0.153E-06	1.075	0.702	0.071
1977	0.103	-0.036	0.139	0.688	0.153E-06	0.893	0.777	0.014
1978	0.452	0.065	0.387	0.688	0.153E-06	1.266	0.860	0.043
1979	0.768	0.059	0.709	0.688	0.153E-06	1.737	0.855	0.600
1980	0.190	0.042	0.148	0.688	0.153E-06	0.974	0.840	0.012
1981	0.426	-0.058	0.485	0.688	0.153E-06	1.234	0.760	0.130
1982	0.278	-0.157	0.434	0.688	0.153E-06	1.063	0.689	0.079
1983	0.308	-0.198	0.506	0.688	0.153E-06	1.096	0.661	0.157
1984	0.361	0.039	0.322	0.688	0.153E-06	1.156	0.838	0.013
1985	-0.115	0.138	-0.253	0.688	0.153E-06	0.718	0.925	0.247
1986	0.167	0.246	-0.079	0.688	0.153E-06	0.952	1.030	0.121
1987	0.207	0.382	-0.175	0.688	0.153E-06	0.991	1.180	0.188
1988	0.246	0.449	-0.203	0.688	0.153E-06	1.030	1.262	0.209
1989	-0.032	0.338	-0.370	0.688	0.153E-06	0.780	1.130	0.342
1990	0.277	0.175	0.102	0.688	0.153E-06	1.063	0.960	0.026
1991	-0.011	0.087	-0.098	0.688	0.153E-06	0.797	0.879	0.133
1992	0.034	0.080	-0.046	0.688	0.153E-06	0.833	0.873	0.100
1993	-0.608	0.039	-0.647	0.688	0.153E-06	0.439	0.838	0.568
1994	-0.076	0.003	-0.079	0.688	0.153E-06	0.747	0.808	0.121
1995	-0.500	0.030	-0.530	0.688	0.153E-06	0.489	0.830	0.473
1996	-0.430	0.025	-0.455	0.688	0.153E-06	0.524	0.826	0.411
1997	-0.636	-0.088	-0.548	0.688	0.153E-06	0.426	0.738	0.488
1998	-0.470	-0.220	-0.250	0.688	0.153E-06	0.503	0.646	0.245
1999	-0.440	-0.257	-0.183	0.688	0.153E-06	0.519	0.623	0.194
2000	-0.296	-0.213	-0.083	0.688	0.153E-06	0.599	0.651	0.124
2001	-0.708	-0.145	-0.562	0.688	0.153E-06	0.397	0.697	0.500
2002	-0.708	-0.274	-0.434	0.688	0.153E-06	0.397	0.612	0.394
2003	-0.533	-0.391	-0.142	0.688	0.153E-06	0.473	0.545	0.164
2004	-0.298	-0.362	0.065	0.688	0.153E-06	0.598	0.561	0.041
2005	-0.614	-0.394	-0.219	0.688	0.153E-06	0.436	0.543	0.221
2006	-0.226	-0.321	0.095	0.688	0.153E-06	0.643	0.585	0.029

Selectivities by age

Year	0	1	2	3	4	5
1970	0.000	0.003	0.231	1.000	0.964	0.212

1971	0.000	0.003	0.231	1.000	0.964	0.212
1972	0.000	0.003	0.231	1.000	0.964	0.212
1973	0.000	0.003	0.231	1.000	0.964	0.212
1974	0.000	0.003	0.231	1.000	0.964	0.212
1975	0.000	0.003	0.231	1.000	0.964	0.212
1976	0.000	0.003	0.231	1.000	0.964	0.212
1977	0.000	0.003	0.231	1.000	0.964	0.212
1978	0.000	0.003	0.231	1.000	0.964	0.212
1979	0.000	0.003	0.231	1.000	0.964	0.212
1980	0.000	0.003	0.231	1.000	0.964	0.212
1981	0.000	0.003	0.231	1.000	0.964	0.212
1982	0.000	0.003	0.231	1.000	0.964	0.212
1983	0.000	0.003	0.231	1.000	0.964	0.212
1984	0.000	0.003	0.231	1.000	0.964	0.212
1985	0.000	0.003	0.231	1.000	0.964	0.212
1986	0.000	0.003	0.231	1.000	0.964	0.212
1987	0.000	0.003	0.231	1.000	0.964	0.212
1988	0.000	0.003	0.231	1.000	0.964	0.212
1989	0.000	0.003	0.231	1.000	0.964	0.212
1990	0.000	0.003	0.231	1.000	0.964	0.212
1991	0.000	0.003	0.231	1.000	0.964	0.212
1992	0.000	0.003	0.231	1.000	0.964	0.212
1993	0.000	0.003	0.231	1.000	0.964	0.212
1994	0.000	0.003	0.231	1.000	0.964	0.212
1995	0.000	0.003	0.231	1.000	0.964	0.212
1996	0.000	0.003	0.231	1.000	0.964	0.212
1997	0.000	0.003	0.231	1.000	0.964	0.212
1998	0.000	0.003	0.231	1.000	0.964	0.212
1999	0.000	0.003	0.231	1.000	0.964	0.212
2000	0.000	0.003	0.231	1.000	0.964	0.212
2001	0.000	0.003	0.231	1.000	0.964	0.212
2002	0.000	0.003	0.231	1.000	0.964	0.212
2003	0.000	0.003	0.231	1.000	0.964	0.212
2004	0.000	0.003	0.231	1.000	0.964	0.212
2005	0.000	0.003	0.231	1.000	0.964	0.212
2006	0.000	0.003	0.231	1.000	0.964	0.212

5.4 USMEX_LL

Lognormal dist.
month 6 numbers
Ages 0 - 5
log-likelihood = 4.66
deviance = 1.13
Chi-sq. discrepancy= 1.56

Year	Observed	Predicted	Residuals (Obs-pred)	Standard Deviation	Q Catchabil.	Untransfrmd Observed	Untransfrmd Predicted	Chi-square Discrepancy
1993	0.205	0.216	-0.011	0.688	0.213E-06	1.151	1.164	0.080
1994	0.528	0.194	0.334	0.688	0.213E-06	1.589	1.138	0.017
1995	0.077	0.222	-0.145	0.688	0.213E-06	1.012	1.170	0.167
1996	-0.043	0.200	-0.242	0.688	0.213E-06	0.898	1.144	0.239
1997	0.042	0.072	-0.030	0.688	0.213E-06	0.977	1.007	0.091
1998	-0.039	-0.050	0.011	0.688	0.213E-06	0.901	0.891	0.068
1999	0.382	-0.071	0.452	0.688	0.213E-06	1.373	0.873	0.095
2000	0.001	-0.007	0.008	0.688	0.213E-06	0.938	0.930	0.069
2001	-0.232	0.054	-0.286	0.688	0.213E-06	0.743	0.989	0.273
2002	-0.175	-0.110	-0.065	0.688	0.213E-06	0.787	0.840	0.112
2003	-0.025	-0.208	0.183	0.688	0.213E-06	0.914	0.761	0.005
2004	-0.195	-0.174	-0.021	0.688	0.213E-06	0.771	0.787	0.085
2005	-0.285	-0.215	-0.070	0.688	0.213E-06	0.705	0.756	0.115
2006	-0.240	-0.123	-0.118	0.688	0.213E-06	0.737	0.829	0.147

Selectivities by age

Year	0	1	2	3	4	5
1993	0.000	0.006	0.281	1.000	0.656	0.052
1994	0.000	0.006	0.281	1.000	0.656	0.052
1995	0.000	0.006	0.281	1.000	0.656	0.052
1996	0.000	0.006	0.281	1.000	0.656	0.052
1997	0.000	0.006	0.281	1.000	0.656	0.052
1998	0.000	0.006	0.281	1.000	0.656	0.052
1999	0.000	0.006	0.281	1.000	0.656	0.052
2000	0.000	0.006	0.281	1.000	0.656	0.052
2001	0.000	0.006	0.281	1.000	0.656	0.052
2002	0.000	0.006	0.281	1.000	0.656	0.052
2003	0.000	0.006	0.281	1.000	0.656	0.052
2004	0.000	0.006	0.281	1.000	0.656	0.052
2005	0.000	0.006	0.281	1.000	0.656	0.052
2006	0.000	0.006	0.281	1.000	0.656	0.052

5.5 US_RR

Lognormal dist.
month 6 numbers
Ages 0 - 5
log-likelihood = 0.24
deviance = 15.20
Chi-sq. discrepancy= 7.28

Year	Observed	Predicted	Residuals (Obs-pred)	Standard Deviation	Q Catchabil.	Untransfrmd Observed	Untransfrmd Predicted	Chi-square Discrepancy
1986	0.789	0.349	0.441	0.688	0.104E-06	1.939	1.248	0.084
1987	0.046	0.429	-0.383	0.688	0.104E-06	0.922	1.352	0.352
1988	-0.456	0.300	-0.757	0.688	0.104E-06	0.558	1.189	0.654
1989	-0.437	0.197	-0.634	0.688	0.104E-06	0.569	1.073	0.558
1990	-0.911	0.086	-0.998	0.688	0.104E-06	0.354	0.960	0.829

1991	-0.437	0.151	-0.587	0.688	0.104E-06	0.569	1.024	0.520
1992	-0.820	0.109	-0.929	0.688	0.104E-06	0.388	0.982	0.781
1993	0.003	0.085	-0.082	0.688	0.104E-06	0.883	0.959	0.123
1994	0.665	0.119	0.546	0.688	0.104E-06	1.712	0.991	0.217
1995	0.490	0.113	0.377	0.688	0.104E-06	1.438	0.986	0.037
1996	-0.717	-0.062	-0.655	0.688	0.104E-06	0.430	0.828	0.575
1997	-0.822	-0.156	-0.666	0.688	0.104E-06	0.387	0.753	0.583
1998	-0.121	-0.191	0.070	0.688	0.104E-06	0.780	0.727	0.039
1999	0.627	-0.071	0.699	0.688	0.104E-06	1.649	0.820	0.568
2000	0.489	0.023	0.466	0.688	0.104E-06	1.436	0.901	0.110
2001	0.556	-0.139	0.695	0.688	0.104E-06	1.536	0.766	0.558
2002	0.168	-0.340	0.508	0.688	0.104E-06	1.042	0.627	0.160
2003	0.283	-0.224	0.507	0.688	0.104E-06	1.169	0.704	0.159
2004	0.156	-0.359	0.515	0.688	0.104E-06	1.029	0.615	0.169
2005	0.063	-0.279	0.342	0.688	0.104E-06	0.938	0.666	0.020
2006	0.383	-0.140	0.523	0.688	0.104E-06	1.291	0.765	0.181

Selectivities by age

Year	0	1	2	3	4	5
1986	0.000	0.098	1.000	0.188	0.080	0.027
1987	0.000	0.098	1.000	0.188	0.080	0.027
1988	0.000	0.098	1.000	0.188	0.080	0.027
1989	0.000	0.098	1.000	0.188	0.080	0.027
1990	0.000	0.098	1.000	0.188	0.080	0.027
1991	0.000	0.098	1.000	0.188	0.080	0.027
1992	0.000	0.098	1.000	0.188	0.080	0.027
1993	0.000	0.098	1.000	0.188	0.080	0.027
1994	0.000	0.098	1.000	0.188	0.080	0.027
1995	0.000	0.098	1.000	0.188	0.080	0.027
1996	0.000	0.098	1.000	0.188	0.080	0.027
1997	0.000	0.098	1.000	0.188	0.080	0.027
1998	0.000	0.098	1.000	0.188	0.080	0.027
1999	0.000	0.098	1.000	0.188	0.080	0.027
2000	0.000	0.098	1.000	0.188	0.080	0.027
2001	0.000	0.098	1.000	0.188	0.080	0.027
2002	0.000	0.098	1.000	0.188	0.080	0.027
2003	0.000	0.098	1.000	0.188	0.080	0.027
2004	0.000	0.098	1.000	0.188	0.080	0.027
2005	0.000	0.098	1.000	0.188	0.080	0.027
2006	0.000	0.098	1.000	0.188	0.080	0.027

5.6 US_PLL ATL

Lognormal dist.
month 6 numbers
Ages 0 - 5
log-likelihood = 6.66
deviance = 1.61
Chi-sq. discrepancy= 2.04

Year	Observed	Predicted	Residuals (Obs-pred)	Standard Deviation	Q Catchabil.	Untransfrmd Observed	Untransfrmd Predicted	Chi-square Discrepancy
1987	0.587	0.446	0.140	0.688	0.200E-06	1.696	1.474	0.014
1988	0.652	0.479	0.174	0.688	0.200E-06	1.811	1.523	0.006
1989	0.588	0.351	0.238	0.688	0.200E-06	1.699	1.339	0.000
1990	0.388	0.200	0.188	0.688	0.200E-06	1.391	1.152	0.004
1991	0.140	0.128	0.012	0.688	0.200E-06	1.085	1.072	0.067
1992	0.210	0.143	0.067	0.688	0.200E-06	1.164	1.088	0.040
1993	-0.279	0.090	-0.369	0.688	0.200E-06	0.713	1.032	0.341
1994	-0.125	0.072	-0.197	0.688	0.200E-06	0.832	1.014	0.205
1995	-0.040	0.100	-0.141	0.688	0.200E-06	0.906	1.043	0.163
1996	-0.298	0.078	-0.376	0.688	0.200E-06	0.700	1.020	0.346
1997	-0.191	-0.059	-0.131	0.688	0.200E-06	0.780	0.889	0.156
1998	-0.316	-0.177	-0.139	0.688	0.200E-06	0.687	0.790	0.162
1999	-0.178	-0.199	0.020	0.688	0.200E-06	0.789	0.773	0.063
2000	-0.091	-0.131	0.040	0.688	0.200E-06	0.861	0.827	0.053
2001	-0.218	-0.059	-0.160	0.688	0.200E-06	0.758	0.889	0.177
2002	-0.293	-0.238	-0.055	0.688	0.200E-06	0.703	0.743	0.106
2003	-0.423	-0.340	-0.082	0.688	0.200E-06	0.618	0.671	0.123
2004	-0.063	-0.291	0.228	0.688	0.200E-06	0.886	0.705	0.000
2005	-0.013	-0.345	0.332	0.688	0.200E-06	0.931	0.668	0.016
2006	-0.036	-0.248	0.211	0.688	0.200E-06	0.910	0.736	0.001

Selectivities by age

Year	0	1	2	3	4	5
1987	0.000	0.006	0.267	1.000	0.477	0.026
1988	0.000	0.006	0.267	1.000	0.477	0.026
1989	0.000	0.006	0.267	1.000	0.477	0.026
1990	0.000	0.006	0.267	1.000	0.477	0.026
1991	0.000	0.006	0.267	1.000	0.477	0.026
1992	0.000	0.006	0.267	1.000	0.477	0.026
1993	0.000	0.006	0.267	1.000	0.477	0.026
1994	0.000	0.006	0.267	1.000	0.477	0.026
1995	0.000	0.006	0.267	1.000	0.477	0.026
1996	0.000	0.006	0.267	1.000	0.477	0.026
1997	0.000	0.006	0.267	1.000	0.477	0.026
1998	0.000	0.006	0.267	1.000	0.477	0.026
1999	0.000	0.006	0.267	1.000	0.477	0.026
2000	0.000	0.006	0.267	1.000	0.477	0.026
2001	0.000	0.006	0.267	1.000	0.477	0.026
2002	0.000	0.006	0.267	1.000	0.477	0.026
2003	0.000	0.006	0.267	1.000	0.477	0.026
2004	0.000	0.006	0.267	1.000	0.477	0.026
2005	0.000	0.006	0.267	1.000	0.477	0.026
2006	0.000	0.006	0.267	1.000	0.477	0.026

5.7 VEN_LL

Lognormal dist.
month 6 numbers
Ages 0 - 5
log-likelihood = 2.19
deviance = 3.83
Chi-sq. discrepancy= 3.45

Year	Observed	Predicted	Residuals (Obs-pred)	Standard Deviation	Q Catchabil.	Untransfrmd Observed	Untransfrmd Predicted	Chi-square Discrepancy
1991	0.132	0.150	-0.017	0.688	0.206E-06	1.045	1.063	0.083
1992	0.218	0.138	0.080	0.688	0.206E-06	1.138	1.051	0.035
1993	0.605	0.106	0.499	0.688	0.206E-06	1.676	1.018	0.148
1994	-0.378	0.061	-0.439	0.688	0.206E-06	0.627	0.972	0.398
1995	-0.277	0.070	-0.346	0.688	0.206E-06	0.694	0.981	0.322
1996	-0.011	0.086	-0.097	0.688	0.206E-06	0.905	0.997	0.133
1997	-0.604	-0.016	-0.588	0.688	0.206E-06	0.500	0.901	0.521
1998	-0.051	-0.138	0.087	0.688	0.206E-06	0.870	0.797	0.032
1999	-0.075	-0.178	0.103	0.688	0.206E-06	0.849	0.766	0.026
2000	-0.375	-0.179	-0.196	0.688	0.206E-06	0.629	0.765	0.204
2001	0.815	-0.099	0.914	0.688	0.206E-06	2.067	0.829	1.547

Selectivities by age

Year	0	1	2	3	4	5
1991	0.000	0.018	0.132	0.906	1.000	0.322
1992	0.000	0.018	0.132	0.906	1.000	0.322
1993	0.000	0.018	0.132	0.906	1.000	0.322
1994	0.000	0.018	0.132	0.906	1.000	0.322
1995	0.000	0.018	0.132	0.906	1.000	0.322
1996	0.000	0.018	0.132	0.906	1.000	0.322
1997	0.000	0.018	0.132	0.906	1.000	0.322
1998	0.000	0.018	0.132	0.906	1.000	0.322
1999	0.000	0.018	0.132	0.906	1.000	0.322
2000	0.000	0.018	0.132	0.906	1.000	0.322
2001	0.000	0.018	0.132	0.906	1.000	0.322

5.8 VEN_PS

Lognormal dist.
month 6 biomass
Ages 0 - 4
log-likelihood = 2.60
deviance = 11.97
Chi-sq. discrepancy= 8.72

Year	Observed	Predicted	Residuals (Obs-pred)	Standard Deviation	Q Catchabil.	Untransfrmd Observed	Untransfrmd Predicted	Chi-square Discrepancy
1983	0.863	0.003	0.860	0.688	0.222E-07	13.589	5.750	1.233
1984	0.050	0.144	-0.094	0.688	0.222E-07	6.027	6.618	0.131
1985	0.573	0.269	0.304	0.688	0.222E-07	10.170	7.505	0.008
1986	0.042	0.321	-0.279	0.688	0.222E-07	5.977	7.901	0.268
1987	-0.226	0.421	-0.646	0.688	0.222E-07	4.574	8.731	0.568
1988	0.095	0.395	-0.300	0.688	0.222E-07	6.304	8.511	0.285
1989	0.868	0.312	0.556	0.688	0.222E-07	13.656	7.831	0.233
1990	0.200	0.187	0.013	0.688	0.222E-07	7.002	6.915	0.067
1991	0.221	0.169	0.052	0.688	0.222E-07	7.151	6.790	0.047
1992	-0.175	0.109	-0.284	0.688	0.222E-07	4.812	6.395	0.272
1993	-0.040	-0.037	-0.002	0.688	0.222E-07	5.511	5.523	0.075
1994	0.159	0.071	0.088	0.688	0.222E-07	6.720	6.156	0.032
1995	-0.639	0.113	-0.752	0.688	0.222E-07	3.025	6.416	0.650
1996	0.167	0.045	0.122	0.688	0.222E-07	6.777	5.998	0.019
1997	-0.227	-0.103	-0.124	0.688	0.222E-07	4.569	5.173	0.151
1998	-0.437	-0.227	-0.209	0.688	0.222E-07	3.704	4.567	0.214
1999	-0.054	-0.288	0.235	0.688	0.222E-07	5.434	4.297	0.000
2000	0.144	-0.174	0.318	0.688	0.222E-07	6.624	4.818	0.012
2001	0.837	-0.215	1.052	0.688	0.222E-07	13.243	4.623	2.621
2002	0.356	-0.297	0.653	0.688	0.222E-07	8.181	4.259	0.439
2003	-0.360	-0.405	0.045	0.688	0.222E-07	3.999	3.822	0.050
2004	-0.874	-0.405	-0.469	0.688	0.222E-07	2.393	3.824	0.423
2005	-1.543	-0.405	-1.138	0.688	0.222E-07	1.226	3.824	0.921

Selectivities by age

Year	0	1	2	3	4
1983	0.014	0.622	0.865	1.000	0.204
1984	0.014	0.622	0.865	1.000	0.204
1985	0.014	0.622	0.865	1.000	0.204
1986	0.014	0.622	0.865	1.000	0.204
1987	0.014	0.622	0.865	1.000	0.204
1988	0.014	0.622	0.865	1.000	0.204
1989	0.014	0.622	0.865	1.000	0.204
1990	0.014	0.622	0.865	1.000	0.204
1991	0.014	0.622	0.865	1.000	0.204
1992	0.014	0.622	0.865	1.000	0.204
1993	0.014	0.622	0.865	1.000	0.204
1994	0.014	0.622	0.865	1.000	0.204
1995	0.014	0.622	0.865	1.000	0.204
1996	0.014	0.622	0.865	1.000	0.204
1997	0.014	0.622	0.865	1.000	0.204
1998	0.014	0.622	0.865	1.000	0.204
1999	0.014	0.622	0.865	1.000	0.204
2000	0.014	0.622	0.865	1.000	0.204
2001	0.014	0.622	0.865	1.000	0.204
2002	0.014	0.622	0.865	1.000	0.204
2003	0.014	0.622	0.865	1.000	0.204
2004	0.014	0.622	0.865	1.000	0.204
2005	0.014	0.622	0.865	1.000	0.204

5.9 EUR-FAD-PS

Lognormal dist.
month 6 biomass
Ages 0 - 1
log-likelihood = 4.80
deviance = 2.35
Chi-sq. discrepancy= 1.90

Year	Observed	Predicted	Residuals (Obs-pred)	Standard Deviation	Q Catchabil.	Untransfrmd Observed	Untransfrmd Predicted	Chi-square Discrepancy
1991	0.054	0.154	-0.100	0.688	0.173E-07	1.960	2.166	0.135
1992	-0.380	0.059	-0.438	0.688	0.173E-07	1.270	1.969	0.398
1993	0.065	0.143	-0.078	0.688	0.173E-07	1.980	2.141	0.120
1994	0.002	0.135	-0.133	0.688	0.173E-07	1.860	2.125	0.158
1995	0.161	0.008	0.153	0.688	0.173E-07	2.180	1.871	0.011
1996	0.029	-0.026	0.055	0.688	0.173E-07	1.910	1.808	0.046
1997	-0.130	0.040	-0.170	0.688	0.173E-07	1.630	1.933	0.185
1998	-0.428	0.245	-0.673	0.688	0.173E-07	1.210	2.372	0.589
1999	0.034	0.022	0.011	0.688	0.173E-07	1.920	1.898	0.067
2000	0.080	0.013	0.067	0.688	0.173E-07	2.010	1.880	0.040
2001	-0.014	-0.135	0.121	0.688	0.173E-07	1.830	1.622	0.020
2002	0.085	-0.009	0.094	0.688	0.173E-07	2.020	1.839	0.029
2003	0.161	-0.217	0.378	0.688	0.173E-07	2.180	1.494	0.038
2004	0.197	-0.128	0.325	0.688	0.173E-07	2.260	1.633	0.014
2005	0.210	-0.101	0.311	0.688	0.173E-07	2.290	1.677	0.010
2006	-0.124	-0.202	0.078	0.688	0.173E-07	1.640	1.516	0.035

Selectivities by age

Year	0	1
1991	0.788	1.000
1992	0.788	1.000
1993	0.788	1.000
1994	0.788	1.000
1995	0.788	1.000
1996	0.788	1.000
1997	0.788	1.000
1998	0.788	1.000
1999	0.788	1.000
2000	0.788	1.000
2001	0.788	1.000
2002	0.788	1.000
2003	0.788	1.000
2004	0.788	1.000
2005	0.788	1.000
2006	0.788	1.000

5.10 EUR-PS 3%

Lognormal dist.
month 6 biomass
Ages 0 - 5
log-likelihood = 3.47
deviance = 0.53
Chi-sq. discrepancy= 0.93

Year	Observed	Predicted	Residuals (Obs-pred)	Standard Deviation	Q Catchabil.	Untransfrmd Observed	Untransfrmd Predicted	Chi-square Discrepancy
1970	0.101	0.290	-0.188	0.688	0.187E-07	5.061	6.111	0.198
1971	-0.057	0.215	-0.273	0.688	0.187E-07	4.318	5.672	0.263
1972	0.047	0.141	-0.094	0.688	0.187E-07	4.795	5.266	0.131
1973	0.055	0.068	-0.013	0.688	0.187E-07	4.833	4.894	0.080
1974	-0.038	-0.033	-0.004	0.688	0.187E-07	4.405	4.424	0.076
1975	0.037	-0.135	0.171	0.688	0.187E-07	4.744	3.997	0.007
1976	0.026	-0.238	0.264	0.688	0.187E-07	4.693	3.604	0.001
1977	0.008	-0.169	0.177	0.688	0.187E-07	4.610	3.863	0.006
1978	-0.086	-0.080	-0.007	0.688	0.187E-07	4.195	4.223	0.077
1979	-0.092	-0.058	-0.034	0.688	0.187E-07	4.171	4.314	0.093

Selectivities by age

Year	0	1	2	3	4	5
1970	0.040	0.273	0.422	0.632	1.000	0.227
1971	0.040	0.273	0.422	0.632	1.000	0.227
1972	0.040	0.273	0.422	0.632	1.000	0.227
1973	0.040	0.273	0.422	0.632	1.000	0.227
1974	0.040	0.273	0.422	0.632	1.000	0.227
1975	0.040	0.273	0.422	0.632	1.000	0.227
1976	0.040	0.273	0.422	0.632	1.000	0.227
1977	0.040	0.273	0.422	0.632	1.000	0.227
1978	0.040	0.273	0.422	0.632	1.000	0.227
1979	0.040	0.273	0.422	0.632	1.000	0.227

5.11 EU-DAKAR

Lognormal dist.
month 6 biomass
Ages 0 - 4
log-likelihood = 3.24
deviance = 20.41
Chi-sq. discrepancy= 12.29

			Residuals	Standard	Q	Untransfrmd	Untransfrmd	Chi-square

Year	Observed	Predicted	(Obs-pred)	Deviation	Catchabil.	Observed	Predicted	Discrepancy
1970	-0.200	0.070	-0.271	0.688	0.477E-08	0.644	0.844	0.261
1971	-0.213	0.051	-0.264	0.688	0.477E-08	0.636	0.828	0.256
1972	-0.207	0.053	-0.260	0.688	0.477E-08	0.640	0.830	0.253
1973	-0.290	-0.008	-0.282	0.688	0.477E-08	0.589	0.781	0.270
1974	0.162	-0.068	0.229	0.688	0.477E-08	0.925	0.735	0.000
1975	-0.664	-0.057	-0.608	0.688	0.477E-08	0.405	0.744	0.536
1976	-0.563	0.004	-0.567	0.688	0.477E-08	0.448	0.790	0.503
1977	-0.140	0.137	-0.277	0.688	0.477E-08	0.684	0.902	0.266
1978	-1.092	0.130	-1.222	0.688	0.477E-08	0.264	0.896	0.972
1979	-0.457	0.047	-0.505	0.688	0.477E-08	0.498	0.825	0.452
1981	0.263	-0.097	0.361	0.688	0.477E-08	1.024	0.714	0.029
1982	0.215	-0.026	0.241	0.688	0.477E-08	0.976	0.767	0.000
1983	0.234	0.153	0.081	0.688	0.477E-08	0.994	0.917	0.034
1984	0.590	0.253	0.338	0.688	0.477E-08	1.420	1.013	0.019
1985	0.327	0.334	-0.007	0.688	0.477E-08	1.091	1.099	0.077
1986	0.739	0.350	0.389	0.688	0.477E-08	1.647	1.117	0.044
1987	0.859	0.400	0.459	0.688	0.477E-08	1.858	1.174	0.102
1988	0.826	0.286	0.541	0.688	0.477E-08	1.798	1.047	0.208
1989	-0.597	0.183	-0.781	0.688	0.477E-08	0.433	0.945	0.673
1990	0.745	0.118	0.627	0.688	0.477E-08	1.658	0.886	0.375
1991	0.422	0.196	0.226	0.688	0.477E-08	1.200	0.957	0.000
1992	1.090	0.074	1.015	0.688	0.477E-08	2.340	0.848	2.289
1993	0.881	-0.070	0.951	0.688	0.477E-08	1.899	0.734	1.791
1994	0.586	0.111	0.476	0.688	0.477E-08	1.414	0.879	0.120
1995	0.071	0.094	-0.023	0.688	0.477E-08	0.845	0.864	0.086
1996	0.562	-0.046	0.609	0.688	0.477E-08	1.381	0.751	0.334
1997	-0.295	-0.131	-0.164	0.688	0.477E-08	0.586	0.690	0.180
1998	-1.261	-0.187	-1.074	0.688	0.477E-08	0.223	0.653	0.880
1999	-0.208	-0.222	0.013	0.688	0.477E-08	0.639	0.630	0.066
2000	-0.961	-0.096	-0.865	0.688	0.477E-08	0.301	0.715	0.736
2001	-0.490	-0.317	-0.173	0.688	0.477E-08	0.482	0.573	0.187
2002	-0.074	-0.322	0.248	0.688	0.477E-08	0.731	0.570	0.000
2003	0.059	-0.366	0.425	0.688	0.477E-08	0.835	0.546	0.071
2004	-0.213	-0.448	0.235	0.688	0.477E-08	0.636	0.503	0.000
2005	-0.416	-0.359	-0.057	0.688	0.477E-08	0.519	0.550	0.107
2006	-0.291	-0.226	-0.066	0.688	0.477E-08	0.588	0.628	0.113

