Stock Annex for Sea bass in IVb,c and VIIa, d–h

Stock-specific documentation of standard assessment procedures used by ICES.

Stock	European sea bass (*Dicentrarchus labrax*) in Subarea IVb,c and VIIa, d–h (BSS-47)
Working Group	WGCSE
Date	May 2014
Revised by	Mike Armstrong and Mickael Drogou, May 2015
Revisions	v1. WGNEW (bass in all areas)
	v2. IBPNEW 2012 (retaining only information for BSS-47)
	v3. WGCSE 2013 with revisions
	v4. WGCSE 2014 with revisions from IBP-bass
	v5. WGCSE 2015

A. General

A.1. Stock definition

Bass *Dicentrarchus labrax* is a widely distributed species in Northeast Atlantic shelf waters with a range from southern Norway, through the North Sea, the Irish Sea, the Bay of Biscay, the Mediterranean and the Black Sea to Northwest Africa. The species is at the northern limits of its range around the British Isles and southern Scandinavia.

Stock structure of sea bass in the Northeast Atlantic has been reviewed by WGNEW 2012 and IBP-NEW 2012 based on evidence from genetics studies, tagging studies, distribution of commercial catches and similarities in stock trends between areas, drawing also on extensive information contained in previous WGNEW and ICES SGBASS reports.

IBP-NEW and WGCSE considers that stock structure remains uncertain, and recommends further studies on sea bass stock identity, using conventional and electronic tagging, genetics and other individual and population markers (e.g. otolith microchemistry and shape), together with data on spawning distribution, larval transport and VMS data for vessels tracking migrating bass shoals, to confirm and quantify the exchange rate of sea bass between sea areas that could form management units for this stock. Such information is critical to support development of models to describe the spatial dynamic of the species under environmental drivers (e.g. temperature and food). Such a modelling work is being carried out in France in the framework of a PhD study (R. Lopez), and in the UK.

The pragmatic view of IBP-NEW 2012 was to structure the baseline stock assessments into four units:

- Assessment area 1. Sea bass in ICES Areas IVbc, VIId, VIIe,h and VIa,f&g (lack of clear genetic evidence; concentration of Area IV bass fisheries in the southern North Sea; seasonal movements of bass across ICES divisions). Relatively data-rich area with data on fishery landings and length/age composition; discards estimates and lengths; growth and maturity parameters; juvenile surveys, fishery lpue trends. [Bass-47].

- Assessment area 2. Sea bass in Biscay (ICES Subarea VIIIa,b). Available data are fishery landings, with length compositions from 2000; discards from 2009; some fishery lpue.
- Assessment area 3. Sea bass in VIIIc and IXa (landings, effort).
- Assessment area 4. Sea bass in Irish coastal waters (VIa, VIIb, VIIj). Available data: Recreational fishery catch rates; no commercial fishery operating. [Bass-wosi].

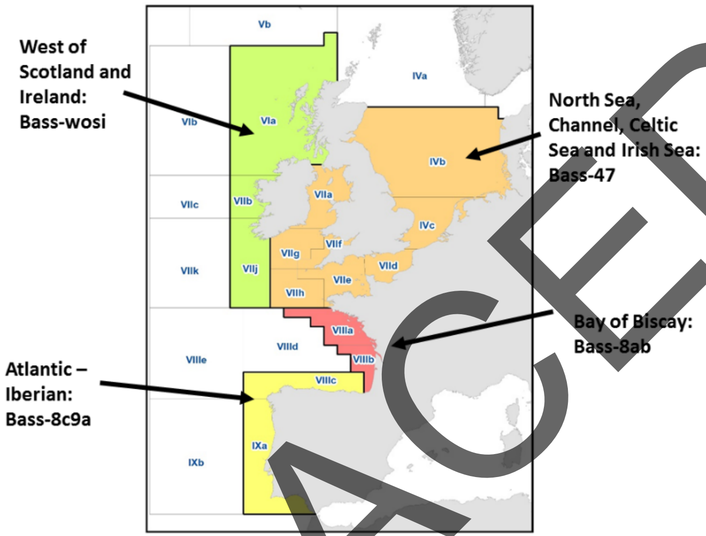

Figure A1.1. Current stock definitions for sea bass.

Fishery landings of sea bass are extremely small in Irish coastal waters of VIIa and VIIg and the stock assessment for assessment area 1will not reflect the sea bass populations around the Irish coast, which may be more strongly affiliated to the population in area 4 off southern, western and Northern Ireland.

At IBP-New (ICES, 2012a), it was agreed that sea bass in the North Sea (IVb&c) and in the Irish Sea, Channel and Celtic Sea (VIIa,d,e,f,g&h) would be treated as a functional stock unit as there is no clear basis from fishery data, tagging and genetics studies to subdivide the populations in the Irish Sea, Celtic Sea, Channel and North Sea into independent stock units. Supporting information can be found in the IBP-New report. The other stock units defined for sea bass are: west of Scotland and Ireland (VIa and VIIb,j; Bay Of Biscay (VIIIa,b); and the more southerly population in VIIIc and IXa.

