REPORT OF THE 2009 PORBEAGLE STOCK ASSESSMENTS MEETING

(Copenhagen, Denmark, June 22 to 27, 2009)

1. Opening, adoption of Agenda and meeting arrangements

The meeting was opened by Dr. Jim Ellis and Andrés Domingo, and the chairs welcomed Working Group participants. Helle Gjeding Jørgensen welcomed participants on behalf of the ICES Secretariat and Laurence Kell, on behalf of ICCAT, thanked ICES for hosting this joint ICES/ICCAT meeting, The chairs summarised the terms of reference for the meeting and presented a background of the process. After opening the meeting, the Agenda was reviewed and adopted (**Appendix 1**). The List of Participants is included as **Appendix 2**. The List of Documents presented at the meeting is attached as **Appendix 3.**

The following participants served as Rapporteurs for various sections of the report:

Section	*Rapporteurs*
1	L. Kell
2	S. Campana, S. McCully, S. Fowler, E. Cortés
3	E. Cortés, E. Babcock, S. Campana, L. Kell
4	G. Scott
5, 6, 8,	J. Ellis and A. Domingo
7	V. Restrepo

2. Update of data for assessment

2.1 Stock structure and life history parameters

The issue of stock structure and life history parameters was addressed in the following presented papers: SCRS/2009/188; SCRS/2009/089; SCRS/2009/090; SCRS/2009/092; SCRS/2009/094. Some of these papers also presented biological information or genetic and tagging studies and are described in these respects in subsequent sections of this report.

SCRS/2009/188 updated some preliminary results from SCRS/2008/152, presenting updated information on the French targeted porbeagle fishery. Biological parameters, including sex ratio, catch composition, size at maturity, diet composition, trophic level and growth curves from porbeagle caught from the Bay of Biscay and Celtic Sea were presented. The differences in growth parameters noted between this study and that reported for the NW Atlantic support the hypothesis of two separate stocks in the North Atlantic.

Document SCRS/2009/089 presented new data on the size composition, sex ratio and distribution of porbeagle, collected by the Uruguayan pelagic longline fleet observer program. Data on the size at maturity for males (clasper length vs. fork length) were provided, and a possible nursery area in the open ocean off Uruguay and south of Brazil, where porbeagle of 67-119 cm fork length were caught in the summer of 2009, was illustrated.

Document SCRS/2009/090 presented data on the genetic structure of porbeagle in the Atlantic Ocean based on the analysis of mitochondrial DNA of 53 specimens, from both the North Atlantic (41°38-41°50'N, 55°16'-55°74'W, n = 4) and South Atlantic (39°26'-43°41'S, 00°05'-26°59'E, n = 49). These data support the current view of restricted gene flow between the North and South Atlantic populations. While this study suggested that the South Atlantic population could be divided into more than one sub-population, data were insufficient and further research is required to examine the structure of southern hemisphere stocks.

The document SCRS/2009/092 is presented to the working group as a "porbeagle national report" to summarize the most important Spanish fisheries within the ICCAT, ICES and NAFO convention areas where potential impact on porbeagle could be expected based on the areas of distribution of this species and their geographical overlap with the areas of activity of some of these fleets. Any targeted fishery is developed by Spain on this species. The porbeagle is a very rare bycatch within ICES and NAFO fisheries of CE-Spain and the level of their possible bycatch should be considered null or negligible.

Additionally, the Spanish surface longline targeting swordfish (*Xiphias gladius*) within the ICCAT convention area has sporadically caught porbeagle as a low prevalent bycatch in the North and South Atlantic areas, with the two most prevalent shark species being blue shark (*Prionace glauca*) and, to a lesser extent, shortfin mako (*Isurus oxyrinchus*). The paper summarize some of the old and recent scientific references on this Spanish fleet where information on porbeagle was included since mid eighties of last century about, areas of activity, level of catches, catch rates, size, length-weight relationships, sex-ratio at size, relative prevalence, etc. as well as recent catch estimations and standardized CPUE trends. The paper also summarizes other papers presented to the working group (SCRS/2009/053, SCRS/2009/062 and SCRS/2009/087).

Document SCRS/2009/094 presented information about migratory routes, potential nursery areas, swimming behavior, and environmental associations in the NW Atlantic. Pop-up satellite archival tags were deployed on 20 porbeagles in November 2006. The sharks, ten males and ten females, ranged from 128-154 cm fork length, and were tagged and released from a commercial longliner fishing on the northwestern edge of Georges Bank, about 150 km east of Cape Cod, MA. Based on known and derived geopositions, the porbeagle exhibited broad seasonally dependent horizontal and vertical movements ranging from 77-870 km and from the surface to 1300 m depth, respectively. All of the sharks remained in the NW Atlantic, from the Gulf of St. Lawrence and the coast of Nova Scotia to Georges Bank and oceanic and shelf waters south to North Carolina. In general, the population appeared to contract during the summer and autumn, with more extensive radiation in the winter and spring. Although sharks moved through temperatures ranging from 2-26°C, the majority of time (76%) was spent in water ranging from 8-16°C. In the spring and summer months, the sharks were epipelagic, swimming in the upper 200m of the water column. In late autumn and winter, some of the porbeagle (n=10) moved to mesopelagic depths (200-1000 m). Temperature records indicate that these fish were likely associated with the Gulf Stream. Since none of these fish moved to the NE Atlantic, this work also supported the two stock hypotheses for the North Atlantic.

2.2 Stock definition

Maps of the North Atlantic, with ICCAT, NAFO and ICES boundaries are shown in **Figure 1**. **Figure 2** shows the distribution of porbeagle in the Atlantic and other oceans.

2.2.1 NW Atlantic porbeagle

Northwest Atlantic porbeagles are largely concentrated in the waters on and adjacent to the continental shelf of North America. Observer data from the Canadian, U.S., Spanish and Icelandic fleets indicate that porbeagles are found throughout the high seas of the North Atlantic north of 35°N, but that the CPUE on the high seas is relatively low. Conventional tagging data (~200 recaptures from three separate studies) indicate that NW Atlantic porbeagles are highly migratory within their stock area, but do not undertake trans-Atlantic migrations. More recent satellite tagging results reinforce this conclusion. Therefore the ICCAT sub-group concludes that there is a single stock of porbeagle in the NW Atlantic north of 35°N and west of 42°W, corresponding roughly to ICCAT region BIL94b and NAFO areas 0-6.

2.2.2 NE Atlantic porbeagle

The ICCAT sub-group considered that there is a single-stock of porbeagle in the NE Atlantic that occupies the entire ICES area (sub-areas I-XIV). This stock extends from the Barents Sea to northwest Africa. For management purposes the southern boundary of the stock is 36°N and the western boundary at 42°W. Given that porbeagle abundance in the central Atlantic appears to be small, ICCAT region BIL94b is a reasonable approximation of NE Atlantic porbeagle stock area. Historic tagging studies and recent satellite tagging studies indicate that few, if any, porbeagles make transatlantic crossings.

2.2.3 SW Atlantic porbeagle

The distribution of the porbeagle stock in the SW Atlantic, south of 25°S and west of 20°W was considered. It was suggested that it could apparently comprise waters of the southeast Pacific Ocean but more robust data are required to confirm this fact which would have direct implications on the management of this stock.

2.2.4 SE Atlantic porbeagle

The distribution of the porbeagle stock in the SE Atlantic, south of 25°S and east of 20°W was considered. It was suggested that it could apparently comprise waters of the southwest Indian Ocean but more robust data are required to confirm this fact which would have direct implications on the management of this stock.

2.2.5 Information from other Publications

Documents SCRS/2001/085 and SCRS/2005/095 contributed information on the distribution in the North hemisphere and catches in the high seas.

2.3 Summary of life-history parameters

Porbeagle life history parameters are reasonably well known for the NW Atlantic and South Pacific stocks, with less information available for the NE Atlantic and even less for South Atlantic stocks. Some biological parameters (e.g. growth) differ markedly between the NW Atlantic and South Pacific, indicating that at least some of the parameters are not universal among the stocks, although other parameters (e.g. fecundity) are similar. Available life history information is summarized in **Table 1.**

Available information suggests that NE Atlantic porbeagle life history characteristics are somewhat similar to those of the NW Atlantic, although growth rates in the NE Atlantic are lower than those in the NW Atlantic. Virtually no information is available on South Atlantic porbeagle. However, given that southern Atlantic porbeagle distribution appears to be continuous around the tip of South America and southern Africa, it seems probable that south Atlantic parameters would be more similar to those of the South Pacific than to those of the North Atlantic.

2.4 Catch estimates

2.4.1 Overview of national landings

Available catch reports held in the ICCAT Task I data base (as of 12 June 2009, **Table 2**, **Figure 3**) were reviewed and found to be generally incomplete, especially for the South Atlantic fisheries. Information held in various literature sources and made available by National Scientists attending the meeting was compared to Task I reports and incorporated into a catch compilation for the purposes of conducting the assessment. Efforts to estimate catches for non-reporting longline fleets were undertaken using observer data, where available. The approach used is further discussed in subsequent paragraphs.

The Working Group considered the separation of the NE and NW stocks of porbeagle at 40^{o}W longitude and the separation of the SE and SW stocks at 20^{o}W longitude. Catches reported and estimated for the Spanish longline fleet in SCRS/2009/087 represented a 1950-2008 time-series of northern hemisphere porbeagle harvest estimates for this fleet. These estimates were partitioned between the NW and NE stock areas in proportion to the distribution of hooks fished by the Spanish fleet based on the hooks time series data base maintained at ICCAT, which provides estimated nominal longline effort (hooks fished) in monthly time steps and 5x5 spatial resolution. Similar partitioning was done for reported catches for other fleets which reported some catches from the NWC Atlantic fishing area in Task I.

2.4.2 Discards information

Insufficient data were available, although as porbeagle is a high-value species, it is unlikely that large numbers are discarded. Discard survival is not known for either longline-caught porbeagle (which could be high) or for porbeagle caught in other fisheries on the continental shelf.

2.4.3 Quality of catch data

Catch data are thought to be relatively complete for the NW Atlantic, although it is noted that landings are estimated for some high seas fleets. Although there is a long time-series for landings data in the NE Atlantic, some European states have incomplete recording of porbeagle (or they have been reported as generic sharks). Although catch data for this stock are considered to be underestimates, these are mostly for nations catching small quantities, and data are available for the major fishing nations.

Catch data for South Atlantic stocks are incomplete, as the stock(s) may extend into the SE Pacific and SW Indian Oceans.

2.4.4 Overview of missing data and methods to estimate catches

SCRS/2009/062 presented an overview of the recent FAO statistics on porbeagle shark and examined their relationship with the reported catch of the related shortfin mako *Isurus oxyrinchus*, establishing a ratio between the two. The data suggest that there may be some inconsistencies between the statistics reported for the two species over the time series, emphasizing the need to maintain smooth coordination between the RFMOs and the FAO and to set up programs aimed at the dissemination of specific information directed at the different countries, to improve the statistics of these species.

SCRS/2009/087 presented the historic catch series of porbeagle by the Spanish surface longline fleet targeting swordfish in the North Atlantic for the period 1950-2008, reconstructed using various information sources, such as previous studies by the authors and data from Task I available on ICCAT's database, always considering the ratio between porbeagle and the target species. An increasing trend was observed from 1950-1989. Thereafter there has been a declining trend with strong variations from year to year until the end of the period.

Estimates of potential porbeagle catch by various longline fleets which fished in areas where porbeagle are known to occur were based on observed catch of porbeagle relative to the catch of tunas and swordfish, following approaches adopted previously for estimating catches of blue and shortfin mako shark catches from non-reporting longline fleets (see, for example, SCRS/2008/017 – the report of the 2008 shark assessment meeting). **Figure 4** provides an overview of the overall longline effort distribution compared to the distribution of porbeagle in the Atlantic, which indicates the potential overlap is restricted generally to 30^o or greater latitudes in both hemispheres.

Observer data considered sufficient to conduct this estimation were available to the Working Group only for the NW and SW stock areas. For the NW, Canadian and U.S. observer data from their national fleets and Canadian observer data from Japanese vessels operating in the Canadian EEZ were available. For the SW Atlantic, Uruguayan observer data were available for analysis. Icelandic observer data from Japanese vessels operating in Iceland's EEZ were also provided to the Working Group, but these data were considered too geographically limited to be applied across the entire NE Atlantic non-reporting longline fleets. Observer data from other fleets were requested, but not received during the meeting.

This method requires observer data from the area and fishery in question to determine the underlying catch ratio, and makes several assumptions. The key assumption is that the observer-based catch ratio is applicable to other fisheries, times and locations. To test this assumption, observer data from three sources (Canada, U.S. and Iceland) were analyzed in terms of porbeagle catches relative to those of tunas and/or swordfish. The resulting ratios were mapped by 5-degree squares (**Figures 5, 6** and **7**).

The observed maps of catch ratios indicated that the relative abundance of porbeagle in the catch tended to be greatest on or near the continental shelf, and declined markedly in the high seas. There were significant and sometimes large differences in catch ratios among fisheries from different nations, but the relative proportion of porbeagle in the high seas catch was almost always less than 2%. Based on these results, estimation of total (unreported) porbeagle catch in the high seas fisheries of nations which have not previously reported porbeagle catch can be only approximated using catch ratios. In addition, the underlying observed catch ratios must be spatially structured (e.g. by 5-degree squares) if they are to be useful.

This result is consistent with general belief about the (current) density distribution of the catches with the dominant part of the catch coming from continental shelf and shelf-edge fishing grounds, although high-seas catches do occur. At a coarser resolution (5x5), the latitudinal gradient was not strong. In the NW, the Canadian observer data from Japanese vessels showed the broadest geographical coverage and for that reason were selected to form the basis for estimating the proportion of porbeagle to tunas and swordfish in the catch to apply against the catches of non-reporting longline fleets. In the SW, the Uruguayan observer data were used.

Figure 8 shows the pattern in the proportion of porbeagle to tunas and swordfish applied against the catches of swordfish and tunas by longline fleets not reporting porbeagle in the NW and SW stock areas.

In the SW region, both a gear (monofilament vs. multifilament) and longitude effect was hypothesized based on the observations. **Tables 3 and 4** and **Figures 9** and **10** provide the estimated porbeagle catches for non-reporting fleets in these regions by this method. These estimates have high, but unquantified levels of uncertainty owing to the limited observations on catch ratios across fleets and time, but provide a basis for considering the potential impact of these fleets on overall porbeagle catch levels compared to directed fleet catches.

Table 5 and **6** and **Figures 11** and **12** show the catch patterns used in the assessment for the NE and NW stocks, respectively. For the Southern Hemisphere the reported catch data are sporadic at best, with only a few fleets reporting any information. In addition, there is belief that catches made in the southeastern Pacific and southwestern Indian Ocean impact the SW and SE Atlantic porbeagle stocks respectively, which should be taken into consideration into future assessments.

2.4.5 Nominal and estimated landings of porbeagle by stock

Figure 13 draws comparison of NW Atlantic catch compilations made at this meeting, including estimates of catch by non-reporting longline fleets, with those reported in SCRS/2009/05. There are relatively small differences in these catch compilations which warrant further investigation.

Table 2 shows the nominal landings of porbeagle (by stock) as reported to ICCAT (north western, north eastern and southern hemisphere). These are broadly comparable with data used by ICES WGEF data.

2.5 Trends in catch rates

Overview of fishery-dependent CPUE data

SCRS/2009/069 presented indices of relative abundance developed for porbeagle from the U.S. pelagic longline logbook program (1992-2008). Indices were calculated using a two-step delta-lognormal approach that treats the proportion of positive sets and the CPUE of positive catches separately. Standardized indices with 95% confidence intervals were reported. The time series showed a generally decreasing trend, which can be decomposed into an initial decrease from 1992-2001, followed by a sharp increase to 2003 and a subsequent decrease to 2008.

Document SCRS/2009/091 presented standardized CPUE for porbeagle calculated using the Southern bluefin tuna (SBT) observer data from 1992–2007. The standardized CPUE showed some fluctuations but there was not a clear trend. This result is supposed to indicate that the stock status of porbeagle did not change significantly during the research period in this fishery, although further studies are required to fully support this.

Document SCRS/2009/093 presented standardized indices of catch-per-unit-of-effort (CPUE) of porbeagle caught by the Uruguayan longline fleet. The indices were obtained by Generalized Linear Models (GLM) with a delta lognormal approach. The data in weight of the fish caught were from the fishing logbooks of the Uruguayan longline fleet that operated in the South Atlantic Ocean between 1982 and 2008. The standardized CPUE shows an important decline over the past twelve years, which may or may not be indicative of stock abundance and could be the result of environmental changes, changes in fishing strategies or other changes.

SCRS/2009/053 presented standardized catch rates for North Atlantic porbeagle during the period 1986-2007, caught as low prevalent by-catch in the Spanish surface longline fishery targeting swordfish in the Atlantic Ocean. The analysis was performed using a GLM approach assuming a delta-lognormal distribution error and considered several factors such as longline style, quarter, bait and also spatial effects by including seven zones. The base case suggested a moderately decreasing trend between 1986 and 1996, a period of stability until the year 2000 and a slight increase thereafter. The results obtained using only the traditional style longline indicate that the trend was substantially stable from 1986-2000. The results obtained show standardized CPUE trends that were very similar for the whole time series, regardless of the type of analysis conducted. Scientific estimations of annual catches for the period 1997-2008 were also updated. The Working Group requested the authors to make additional runs restricted to the defined zones 1&2 (West) and 4&5 (East) to provide indices of abundance for the NW and NE Atlantic stocks, respectively. These additional analyses were made available to the group as Annex 1 to

SCRS/2009/053. However, reservations were expressed by the authors about the appropriateness of the areas selected by the group for monitoring "stocks" or “units" of North Atlantic porbeagle taking into consideration the catch distribution.

Figure 14 shows the CPUE trends for the Atlantic porbeagle North western, North eastern and South western stocks.

Availability of fishery-independent surveys

No fisheries-independent data were available to the group, and the absence of such data means that there is a reliance on fishery-dependent trends. Fishery-dependent data for fisheries targeting porbeagle may not reflect overall stock abundance, and fisheries-dependent data for fisheries where porbeagle are a by-catch may be highly variable.

3. Assessment model and results

3.1 Bayesian surplus production model

3.1.1 Methods

Document SCRS/2009/068 applied a Bayesian Surplus Production (BSP) model to estimate status and project population trends for NW Atlantic porbeagle. This model was used in previous ICCAT assessments for blue and shortfin mako shark in 2004 and 2008. An informative prior was developed for the rate of population increase (*r*) based on demographic data. Catch and catch per unit effort data were taken from the 2005 assessment of Gibson and Campana. The BSP model results were more pessimistic than the results of the age structured assessment model, because the BSP model was only fitted to CPUE data for mature sharks, which have declined more than immature sharks. The authors recommended using the BSP model to assess the status of NE Atlantic and South Atlantic porbeagle populations, provided that it is possible to develop at least one CPUE index of abundance for each population, as well as a time series of catches. If catch data are not available for the entire history of the fishery, the BSP model can estimate catches from longline effort data in the early years of the fishery.

NW Atlantic porbeagle

To determine whether the BSP model gives similar results to the age- and space-structured model applied to NW Atlantic porbeagle, it would be preferable to be able to fit the BSP model to a standardized CPUE index in units of biomass of all porbeagle sharks for all areas combined. Such an index was not available for the 2009 Canadian assessment (SCRS/2009/095), because the CPUEs were standardized within the assessment model in 2009 so that it was not possible to extract a standardized CPUE series independent of the age-structured model. In the 2005 Canadian assessment (Gibson and Campana 2005), the CPUE indices were standardized independently of the model, but were standardized separately for immature and mature sharks in each of three spatial regions. We entered these six CPUE series into the BSP model as biomass indices, either weighted by the relative proportion of total catch in numbers in each series in each year, or weighted equally. It was not possible to weight by total catch in biomass in each series in each year because these data were not available. The total catches from Gibson and Campana (2005) were used for consistency between the two models. The informative prior for *r* had a mean of 0.05 and a CV of 10%, as specified in SCRS/2009/068. The prior for *K* was uniform on log *K* and the prior for *Bo/K* was lognormal with a mean of 1.0 and a CV of 0.20.

To use the BSP model to assess the status of NW Atlantic porbeagle in 2009, we ran the BSP model with eight CPUE series: the six Canadian CPUE series through 2004, the U.S. series, and the Spanish series for area 1 and 2 only. Each point in each data series was given equal weight. Thus, the Canadian series together were given more weight than either the U.S. or the Spanish series. This seemed appropriate considering that the majority of the catches come from the Canadian fleet. Catches were taken from the ICCAT Task I data, as allocated to NE and NW stock areas by the Working Group either with or without additional catches inferred for non-reporting fleets. The same priors were used for *r*, *K* and *Bo/K*.

SW Atlantic porbeagle

For SW Atlantic porbeagle, the catches reported to ICCAT are very small and began in 1982. Unreported catches are probably substantial given the large and increasing longline effort in the SW Atlantic region. One CPUE index of abundance was available, for the Uruguayan fleet from 1982 to 2008. The BSP model runs varied in whether the CPUE data points were weighted equally or by the inverse of their CVs, and in how catches were estimated. The catches were either based on those reported to ICCAT, estimated from the longline effort series or estimated from the ratio of porbeagle to other species in the catch (**Tables 2** and **4**). The posterior for *r* was informative, with a mean having the same value used for the Northwest Atlantic (0.05) and a standard deviation twice that in the North Atlantic, implying a CV of 0.21. The prior for *K* was uniform on log *K* and the prior for *Bo/K* was lognormal with a mean of 1.0 and a CV of 0.20, with *Bo* being the biomass in the first year for which either catch or effort data were available.

NE Atlantic porbeagle

For NE Atlantic porbeagle, the highest catches occurred in the 1930s and 1950s, long before any CPUE data were available to track abundance trends (**Figure 15**). We tried several variations of the model, either starting the model run in 1926 or 1961, and with a number of different assumptions (**Table 10**). We used a lognormal prior for *r*, with a mean of 0.062 based on demographic data and a CV of 0.16. This CV implied a standard deviation twice that estimated from the demographic analysis, to make the prior slightly less informative. The prior for *K* was uniform on log *K* with several different upper limits.

3.1.2 Results

NW Atlantic porbeagle

For the BSP model applied to the Canadian assessment data through 2005, it was expected that the model run with the indices weighted by relative catch numbers would give results that were most similar to the age- structured model results, but this was not the case. The catch-weighted model (run a3 in **Table 7**), gave more optimistic results than the age-structured model. This model estimated current (2005) biomass to be 66% of the 1961 biomass, compared to the age-structured model result that current numbers were between 10 and 24% of 1961 numbers. The BSP model with equal weighting (run a4 in **Table 7, Figure 16**) gave results that were much more similar to the age-structured model results, estimating current biomass at 37% of 1961 biomass. The BSP model with equal weighting predicted that the population would recover to B_{MSY} in about 20 years with no fishing (**Table 8**). This is roughly consistent with the results of the age-structured model, considering that the age-structured model results are in numbers and the BSP results are in biomass.