Selectivities by age

Year	0	1	2	3	4
1970	0.062	1.000	0.665	0.201	0.047
1971	0.062	1.000	0.665	0.201	0.047
1972	0.062	1.000	0.665	0.201	0.047
1973	0.062	1.000	0.665	0.201	0.047
1974	0.062	1.000	0.665	0.201	0.047
1975	0.062	1.000	0.665	0.201	0.047
1976	0.062	1.000	0.665	0.201	0.047
1977	0.062	1.000	0.665	0.201	0.047
1978	0.062	1.000	0.665	0.201	0.047
1979	0.062	1.000	0.665	0.201	0.047
1981	0.062	1.000	0.665	0.201	0.047
1982	0.062	1.000	0.665	0.201	0.047
1983	0.062	1.000	0.665	0.201	0.047
1984	0.062	1.000	0.665	0.201	0.047
1985	0.062	1.000	0.665	0.201	0.047
1986	0.062	1.000	0.665	0.201	0.047
1987	0.062	1.000	0.665	0.201	0.047
1988	0.062	1.000	0.665	0.201	0.047
1989	0.062	1.000	0.665	0.201	0.047
1990	0.062	1.000	0.665	0.201	0.047
1991	0.062	1.000	0.665	0.201	0.047
1992	0.062	1.000	0.665	0.201	0.047
1993	0.062	1.000	0.665	0.201	0.047
1994	0.062	1.000	0.665	0.201	0.047
1995	0.062	1.000	0.665	0.201	0.047
1996	0.062	1.000	0.665	0.201	0.047
1997	0.062	1.000	0.665	0.201	0.047
1998	0.062	1.000	0.665	0.201	0.047
1999	0.062	1.000	0.665	0.201	0.047
2000	0.062	1.000	0.665	0.201	0.047
2001	0.062	1.000	0.665	0.201	0.047
2002	0.062	1.000	0.665	0.201	0.047
2003	0.062	1.000	0.665	0.201	0.047
2004	0.062	1.000	0.665	0.201	0.047
2005	0.062	1.000	0.665	0.201	0.047
2006	0.062	1.000	0.665	0.201	0.047

5.12 URU-LL

Lognormal dist.
month 6 numbers
Ages 0 - 5
log-likelihood = 1.86
deviance = 15.70
Chi-sq. discrepancy= 10.38

Year	Observed	Predicted	Residuals (Obs-pred)	Standard Deviation	Q Catchabil.	Untransfrmd Observed	Untransfrmd Predicted	Chi-square Discrepancy
1981	0.627	-0.040	0.667	0.688	0.470E-06	6.554	3.365	0.475
1982	0.932	-0.106	1.038	0.688	0.470E-06	8.896	3.149	2.490
1983	-0.050	-0.043	-0.007	0.688	0.470E-06	3.330	3.353	0.077
1984	-0.858	0.117	-0.975	0.688	0.470E-06	1.485	3.936	0.814
1985	0.012	0.221	-0.209	0.688	0.470E-06	3.546	4.368	0.213
1986	0.164	0.309	-0.145	0.688	0.470E-06	4.124	4.769	0.166
1987	0.127	0.419	-0.292	0.688	0.470E-06	3.976	5.324	0.278
1988	0.777	0.400	0.376	0.688	0.470E-06	7.613	5.225	0.037
1989	-0.519	0.285	-0.804	0.688	0.470E-06	2.085	4.657	0.690
1990	-0.609	0.148	-0.757	0.688	0.470E-06	1.904	4.059	0.654

1991	0.672	0.122	0.549	0.688	0.470E-06	6.854	3.957	0.222
1992	0.626	0.112	0.514	0.688	0.470E-06	6.545	3.915	0.168
1993	-1.028	0.071	-1.100	0.688	0.470E-06	1.252	3.760	0.897
1994	0.325	0.071	0.254	0.688	0.470E-06	4.845	3.758	0.000
1995	0.058	0.084	-0.026	0.688	0.470E-06	3.711	3.809	0.088
1996	0.715	0.009	0.707	0.688	0.470E-06	7.159	3.532	0.593
1997	-0.379	-0.109	-0.270	0.688	0.470E-06	2.396	3.140	0.261
1998	-0.255	-0.198	-0.057	0.688	0.470E-06	2.715	2.874	0.107
1999	-0.073	-0.165	0.092	0.688	0.470E-06	3.255	2.969	0.030
2000	0.198	-0.092	0.290	0.688	0.470E-06	4.268	3.195	0.005
2001	-0.283	-0.113	-0.170	0.688	0.470E-06	2.638	3.128	0.185
2002	-0.667	-0.291	-0.376	0.688	0.470E-06	1.796	2.617	0.347
2003	-0.314	-0.311	-0.002	0.688	0.470E-06	2.558	2.564	0.075
2004	-0.318	-0.337	0.019	0.688	0.470E-06	2.547	2.499	0.063
2005	0.528	-0.336	0.864	0.688	0.470E-06	5.937	2.502	1.255
2006	-0.406	-0.226	-0.179	0.688	0.470E-06	2.333	2.792	0.191

Selectivities by age

Year	0	1	2	3	4	5
1981	0.000	0.039	0.572	1.000	0.586	0.120
1982	0.000	0.039	0.572	1.000	0.586	0.120
1983	0.000	0.039	0.572	1.000	0.586	0.120
1984	0.000	0.039	0.572	1.000	0.586	0.120
1985	0.000	0.039	0.572	1.000	0.586	0.120
1986	0.000	0.039	0.572	1.000	0.586	0.120
1987	0.000	0.039	0.572	1.000	0.586	0.120
1988	0.000	0.039	0.572	1.000	0.586	0.120
1989	0.000	0.039	0.572	1.000	0.586	0.120
1990	0.000	0.039	0.572	1.000	0.586	0.120
1991	0.000	0.039	0.572	1.000	0.586	0.120
1992	0.000	0.039	0.572	1.000	0.586	0.120
1993	0.000	0.039	0.572	1.000	0.586	0.120
1994	0.000	0.039	0.572	1.000	0.586	0.120
1995	0.000	0.039	0.572	1.000	0.586	0.120
1996	0.000	0.039	0.572	1.000	0.586	0.120
1997	0.000	0.039	0.572	1.000	0.586	0.120
1998	0.000	0.039	0.572	1.000	0.586	0.120
1999	0.000	0.039	0.572	1.000	0.586	0.120
2000	0.000	0.039	0.572	1.000	0.586	0.120
2001	0.000	0.039	0.572	1.000	0.586	0.120
2002	0.000	0.039	0.572	1.000	0.586	0.120
2003	0.000	0.039	0.572	1.000	0.586	0.120
2004	0.000	0.039	0.572	1.000	0.586	0.120
2005	0.000	0.039	0.572	1.000	0.586	0.120
2006	0.000	0.039	0.572	1.000	0.586	0.120

5.13 BRA-URU-LL

Not used

5.14 CHIN-TAI-LL

Lognormal dist.
month 6 numbers
Ages 0 - 5
log-likelihood = 11.65
deviance = 4.33
Chi-sq. discrepancy= 4.53

Year	Observed	Predicted	Residuals (Obs-pred)	Standard Deviation	Q Catchabil.	Untransfrmd Observed	Untransfrmd Predicted	Chi-square Discrepancy
1970	0.772	0.369	0.403	0.688	0.141E-06	1.712	1.145	0.054
1971	0.251	0.275	-0.024	0.688	0.141E-06	1.017	1.042	0.087
1972	0.328	0.211	0.116	0.688	0.141E-06	1.098	0.978	0.021
1973	0.435	0.133	0.302	0.688	0.141E-06	1.223	0.904	0.008
1974	-0.252	0.041	-0.293	0.688	0.141E-06	0.615	0.824	0.279
1975	-0.212	-0.090	-0.121	0.688	0.141E-06	0.641	0.723	0.149
1976	-0.041	-0.126	0.085	0.688	0.141E-06	0.760	0.698	0.033
1977	-0.145	-0.022	-0.122	0.688	0.141E-06	0.685	0.774	0.150
1978	-0.238	0.066	-0.304	0.688	0.141E-06	0.624	0.846	0.288
1979	-0.200	0.054	-0.255	0.688	0.141E-06	0.648	0.836	0.249
1980	0.006	0.033	-0.027	0.688	0.141E-06	0.796	0.818	0.089
1981	-0.133	-0.061	-0.072	0.688	0.141E-06	0.693	0.745	0.117
1982	-0.394	-0.147	-0.248	0.688	0.141E-06	0.534	0.684	0.244
1983	-0.403	-0.169	-0.234	0.688	0.141E-06	0.529	0.668	0.233
1984	-0.033	0.054	-0.088	0.688	0.141E-06	0.766	0.836	0.127
1985	-0.133	0.149	-0.282	0.688	0.141E-06	0.693	0.919	0.270
1986	0.083	0.254	-0.171	0.688	0.141E-06	0.860	1.021	0.185
1987	-0.009	0.381	-0.391	0.688	0.141E-06	0.784	1.159	0.358
1988	0.342	0.432	-0.091	0.688	0.141E-06	1.114	1.220	0.129
1989	-0.020	0.320	-0.340	0.688	0.141E-06	0.776	1.090	0.317
1990	-0.020	0.166	-0.186	0.688	0.141E-06	0.776	0.935	0.196
1991	0.110	0.088	0.022	0.688	0.141E-06	0.884	0.865	0.062
1992	-0.199	0.082	-0.280	0.688	0.141E-06	0.649	0.859	0.269
1993	0.092	0.042	0.050	0.688	0.141E-06	0.868	0.825	0.048
1994	0.407	0.013	0.394	0.688	0.141E-06	1.189	0.802	0.047
1995	0.391	0.034	0.357	0.688	0.141E-06	1.170	0.819	0.027
1996	0.251	0.016	0.235	0.688	0.141E-06	1.017	0.804	0.000
1997	-0.018	-0.098	0.080	0.688	0.141E-06	0.778	0.718	0.035
1998	-0.010	-0.217	0.207	0.688	0.141E-06	0.783	0.637	0.001
1999	-0.315	-0.238	-0.077	0.688	0.141E-06	0.578	0.624	0.120
2000	-0.023	-0.194	0.170	0.688	0.141E-06	0.773	0.652	0.007
2001	-0.277	-0.144	-0.134	0.688	0.141E-06	0.600	0.686	0.158
2002	-0.101	-0.279	0.178	0.688	0.141E-06	0.715	0.599	0.005
2003	-0.096	-0.380	0.284	0.688	0.141E-06	0.719	0.541	0.004
2004	-0.099	-0.360	0.261	0.688	0.141E-06	0.717	0.552	0.001
2005	0.108	-0.383	0.491	0.688	0.141E-06	0.882	0.540	0.138
2006	-0.201	-0.308	0.106	0.688	0.141E-06	0.647	0.582	0.025

Selectivities by age

Year	0	1	2	3	4	5
1970	0.000	0.013	0.272	1.000	0.890	0.204
1971	0.000	0.013	0.272	1.000	0.890	0.204
1972	0.000	0.013	0.272	1.000	0.890	0.204
1973	0.000	0.013	0.272	1.000	0.890	0.204
1974	0.000	0.013	0.272	1.000	0.890	0.204
1975	0.000	0.013	0.272	1.000	0.890	0.204
1976	0.000	0.013	0.272	1.000	0.890	0.204
1977	0.000	0.013	0.272	1.000	0.890	0.204
1978	0.000	0.013	0.272	1.000	0.890	0.204
1979	0.000	0.013	0.272	1.000	0.890	0.204
1980	0.000	0.013	0.272	1.000	0.890	0.204
1981	0.000	0.013	0.272	1.000	0.890	0.204
1982	0.000	0.013	0.272	1.000	0.890	0.204
1983	0.000	0.013	0.272	1.000	0.890	0.204
1984	0.000	0.013	0.272	1.000	0.890	0.204
1985	0.000	0.013	0.272	1.000	0.890	0.204
1986	0.000	0.013	0.272	1.000	0.890	0.204
1987	0.000	0.013	0.272	1.000	0.890	0.204
1988	0.000	0.013	0.272	1.000	0.890	0.204
1989	0.000	0.013	0.272	1.000	0.890	0.204
1990	0.000	0.013	0.272	1.000	0.890	0.204
1991	0.000	0.013	0.272	1.000	0.890	0.204
1992	0.000	0.013	0.272	1.000	0.890	0.204
1993	0.000	0.013	0.272	1.000	0.890	0.204
1994	0.000	0.013	0.272	1.000	0.890	0.204
1995	0.000	0.013	0.272	1.000	0.890	0.204
1996	0.000	0.013	0.272	1.000	0.890	0.204
1997	0.000	0.013	0.272	1.000	0.890	0.204
1998	0.000	0.013	0.272	1.000	0.890	0.204
1999	0.000	0.013	0.272	1.000	0.890	0.204
2000	0.000	0.013	0.272	1.000	0.890	0.204
2001	0.000	0.013	0.272	1.000	0.890	0.204
2002	0.000	0.013	0.272	1.000	0.890	0.204
2003	0.000	0.013	0.272	1.000	0.890	0.204
2004	0.000	0.013	0.272	1.000	0.890	0.204
2005	0.000	0.013	0.272	1.000	0.890	0.204
2006	0.000	0.013	0.272	1.000	0.890	0.204

5.15 TROP-PS

Lognormal dist.
month 6 numbers
Ages 3 - 5
log-likelihood = 5.99
deviance = 8.19
Chi-sq. discrepancy= 4.61

Year	Observed	Predicted	Residuals (Obs-pred)	Standard Deviation	Q Catchabil.	Untransfrmd Observed	Untransfrmd Predicted	Chi-square Discrepancy
1980	-0.780	0.164	-0.945	0.688	0.320E-08	0.250	0.643	0.793
1981	0.175	0.061	0.114	0.688	0.320E-08	0.650	0.580	0.022
1982	-0.336	-0.071	-0.265	0.688	0.320E-08	0.390	0.508	0.257
1983	-0.108	-0.283	0.175	0.688	0.320E-08	0.490	0.411	0.006
1984	-1.166	-0.067	-1.100	0.688	0.320E-08	0.170	0.510	0.897
1985	0.095	0.061	0.034	0.688	0.320E-08	0.600	0.580	0.055
1986	0.044	0.204	-0.160	0.688	0.320E-08	0.570	0.669	0.177
1987	0.128	0.350	-0.223	0.688	0.320E-08	0.620	0.775	0.224
1988	0.044	0.538	-0.494	0.688	0.320E-08	0.570	0.934	0.444
1989	0.606	0.539	0.067	0.688	0.320E-08	1.000	0.936	0.040
1990	0.565	0.405	0.160	0.688	0.320E-08	0.960	0.818	0.009
1991	0.235	0.229	0.006	0.688	0.320E-08	0.690	0.686	0.070
1992	0.112	0.158	-0.046	0.688	0.320E-08	0.610	0.639	0.100
1993	-0.087	0.095	-0.183	0.688	0.320E-08	0.500	0.600	0.194
1994	0.144	0.024	0.120	0.688	0.320E-08	0.630	0.559	0.020
1995	0.095	0.005	0.090	0.688	0.320E-08	0.600	0.548	0.031
1996	0.026	0.060	-0.034	0.688	0.320E-08	0.560	0.580	0.093
1997	0.235	0.015	0.220	0.688	0.320E-08	0.690	0.554	0.000
1998	-0.029	-0.098	0.069	0.688	0.320E-08	0.530	0.494	0.039
1999	-0.215	-0.215	0.000	0.688	0.320E-08	0.440	0.440	0.073
2000	-0.310	-0.272	-0.039	0.688	0.320E-08	0.400	0.416	0.096
2001	-0.068	-0.203	0.135	0.688	0.320E-08	0.510	0.446	0.015
2002	0.249	-0.234	0.484	0.688	0.320E-08	0.700	0.432	0.129
2003	0.370	-0.368	0.738	0.688	0.320E-08	0.790	0.377	0.700
2004	-0.029	-0.341	0.312	0.688	0.320E-08	0.530	0.388	0.010
2005	-0.087	-0.383	0.296	0.688	0.320E-08	0.500	0.372	0.006
2006	0.095	-0.371	0.466	0.688	0.320E-08	0.600	0.376	0.110

Selectivities by age

Year	3	4	5
1980	29.518	54.953	78.542
1981	29.518	54.953	78.542
1982	29.518	54.953	78.542
1983	29.518	54.953	78.542
1984	29.518	54.953	78.542
1985	29.518	54.953	78.542
1986	29.518	54.953	78.542
1987	29.518	54.953	78.542
1988	29.518	54.953	78.542
1989	29.518	54.953	78.542
1990	29.518	54.953	78.542
1991	29.518	54.953	78.542
1992	29.518	54.953	78.542
1993	29.518	54.953	78.542
1994	29.518	54.953	78.542
1995	29.518	54.953	78.542

1996	29.518	54.953	78.542
1997	29.518	54.953	78.542
1998	29.518	54.953	78.542
1999	29.518	54.953	78.542
2000	29.518	54.953	78.542
2001	29.518	54.953	78.542
2002	29.518	54.953	78.542
2003	29.518	54.953	78.542
2004	29.518	54.953	78.542
2005	29.518	54.953	78.542
2006	29.518	54.953	78.542

5.16 CAN-IS-BB

Lognormal dist.
month 6 biomass
Ages 0 - 4
log-likelihood = -103.24
deviance = 226.64
Chi-sq. discrepancy= 323.79

Year	Observed	Predicted	Residuals (Obs-pred)	Standard Deviation	Q Catchabil.	Untransfrmd Observed	Untransfrmd Predicted	Chi-square Discrepancy
1980	-1.991	0.078	-2.070	0.688	0.282E-09	0.010	0.076	1.337
1981	-1.284	-0.066	-1.218	0.688	0.282E-09	0.020	0.066	0.969
1982	0.289	-0.061	0.350	0.688	0.282E-09	0.094	0.066	0.024
1983	0.855	0.086	0.769	0.688	0.282E-09	0.166	0.077	0.814
1984	2.171	0.176	1.995	0.688	0.282E-09	0.620	0.084	38.064
1985	1.338	0.316	1.022	0.688	0.282E-09	0.269	0.097	2.344
1986	0.896	0.335	0.561	0.688	0.282E-09	0.173	0.099	0.241
1987	1.700	0.426	1.274	0.688	0.282E-09	0.387	0.108	5.468
1988	1.740	0.376	1.363	0.688	0.282E-09	0.402	0.103	7.169
1989	1.214	0.295	0.920	0.688	0.282E-09	0.238	0.095	1.582
1990	2.148	0.167	1.981	0.688	0.282E-09	0.605	0.084	36.747
1991	2.025	0.209	1.815	0.688	0.282E-09	0.535	0.087	24.419
1992	1.479	0.099	1.380	0.688	0.282E-09	0.310	0.078	7.531
1993	0.695	-0.040	0.735	0.688	0.282E-09	0.142	0.068	0.688
1994	0.176	0.098	0.078	0.688	0.282E-09	0.084	0.078	0.036
1995	-0.679	0.119	-0.797	0.688	0.282E-09	0.036	0.080	0.685
1996	2.033	0.010	2.022	0.688	0.282E-09	0.539	0.071	40.634
1997	-0.092	-0.087	-0.005	0.688	0.282E-09	0.064	0.065	0.076
1998	2.379	-0.208	2.587	0.688	0.282E-09	0.763	0.057	148.409
1999	0.029	-0.243	0.271	0.688	0.282E-09	0.073	0.055	0.002
2000	-3.439	-0.118	-3.321	0.688	0.282E-09	0.002	0.063	1.557
2001	-7.484	-0.286	-7.198	0.688	0.282E-09	0.000	0.053	1.648
2002	-1.054	-0.294	-0.760	0.688	0.282E-09	0.025	0.053	0.657
2003	-0.426	-0.353	-0.073	0.688	0.282E-09	0.046	0.050	0.117
2004	-0.618	-0.436	-0.182	0.688	0.282E-09	0.038	0.046	0.193
2005	-2.617	-0.366	-2.250	0.688	0.282E-09	0.005	0.049	1.387
2006	-1.481	-0.233	-1.249	0.688	0.282E-09	0.016	0.056	0.987

Selectivities by age

Year	0	1	2	3	4
1980	0.006	0.971	1.000	0.519	0.457
1981	0.006	0.971	1.000	0.519	0.457
1982	0.006	0.971	1.000	0.519	0.457
1983	0.006	0.971	1.000	0.519	0.457
1984	0.006	0.971	1.000	0.519	0.457
1985	0.006	0.971	1.000	0.519	0.457
1986	0.006	0.971	1.000	0.519	0.457
1987	0.006	0.971	1.000	0.519	0.457
1988	0.006	0.971	1.000	0.519	0.457
1989	0.006	0.971	1.000	0.519	0.457
1990	0.006	0.971	1.000	0.519	0.457
1991	0.006	0.971	1.000	0.519	0.457
1992	0.006	0.971	1.000	0.519	0.457
1993	0.006	0.971	1.000	0.519	0.457
1994	0.006	0.971	1.000	0.519	0.457
1995	0.006	0.971	1.000	0.519	0.457
1996	0.006	0.971	1.000	0.519	0.457
1997	0.006	0.971	1.000	0.519	0.457
1998	0.006	0.971	1.000	0.519	0.457
1999	0.006	0.971	1.000	0.519	0.457
2000	0.006	0.971	1.000	0.519	0.457
2001	0.006	0.971	1.000	0.519	0.457
2002	0.006	0.971	1.000	0.519	0.457
2003	0.006	0.971	1.000	0.519	0.457
2004	0.006	0.971	1.000	0.519	0.457
2005	0.006	0.971	1.000	0.519	0.457
2006	0.006	0.971	1.000	0.519	0.457

5.17 NOT-USED

Not used

5.18 NOT-USED

Not used
===

TOTAL NUMBER OF FUNCTION EVALUATIONS = 11363

Run 10. This file contains basic model inputs and results.

****

VPA-2BOX

SUMMARY STATISTICS AND DIAGNOSTIC OUTPUT
****

YFT 1970-2006 RUN 10
12:55, 27 July 2008

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=====================================================================
Total objective function =       -25.19
      (with constants)   =       297.36
Number of parameters (P) =           58
Number of data points (D)=          351
AIC : 2*objective+2P     =       710.72
AICc: 2*objective+2P(...)=       734.16
BIC : 2*objective+Plog(D)=       934.65
Chi-square discrepancy   =       418.18

Loglikelihoods (deviance)=       -44.16 (      352.21)
   effort data           =       -44.16 (      352.21)

Log-posteriors           =        56.79
   catchability          =         0.00
   f-ratio               =        56.79
   natural mortality     =         0.00
   mixing coeff.       =         0.00

Constraints              =        12.56
   terminal F            =        10.19
   stock-rec./sex ratio  =         2.37