In the absence of new information the pragmatic view of WGCSE 2015 is to continue to assume the presence of discrete sea bass stocks off southern Ireland and in the Bay of Biscay (VIIIab) and Iberian waters (VIIIc, IXa).

A.2. Fishery

General description

The commercial sea bass fisheries in Areas IV and VII have two distinct components: an offshore fishery on pre-spawning and spawning bass during November to April, predominantly by pelagic trawlers from France and the UK, and small-scale fisheries catching mature fish returning to coastal areas following spawning and in some cases immature sea bass. The inshore fisheries include many small (10 m and under) vessels using a variety of fishing methods (e.g. trawl, handline, longline, nets, rod and line). The fishery may be either targeting sea bass or taking sea bass as a bycatch with other species. Historical landings data for the small-scale fisheries have often been poorly recorded. Although sea bass can occur as target or bycatch of many vessels, the bulk of the catch can be taken by relatively few vessels. For example in the UK in 2010, sea bass landings were reported by 1480 vessels (including 1207 of 10 m and under), 10% of which were responsible for over 70% of the total landings of 719 t (Walmsley and Armstrong, 2012). For France, in 2009 sea bass landings were reported by 2226 vessels including 976 of 10 m and under. Three main métiers were responsible for over 83% of the total landings. Pelagic trawlers (31.5% of total landings, for 58 vessels and 276 seamen) and "liners+handliners" (21.7% of total landings for 416 vessels and 634 seamen) are very economically dependent of this species (Drogou *et al*., 2011). French bottom trawlers often do not target sea bass, but this gear does represent 30.1% of the total landings (for 832 vessels and 2769 seamen). (Drogou *et al*., 2011).

In 2014 a large decrease in French midwater landings has been observed due to the very bad weather conditions, and the vessels switched effort to hake. Seabass landings have also moved from 1591 tons in 2013 to 242 tons in 2014, and this métier accounted in 2014 for only 9% of the total international landings. A decrease was also observed in French bottom trawlers for the same reason to a lesser extent.

According to the CHARM 3 Atlas of the Channel Fisheries, sea bass production in value represented €31 937 in 2008. It's the third most valuable species caught in the Channel (source: Agrimer) in 2008 behind sole and monkfish (tuna is not included in statistics). The market value sea bass depends greatly on how it's caught, giving added value to certain métiers: in 2013 according to the database SACROIS (Ifremer-DPMA), mean price of sea bass sold in France by liners was €17 per Kg compared with €7 per Kg for pelagic trawl, reflecting differences in volume and fish condition.

Sea bass are a popular target for recreational fishing in Europe, particularly for angling in the UK, Ireland and France, and increasingly in parts of southern Norway, the Netherlands and Belgium. Relatively little historical data are available on recreational fisheries although several European countries are now carrying out surveys to meet the requirements of the EU Data Collection Framework and for other purposes (ICES 2009; 2010; 2011, 2012c; Herfault *et al*., 2010; Rocklin *et al*., 2014; Van der Hammen and De Graaf, 2012,205; Armstrong *et al*., 2013.).

More detailed descriptions of national fisheries can be found in ICES WGCSE 2015 (ICES 2015) and in Armstrong and Drogou (2014).

Fishery management regulations

Sea bass are not subject to EU TACs and quotas. Commercial vessels catching bass within cod recovery zones are subject to days-at-sea limits according to gear, mesh and species composition. Under EU regulation, the MLS of bass in the Northeast Atlantic is 36 cm total length, and there is effectively a banned range for enmeshing nets of 70–89 mm stretched mesh in Regions 1 and 2 of Community waters[1]. Emergency measures

[1] Region 1: All waters which lie to the north and west of a line running from a point at latitude 48°N, longitude 18°W; thence due north to latitude 60°N; thence due east to longitude 5°W; thence due north to latitude 60°30'N; thence due east to longitude 4°W; thence due north to latitude 64°N; thence due east to the coast of Norway.

were introduced by the EU banning pelagic / midwater trawling for bass from January to end of April 2015. A bag limit of 3 fish per day was introduced in 2015 for recreational fishing (EU Regulation 2015/523 of 25 March 2015).

A variety of national restrictions on commercial bass fishing are also in place. These include:

- a landings limit of 5 t/boat/week for all French and UK trawlers landing bass;
- closure of 37 bass nursery areas in England and Wales to specified fishing methods;
- UK regional byelaws in Cornwall and South Wales stipulating a 37.5 cm MLS;
- a minimum gillnet mesh size of 100 mm in South Wales;
- a variety of control measures in Ireland that effectively ban commercial fishing for bass in Irish waters; plus MLS of 40cm;
- a licensing system from 2012 in France for commercial gears targeting sea bass.
- voluntary closed season from February to mid-March for longline and handline bass fisheries in Brittany.