These results demonstrated that the BSP model can adequately capture the population dynamics of the porbeagle shark, but the model is quite sensitive to how the input CPUE series are calculated and weighted. Standardized CPUE indices calculated in biomass and weighted by catch in biomass would be most consistent with the assumptions of the BSP model.

To further explore the implications of the informative prior on *r* on the final results, we ran a retrospective analysis, including the CPUE data only through 1998, 2000 or 2002 (runs a403, a402 and a401 in **Table 7**). The posterior distribution of *r* remained similar to the prior for all the retrospective runs. The CVs of the other parameters were lowest when the data were included through 2002, and increased as more years of data were removed in some cases. The credibility interval of biomass relative to B_{MSY} was narrowest when data were included through 2002. We expected the CVs to be lower when more years of data were included. This was generally true for data from 1998 to 2002. Presumably the higher CVs using the 2003 and 2004 data were caused by the high variability of the data in those years.

The results of the BSP model applied to data through 2009 (runs NW1 and NW2 in **Table 7, Figure 17**) were similar to the results in the Canadian age structured assessment with only Canadian data (SCRS/2009/095). Both catch series gave similar results. These two models showed a depletion similar to that found in 2004, but a low current fishing mortality rate relative to *Fmsy* (**Figure 18**), because the 2008 catches were low.

SW Atlantic porbeagle

For all the catch scenarios, the model estimated that biomass had declined since the beginning of the fishery, consistent with the decline seen in the Uruguay longline CPUE data (**Table 9** and **Figures 19** to **22**). The most apparent difference between the model runs is the estimate of *K*. Because the catch series scales the biomass estimates, the model runs that used the ICCAT catches, which were never above 40 t per year, estimated *K* around 1000 t. This low value allowed the model to fit a declining biomass trend with very small catches (runs SW1 and SW2). When catches were estimated from effort, with the constant of proportionality between catch and effort calculated either for 2005-2006 (run SW4) or 1997-2007 (run SW4), the estimated *K* was much higher (11,000-24,000 t). With the ratio estimate of catch, which was much higher than the catches estimated from the effort particularly in recent years, the estimated *K* was 71,000 t. All models estimated recent fishing mortality rates above *Fmsy*, although the median *F* dropped below *Fmsy* in 2009 for run SW4. For all models the replacement yield was very low. This result is driven by the trend in the Uruguay longline series. CPUE data from the other fleets in the region would be useful to verify this trend.

NE Atlantic porbeagle

The posterior distributions of *r* were similar to the prior distributions for all model runs (**Table 10**). The prior for *K* was uniform on log *K*, with an upper limit of 100,000 t. This upper limit was set to be somewhat higher than the total of the catch series from 1926 to the present (total catch= 92,000 t). With equal weighting of all the data points in both CPUE series and starting the model in 1926 (**Figure 23, Table 10**), the model estimated a declining population trend with biomass currently depleted to 78% of the biomass that would sustain the maximum sustainable yield, *Bmsy*. The posterior distribution of *K* had a mode around 60,000 t, but there was a substantial probability assigned to values as high as the upper limit of 100,000 t. To determine whether the data supported a higher value of *K*, we ran the model with a biologically unreasonable high upper limit of *K* of 1.0E8 t (run NE101 in **Table 10**). The model estimated a posterior of *K* that was similar to the uniform on log *K* prior, implying that there was very little information in the data to allow the model to estimate any of the parameters. Because the prior was only weakly informative, and allowed a substantial probability to be assigned to high values of *K*, this model estimated a very high expected value of *K*, with almost no depletion of the population. A biomass of 1.0E8 t of porbeagle is not likely, given that catch rates are relatively low compared to the catch rates of swordfish, tunas and other sharks, all of which have biomass levels that are lower than 1.0E8. Also, the estimated total biomass of porbeagle in the Northwest Atlantic is around 10,000 t. We also tried a lower maximum K of 80,000 t, and this gave similar results to those with an upper limit of 100,000 t. The rest of the model runs specified 100,000 t as the maximum value of *K*.

Weighting the CPUE series of Spain and France by their relative catches gave results similar to the equal weighting case (**Table 10** and **Figure 23**). Starting the model in 1961 and setting an informative prior on the level of depletion of the population in 1961, with a mean of either 1.0, 0.5 or 0.2 gave somewhat different results. All of these models found that the population continued to decline slightly after 1961, consistent with the decline in the French CPUE series. The current level of depletion and current fishing mortality rates were dependent on the level of depletion assumed in 1961. Considering that the largest catches in the fishery took place before 1961, the model runs that assumed model depletion in 1961, or started in 1926 are more realistic than those that assumed a high biomass in 1961.

Figure 24 shows the current status of northeast Atlantic porbeagle for the BSP model and the ASPM model. These results are highly uncertain, given that the majority of the fishery removals occurred before data were available to estimate abundance trends. All the models that used biologically plausible assumptions about unfished biomass inferred that the population is currently depleted.

3.2 Catch-free, age-structured production model (CFASPM)

3.2.1 Methods

A state-space, catch-free, age-structured production model (CFASPM; Porch *et al.* 2005) was applied to the SW Atlantic stock of porbeagle to provide contrast with the BSP model. Briefly, this is an age-structured production model that does not require catches, and recasts the population dynamics in terms relative to virgin biomass. Dynamics incorporate age-specific parameters for survival, fecundity, maturity, growth, and selectivity. The stock-recruitment function is parameterized in terms of maximum reproductive rate at low density (alpha; Myers *et al.* 1999). Two periods are considered in the model: a historic period, for which the data are sparse, and a modern period, for which there are data, such as catch rates. During the historic period, the model uses a relative biomass trend. Biological, fishery and other inputs used for the SW Atlantic porbeagle stock are listed in **Table 11**.

3.2.2 Results

SW Atlantic porbeagle

Table 12 summarizes stock status estimates from the model run, in which the historical period was 1961-1981 and the modern period, 1982-2008. The model was fitted to the Uruguayan longline CPUE series in the modern period. A selectivity function was derived from length frequency data obtained by the Uruguayan longline observer program, which were transformed into ages using the growth curve from the NW Atlantic. A logistic selectivity curve was thus estimated. At the request of the Working Group, the slope of the curve was subsequently increased slightly (shifted to the left) to better accommodate early age classes (**Figure 25**). The model did not use effort data, rather a constant F was estimated for the historic period, and an average F with annual deviations was estimated for the modern period. The estimate of current spawning stock biomass (SSB) was 18% of virgin level and SSB_{2008}/SSB_{MSY} was 0.48. Current fishing mortality rate (F_{2008}) was estimated to be 0.056, or over F_{MSY} (0.03), thus F_{2008}/F_{MSY}=1.72. The maximum lifetime reproductive rate (alpha) was only 2.95 and M=0.20. The fit to the index is shown in **Figure 26**. The relative trend in SSB shows that the model predicted a depletion of 46% by the beginning of the modern period in 1982 (**Figure 27**). Stock status results from the CFASPM were thus in general agreement with predictions from the BSP model (SSB_{2008}/SSB_{MSY} = 0.48 vs. B_{2008}/B_{MSY} = 0.78; F_{2008}/F_{MSY}=1.72 vs. F_{2008}/F_{MSY}=2.07, **Figure 22**).

3.3 Age-structured production model (ASPM)

3.3.1 Methods

A state-space, age-structured production model (ASPM; Porch *et al.* 2005) was applied to the NE Atlantic stock of porbeagle o provide contrast with the BSP model. The model dynamics are age-structured, incorporating age-specific parameters for survival, fecundity, maturity, growth, and selectivity, as in the CFASPM model described above. The stock-recruitment function is also parameterized in terms of maximum reproductive rate at low density (alpha; Myers *et al.* 1999). In this case, a prior is given to virgin recruitment (R0) and pup (age-0) survival, and age-specific M-values for ages 1+ are imputed. The values of M were the same as those used for the NW Atlantic stock assessment, i.e., M=0.10 for immature and M=0.2 for mature individuals. The model also has the ability to consider two periods: a historic period, for which the data are sparse, and which begins when virgin conditions can be assumed; and a modern period, for which there are more data. The model assumes a constant effort for the modern period, but allows for process error (annual deviations in fishing effort). The effort for the historic period can be set at different levels. Biological, fishery and other inputs used for the NE Atlantic porbeagle stock are listed in **Table 13**.

3.3.2 Results

NE Atlantic porbeagle

Table 14 summarizes stock status estimates from the model run, in which the historical period was 1926-1971 and the modern period, 1972-2008. The model was fitted to catches in 1926-2008 and to two indices in the modern period: the French longline CPUE series (1972-2008) and the Spanish longline CPUE series (1981-2007). A selectivity function was derived from length frequency data obtained from the French longline fleet, which were transformed into ages using a growth curve recently derived for the NE Atlantic stock. A logistic selectivity curve was thus estimated (**Figure 28**).

Current depletion with respect to virgin conditions was 6% in biomass and 7% in numbers **(Figure 29**). Current relative spawning stock fecundity (SSF_{2008}/SSF_{MSY}) was only 0.09. Current fishing mortality rate (F_{2008}) was estimated to be 0.09, well over F_{MSY} (0.03), and thus F_{2008}/F_{MSY}=3.45. The relative SSF and F trajectories were below and above sustainable levels, respectively (**Figure 30**). The fit to the catches and indices of relative abundance is shown in **Figure 31**.

Because the Working Group felt that the high constant F, on the order of 0.08, estimated by the model for the historic period was unrealistic, it was decided to explore the effect of assuming other levels of F on results. Two runs were conducted, one with an F=50% of the value estimated in the original run and one with F=0. Stock status improved (SSF_{2008}/SSF_{MSY}=0.21 and 0.43, respectively) and the level of overfishing decreased (F_{2008}/F_{MSY}=2.54 and 3.32, respectively) (**Table 14**).

3.4 Age structured assessment model

3.4.1 Methods and results

SCRS/2009/095 evaluated the current status of porbeagle in the NW Atlantic using a forward projecting, age- and sex-structured life history model, fit to catch-at-length and catch per unit effort data between 1961 and 2008. Four variants of the population model were presented, all of which differed in their assumed productivity. The total population size is currently estimated to be about 22% to 27% of its size in 1961 and about 95% to 103% its size in 2001. The estimated number of mature females in 2009 is in the range of 11,000 to 14,000 individuals, or 12% to 16% of its 1961 level and 83% to 103% of its 2001 value. All analyses indicated that this porbeagle stock can recover at fishing mortalities below 4% of the vulnerable biomass. Under the low productivity model, recovery to SSN_{MSY} was predicted to take over 100 years at exploitation rates of 4% of the vulnerable biomass. All other models predicted recovery times to SSN_{MSY} on the order of decades.

The implications of flat-topped selectivity patterns were explored at the meeting. The fit of the flat-topped selectivity model was considerably worse (objective function value of 16277 versus the original 13212), and there were extreme residual patterns in proportions at length, indicating that the model was inappropriate. Although the resulting fishing mortality estimates were reduced by about half, and fishable biomass doubled, all fishing mortality reference points were reduced accordingly, producing little net change in recovery trajectory or time.

3.5 Gadget

3.5.1 Methods

A Gadget (Globally applicable Area Disaggregated General Ecosystem Toolbox, Begley 2003, http://www.hafro.is/gadget) implementation for northeast Atlantic porbeagle was presented SCRS/2009/071 and updated with the new catch and CPUE data made available at the meeting. GADGET provides a flexible and powerful tool for creating ecosystem models. It can be fitted for a variety of assumptions related to the fisheries, stock structure and life history parameters and using data on catch and relative abundance (which may be biomass, age- or size-based), tagging and stomach contents. A single stock, area, fleet, age- and length- structured model was developed, which can now be used for projecting forwards under different management scenarios. Gadget can potentially be used to evaluate the value of collecting additional information on fisheries and biology and of using alternative management measures and assessment methods, particularly as it will allow spatial structure to be represented. It is intended to use it in the future to evaluate stock assessment methods like BSP and ASPM. Also for species like porbeagle where there are few data and large uncertainty, Gadget can help in the development of precautionary management by evaluating alternative measures such as size limits and time-area restrictions and help design research projects to improve our knowledge on porbeagle and the fisheries in which they are taken.

4. Projections

4.1 Bayesian surplus production model

NE Altantic porbeagle

The five most credible BSP model runs for Northeast Atlantic porbeagle were used to generate projected abundance trajectories for a range of constant catch and constant harvest rate management strategies. The resulting expected biomass relative to *Bmsy*, probability that biomass will be above *Bmsy*, probability that biomass will be above the current biomass and median number of years to rebuild (**Table 15, Figure 32**) vary between models. The current TAC of 436 t is likely to cause the population to remain fairly stable under most models. Reductions in fishing mortality are required to allow the population to rebuild, and rebuilding will take several decades under most models (**Table 16**).

4.2 Yield per recruit analysis

The BSP analysis concentrates on total allowable catch; however, as noted below the development of precautionary management also requires the evaluation of alternative measures such as size limits and restrictions intended to improve selection pattern in the fisheries. Therefore a yield per recruit analysis using FLR (ww.flr-project.org) was conducted.

The effect of different selection patterns on the NE Atlantic porbeagle stock were evaluated in F**igure 33** This shows four selection patterns corresponding to flat-topped and dome-shaped (thick and thin lines, respectively) curves and with maximum selectivity at either age 5 or13 (red and blue, respectively). Age 13 corresponds to age at maturity of females and to the current maximum landing length (MLL) of 210 cm fork length. Life history parameters were taken from the Gadget implementation.

The analysis shows that both potential stock size and yields are increased if fishing mortality is reduced on immature fish (blue).

In **Figure 34** fishing mortality on individuals greater than the MLL is reduced to 0.

Table 17 shows the fishing mortality, yield, biomass and SSB relative to that achieved at the effort level corresponding to the $F_{0.1}$ level for a flat-topped selection pattern with maximum selection at age 3. The difference due to the MLL, as also seen by comparing **Figures 33** and **34**, is that stock levels are improved at the expense of yield

5. Research recommendations

The Group considered the importance of developing research projects at the regional (stock) level which will result in rapidly increasing our available knowledge on porbeagle sharks:

- Scientists were urged to study the technical and operative aspects of the fleets that could reduce the incidental catch of sharks and/or maximise the opportunity for live release,
- Prepare better estimates of discards in shelf and high-seas fisheries and initiate studies to measure post-release survival.
- Observer programs to collect better resolution data on catch rates for those fleets where there is a high likelihood of porbeagle by-catch, including from existing marine mammal observer programmes.
- Better understand the dynamics of porbeagle in the southern hemisphere in conjunction with other RFMOs, including IOTC, CCSBT, and IATTC so as to collate better data on catch, distribution, commercial CPUE and stock structure.
- Given that the stock identity for South Atlantic stocks is unclear, further studies (including genetic studies as well as life-history and tagging studies) are required to better inform on stock units in the southern hemisphere.
- Although stock structure in the North Atlantic is better understood, there is a need for specific investigations. For example, to better understand the affinity of catches off Iceland, and potential mixing between NW African and Mediterranean porbeagle.
- A better understanding of vertical and migratory movements of porbeagle in the main areas of their distribution is required to better understand the potential interaction between the populations and fishing activities.

- Porbeagle may associate with hydrographic features (or as an indirect effect via associating with their main prey). A better understanding of the temporal and spatial distribution of porbeagle in relation to such environmental/ecosystem features (including population structure) may facilitate our understanding of catch and CPUE trends.

- Spatial management of porbeagle has been established in Canadian waters. A better knowledge of the distribution and fidelity of critical porbeagle habitats (including pupping and nursery grounds, and sites with a high proportion of mature females) would facilitate more widespread use of spatial management.

- The reliance of fishery-dependent data for assessments is problematic, as such data are not necessarily informative. Fisheries-independent surveys for porbeagle are required in the main stock areas.

- More historical information on catch and effort data may be available and should be investigated. In the absence of historical effort data, estimates of fleet size could provide a useful surrogate.

- Given that porbeagle are a key pelagic stock on continental shelf ecosystems as well as in the high seas, ICCAT and RFMOs (e.g. NAFO, ICES) should continue to cooperate in developing assessments and management actions for this species.

6. Management recommendations

Precautionary management measures should be considered for those stocks where there is the greatest biological vulnerability and conservation concern, and for which there are very few data. Porbeagle are known to be susceptible to over-fishing.

Given that porbeagle are primarily a continental shelf species, management measures should be harmonized between all relevant RFMOs, and ICCAT should facilitate appropriate communication.

South Atlantic

Data for southern hemisphere porbeagle are too limited to provide a robust indication on the status of the stock(s). Limited data indicate a decline in CPUE in the Uruguayan fleet, suggesting a potential decline in porbeagle abundance in the SW Atlantic to levels below MSY. Results of the two modeling approaches applied to the SW Atlantic stock (BSP and CFASPM) coincided in estimating depletion levels below MSY and fishing mortality rates above those producing MSY. But catch and other data are generally too limited to allow definition of sustainable harvest levels. Catch reconstruction indicates that reported landings grossly under-estimate actual landings.

Information and data for porbeagle in the SE Atlantic are too limited to assess their status. Available catch rate patterns suggest stability since the early 1990s. This trend cannot be viewed in a longer term context and so are not informative on current levels relative to $_{BMSY}$.

Given the history of depletion in the North Atlantic, suggestion of decline to below MSY in the SW Atlantic and lack of basic catch and effort data from the total fleets impacting the stock (including non ICCAT fleets) the Commission should consider adopting precautionary measures, including restricting fisheries affecting the stock(s) to by-catch only and/or restricting fishing activities in areas known to have high abundance of important life-history stages (e.g. mating, pupping and nursery grounds). Other (national) fleets should report catch and effort data in accordance with Resolution 07-06.

The distribution of South Atlantic stock(s) extends into other ocean basins, emphasizing the need to harmonize both biological and fisheries data collection and management with other RFMOs.

NE Atlantic

The NE Atlantic stock has the longest history of commercial exploitation. The lack of CPUE data for the peak of the fishery adds considerable uncertainty in identifying the current status relative to virgin biomass. Exploratory assessments indicate that current biomass is below B_{MSY} and that recent fishing mortality is near or possibly above F_{MSY}.

ICES consider the stock to be depleted, especially in the northern parts of the ICES area. ICES suggested that the stock was still depleted, and fisheries in the northern parts of the stock area had not resumed since the peak of that fishery. Fisheries in the southern part of the stock area continue at low levels, with some evidence of a decline over time in CPUE. CPUE data for the peak of the fishery were not available and thus do not reflect longer term trends.

The assessments conducted at this meeting support the previous ICES view of stock depletion.

ICES (2008) advised, in the absence of a quantitative assessment "*Given the state of the stock, no targeted fishing for porbeagle should be permitted and by-catch should be limited and landings of porbeagle should not be allowed*".

Existing EC management measures in the NE Atlantic include a TAC. Reported landings in 2008 were less than the TAC. A maximum landing length (210 cm fork length) was introduced in 2009 to deter fisheries targeting mature females.

Given the depleted state of the stock, its low productivity, and uncertainty in the assessment, conservative management measures are appropriate under the precautionary approach. The Commission should consider adopting TACs which provide a high probability of allowing stock rebuilding. Additionally, the Commission should consider restricting fishing activities in areas known to have high abundance of important life-history stages (e.g. mating, pupping and nursery grounds). Nations and RFMOs should consider adopting further management measures to reduce fishing mortality (e.g. the EC brought in size restrictions).

High-seas fisheries should not target porbeagle and all by-catch should be reported. Due to their lower abundance in the high seas, by-catch data collection and reporting would require scientific observer sampling at a high level of coverage. Increased effort on the high seas within the stock area could compromise stock recovery efforts.

Recovery of this stock to B_{MSY} under zero fishing mortality is estimated to take ca. 15-34 years (**Table 15**). Sustained reductions in fishing mortality would be required if there is to be any stock recovery (**Table 16**).

The current TAC (436 t) may allow the stock to remain stable, at its current depleted biomass level, under most credible model scenarios. Catches close to the current TAC (e.g. 400 t) imply catch levels that could allow rebuilding to B_{MSY} under some model scenarios, but with a high degree of uncertainty and on a time scale of 60 (40-124) years.

Constant catches of 200 t or less resulted in higher probabilities of recovery to B_{MSY} within 25-50 years under nearly all model scenarios.

Given uncertainty in the assessment and the low productivity of the stock, any fishery should be closely monitored and assessed at frequent intervals.

NW Atlantic

Canadian scientists updated their assessment of the NW Atlantic porbeagle stock. This assessment indicates that biomass is depleted to well below B_{MSY}, although recent fishing mortality is also below F_{MSY}. Recent biomass appears to be increasing. There is now a conservative harvest regime (TAC of 185 t relative to the MSY catch of 250 t; closure of the mating grounds to target fisheries) in place in the Canadian EEZ. Despite this, stock rebuilding is projected to take decades due to the low productivity of the species.

Additional modelling by the Working Group using a surplus production approach indicated a similar view of stock status, i.e., depletion to levels below B_{MSY} and current fishing mortality rates also below F_{MSY}.

The success of the Canadian recovery program is contingent on proper accounting of all catches, including high-seas fleets. Catches within the Canadian EEZ appear to be well accounted for. However, the quantities of porbeagle taken in high-seas longline fleets are unclear, as there is widespread non-reporting and generic reporting of sharks.

Estimates of potential porbeagle catch by various high-seas longline fleets which fished in areas where porbeagle are known to occur were reconstructed based on observed catch ratios of porbeagle relative to tunas and swordfish. For the NW Atlantic this reconstruction indicates that unaccounted high-seas longline catches of porbeagle were a minor proportion of the total reported catch historically and catches have been even smaller in recent years.

The inclusion of reconstructed high-seas catches into the assessment did not appreciably affect the output. Future assessments should cover the entire stock area. Because the high-seas catches are currently low in proportion to the total reported catch it is not expected that inclusion of the reconstructed catches would appreciably change the catch levels required to achieve the conservation objectives in the Canadian Management Plan.

The United States has adopted management plans to reduce fishing mortality on porbeagle, in support of management plans introduced into Canadian waters, including a TAC of 11.3 t dressed weight (dw), of which 1.7 t dw are allocated as a commercial quota (2008).

The Commission should adopt management measures that support the recovery objectives of the Canadian Management Plan. High-seas fisheries should not target porbeagle and all by-catch should be reported. Due to their lower abundance in the high seas, by-catch data collection and reporting would require scientific observer sampling at a high level of coverage.

Areas known to have high abundance of important life-history stages (e.g. mating, pupping and nursery grounds) should be subject to fishing restrictions. Such grounds are not exclusively in the Canadian EEZ.

Increased effort on the high seas within the stock area could compromise stock recovery efforts.

7. Executive Summary for Porbeagle

The group decided to finish and approve the executive summary for porbeagle during the species group meeting in September.

8. Other matters

No other matters were discussed.

9. Report adoption and closure

The report will be adopted by correspondence. The Chairmen thanked participants for their hard work.
The meeting was adjourned.