Out of bounds penalty    =         0.00
=====================================================================
```

TABLE 1. FISHING MORTALITY RATE FOR Yellowfin Tuna 2008

	0	1	2	3	4	5
1970	0.009	0.131	0.097	0.173	0.194	0.050
1971	0.009	0.122	0.181	0.157	0.169	0.042
1972	0.012	0.129	0.222	0.248	0.209	0.052
1973	0.007	0.115	0.188	0.282	0.276	0.066
1974	0.023	0.169	0.224	0.312	0.347	0.082
1975	0.040	0.177	0.298	0.356	0.585	0.136
1976	0.045	0.193	0.218	0.383	0.692	0.157
1977	0.035	0.210	0.229	0.368	0.670	0.147
1978	0.040	0.213	0.263	0.378	0.458	0.099
1979	0.048	0.241	0.146	0.387	0.489	0.106
1980	0.082	0.243	0.204	0.316	0.500	0.108
1981	0.121	0.272	0.232	0.362	0.800	0.180
1982	0.055	0.334	0.245	0.488	0.904	0.213
1983	0.069	0.245	0.226	0.626	1.046	0.247
1984	0.053	0.290	0.270	0.269	0.306	0.070
1985	0.069	0.191	0.240	0.323	0.640	0.134
1986	0.070	0.177	0.145	0.371	0.546	0.103
1987	0.119	0.205	0.148	0.260	0.497	0.088
1988	0.112	0.252	0.131	0.301	0.281	0.048
1989	0.109	0.243	0.118	0.314	0.576	0.099
1990	0.133	0.296	0.143	0.389	0.839	0.147
1991	0.127	0.289	0.153	0.377	0.741	0.130
1992	0.115	0.272	0.169	0.395	0.852	0.148
1993	0.151	0.267	0.217	0.456	0.695	0.118
1994	0.112	0.311	0.295	0.374	0.854	0.143
1995	0.122	0.294	0.198	0.333	0.774	0.135
1996	0.127	0.352	0.208	0.348	0.685	0.128
1997	0.105	0.401	0.191	0.299	0.609	0.126
1998	0.083	0.416	0.239	0.342	0.804	0.186
1999	0.131	0.535	0.292	0.370	0.623	0.156
2000	0.175	0.352	0.176	0.516	0.652	0.171
2001	0.155	0.687	0.265	0.424	0.846	0.229
2002	0.171	0.503	0.219	0.367	0.616	0.180
2003	0.175	0.525	0.186	0.439	0.615	0.197
2004	0.149	0.435	0.260	0.385	0.631	0.214
2005	0.160	0.410	0.192	0.314	0.567	0.197
2006	0.143	0.299	0.211	0.391	0.584	0.204

TABLE 2. ABUNDANCE AT THE BEGINNING OF THE YEAR [BY AREA] FOR Yellowfin Tuna 2008

	0	1	2	3	4	5
1970	55754410.	26075935.	8662439.	5399353.	2498986.	2339937.
1971	54790348.	24816407.	10273896.	4312957.	2492624.	2351162.
1972	47032848.	24394085.	9870486.	4707253.	2023399.	2392913.
1973	51598339.	20891423.	9632340.	4339346.	2016684.	2147944.
1974	56438414.	23025933.	8365393.	4381645.	1797126.	1943515.
1975	68711754.	24781423.	8734544.	3670825.	1759384.	1679888.
1976	71327404.	29669227.	9327187.	3557013.	1410672.	1342659.
1977	62955983.	30628402.	10988247.	4116392.	1330592.	1017118.
1978	58377594.	27318799.	11150183.	4795328.	1563444.	855697.
1979	62184709.	25193650.	9916057.	4704961.	1804084.	968079.
1980	58772998.	26621652.	8894440.	4701033.	1753795.	1084888.
1981	85481877.	24330807.	9381395.	3980181.	1881324.	1118207.
1982	72408502.	34032890.	8327789.	4080841.	1520495.	976462.
1983	93679565.	30806698.	10948583.	3575910.	1374388.	771317.
1984	80672423.	39283432.	10835469.	4795516.	1049181.	595718.
1985	92044266.	34361419.	13201992.	4540072.	2011466.	728987.
1986	79828955.	38584252.	12754302.	5699738.	1803848.	931880.
1987	80704010.	33460991.	14522197.	6053296.	2159538.	1034850.
1988	68444054.	32195035.	12253292.	6873186.	2561852.	1240796.
1989	81583256.	27484742.	11244101.	5899569.	2792645.	1709998.
1990	79323441.	32869875.	9690246.	5484003.	2366162.	1711798.

1991	76193992.	31215988.	10985457.	4610022.	2039879.	1372014.
1992	81923536.	30149307.	10502783.	5172922.	1735774.	1194360.
1993	88889455.	32813290.	10321825.	4869105.	1912447.	971569.
1994	68017359.	34346748.	11291498.	4561154.	1693772.	997793.
1995	65603142.	27333214.	11311567.	4615868.	1722308.	870360.
1996	65500438.	26103018.	9150664.	5092199.	1815019.	853260.
1997	74239906.	25925386.	8250134.	4078295.	1973589.	914371.
1998	95693809.	30045552.	7800932.	3739637.	1659292.	1031432.
1999	71457060.	39581840.	8902601.	3372047.	1457695.	877607.
2000	74638276.	28157126.	10418232.	3647024.	1278811.	841102.
2001	74939431.	28141072.	8901403.	4795272.	1194655.	754572.
2002	65424217.	28848665.	6359189.	3749685.	1723013.	610520.
2003	61595949.	24765699.	7835700.	2802582.	1425323.	790609.
2004	73837594.	23237480.	6584292.	3571242.	991828.	779340.
2005	56463887.	28575638.	6759904.	2785189.	1333723.	634829.
2006	49948365.	21628769.	8520186.	3062598.	1116358.	701217.
2007		19450311.	7204902.	3786102.	1137160.	655569.

TABLE 3. CATCH OF Yellowfin Tuna 2008

	0	1	2	3	4	5
1970	361290.	2229482.	607301.	650369.	335068.	85575.
1971	344448.	1977021.	1287353.	474486.	293744.	72602.
1972	370595.	2052767.	1492978.	786068.	289931.	91172.
1973	243206.	1577104.	1251198.	811921.	370436.	103603.
1974	886952.	2496615.	1274896.	897957.	403301.	115146.
1975	1850686.	2801854.	1719568.	842170.	602660.	162022.
1976	2183572.	3635133.	1388487.	867883.	547868.	148267.
1977	1488116.	4057058.	1711726.	970685.	504842.	105140.
1978	1592943.	3664928.	1963323.	1155362.	441937.	60903.
1979	2028285.	3775358.	1022740.	1156845.	537482.	73775.
1980	3200008.	4016663.	1247358.	972350.	532110.	83719.
1981	6758071.	4062149.	1479983.	926044.	810154.	139639.
1982	2657563.	6800765.	1379253.	1214320.	710570.	142131.
1983	4323476.	4680819.	1680974.	1290371.	704840.	128569.
1984	2901125.	6946804.	1953147.	861417.	211065.	30274.
1985	4268983.	4165569.	2143130.	957578.	738008.	69106.
1986	3706439.	4362541.	1306129.	1351567.	586169.	68951.
1987	6280192.	4318997.	1513905.	1055188.	652139.	65881.
1988	5045170.	5018133.	1138051.	1362108.	479093.	44092.
1989	5844442.	4139343.	946698.	1212904.	945449.	121843.
1990	6840077.	5910204.	977104.	1354542.	1052048.	177816.
1991	6313402.	5500947.	1181880.	1108701.	832673.	126849.
1992	6170239.	5029419.	1236534.	1294467.	780051.	124612.
1993	8654594.	5382283.	1528458.	1371075.	745384.	81507.
1994	4983084.	6443400.	2198100.	1089902.	762615.	100493.
1995	5210909.	4889679.	1543835.	1000446.	724878.	82982.
1996	5415623.	5453178.	1306456.	1144517.	699652.	77460.
1997	5109588.	6051401.	1090160.	805058.	697640.	81796.
1998	5261746.	7237372.	1260581.	828678.	716679.	132870.
1999	6104314.	11684800.	1722161.	797909.	524019.	96085.
2000	8362333.	5878954.	1274923.	1133947.	475691.	100301.
2001	7465211.	10065910.	1576328.	1271341.	534448.	117632.
2002	7175201.	8115388.	952183.	882558.	613958.	76429.
2003	6879341.	7202107.	1008228.	764832.	507098.	107459.
2004	7118910.	5801751.	1149694.	874474.	360014.	114175.
2005	5792990.	6796869.	895413.	573610.	446518.	86079.
2006	4628314.	3926747.	1232116.	759365.	382044.	98240.

TABLE 4. SPAWNING STOCK FECUNDITY AND RECRUITMENT OF Yellowfin Tuna 2008

year	spawning biomass	recruits from VPA
1970	452061.	55754410.
1971	423048.	54790348.
1972	411420.	47032848.
1973	381632.	51598339.
1974	355344.	56438414.
1975	311738.	68711754.
1976	265347.	71327404.
1977	252932.	62955983.
1978	272542.	58377594.
1979	290143.	62184709.
1980	296829.	58772998.
1981	282729.	85481877.
1982	255400.	72408502.
1983	217599.	93679565.
1984	229378.	80672423.
1985	277632.	92044266.
1986	314297.	79828955.
1987	351375.	80704010.
1988	411351.	68444054.
1989	427222.	81583256.
1990	390735.	79323441.
1991	327078.	76193992.
1992	313194.	81923536.
1993	297839.	88889455.
1994	280258.	68017359.
1995	274757.	65603142.
1996	291581.	65500438.
1997	277349.	74239906.
1998	259041.	95693809.
1999	228871.	71457060.
2000	223352.	74638276.
2001	243476.	74939431.
2002	232604.	65424217.
2003	204756.	61595949.

2004	203493.	73837594.
2005	189337.	56463887.
2006	190327.	49948365.

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TABLE 5. FITS TO INDEX DATA FOR Yellowfin Tuna 2008

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5.1 BRA_BB

Lognormal dist.
month 6 biomass
Ages 0 - 4
log-likelihood = -1.43
deviance = 21.65
Chi-sq. discrepancy= 30.04

Year	Observed	Predicted	Residuals (Obs-pred)	Standard Deviation	Q Catchabil.	Untransfrmd Observed	Untransfrmd Predicted	Chi-square Discrepancy
1981	1.614	-0.096	1.711	0.687	0.160E-08	1.391	0.251	18.855
1982	-0.269	-0.089	-0.180	0.687	0.160E-08	0.212	0.253	0.192
1983	0.732	0.176	0.556	0.687	0.160E-08	0.576	0.330	0.237
1984	0.012	0.171	-0.159	0.687	0.160E-08	0.280	0.328	0.177
1985	-0.279	0.340	-0.619	0.687	0.160E-08	0.209	0.389	0.548
1986	-0.279	0.323	-0.602	0.687	0.160E-08	0.209	0.382	0.534
1987	0.063	0.418	-0.355	0.687	0.160E-08	0.295	0.421	0.331
1988	0.165	0.305	-0.139	0.687	0.160E-08	0.327	0.375	0.162
1989	0.076	0.251	-0.174	0.687	0.160E-08	0.299	0.356	0.188
1990	0.807	0.115	0.692	0.687	0.160E-08	0.620	0.310	0.555
1991	-0.390	0.243	-0.633	0.687	0.160E-08	0.187	0.353	0.560
1992	0.062	0.120	-0.057	0.687	0.160E-08	0.295	0.312	0.107
1993	0.234	-0.088	0.322	0.687	0.160E-08	0.350	0.253	0.013
1994	-0.278	0.142	-0.420	0.687	0.160E-08	0.210	0.319	0.384
1995	-0.983	0.188	-1.171	0.687	0.160E-08	0.104	0.334	0.947
1996	0.044	0.019	0.025	0.687	0.160E-08	0.289	0.282	0.060
1997	0.421	-0.086	0.506	0.687	0.160E-08	0.422	0.254	0.160
1998	0.154	-0.221	0.376	0.687	0.160E-08	0.323	0.222	0.037
1999	-0.906	-0.233	-0.673	0.687	0.160E-08	0.112	0.219	0.591
2001	0.900	-0.279	1.180	0.687	0.160E-08	0.681	0.209	4.094
2002	0.049	-0.343	0.391	0.687	0.160E-08	0.291	0.197	0.047
2003	-0.151	-0.328	0.176	0.687	0.160E-08	0.238	0.200	0.006
2004	-1.118	-0.444	-0.674	0.687	0.160E-08	0.091	0.178	0.592
2005	-0.985	-0.410	-0.575	0.687	0.160E-08	0.103	0.184	0.512
2006	0.305	-0.193	0.498	0.687	0.160E-08	0.376	0.228	0.149

Selectivities by age

Year	0	1	2	3	4
1981	0.007	0.624	1.000	0.194	0.010
1982	0.007	0.624	1.000	0.194	0.010
1983	0.007	0.624	1.000	0.194	0.010
1984	0.007	0.624	1.000	0.194	0.010
1985	0.007	0.624	1.000	0.194	0.010
1986	0.007	0.624	1.000	0.194	0.010
1987	0.007	0.624	1.000	0.194	0.010
1988	0.007	0.624	1.000	0.194	0.010
1989	0.007	0.624	1.000	0.194	0.010
1990	0.007	0.624	1.000	0.194	0.010
1991	0.007	0.624	1.000	0.194	0.010
1992	0.007	0.624	1.000	0.194	0.010
1993	0.007	0.624	1.000	0.194	0.010
1994	0.007	0.624	1.000	0.194	0.010
1995	0.007	0.624	1.000	0.194	0.010
1996	0.007	0.624	1.000	0.194	0.010
1997	0.007	0.624	1.000	0.194	0.010
1998	0.007	0.624	1.000	0.194	0.010
1999	0.007	0.624	1.000	0.194	0.010
2001	0.007	0.624	1.000	0.194	0.010
2002	0.007	0.624	1.000	0.194	0.010
2003	0.007	0.624	1.000	0.194	0.010
2004	0.007	0.624	1.000	0.194	0.010
2005	0.007	0.624	1.000	0.194	0.010
2006	0.007	0.624	1.000	0.194	0.010

5.2 BRA_LL

Lognormal dist.
month 6 numbers
Ages 0 - 5
log-likelihood = 4.25
deviance = 7.29
Chi-sq. discrepancy= 3.57

Year	Observed	Predicted	Residuals (Obs-pred)	Standard Deviation	Q Catchabil.	Untransfrmd Observed	Untransfrmd Predicted	Chi-square Discrepancy
1986	0.178	0.262	-0.084	0.687	0.140E-07	0.177	0.192	0.125
1987	0.416	0.307	0.109	0.687	0.140E-07	0.224	0.201	0.024
1988	0.645	0.311	0.334	0.687	0.140E-07	0.282	0.202	0.018
1989	0.571	0.238	0.333	0.687	0.140E-07	0.262	0.188	0.017
1990	0.752	0.171	0.581	0.687	0.140E-07	0.313	0.175	0.281
1991	0.177	0.115	0.062	0.687	0.140E-07	0.176	0.166	0.042
1992	-0.300	0.099	-0.399	0.687	0.140E-07	0.109	0.163	0.367
1993	-1.013	0.096	-1.109	0.687	0.140E-07	0.054	0.163	0.908
1994	-0.468	0.076	-0.544	0.687	0.140E-07	0.093	0.159	0.487
1995	-0.661	0.031	-0.692	0.687	0.140E-07	0.076	0.152	0.607
1996	0.299	-0.011	0.310	0.687	0.140E-07	0.199	0.146	0.010
1997	0.085	-0.070	0.155	0.687	0.140E-07	0.161	0.138	0.010

1998	0.327	-0.071	0.398	0.687	0.140E-07	0.205	0.138	0.052
1999	0.104	-0.048	0.152	0.687	0.140E-07	0.164	0.141	0.011
2000	0.008	-0.080	0.088	0.687	0.140E-07	0.149	0.136	0.031
2001	-0.086	-0.114	0.028	0.687	0.140E-07	0.136	0.132	0.058
2002	-0.573	-0.197	-0.376	0.687	0.140E-07	0.083	0.121	0.348