Depending on country, measures affecting recreational fisheries include minimum landing sizes, restrictions on sale of catch, bag limits (Ireland), and gear restrictions (France; Netherlands).

Management applicable to 2015

In IVbc and VIIa,d–h (North Sea, Channel, Celtic Sea and Irish Sea) the European Council has adopted emergency measures to help sea bass recover (Recent scientific analyses have reinforced previous concerns about the state of the stock and advised urgently to reduce fishing by 80%). Effective emergency measures in January 2015 placed a ban on targeting the fish stock by pair-trawling while it is reproducing, during the spawning season, which runs until the end of April 2015. Bag limit of 3 fish per day was introduced for recreational fishing in 2015. The European Commission is consulting with Member States and stakeholders during 2013–2015 to establish a broader, balanced package of measures to control fishing mortality and rebuild the stock.

A.3. Ecosystem aspects

Temperature appears to be a major driver for bass production and distribution (Pawson, 1992). Reynolds *et al*. (2003) observed a positive relationship between annual seawater temperature during the development phases of eggs and larvae of sea bass and the timing and (possibly) abundance of post-larval recruitment to nursery areas. In addition, early growth is related to summer temperature and survival of 0-groups through the first winter is affected by body size (and fat reserves) and water temperature (Lancaster, 1991; Pawson, 1992). Prolonged periods of temperatures below 5–6°C may lead to high levels of mortality in 0-groups in estuaries during cold winters. As a result, any SSB–recruit relationships may be obscured by temperature effects (Pawson *et al*., 2007a). WGCSE 2014 presented time series of UK inshore coastal temperatures

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Region 2: All waters situated north of latitude 48°N, but excluding the waters in Region 1 and ICES Divisions IIIb, IIIc and IIId.

during January to March and examined correlations with bass recruitment (Figure A.3.1).

Figure A.3.1. (a) Mean January–March coastal sea temperatures at five sites along the south coast of England, compared with the time-series of sea bass recruitment estimates from the update WGCSE assessment, including pre-1985 values from estimated recruit deviations back to 1975. (b)–(d): correlation between sea bass recruitment and (b) mean temperature for the five sites in the year of spawning; (c) mean temperature in the year of spawning and the following spring; and (d) the same as (c) but restricting the series to 1988 onwards (From ICES WGCSE 2014).

B. Data

B.1. Commercial catch

B1.1 Landings data

Data available

Landings series for use in the assessment are available from three sources:

i) Official statistics recorded in the ICES FishStat database since around the mid-1970s.

ii) French landings for 1999–2013 from a separate analysis by Ifremer of logbook, auction and VMS data, with earlier official data adjusted as described below.

iii) Survey estimates of landings from the UK fleet of 10 m and under vessels (which are not obliged to provide EU logbooks), carried out by Cefas.

Total international landings of sea bass in European waters from sources (i) and (ii) combined increased from around 2000 t in the late 1970s to over 8000 t by 2006, the bulk coming from Areas IVb,c, VIIe and VIII. An important driver of the increase in landings since the 1990s was the increased landings in Divisions IVb,c, VIId and VIIe,h, coinciding with the large 1989 year class and a northward expansion of the sea bass population in the North Sea during a period of increasing sea temperatures.

Quality of official landings data

The official landings data for sea bass available to WGCSE 2015 are subject to several uncertainties that can affect the accuracy of assessments:

- Incomplete reporting of landings in the 1970s and early 1980s when the fisheries were developing (the assessment uses only data from 1985 onwards);
- Reporting of official French data by port rather than fishing ground before 2000. (The best landings estimates are from auctions for this period. During WGCSE, no fishing grounds could be identified for these landings).
- Poor reporting accuracy for small vessels that do not supply EU logbooks.

From 2000 onwards, Ifremer has provided revised French landings from a separate analysis of logbook and auction data which allocates landings correctly by fishing ground. To generate a consistent series of French landings from 1985 onwards for the Area IV&VII assessment, IBP-New 2012 adjusted pre-2000 official landings from the ICES database by the average of the Ifremer correction factors by area from 2000–2010:

- IVbc+VIId: 1.04; VIIeh: 1.6; VIIafg: 0.62.