Gibson and Campana 2005
Myers *et al.* 1999
Poech et al. 2005
Begley 2003
2008 SHK detailed report

Appendix 1

AGENDA

1 Opening, adoption of agenda and meeting arrangements
2 Update of data for assessment
  2.1 Stock structure and life history parameters
  2.2 Stock definition
  2.3 Summary of life-history parameters
  2.4 Catch estimates
  2.5 Trends in catch rates
3 Assessment model and results
  3.1 Bayesian surplus production model
  3.2 Catch-free, age-structured production model
  3.3 Age-structured production model
  3.4 Age structured assessment model
  3.5 Gadget
4 Projections
  4.1 Bayesian surplus production model
  4.2 Yield per recruit analysis
5 Research recommendations
6 Management recommendations
7 Executive Summary for Porbeagle
8 Other matters
9 Report adoption and closure

Appendix 2

LIST OF PARTICIPANTS

Contracting Parties

Canada

Campana, Steve
Population Ecology Division, Bedford Institute of Oceanography, , 1 Challenger Drive; P.O. Box 1006, Dartmouth, Nova Scotia B2Y 4A2
Tel: + 1 902 426-3233, Fax: +1 902 426-1506, E-Mail: Steven.Campana@mar.dfo-mpo.gc.ca

European Community

Steven Beggs
Agri-food and Biosciences Institute 18a Newforge Lane BT9 5PX Belfast United Kingdom
Tel: +44 2890 255 472, E-Mail: steven.beggs@afbini.gov.u

Gérard Biais
IFREMER L Houmeau Station. P.O. Box 7. F-17137 L Houmeau. France
Tel. +33 546 500 661, Fax +33 546 500 650, E-mail: gerard.biais@ifremer.fr

Maurice Clarke
Marine Institute Rinville Oranmore . Co. Galway. Ireland
Tel: +353 91387200, Fax +353 91387201, E-mail: maurice.clarke@marine.ie

Guzmán Diez
AZTI-Tecnalia AZTI Sukarrieta, Txatxarramendi ugartea z/g E-48395 Sukarrieta (Bizkaia), Spain
Tel: + 34 946029444, Fax +34 946870006, E-mail: gdiez@azti.es

Helen Dobby
Marine Scotland – Science Marine Laboratory. P.O. Box 101 AB11 9DB Aberdeen Torry. United Kingdom
Tel: +44 1224 876544, Fax +44 1224 295511, E-mail: h.dobby@marlab.ac.uk

Jim Ellis (WGEF Chair)

Centre for Environment, Fisheries & Aquaculture Science Lowestoft Laboratory. Pakefield Road. NR33 0HT Lowestoft. Suffolk. UK
Tel: +44 1502 524300, Fax +44 1502 513865, Email: jim.ellis@cefas.co.uk

Ivone Figueiredo
INRB-IPIMAR. Avenida de Brasilia. PT-1449-006 Lisbon. Portugal
Tel: + 351 21 3027131, Fax + 351 21 33319067, E-mail: ivonefig@ipimar.pt

Sonya Fordham
Policy Director, The Ocean Conservancy, The Shark Alliance and Shark Conservation Program Director, c/o. Oceana. Rue Montoyer, 39, 1000 Brussels, Belgium
Tel: +322 513 2242, Fax: +1 202 872 0619, E-mail: sonja@oceanconservancy.org

Sarah Fowler
Nature Bureau International. 36 Kingfisher Court Hambridge Road. RG14 5SJ Newbury, UK
E-mail: sarah@NatureBureau.co.uk

Boris Frentzel-Beyme
Artenschutzexperte der D.E.G. Biozeutrum Griundel und Zool. Museum Universitat Hamburg
D-20146 Hamburg. Germany
Tel: + 49 (0) 40 431 93400 E-mail: borisfbeyme@elasmo.de

Henk Heessen
Wageningen IMARES. P.O. Box 68. NL-1970 AB Ijmuiden. Netherlands
E-Mail: henk.heessen@wur.nl

Graham Johnston
Marine Institute. Rinville. Oranmore, Co. Galway. Ireland
Tel: +353 91 307490, E-Mail: graham.johnston@marine.ie

Armelle Jung
APECS Association Pour l'Etude et la Conservation des Sélaciens. France
E-Mail: armelle.jung@asso-apecs.org

Sophy McCully
Centre for Environment, Fisheries and Aquaculture Science. Pakefield Road NR33 0HT Lowestoft Suffolk, United Kingdom
Tel: +44 1502 527754, Fax +44 1502 513865, E-Mail: sophy.mccully@cefas.co.uk

Mejuto García, Jaime
Instituto Español de Oceanografía, C.O de A Coruña, Paseo Marítimo Alcalde Francisco Vázquez, 10 - P.O. Box 130, 15001 A Coruña, ESPAÑA
Tel: +34 981 205 362//981 21 8151, Fax: +34 981 229 077, E-Mail: jaime.mejuto@co.ieo.es

Jose de Oliveira
Centre for Environment, Fisheries and Aquaculture Science Lowestoft Laboratory. Pakefield Road NR33 0HT Lowestoft Suffolk,
United Kingdom
Tel: +44 1502 527 7 27, Fax +44 1502 524 511, E-Mail: jose.deoliveira@cefas.co.uk

Ortiz de Urbina, Jose María
Instituto Español de Oceanografía, C.O de Málaga, Apartado 285 - Puerto Pesquero s/n, 29640 Fuengirola, Málaga, ESPAÑA
Tel: +34 952 47 1907, Fax: +34 952 463 808, E-Mail: urbina@ma.ieo.es

Harriët van Overzee
Wageningen IMARES, P.O. Box 68, NL-1970 AB Ijmuiden, Netherlands
Tel: +31 317 487185, Fax +31 317 487326, E-Mail: harriet.vanoverzee@wur.nl

Mário Rui Rilho de Pinho
University of the Azores. Departament Occeanography and Fisheries DOP Universidade dos Açores Caiz Sta Cruz. PT-9909 862 Horta Azores, Portugal
Tel: +351 292 200 400, Fax +351 292 200 411, E-Mail: maiuka@uac.pt

Scott, Finlay
CEFAS - Lowestoft Laboratory, Pakefield Road, Lowestoft, Suffolk, REINO UNIDO
Tel: +44 1502 524 257, Fax: +44 1502 524 511, E-Mail: finlay.scott@cefas.co.uk

Bernard Séret
L Institut de Recherche pour le Développement (IRD). 55 rue Buffon F-75 231 PARIS Cedex 05, France
E-Mail : seret@mnhn.fr

Charlott Stenberg
Swedish Board of Fisheries. P.O. Box 423 SE-401 26 Gothenburg, Sweden
Tel: +46 317 430420, Fax +46 317 430444, E-Mail: charlott.stenberg@fiskeriverket.se

Ingo Stürmer
Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, Division N I 3 (Species Conservation), PO 12 06 29, 10178 Berlin, Germany
Tel: +49 173 28 95 963, E-Mail: ingo.stuermer@bmu.bund.de; stuermer@anawis.com

Francisco Velasco
Instituto Español de Oceanografía Centro Oceanográfico de Santander, P.O. Box 240, E-39080 Santander, Spain
Tel: +34 942 291060, Fax +34 942 275072, E-Mail: francisco.velasco@st.ieo.es

Japan

Hiroaki Matsunaga
Tropical Tuna Fish Resources Division, National Research Institute of Far Seas Fisheries, Fisheries Research Agency, 5-7-1 Orido Shimizu-ku, Shizuoka 424-8633, Japan
Tel: +81 54 336 6000, Fax: +81 54 335 9642, E-Mail: matsuh@fra.affrc.go.jp

Norway

Tone Vollen
Institute of Marine Research, P.O. Box 6404 N-9294 Tromsø, Norway
Tel: +47 95880793, Fax +47 77609701, E-Mail: tone.vollen@imr.no

Russian Federation

Andrey Dolgov
Knipovich Polar Research Institute of Marine Fisheries and Oceanography. 6 Knipovitch Street RU-183763 Murmansk. Russian Federation
Tel: +7 8152 473064, Fax +7 8152 473331, E-mail: dolgov@pinro.ru

United States

Babcock, Elisabeth
Pew Institute for Ocean Science, Rosenstiel School of Marine and Atmospheric Science, University of Miami, 4600 Rickenbacker Causeway, Miami, Florida 33149
Tel: +1 305 421 4852, Fax: +1 305 421 4077, E-Mail: ebabcock@rsmas.miami.edu

Cortés, Enric
Research Fishery Biologist, NOAA-Fisheries, Southeast Fisheries Science Center, Panama City Laboratory, 3500 Delwood Beach Road, Panama City, Florida
Tel: +1 850 234 6541, Fax: +1 850 235 3559, E-Mail: enric.cortes@noaa.gov

Scott, Gerald P.
SCRS Chairman, NOAA Fisheries, Southeast Fisheries Science Center Sustainable Fisheries Division, 75 Virginia Beach Drive, Miami, Florida 33149
Tel: +1 305 361 4261, Fax: +1 305 361 4219, E-Mail: gerry.scott@noaa.gov

Uruguay

Domingo, Andrés
Dirección Nacional de Recursos Acuáticos - DINARA, Sección y Recursos Pelágicos de Altura, Constituyente 1497, 11200 Montevideo
Tel: +5982 40 46 89, Fax: +5982 41 32 16, E-Mail: adomingo@dinara.gub.uy

ICCAT SECRETARIAT

C/Corazón de María, 8 (6th fl.)
28002 Madrid, Spain
Tel: +34 91 416 5600, Fax: +34 91 415 2612, E-Mail: iccat@info.int
Kell, Laurie
Restrepo, Victor

Appendix 3

LIST OF DOCUMENTS

SCRS/2009/053	Historical data and standardized catch rates of porbeagle (Lamna nasus) caught as bycatch of the Spanish surface longline fishery targeting swordfish (Xiphias gladius) in the Atlantic ocean. Mejuto, J., Ortiz, J., García-Cortés, B., Ortiz de Urbina, J. and Ramos-Cartelle, A. M.
SCRS/2009/062	A short note on the f.a.o. statistics for the porbeagle shark (Lamna nasus) in the Atlantic and its relation to other lamnid. Fernández-Costa, J. and Mejuto, J.
SCRS/2009/068	Bayesian surplus production model applied to porbeagle catch, CPUE and effort data. Babcock, B.A. and Cortes, E.
SCRS/2009/069	Standardized catch rates for porbeagle sharks from the us pelagic longline logbook program. Cortés, E.
SCRS/2009/071	A Novel Application of the Gadget Operating Model to North East Atlantic Porbeagle. S. R. McCully, F. Scott, L. T. Kell, J. R. Ellis and D. Howell
SCRS/2009/087	Estimación retrospectiva de capturas de porbeagle (Lamna nasus) en la pesquería española de palangre de superficie de pez espada en el Atlántico norte. Mejuto, J., García-Cortés, B., and Ramos-Cartelle, A. M.
SCRS/2009/089	Análisis de la información de Lamna nasus obtenida por el programa de observadores de Uruguay en el Atlántico sudoccidental . Forselledo, R., Pons, M. and Domingo, A.
SCRS/2009/090	Population structure of Porbeagle (Lamna nasus) in the Atlantic Ocean as inferred from mitochondrial DNA control region sequences. Kitamura, T.
SCRS/2009/091	CPUE trend for porbeagle caught by the Japanese tuna longline in the SBT fishery ground during 1992-2007. Matsunaga, H.
SCRS/2009/092	National Report EC-Spain, Atlantic Lamna nasus, ICES+ICCAT meeting 2009. Mejuto, J., Punzón, A. and González, F.
SCRS/2009/093	Standardized CPUE of porbeagle shark (Lamna nasus) caught by Uruguayan pelagic longline fleet (1982-2008). Pons, M. and Domingo, A.
SCRS/2009/094	Habitat Utilization and Movement Patterns of Porbeagle Sharks (Lamna nasus) in the Western North Atlantic. Skomal, G., Marshall, H., Chisholm, J., Natanson, L. and Bernal, D.
SCRS/2009/095	Population dynamics of porbeagle in the northwest Atlantic, with an assessment of status to 2009 and projections for recovery. Campana, S.E., Jamie, A., Gibson, F., Fowler, M., Dorey, A. and Joyce, W.
SCRS/2009/188	Data On French Targeted Porbeagle (Lamna Nasus) Fishery In The Northeast Atlantic Ocean: Captures And Biological Parameters. Jung, A., Lorrain,A., Cherel,Y., Priac,A., Baillon ,S. and Campana, S.

Table 1. Summary of porbeagle biological parameters, adapted from Francis et al (2008).[a]

	Southern hemisphere stock(s)[b]		*NW Atlantic*		*NE Atlantic*	
Parameter	*Value*	*Source*	*Value*	*Source*	*Value*	*Source*
Length–weight relationship (kg, cm)	F+M: $W=8.91\times10^{-6}\,FL^{3.128}$ (juveniles < 150 cm)	1	F+M: $W=5\times10^{-5}\,FL^{2.713}$ F+M: $W = 1.4823\times10^{-5}\,FL^{2.9641}$	4 18	F+M: $W= 1.292\times10^{-4}\,TL^{2.4644}$ F: $W= 3\times10^{-5}\,FL^{2.8164}$ M: $W=5\times10^{-5}\,FL^{2.7290}$	15 14 14
Length at birth (cm)	58–67 FL	1, 2	60–75 FL	16, 17	Similar to NW Atlantic?	
Length at maturity (cm)	F: 170–180 FL M: 140–150 FL	3	F: 210–230 FL; 50% 218 FL M: 162–185 FL; 50% 174 FL	6 6	F: 200-250 FL M: 150-200 FL	12 12
Growth	NZ: FL=66.5+19.8 Age Aust: FL=65.4+16.1 Age (juveniles < 150 cm)	1	F+M: $FL=289.4(1-e^{-0.066\,(t+6.06)})$ F: $FL=309.8(1-e^{-0.060\,(t+5.90)})$ M: $FL=257.7(1-e^{-0.080\,(t+5.78)})$	7	F+M: $FL=276.6(1-e^{-0.045\,(t+8.03)})$	13
Median age at maturity (yr)	F: ? M: ?		F: 13 M: 8	6, 7 6, 7	Similar to NW Atlantic?	
Age at recruitment (yr)	0–1	1	0–1	8	0-1?	
Maximum length (cm)	F: 214FL M: 204 FL	1, 2, 11	F: 317 FL; M: 262 FL	9	F: 278 FL; M: 253 FL	5
Longevity (yr)	> 60[19]		> 26	10	>23	13
Natural mortality (yr^{-1})	?		0.10–0.20	4, 8	?	
Gestation period (months)	8–9	1, 2	8–9	6	8-9?	12
Reproductive cycle (yr)	≥ 1	1	1	6	1?	
Mean litter size	3.75	1, 2	3.7–4.0 (3.9)	6	3.7	5
Annual fecundity	≤ 3.75	1, 2	3.7–4.0 (3.9)	6	~3.7	5
Embryonic sex ratio	1:1	1, 2	1:1	6	1:1 ?	

[a]?, unknown; FL, fork length; TL, total length; PL, precaudal length; W, weight; M, males; F, females.
Sources: 1, Francis and Stevens (2000); 2, M. P. Francis, unpubl. data; 3, Francis and Duffy (in press); 4, Campana *et al.* (1999); 5, Gauld (1989); 6, Jensen *et al.* (2002); 7, Natanson *et al.* (2002); 8, Campana *et al.* (2001); 9, S. E. Campana, unpubl. data; 10, Campana *et al.* (2002a); 11,Forselledo *et al*, (XXXX); 12, Aasen (1961); 13 This report; 14, Jung (2008); 15, Ellis and Shackley (1995); 16, Aasen (1963); 17, Compagno (1984); 18, Kohler *et al*. (1995); 19 Francis *et al.* (2007)

[b] All values for the South Atlantic are currently unknown, but are probably closer to the South Pacific values than to those of the North Atlantic

Table 2. Estimated catches (t) of porbeagle (*Lamna nasus*) by major area, gear and flag (as of Jun 12, 2009 at 9:25am).

Year	TOTAL (Landings+Discards)				Landings			Discards		Landings																												Discards		
	ALL	ATN	ATS	MED	ATN	ATS	MED	ATN	ATS	ATN															ATS											MED		ATN		ATS
					All gears	All gears	All gears	All gears	All gears	Canada	EC.Denmark	EC.España	EC.France	EC.Germany	EC.Ireland	EC.Netherlands	EC.Portugal	EC.Sweden	EC.United Kingdom	Faroe Islands	Iceland	Japan	Norway	U.S.A.	Benin	Chile	EC.Bulgaria	EC.España	EC.Netherlands	EC.Poland	EC.Portugal	Falklands	Japan	Seychelles	Uruguay	EC.Italy	EC.Malta	EC.Ireland	U.S.A.	Uruguay
1961	1924	1924			1924															1			1824																	
1962	3016	3016			316															8			2216																	
1963	6563	6563			6563															8			5763																	
1964	9274	9274			9274															1214			86																	
1965	5151	5151			5151					28										178			445																	
1966	2114	2114			2114															741			1373																	
1967	589	589			589															589																				
1968	931	931			931															662			269																	
1969	865	865			865															865																				
1970	205	205			25															25																				
1971	777	777			777								546							231																				
1972	1262	1262			1262								915							26			87																	
1973	1222	1222			1222						158		538	4					21	269	2		23																	
1974	726	726			726						17		373	3					13		2		165																	
1975	1184	1184			1184						265		514	3				1	13	8	4		34																	
1976	1483	1483			1483						233		661						2	37	3		259																	
1977	1118	1118			1118						289		454							295	3		77																	
1978	3231	3231			3231					1	112	287	834							121			76																	
1979	1572	1572			1572					2	72		192					1		299	1		15																	
1980	1594	1594			1594					1	176		896					8	3	425	1		84																	
1981	1370	1370			137						158		768					5	2	344			93																	
1982	584	584			585					1	84		199					6	1	259	1		33	1																
1983	1141	1141			1141					9	45		791					5	2	256			33																	
1984	706	706			76					2	38		411					9	5	126	1		96	0																
1985	664	664			664					26	72		254					1	12	21			8	0																

1986	706	706			76					24	114		26					8	6	27			24	0																
1987	813	813			813					59	56		28				3	5	3	381			25	1																
1988	957	955	1		955	1				83	33		446				3	3	3	373			11	0				0					1							
1989	971	971	0		972	0				73	33		341				2	3	15	477			25	2						0										
1990	1282	1282			1282					78	46		551				2	2	9	55			43	2																
1991	1944	1943	0		1943	0				329	85		3				1	2		1189			32	5			0													
1992	2588	2588	1		2586	1		2		813	8		496				0	4		1149	1		41	1						1									2	
1993	1889	1888	1		1888	1				919	91		633					3		165	3		24	5						0		1	1							
1994	2676	2674	2	0	2673	2	0	1		1575	93		82					2		48	4		24	16		1		0		1			0				0		1	
1995	2121	2118	3	0	2118	3	0			1353	86		565					2	0	44	6		26	35				0				0	0		3		0			
1996	1518	1514	3	1	1514	3	1			16	72		267					1		8	6	5	28	78				0				0	3				1			
1997	1859	1833	26	0	1833	26	0			1334	69	25	315					1		9	3	4	17	56	4	0		2				0	14		5		0			
1998	1469	1451	17	1	146	16	1		1	17	85	25	219					1	1	7	4		27	13	0			2				1	1	1	13		1			1
1999	1403	1393	10	0	1392	9	0	1	1	965	17	18	240	0	7		0	1	6	1	2		32	3	5			2				0	1		2		0	1		1
2000	1468	1456	11	1	1456	11	1			92	73	13	41	17	1		7	1	8		2		22	2				7				1			4		1			
2001	999	998	1	2	998	1	2			499	76	24	361	1	6		4	1	12		3		11	1				1				0					2			
2002	848	838	2	0	838	2	0			237	42	54	461	3	3		1		1		2		14	1				2				0			8		0			
2003	637	593	44	0	593	44	0			142		27	34				11				1		19	1				9							34		0			
2004	727	707	17	3	77	17	3			232		12	413				5				1			1				4			4				8	2	0			
2005	571	539	4	2	539	4	2			22		14	276				14		24		0		8	0				0			2				28	1	1			
2006	504	466	37	1	466	37	1			192		34	194				6		11		1		27	0				3							34	1				
2007	490	482	9	0	482	9	0			93		8	354			0	0		26		1			0				5	0						3		0			

Table 3. Estimates of potential porbeagle catch for non-reporting longline fleets operating in the NW stock areas based on catch-ratios.

Year	Belize	China P.R.	Chinese Taipei	Cuba	EC.Portugal	Japan	Korea Rep.	Venezuela	Barbados	Cambodia	Libya	NEI (ETRO)	NEI (Flag related)	Norway	Panama	Philippines	Seychelles	Sierra Leone	St. Vincent and Grenadines	Trinidad and Tobago	U.S.S.R.	UK.Bermuda	Grand Total
1962						0.5																	0.5
1963						29.9																	29.9
1964						28.0								0.4									28.4
1965						57.0								0.0									57.1
1966						36.0								0.1									36.1
1967						20.8																	20.8
1968			0.5	0.1		15.8																	16.4
1969			8.6	0.6		15.1																	24.3
1970			7.1	0.0		39.6																	46.8
1971			9.2	0.1		101.3															0.0		110.6
1972			28.0	0.4		16.3	1.4								0.0						0.0		46.1
1973			40.6	0.1		50.3	1.0								0.5						0.0		92.5
1974			36.2	0.1		51.3	0.6								0.1								88.3
1975			39.7	0.2		17.9	5.6								0.4						0.0		63.8
1976			62.8	0.3		82.1	20.3								8.9								174.4
1977			61.9	0.0		78.6	39.7								3.9								184.2
1978			54.4	0.0		59.8	14.1								6.0								134.4
1979			49.2	0.1		95.6	23.5								2.8								171.3
1980			29.8	0.0		121.8	1.3								1.1								154.0
1981			20.5	0.0		145.7	0.5								0.8								167.5
1982			32.6	0.1		44.1	0.8					0.1											77.6
1983			38.2	0.4		61.7	0.6					0.0	2.7										103.5

1984			66.1	0.2		50.2	0.2	0.1					2.7							0.1			119.6
1985			57.1	0.4		61.4	0.2						1.9										121.1
1986			95.6	0.8		64.5	2.4						5.9		18.3								187.4
1987			40.7	0.1		74.4		7.4					3.9										126.5
1988			6.9	0.0		71.4		10.6				0.3	0.4										89.5
1989			3.2			49.1		13.1															65.4
1990			0.3			54.9		2.5															57.6
1991						42.5		0.9															43.4
1992			0.0			46.8		1.9			0.8		0.0										49.5
1993		0.0	3.9			28.7		1.8			0.3		0.1										34.7
1994		0.1	9.9			27.0		4.2			0.1	0.0	0.4										41.6
1995		0.0	12.1			10.8		1.4			0.0		0.4										24.7
1996		0.1	26.9			9.9		6.7			0.6	0.2	1.8										46.1
1997			17.9			9.1		2.4	0.1		0.2	0.1	1.6										31.4
1998			13.4		0.7	19.5		8.5	0.3		0.2		5.7			0.0							48.3
1999			27.3		0.7	34.9		9.1	0.8	0.0	0.9	0.2	8.5			0.0						0.1	82.4
2000			19.1		0.0	22.9		5.6	0.2		0.2	0.1	2.8			0.4	0.0	0.0	3.7			0.1	55.3
2001			17.9			27.2		2.2	0.4		0.0	0.3	1.9			0.2		0.0	3.1			0.1	53.3
2002			22.5			21.1		0.2	0.1		0.4	0.0	0.0						0.8				45.7
2003			11.6		0.0	7.3		0.1	0.1		0.2	0.0	0.0										19.3
2004			7.7	0.7		19.6			0.1			0.0											29.3
2005			6.8	1.0		27.3		0.0	0.1			0.0							0.0				36.1
2006			4.7	0.8	0.0	18.3			0.4		0.1	0.0											24.3
2007	0.1		2.6		0.1	5.2			0.1										1.6			0.1	9.8

Table 4. Estimates of potential porbeagle catch for non-reporting longline fleets operating in the SW stock areas based on catch-ratios.