2003	-0.043	-0.279	0.236	0.687	0.140E-07	0.142	0.112	0.000
2004	0.020	-0.285	0.305	0.687	0.140E-07	0.151	0.111	0.009
2005	-0.415	-0.268	-0.147	0.687	0.140E-07	0.098	0.113	0.168
2006	-0.022	-0.283	0.261	0.687	0.140E-07	0.145	0.111	0.001

Selectivities by age

Year	0	1	2	3	4	5
1986	0.018	0.172	0.407	1.000	1.000	1.000
1987	0.018	0.172	0.407	1.000	1.000	1.000
1988	0.018	0.172	0.407	1.000	1.000	1.000
1989	0.018	0.172	0.407	1.000	1.000	1.000
1990	0.018	0.172	0.407	1.000	1.000	1.000
1991	0.018	0.172	0.407	1.000	1.000	1.000
1992	0.018	0.172	0.407	1.000	1.000	1.000
1993	0.018	0.172	0.407	1.000	1.000	1.000
1994	0.018	0.172	0.407	1.000	1.000	1.000
1995	0.018	0.172	0.407	1.000	1.000	1.000
1996	0.018	0.172	0.407	1.000	1.000	1.000
1997	0.018	0.172	0.407	1.000	1.000	1.000
1998	0.018	0.172	0.407	1.000	1.000	1.000
1999	0.018	0.172	0.407	1.000	1.000	1.000
2000	0.018	0.172	0.407	1.000	1.000	1.000
2001	0.018	0.172	0.407	1.000	1.000	1.000
2002	0.018	0.172	0.407	1.000	1.000	1.000
2003	0.018	0.172	0.407	1.000	1.000	1.000
2004	0.018	0.172	0.407	1.000	1.000	1.000
2005	0.018	0.172	0.407	1.000	1.000	1.000
2006	0.018	0.172	0.407	1.000	1.000	1.000

5.3 JPN_LL

Lognormal dist.
month 6 numbers
Ages 0 - 5
log-likelihood = 9.03
deviance = 9.75
Chi-sq. discrepancy= 6.99

Year	Observed	Predicted	Residuals (Obs-pred)	Standard Deviation	Q Catchabil.	Untransfrmd Observed	Untransfrmd Predicted	Chi-square Discrepancy
1970	0.526	0.350	0.176	0.687	0.134E-06	1.364	1.143	0.006
1971	0.283	0.290	-0.007	0.687	0.134E-06	1.069	1.077	0.077
1972	0.643	0.253	0.390	0.687	0.134E-06	1.533	1.038	0.046
1973	0.329	0.180	0.149	0.687	0.134E-06	1.119	0.965	0.012
1974	0.566	0.097	0.470	0.687	0.134E-06	1.420	0.888	0.115
1975	0.250	-0.042	0.292	0.687	0.134E-06	1.034	0.773	0.006
1976	0.288	-0.119	0.407	0.687	0.134E-06	1.075	0.715	0.058
1977	0.103	-0.054	0.157	0.687	0.134E-06	0.893	0.763	0.009
1978	0.452	0.032	0.419	0.687	0.134E-06	1.266	0.832	0.067
1979	0.768	0.038	0.731	0.687	0.134E-06	1.737	0.837	0.680
1980	0.190	0.029	0.161	0.687	0.134E-06	0.974	0.830	0.009
1981	0.426	-0.063	0.490	0.687	0.134E-06	1.234	0.756	0.139
1982	0.278	-0.170	0.448	0.687	0.134E-06	1.063	0.680	0.092
1983	0.308	-0.227	0.535	0.687	0.134E-06	1.096	0.642	0.202
1984	0.361	-0.017	0.378	0.687	0.134E-06	1.156	0.792	0.039
1985	-0.115	0.084	-0.199	0.687	0.134E-06	0.718	0.876	0.206
1986	0.167	0.195	-0.029	0.687	0.134E-06	0.952	0.979	0.090
1987	0.207	0.324	-0.118	0.687	0.134E-06	0.991	1.115	0.147
1988	0.246	0.401	-0.155	0.687	0.134E-06	1.030	1.203	0.174
1989	-0.032	0.333	-0.365	0.687	0.134E-06	0.780	1.124	0.339
1990	0.277	0.194	0.083	0.687	0.134E-06	1.063	0.979	0.033
1991	-0.011	0.100	-0.111	0.687	0.134E-06	0.797	0.890	0.142
1992	0.034	0.083	-0.050	0.687	0.134E-06	0.833	0.876	0.102
1993	-0.608	0.033	-0.641	0.687	0.134E-06	0.439	0.833	0.566
1994	-0.076	0.008	-0.084	0.687	0.134E-06	0.747	0.812	0.124
1995	-0.500	0.028	-0.528	0.687	0.134E-06	0.489	0.829	0.474
1996	-0.430	0.030	-0.460	0.687	0.134E-06	0.524	0.830	0.417
1997	-0.636	-0.060	-0.576	0.687	0.134E-06	0.426	0.759	0.513
1998	-0.470	-0.164	-0.307	0.687	0.134E-06	0.503	0.684	0.291
1999	-0.440	-0.212	-0.228	0.687	0.134E-06	0.519	0.652	0.229
2000	-0.296	-0.176	-0.120	0.687	0.134E-06	0.599	0.676	0.149
2001	-0.708	-0.117	-0.590	0.687	0.134E-06	0.397	0.716	0.525
2002	-0.708	-0.246	-0.462	0.687	0.134E-06	0.397	0.630	0.419
2003	-0.533	-0.347	-0.186	0.687	0.134E-06	0.473	0.570	0.196
2004	-0.298	-0.340	0.042	0.687	0.134E-06	0.598	0.573	0.051
2005	-0.614	-0.396	-0.218	0.687	0.134E-06	0.436	0.542	0.220
2006	-0.226	-0.331	0.105	0.687	0.134E-06	0.643	0.579	0.025

Selectivities by age

Year	0	1	2	3	4	5
1970	0.000	0.003	0.231	1.000	1.000	1.000
1971	0.000	0.003	0.231	1.000	1.000	1.000
1972	0.000	0.003	0.231	1.000	1.000	1.000
1973	0.000	0.003	0.231	1.000	1.000	1.000
1974	0.000	0.003	0.231	1.000	1.000	1.000
1975	0.000	0.003	0.231	1.000	1.000	1.000
1976	0.000	0.003	0.231	1.000	1.000	1.000
1977	0.000	0.003	0.231	1.000	1.000	1.000
1978	0.000	0.003	0.231	1.000	1.000	1.000
1979	0.000	0.003	0.231	1.000	1.000	1.000
1980	0.000	0.003	0.231	1.000	1.000	1.000
1981	0.000	0.003	0.231	1.000	1.000	1.000
1982	0.000	0.003	0.231	1.000	1.000	1.000

1983	0.000	0.003	0.231	1.000	1.000	1.000
1984	0.000	0.003	0.231	1.000	1.000	1.000
1985	0.000	0.003	0.231	1.000	1.000	1.000
1986	0.000	0.003	0.231	1.000	1.000	1.000
1987	0.000	0.003	0.231	1.000	1.000	1.000
1988	0.000	0.003	0.231	1.000	1.000	1.000
1989	0.000	0.003	0.231	1.000	1.000	1.000
1990	0.000	0.003	0.231	1.000	1.000	1.000
1991	0.000	0.003	0.231	1.000	1.000	1.000
1992	0.000	0.003	0.231	1.000	1.000	1.000
1993	0.000	0.003	0.231	1.000	1.000	1.000
1994	0.000	0.003	0.231	1.000	1.000	1.000
1995	0.000	0.003	0.231	1.000	1.000	1.000
1996	0.000	0.003	0.231	1.000	1.000	1.000
1997	0.000	0.003	0.231	1.000	1.000	1.000
1998	0.000	0.003	0.231	1.000	1.000	1.000
1999	0.000	0.003	0.231	1.000	1.000	1.000
2000	0.000	0.003	0.231	1.000	1.000	1.000
2001	0.000	0.003	0.231	1.000	1.000	1.000
2002	0.000	0.003	0.231	1.000	1.000	1.000
2003	0.000	0.003	0.231	1.000	1.000	1.000
2004	0.000	0.003	0.231	1.000	1.000	1.000
2005	0.000	0.003	0.231	1.000	1.000	1.000
2006	0.000	0.003	0.231	1.000	1.000	1.000

5.4 USMEX_LL

Lognormal dist.
month 6 numbers
Ages 0 - 5
log-likelihood = 4.74
deviance = 1.04
Chi-sq. discrepancy= 1.52

Year	Observed	Predicted	Residuals (Obs-pred)	Standard Deviation	Q Catchabil.	Untransfrmd Observed	Untransfrmd Predicted	Chi-square Discrepancy
1993	0.205	0.196	0.009	0.687	0.173E-06	1.151	1.140	0.068
1994	0.528	0.175	0.353	0.687	0.173E-06	1.589	1.116	0.026
1995	0.077	0.196	-0.119	0.687	0.173E-06	1.012	1.140	0.148
1996	-0.043	0.185	-0.228	0.687	0.173E-06	0.898	1.128	0.228
1997	0.042	0.095	-0.054	0.687	0.173E-06	0.977	1.031	0.105
1998	-0.039	-0.005	-0.034	0.687	0.173E-06	0.901	0.932	0.093
1999	0.382	-0.043	0.425	0.687	0.173E-06	1.373	0.898	0.072
2000	0.001	0.001	0.000	0.687	0.173E-06	0.938	0.938	0.073
2001	-0.232	0.043	-0.275	0.687	0.173E-06	0.743	0.978	0.265
2002	-0.175	-0.093	-0.082	0.687	0.173E-06	0.787	0.854	0.123
2003	-0.025	-0.178	0.153	0.687	0.173E-06	0.914	0.785	0.011
2004	-0.195	-0.183	-0.013	0.687	0.173E-06	0.771	0.781	0.080
2005	-0.285	-0.230	-0.055	0.687	0.173E-06	0.705	0.745	0.105
2006	-0.240	-0.159	-0.081	0.687	0.173E-06	0.737	0.800	0.123

Selectivities by age

Year	0	1	2	3	4	5
1993	0.000	0.006	0.281	1.000	1.000	1.000
1994	0.000	0.006	0.281	1.000	1.000	1.000
1995	0.000	0.006	0.281	1.000	1.000	1.000
1996	0.000	0.006	0.281	1.000	1.000	1.000
1997	0.000	0.006	0.281	1.000	1.000	1.000
1998	0.000	0.006	0.281	1.000	1.000	1.000
1999	0.000	0.006	0.281	1.000	1.000	1.000
2000	0.000	0.006	0.281	1.000	1.000	1.000
2001	0.000	0.006	0.281	1.000	1.000	1.000
2002	0.000	0.006	0.281	1.000	1.000	1.000
2003	0.000	0.006	0.281	1.000	1.000	1.000
2004	0.000	0.006	0.281	1.000	1.000	1.000
2005	0.000	0.006	0.281	1.000	1.000	1.000
2006	0.000	0.006	0.281	1.000	1.000	1.000

5.5 US_RR

Lognormal dist.
month 6 numbers
Ages 0 - 5
log-likelihood = 0.40
deviance = 14.99
Chi-sq. discrepancy= 7.18

Year	Observed	Predicted	Residuals (Obs-pred)	Standard Deviation	Q Catchabil.	Untransfrmd Observed	Untransfrmd Predicted	Chi-square Discrepancy
1986	0.789	0.319	0.470	0.687	0.102E-06	1.939	1.212	0.116
1987	0.046	0.397	-0.351	0.687	0.102E-06	0.922	1.310	0.327
1988	-0.456	0.273	-0.730	0.687	0.102E-06	0.558	1.157	0.636
1989	-0.437	0.178	-0.615	0.687	0.102E-06	0.569	1.052	0.544
1990	-0.911	0.076	-0.987	0.687	0.102E-06	0.354	0.950	0.826
1991	-0.437	0.143	-0.580	0.687	0.102E-06	0.569	1.016	0.516
1992	-0.820	0.103	-0.923	0.687	0.102E-06	0.388	0.976	0.781
1993	0.003	0.086	-0.083	0.687	0.102E-06	0.883	0.959	0.124
1994	0.665	0.124	0.541	0.687	0.102E-06	1.712	0.997	0.211
1995	0.490	0.124	0.366	0.687	0.102E-06	1.438	0.997	0.032
1996	-0.717	-0.046	-0.670	0.687	0.102E-06	0.430	0.841	0.590
1997	-0.822	-0.134	-0.688	0.687	0.102E-06	0.387	0.770	0.604
1998	-0.121	-0.171	0.049	0.687	0.102E-06	0.780	0.742	0.048
1999	0.627	-0.054	0.681	0.687	0.102E-06	1.649	0.834	0.523
2000	0.489	0.052	0.437	0.687	0.102E-06	1.436	0.928	0.083
2001	0.556	-0.114	0.671	0.687	0.102E-06	1.536	0.785	0.493
2002	0.168	-0.326	0.494	0.687	0.102E-06	1.042	0.636	0.144

2003	0.283	-0.218	0.501	0.687	0.102E-06	1.169	0.708	0.154
2004	0.156	-0.365	0.521	0.687	0.102E-06	1.029	0.611	0.180
2005	0.063	-0.284	0.347	0.687	0.102E-06	0.938	0.663	0.023
2006	0.383	-0.165	0.547	0.687	0.102E-06	1.291	0.747	0.222

Selectivities by age

Year	0	1	2	3	4	5
1986	0.000	0.100	1.000	0.186	0.076	0.025
1987	0.000	0.100	1.000	0.186	0.076	0.025
1988	0.000	0.100	1.000	0.186	0.076	0.025
1989	0.000	0.100	1.000	0.186	0.076	0.025
1990	0.000	0.100	1.000	0.186	0.076	0.025
1991	0.000	0.100	1.000	0.186	0.076	0.025
1992	0.000	0.100	1.000	0.186	0.076	0.025
1993	0.000	0.100	1.000	0.186	0.076	0.025
1994	0.000	0.100	1.000	0.186	0.076	0.025
1995	0.000	0.100	1.000	0.186	0.076	0.025
1996	0.000	0.100	1.000	0.186	0.076	0.025
1997	0.000	0.100	1.000	0.186	0.076	0.025
1998	0.000	0.100	1.000	0.186	0.076	0.025
1999	0.000	0.100	1.000	0.186	0.076	0.025
2000	0.000	0.100	1.000	0.186	0.076	0.025
2001	0.000	0.100	1.000	0.186	0.076	0.025
2002	0.000	0.100	1.000	0.186	0.076	0.025
2003	0.000	0.100	1.000	0.186	0.076	0.025
2004	0.000	0.100	1.000	0.186	0.076	0.025
2005	0.000	0.100	1.000	0.186	0.076	0.025
2006	0.000	0.100	1.000	0.186	0.076	0.025

5.6 US_PLL ATL

Lognormal dist.
month 6 numbers
Ages 0 - 5
log-likelihood = 6.65
deviance = 1.74
Chi-sq. discrepancy= 2.11

Year	Observed	Predicted	Residuals (Obs-pred)	Standard Deviation	Q Catchabil.	Untransfrmd Observed	Untransfrmd Predicted	Chi-square Discrepancy
1987	0.587	0.370	0.217	0.687	0.156E-06	1.696	1.365	0.001
1988	0.652	0.436	0.216	0.687	0.156E-06	1.811	1.459	0.001
1989	0.588	0.367	0.221	0.687	0.156E-06	1.699	1.361	0.000
1990	0.388	0.230	0.159	0.687	0.156E-06	1.391	1.187	0.009
1991	0.140	0.144	-0.003	0.687	0.156E-06	1.085	1.089	0.075
1992	0.210	0.125	0.085	0.687	0.156E-06	1.164	1.069	0.033
1993	-0.279	0.077	-0.356	0.687	0.156E-06	0.713	1.019	0.331
1994	-0.125	0.055	-0.180	0.687	0.156E-06	0.832	0.997	0.192
1995	-0.040	0.075	-0.115	0.687	0.156E-06	0.906	1.017	0.146
1996	-0.298	0.067	-0.365	0.687	0.156E-06	0.700	1.009	0.338
1997	-0.191	-0.023	-0.168	0.687	0.156E-06	0.780	0.922	0.183
1998	-0.316	-0.123	-0.193	0.687	0.156E-06	0.687	0.834	0.202
1999	-0.178	-0.163	-0.015	0.687	0.156E-06	0.789	0.801	0.082
2000	-0.091	-0.121	0.030	0.687	0.156E-06	0.861	0.835	0.057
2001	-0.218	-0.076	-0.142	0.687	0.156E-06	0.758	0.874	0.164
2002	-0.293	-0.210	-0.084	0.687	0.156E-06	0.703	0.765	0.124
2003	-0.423	-0.298	-0.124	0.687	0.156E-06	0.618	0.700	0.152
2004	-0.063	-0.301	0.238	0.687	0.156E-06	0.886	0.698	0.000
2005	-0.013	-0.350	0.336	0.687	0.156E-06	0.931	0.665	0.019
2006	-0.036	-0.280	0.244	0.687	0.156E-06	0.910	0.713	0.000

Selectivities by age

Year	0	1	2	3	4	5
1987	0.000	0.006	0.270	1.000	1.000	1.000
1988	0.000	0.006	0.270	1.000	1.000	1.000
1989	0.000	0.006	0.270	1.000	1.000	1.000
1990	0.000	0.006	0.270	1.000	1.000	1.000
1991	0.000	0.006	0.270	1.000	1.000	1.000
1992	0.000	0.006	0.270	1.000	1.000	1.000
1993	0.000	0.006	0.270	1.000	1.000	1.000
1994	0.000	0.006	0.270	1.000	1.000	1.000
1995	0.000	0.006	0.270	1.000	1.000	1.000
1996	0.000	0.006	0.270	1.000	1.000	1.000
1997	0.000	0.006	0.270	1.000	1.000	1.000
1998	0.000	0.006	0.270	1.000	1.000	1.000
1999	0.000	0.006	0.270	1.000	1.000	1.000
2000	0.000	0.006	0.270	1.000	1.000	1.000