The accuracy of UK landings statistics is expected to have improved since the introduction of the Registration of Buyers and Sellers scheme in 2005/2006, particularly for recording of marketed landings of small vessels that do not have to supply EU logbooks. However, the official reported landings of sea bass in the UK are known to underestimate the true total landings, particularly for small-scale inshore fisheries where there has been no requirement to submit EC logbooks. Prior to the introduction of Buyers and Sellers requiring sales documentation, local fishery inspectors estimated landings of the under-10 m fleet using whatever information they had available from auctions, and frequently entered aggregated estimates for multiple vessels into the fishery landings database. Unfortunately the Buyers and Sellers regulations do not cover all landings. The EU Control Regulation allows landings of less than 30 kg to be disposed of for personal consumption without providing sales slips or other documents. This is ostensibly to reduce the administrative burden for a skipper disposing of small quantities for personal use. However, for small-scale fisheries where there are very large numbers of small vessels often catching small quantities, the cumulative catch of unrecorded small landings can be relatively high. This is likely to be an issue over the full time-series.

The UK(England) has previously carried out independent surveys to estimate historical landings data for sea bass, particularly for smaller vessels not supplying EU logbooks. A voluntary logbook scheme was carried out in conjunction with a biennial census of vessels catching sea bass. The census covers different segments of coast in different years (Pickett, 1990). The scheme was stratified by area, gear and vessel characteristics. Selected vessels from the strata kept logbooks for periods ranging from one to 25 years, and comprised what could be described as a "reference" fleet as opposed to a randomised selection of vessels each year. The scheme was terminated in 2007 and 2008, and reinstated for a further two years (2009 and 2010) before being terminated again. The scheme has now been suspended permanently. The landings tables in some earlier ACOM advice included "unallocated" landings which were the difference between the voluntary logbook estimates and the official UK statistics in each ICES area.

A review of the Cefas logbook scheme in 2012 (Armstrong and Walmsley, 2012a) showed that the previous estimates included recreational charter boats. After removal of these landings, the Cefas logbook estimates for nets and lines still showed substantial differences with official estimates (Figure B1.1). For fixed/driftnets, the landings including the Cefas logbook estimates for under 10 m vessels results in a landings series that is on average around three times higher than the official statistics. For lines, the ratio fluctuates around 3.0 for a large part of the series but was larger from 2000–2005. Insufficient logbooks were available for trawls to allow estimation of fleet-wide landings.

The Armstrong and Walmsley (2012a) review concluded that the survey is sensibly spread over a range of vessel types and gears, but is over-stratified and has insufficient (and declining) coverage of the many survey strata while using *adhoc*, judgment-based vessel selection schemes rather than randomized selection. Despite the potential biases, the survey results for commercial vessels confirm that the historical official reported landings of sea bass are likely to be underestimates. Neither data source for UK 10m and under vessels is considered accurate over the historical time series but ICES WGNEW (ICES, 2008) and IBPBass (ICES, 2014) found that the stock trends from a statistical assessment model were relatively insensitive to the choice of these two catch histories. The main effect of including the additional landings is to scale biomass estimates up without altering the trend. Total fishing mortality estimates are not affected, as the age profiles of the catches remains more-or-less the same, but the proportion of total F attributable to recreational fisheries in the final stock assessment is reduced slightly by the additional commercial landings. Given the small contribution of UK reported landings of under-10m fleets to total international landings of bass, the uncertainties concerning the level of bias in the Cefas logbook estimates, and the lack of such estimates after 2011, the official statistics have been retained in the current assessment. Of more concern would be any change in reporting accuracy over time, as this would lead to biased assessment trends using reported landings figures.