Year	Argentina	Barbados	Belize	Brasil	Cambodia	China P.R.	Chinese Taipei	Cuba	EC.España	EC.Portugal	Japan	Korea Rep.	Libya	NEI (ETRO)	NEI (Flag related)	Panama	Philippines	Russian Federation	Seychelles	St. Vincent and	Trinidad and Tobago	U.S.A.	U.S.S.R.	Venezuela	Grand Total
1956											0.8														0.8
1957											1.0														1.0
1958				7.4							0.4														7.8
1959	14.3			25.3							2.4														42.0
1960	18.5			20.1							13.5														52.1
1961	26.8			21.8							4.2														52.8
1962	53.0			7.7							21.3														82.0
1963	109.4			11.1				0.0			33.6														154.2
1964	85.8			7.8				0.0			68.6	0.0													162.2
1965	73.7			3.8			0.0	0.0			68.4	0.0													146.1
1966	11.1			2.8			0.0	0.0			22.6	0.5													37.1
1967	8.3			3.9			0.1				14.4	1.3													28.0
1968	18.0			4.3			2.8	0.5			23.1	15.0											0.0		63.8
1969	10.3			3.0			30.9	1.8			329.5	16.1											0.0		391.6
1970	8.6			4.6			142.1	0.1			295.6	11.5											0.0		462.5
1971	5.9			2.9			59.6	0.1			24.7	11.1											0.0		104.3
1972	22.9			2.2			37.4	0.1			81.0	27.5				0.4							0.0		171.5
1973	19.7			3.0			40.5	0.2			2.6	28.1				12.6							0.0		106.7
1974	9.9			7.9			59.6	0.6			0.0	31.9				6.5							0.0		116.5
1975	20.2			8.5			26.2	0.2			0.2	24.3				2.5							0.0		82.2
1976	25.5			7.0			32.6	0.4				20.0				5.2									90.8
1977	24.2			15.1			33.0	0.1			0.1	54.8				2.0							0.0		129.2
1978	2.5			67.9			57.8	0.1			1.1	14.9				2.1							0.0		146.4
1979				74.4			73.8	0.2			0.1	13.2				1.5									163.2
1980	0.3			58.6			56.9	0.3			17.5	16.0				3.9									153.5

1981	0.6			103.2			52.2	0.3			57.2	14.0				1.8							0.0		246.8
1982				97.8			50.5	1.1			8.9	11.5				3.6								0.3	266.7
1983				85.4			34.9	1.3			1.0	10.9			1.0	4.7					0.1			1.2	289.1
1984				56.1			19.9	0.5			0.1	9.8			0.5	4.9					0.0			0.8	304.1
1985				50.4			26.7	2.1			35.3	12.4			0.7	15.3					0.0			1.0	319.7
1986				141.0			59.9	0.3			121.9	5.7			1.6	12.5								0.6	420.3
1987				94.7			72.1	1.1	0.8		91.7	5.3			9.3									0.1	348.0
1988				95.8			84.9	0.2			117.6	6.3			22.6	0.8					0.0			0.4	381.9
1989				101.5			108.2	0.2			15.2	19.0		13.9	35.6	7.1					0.0			0.3	341.1
1990				95.5			142.3	1.1	0.7		37.2	3.3		1.9	11.1	8.0									328.0
1991				81.0			72.6	0.0	12.9		47.7	2.8		0.1	7.8	13.6									256.1
1992				128.0			191.9	0.2	12.0		11.5	1.5	0.1	0.1	13.6	1.6									384.5
1993				59.6		0.1	85.0		32.5		12.6	0.5	0.2	0.4	9.5	5.6									212.7
1994				32.4		0.6	145.9		34.9		13.7	2.2	0.1	0.7	21.5	24.2									281.4
1995		0.1		48.8		0.3	56.7		42.8		5.6	0.9	0.0	0.4	7.5	4.0									180.1
1996		0.0		32.8		0.0	167.6		27.8		5.9	6.4	0.1	1.0	44.9	20.9									326.5
1997		0.2		36.0		0.0	64.9	0.0	24.5	0.5	4.0	1.2	0.0	0.6	22.4	2.6									174.6
1998		0.4		37.5		0.0	170.2		11.0		0.7		0.0	1.1	35.5		0.2								279.0
1999		0.1		58.0	0.0	12.7	72.9		12.3		1.2		0.0	0.4	10.3	0.1	0.1								183.6
2000		0.4		60.1		35.6	83.7		19.8	0.0	6.7		0.1	0.4	14.9	1.0	0.3		0.1			0.6			240.2
2001		0.1		66.6		3.8	28.9		13.3	0.6	4.5		0.1	0.1	3.0		0.1					0.6			141.8
2002		0.6		73.7		0.0	92.7		12.5	0.5	3.4		0.1	0.0	1.1		0.2		0.0			0.4			204.7
2003		0.3		49.4		5.4	94.6		13.9	1.0	2.3		0.1	0.0	0.5		0.2								188.5
2004		0.1		36.9		3.8	39.4		17.8	0.7	11.0			0.0			1.0								138.3
2005		0.1	0.0	52.3		1.6	43.2		20.6	0.6	2.8	0.0		0.0			3.0	0.0							153.9
2006		0.2		31.9		1.9	46.8		13.4	1.2	3.4		0.0	0.0			0.5			0.0					118.5
2007		0.1	0.7	22.6		6.4	98.5		17.3	1.7	3.6	3.0								0.3					164.6

Table 5. Estimated harvest levels of northeastern Atlantic porbeagle by flag adopted by the Working Group for the assessment.

Year	EC.Denmark	EC.España	Norway	EC.France	EC.Germany	EC.Ireland	EC.Netherlands	EC.Portugal	EC.Sweden	EC.United Kingdom	Iceland	Japan	Norway	Faroes	U.S.A.	EC.Italy	EC.Malta	Total
1925																		0.0
1926			279.0										279.0					279.0
1927			457.0										457.0					457.0
1928			611.0										611.0					611.0
1929			832.0										832.0					832.0
1930			1,505.0										1,505.0					1,505.0
1931			1,106.0										1,106.0					1,106.0
1932			1,603.0										1,603.0					1,603.0
1933			3,884.0										3,884.0					3,884.0
1934			3,626.0										3,626.0					3,626.0
1935			1,993.0										1,993.0					1,993.0
1936			2,459.0										2,459.0					2,459.0
1937			2,805.0										2,805.0					2,805.0
1938			2,733.0										2,733.0					2,733.0
1939			2,213.0										2,213.0					2,213.0
1940			104.0										104.0					104.0
1941			283.0										283.0					283.0
1942			288.0										288.0					288.0
1943			351.0										351.0					351.0
1944			321.0										321.0					321.0
1945			927.0										927.0					927.0
1946			1,088.0										1,088.0					1,088.0
1947			2,824.0										2,824.0					2,824.0
1948			1,914.0										1,914.0					1,914.0
1949			1,251.0										1,251.0					1,251.0
1950	1,900.0	4.5	1,358.0										1,358.0					3,262.5
1951	1,600.0	3.0	778.0										778.0					2,381.0
1952	1,600.0	3.0	606.0										606.0					2,209.0

1953	1,100.0	3.7	712.0							712.0	100.0		1,915.7
1954	700.0	1.0	594.0							594.0	300.0		1,595.0
1955	600.0	1.9	897.0							897.0	100.0		1,598.9
1956	400.0	1.2	871.0							871.0			1,272.2
1957	600.0	3.1	1,097.0							1,097.0	100.0		1,800.1
1958	900.0	2.6	1,080.0					7.0		1,080.0	300.0		2,289.6
1959	600.0	3.4	1,183.0					9.0		1,183.0	600.0		2,395.4
1960	400.0	2.2	1,929.0					10.0		1,929.0	500.0		2,841.2
1961	600.0	5.3	2,145.0					9.0		1,053.0			1,667.3
1962	400.0	7.2	1,771.0					20.0		444.0			871.2
1963	200.0	3.1	4,554.0					17.0		121.0			341.1
1964	300.0	5.6	5,594.0					5.0		89.0			399.6
1965	200.0	4.5	2,329.0					8.0		204.0			416.5
1966	200.0	9.3	576.0					6.0		218.0			433.3
1967	200.0	8.4	305.0					7.0		305.0			520.4
1968	100.0	11.0	881.0					7.0		612.0			730.0
1969	100.0	10.9	909.0					3.0		909.0			1,022.9
1970	200.0	9.8	269.0					5.0		269.0			483.8
1971	400.0	10.5	211.0	546.0				7.0		211.0			1,174.5
1972	500.0	10.0	293.0	915.0				15.0	6.0	206.0			1,652.0
1973	158.0	11.9	230.0	538.0	4.0			21.0	2.0	230.0			964.9
1974	170.0	9.0	165.0	373.0	3.0			13.0	2.0	165.0			735.0
1975	265.0	11.7	304.0	514.0	3.0		1.0	13.0	4.0	304.0			1,115.7
1976	233.0	8.8	259.0	661.0			3.0	20.0	3.0	259.0			1,187.8
1977	289.0	10.3	77.0	454.0					3.0	77.0			833.3
1978	112.0	11.3	76.0	834.0						76.0			1,033.3
1979	72.0	8.0	106.0	1,092.0			5.0	1.0	1.0	106.0			1,285.0
1980	176.0	11.8	84.0	896.0			8.0	3.0	1.0	84.0			1,179.8
1981	158.0	12.5	93.0	768.0			5.0	2.0	1.0	93.0			1,039.5
1982	84.0	14.2	33.0	199.0			6.0	1.0	1.0	33.0			338.2
1983	45.0	28.0	33.0	791.0			5.0	2.0	1.0	33.0			905.0
1984	38.0	20.0	97.0	411.0			9.0	5.0	1.0	80.0			564.0
1985	72.0	23.1	80.0	254.0			10.0	12.0	1.0	80.0			452.1
1986	114.0	25.5	24.0	260.0			8.0	6.0	1.0	24.0			438.5
1987	56.0	30.0	25.0	280.0		3.0	5.0	3.0	1.0	25.0		0.0	403.0
1988	33.0	60.9	12.0	446.0		3.0	3.0	3.0	1.0	12.0			561.9

1989	33.0	40.0	27.0	341.0				1.6	3.0	15.0	1.0		27.0					461.6
1990	46.0	25.9	45.0	551.0				2.0	1.7	8.7			45.0					680.3
1991	85.0	46.5	35.0	300.0				1.1	2.4				35.0					470.0
1992	80.0	15.0	43.0	496.0				0.3	3.8		1.0		43.0					639.1
1993	91.3	20.5	24.0	633.0	1.0			1.0	2.5		3.0		24.0					776.3
1994	93.0	49.0	26.0	820.0				1.0	2.1		4.1		26.0	48.0			0.1	1,043.4
1995	86.0	17.4	28.0	565.0				1.0	2.2	0.1	6.0		28.0	44.0			0.2	749.9
1996	72.0	38.8	31.0	267.0				1.0	1.1		5.0	3.0	31.0	8.0			1.0	427.9
1997	69.0	23.0	19.0	315.0				1.0	1.3		2.9	2.0	19.0	9.0			0.2	442.4
1998	85.0	21.6	28.0	219.0	2.0			1.0	0.5	0.6	4.4		28.0	7.0			0.9	370.0
1999	107.0	15.0	34.0	239.7	0.3	7.9		0.1	0.8	6.2	2.3		34.0	10.0			0.3	423.5
2000	73.0	11.3	23.0	410.0	16.7	1.0		15.2	1.1	7.5	1.6		23.0	13.0			0.5	573.8
2001	76.0	23.3	17.0	361.0	1.1	6.0		4.2	0.5	11.9	2.9		17.0	8.0			1.1	513.0
2002	42.0	49.3	14.0	461.0	3.0	3.3		10.6		10.2	1.7		14.0	10.0	0.0		0.0	605.1
2003	21.0	22.3	19.0	303.1	5.0	11.0		3.9		25.0	1.2		19.0	14.0			0.1	425.6
2004	20.0	8.8	24.4	412.8	6.8	18.2		57.0	4.7	24.0	1.2		24.4	5.0		2.4	0.5	585.9
2005	4.0	10.5	11.0	276.3	4.5	3.1		10.3	0.1	24.4	0.3		11.0	19.0		1.1	0.6	365.2
2006	3.0	25.6	27.4	194.2	0.4	3.7		6.4	0.0	11.4	0.8		27.4	21.0		0.7		294.6
2007	2.0	6.3	9.8	353.9		7.8	0.1	1.6	0.8	26.0	0.1		9.8				0.5	408.8
2008	1.0	31.6		221.0		7.0		0.9	0.3	13.0	0.2		12.0					287.0

Table 6. Estimated harvest levels of northwestern Atlantic porbeagle by flag. The column labeled SCRS/2009/05 represents the catch compilation used in the assessment presented in that document and the %Diff column represents the percentage difference between the estimates compiled at this meeting and SCRS/2009/095.

Year	Faroe Islands	Canada	EC.España	EC.Portugal	Japan	St.Pierre et Miquelon	Norway	U.S.A.	Non-reporting LL	NWToT	SCRS/09/95	% Diff
1961	100.0						1,824.0			1,924.0	1,924.0	0.0%
1962	800.0						2,216.0			3,016.0	3,016.0	0.0%
1963	800.0						5,763.0		0.5	6,563.5	6,563.0	0.0%
1964	1,214.0						8,060.0		29.9	9,303.9	9,281.0	0.2%
1965	1,078.0	28.0					4,045.0		28.4	5,179.4	5,151.0	0.5%
1966	741.0						1,373.0		57.1	2,171.1	2,114.0	2.6%
1967	589.0								36.1	625.1	625.0	0.0%
1968	662.0						269.0		20.8	951.8	1,068.0	-12.2%
1969	865.0								16.4	881.4	1,073.0	-21.7%
1970	205.0								24.3	229.3	879.0	-283.3%
1971	231.0								46.8	277.8	452.0	-62.7%
1972	260.0						87.0		110.6	457.6	347.0	24.2%
1973	269.0								46.1	315.1	269.0	14.6%
1974									92.5	92.5	0.0	100.0%
1975	80.0								88.3	168.3	80.0	52.5%
1976	307.0								63.8	370.8	307.0	17.2%
1977	295.0								174.4	469.4	295.0	37.2%
1978	121.0	1.0							184.2	306.2	122.0	60.2%
1979	299.0	2.0							134.4	435.4	301.0	30.9%
1980	425.0	1.0							171.3	597.3	426.0	28.7%
1981	344.0								154.0	498.0	347.0	30.3%
1982	259.0	1.0						0.1	167.5	427.6	261.0	39.0%
1983	256.0	9.0						0.0	77.6	342.6	265.0	22.6%
1984	126.0	20.0					96.0	0.2	103.5	345.7	164.0	52.6%
1985	210.0	26.0						0.3	119.6	355.9	236.0	33.7%

1986	270.0	24.0						0.2	121.1	415.3	300.0	27.8%
1987	381.0	59.0						1.5	187.4	628.9	468.0	25.6%
1988	373.0	83.0	7.6					0.4	126.5	590.5	500.0	15.3%
1989	477.0	73.0	1.5					2.5	89.5	643.4	566.0	12.0%
1990	550.0	78.0	0.4					2.0	65.4	695.8	664.0	4.6%
1991	1,189.0	329.0	0.4					4.8	57.6	1,580.9	1,566.9	0.9%
1992	1,149.0	813.0	0.0					3.6	43.4	2,008.9	1,991.0	0.9%
1993	165.0	919.0	0.5					51.1	49.5	1,185.1	1,432.0	-20.8%
1994	48.0	1,575.0	3.4					107.5	34.7	1,768.6	1,578.0	10.8%
1995	44.0	1,353.2	1.2			7.0		35.3	41.6	1,482.3	1,364.0	8.0%
1996	8.0	1,050.5	2.4		2.0	40.0		77.7	24.7	1,203.3	1,100.0	8.6%
1997	9.0	1,334.1	2.2		2.0	13.0		55.8	46.1	1,460.3	1,336.7	8.5%
1998	7.0	1,070.1	3.1			20.0		12.5	31.4	1,144.2	1,095.1	4.3%
1999	10.0	965.3	3.2					3.2	48.3	1,030.0	966.8	6.1%
2000		902.3	1.9			13.0		1.1	82.4	1,000.7	940.7	6.0%
2001		498.6	0.8			2.0		0.9	55.3	557.6	528.4	5.2%
2002		236.6	5.1			1.0		0.9	53.3	296.9	235.6	20.6%
2003		142.4	4.2			2.0		0.0	45.7	194.3	142.9	26.4%
2004		231.5	2.3			4.0		0.6	19.3	257.8	228.5	11.4%
2005		202.2	3.5	0.5				0.0	29.3	235.4	210.4	10.6%
2006		192.2	7.9	0.0				0.4	36.1	236.7	198.8	16.0%
2007		93.4	1.7					0.1	24.3	119.4	99.0	17.1%
2008		125.0	9.5					0.0	9.8	144.3	162.0	-12.3%

Table 7. BSP model definitions, and posterior expected values and CVs of the estimated parameters for northwest Atlantic.

(a) Run definitions

Run	a3	a4	a402	a401	a403	NW1	NW2
Current year	2005	2005	2005	2005	2005	2009	2009
Last year of data	2004	2004	2002	2000	1998	2008	2008
Weighting of CPUEs	Catch	Equal	Equal	Equal	Equal	Equal	Equal

(b) Runs ending in 2005

	Catch weighted		Equal weight, data to 2004		Equal weight, to 2002		Equal weight, to 2000		Equal weight, to 1998	
Run	a3		a4		a401		a402		a403	
Parameter	EV	CV	EV	CV	EV	CV	EV	CV	EV	CV
K	69858	0.22	51149	0.17	47107	0.13	50985	0.20	58829	0.25
r	0.05	0.10	0.05	0.10	0.05	0.10	0.05	0.10	0.05	0.10
Binit	61252	0.24	44184	0.17	40463	0.10	44059	0.20	51092	0.26
MSY	844.96	0.23	615.82	0.18	567.15	0.15	614.08	0.21	709.55	0.26
repY	742.4	0.19	493	0.27	359	0.31	458.47	0.37	590.52	0.35
Bmsy	34929	0.22	25575	0.17	23554	0.13	25492	0.20	29414	0.25
Bcur	42205	0.42	16969	0.60	10154	0.56	16254	0.77	27209	0.68
Bcur/K	0.58	0.26	0.32	0.40	0.21	0.43	0.3	0.52	0.42	0.46
Bcur/Bmsy	1.16	0.26	0.64	0.40	0.42	0.43	0.6	0.52	0.85	0.46
Bcur/Binit	0.66	0.25	0.37	0.38	0.24	0.40	0.34	0.50	0.48	0.45
Ccur/MSY	0.27	0.24	0.36	0.15	0.39	0.13	0.37	0.17	0.33	0.23
Ccur/repY	0.31	0.25	0.47	0.27	0.67	0.30	0.55	0.42	0.45	0.66
Fcur/Fmsy	0.28	0.64	0.67	0.41	1.07	0.39	0.83	0.60	0.59	1.13

(c) Runs ending in 2009

	ICCAT catches		Catches est. from ratios	
Run	NW1		NW2	
Parameter	EV	CV	EV	CV
K	47650	0.13	50808	0.13
r	0.05	0.10	0.05	0.11
Binit	41198	0.11	43929	0.11
MSY	577.01	0.14	612.69	0.14
repY	476.41	0.20	504.64	0.21
Bmsy	23825	0.13	25404	0.13
Bcur	15608	0.40	16631	0.41
Bcur/K	0.32	0.30	0.32	0.31
Bcur/Bmsy	0.65	0.30	0.65	0.31
Bcur/Binit	0.37	0.27	0.37	0.28
Ccur/MSY	0.02	0.13	0.02	0.13
Ccur/repY	0.02	0.20	0.02	0.21
Fcur/Fmsy	0.03	0.31	0.03	0.32

Table 8. Decision table for the BSP model fitted to the six series in the Canadian 2005 assessment for northwest Atlantic porbeagle, with each data point weighted equally. Harvest policies are harvest rates (HR) as a fraction of total biomass.

Horizon	Policy	E(Bfin/K)	E(Bfin/Bmsy)	P(Bfin<0.2K)	P(Bfin>Bmsy)	P(Bfin>Bcur)	P(Ffin<Fcur)
10 -year	HR= 0	0.42	0.85	0.01	0.25	1	1
	HR= 0.02	0.35	0.71	0.05	0.12	0.94	0.27
	HR= 0.04	0.29	0.59	0.16	0.04	0.15	0
	HR= 0.07	0.22	0.44	0.46	0	0	0
20 -year	HR= 0	0.53	1.07	0	0.55	1	1
	HR= 0.02	0.39	0.77	0.01	0.15	0.94	0.27
	HR= 0.04	0.27	0.55	0.17	0	0.15	0
	HR= 0.07	0.16	0.32	0.8	0	0	0
50 -year	HR= 0	0.82	1.63	0	1	1	1
	HR= 0.02	0.47	0.94	0	0.37	0.94	0.27
	HR= 0.04	0.24	0.48	0.26	0	0.15	0
	HR= 0.07	0.07	0.14	1	0	0	0

Table 9. BSP model definitions, and posterior expected values and CVs of the estimated parameters for southwest Atlantic.