2001	0.000	0.006	0.270	1.000	1.000	1.000
2002	0.000	0.006	0.270	1.000	1.000	1.000
2003	0.000	0.006	0.270	1.000	1.000	1.000
2004	0.000	0.006	0.270	1.000	1.000	1.000
2005	0.000	0.006	0.270	1.000	1.000	1.000
2006	0.000	0.006	0.270	1.000	1.000	1.000

5.7 VEN_LL

Lognormal dist.
month 6 numbers
Ages 0 - 5
log-likelihood = 2.22
deviance = 3.82
Chi-sq. discrepancy= 3.43

Year	Observed	Predicted	Residuals (Obs-pred)	Standard Deviation	Q Catchabil.	Untransfrmd Observed	Untransfrmd Predicted	Chi-square Discrepancy

1991	0.132	0.140	-0.008	0.687	0.179E-06	1.045	1.053	0.078
1992	0.218	0.122	0.096	0.687	0.179E-06	1.138	1.034	0.028
1993	0.605	0.079	0.526	0.687	0.179E-06	1.676	0.991	0.188
1994	-0.378	0.046	-0.424	0.687	0.179E-06	0.627	0.959	0.388
1995	-0.277	0.051	-0.328	0.687	0.179E-06	0.694	0.963	0.308
1996	-0.011	0.072	-0.083	0.687	0.179E-06	0.905	0.983	0.124
1997	-0.604	-0.010	-0.594	0.687	0.179E-06	0.500	0.906	0.528
1998	-0.051	-0.104	0.054	0.687	0.179E-06	0.870	0.825	0.046
1999	-0.075	-0.152	0.077	0.687	0.179E-06	0.849	0.786	0.036
2000	-0.375	-0.158	-0.218	0.687	0.179E-06	0.629	0.782	0.221
2001	0.815	-0.087	0.902	0.687	0.179E-06	2.067	0.839	1.486

Selectivities by age

Year	0	1	2	3	4	5
1991	0.000	0.018	0.132	0.906	1.000	1.000
1992	0.000	0.018	0.132	0.906	1.000	1.000
1993	0.000	0.018	0.132	0.906	1.000	1.000
1994	0.000	0.018	0.132	0.906	1.000	1.000
1995	0.000	0.018	0.132	0.906	1.000	1.000
1996	0.000	0.018	0.132	0.906	1.000	1.000
1997	0.000	0.018	0.132	0.906	1.000	1.000
1998	0.000	0.018	0.132	0.906	1.000	1.000
1999	0.000	0.018	0.132	0.906	1.000	1.000
2000	0.000	0.018	0.132	0.906	1.000	1.000
2001	0.000	0.018	0.132	0.906	1.000	1.000

5.8 VEN_PS

Lognormal dist.
month 6 biomass
Ages 0 - 4
log-likelihood = 2.77
deviance = 11.76
Chi-sq. discrepancy= 8.48

Year	Observed	Predicted	Residuals (Obs-pred)	Standard Deviation	Q Catchabil.	Untransfrmd Observed	Untransfrmd Predicted	Chi-square Discrepancy
1983	0.863	-0.014	0.877	0.687	0.216E-07	13.589	5.654	1.341
1984	0.050	0.125	-0.075	0.687	0.216E-07	6.027	6.499	0.119
1985	0.573	0.246	0.328	0.687	0.216E-07	10.170	7.329	0.015
1986	0.042	0.292	-0.250	0.687	0.216E-07	5.977	7.676	0.246
1987	-0.226	0.387	-0.613	0.687	0.216E-07	4.574	8.444	0.543
1988	0.095	0.362	-0.267	0.687	0.216E-07	6.304	8.231	0.259
1989	0.868	0.285	0.583	0.687	0.216E-07	13.656	7.621	0.286
1990	0.200	0.170	0.030	0.687	0.216E-07	7.002	6.796	0.058
1991	0.221	0.160	0.061	0.687	0.216E-07	7.151	6.728	0.043
1992	-0.175	0.104	-0.279	0.687	0.216E-07	4.812	6.360	0.269
1993	-0.040	-0.039	0.000	0.687	0.216E-07	5.511	5.512	0.073
1994	0.159	0.076	0.082	0.687	0.216E-07	6.720	6.188	0.034
1995	-0.639	0.124	-0.763	0.687	0.216E-07	3.025	6.489	0.662
1996	0.167	0.062	0.105	0.687	0.216E-07	6.777	6.101	0.025
1997	-0.227	-0.081	-0.146	0.687	0.216E-07	4.569	5.289	0.167
1998	-0.437	-0.201	-0.236	0.687	0.216E-07	3.704	4.691	0.235
1999	-0.054	-0.262	0.208	0.687	0.216E-07	5.434	4.412	0.001
2000	0.144	-0.144	0.289	0.687	0.216E-07	6.624	4.963	0.005
2001	0.837	-0.179	1.016	0.687	0.216E-07	13.243	4.795	2.318
2002	0.356	-0.269	0.624	0.687	0.216E-07	8.181	4.383	0.374
2003	-0.360	-0.391	0.031	0.687	0.216E-07	3.999	3.877	0.057
2004	-0.874	-0.401	-0.473	0.687	0.216E-07	2.393	3.839	0.428
2005	-1.543	-0.412	-1.131	0.687	0.216E-07	1.226	3.798	0.922

Selectivities by age

Year	0	1	2	3	4
1983	0.015	0.629	0.869	1.000	0.198
1984	0.015	0.629	0.869	1.000	0.198
1985	0.015	0.629	0.869	1.000	0.198
1986	0.015	0.629	0.869	1.000	0.198
1987	0.015	0.629	0.869	1.000	0.198
1988	0.015	0.629	0.869	1.000	0.198
1989	0.015	0.629	0.869	1.000	0.198
1990	0.015	0.629	0.869	1.000	0.198
1991	0.015	0.629	0.869	1.000	0.198
1992	0.015	0.629	0.869	1.000	0.198
1993	0.015	0.629	0.869	1.000	0.198
1994	0.015	0.629	0.869	1.000	0.198
1995	0.015	0.629	0.869	1.000	0.198
1996	0.015	0.629	0.869	1.000	0.198
1997	0.015	0.629	0.869	1.000	0.198
1998	0.015	0.629	0.869	1.000	0.198
1999	0.015	0.629	0.869	1.000	0.198
2000	0.015	0.629	0.869	1.000	0.198
2001	0.015	0.629	0.869	1.000	0.198
2002	0.015	0.629	0.869	1.000	0.198
2003	0.015	0.629	0.869	1.000	0.198
2004	0.015	0.629	0.869	1.000	0.198
2005	0.015	0.629	0.869	1.000	0.198

5.9 EUR-FAD-PS

Lognormal dist.
month 6 biomass
Ages 0 - 1
log-likelihood = 4.77
deviance = 2.48
Chi-sq. discrepancy= 1.95

Residuals Standard Q Untransfrmd Untransfrmd Chi-square

Year	Observed	Predicted	(Obs-pred)	Deviation	Catchabil.	Observed	Predicted	Discrepancy
1991	0.054	0.152	-0.098	0.687	0.170E-07	1.960	2.161	0.133
1992	-0.380	0.061	-0.440	0.687	0.170E-07	1.270	1.973	0.401
1993	0.065	0.148	-0.084	0.687	0.170E-07	1.980	2.153	0.124
1994	0.002	0.145	-0.143	0.687	0.170E-07	1.860	2.145	0.165
1995	0.161	0.021	0.140	0.687	0.170E-07	2.180	1.896	0.014
1996	0.029	-0.011	0.040	0.687	0.170E-07	1.910	1.836	0.053
1997	-0.130	0.051	-0.181	0.687	0.170E-07	1.630	1.953	0.193
1998	-0.428	0.257	-0.685	0.687	0.170E-07	1.210	2.401	0.601
1999	0.034	0.041	-0.007	0.687	0.170E-07	1.920	1.933	0.077
2000	0.080	0.022	0.058	0.687	0.170E-07	2.010	1.898	0.044
2001	-0.014	-0.131	0.117	0.687	0.170E-07	1.830	1.628	0.021
2002	0.085	-0.011	0.096	0.687	0.170E-07	2.020	1.836	0.028
2003	0.161	-0.223	0.383	0.687	0.170E-07	2.180	1.486	0.042
2004	0.197	-0.136	0.333	0.687	0.170E-07	2.260	1.620	0.017
2005	0.210	-0.129	0.339	0.687	0.170E-07	2.290	1.632	0.019
2006	-0.124	-0.258	0.134	0.687	0.170E-07	1.640	1.435	0.016

Selectivities by age

Year	0	1
1991	0.795	1.000
1992	0.795	1.000
1993	0.795	1.000
1994	0.795	1.000
1995	0.795	1.000
1996	0.795	1.000
1997	0.795	1.000
1998	0.795	1.000
1999	0.795	1.000
2000	0.795	1.000
2001	0.795	1.000
2002	0.795	1.000
2003	0.795	1.000
2004	0.795	1.000
2005	0.795	1.000
2006	0.795	1.000

5.10 EUR-PS 3%

Lognormal dist.
month 6 biomass
Ages 0 - 5
log-likelihood = 3.57
deviance = 0.37
Chi-sq. discrepancy= 0.88

Year	Observed	Predicted	Residuals (Obs-pred)	Standard Deviation	Q Catchabil.	Untransfrmd Observed	Untransfrmd Predicted	Chi-square Discrepancy
1970	0.101	0.213	-0.112	0.687	0.192E-07	5.061	5.662	0.143
1971	-0.057	0.162	-0.220	0.687	0.192E-07	4.318	5.379	0.222
1972	0.047	0.116	-0.069	0.687	0.192E-07	4.795	5.135	0.114
1973	0.055	0.058	-0.002	0.687	0.192E-07	4.833	4.845	0.075
1974	-0.038	-0.028	-0.010	0.687	0.192E-07	4.405	4.448	0.079
1975	0.037	-0.116	0.152	0.687	0.192E-07	4.744	4.075	0.011
1976	0.026	-0.211	0.237	0.687	0.192E-07	4.693	3.702	0.000
1977	0.008	-0.137	0.145	0.687	0.192E-07	4.610	3.990	0.013
1978	-0.086	-0.042	-0.045	0.687	0.192E-07	4.195	4.388	0.099
1979	-0.092	-0.016	-0.076	0.687	0.192E-07	4.171	4.503	0.119

Selectivities by age

Year	0	1	2	3	4	5
1970	0.040	0.271	0.420	0.631	1.000	0.243
1971	0.040	0.271	0.420	0.631	1.000	0.243
1972	0.040	0.271	0.420	0.631	1.000	0.243
1973	0.040	0.271	0.420	0.631	1.000	0.243
1974	0.040	0.271	0.420	0.631	1.000	0.243
1975	0.040	0.271	0.420	0.631	1.000	0.243
1976	0.040	0.271	0.420	0.631	1.000	0.243
1977	0.040	0.271	0.420	0.631	1.000	0.243
1978	0.040	0.271	0.420	0.631	1.000	0.243
1979	0.040	0.271	0.420	0.631	1.000	0.243

5.11 EU-DAKAR

Lognormal dist.
month 6 biomass
Ages 0 - 4
log-likelihood = 3.31
deviance = 20.45
Chi-sq. discrepancy= 12.16

Year	Observed	Predicted	Residuals (Obs-pred)	Standard Deviation	Q Catchabil.	Untransfrmd Observed	Untransfrmd Predicted	Chi-square Discrepancy
1970	-0.200	0.007	-0.208	0.687	0.472E-08	0.644	0.793	0.213
1971	-0.213	0.006	-0.219	0.687	0.472E-08	0.636	0.791	0.221
1972	-0.207	0.020	-0.227	0.687	0.472E-08	0.640	0.803	0.228
1973	-0.290	-0.029	-0.261	0.687	0.472E-08	0.589	0.764	0.254
1974	0.162	-0.082	0.244	0.687	0.472E-08	0.925	0.725	0.000
1975	-0.664	-0.068	-0.597	0.687	0.472E-08	0.405	0.735	0.530
1976	-0.563	-0.002	-0.561	0.687	0.472E-08	0.448	0.785	0.501
1977	-0.140	0.134	-0.274	0.687	0.472E-08	0.684	0.900	0.265
1978	-1.092	0.126	-1.218	0.687	0.472E-08	0.264	0.892	0.975
1979	-0.457	0.041	-0.499	0.687	0.472E-08	0.498	0.820	0.449
1981	0.263	-0.106	0.369	0.687	0.472E-08	1.024	0.708	0.034

1982	0.215	-0.031	0.247	0.687	0.472E-08	0.976	0.763	0.000
1983	0.234	0.149	0.085	0.687	0.472E-08	0.994	0.913	0.033
1984	0.590	0.245	0.346	0.687	0.472E-08	1.420	1.005	0.022
1985	0.327	0.322	0.005	0.687	0.472E-08	1.091	1.086	0.070
1986	0.739	0.333	0.405	0.687	0.472E-08	1.647	1.098	0.057
1987	0.859	0.383	0.477	0.687	0.472E-08	1.858	1.154	0.123
1988	0.826	0.272	0.554	0.687	0.472E-08	1.798	1.033	0.233
1989	-0.597	0.177	-0.774	0.687	0.472E-08	0.433	0.939	0.671
1990	0.745	0.119	0.626	0.687	0.472E-08	1.658	0.887	0.378
1991	0.422	0.201	0.221	0.687	0.472E-08	1.200	0.962	0.000
1992	1.090	0.082	1.008	0.687	0.472E-08	2.340	0.854	2.248
1993	0.881	-0.058	0.939	0.687	0.472E-08	1.899	0.743	1.725
1994	0.586	0.129	0.457	0.687	0.472E-08	1.414	0.895	0.102
1995	0.071	0.117	-0.046	0.687	0.472E-08	0.845	0.885	0.100
1996	0.562	-0.018	0.580	0.687	0.472E-08	1.381	0.773	0.281
1997	-0.295	-0.099	-0.196	0.687	0.472E-08	0.586	0.713	0.204
1998	-1.261	-0.158	-1.103	0.687	0.472E-08	0.223	0.672	0.904
1999	-0.208	-0.190	-0.018	0.687	0.472E-08	0.639	0.651	0.084
2000	-0.961	-0.057	-0.904	0.687	0.472E-08	0.301	0.743	0.768
2001	-0.490	-0.282	-0.208	0.687	0.472E-08	0.482	0.593	0.213
2002	-0.074	-0.296	0.223	0.687	0.472E-08	0.731	0.585	0.000
2003	0.059	-0.350	0.409	0.687	0.472E-08	0.835	0.555	0.059
2004	-0.213	-0.439	0.226	0.687	0.472E-08	0.636	0.507	0.000
2005	-0.416	-0.357	-0.059	0.687	0.472E-08	0.519	0.550	0.108
2006	-0.291	-0.243	-0.048	0.687	0.472E-08	0.588	0.617	0.101

Selectivities by age

Year	0	1	2	3	4
1970	0.062	1.000	0.666	0.200	0.047
1971	0.062	1.000	0.666	0.200	0.047
1972	0.062	1.000	0.666	0.200	0.047
1973	0.062	1.000	0.666	0.200	0.047
1974	0.062	1.000	0.666	0.200	0.047
1975	0.062	1.000	0.666	0.200	0.047
1976	0.062	1.000	0.666	0.200	0.047
1977	0.062	1.000	0.666	0.200	0.047
1978	0.062	1.000	0.666	0.200	0.047
1979	0.062	1.000	0.666	0.200	0.047
1981	0.062	1.000	0.666	0.200	0.047
1982	0.062	1.000	0.666	0.200	0.047
1983	0.062	1.000	0.666	0.200	0.047
1984	0.062	1.000	0.666	0.200	0.047
1985	0.062	1.000	0.666	0.200	0.047
1986	0.062	1.000	0.666	0.200	0.047
1987	0.062	1.000	0.666	0.200	0.047
1988	0.062	1.000	0.666	0.200	0.047
1989	0.062	1.000	0.666	0.200	0.047
1990	0.062	1.000	0.666	0.200	0.047
1991	0.062	1.000	0.666	0.200	0.047
1992	0.062	1.000	0.666	0.200	0.047
1993	0.062	1.000	0.666	0.200	0.047
1994	0.062	1.000	0.666	0.200	0.047
1995	0.062	1.000	0.666	0.200	0.047
1996	0.062	1.000	0.666	0.200	0.047
1997	0.062	1.000	0.666	0.200	0.047
1998	0.062	1.000	0.666	0.200	0.047
1999	0.062	1.000	0.666	0.200	0.047
2000	0.062	1.000	0.666	0.200	0.047
2001	0.062	1.000	0.666	0.200	0.047
2002	0.062	1.000	0.666	0.200	0.047
2003	0.062	1.000	0.666	0.200	0.047
2004	0.062	1.000	0.666	0.200	0.047
2005	0.062	1.000	0.666	0.200	0.047
2006	0.062	1.000	0.666	0.200	0.047

5.12 URU-LL

Lognormal dist.
month 6 numbers
Ages 0 - 5
log-likelihood = 1.92
deviance = 15.71
Chi-sq. discrepancy= 10.54

Year	Observed	Predicted	Residuals (Obs-pred)	Standard Deviation	Q Catchabil.	Untransfrmd Observed	Untransfrmd Predicted	Chi-square Discrepancy
1981	0.627	-0.041	0.668	0.687	0.408E-06	6.554	3.361	0.484
1982	0.932	-0.121	1.053	0.687	0.408E-06	8.896	3.102	2.658
1983	-0.050	-0.083	0.033	0.687	0.408E-06	3.330	3.222	0.056
1984	-0.858	0.058	-0.916	0.687	0.408E-06	1.485	3.709	0.776
1985	0.012	0.174	-0.162	0.687	0.408E-06	3.546	4.169	0.179
1986	0.164	0.259	-0.095	0.687	0.408E-06	4.124	4.537	0.132
1987	0.127	0.369	-0.242	0.687	0.408E-06	3.976	5.064	0.240