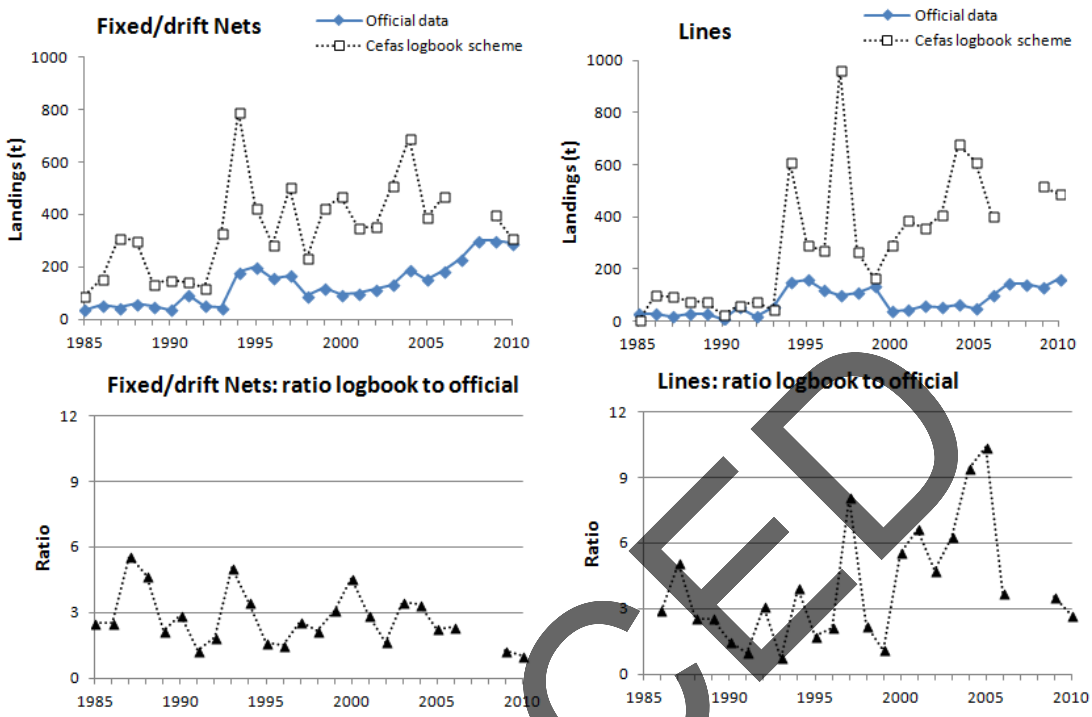


Figure B1.1. Top: estimates of sea bass landings for under-10 m UK netters and liners based on the Cefas logbook and port survey scheme. Bottom: ratio of landings of these gears including the Cefas logbook estimates for <10 m commercial vessels, and the total official reported landings of all UK vessels using these gears.

Dutch landings

Landings and effort data from the commercial fleet are available from the EU logbooks; market category composition of landings is available from the auction data (sale slips); and size and age data are available through market sampling. The fisheries were described in detail in van der Hammen *et al.* (2013).

EU logbook data

Official EU logbook data of the entire Dutch fleet are maintained by the NVWA (formerly known as the General Inspection Service, AID). IMARES has access to these logbooks and stores the data in a database (VISSTAT). EU logbook data contain information on:

- landings (kg): by vessel, trip, ICES statistical rectangle and species;
- effort (days absent from port): by vessel, trip and ICES statistical rectangle;
- vessel information: length, engine power and gear used.

Logbook data are available from the entire Dutch fishing fleet and from foreign vessels landing their catches in the Netherlands.

Auction data: landings by market category

Auction data cover both the total Dutch fishing fleet and foreign vessels landing their catches on Dutch auctions. These data are also stored in VISSTAT and contain information on:

- landings by market category (kg): by vessel, trip (landing date) and species.

Further information on availability and quality of landings data by country is provided by IBPBass (ICES, 2014).

B1.2 Discards estimates

UK data

Survey design and analysis

Estimation of bass discards is problematic because the observer scheme covers all vessel trips in a stratum without reference to target species, and overall it samples less than 1% of all fishing trips. As bass are absent or at very low numbers in a large fraction of fishing trips throughout the year, particularly in winter, the amount of sample data on bass is very low and the estimates are likely to have poor precision and variable biases related to inclusion of under 10 m vessels. Vessels under 10 m, that are responsible for a large fraction of bass catches, were excluded until recent years on health and safety and other logistical grounds, and although under 10 m vessels are now included since 2007, the fleet of vessels under 7 m remains excluded.

Raising of UK discards data to the fleet level is currently performed using a ratio estimator using the ratio of reported landings in a stratum to the computed retained weight of sea bass in sampled trips. This assumes that the retention curve for sampled vessels is representative of all vessels in the stratum.

Data coverage and quality

UK discards data are available for métiers associated with trawls and fixed/driftnets only. Discards from commercial line boats are expected to be relatively low and have high survival, so this fleet sector is excluded from the scheme for sea bass. As sampling is targeted at all species, annual coverage of the bass fisheries is relatively limited.

Numerically, the largest numbers of bass discarded from UK fisheries are from the bottom trawl fleet, with much smaller numbers from nets and even less from beam trawls. Only eleven midwater pair trawl trips were observed up to 2013, and discarding of bass was negligible as the fishery targets mainly adult bass. No bass discards were observed in the eight longline trips observed. The raised length frequencies of discarded and retained bass, aggregated over all years, are available along with the retention ogives. It is clear that discarding is driven primarily by the minimum landing size of 36 cm (see IBPBass 2014 report).

Sampling levels for UK and French discard sampling, and discards estimates, are given in the WGCSE report and updated annually.

French data

Survey design and analysis

The French sampling schemes also utilise vessel-list sampling frames and random selection of vessels within strata defined by area and fleet sector. From the activity calendars of French vessels for year n-1, vessels are grouped by the métiers practiced. Thus, a vessel may belong to multiple groups if practicing several métiers in the period. If the métier has to be sampled in priority No. 1, the vessel to be boarded is chosen randomly within this group of vessels. The observer then chooses to go on board for a trip. During the trip, the fishing operations corresponding to métier No. 1 are sampled. Optionally, if the vessel practices several métier during the trip, fishing operation of the métier No 2 will also be sampled if the métier No.2 is included in the annual sampling plan. If the métier is not part of the plan, it is requested to sample at least one fishing operation of this métier in the trip. (complete document on sampling protocol in French :http://sih.ifremer.fr/content/download/5587/40495/file/Manuel_OBSMER_V2_2_2012.pdf)

Data coverage and quality

Discards data are only available for French fleets from 2009 onwards. For 2012, results are described in the annual French report on:" http://archimer.ifremer.fr/doc/00167/27787/25978.pdf" for 2012. Discards estimates for France are from vessel selections that for some areas and gears include relatively limited numbers of observed trips where sea bass is caught and discarded. Precision is therefore very low at current sampling rates. In France the low sampling rate observed can be explain by the low discarding rate. Length frequencies were not available at IBPbass for 2013.