(a) Run definitions

Run	SW1	SW2	SW3	SW4	SW5
Weighting of CPUE data	Equal	CV	CV	CV	CV
Catch data	ICCAT	ICCAT	Effort (2005-2006)	Effort (1997-2008)	Ratio
First year of fishery	1982	1982	1961	1961	1957

(b) Results

	ICCAT catch, equal wt		ICCAT catch, CV wt		Effort 2005-2006		Effort (1997-2007)		Catch from ratios	
Run	SW1		SW2		SW3		SW4		SW5	
Parameter	EV	CV	EV	CV	EV	CV	EV	CV	EV	CV
K	952.59	5.87	1296.08	5.48	24777.77	8.70	11807.19	4.96	70699.21	7.77
r	0.05	0.21	0.05	0.21	0.05	0.20	0.05	0.21	0.05	0.21
Binit	940.16	5.91	1241.01	5.52	22895.47	8.78	10919.91	5	65230.25	7.83
Cat0	0.94	1.15	1.00	1.19	NA	NA	NA	NA	NA	NA
MSY	11.36	6.02	15.45	5.62	294.51	9.00	141.21	5.09	846.87	7.99
repY	3.05	2.11	2.70	4.07	39.90	4.42	10.91	4.55	79.62	4.85
Bmsy	476.29	5.87	648.04	5.48	12388.88	8.70	5903.6	4.96	35349.61	7.77
Bcur	787.52	7.07	1112.50	6.30	21446.80	9.96	11227.68	5.17	63028.19	8.65
Bcur/K	0.39	0.51	0.27	0.89	0.28	0.73	0.36	0.79	0.18	1.12
Bcur/Bmsy	0.78	0.51	0.53	0.89	0.57	0.73	0.72	0.79	0.36	1.12
Bcur/Binit	0.40	0.50	0.28	0.89	0.31	0.73	0.4	0.8	0.2	1.12
Ccur/MSY	1.09	0.39	1.27	0.39	0.11	0.87	0.4	0.49	1.64	0.27
Ccur/repY	1.42	3.35	2.86	1.71	0.20	1.99	0.74	4.01	4.48	5.09
Fcur/Fmsy	2.07	0.88	6.31	1.45	0.31	1.48	1.17	1	10.78	1.09

Table 10. BSP model run definitions and results for the northeast Atlantic.

(a) Run definitions

Run	NE1	NE101	NE2	NE6	NE7	NE3	NE4	NE5
Start year	1926	1926	1926	1926	1926	1961	1961	1961
Mean of Bo/K	1	1	1	1	1	1	0.5	0.2
Weighting of CPUE data points	equal	equal	catch	catch	catch	catch	catch	catch
Max K	100000	10000000	100000	80000	100000	100000	100000	100000
r rprior	0.062	0.062	0.062	0.062	0.04	0.062	0.062	0.062

(b) Results for runs starting in 1926

	From 1926		From 1926, High K		From 1926 C weighted		From 1926, low K max		From 1926, lower r prior	
Run	NE1		NE101		NE2		NE6		NE7	
Parameter	EV	CV	EV	CV	EV	CV	EV	CV	EV	CV
K	65543	0.2	1.10E+08	1.87	65091	0.2	60176	0.12	73723	0.13
r	0.06	0.17	0.06	0.16	0.06	0.17	0.06	0.16	0.04	0.16
Binit	60072	0.22	9.99E+07	1.88	59574	0.22	54826	0.14	67196	0.14
MSY	976.26	0.27	1705671	1.9	969.66	0.27	878.72	0.16	708.42	0.16
repY	610.83	0.31	5798.09	3.59	585.32	0.36	549.84	0.38	486.88	0.42
Bmsy	32771	0.2	5.49E+07	1.87	32546	0.2	30088	0.12	36861	0.13
Bcur	28719	0.9	1.10E+08	1.87	27419	0.94	17789	0.88	21055	0.74
Bcur/K	0.39	0.71	0.96	0.14	0.37	0.76	0.28	0.76	0.27	0.63
Bcur/Bmsy	0.78	0.71	1.93	0.14	0.75	0.76	0.56	0.76	0.54	0.63
Bcur/Binit	0.43	0.72	1.08	0.2	0.41	0.77	0.31	0.75	0.3	0.61
Ccur/MSY	0.31	0.21	0.03	2.45	0.31	0.2	0.33	0.14	0.41	0.14
Ccur/repY	0.53	0.39	0.27	24.7	0.58	0.49	0.62	0.47	0.72	0.51
Fcur/Fmsy	0.72	0.74	0.04	4.76	0.83	0.83	0.97	0.69	1.15	0.69

(c) Results for runs starting in 1961

	From 1961, depl 1.0		From 1961, depl. 0.5		From 1961, depl. 0.2	
Run	NE3		NE4		NE5	
Parameter	EV	CV	EV	CV	EV	CV
K	38925.53	0.43	42305.11	0.28	67779.65	0.16
r	0.06	0.16	0.06	0.16	0.06	0.16
Binit	34453.98	0.47	21021.83	0.34	14917.78	0.14
MSY	592.07	0.45	629.92	0.27	990.48	0.11
repY	456.92	0.23	484.7	0.34	470.46	0.41
Bmsy	19462.77	0.43	21152.55	0.28	33889.82	0.16
Bcur	23341.01	0.82	15445.05	0.85	9942.12	0.55
Bcur/K	0.53	0.39	0.34	0.52	0.15	0.49
Bcur/Bmsy	1.05	0.39	0.67	0.52	0.29	0.49
Bcur/Binit	0.6	0.38	0.67	0.46	0.65	0.45
Ccur/MSY	0.55	0.3	0.48	0.19	0.29	0.12
Ccur/repY	0.67	0.31	0.67	0.4	0.72	0.43
Fcur/Fmsy	0.7	0.73	0.96	0.62	1.26	0.52

Table 11. Model inputs for the catch-free, age-structured production model (CFASPM) applied to the southwestern Atlantic porbeagle shark stock.

Stock	Indices	Weighting	Model time	Historic catch period	Initial depletion in hist. per.	VB growth function Females K	Linf (FL)	t0	Length-weight relationship Wa	Wb	Fecundity (pups/litter)	Reproductive frequency	Maturity ogive a50	b	Selectivity function a50	b	Maximum age (plus group)	alpha	M (1-max)
Southwest	Uruguay LL	no	1961-2008	1961-1981	0	0.061	275.2	-5.9	$5x10^{-4}$	2.713	3.9	annual	13	1.042	0.958	0.150	20	LN(2.209,0.2)[1]	LN(0.15,0.2)[1]

[1] Lognormal distribution (mean, CV)

Table 12. Stock status estimates for the southwestern Atlantic porbeagle shark obtained with the CFASPM (values in parentheses are CVs). F_{modern} refers to the fishing mortality in the first year for which data are available (1982); F_{hist} refers to the fishing mortality in the first year of the model run (1926).

Model	Starting year	Objective Function	SSB_{curr}/SSB_0	SSB_{curr}/SSB_{MSY}	F_{curr}	F_{curr}/F_{MSY}	F_{modern}	F_{hist}	F_{MSY}	SPR_{MSY}	M	alpha
SWA Stock; virgin conditions in 1982, scaling indices	1961	-17.17	0.18 (0.55)	**0.48 (0.55)**	0.056 (0.50)	**1.72 (0.51)**	0.059	0.050	0.03 (0.08)	0.58	0.203 (0.19)	2.95 (0.13)

Table 13. Model inputs for the age-structured production model (SPASM) applied to the northeastern Atlantic porbeagle shark stock.

Stock	Indices	Weighting	Model time	Historic catch period	Initial depletion in hist. per.	VB growth function Females K	Linf (FL)	t0	Length-weight relationship Wa	Wb	Fecundity (pups/litter)	Reproductive frequency	Maturity ogive a50	b	Selectivity function a50	b	Maximum age (plus group)	alpha	M (1-max)
Northeast	France LL Spain LL	no	1926-2008	1926-1971	0	0.045	276.6	-8.0	$5x10^{-4}$	2.706	3.9	annual	13	1.042	0.940	0.160	20	LN(0.75,0.25)[1]	U(10^3-10^{10})[2]

[1] Lognormal distribution (mean, CV)
[2] Uniform distribution
(min,max)

Table 14. Stock status estimates for the northeastern Atlantic porbeagle shark obtained with the ASPM.

	Initial run		50% of F		0% of F	
Benchmark	Estimate	CV	Estimate	CV	Estimate	CV
SSF_{2008}/SSF_{MSY}	0.09	0.86	0.21	0.86	0.43	0.86
F_{2008}/F_{MSY}	3.45	1.89	2.54	1.89	3.32	1.89
N_{2008}/N_{MSY}	0.11		0.24		0.46	
MSY	45,633		34,852		14,907	
SPR_{MSY}	0.65		0.71		0.73	
F_{MSY}	0.03		0.02		0.02	
SSF_{MSY}	202,150		167,220		73,912	
N_{MSY}	1,031,734		791,602		339,205	
F_{2008}	0.09		0.05		0.06	
SSF_{2008}	18,523	0.86	35,685	0.86	32,114	0.86
N_{2008}	127,367		204,180		168,624	
SSF_{2008}/SSF_0	0.04	0.86	0.09	0.86	0.18	0.86
B_{2008}/B_0	0.05	0.86	0.11	0.86	0.21	0.86
R_0	210,370	0.24	170,130	0.24	73,811	0.24
Pup-survival	0.99	0.0001	0.82	0.0001	0.77	0.0001
alpha	2.37		1.97		1.84	
steepness	0.37		0.33		0.32	

Table 15. Decision tables for northeast Atlantic porbeagle BSP models, showing (a) the expected biomass relative to Bmsy in 10, 20 or 50 years, (b) the probability that biomass is above Bmsy, (c) the Probability that biomass is above current biomass for a number of constant F and constant total catch management strategies, and (d) the number of years until the median biomass trajectory rebuilds to B_{MSY}.

(a) E(B/Bmsy)

Horizon	Policy	Model run					
		NE1	NE2	NE6	NE7	NE4	Mean
10 -year	TAC= 0	0.97	0.93	0.76	0.68	0.92	0.85
	TAC= 100	0.94	0.90	0.72	0.65	0.86	0.81
	TAC= 200	0.91	0.86	0.68	0.62	0.81	0.78
	TAC= 300	0.87	0.83	0.64	0.59	0.76	0.74
	TAC= 400	0.84	0.79	0.61	0.56	0.70	0.70
	TAC= 436	0.83	0.78	0.59	0.55	0.68	0.69
	TAC= 500	0.80	0.76	0.57	0.53	0.65	0.66
	HRmsy* 0.25	0.91	0.88	0.71	0.64	0.87	0.80
	HRmsy* 0.5	0.85	0.82	0.67	0.61	0.82	0.75
	HRmsy* 0.75	0.79	0.77	0.63	0.58	0.77	0.71
	HRmsy* 1	0.73	0.73	0.59	0.55	0.73	0.67
20 -year	TAC= 0	1.18	1.14	0.98	0.83	1.18	1.06
	TAC= 100	1.11	1.06	0.91	0.76	1.07	0.98
	TAC= 200	1.04	0.99	0.82	0.70	0.96	0.90
	TAC= 300	0.97	0.92	0.74	0.64	0.85	0.82
	TAC= 400	0.90	0.84	0.66	0.57	0.73	0.74

	TAC= 436	0.87	0.82	0.63	0.55	0.69	0.71
	TAC= 500	0.83	0.77	0.58	0.51	0.62	0.66
	HRmsy* 0.25	1.05	1.02	0.88	0.76	1.07	0.96
	HRmsy* 0.5	0.93	0.92	0.79	0.69	0.97	0.86
	HRmsy* 0.75	0.82	0.83	0.71	0.63	0.87	0.77
	HRmsy* 1	0.72	0.74	0.63	0.57	0.79	0.69
50 -year	TAC= 0	1.72	1.68	1.62	1.31	1.75	1.62
	TAC= 100	1.60	1.55	1.47	1.15	1.59	1.47
	TAC= 200	1.46	1.39	1.28	0.98	1.38	1.30
	TAC= 300	1.28	1.20	1.07	0.80	1.11	1.09
	TAC= 400	1.09	1.01	0.84	0.64	0.83	0.88
	TAC= 436	1.02	0.95	0.77	0.59	0.74	0.81
	TAC= 500	0.91	0.85	0.66	0.51	0.59	0.70
	HRmsy* 0.25	1.44	1.44	1.37	1.11	1.53	1.38
	HRmsy* 0.5	1.18	1.21	1.15	0.93	1.31	1.16
	HRmsy* 0.75	0.96	1.01	0.94	0.77	1.11	0.96
	HRmsy* 1	0.76	0.83	0.77	0.64	0.93	0.79

(b) P (B>Bmsy)

Horizon	Policy						
		NE1	NE2	NE6	NE7	NE4	Mean
10 -year	TAC= 0	0.37	0.36	0.23	0.20	0.36	0.30
	TAC= 100	0.36	0.35	0.22	0.19	0.32	0.29
	TAC= 200	0.35	0.34	0.21	0.18	0.27	0.27
	TAC= 300	0.35	0.33	0.20	0.17	0.24	0.26
	TAC= 400	0.34	0.33	0.19	0.16	0.21	0.25
	TAC= 436	0.34	0.33	0.19	0.16	0.20	0.24
	TAC= 500	0.33	0.32	0.18	0.15	0.19	0.23
	HRmsy* 0.25	0.35	0.34	0.21	0.18	0.31	0.28
	HRmsy* 0.5	0.33	0.33	0.19	0.16	0.26	0.25
	HRmsy* 0.75	0.31	0.31	0.17	0.14	0.22	0.23
	HRmsy* 1	0.30	0.30	0.16	0.12	0.18	0.21
20 -year	TAC= 0	0.53	0.50	0.39	0.30	0.67	0.48
	TAC= 100	0.48	0.46	0.33	0.26	0.54	0.41
	TAC= 200	0.44	0.42	0.30	0.24	0.44	0.37
	TAC= 300	0.40	0.39	0.27	0.22	0.35	0.33
	TAC= 400	0.38	0.36	0.23	0.19	0.27	0.29
	TAC= 436	0.37	0.36	0.23	0.19	0.25	0.28
	TAC= 500	0.36	0.34	0.21	0.17	0.22	0.26
	HRmsy* 0.25	0.44	0.44	0.31	0.24	0.55	0.40
	HRmsy* 0.5	0.38	0.37	0.25	0.20	0.44	0.33
	HRmsy* 0.75	0.33	0.33	0.20	0.16	0.32	0.27
	HRmsy* 1	0.28	0.29	0.15	0.11	0.22	0.21
50 -year	TAC= 0	0.99	0.98	0.98	0.78	1.00	0.95
	TAC= 100	0.96	0.92	0.89	0.62	0.97	0.87

	TAC= 200	0.87	0.80	0.77	0.48	0.85	0.75
	TAC= 300	0.72	0.66	0.58	0.37	0.65	0.60
	TAC= 400	0.58	0.54	0.44	0.30	0.46	0.46
	TAC= 436	0.54	0.50	0.40	0.27	0.39	0.42
	TAC= 500	0.47	0.45	0.33	0.23	0.30	0.36
	HRmsy* 0.25	0.95	0.92	0.89	0.60	0.98	0.87
	HRmsy* 0.5	0.74	0.75	0.71	0.40	0.92	0.70
	HRmsy* 0.75	0.44	0.52	0.42	0.23	0.71	0.46
	HRmsy* 1	0.19	0.30	0.18	0.09	0.40	0.23

(c) P (B>Bcur)

		P (B>Bcur)					
Horizon	Policy						
		NE1	NE2	NE6	NE7	NE4	Mean
10 -year	TAC= 0	1.00	1.00	1.00	1.00	1.00	1.00
	TAC= 100	1.00	1.00	1.00	1.00	1.00	1.00
	TAC= 200	1.00	0.99	0.98	0.95	0.98	0.98
	TAC= 300	0.96	0.91	0.89	0.80	0.88	0.89
	TAC= 400	0.84	0.77	0.73	0.59	0.67	0.72
	TAC= 436	0.78	0.71	0.66	0.52	0.58	0.65
	TAC= 500	0.68	0.62	0.53	0.42	0.44	0.54
	HRmsy* 0.25	0.97	0.99	1.00	1.00	1.00	0.99
	HRmsy* 0.5	0.76	0.80	0.95	1.00	0.97	0.90
	HRmsy* 0.75	0.70	0.73	0.88	0.91	0.93	0.83
	HRmsy* 1	0.62	0.68	0.82	0.79	0.86	0.75
20 -year	TAC= 0	1.00	1.00	1.00	1.00	1.00	1.00
	TAC= 100	1.00	1.00	1.00	1.00	1.00	1.00
	TAC= 200	1.00	0.99	0.98	0.95	0.98	0.98
	TAC= 300	0.96	0.91	0.89	0.80	0.88	0.89
	TAC= 400	0.84	0.77	0.73	0.59	0.67	0.72
	TAC= 436	0.78	0.71	0.66	0.52	0.58	0.65
	TAC= 500	0.68	0.62	0.53	0.42	0.44	0.54
	HRmsy* 0.25	0.97	0.99	1.00	1.00	1.00	0.99
	HRmsy* 0.5	0.76	0.80	0.95	1.00	0.97	0.90
	HRmsy* 0.75	0.70	0.73	0.88	0.91	0.93	0.83
	HRmsy* 1	0.62	0.68	0.82	0.79	0.86	0.75
50 -year	TAC= 0	1.00	1.00	1.00	1.00	1.00	1.00
	TAC= 100	1.00	1.00	1.00	1.00	1.00	1.00
	TAC= 200	1.00	0.99	0.98	0.95	0.98	0.98
	TAC= 300	0.96	0.91	0.89	0.80	0.88	0.89
	TAC= 400	0.84	0.77	0.73	0.59	0.67	0.72
	TAC= 436	0.78	0.71	0.66	0.52	0.58	0.65
	TAC= 500	0.68	0.62	0.53	0.42	0.44	0.54
	HRmsy* 0.25	0.97	0.99	1.00	1.00	1.00	0.99
	HRmsy* 0.5	0.76	0.80	0.95	1.00	0.97	0.90

HRmsy* 0.75	0.70	0.73	0.88	0.91	0.93	0.83
HRmsy* 1	0.62	0.68	0.82	0.79	0.86	0.75

(d) Median number of years to rebuild.

	NE1	NE2	NE6	NE7	NE4
TAC= 0	2028	2030	2034	2043	2024
TAC= 100	2031	2033	2038	2050	2028
TAC= 200	2035	2037	2044	>2059	2034
TAC= 300	2040	2043	2052	>2059	2044
TAC= 400	2049	2053	>2059	>2059	>2059
TAC= 436	2053	2059	>2059	>2059	>2059
TAC= 500	>2059	>2059	>2059	>2059	>2059
HRmsy* 0.25	2033	2034	2039	2053	2028
HRmsy* 0.5	2043	2042	2048	>2059	2033
HRmsy* 0.75	>2059	2058	>2059	>2059	2043
HRmsy* 1	>2059	>2059	>2059	>2059	>2059

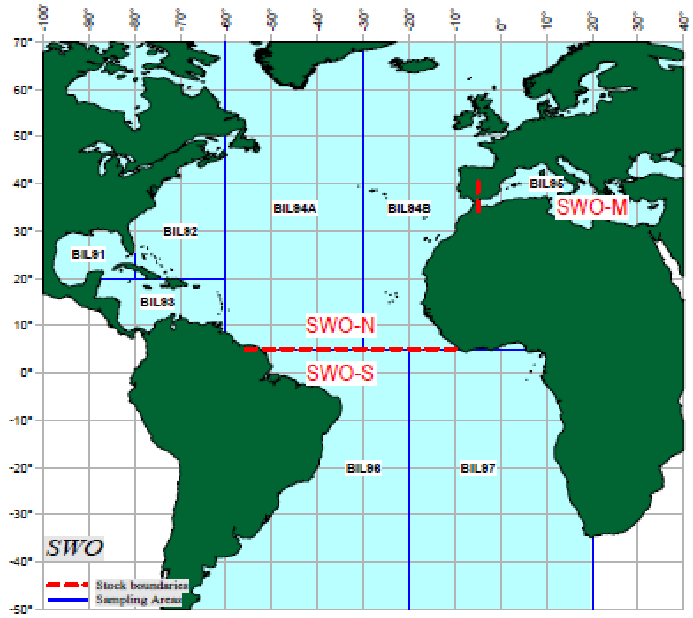
Table 16. Average probabilities across the 5 most credible BSP model runs for the northeast Atlantic porbeagle population.

Total catch	***Probability of some increase within 10 years***	***Probability of stock rebuilding to BMSY within:***	
		20 years	***50 years***
0	1.00	0.478	0.946
100	1.00	0.414	0.872
200	0.98	0.368	0.754
300	0.89	0.326	0.596
400	0.72	0.286	0.464

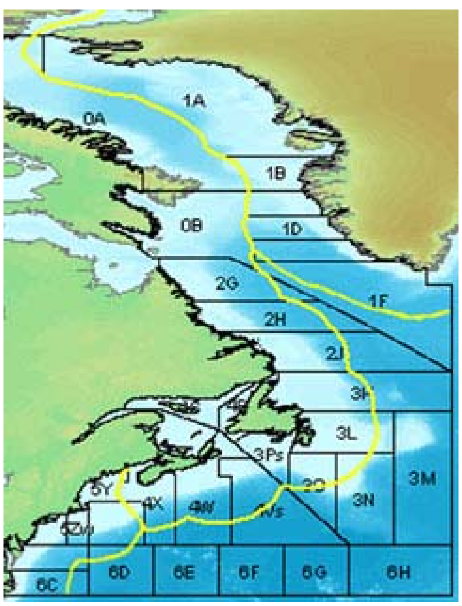
Table 17 Fishing mortality, yield, biomass and SSB relative to that achieved at the effort level corresponding to the $F_{0.1}$ level for a flat-topped selection pattern with maximum selection at age 3.

Selection Pattern	***Age Max Selection***	***Maximum Landing Length***	***F***	***Yield***	***Biomass***	***SSB***
Domed	5	No	211%	68%	202%	120%
Flat	13	No	211%	79%	280%	176%
Domed	13	No	279%	68%	295%	178%
Flat	5	Yes	150%	84%	134%	105%
Domed	5	Yes	217%	67%	206%	120%
Flat	13	Yes	698%	35%	377%	191%
Domed	13	Yes	698%	35%	377%	191%

ICCAT



NAFO (left) and ICES (right) boundaries



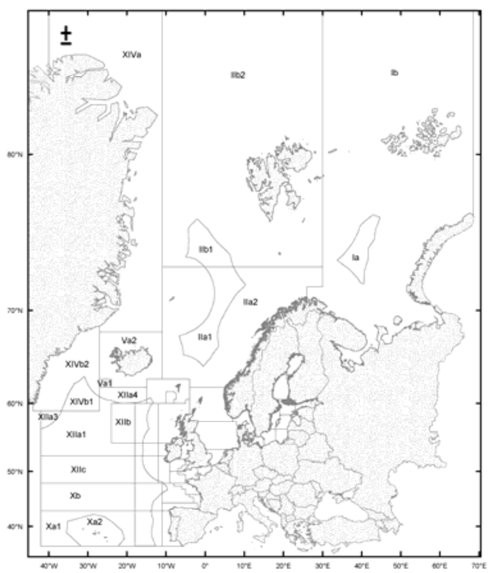


Figure 1. Maps of the North Atlantic terms of ICCAT, NAFO and ICES boundaries.