1988	0.777	0.378	0.399	0.687	0.408E-06	7.613	5.109	0.052
1989	-0.519	0.302	-0.821	0.687	0.408E-06	2.085	4.737	0.707
1990	-0.609	0.176	-0.785	0.687	0.408E-06	1.904	4.174	0.679
1991	0.672	0.136	0.536	0.687	0.408E-06	6.854	4.012	0.203
1992	0.626	0.110	0.516	0.687	0.408E-06	6.545	3.907	0.173
1993	-1.028	0.072	-1.100	0.687	0.408E-06	1.252	3.761	0.902
1994	0.325	0.069	0.255	0.687	0.408E-06	4.845	3.754	0.001
1995	0.058	0.082	-0.024	0.687	0.408E-06	3.711	3.800	0.087
1996	0.715	0.022	0.693	0.687	0.408E-06	7.159	3.581	0.557
1997	-0.379	-0.065	-0.314	0.687	0.408E-06	2.396	3.280	0.297
1998	-0.255	-0.146	-0.109	0.687	0.408E-06	2.715	3.027	0.141
1999	-0.073	-0.133	0.060	0.687	0.408E-06	3.255	3.066	0.043
2000	0.198	-0.071	0.269	0.687	0.408E-06	4.268	3.263	0.002
2001	-0.283	-0.099	-0.184	0.687	0.408E-06	2.638	3.171	0.195
2002	-0.667	-0.254	-0.414	0.687	0.408E-06	1.796	2.717	0.379
2003	-0.314	-0.279	-0.035	0.687	0.408E-06	2.558	2.649	0.093

2004	-0.318	-0.330	0.012	0.687	0.408E-06	2.547	2.517	0.067
2005	0.528	-0.335	0.863	0.687	0.408E-06	5.937	2.505	1.263
2006	-0.406	-0.250	-0.156	0.687	0.408E-06	2.333	2.727	0.174

Selectivities by age

Year	0	1	2	3	4	5
1981	0.000	0.039	0.572	1.000	1.000	1.000
1982	0.000	0.039	0.572	1.000	1.000	1.000
1983	0.000	0.039	0.572	1.000	1.000	1.000
1984	0.000	0.039	0.572	1.000	1.000	1.000
1985	0.000	0.039	0.572	1.000	1.000	1.000
1986	0.000	0.039	0.572	1.000	1.000	1.000
1987	0.000	0.039	0.572	1.000	1.000	1.000
1988	0.000	0.039	0.572	1.000	1.000	1.000
1989	0.000	0.039	0.572	1.000	1.000	1.000
1990	0.000	0.039	0.572	1.000	1.000	1.000
1991	0.000	0.039	0.572	1.000	1.000	1.000
1992	0.000	0.039	0.572	1.000	1.000	1.000
1993	0.000	0.039	0.572	1.000	1.000	1.000
1994	0.000	0.039	0.572	1.000	1.000	1.000
1995	0.000	0.039	0.572	1.000	1.000	1.000
1996	0.000	0.039	0.572	1.000	1.000	1.000
1997	0.000	0.039	0.572	1.000	1.000	1.000
1998	0.000	0.039	0.572	1.000	1.000	1.000
1999	0.000	0.039	0.572	1.000	1.000	1.000
2000	0.000	0.039	0.572	1.000	1.000	1.000
2001	0.000	0.039	0.572	1.000	1.000	1.000
2002	0.000	0.039	0.572	1.000	1.000	1.000
2003	0.000	0.039	0.572	1.000	1.000	1.000
2004	0.000	0.039	0.572	1.000	1.000	1.000
2005	0.000	0.039	0.572	1.000	1.000	1.000
2006	0.000	0.039	0.572	1.000	1.000	1.000

5.13 BRA-URU-LL

Not used

5.14 CHIN-TAI-LL

Lognormal dist.
month 6 numbers
Ages 0 - 5
log-likelihood = 11.89
deviance = 4.03
Chi-sq. discrepancy= 4.45

Year	Observed	Predicted	Residuals (Obs-pred)	Standard Deviation	Q Catchabil.	Untransfrmd Observed	Untransfrmd Predicted	Chi-square Discrepancy
1970	0.772	0.327	0.445	0.687	0.123E-06	1.712	1.098	0.089
1971	0.251	0.274	-0.023	0.687	0.123E-06	1.017	1.041	0.086
1972	0.328	0.236	0.092	0.687	0.123E-06	1.098	1.002	0.030
1973	0.435	0.164	0.272	0.687	0.123E-06	1.223	0.933	0.002
1974	-0.252	0.081	-0.333	0.687	0.123E-06	0.615	0.858	0.312
1975	-0.212	-0.048	-0.163	0.687	0.123E-06	0.641	0.754	0.180
1976	-0.041	-0.111	0.070	0.687	0.123E-06	0.760	0.709	0.039
1977	-0.145	-0.043	-0.102	0.687	0.123E-06	0.685	0.758	0.136
1978	-0.238	0.034	-0.272	0.687	0.123E-06	0.624	0.819	0.263
1979	-0.200	0.034	-0.234	0.687	0.123E-06	0.648	0.819	0.233
1980	0.006	0.022	-0.016	0.687	0.123E-06	0.796	0.809	0.082
1981	-0.133	-0.066	-0.067	0.687	0.123E-06	0.693	0.741	0.113
1982	-0.394	-0.161	-0.233	0.687	0.123E-06	0.534	0.674	0.233
1983	-0.403	-0.202	-0.202	0.687	0.123E-06	0.529	0.647	0.208
1984	-0.033	-0.004	-0.030	0.687	0.123E-06	0.766	0.789	0.090
1985	-0.133	0.097	-0.230	0.687	0.123E-06	0.693	0.872	0.230
1986	0.083	0.204	-0.121	0.687	0.123E-06	0.860	0.970	0.149
1987	-0.009	0.325	-0.334	0.687	0.123E-06	0.784	1.096	0.314
1988	0.342	0.389	-0.048	0.687	0.123E-06	1.114	1.168	0.101
1989	-0.020	0.319	-0.339	0.687	0.123E-06	0.776	1.089	0.317
1990	-0.020	0.186	-0.206	0.687	0.123E-06	0.776	0.953	0.211
1991	0.110	0.101	0.009	0.687	0.123E-06	0.884	0.876	0.068
1992	-0.199	0.083	-0.281	0.687	0.123E-06	0.649	0.860	0.271
1993	0.092	0.037	0.055	0.687	0.123E-06	0.868	0.821	0.045
1994	0.407	0.016	0.391	0.687	0.123E-06	1.189	0.804	0.047
1995	0.391	0.031	0.360	0.687	0.123E-06	1.170	0.817	0.029
1996	0.251	0.022	0.229	0.687	0.123E-06	1.017	0.809	0.000
1997	-0.018	-0.067	0.049	0.687	0.123E-06	0.778	0.740	0.048
1998	-0.010	-0.163	0.153	0.687	0.123E-06	0.783	0.673	0.011
1999	-0.315	-0.196	-0.119	0.687	0.123E-06	0.578	0.651	0.148
2000	-0.023	-0.161	0.138	0.687	0.123E-06	0.773	0.674	0.014
2001	-0.277	-0.121	-0.157	0.687	0.123E-06	0.600	0.702	0.175
2002	-0.101	-0.250	0.149	0.687	0.123E-06	0.715	0.617	0.012
2003	-0.096	-0.339	0.243	0.687	0.123E-06	0.719	0.564	0.000
2004	-0.099	-0.342	0.243	0.687	0.123E-06	0.717	0.562	0.000
2005	0.108	-0.385	0.493	0.687	0.123E-06	0.882	0.539	0.143
2006	-0.201	-0.322	0.120	0.687	0.123E-06	0.647	0.574	0.020

Selectivities by age

Year	0	1	2	3	4	5
1970	0.000	0.013	0.272	1.000	1.000	1.000
1971	0.000	0.013	0.272	1.000	1.000	1.000
1972	0.000	0.013	0.272	1.000	1.000	1.000
1973	0.000	0.013	0.272	1.000	1.000	1.000
1974	0.000	0.013	0.272	1.000	1.000	1.000
1975	0.000	0.013	0.272	1.000	1.000	1.000
1976	0.000	0.013	0.272	1.000	1.000	1.000
1977	0.000	0.013	0.272	1.000	1.000	1.000
1978	0.000	0.013	0.272	1.000	1.000	1.000

1979	0.000	0.013	0.272	1.000	1.000	1.000
1980	0.000	0.013	0.272	1.000	1.000	1.000
1981	0.000	0.013	0.272	1.000	1.000	1.000
1982	0.000	0.013	0.272	1.000	1.000	1.000
1983	0.000	0.013	0.272	1.000	1.000	1.000
1984	0.000	0.013	0.272	1.000	1.000	1.000
1985	0.000	0.013	0.272	1.000	1.000	1.000
1986	0.000	0.013	0.272	1.000	1.000	1.000
1987	0.000	0.013	0.272	1.000	1.000	1.000
1988	0.000	0.013	0.272	1.000	1.000	1.000
1989	0.000	0.013	0.272	1.000	1.000	1.000
1990	0.000	0.013	0.272	1.000	1.000	1.000
1991	0.000	0.013	0.272	1.000	1.000	1.000
1992	0.000	0.013	0.272	1.000	1.000	1.000
1993	0.000	0.013	0.272	1.000	1.000	1.000
1994	0.000	0.013	0.272	1.000	1.000	1.000
1995	0.000	0.013	0.272	1.000	1.000	1.000
1996	0.000	0.013	0.272	1.000	1.000	1.000
1997	0.000	0.013	0.272	1.000	1.000	1.000
1998	0.000	0.013	0.272	1.000	1.000	1.000
1999	0.000	0.013	0.272	1.000	1.000	1.000
2000	0.000	0.013	0.272	1.000	1.000	1.000
2001	0.000	0.013	0.272	1.000	1.000	1.000
2002	0.000	0.013	0.272	1.000	1.000	1.000
2003	0.000	0.013	0.272	1.000	1.000	1.000
2004	0.000	0.013	0.272	1.000	1.000	1.000
2005	0.000	0.013	0.272	1.000	1.000	1.000
2006	0.000	0.013	0.272	1.000	1.000	1.000

5.15 TROP-PS

Lognormal dist.
month 6 biomass
Ages 3 - 5
log-likelihood = 6.38
deviance = 7.55
Chi-sq. discrepancy= 4.21

Year	Observed	Predicted	Residuals (Obs-pred)	Standard Deviation	Q Catchabil.	Untransfrmd Observed	Untransfrmd Predicted	Chi-square Discrepancy
1980	-0.780	0.167	-0.948	0.687	0.245E-08	0.250	0.645	0.799
1981	0.175	0.023	0.152	0.687	0.245E-08	0.650	0.558	0.011
1982	-0.336	-0.092	-0.244	0.687	0.245E-08	0.390	0.498	0.241
1983	-0.108	-0.315	0.207	0.687	0.245E-08	0.490	0.398	0.001
1984	-1.166	-0.093	-1.073	0.687	0.245E-08	0.170	0.497	0.884
1985	0.095	0.059	0.036	0.687	0.245E-08	0.600	0.579	0.054
1986	0.044	0.194	-0.150	0.687	0.245E-08	0.570	0.662	0.170
1987	0.128	0.318	-0.190	0.687	0.245E-08	0.620	0.750	0.200
1988	0.044	0.470	-0.426	0.687	0.245E-08	0.570	0.873	0.389
1989	0.606	0.485	0.121	0.687	0.245E-08	1.000	0.886	0.020
1990	0.565	0.369	0.196	0.687	0.245E-08	0.960	0.789	0.002
1991	0.235	0.190	0.045	0.687	0.245E-08	0.690	0.659	0.050
1992	0.112	0.129	-0.018	0.687	0.245E-08	0.610	0.621	0.083
1993	-0.087	0.080	-0.167	0.687	0.245E-08	0.500	0.591	0.183
1994	0.144	0.011	0.133	0.687	0.245E-08	0.630	0.552	0.016
1995	0.095	0.025	0.070	0.687	0.245E-08	0.600	0.560	0.039
1996	0.026	0.088	-0.062	0.687	0.245E-08	0.560	0.596	0.110
1997	0.235	0.018	0.217	0.687	0.245E-08	0.690	0.555	0.001
1998	-0.029	-0.072	0.043	0.687	0.245E-08	0.530	0.508	0.051
1999	-0.215	-0.192	-0.023	0.687	0.245E-08	0.440	0.450	0.086
2000	-0.310	-0.272	-0.038	0.687	0.245E-08	0.400	0.416	0.095
2001	-0.068	-0.107	0.040	0.687	0.245E-08	0.510	0.490	0.053
2002	0.249	-0.160	0.409	0.687	0.245E-08	0.700	0.465	0.060
2003	0.370	-0.300	0.670	0.687	0.245E-08	0.790	0.404	0.492
2004	-0.029	-0.295	0.266	0.687	0.245E-08	0.530	0.406	0.002
2005	-0.087	-0.345	0.258	0.687	0.245E-08	0.500	0.386	0.001
2006	0.095	-0.380	0.475	0.687	0.245E-08	0.600	0.373	0.121

Selectivities by age

Year	3	4	5
1980	1.000	1.000	1.000
1981	1.000	1.000	1.000
1982	1.000	1.000	1.000
1983	1.000	1.000	1.000
1984	1.000	1.000	1.000
1985	1.000	1.000	1.000
1986	1.000	1.000	1.000
1987	1.000	1.000	1.000
1988	1.000	1.000	1.000
1989	1.000	1.000	1.000
1990	1.000	1.000	1.000
1991	1.000	1.000	1.000
1992	1.000	1.000	1.000
1993	1.000	1.000	1.000
1994	1.000	1.000	1.000
1995	1.000	1.000	1.000
1996	1.000	1.000	1.000
1997	1.000	1.000	1.000
1998	1.000	1.000	1.000
1999	1.000	1.000	1.000
2000	1.000	1.000	1.000
2001	1.000	1.000	1.000
2002	1.000	1.000	1.000
2003	1.000	1.000	1.000
2004	1.000	1.000	1.000
2005	1.000	1.000	1.000
2006	1.000	1.000	1.000

5.16 CAN-IS-BB

Lognormal dist.
month 6 biomass
Ages 0 - 4
log-likelihood = -104.64
deviance = 229.58
Chi-sq. discrepancy= 320.68

Year	Observed	Predicted	Residuals (Obs-pred)	Standard Deviation	Q Catchabil.	Untransfrmd Observed	Untransfrmd Predicted	Chi-square Discrepancy
1980	-1.991	0.060	-2.052	0.687	0.275E-09	0.010	0.075	1.340
1981	-1.284	-0.085	-1.199	0.687	0.275E-09	0.020	0.065	0.963
1982	0.289	-0.078	0.368	0.687	0.275E-09	0.094	0.065	0.033
1983	0.855	0.071	0.784	0.687	0.275E-09	0.166	0.076	0.886
1984	2.171	0.159	2.013	0.687	0.275E-09	0.620	0.083	40.044
1985	1.338	0.295	1.043	0.687	0.275E-09	0.269	0.095	2.556
1986	0.896	0.309	0.587	0.687	0.275E-09	0.173	0.096	0.294
1987	1.700	0.397	1.303	0.687	0.275E-09	0.387	0.105	6.037
1988	1.740	0.349	1.391	0.687	0.275E-09	0.402	0.100	7.851
1989	1.214	0.273	0.942	0.687	0.275E-09	0.238	0.093	1.747
1990	2.148	0.154	1.994	0.687	0.275E-09	0.605	0.082	38.279
1991	2.025	0.203	1.822	0.687	0.275E-09	0.535	0.087	25.050
1992	1.479	0.097	1.382	0.687	0.275E-09	0.310	0.078	7.650
1993	0.695	-0.037	0.732	0.687	0.275E-09	0.142	0.068	0.686
1994	0.176	0.107	0.069	0.687	0.275E-09	0.084	0.079	0.039
1995	-0.679	0.133	-0.812	0.687	0.275E-09	0.036	0.081	0.700
1996	2.033	0.031	2.001	0.687	0.275E-09	0.539	0.073	38.979
1997	-0.092	-0.060	-0.032	0.687	0.275E-09	0.064	0.067	0.092
1998	2.379	-0.180	2.559	0.687	0.275E-09	0.763	0.059	140.841
1999	0.029	-0.214	0.243	0.687	0.275E-09	0.073	0.057	0.000
2000	-3.439	-0.084	-3.355	0.687	0.275E-09	0.002	0.065	1.570
2001	-7.484	-0.250	-7.234	0.687	0.275E-09	0.000	0.055	1.658
2002	-1.054	-0.263	-0.792	0.687	0.275E-09	0.025	0.054	0.684
2003	-0.426	-0.335	-0.091	0.687	0.275E-09	0.046	0.051	0.129
2004	-0.618	-0.430	-0.188	0.687	0.275E-09	0.038	0.046	0.198
2005	-2.617	-0.368	-2.249	0.687	0.275E-09	0.005	0.049	1.395
2006	-1.481	-0.252	-1.229	0.687	0.275E-09	0.016	0.055	0.981

Selectivities by age

Year	0	1	2	3	4
1980	0.006	0.971	1.000	0.520	0.455
1981	0.006	0.971	1.000	0.520	0.455
1982	0.006	0.971	1.000	0.520	0.455
1983	0.006	0.971	1.000	0.520	0.455
1984	0.006	0.971	1.000	0.520	0.455
1985	0.006	0.971	1.000	0.520	0.455
1986	0.006	0.971	1.000	0.520	0.455
1987	0.006	0.971	1.000	0.520	0.455
1988	0.006	0.971	1.000	0.520	0.455
1989	0.006	0.971	1.000	0.520	0.455
1990	0.006	0.971	1.000	0.520	0.455
1991	0.006	0.971	1.000	0.520	0.455
1992	0.006	0.971	1.000	0.520	0.455
1993	0.006	0.971	1.000	0.520	0.455
1994	0.006	0.971	1.000	0.520	0.455
1995	0.006	0.971	1.000	0.520	0.455
1996	0.006	0.971	1.000	0.520	0.455