Spain

No bass discards were observed for any métier in the 2003-2013 period. Number of sampled hauls per métier and area were presented to IBP-NEW 2012 (see assessment report).

Discards data from other European countries

Discards data for Dutch beam trawlers were presented to ICES IBP-NEW 2012, as annual mean numbers discarded per hour in 2004–2010. No commercial fisheries for sea bass exist in Ireland.

B1.3 Recreational catches

Recreational marine fishery surveys covering different parts of the sea bass stock in the North Sea, Channel, Celtic Sea and Irish Sea have been developed in France, Netherlands, England and Belgium (ICES, 2012c). Survey design and methods of recreational catch estimation are described in IBPBass 2014.

Data from France

A survey of recreational fishers, focusing mainly on bass, was conducted between 2009 and 2011. Estimates of sea bass recreational catches were obtained from a panel of 121 recreational fishermen recruited during a random digit dialling screening survey of 15 000 households in the targeted districts. The estimated recreational catch of bass in the Bay of Biscay and in the Channel was 3170 t of which 2350 t was kept and 830 t released. The estimates for Subarea IV and VII were 940 t kept and 332 t released.

The precision of the combined Biscay and Channel estimate was relatively low (CV=26%; note that the figure of 51% given in IBPNEW 2012 (ICES, 2012a) was incorrect). This gives an average and 95% confidence intervals of 3170 t [1554 t; 4786 t] for the whole Subareas IV, VII and VIII. Increasing the panel from 121 to 210 fishermen would be expected to improve precision to 20% and increasing this panel to 500 would improve precision to 13%.

The main gears used, in order of total catch, were fishing rod with artificial lure, fishing rod with bait, handline, longline, net and spear fishing. Approximately 80% of the recreational catch was taken by sea angling (rod and line or handline).

A new survey was conducted from July 2011 to December 2012, based on a similar methodology to the previous study (not only on sea bass this time, but also on other marine species including crustaceans and cephalopods). A random digit dialling screening survey of 16 130 households led to the recruitment of a panel of 183 fishermen to keep logbooks. In parallel, 151 fishermen were recruited on site by the Promopeche association, and 30 more via the sea bass fishermen panel set up in 2009. This resulted in 364 panel members keeping logbooks describing their catches (species, weight, size, etc.) The focus of the survey on sea bass shows that in Atlantic (Bay of Biscay and Channel), the estimated recreational catch of bass in 2012 was 3922 t of which 3146 t was kept and 776 t released. At this time results have to be considered as provisional, (results split between Bay and Biscay and Channel are not available yet with relative standard error).

UK (E&W)

A new survey programme *Sea Angling 2012*, based on a statistically sound survey design started in 2012 to estimate fishing effort, catches (kept and released) and fish sizes for shore based and boat angling in England. The survey does not cover other forms of recreational fishing. Results are available in Armstrong *et al.*, 2013.

The surveys adopted, where possible, statistically-sound, probability-based survey designs, building on knowledge gained through participation in the ICES Working Group on Recreational Fishery Surveys (WGRFS). Two survey approaches were adopted: firstly a stratified random survey of charter boats from a list frame covering ports in England, and secondly an on-site stratified random survey of shore anglers and private boat anglers to estimate mean catch per day, combined with annual effort estimates derived from questions added to a monthly Office of National Statistics household survey covering Great Britain.

A list of almost 400 charter boats was compiled for the charter boat survey, and 166 skippers agreed to participate. Each month over a twelve month period in 2012 and 2013, 34 randomly-selected skippers completed a diary documenting their activities, catches and sizes of fish. A diary was completed whether or not any fishing took place. Data from 5300 anglers were collected. Total annual catches were estimated by raising the monthly catches per vessel from the diaries to all vessel-month combinations in the frame, and raising this to all vessels including refusals. The estimated total annual catch of sea bass for the entire coast of England was 44 t (RSE 31%) of which 31 t was kept. The release rate by number was 37%. The charter boat survey has potential bias due to the large non-response rate, if non-respondents have different catch rates to respondents.