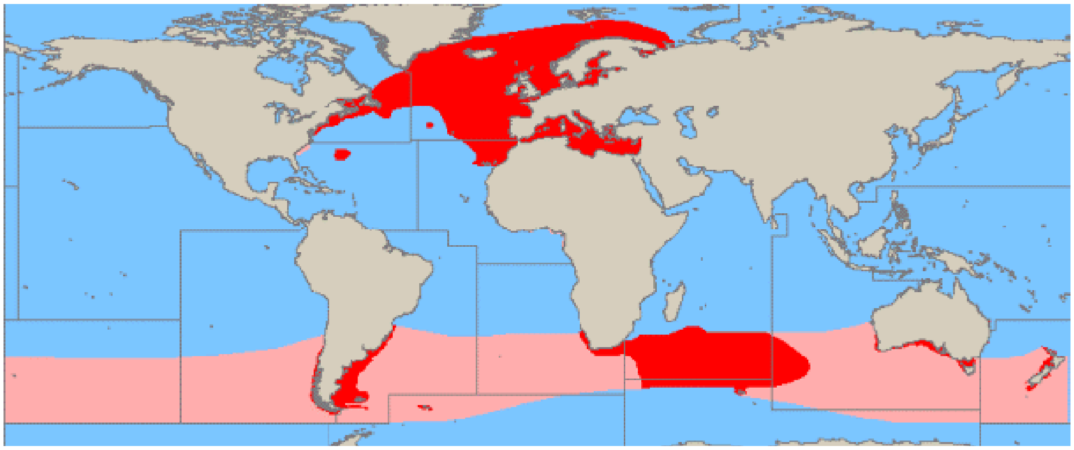


Figure 2. Distribution of the porbeagle stock in the East Atlantic, south of 25°S and East of 20°W.

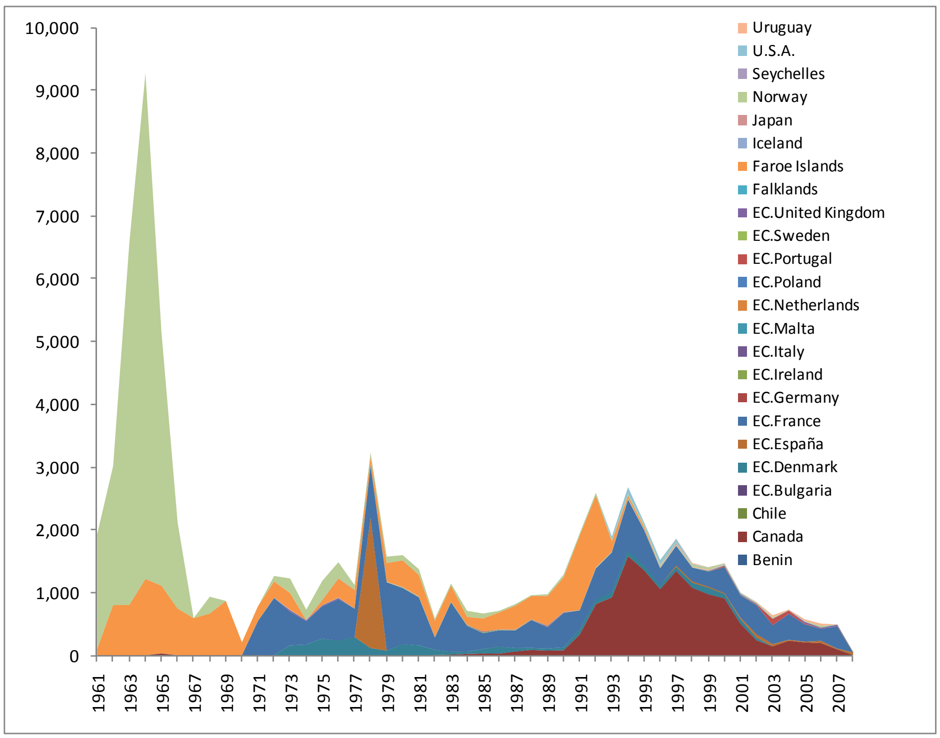


Figure 3 Reported and estimated catches of Atlantic porbeagle held in Task I (as of June 12, 2009).

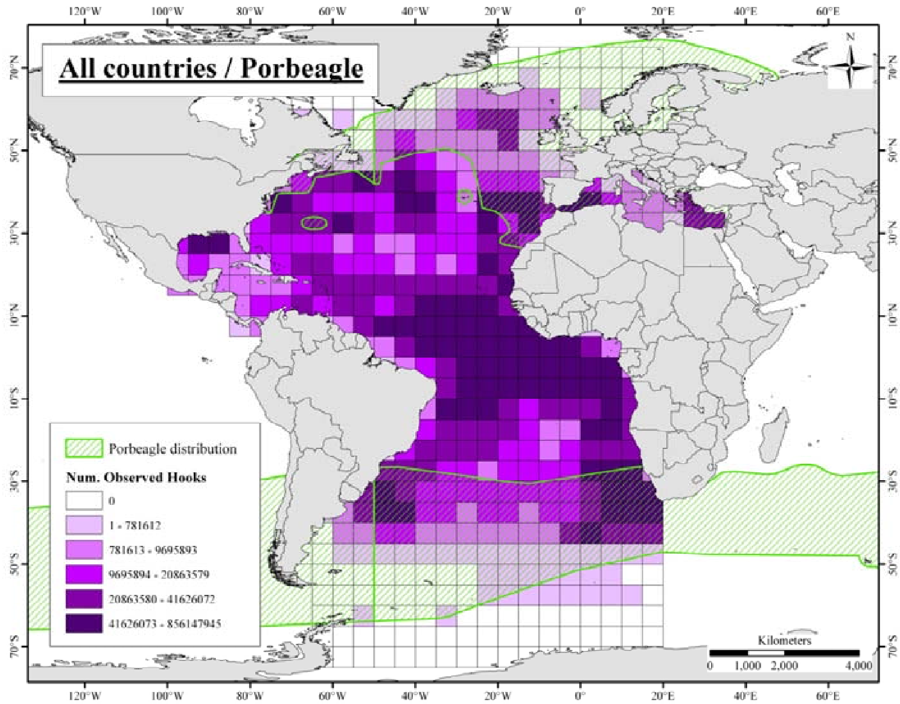


Figure 4. Density distribution of hooks fished by longline fisheries for Atlantic tuna and tuna-like species from 1950-2007 overlapped with the distribution of porbeagle in the Atlantic**.**

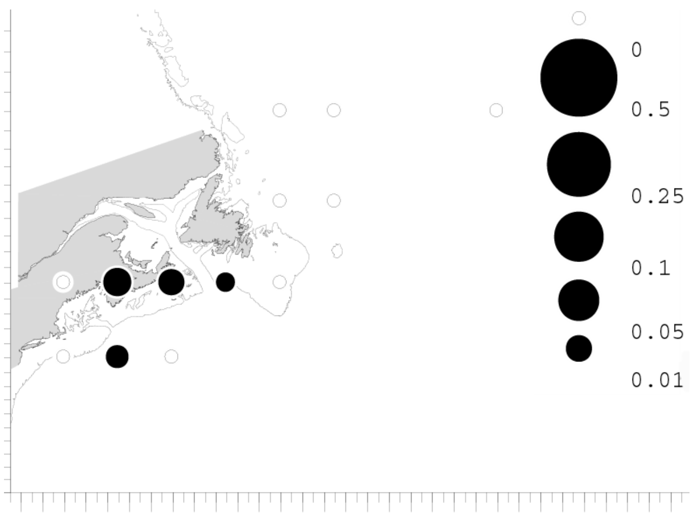


Figure 5. Porbeagle:swordfish/tuna catches as observed in the Japanese pelagic longline fishery.

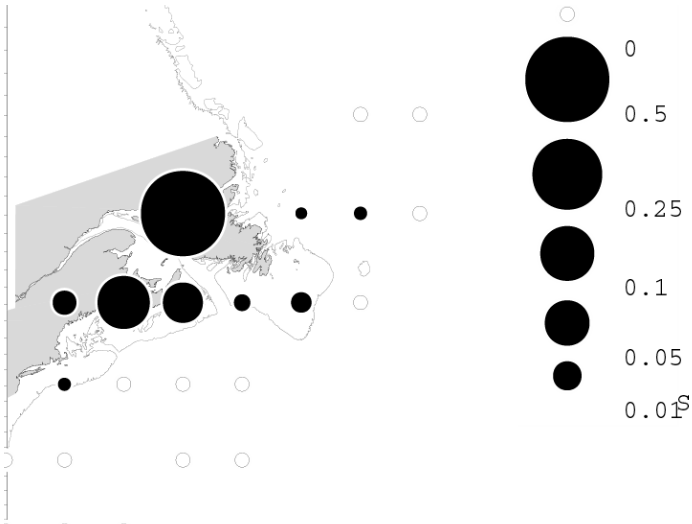


Figure 6. Porbeagle: swordfish/tuna catch ratios as observed in the Canadian pelagic longline fishery.

Figure 7. Porbeagle: swordfish/tuna catch ratios as observed in the U.S. swordfish fishery.

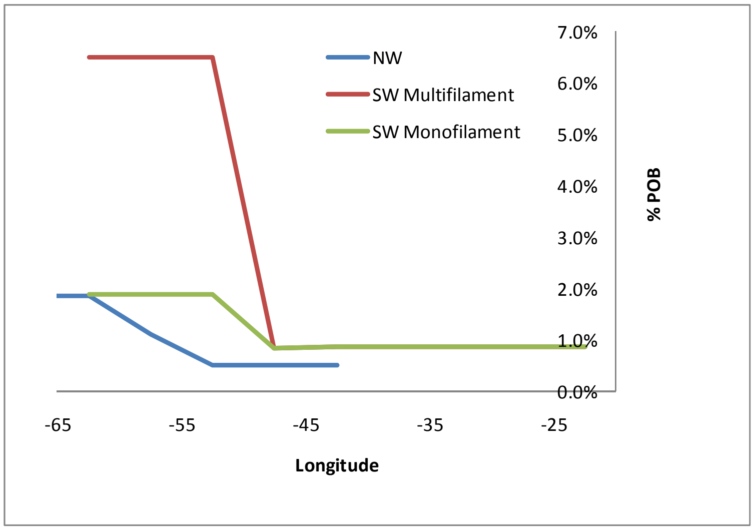


Figure 8. Percentage of porbeagle observed in catch of tunas and swordfish as a function of longitude, hemisphere and gear-type (multifilament and monofilament mainline) used in estimating potential porbeagle catch for non-reporting longline fleets fishing in the stock areas.

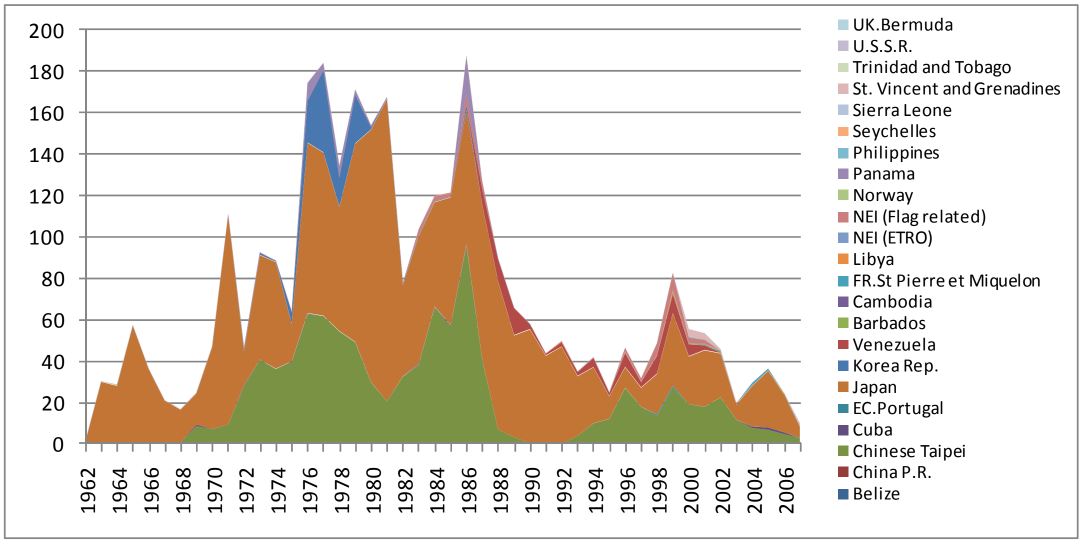


Figure 9. Estimated potential catch of porbeagle by non-reporting longline fleets using catch ratios for the NW stock. Limited observations across the time-series result in an unquantified uncertainty in the estimates.

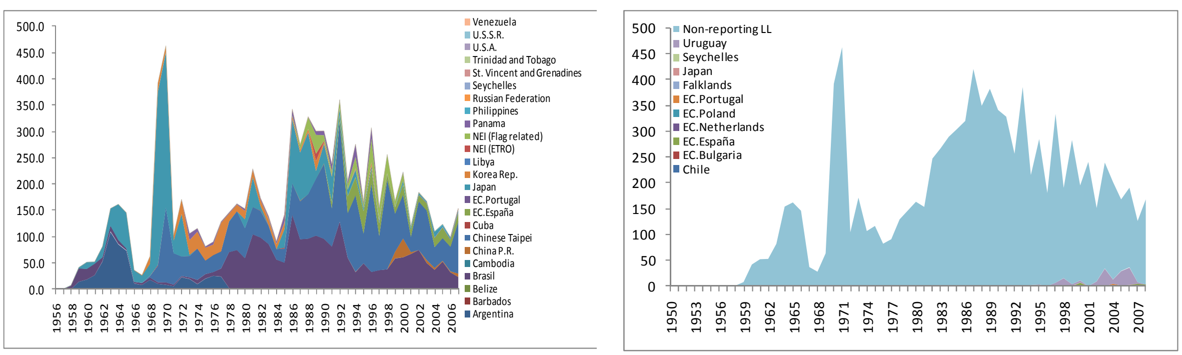


Figure 10. Left plate: Estimated potential catch of porbeagle by non-reporting longline fleets using catch ratios for the SW stock. Very limited observations across the time-series result in a high but unquantified uncertainty in the estimates. Right plate: Comparison of estimates for non-reporting longline fleets with reported catch levels held in the Task I data set for the SW stock area.

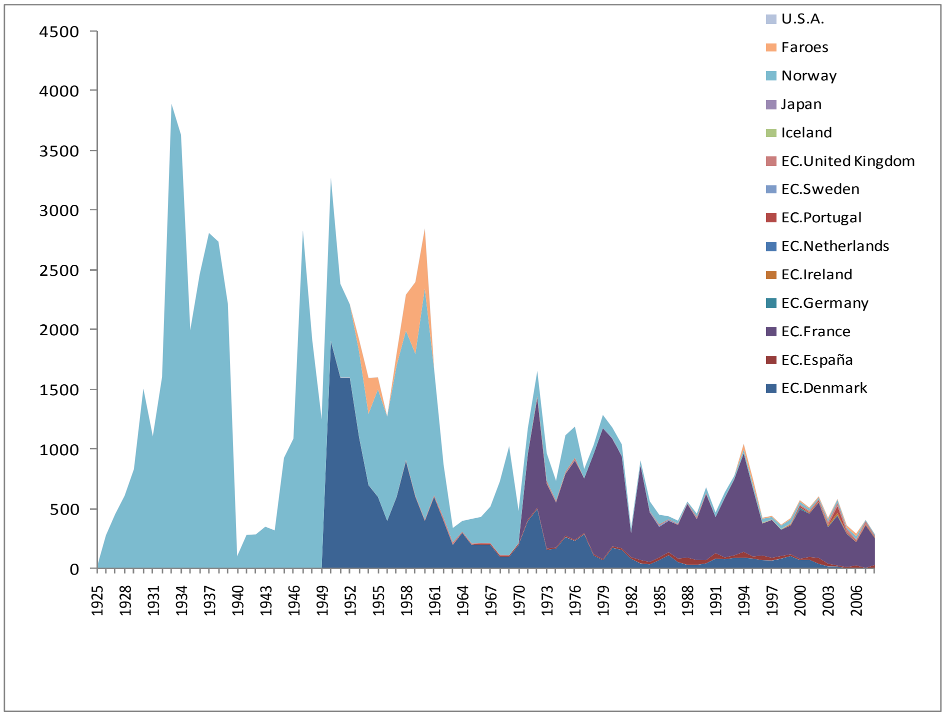


Figure 11. Catch by flag of porbeagle sharks from the northeastern Atlantic used in the assessment. While these catches are considered the best available,, they are believed to underestimate the pelagic longline catches for this species.

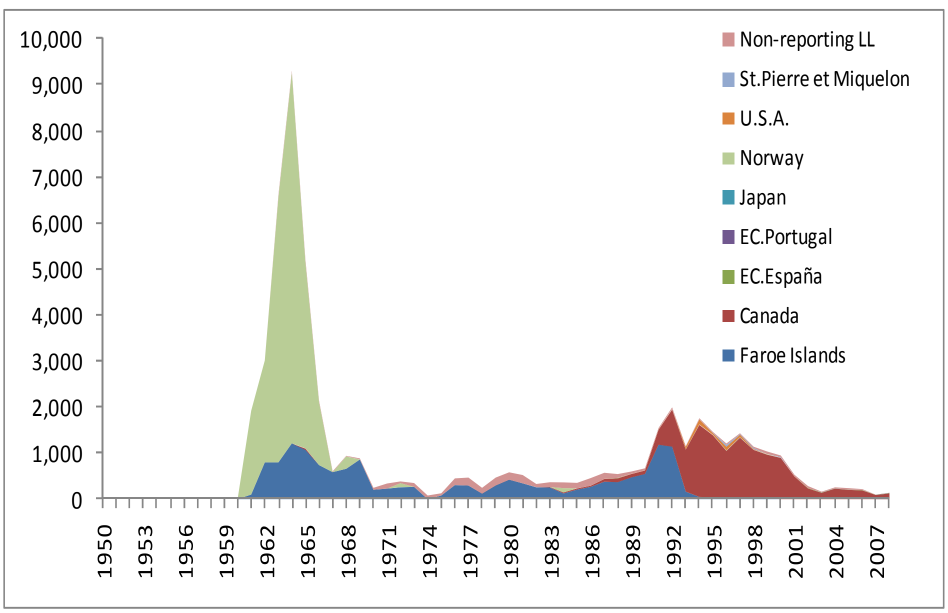


Figure 12. Catch by flag of porbeagle sharks from the northwestern Atlantic available for the assessment, including estimated catch by non-reporting longline fleets which, in this case represents a small proportion of the overall total.

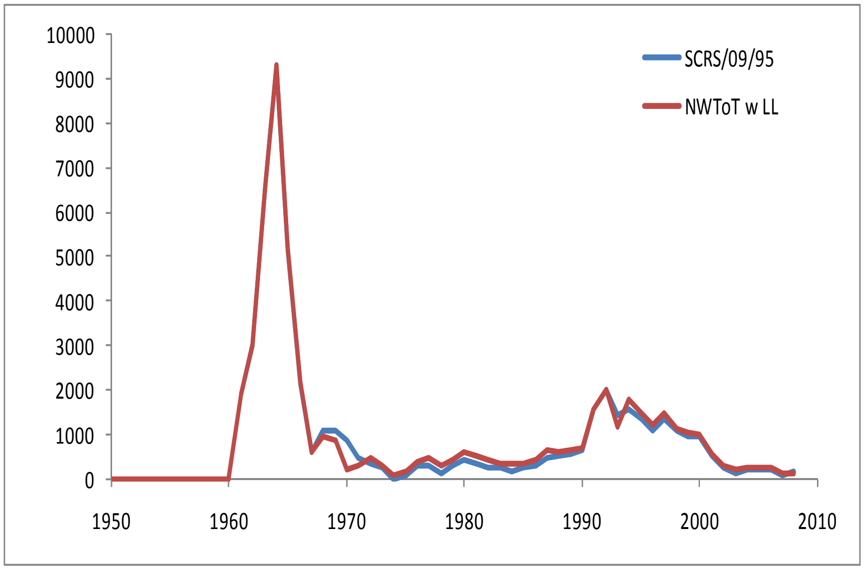


Figure 13. Comparison of northwestern Atlantic catch compilations made at this meeting, including estimates of catch by non-reporting longline fletes, with those reported in SCRS/2009/095. There are relatively small differences in these catch compilations which warrant further investigation.

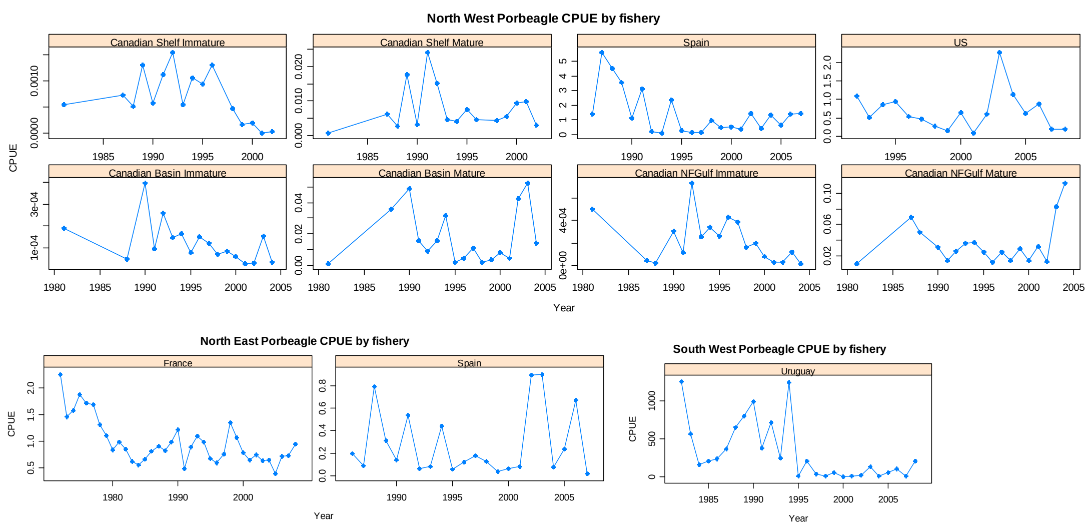


Figure 14. CPUE series for the porbeagle NW stock (upper figures), NE stock (lower left figures) and SW stock (lower right figure).

.