1997	0.006	0.971	1.000	0.520	0.455
1998	0.006	0.971	1.000	0.520	0.455
1999	0.006	0.971	1.000	0.520	0.455
2000	0.006	0.971	1.000	0.520	0.455
2001	0.006	0.971	1.000	0.520	0.455
2002	0.006	0.971	1.000	0.520	0.455
2003	0.006	0.971	1.000	0.520	0.455
2004	0.006	0.971	1.000	0.520	0.455
2005	0.006	0.971	1.000	0.520	0.455
2006	0.006	0.971	1.000	0.520	0.455

5.17 NOT-USED

Not used

5.18 NOT-USED

Not used

===

TOTAL NUMBER OF FUNCTION EVALUATIONS = 9774

Appendix 8

Detailed Results of the Application of the Catch Only Model to the Assessment of the Atlantic Skipjack Tuna

Table Appendix 8.1. Quantiles for the posterior distributions for *MSY* for COM runs C.1 to C.6 fitted to catch data from 1985 to 2006 for SKJ-E.

Quantile	*RUN C.1*	*RUN C.2*	*RUN C.3*	*RUN C.4*	*RUN C.5*	*RUN C.6*
5%	114 351	114 042	115 711	114 422	116 969	117 642
10%	119 585	119 402	121 736	119 598	121 763	122 714
25%	129 206	129 400	133 617	128 595	131 181	133 591
50%	143 633	145 005	155 552	142 865	146 103	156 326
75%	174 250	176 562	201 661	175 652	178 324	223 066
80%	188 831	189 313	219 754	192 134	191 662	247 780
95%	314 115	294 163	414 574	331 800	283 543	437 924

Table Appendix 8.2 Quantiles for the posterior distributions for B/B_{MSY} for COM runs C.1 to C.6 fitted to catch data from 1985 to 2006 for SKJ-E.

Quantile	*RUN 1*	*RUN 2*	*RUN 3*	*RUN 4*	*RUN 5*	*RUN 6*
5%	0.64	0.65	0.70	0.64	0.64	0.67
10%	0.74	0.76	0.82	0.74	0.75	0.78
25%	0.94	0.98	1.07	0.92	0.96	1.01
50%	1.20	1.24	1.37	1.17	1.21	1.32
75%	1.47	1.47	1.57	1.45	1.47	1.60
80%	1.52	1.52	1.61	1.52	1.52	1.65
95%	1.74	1.71	1.80	1.75	1.70	1.81

Skipjack western stock

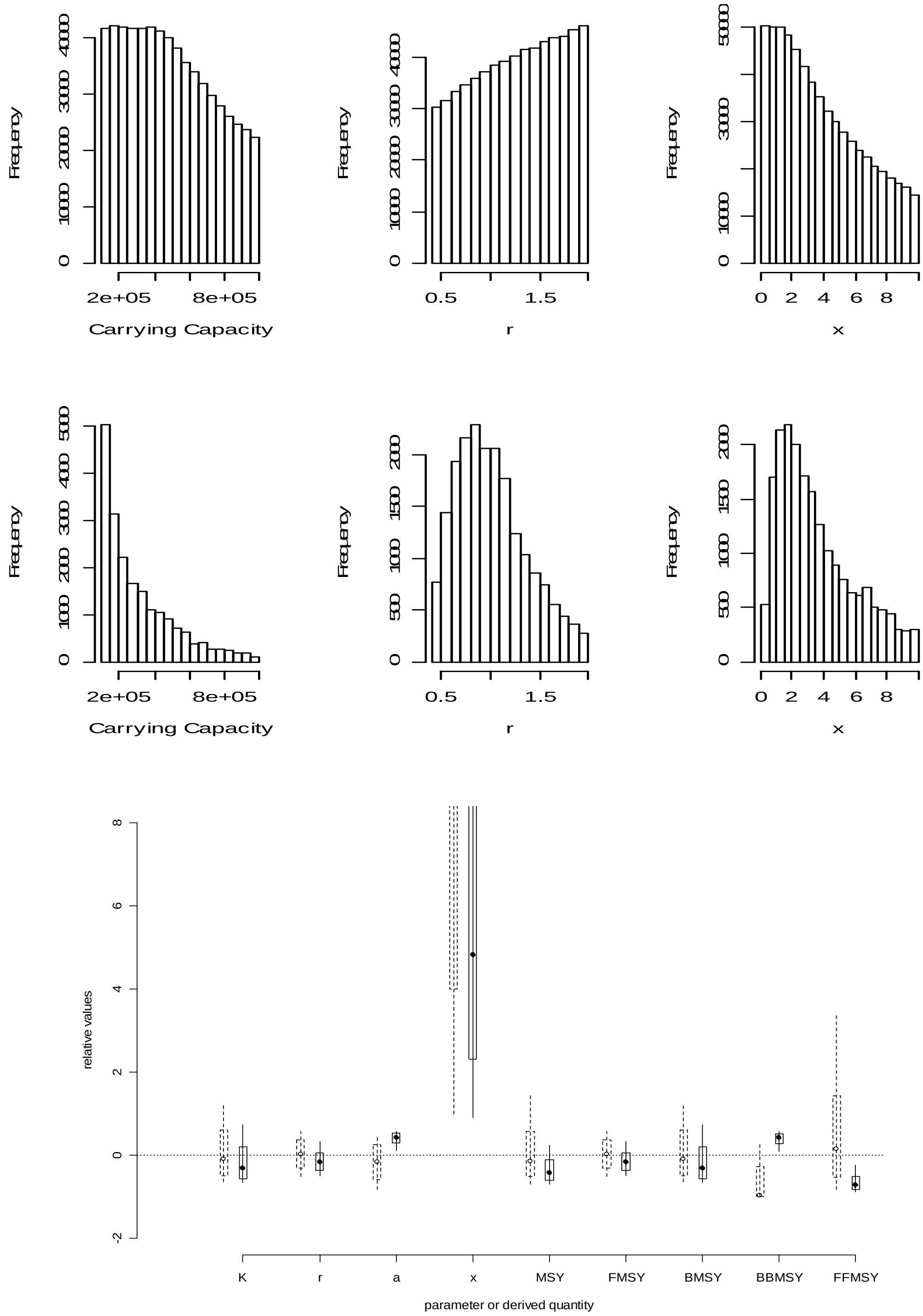


Figure Appendix 8.1 Pre-data, post-model priors (top row) and posteriors (middle row) and relative priors and posteriors (bottom row) for the COM run A.1 fitted to catch data from 1976 to 2006 for western skipjack. The priors (dashed boxes) and posteriors (solid boxes) were relativised to be in the same scale. The dashed boxes for management quantities are the values obtained by runing the model only with the priors. The combinations of parameters from the priors that do not cause extintion of the population are called pre-data post-model priors.

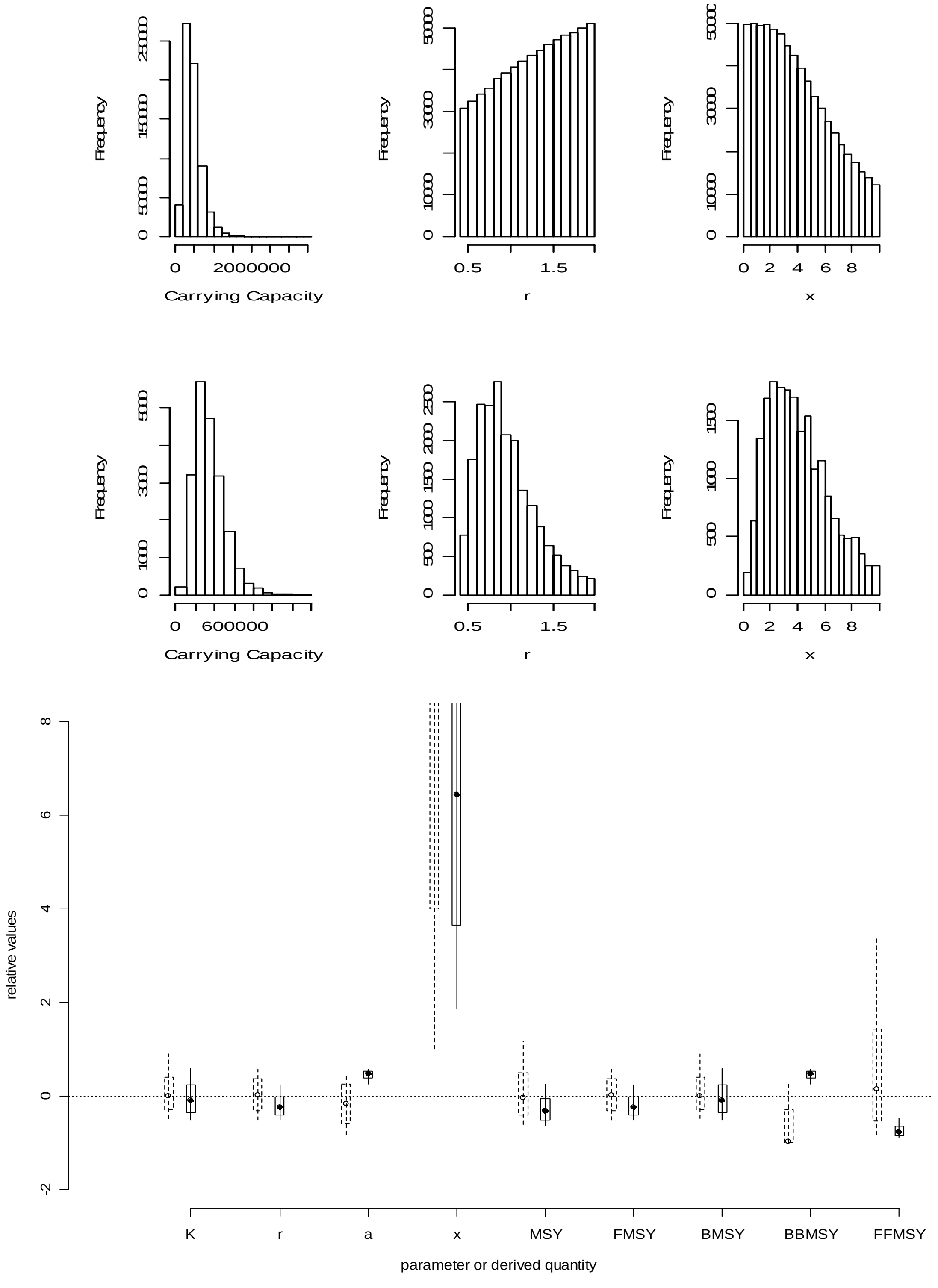


Figure Appendix 8.2 Pre-data, post-model priors (top row) and posteriors (middle row) and relative priors and posteriors (bottom row) for the COM run A.2 fitted to catch data from 1976 to 2006 for western skipjack. See **Figure Appendix 5.1** for explanations.

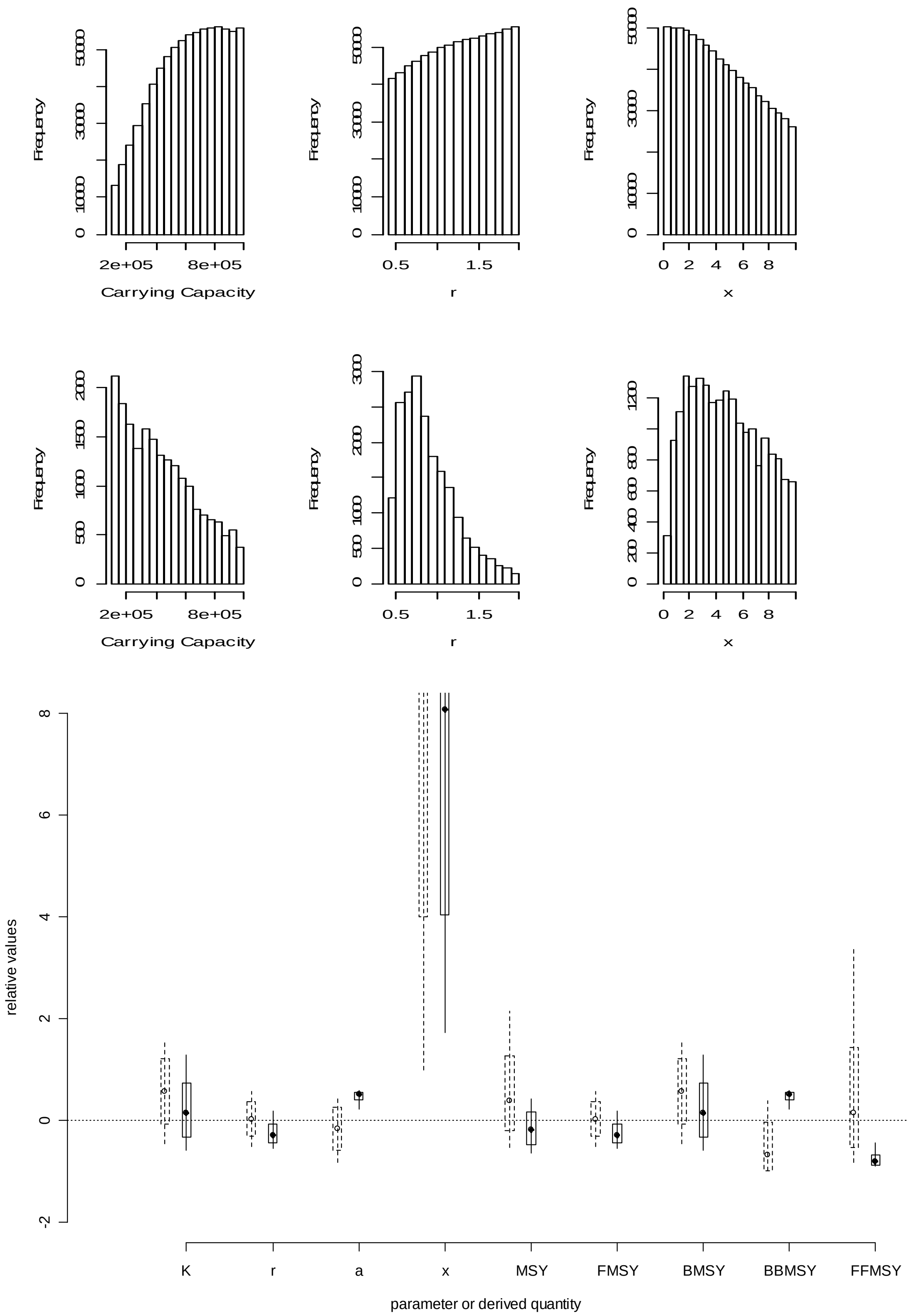


Figure Appendix 8.3 Pre-data, post-model priors (top row) and posteriors (middle row) and relative priors and posteriors (bottom row) for the COM run A.3 fitted to catch data from 1976 to 2006 for SKJ-W. See **Figure Appendix 5.1** for explanations.

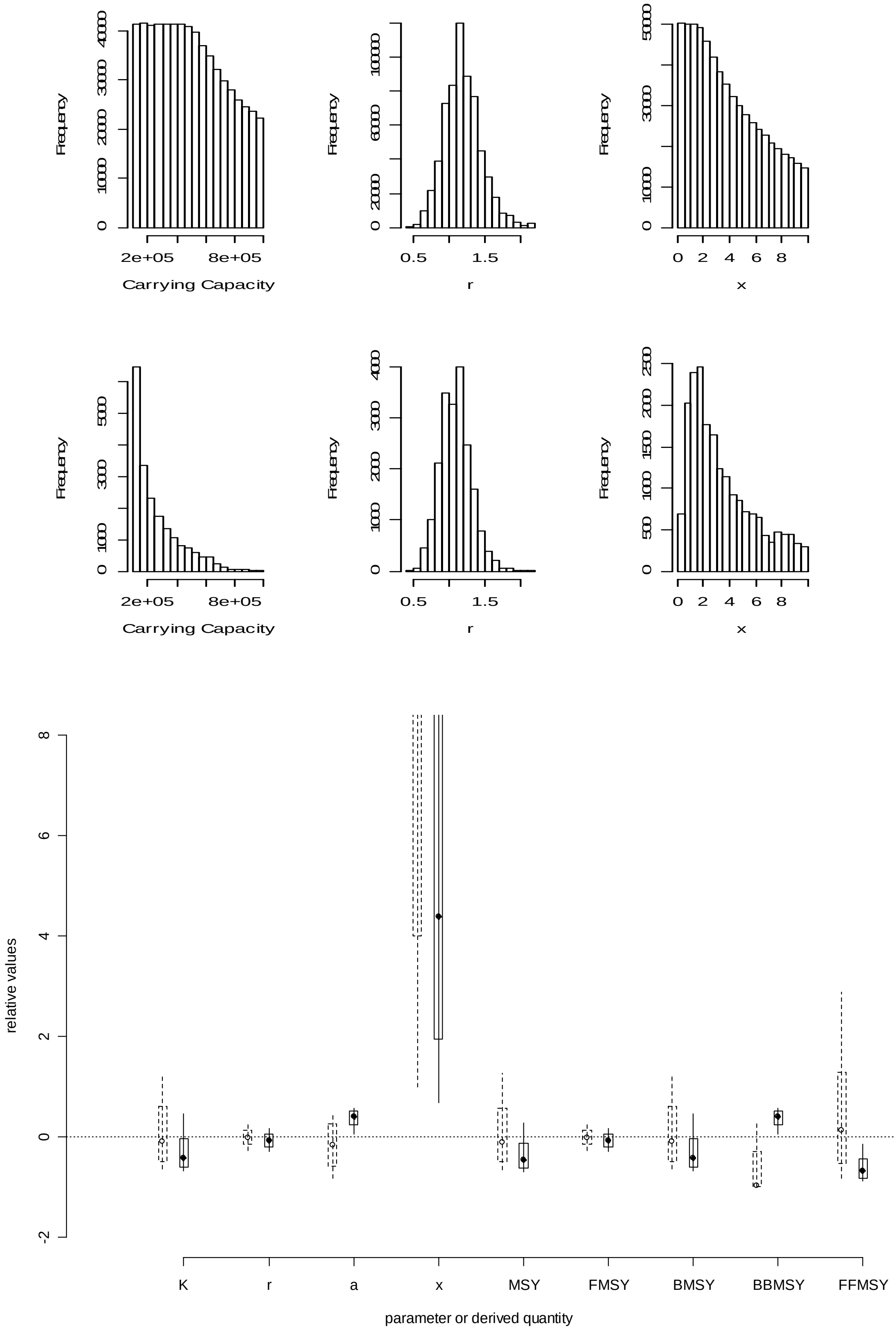


Figure Appendix 8.4. Pre-data, post-model priors (top row) and posteriors (middle row) and relative priors and posteriors (bottom row) for the COM run A.4 fitted to catch data from 1976 to 2006 for SKJ-W. See **Figure Appendix 5.1** for explanations.

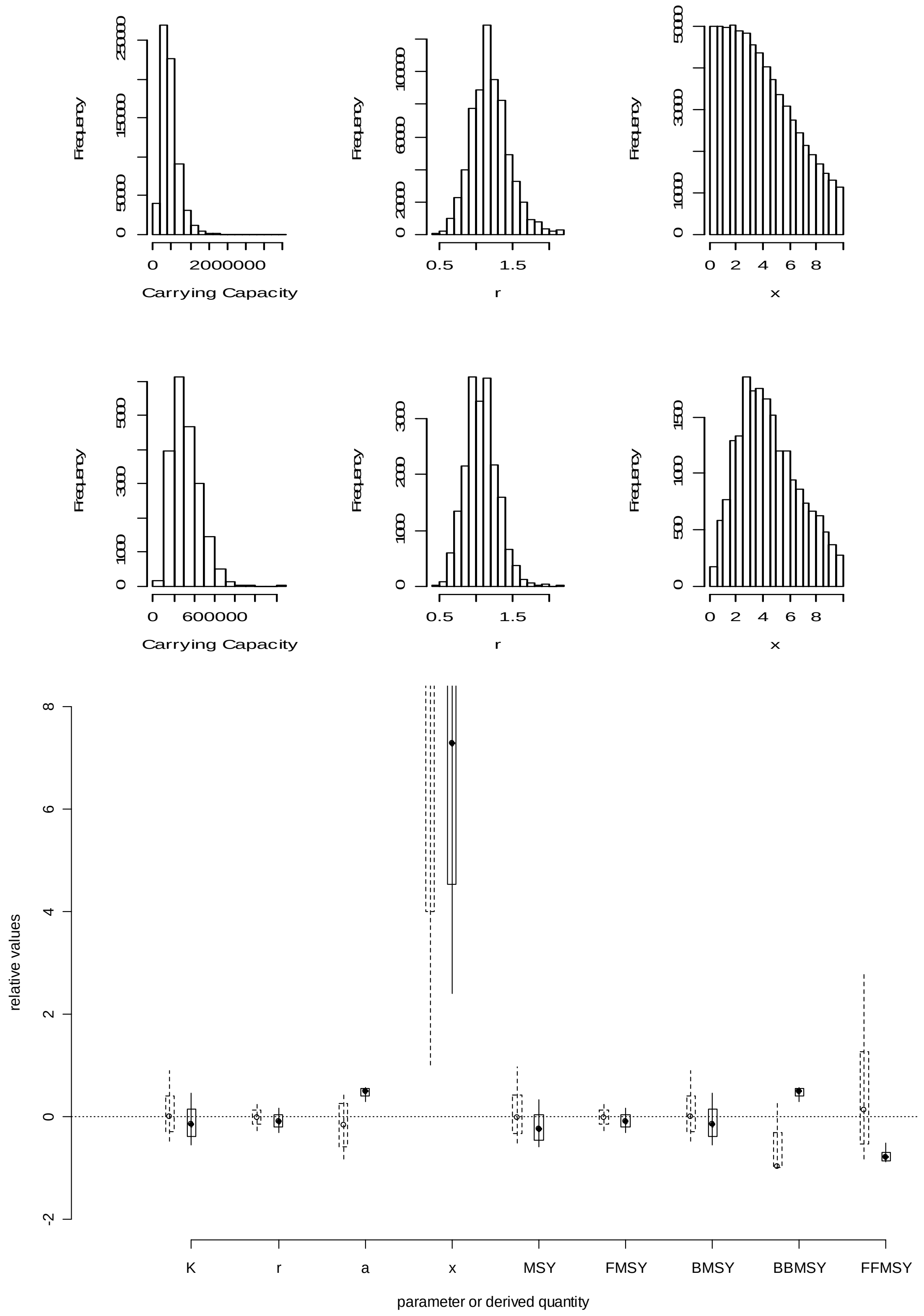


Figure Appendix 8.5 Pre-data, post-model priors (top row) and posteriors (middle row) and relative priors and posteriors (bottom row) for the COM run A.5 fitted to catch data from 1976 to 2006 for SKJ-W. See **Figure Appendix 5.1** for explanations.

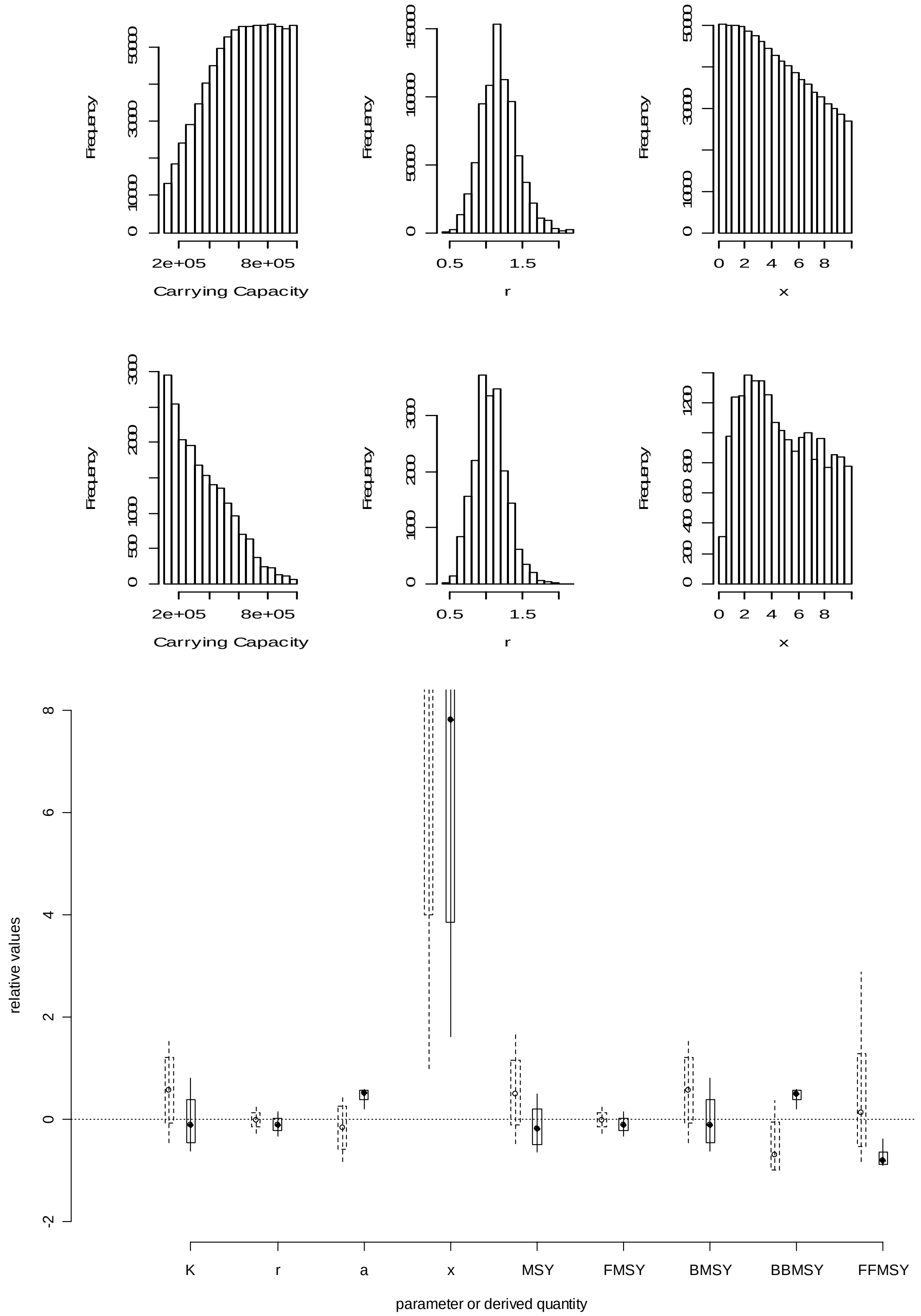


Figure Appendix 8.6 Pre-data, post-model priors (top row) and posteriors (middle row) and relative priors and posteriors (bottom row) for the COM run A.6 fitted to catch data from 1976 to 2006 for SKJ-W. See **Figure Appendix 5.1** for explanations.

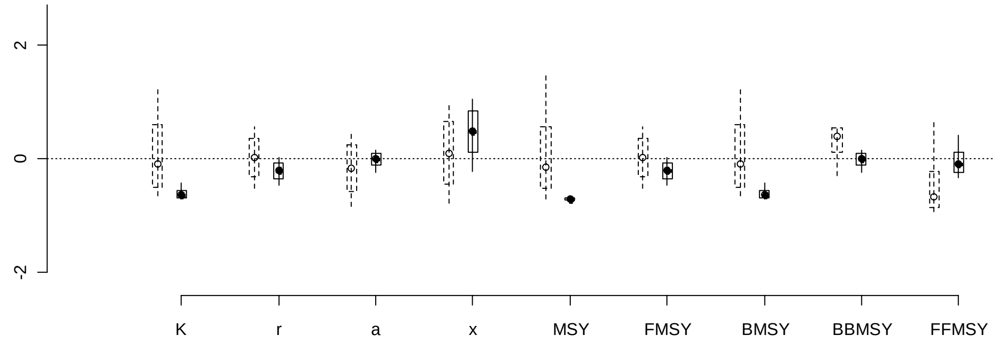


Figure Appendix 8.7 Relative priors and posteriors for the COM run B.1 fitted to catch data from 1976 to 2006 for SKJ-W. See **Figure Appendix 5.1** for explanations.

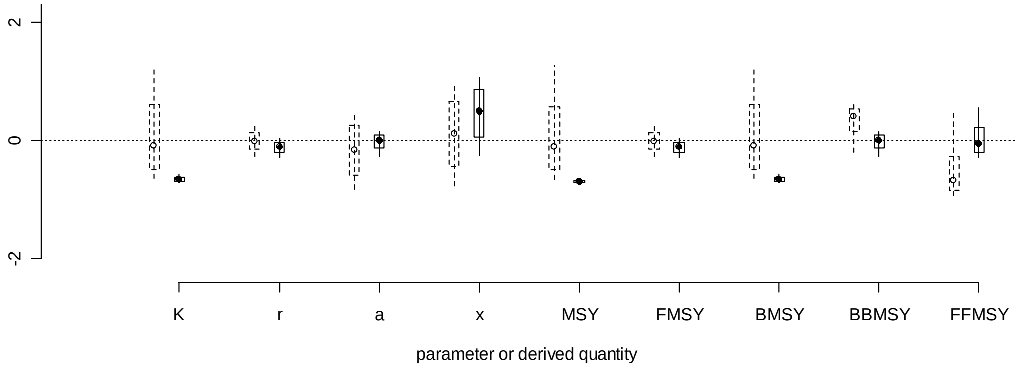


Figure Appendix 8.8 Relative priors and posteriors for the COM run B.4 fitted to catch data from 1976 to 2006 for SKJ-W. See **Figure Appendix 5.1** for explanations.

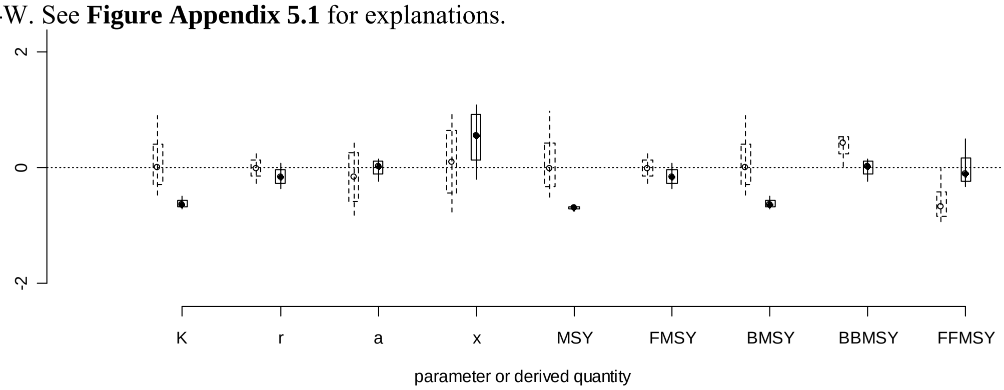


Figure Appendix 8.9 Relative priors and posteriors for the COM run B.5 fitted to catch data from 1976 to 2006 for SKJ-W. See **Figure Appendix 5.1** for explanations.

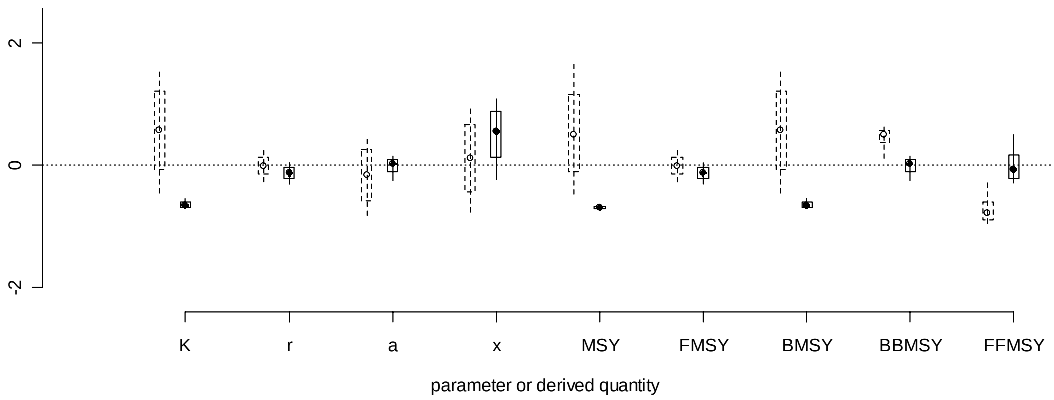


Figure Appendix 8.10 Relative priors and posteriors for the COM run B.6 fitted to catch data from 1976 to 2006 for SKJ-W. See **Figure Appendix 5.1** for explanations.

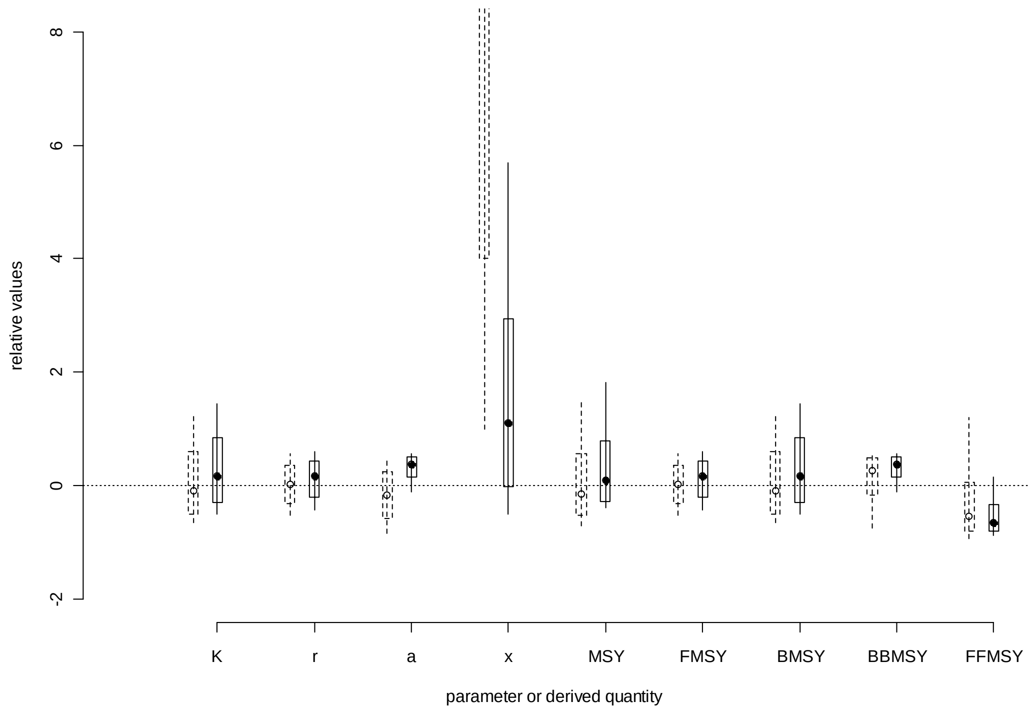


Figure Appendix 8.11 Relative priors and posteriors for the COM run A.1 fitted to catch data from 1950 to 2006 for SKJ-E. See **Figure Appendix 5.1** for explanations.

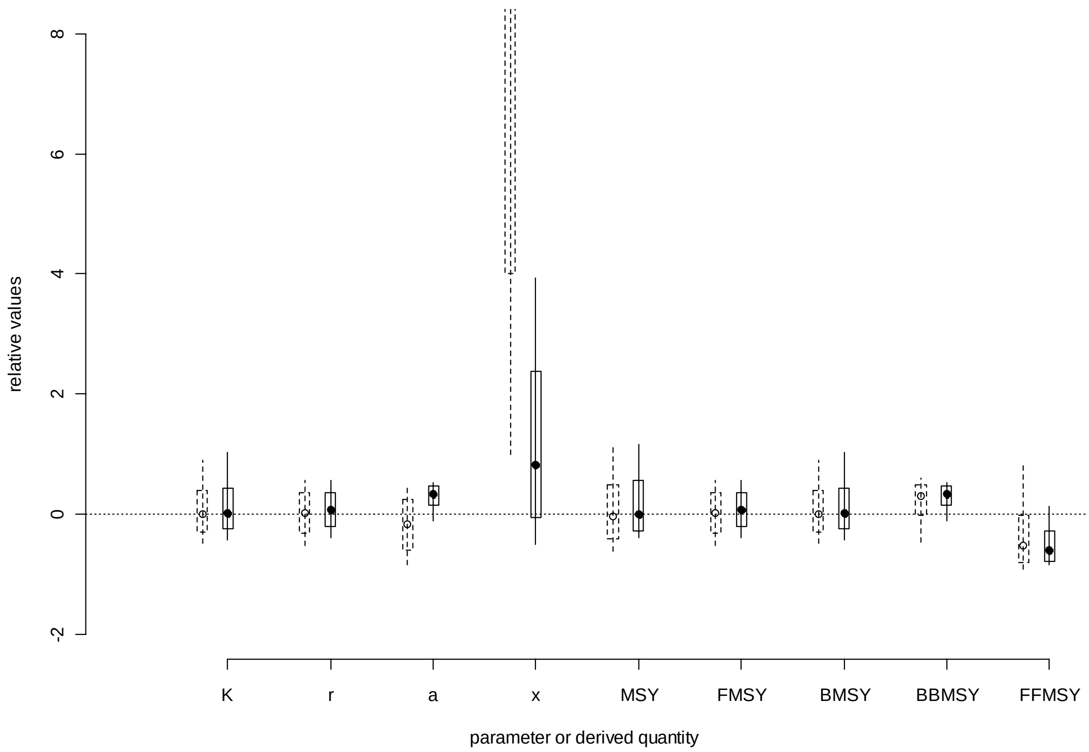


Figure Appendix 8.12. Relative priors and posteriors for the COM run A.2 fitted to catch data from 1950 ro 2006 for SKJ-E. See **Figure Appendix 5.1** for explanations.

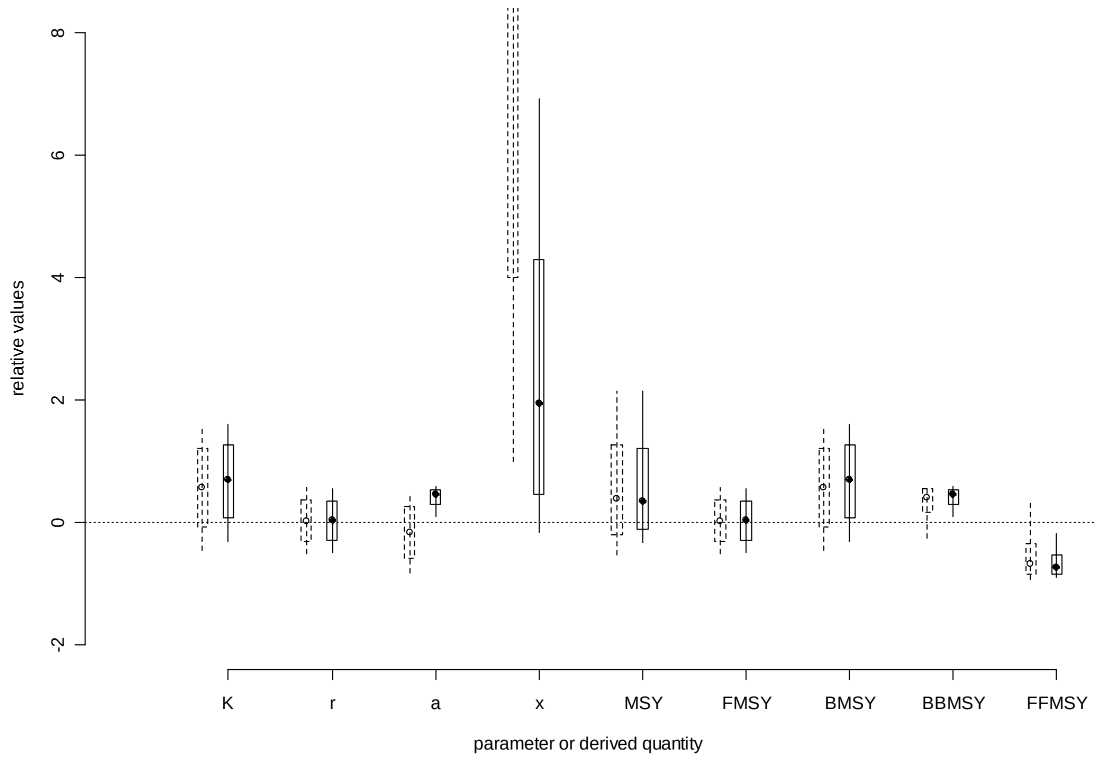


Figure Appendix 8.13 Relative priors and posteriors for the COM run A.3 fitted to catch data from 1950 to 2006 for SKJ-E. See **Figure Appendix 5.1** for explanations.

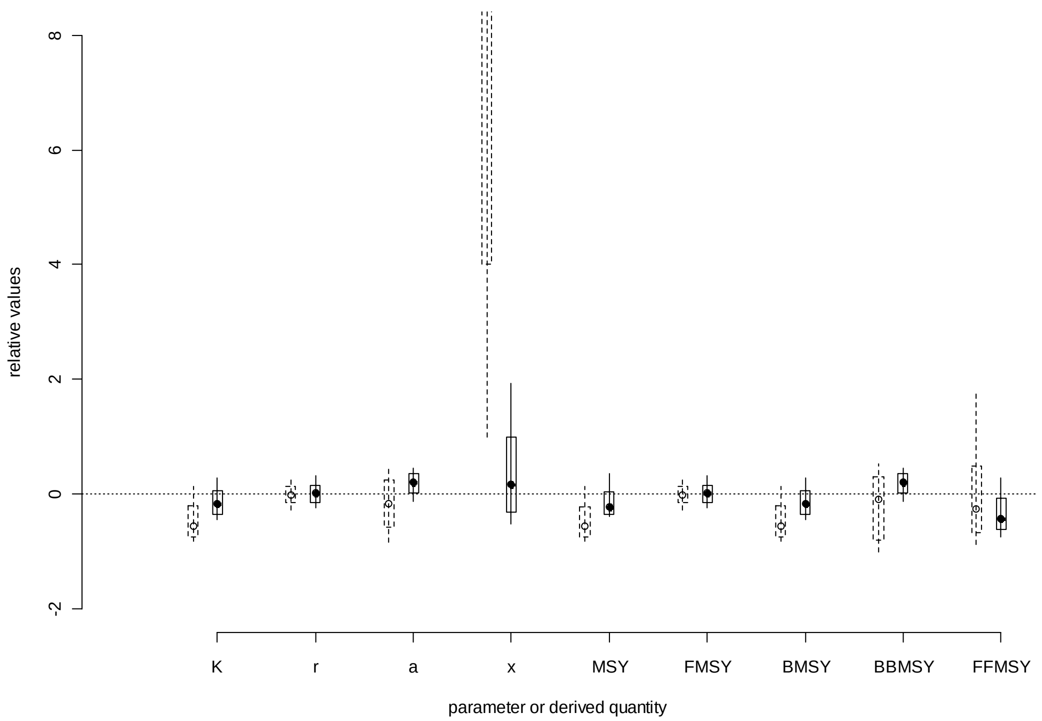


Figure Appendix 8.14 Relative priors and posteriors for the COM run A.4 fitted to catch data from 1950 to 2006 for SKJ-E. See **Figure Appendix 5.1** for explanations.

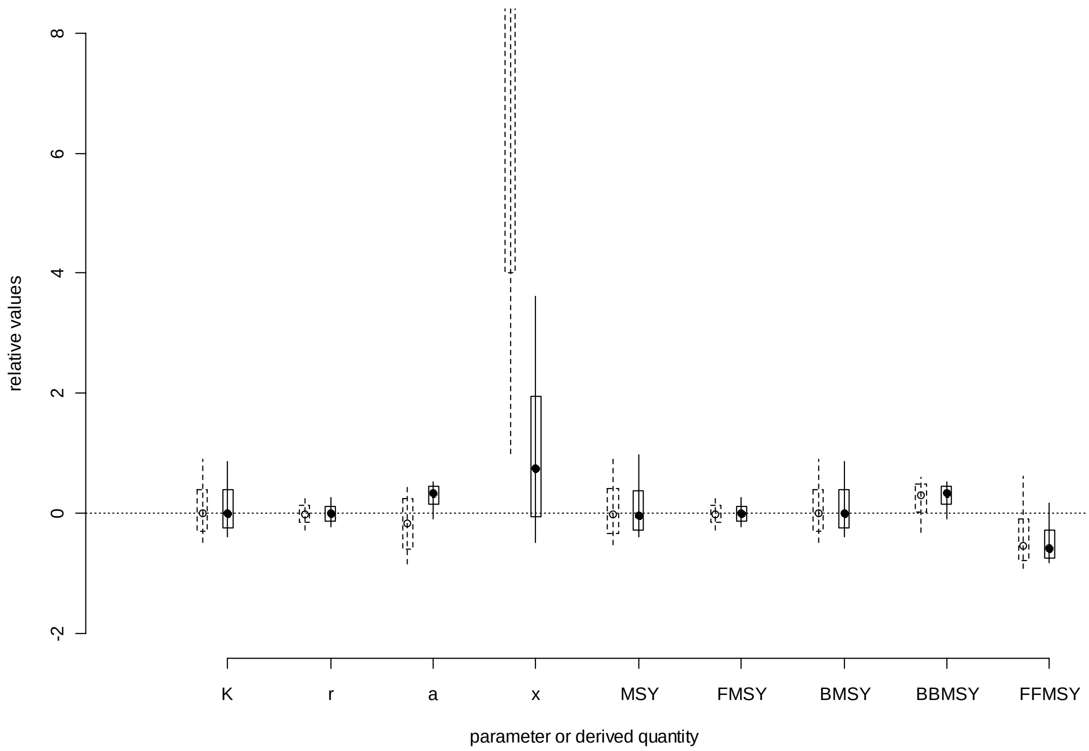


Figure Appendix 8.15 Relative priors and posteriors for the COM run A.5 fitted to catch data from 1950 to 2006 for SKJ-E. See **Figure Appendix 5.1** for explanations.

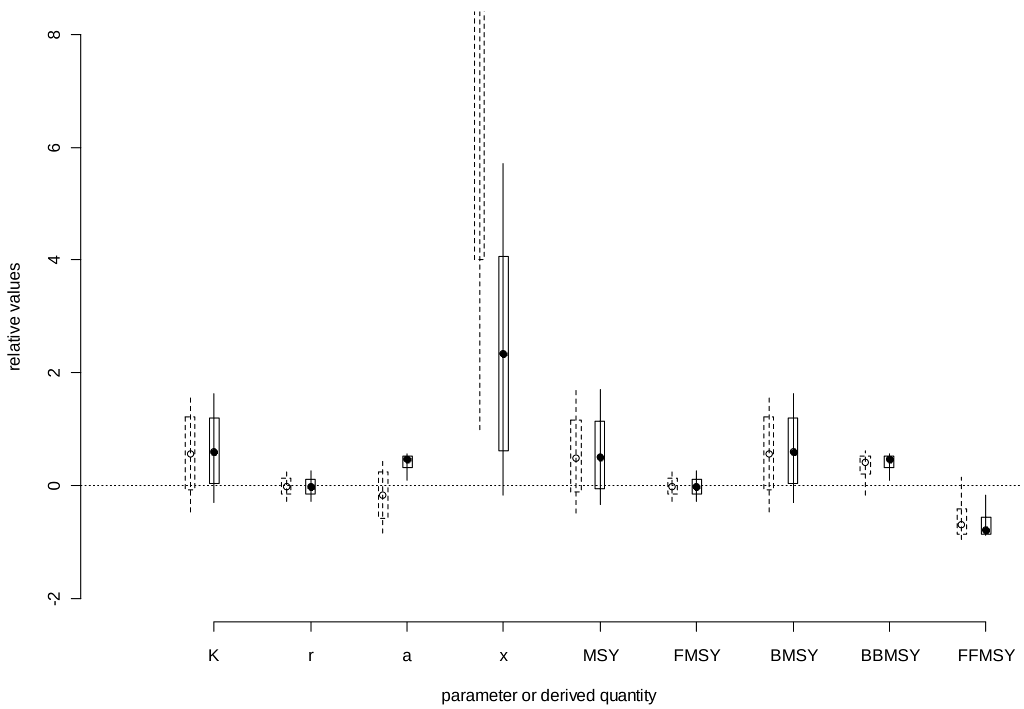


Figure Appendix 8.16 Relative priors and posteriors for the COM run A.6 fitted to catch data from 1950 to 2006 for SKJ-E. See **Figure Appendix 5.1** for explanations.

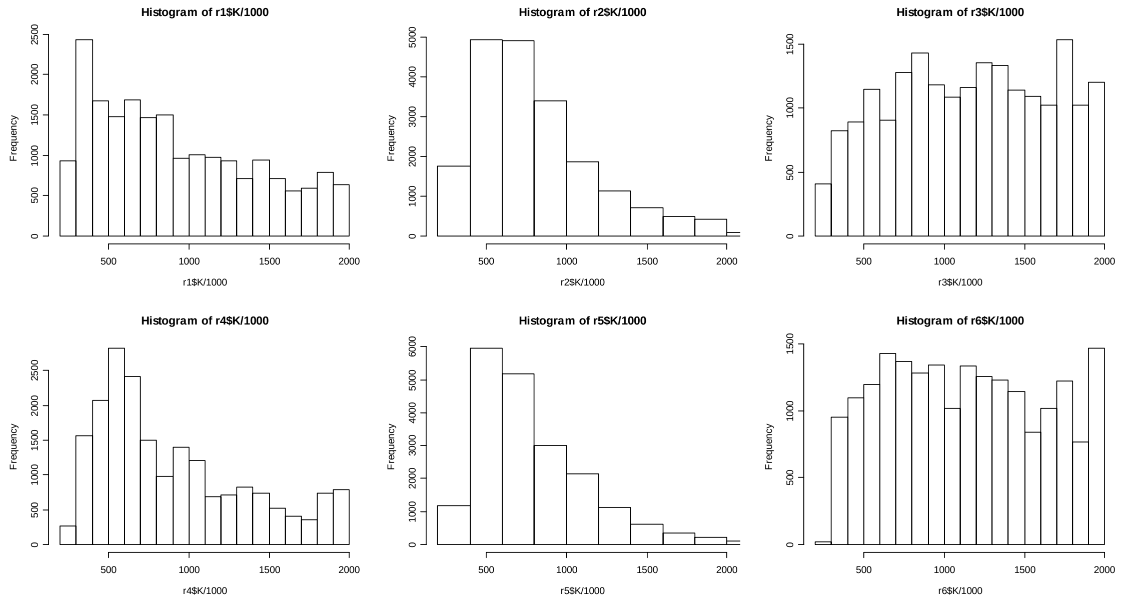


Figure Appendix 8.17 Posterior distributions for *K* for COM runs A.1 to A.6 fitted to catch data from 1950 to 2006 for SKJ-E.

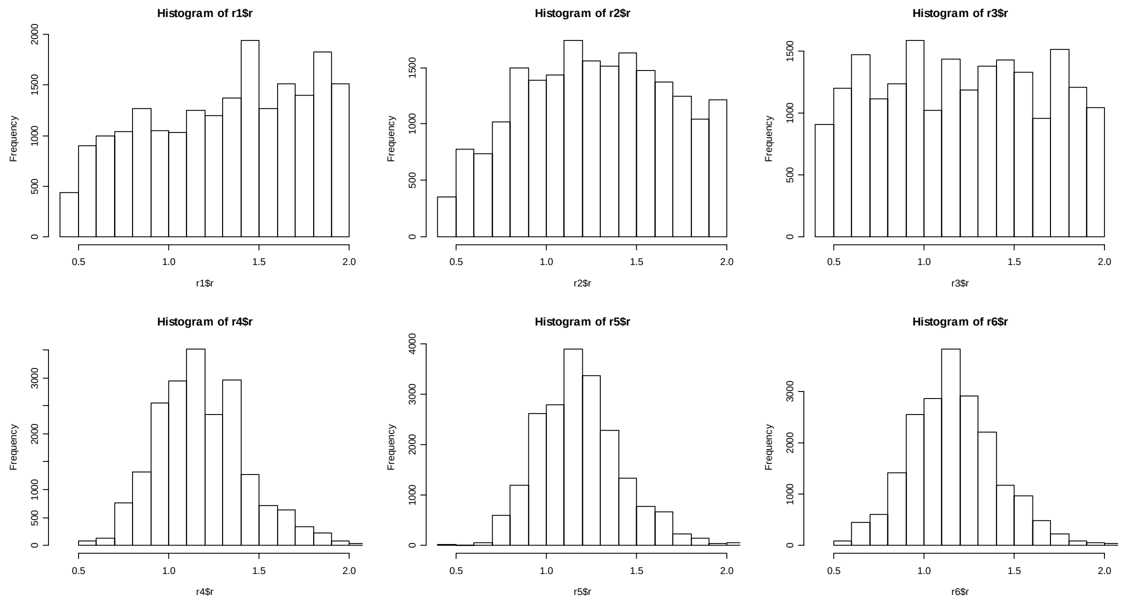


Figure Appendix 8.18. Posterior distributions for r for COM runs A.1 to A.6 fitted to catch data from 1950 to 2006 for SKJ-E.

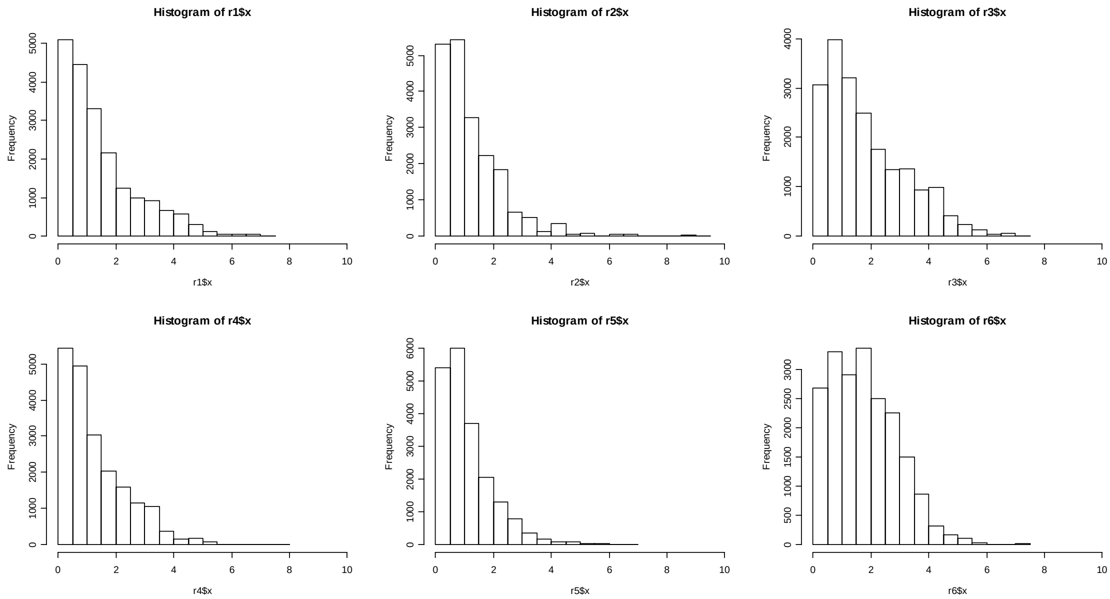


Figure Appendix 8.19 Posterior distributions for *x* for COM runs A.1 to A.6 fitted to catch data from 1950 to 2006 for SKJ-E.

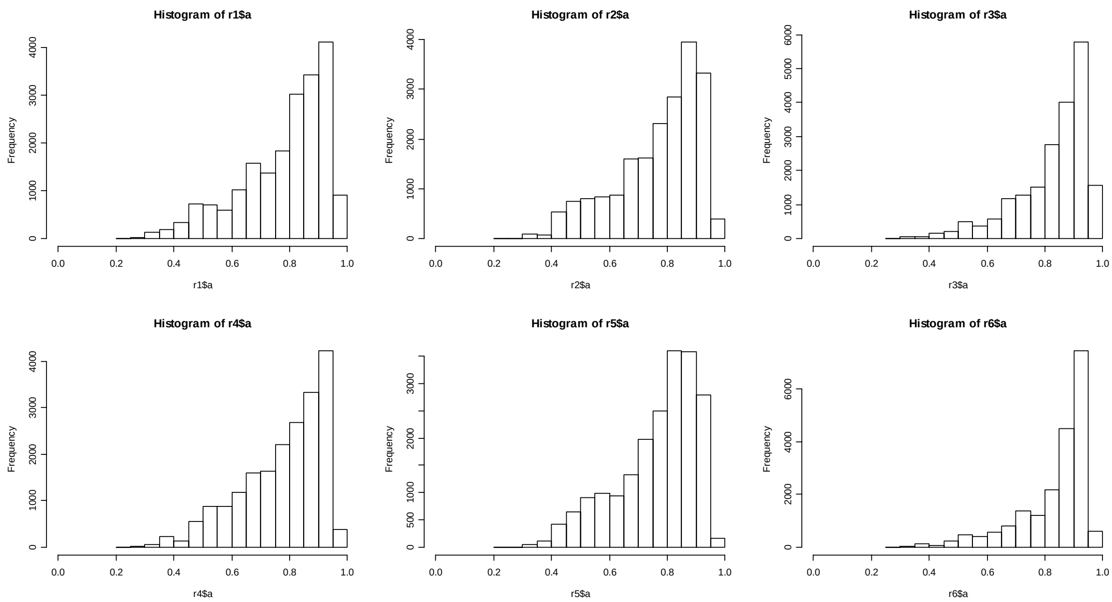


Figure Appendix 8.20 Posterior distributions for *a* for COM runs A.1 to A.6 fitted to catch data from 1950 to 2006 for SKJ-E.

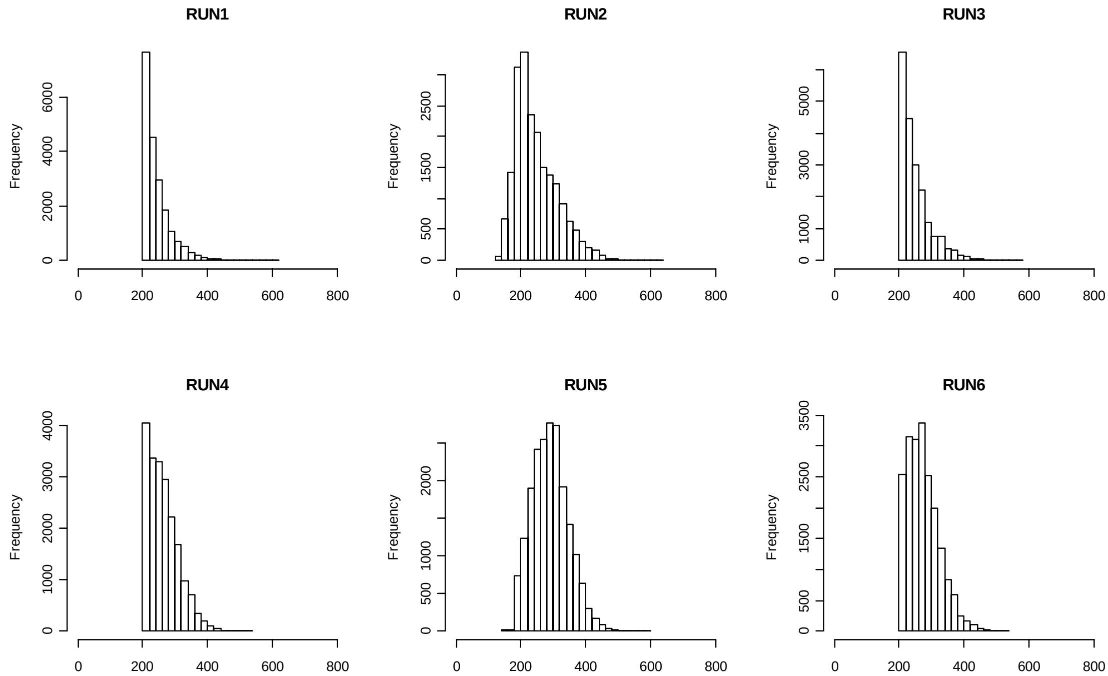


Figure Appendix 8.21 Posterior distributions for K for COM runs B.1 to B.6 fitted to catch data from 1965 to 1984 for SKJ-E.

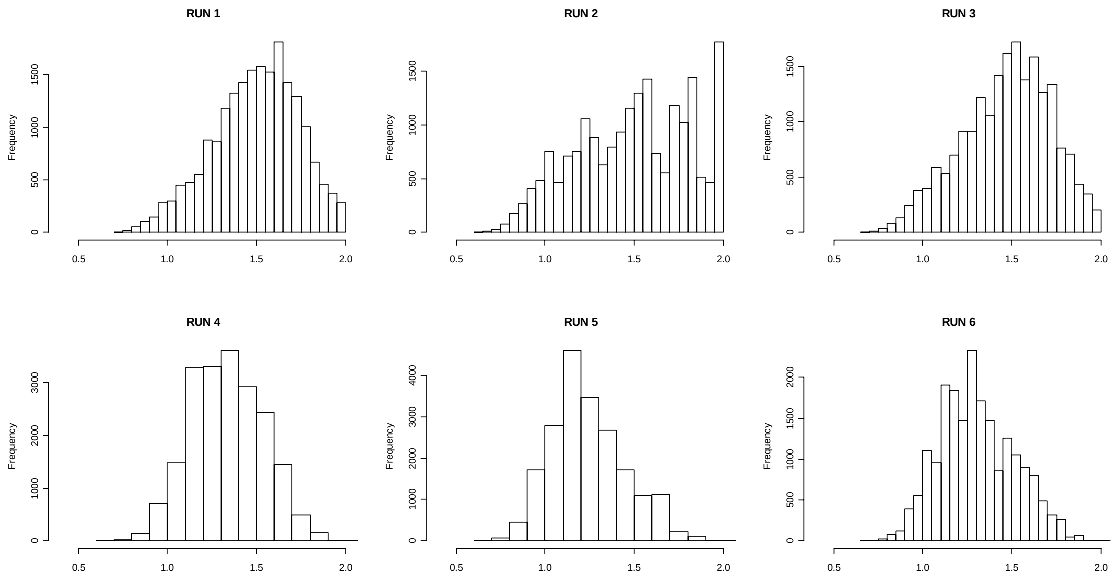


Figure Appendix 8.22 Posterior distributions for r for COM runs B.1 to B.6 fitted to catch data from 1965 to 1984 for SKJ-E.

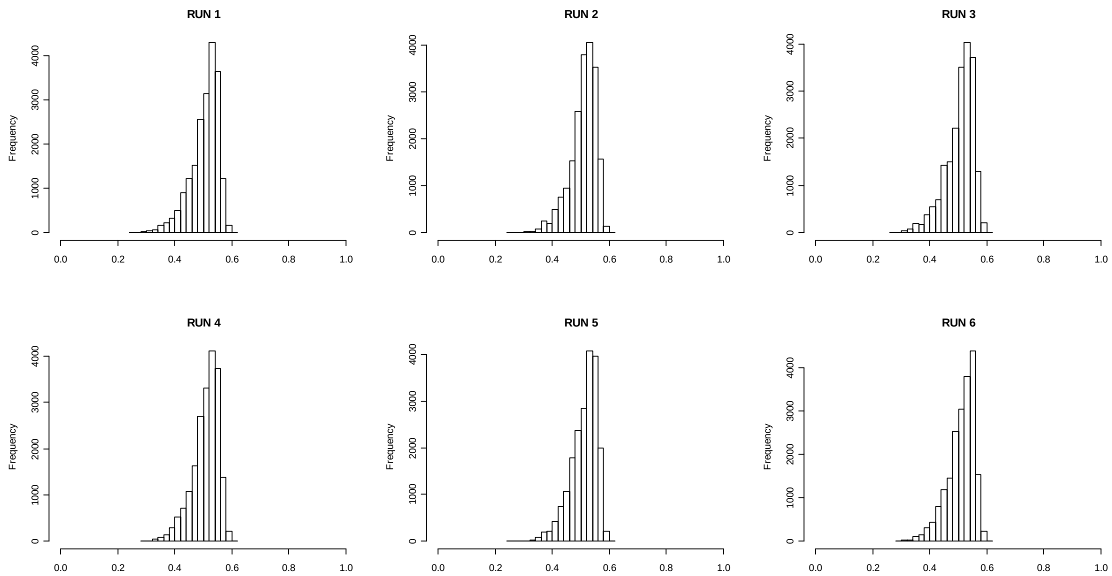


Figure Appendix 8.23 Posterior distributions for COM runs B.1 to B.6 fitted to catch data from 1965 to 1984 for SKJ-E.

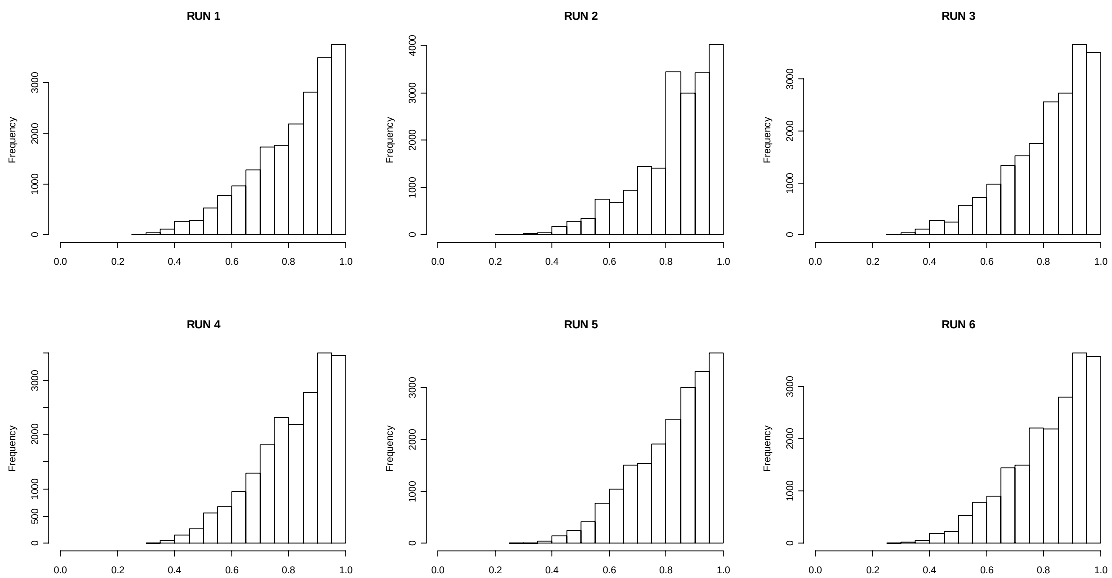


Figure Appendix 8.24 Posterior distributions for x for COM runs B.1 to B.6 fitted to catch data from 1965 to 1984 for SKJ-E.

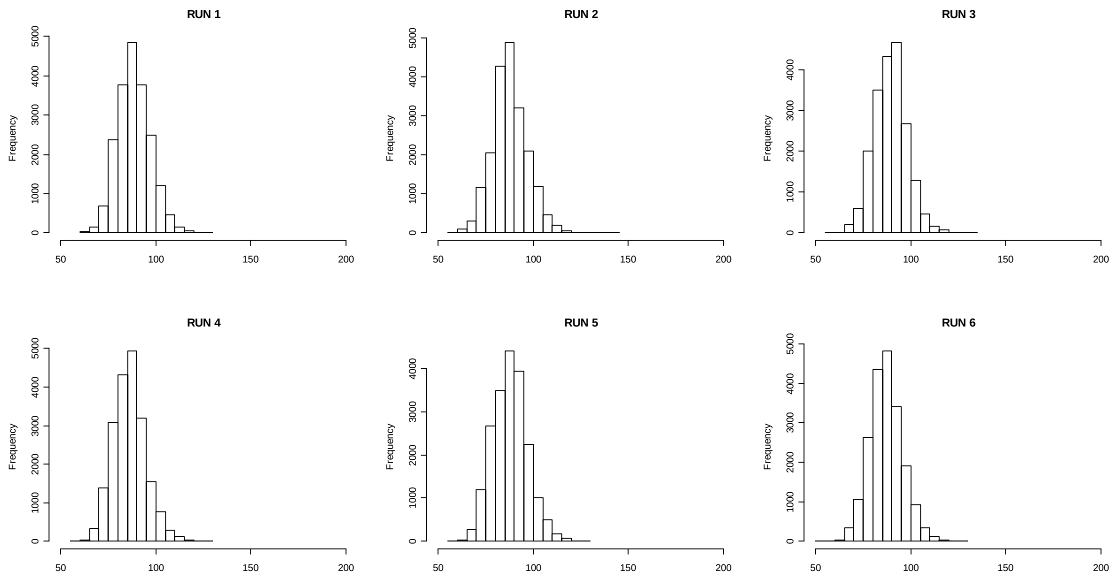
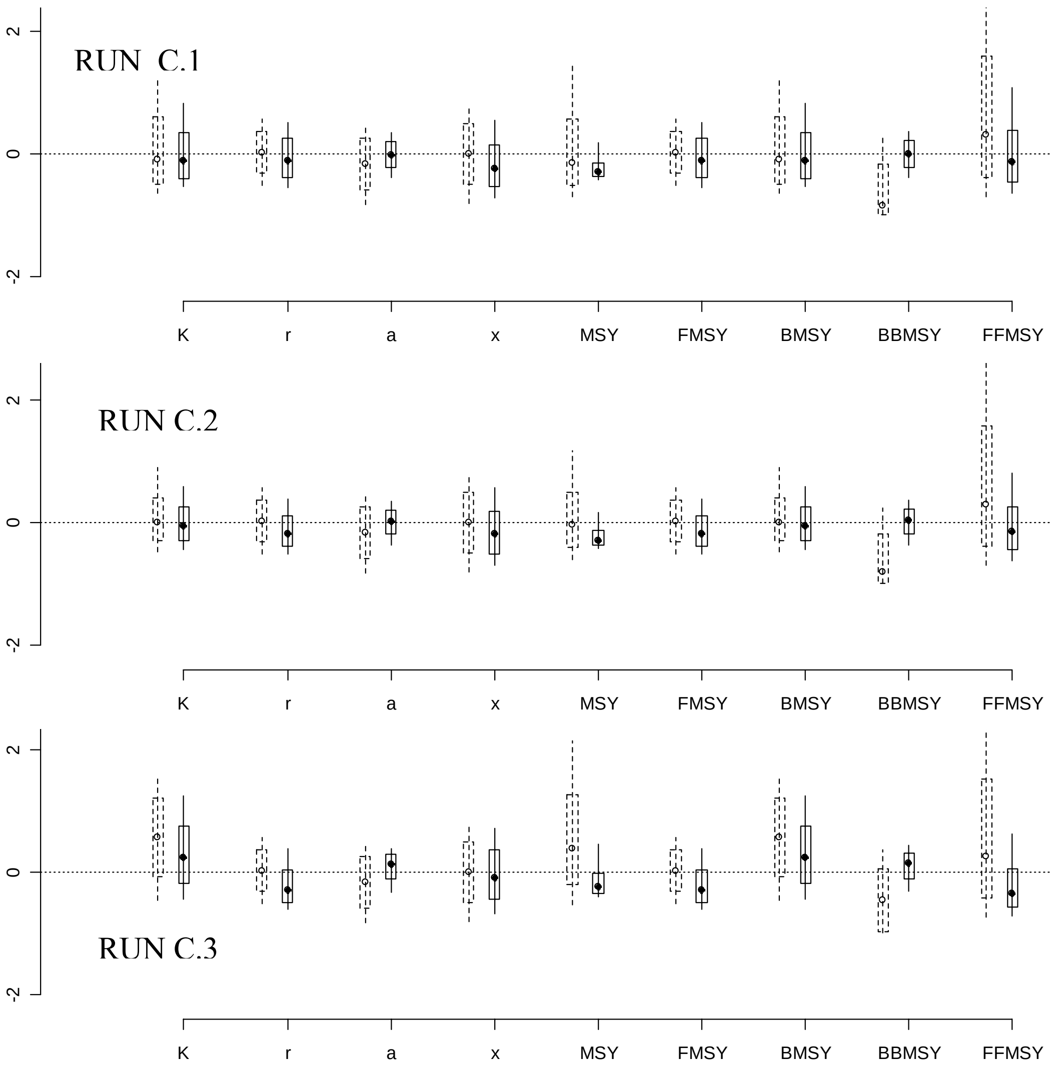


Figure Appendix 8.25 Posterior distributions for *MSY* for COM runs B.1 to B.6 fitted to catch data from 1965 to 1984 for SKJ-E.



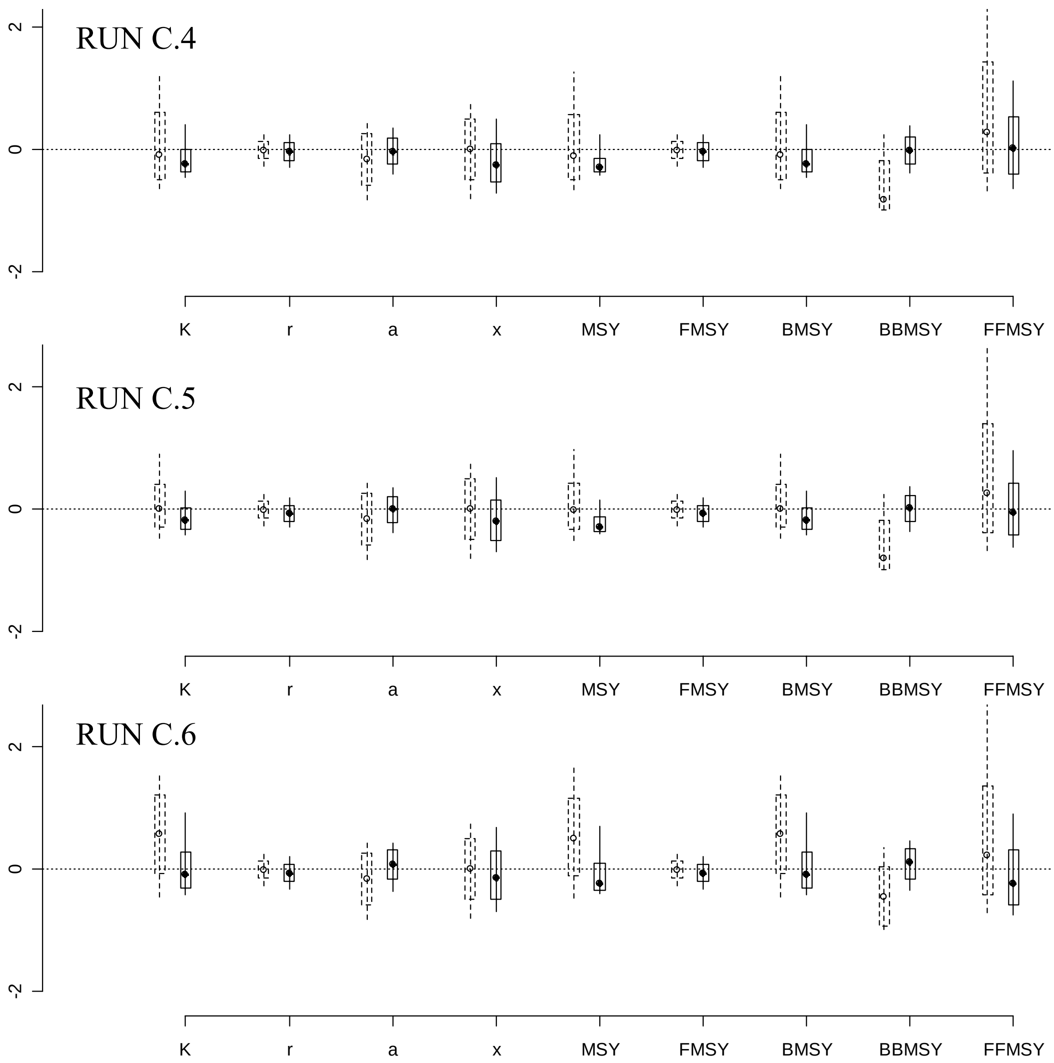


Figure Appendix 8.26 Relative priors and posteriors for the COM runs C.1 to C.6 fitted to catch data from 1985 to 2006 for SKJ-E. See **Figure Appendix 5.1** for explanations.

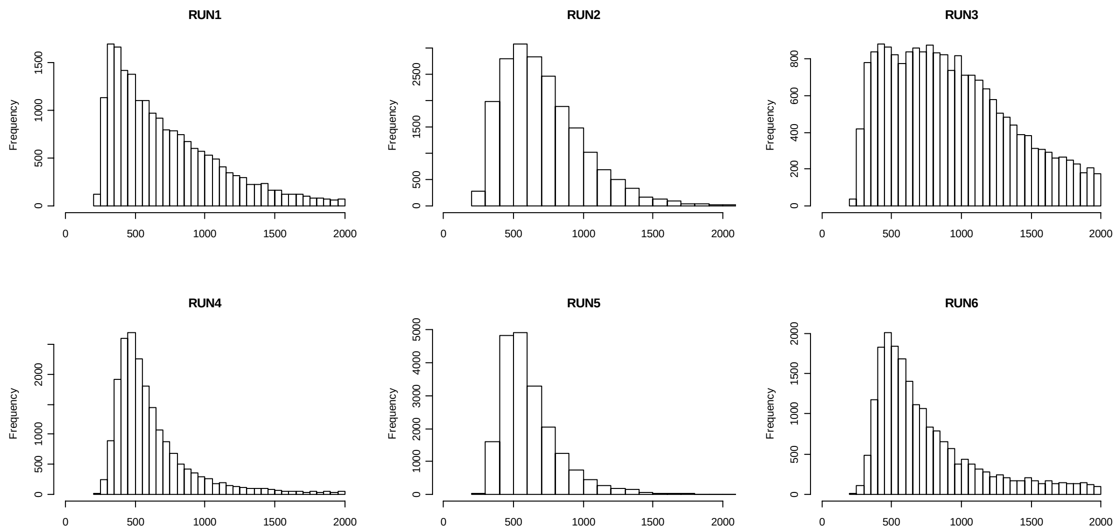


Figure Appendix 8.27 Posterior distributions for *K* for COM runs C.1 to C.6 fitted to catch data from 1985 to 2006 for SKJ-E.

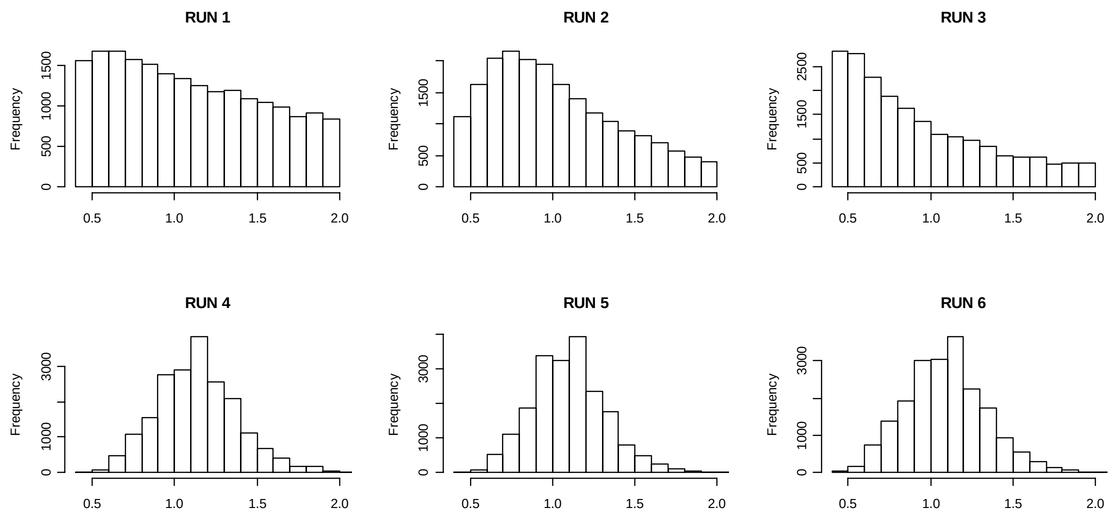


Figure Appendix 8.28 Posterior distributions for r for COM runs C.1 to C.6 fitted to catch data from 1985 to 2006 for SKJ-E.

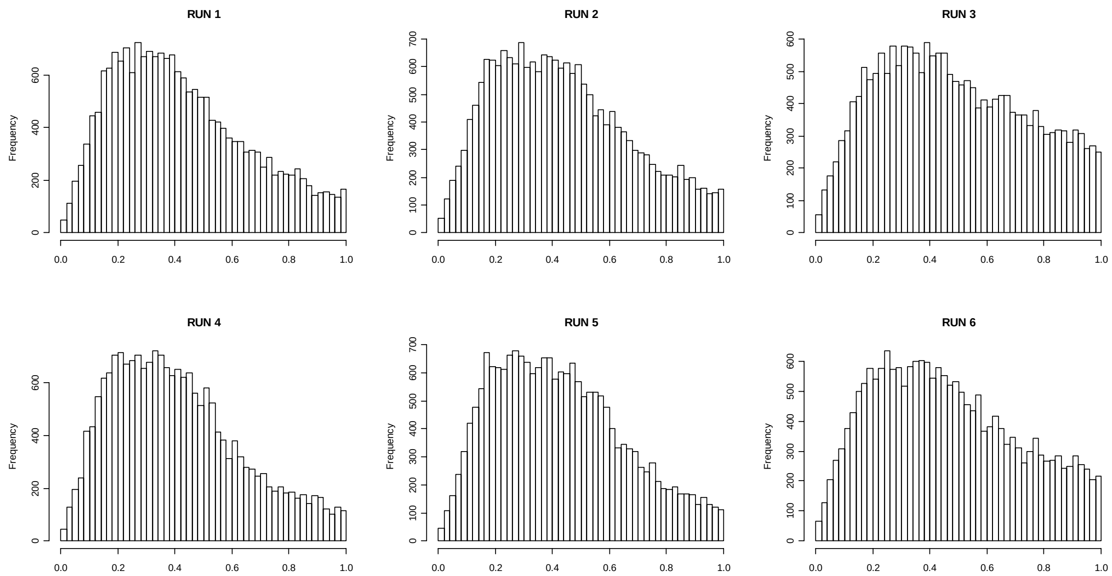


Figure Appendix 8.28 Posterior distributions for x for COM runs C.1 to C.6 fitted to catch data from 1985 to 2006 for SKJ-E.

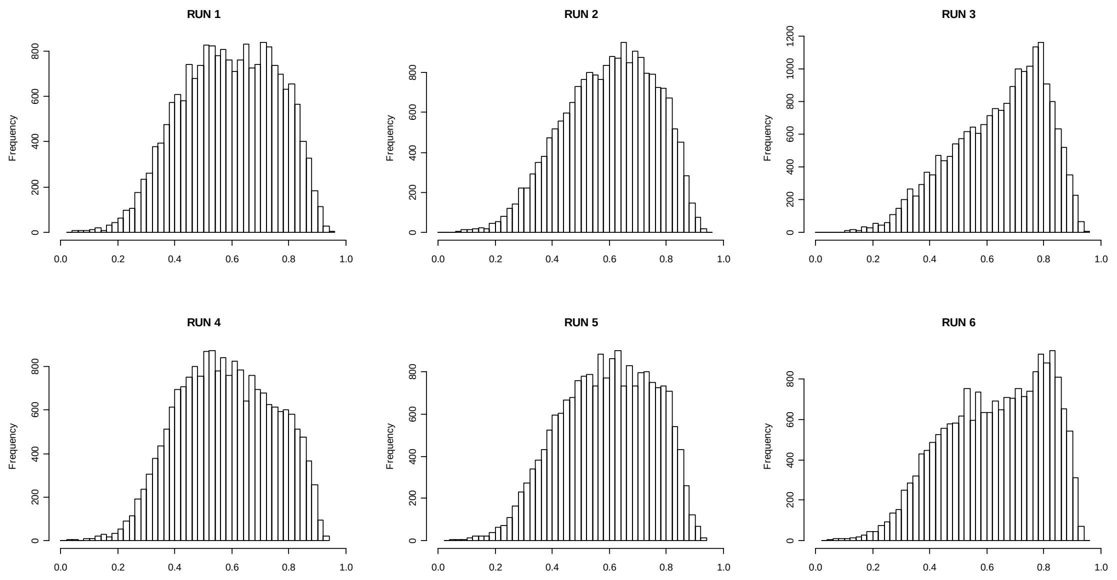


Figure Appendix 8.28 Posterior distributions for *a* for COM runs C.1 to C.6 fitted to catch data from 1985 to 2006 for SKJ-E.

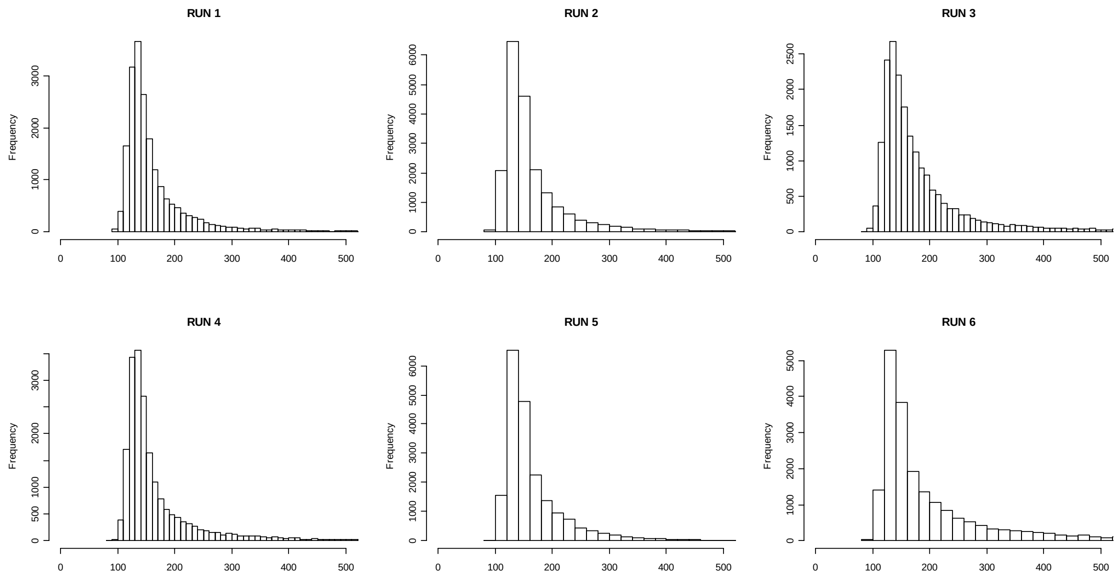


Figure Appendix 8.29. Posterior distributions for *MSY* for COM runs C.1 to C.6 fitted to catch data from 1985 to 2006 for SKJ-E.

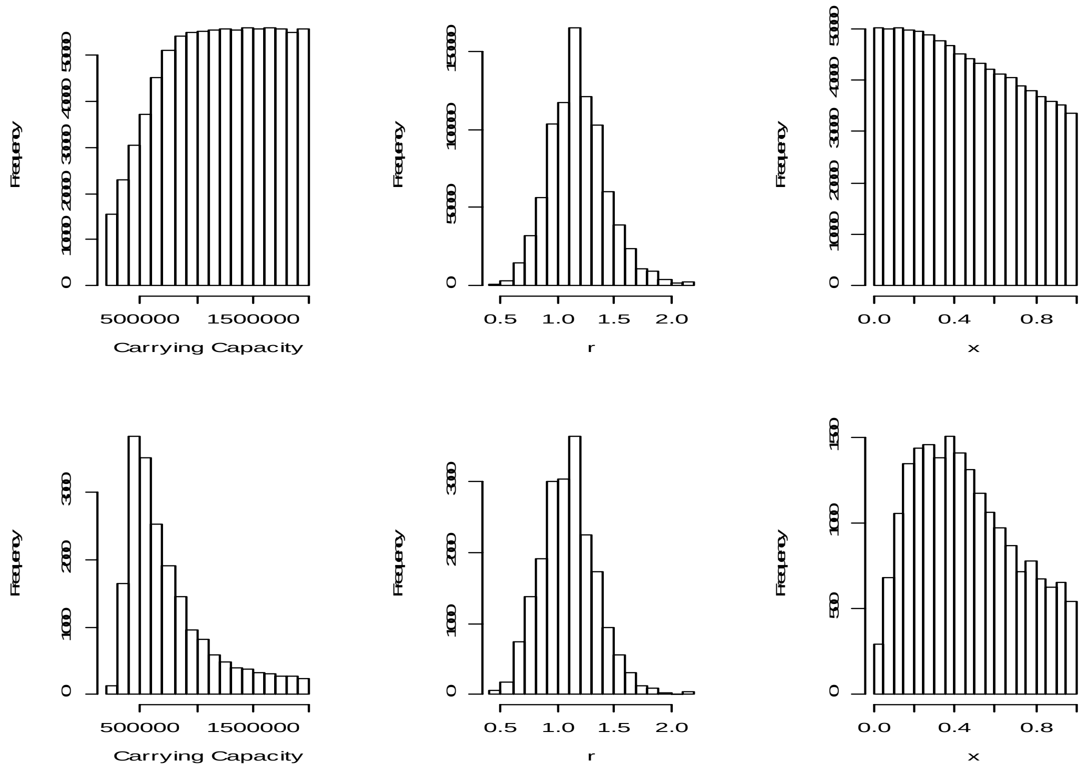


Figure Appendix 8.30. Pre-data, post-model priors (top row) and posteriors (bottom row) for run C.6 fitted to catch data from 1985 to 2006 for SKJ-E.

Appendix 9

Yield-Per-Recruit and Spawning Biomass-Per-Recruit of the Tropical Tunas with Modification of Fleet-Specific Fishing Mortality

TROPICAL TUNA SPECIES GROUP

1. Introduction

During the 2008 ICCAT Yellowfin and Skipjack Stock Assessments Meeting (Florianópolis, Brazil, July 21 to 29, 2008) The Tropical Species Group reviewed the 2007 Report of Panel 1, which included as part of the discussions, the suggestion that the SCRS analyze and present a range of options to the Commission, in time for consideration at the 2008 Special Meeting, to increase the yield per recruit and MSY of bigeye tuna by reducing mortality on small bigeye tuna through the use of such measures as closed areas (i.e. total closure of all surface fisheries) and moratoriums on the use of fish aggregating devices (FADs). In addition it was also suggested that the SCRS analyze the impacts of such measures on the catches of yellowfin tuna and skipjack tuna.

This report contains the results of one such analysis, as presented and discussed during the 2008 Tropical Tunas Species Group meeting (September 24 to 26, 2008) and described in document SCRS/2008/170. This report discusses the effect of reducing or increasing the effective fishing mortality of two fleets, the equatorial surface fleet and an aggregate fleet (all others) on the yield-per-recruit (YPR) and spawning stock biomass-per-recruit (SPR) of yellowfin and bigeye tunas.

2. Methods

The analyses presented in this report used a method developed in response to the Commissions' concerns, and described in SCRS/2008/170. This method can be used to estimate the effects of changes in fishing mortality (F) by age, fleet, gear and/or area on estimates of YPR and SPR. For this analysis, the effective fishing mortality of the equatorial surface fleet (EU PS + Ghana PS + Ghana BB) and an aggregated fleet (all others) was varied from 0% to 200% of recent values (YFT: 2003-2005; BET: 2002-2004). Age-specific biological inputs (weight of catch, weight of spawning stock, maturity and natural mortality at age) and the resulting fishing mortality at age from the most recent virtual population analysis models (YFT: 2008; BET:2007) were used to parameterize the models.

3. Results

3.1 Yellowfin tuna