The Office of National Statistics (ONS) household survey covered 12 000 households during 2012, and from this it was estimated that 2.2% of adults over 16 years old went sea angling at least once in the previous year. The surveys estimated there are 884 000 sea anglers in England. Estimation of fishing effort by shore and private boat anglers proved very difficult due to the overall low number of households with sea anglers in the survey. A range of methods was explored to estimate annual and seasonal effort using the ONS data alone, and combining it with observations from on-site and on-line surveys. It has not been possible yet to agree on a best estimate of effort, and for that reason the estimates of total catch (cpue × effort) for shore and private boat angling are given as a range of plausible values.

The survey of anglers fishing from the shore and private boats to estimate cpue was carried out throughout 2012 using on-site interviews. A stratified random design was adopted to select shore sites and boat landing sites on a weekly basis from site lists stratified into low-activity and high-activity sites. The shore survey used roving-creel methods (collecting data from partial angling trips), and the private boat survey a roving access-point survey (data from completed trips). Visits were made to 1475 shore sites and 425 private boat sites, and 2440 anglers were interviewed. The mean daily catch rate of kept and released fish of each species was estimated based on the survey design, and sizes of caught fish were recorded. Cpue for shore angling was estimated using catches for the observed trip duration and estimates of expected total trip duration for that day. A length-of-stay bias correction was applied based on expected total trip duration. The catch-per-day estimates were combined with estimates of total annual fishing effort (days fished) obtained from the ONS survey to estimate total annual catches. Release rates, by number, were 82% for shore angling and 57% for private boats. Non-response rates were very low (<10%) in this survey. The range of point estimates for shore-caught bass was 98–143 t (total) and 38–56 t (kept), and for private and rented boats was 194–546 t (total) and 142–367 t (kept). The relative standard errors for the individual shore and private boat estimates were relatively high at 40–50%.

Combining the catch estimates for charter boats, private boats and shore angling, the point estimates of annual kept weights of sea bass ranged from 230 t–440 t (Table 2.4.1c), compared with total UK commercial landings of almost 900 t in 2012. The combined estimates of bass catches had precision (relative standard error) estimates of 26%–38%for the different effort estimation methods. The relatively large standard errors combined with the range of plausible methods of estimating effort for shore and private boats.

Netherlands

Sea bass are taken by recreational sea anglers in the Netherlands. A recent survey investigated the amount of sea bass caught by recreational fishers (van der Hammen and de Graaf, 2012, 2015; ICES, 2012c) from March 2010 to February 2011 and from March 2013 to February 2013. Estimates of recreational sea bass were obtained from a panel of 1043 recreational fishermen (in the first survey) recruited during a telephone survey of 109 293 people. Revised estimates were provided to WGCSE 2013 (ICES, 2013a). The catch weights are estimated with a limited amount of length–frequency data, and are therefore less reliable than the estimates in numbers (and may also be adjusted if more data are available). For the same reason, there are no 'returned' estimates by weight (yet).

The estimated total recreational catch of sea bass was 366 000 fish (RSE 30%), of which 234 000 were retained, equivalent to 138 t. These results are mainly applicable to Subarea IV.

Belgium

A recreational fishing survey was conducted in 2013 in Belgium by the Belgian Fisheries Institute, using a questionnaire approach, in order to meet DCF requirements. The estimated retained catch of sea bass was 60 t.

Hooking mortality rates

The US National Marine Fisheries Service has in the past used an average hooking mortality of 9% for striped bass, estimated by Diodati and Richards (1996). Striped bass are very similar to European sea bass in terms of morphology, habitats and angling methods. A literature review of hooking mortality for a range of species compiled by the Massachusetts Division of Marine Fisheries included a total of 40 different experiments by 16 different authors where striped bass hooking mortality was estimated over two or more days (Gary A. Nelson, Massachusetts Division of Marine Fisheries, pers. comm.) The mean hooking mortality rate was 0.19 (standard deviation 0.19). Direct experiments are needed on European seabass to estimate hooking mortality for conditions and angling methods typical of European fisheries.

Total recreational catch

Total catches are given in the WGCSE report and updated when new estimates become available. They are also documented in the annual reports of the ICES Working Group on recreational fisheries (WGRFS).

B.2. Biological sampling

B2.1 Length and age compositions of landed and discarded fish in commercial fisheries

Length and age compositions of sea bass landings were available to WGCSE 2015 from sampling in the UK and France.

UK

Sampling methods and analysis

The UK(E&W) sampling programme for length compositions of sea bass covers sampling at sea and on shore. The sampling design for at-sea sampling is described above. The on-shore sampling programme uses an area list frame comprising port days, currently stratified by quarter, ICES Division and an index of "port size". "Large" ports are sampled more intensively than "small ports". Separate list frames of ports are established for pelagic trawlers, beam trawlers and demersal trawl, nets and lines. Sampling targets are set to achieve a specified number of port visits by stratum, taking account the need for fleet based as well as stock based data specified by the EU Data Collection Framework, although other diagnostics are monitored such as numbers of fish measures and otoliths/scales collected by species. This scheme has only been in development and operation since around 2010 when Cefas took over the sampling from the Marine and Fisheries Agency. Prior to then, the sampling targets were mainly set as numbers of fish of each species to measure or age by quarter, district, and gear groupings, with minimum numbers of sampling trips also specified to spread the sampling out.