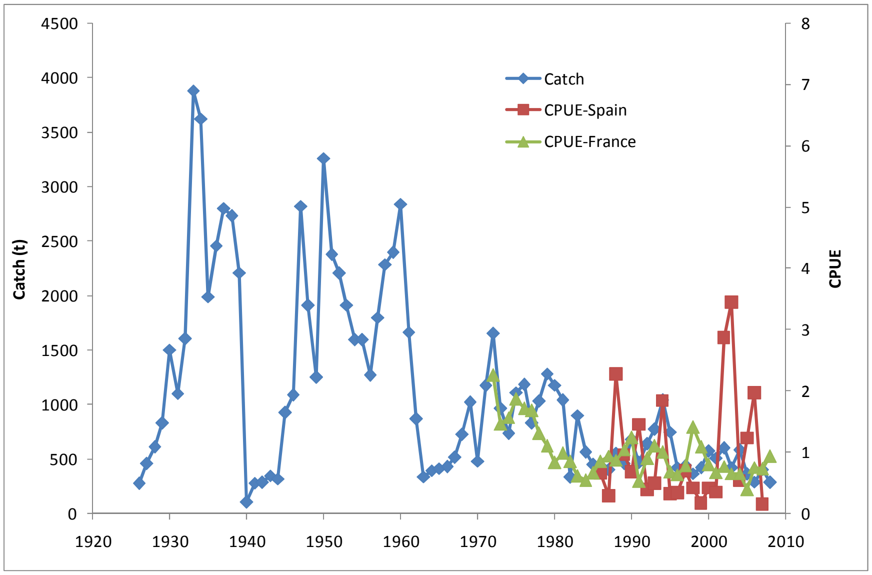


Figure 15. Catch and CPUE data for northeast Atlantic porbeagle**.**

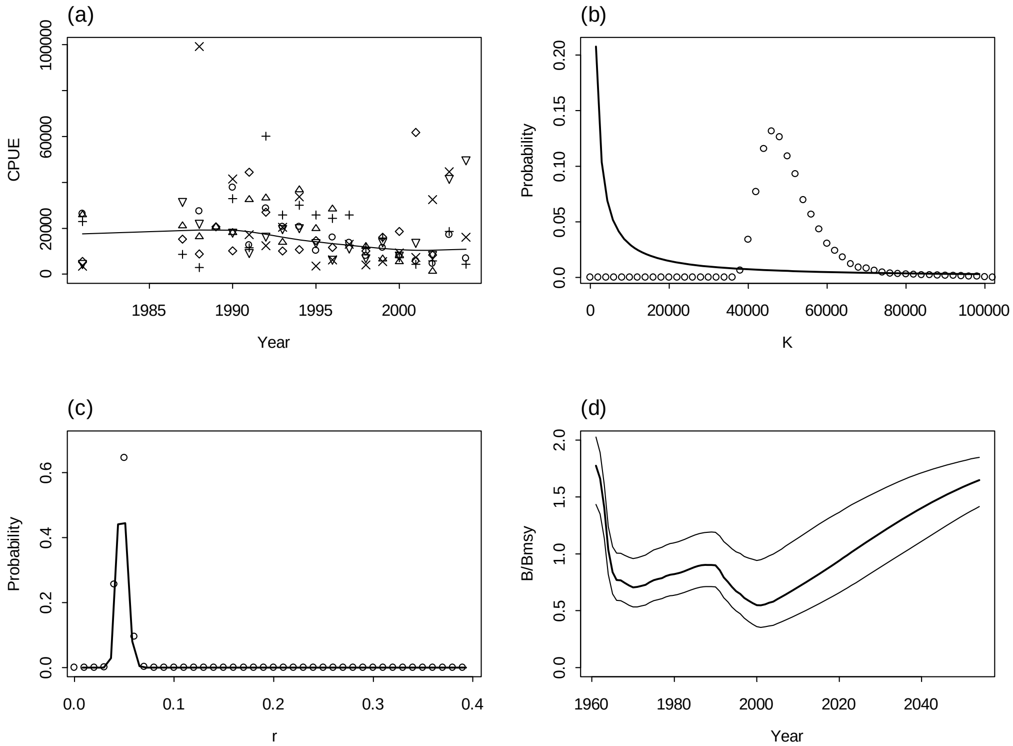


Figure 16. For northwest Atlantic porbeagle BSP model run fitted to the six Canadian series weighted equally, (a) fitted biomass trend (line) and CPUE series (points), (b) prior (line) and posterior (points) distributions of r, (c) prior and posterior distributions of K, and (d) the median and 80% credibility interval for biomass relative to B_{MSY} with no fishing after 2004.

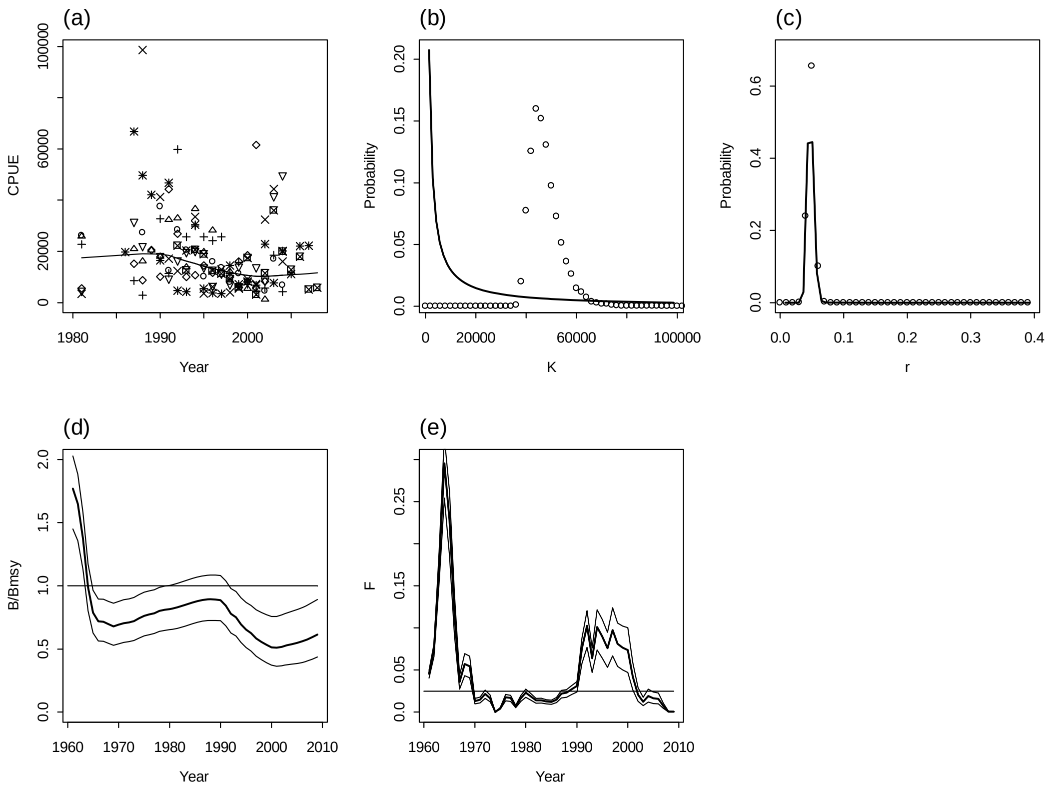


Figure 17. For the BSP model ending in 2009 with equal weighting, and the Canadian, U.S. and Spanish CPUE series, (a) CPUE series and fitted biomass trend, (b) prior (line) and posterior (points) of K, (c) prior and posterior of r, and median and 80% credibility interval of (d) biomass relative to B_{MSY} and (e) F.

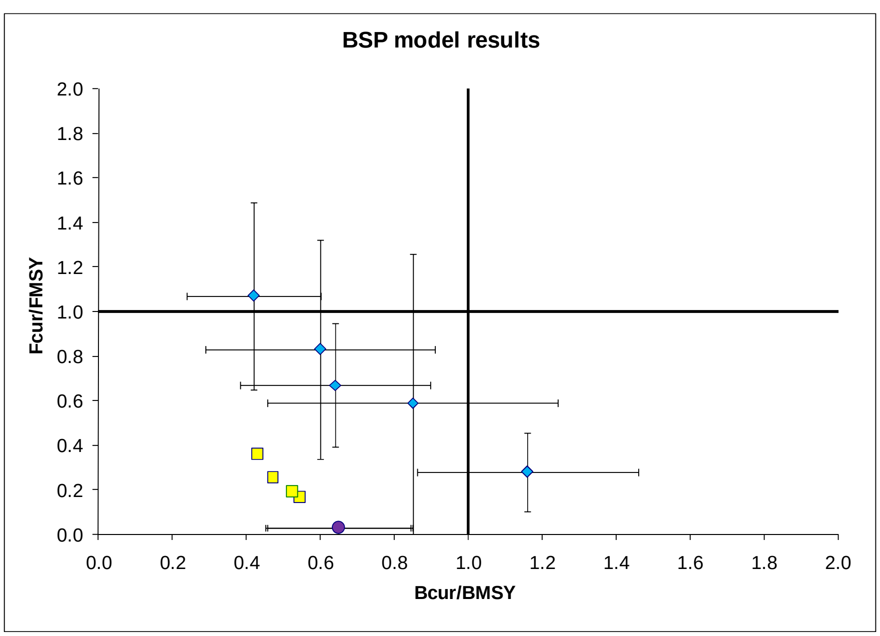


Figure 18. Phase plot showing the expected value of B/B_{MSY} and F/F_{MSY} in the current year, which is either 2005 (diamonds) or 2009 (circles), for the runs described in Table BSP NW 1, as well as approximate values from SCRS/2009/095 (squares). B/B_{MSY} was approximated from SCRS/2009/095 as N2009/N1961 times 2. Error bars are plus and minus one standard deviation.

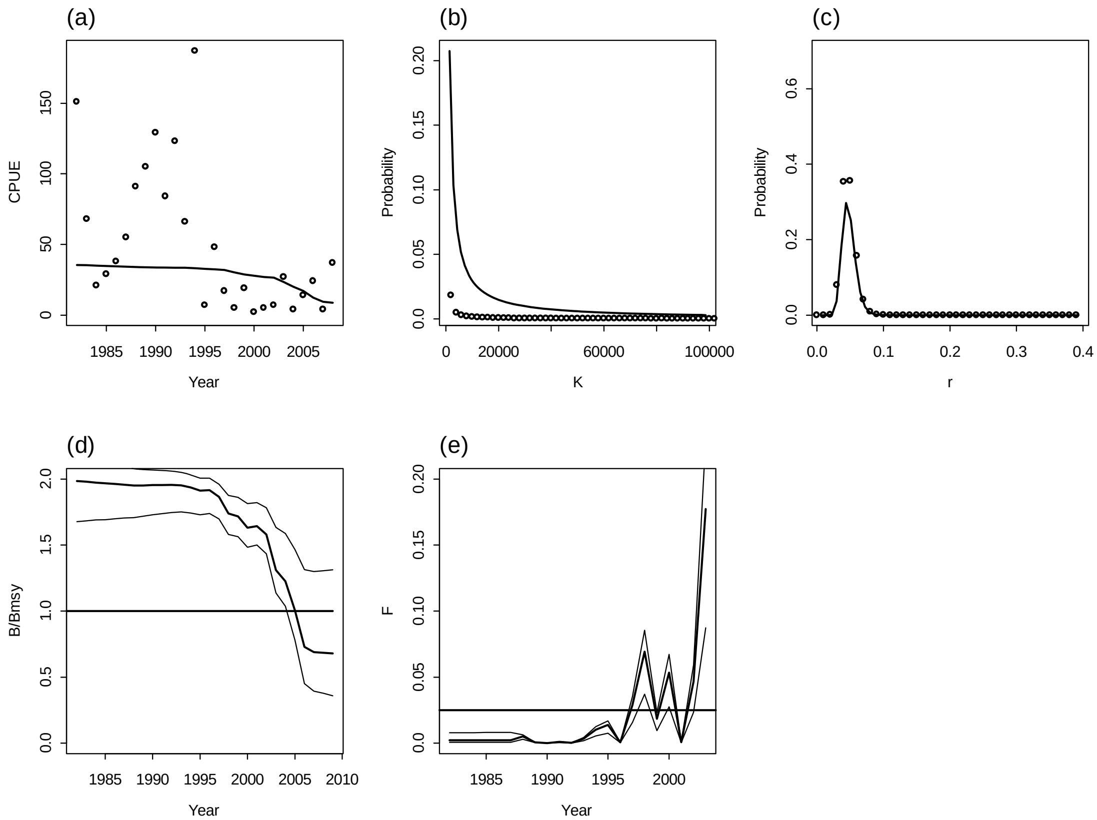


Figure 19. BSP results for Southwest Atlantic porbeagle, with the Uruguay CPUE series and equal weighting of data points and ICCAT Task 1 catches (run SW1), (a) CPUE series and fitted biomass trend, (b) prior (line) and posterior (points) of *K*, (c) prior and posterior of *r*, and median and 80% credibility interval of (d) biomass relative to B_{MSY} and (e) F.

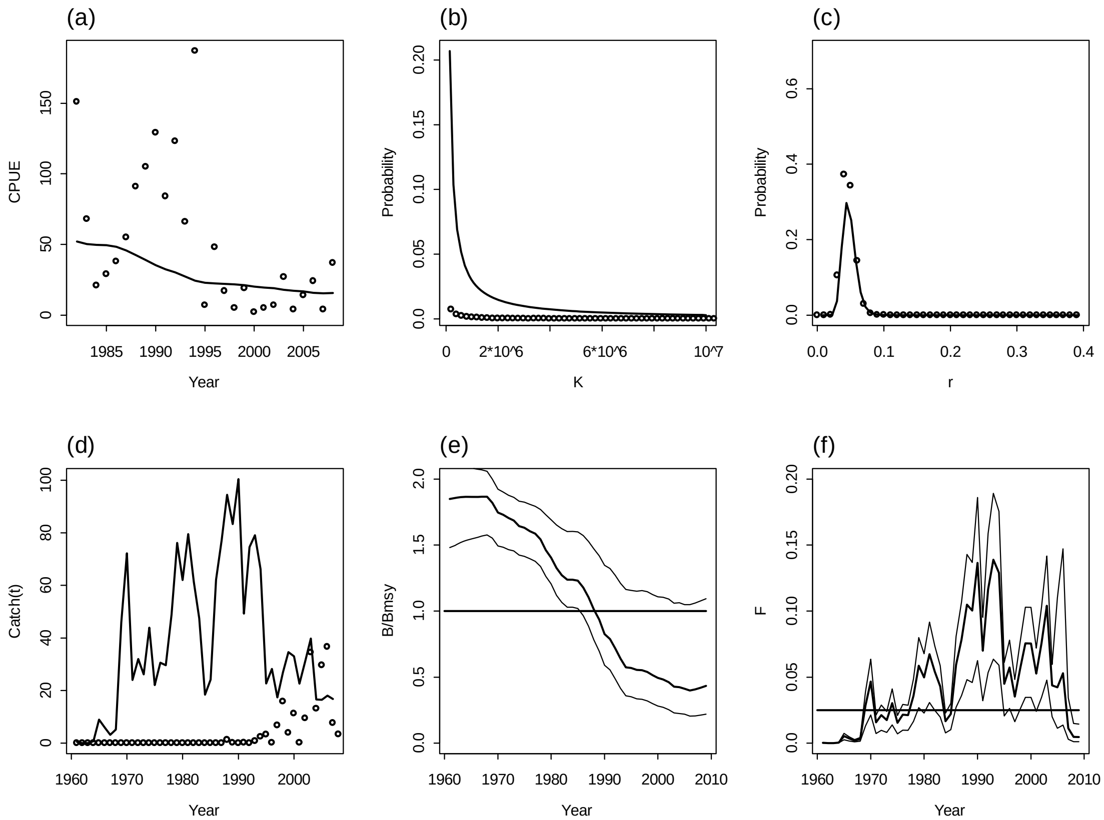


Figure 20. BSP model for the southwest Atlantic assuming that catches are proportional to effort (run SW3), with the constant of proportionality calculated with data from 2005-2006, (a) CPUE series and fitted biomass trend, (b) prior (line) and posterior (points) of *K*, (c) prior and posterior of *r*, (d) estimated (line) and reported (points) catches, and median and 80% credibility interval of (e) biomass relative to B_{MSY} and (f) F.

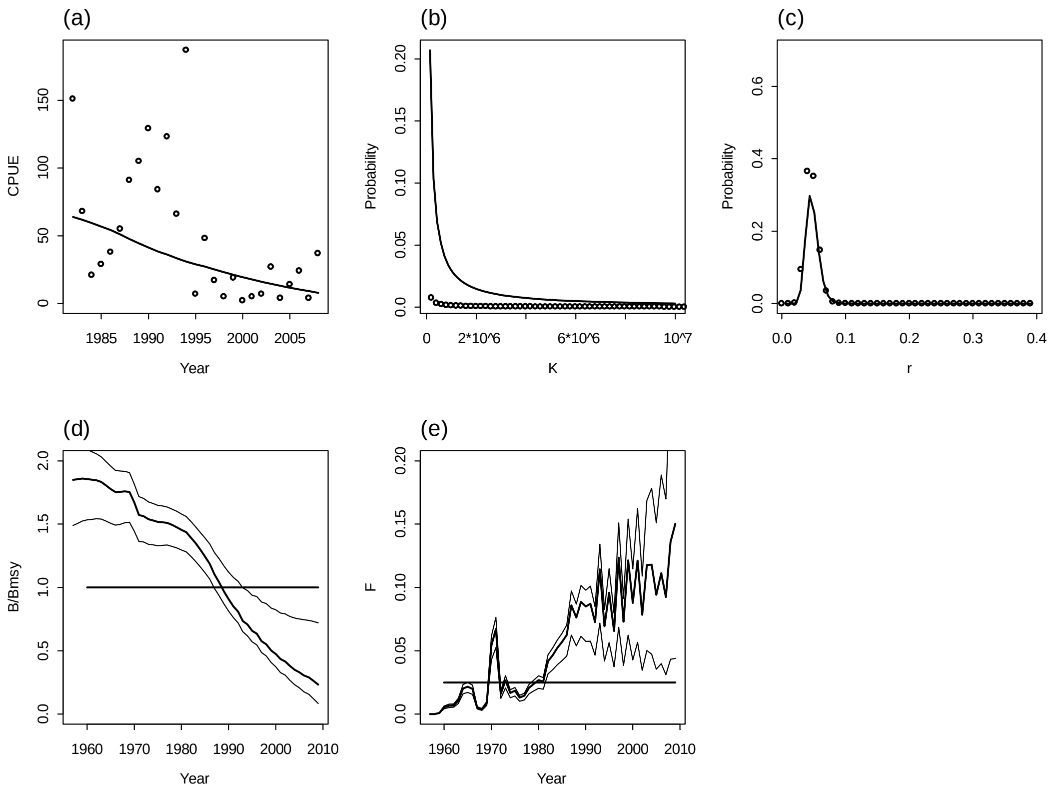


Figure 21. BSP results for southwest Atlantic porbeagle, with catches estimated from the ratio of porbeagle to tuna and swordfish (run SW5), (a) CPUE series and fitted biomass trend, (b) prior (line) and posterior (points) of *K*, (c) prior and posterior of *r*, and median and 80% credibility interval of (d) biomass relative to B_{MSY} and (e) F.

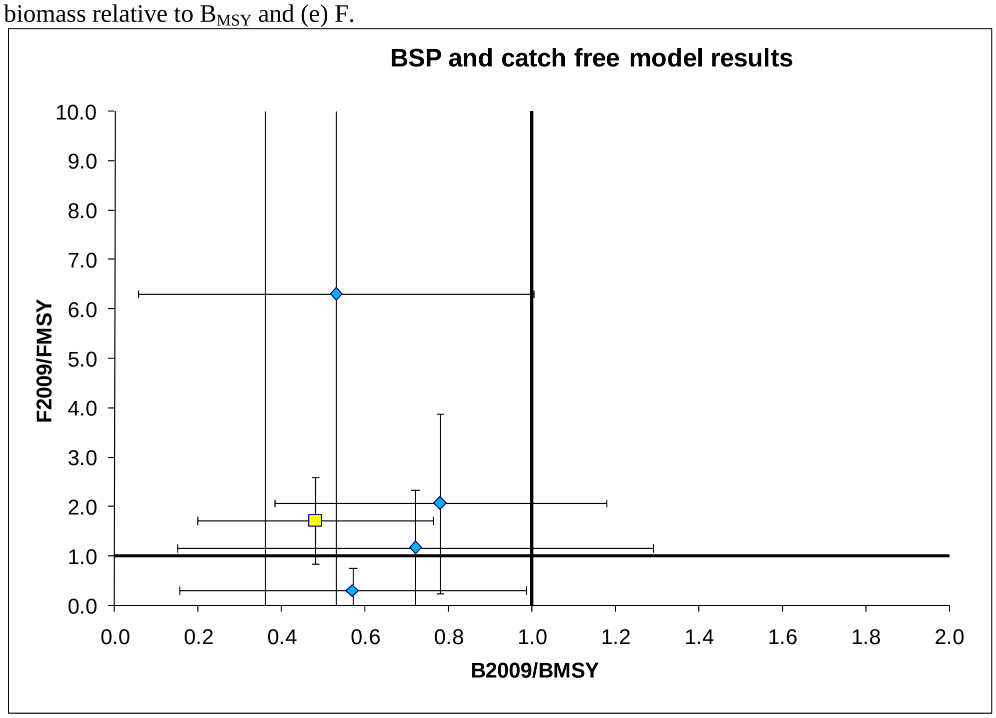


Figure 22. Phase plot for the southwest Atlantic porbeagle, showing status in 2009 from both the BSP model runs (diamonds) and the catch free age structured production model (square) results. Error bars are plus and minus one standard deviation.

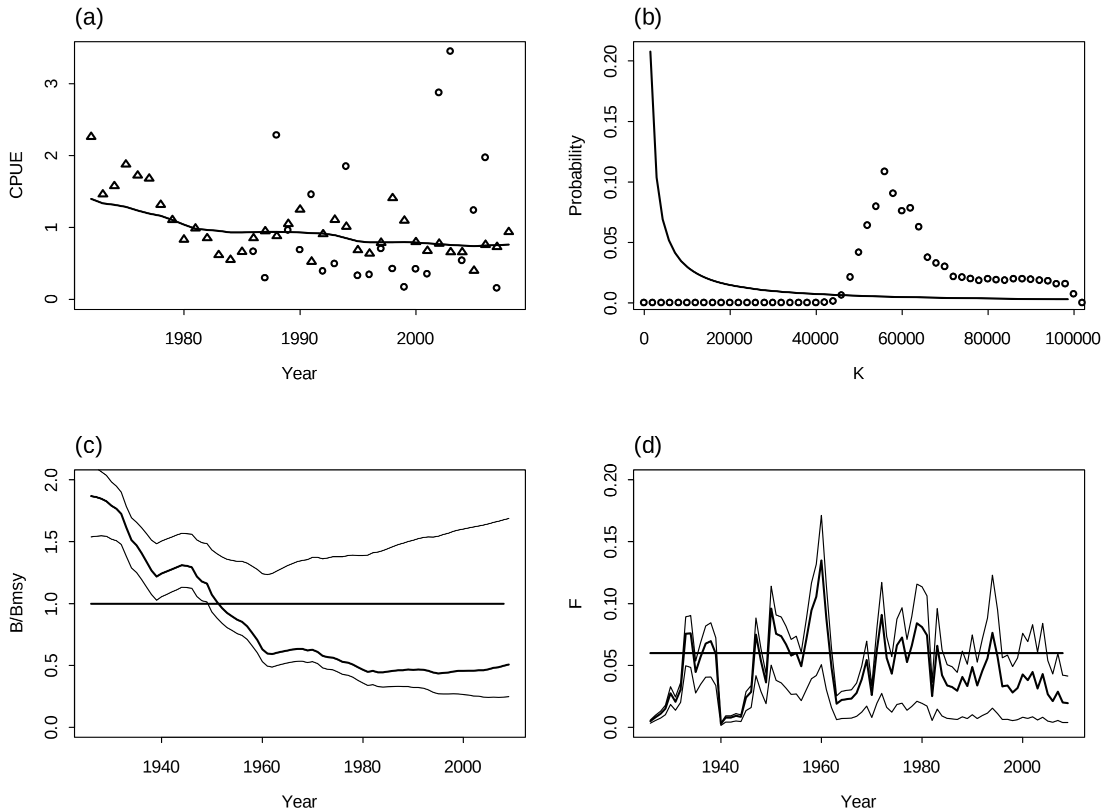


Figure 23. Equal weighting. Spain (area 4 and 5) and France (standardized), with catch data from 1926 and maximum of K set to 100000 (run NE1),), (a) CPUE series and fitted biomass trend, (b) prior (line) and posterior (points) of *K* and median and 80% credibility interval of (c) biomass relative to B_{MSY} and (d) F.