Two VPA base models were used to provide management advice during the 2008 assessment of yellowfin tuna, Runs 5 and 10. The results of the runs are quite similar. According to these runs, the recent YPR (kg) of yellowfin is 1.73 to 1.78 (**Table Appendix 9.1 and Table Appendix 9.2**, both F multipliers = 1.0). The greatest increases in YPR (>1.9) are achieved by reducing the equatorial surface fleet by 40-100% and increasing the effective F of the other fleets by a similar amount (**Table Appendix 9.1 and Table Appendix 9.2)**. The current SPR (kg) of yellowfin is 3.11 to 3.22 (**Table Appendix 9.3 and 4)**. Simultaneous increases in YPR and SPR can occur with certain fleet modifications. These cases are summarized in **Table Appendix 9.5**. YPR and SPR (expressed as a percentage of SPR_{MAX}) results are also illustrated in **Figure Appendix 9.1**.

3.2 Bigeye tuna

According to the base VPA run, the recent YPR (kg) of bigeye is 1.82 (**Table Appendix 9.6**, both F multipliers = 1.0). The greatest increases in YPR (>2.0) are achieved by reducing the equatorial surface fleet by 20-100% and increasing the effective F of the other fleets by a similar amount (**Table Appendix9.6)**. The current SPR (kg) of bigeye is 8.3 (**Table Appendix 9.7**). Simultaneous increases in YPR and SPR can occur with certain fleet modifications. These cases are summarized in **Table Appenidx 9.8**. YPR and SPR (expressed as a percentage of SPR_{MAX}) results are also illustrated in **Figure Appendix 9.2**.

4. Discussion

The results of these analyses indicate that modest gains in yield-per-recruit for yellowfin and bigeye can be obtained by simultaneously decreasing considerably the surface fleet fishing mortality and noticeably increasing the fishing mortality exerted by the other fleets (**Table Appendix 9.5 and Table Appendix 9.8**). At this time, no analyses were attempted regarding skipjack tuna. The 2008 stock assessment models conducted for skipjack did not provide estimates of fishing mortality-at-age which are required for this analysis. The Tropical Species Group recommends that analyses of skipjack be conducted in the near future. The group also recommends the development of multi-species approaches.

The Tropical Species Group emphasizes that this analysis is a simplified treatment of the data. A more detailed analysis would separate surface fleet catches under floating aggregation devices (FADs) from those targeting free schools. The selectivity of the two fleet components differs substantially; FAD catches are dominated by the youngest animals. This may be particularly important for yellowfin because a substantial fraction of the equatorial catches of this species are older animals captured in free schools. Unfortunately, this analysis could not be accomplished since no estimates of catch-at-age for the free school and FAD components were available at the time of the meeting. The group recommends that this analysis be conducted in the near future.

The Tropical Species Group notes that these results are very sensitive to the assumed natural mortality vectors, which are quite high on ages 0 and 1 (M=0.8) and also poorly known. Also, changes in the method used by ICCAT to convert catch-at-size to catch-at-age may result in important differences in the fishing mortality-at-age vectors used for these analyses. Noting these concerns and the time constraints imposed by a three day meeting, the Tropical Species Group acknowledges that these results do not represent a full range of management options, and should be considered preliminary. Therefore, the group did not recommend any particular management measure. The Group suggested that this topic be explored in more detail at a future Intersessional Meeting.

Table Appendix 9.1. YFT VPA RUN 5: Yield per recruit (kg) with modification of fleet-specific fishing mortality. Current YPR (2003-2005) is highlighted.

YPR Run 5		*F Multiplier of Equatorial Surface Fleet*										
		0	**0.2**	**0.4**	**0.6**	**0.8**	**1**	**1.2**	**1.4**	**1.6**	**1.8**	**2**
F Multiplier of Other Fleets	**0**	0.00	0.51	0.88	1.14	1.31	1.43	1.51	1.56	1.58	1.59	1.58
	0.2	0.47	0.86	1.14	1.33	1.46	1.54	1.59	1.61	1.62	1.62	1.60
	0.4	0.84	1.14	1.35	1.49	1.57	1.63	1.65	1.66	1.65	1.64	1.61
	0.6	1.15	1.37	1.51	1.61	1.66	1.69	1.70	1.69	1.67	1.65	1.62
	0.8	1.39	1.55	1.65	1.70	1.73	1.74	1.73	1.71	1.69	1.66	1.63
	1	1.58	1.69	1.75	1.78	1.78	**1.78**	1.75	1.73	1.69	1.66	1.63
	1.2	1.73	1.79	1.83	1.83	1.82	1.80	1.77	1.74	1.70	1.66	1.62
	1.4	1.84	1.88	1.89	1.87	1.85	1.82	1.78	1.74	1.70	1.66	1.62
	1.6	1.93	1.94	1.93	1.90	1.87	1.83	1.78	1.74	1.70	1.65	1.61
	1.8	2.00	1.99	1.96	1.92	1.88	1.83	1.78	1.74	1.69	1.65	1.60
	2	2.05	2.02	1.98	1.93	1.88	1.83	1.78	1.73	1.68	1.64	1.59

Table Appendix 9.2. YFT VPA RUN 10: Yield per recruit (kg) with modification of fleet-specific fishing mortality. Current YPR (2003-2005) is highlighted.

YPR Run 10		*F Multiplier of Equatorial Surface Fleet*										
		0	**0.2**	**0.4**	**0.6**	**0.8**	**1**	**1.2**	**1.4**	**1.6**	**1.8**	**2**
F Multiplier of Other Fleets	**0**	0.00	0.47	0.82	1.06	1.24	1.37	1.45	1.50	1.53	1.54	1.55
	0.2	0.44	0.80	1.07	1.26	1.39	1.48	1.53	1.56	1.58	1.58	1.57
	0.4	0.79	1.08	1.28	1.42	1.51	1.57	1.60	1.61	1.61	1.60	1.59
	0.6	1.08	1.30	1.44	1.54	1.60	1.64	1.65	1.65	1.64	1.62	1.60
	0.8	1.32	1.47	1.58	1.64	1.68	1.69	1.69	1.68	1.66	1.63	1.60
	1	1.51	1.62	1.68	1.72	1.73	**1.73**	1.72	1.69	1.67	1.64	1.61
	1.2	1.66	1.73	1.77	1.78	1.78	1.76	1.74	1.71	1.68	1.64	1.61
	1.4	1.78	1.82	1.83	1.83	1.81	1.78	1.75	1.71	1.68	1.64	1.60
	1.6	1.87	1.89	1.88	1.86	1.83	1.80	1.76	1.72	1.68	1.64	1.60
	1.8	1.94	1.94	1.91	1.88	1.85	1.80	1.76	1.72	1.67	1.63	1.59
	2	2.00	1.97	1.94	1.90	1.85	1.81	1.76	1.71	1.67	1.63	1.59

Table Appendix 9.3. YFT VPA RUN 5: Spawning biomass per recruit (kg) with modification of fleet-specific fishing mortality. Current SPR (2003-2005) is highlighted.

SPR Run 5		*F Multiplier of Equatorial Surface Fleet*										
		0	**0.2**	**0.4**	**0.6**	**0.8**	**1**	**1.2**	**1.4**	**1.6**	**1.8**	**2**
F Multiplier of Other Fleets	**0**	12.42	10.39	8.75	7.39	6.28	5.36	4.59	3.94	3.40	2.94	2.55
	0.2	10.89	9.15	7.72	6.55	5.58	4.78	4.10	3.54	3.06	2.65	2.30
	0.4	9.57	8.07	6.84	5.82	4.98	4.27	3.68	3.18	2.75	2.39	2.08
	0.6	8.44	7.14	6.08	5.19	4.45	3.83	3.31	2.86	2.49	2.17	1.89
	0.8	7.46	6.34	5.41	4.64	3.99	3.44	2.98	2.59	2.25	1.96	1.72
	1	6.62	5.64	4.83	4.15	3.58	**3.10**	2.69	2.34	2.04	1.78	1.56
	1.2	5.89	5.04	4.33	3.73	3.22	2.80	2.43	2.12	1.85	1.62	1.42
	1.4	5.25	4.51	3.88	3.36	2.91	2.53	2.20	1.92	1.69	1.48	1.30
	1.6	4.70	4.04	3.49	3.03	2.63	2.29	2.00	1.75	1.54	1.35	1.19
	1.8	4.21	3.64	3.15	2.74	2.38	2.08	1.82	1.60	1.40	1.23	1.09
	2	3.79	3.28	2.85	2.48	2.16	1.89	1.66	1.46	1.28	1.13	1.00

Table Appendix 9.4. YFT VPA RUN 10: Spawning biomass per recruit (kg) with modification of fleet-specific fishing mortality. Current SPR (2003-2005) is highlighted.

SPR Run 10		*F Multiplier of Equatorial Surface Fleet*										
		0	**0.2**	**0.4**	**0.6**	**0.8**	**1**	**1.2**	**1.4**	**1.6**	**1.8**	**2**
F Multiplier of Other Fleets	**0**	12.42	10.47	8.87	7.54	6.43	5.51	4.73	4.07	3.52	3.05	2.65
	0.2	10.95	9.26	7.87	6.71	5.74	4.93	4.24	3.66	3.17	2.75	2.39
	0.4	9.68	8.21	7.00	5.98	5.13	4.41	3.81	3.30	2.86	2.49	2.17
	0.6	8.58	7.30	6.24	5.35	4.60	3.97	3.43	2.98	2.59	2.25	1.97
	0.8	7.62	6.50	5.57	4.79	4.13	3.57	3.09	2.69	2.34	2.05	1.79
	1	6.79	5.81	4.99	4.30	3.72	**3.22**	2.80	2.44	2.13	1.86	1.63
	1.2	6.06	5.20	4.48	3.87	3.35	2.91	2.53	2.21	1.93	1.69	1.49
	1.4	5.42	4.67	4.03	3.49	3.03	2.63	2.30	2.01	1.76	1.54	1.36
	1.6	4.86	4.20	3.63	3.15	2.74	2.39	2.09	1.83	1.60	1.41	1.24
	1.8	4.37	3.78	3.28	2.85	2.49	2.17	1.90	1.67	1.47	1.29	1.14
	2	3.94	3.41	2.97	2.59	2.26	1.98	1.73	1.52	1.34	1.18	1.04

Table Appendix 9.5. YFT: Fleet-specific multipliers that result in increases in YPR (medium grey with diagonal bar), SPR (light grey) and both YPR and SPR (black) over 2003-2005 levels.

YFT: Run 5		*F Multiplier of Equatorial Surface Fleet*										
		0.0	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
F Multiplier of Other Fleets	0.0											
	0.2											
	0.4											
	0.6											
	0.8											
	1.0											
	1.2											
	1.4											
	1.6											
	1.8											
	2.0											

YFT: Run 10		*F Multiplier of Equatorial Surface Fleet*										
		0.0	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
F Multiplier of Other Fleets	0.0											
	0.2											
	0.4											
	0.6											
	0.8											
	1.0											
	1.2											
	1.4											
	1.6											
	1.8											
	2.0											

Table Appendix 9.6. BET: Yield per recruit (kg) with modification of fleet-specific fishing mortality. Current SPR (2002-2004) is highlighted.

YPR		*F Multiplier of Equatorial Surface Fleet*										
		0	**0.2**	**0.4**	**0.6**	**0.8**	**1**	**1.2**	**1.4**	**1.6**	**1.8**	**2**
F Multiplier of Other Fleets	**0**	0.00	0.16	0.31	0.44	0.56	0.67	0.77	0.86	0.93	1.01	1.07
	0.2	0.50	0.62	0.73	0.83	0.91	0.99	1.06	1.12	1.18	1.23	1.27
	0.4	0.92	1.00	1.08	1.15	1.21	1.26	1.31	1.35	1.38	1.42	1.44
	0.6	1.27	1.32	1.37	1.41	1.45	1.48	1.51	1.53	1.55	1.57	1.58
	0.8	1.55	1.58	1.61	1.63	1.65	1.66	1.68	1.69	1.69	1.70	1.70
	1	1.79	1.80	1.81	1.81	1.82	**1.82**	1.82	1.81	1.81	1.80	1.80
	1.2	1.99	1.98	1.97	1.97	1.95	1.94	1.93	1.92	1.91	1.89	1.88
	1.4	2.15	2.13	2.11	2.09	2.07	2.05	2.03	2.01	1.98	1.96	1.94
	1.6	2.29	2.26	2.22	2.19	2.16	2.13	2.10	2.08	2.05	2.02	2.00
	1.8	2.40	2.36	2.32	2.28	2.24	2.20	2.17	2.13	2.10	2.07	2.04
	2	2.49	2.44	2.39	2.35	2.30	2.26	2.22	2.18	2.15	2.11	2.08

Table Appendix 9.7. BET: Spawning biomass per recruit (kg) with modification of fleet-specific fishing mortality.

SPR		*F Multiplier of Equatorial Surface Fleet*										
		0	**0.2**	**0.4**	**0.6**	**0.8**	**1**	**1.2**	**1.4**	**1.6**	**1.8**	**2**
F Multiplier of Other Fleets	**0**	22.0	20.2	18.5	17.0	15.6	14.3	13.1	12.0	11.0	10.1	9.3
	0.2	19.6	18.0	16.5	15.1	13.9	12.7	11.7	10.7	9.8	9.0	8.3
	0.4	17.5	16.0	14.7	13.5	12.4	11.4	10.4	9.6	8.8	8.1	7.4
	0.6	15.7	14.4	13.2	12.1	11.1	10.2	9.4	8.6	7.9	7.2	6.6
	0.8	14.1	12.9	11.9	10.9	10.0	9.2	8.4	7.7	7.1	6.5	6.0
	1	12.7	11.7	10.7	9.8	9.0	**8.3**	7.6	7.0	6.4	5.9	5.4
	1.2	11.5	10.6	9.7	8.9	8.2	7.5	6.9	6.3	5.8	5.3	4.9
	1.4	10.4	9.6	8.8	8.1	7.4	6.8	6.2	5.7	5.3	4.8	4.4
	1.6	9.5	8.7	8.0	7.3	6.7	6.2	5.7	5.2	4.8	4.4	4.0
	1.8	8.7	8.0	7.3	6.7	6.2	5.7	5.2	4.8	4.4	4.0	3.7
	2	7.9	7.3	6.7	6.1	5.6	5.2	4.8	4.4	4.0	3.7	3.4

Table Appendix 9.8. BET: Fleet-specific multipliers that result in increases in YPR (medium grey diagonal bar), SPR (light grey) and both YPR and SPR (black) over 2002-2004 levels.

BET		*F Multiplier of the Equatorial Surface Fleet*										
		0	**0.2**	**0.4**	**0.6**	**0.8**	**1**	**1.2**	**1.4**	**1.6**	**1.8**	**2**
F multiplier of the Other Fleets	**0**											
	0.2											
	0.4											
	0.6											
	0.8											
	1											
	1.2											
	1.4											
	1.6											
	1.8											
	2											

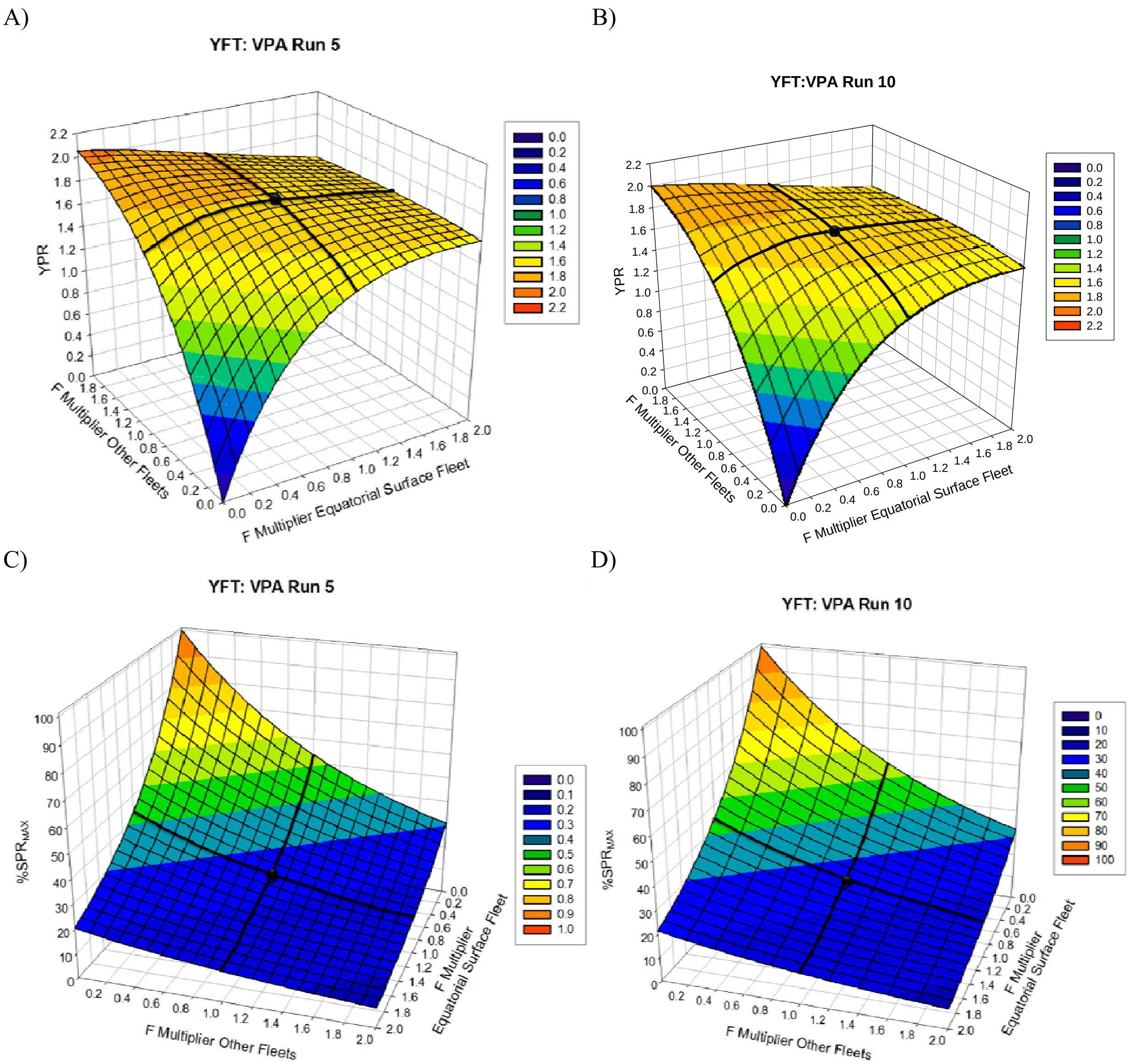


Figure Appendix 9.1. YFT: YPR and SPR with modification of fleet-specific F multipliers. (**A)** YPR VPA Run 5, (**B)** YPR VPA Run 10, (**C)** SPR VPA Run 5 and (**D)** SPR VPA Run 10. The solid lines are at F Multiplier = 1 (current F) for each fleet. The black circle is the current status quo.

A) B)

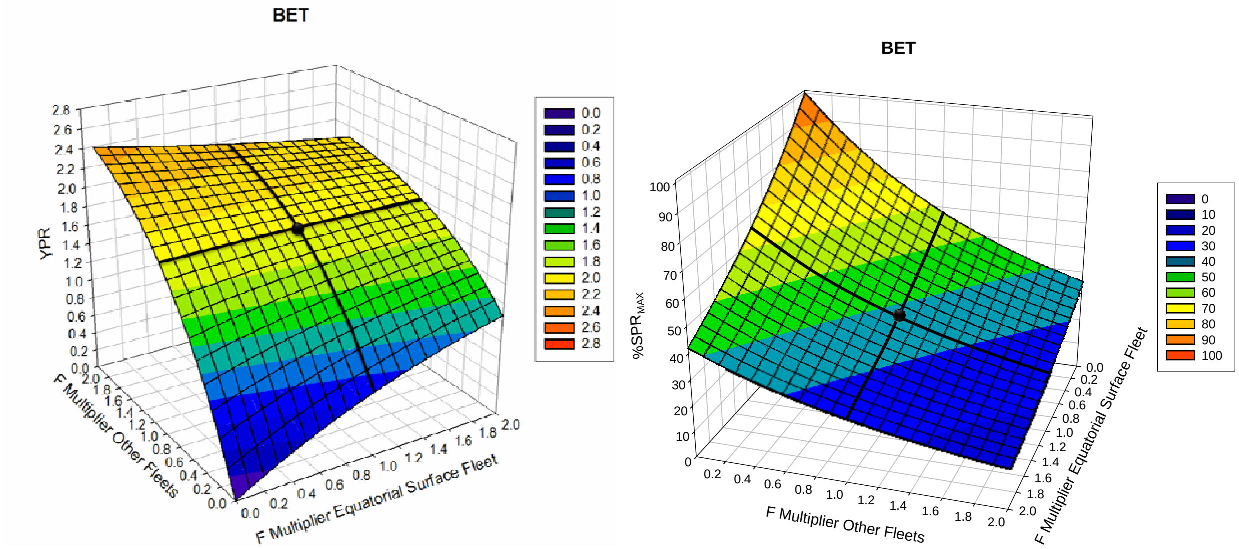


Figure Appendix 9.2. BET: YPR **(A)** and SPR **(B)** with modification of fleet-specific F multipliers. The solid lines are at F Multiplier = 1 (current F) for each fleet. The black circle is the current status quo.