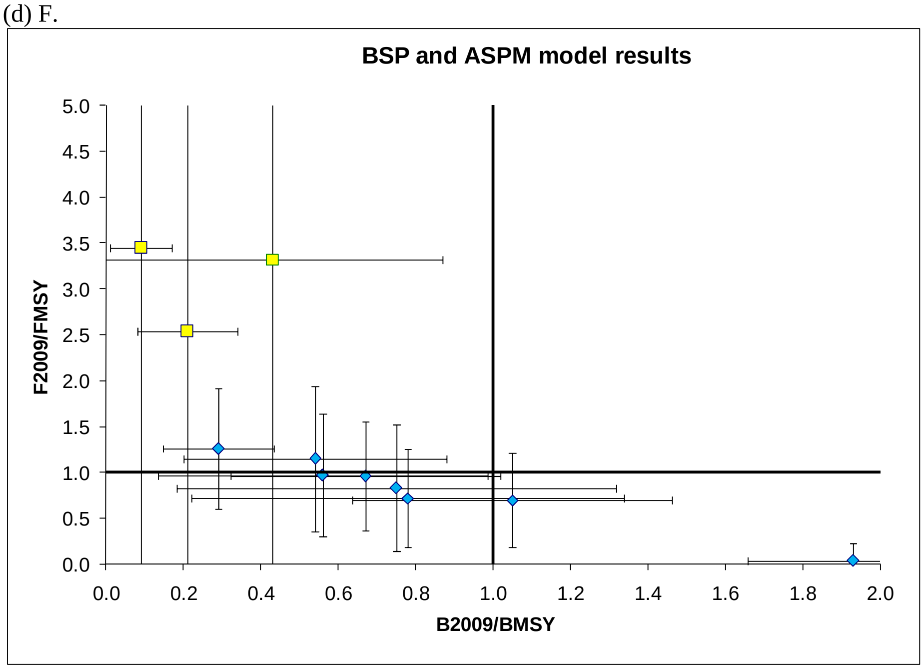


Figure 24. Phase plot showing current status of northeast Atlantic porbeagle for the BSP model (diamonds) and the ASPM model (squares). Error bars are plus and minus one standard deviation.

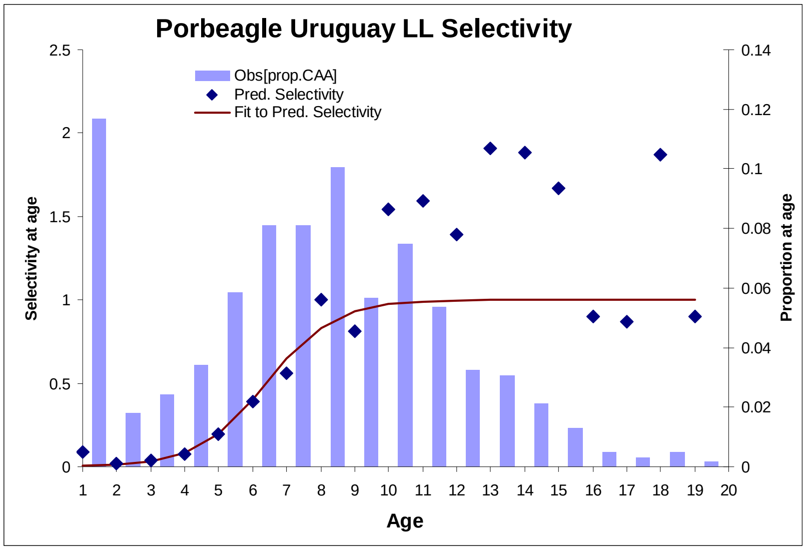


Figure 25. Logistic selectivity function fit to age frequency data estimated from lengths of porbeagle sharks observed in the Uruguayan longline observer program.

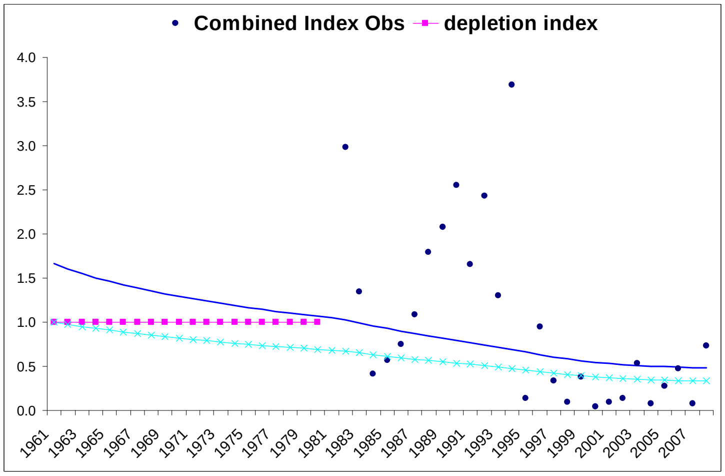


Figure 26. Fit to the Uruguay CPUE index and historical depletion index based on assuming virgin conditions in 1961 for Southwest Atlantic porbeagle shark. The solid line is the fit to the Uruguay index and the hatched line is the fit to the historical depletion index.

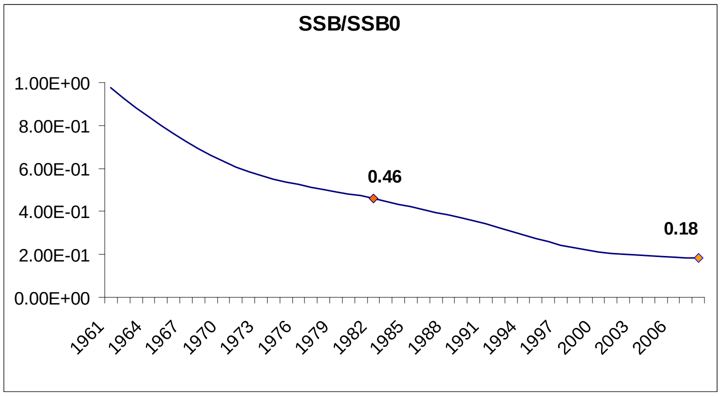


Figure 27. Relative spawning stock biomass (SSB) trend for the CFASP model assuming virgin conditions in 1961 for southwest Atlantic porbeagle shark. The dots indicated on the line correspond to depletion at the beginning of the modern period (1982) and current depletion (2008).

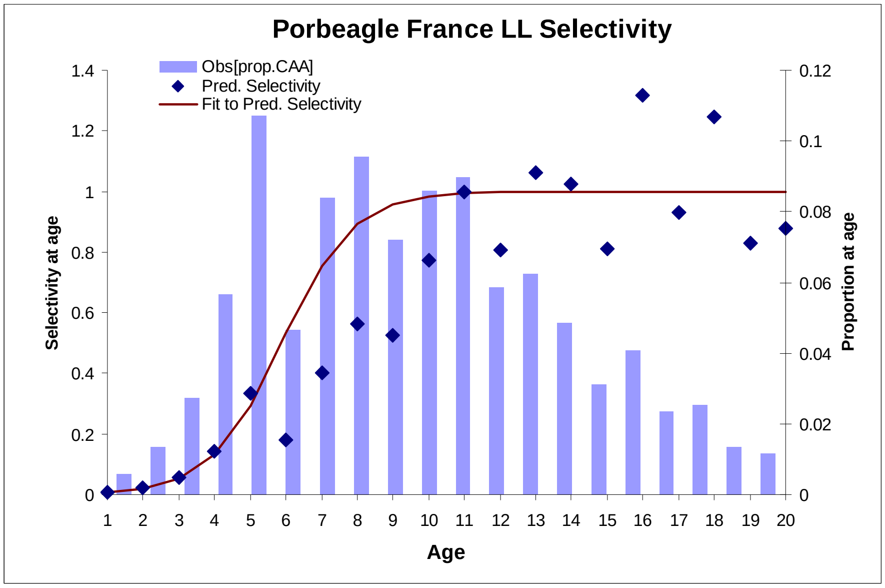


Figure 28. Logistic selectivity function fit to age frequency data estimated from lengths of porbeagle sharks recorded from the French longline fleet.

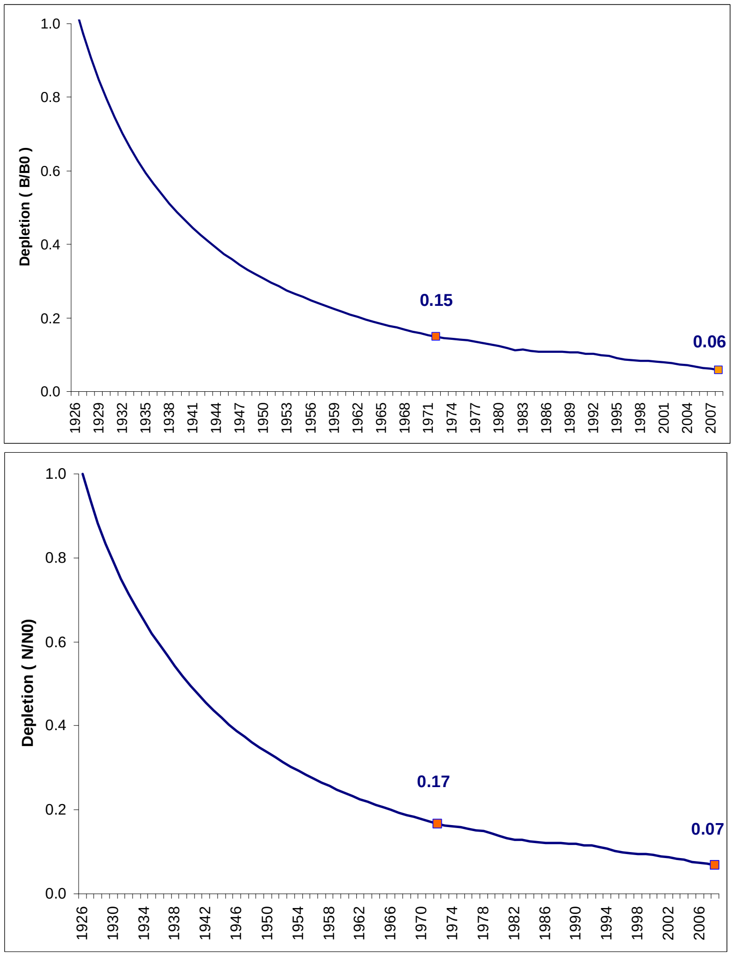


Figure 29. Depletion in total biomass (upper panel) and numbers (lower panel) for the SPAS model assuming virgin conditions in 1926 for Northeast Atlantic porbeagle shark. The dots indicated on the line correspond to depletion at the beginning of the modern period (1972) and current depletion (2008).

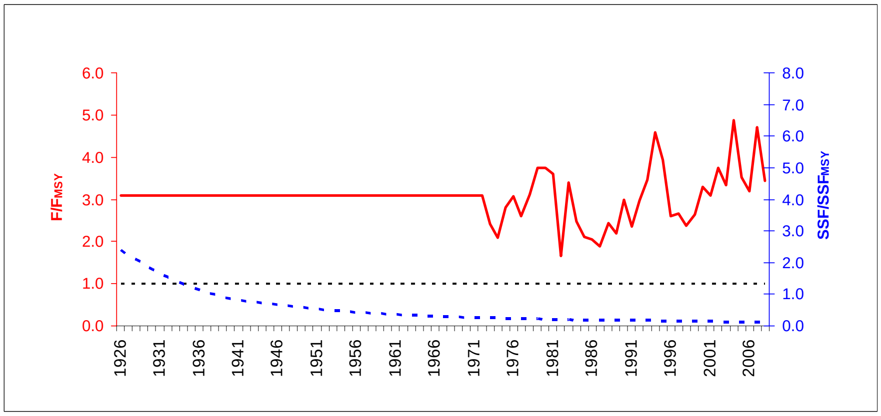


Figure 30. Relative biomass and fishing mortality trajectories for the ASPM model assuming virgin conditions in 1926 for northeast Atlantic porbeagle shark.

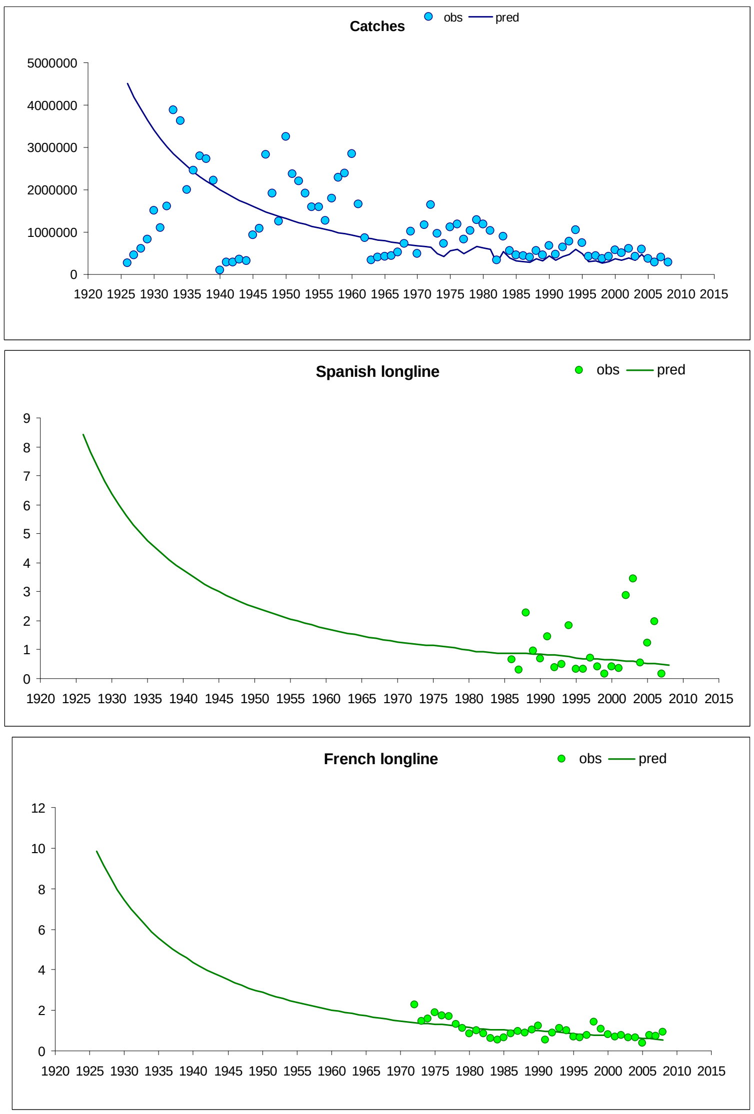


Figure 31. Model fits to catches (upper panel) and CPUE indices for the ASPM model assuming virgin conditions in 1926 for northeast Atlantic porbeagle shark.

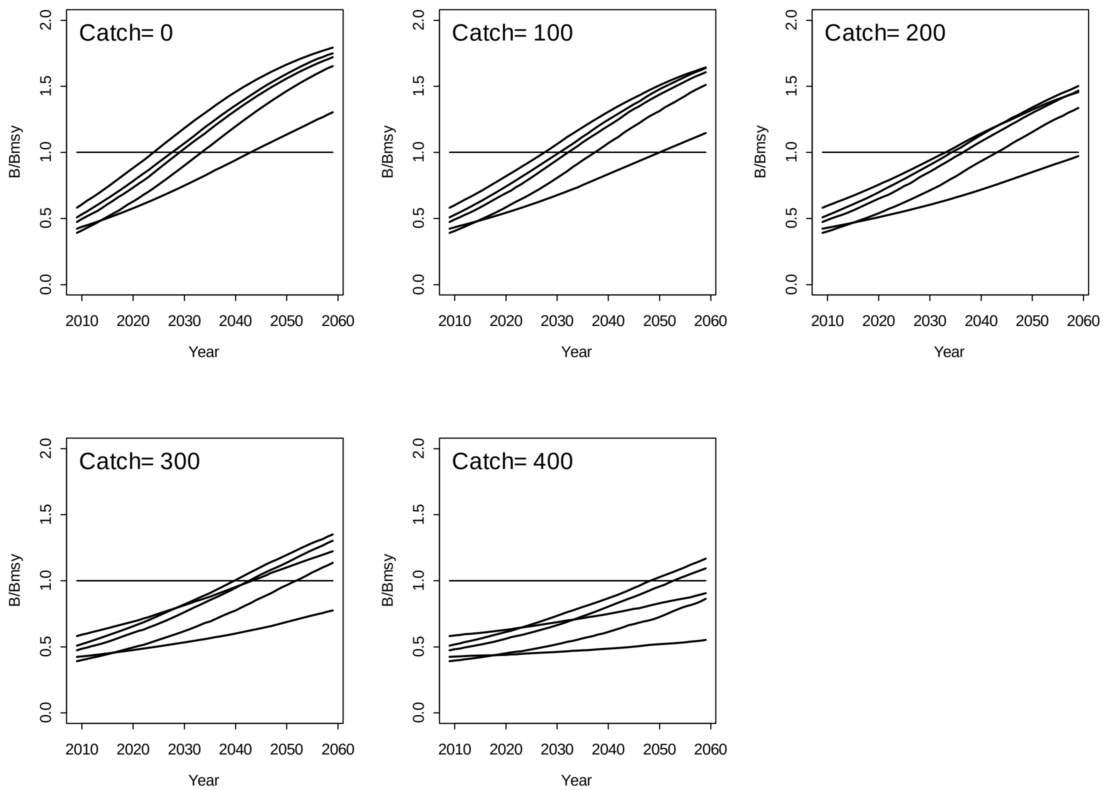


Figure 32. Median trajectories of B/BMSY for each total catch strategy. Each line is one of the five credible BSP model runs.

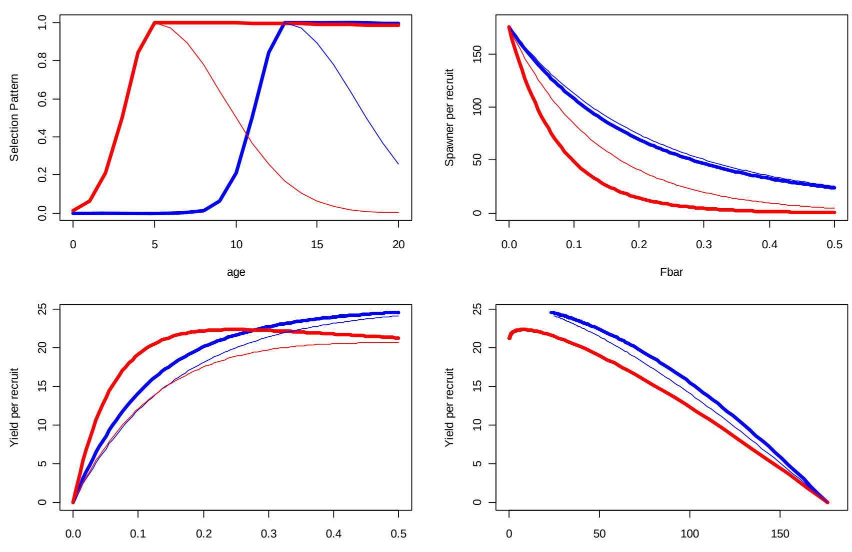


Figure 33. Per recruit analysis, top-left) selection pattern, top-right) Spawner per recruit, bottom-left) Yield per recruit, bottom-right) Yield vs. SSB.

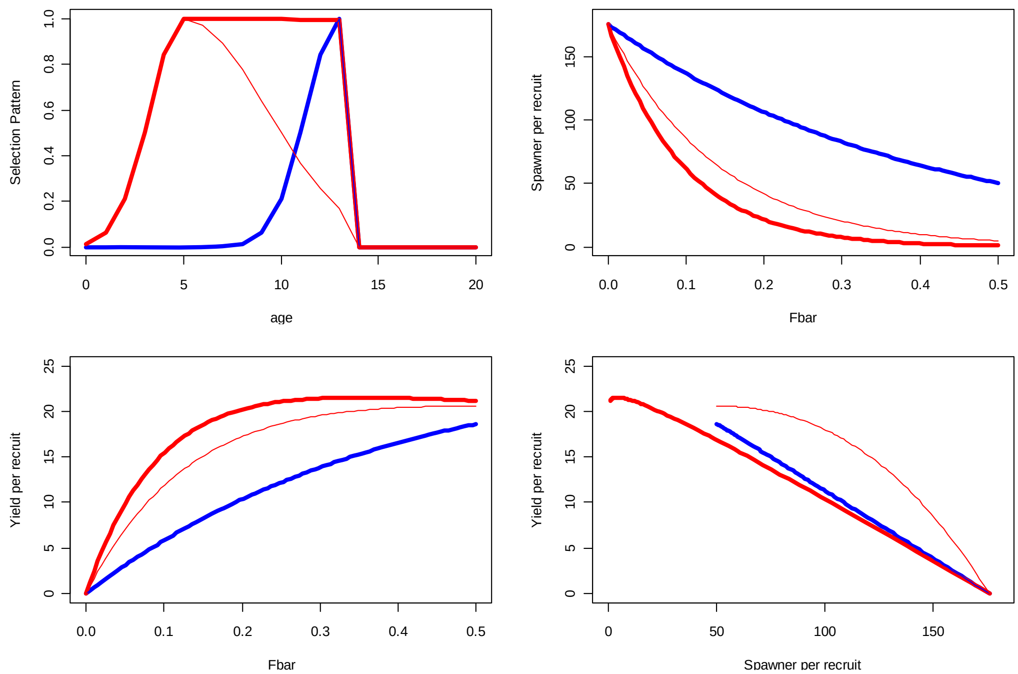


Figure 34. Per recruit analysis for a 100% effective MLL, top-left) selection pattern, top-right) Spawner per recruit bottom-left) Yield per recruit, bottom-right) Yield vs. SSB.