Length compositions are first vessel-raised using ratios of landed live weight to predicted live weight of the length frequency calculated from a length–weight relationship:

$$W\ (kg) = 0.00001296\ (L+0.5)^{2.969}$$

Raised LFDs are then summed over vessels within a sampling stratum and raised to give total raised fleet LFDs per stratum, which are then combined. This procedure ensures sums-of-products ratios of 1.0, but will lead to some bias in numbers-at-length due to discrepancies between true fish weights and calculated fish weights from the length–weight relationship.

Data coverage and quality

Age compositions for UK commercial fishery landings of sea bass are derived from biennial (January–June and July–December) age–length keys (ALK) constructed for four areas: IVb,c; VIId, VIIe,h and VIIa,f,g. These are applied to fleet-raised landings length frequencies for each of four gear groups (bottom trawls; midwater trawls; fixed/driftnets and lines) in each area. Further details are given in the ICES IBP-NEW (ICES, 2012a) and WGCSE (ICES, 2013a) reports and in the stock annex along with tables giving numbers of trips sampled for length and age and numbers of fish measured and aged.

A recommendation of WGCSE 2013 was to expand the UK age frequencies to the full recorded age range and to re-evaluate the plus-group definition (previously at 12+). Sea bass have been recorded to almost 30 years of age, and it was thought that having more true ages in the Stock Synthesis input data could allow better estimates of early recruit deviations. The necessary extractions were done for IBPBass, and the data were examined in detail by Armstrong and Readdy (IBPBass Working Document_01). Bubble plots and catch curves showed that coherent information on year classes was present well beyond the last true age (11) previously adopted. The exploratory SS3 runs show that the different choices of plus-group (12+; 16+; 18+; 20+) have relatively little impact on the results, other than (as hoped) a slightly better estimation of early recruit deviations. Expanding the age compositions may help fit domed selection curves for fleets where this is appropriate, but risks an increasing number of zero catch entries for older ages as recent weak year classes feed into future catches and become depleted. A plus-gp of 16+ was recommended for further model development and agreed by IBPBass. Sampling of midwater trawls prior to 1996, and in 1997, was considered too poor to develop age compositions. All datasets show a very strong 1989 year class and very weak 1985–1987 year classes.

France

Sampling methods and analysis

The French sampling programme for length compositions of sea bass covers sampling at sea and on shore. Since 2009, both sampling types are first based on métiers composition and their relative importance per fishing harbours and month. Both are also designed to sample the whole catch following a concurrent sampling of species, potentially leading to low sea bass sample size. In order to complement this effort, specific sampling for sea bass at the market is added at times and harbours when higher landings are occurring, especially from métiers targeting sea bass. The sampling frame is based on the main harbours, gear types (or grouping of métiers) and month and is available to all samplers on a dedicated website. Real time follow-up of the plan, refusal rates and their reasons, time taken to sample, all this information is also available from the website, together with sampling protocol (in French:

http://sih.ifremer.fr/content/download/5587/40495/file/Manuel_OBSMER_V2_2_2012.pdf). Before 2009, only market specific sampling was in place, and the sampling plan was designed and followed by the stock coordinator. The French sampling programme for age compositions of sea bass is based on age–length keys with fixed allocation. For the VIIeh area, quarterly French landings at auctions are sampled in order to collect five scales (from 2000 to 2008) or three scales (from 2009) by length class (cm). For the VIIIab area the information is available only from 2010. For other areas the information is not available. All length samples are populated in a central database (Harmonie) and regular extracts are available in the COST format. Raising the data to the population is done using COST tools and a special forum for discussing the outcomes of the analysis is held every year in March, in order to gather all stock coordinators and prepare the datasets for the assessment working groups.

Data coverage and quality

Length compositions of French sea bass commercial landings are constructed from2014 for the area including IVb,c; VIId, VIIe,h and VIIa,f,g, for all métier. The input data for French fleets in Stock Synthesis are the fleet-aggregated length compositions in 2 cm classes (20–21.9, 22–23.9, etc.) for each year from 2000 onwards.

The statistical design of fishery sampling schemes has undergone change in recent years in the UK and France, following recommendations from ICES workshops on sampling survey design, with a move towards more representative sampling across trips within fleet segments. This can result in sampling more trips that have small catches of bass, and is one reason for the increase in numbers of sampled trips with bass since 2009 in France which does not imply an increase of the proportion in numbers of fish measured per trip.

Other countries

Fishery landings length or age compositions from other countries catching bass were not available to IBPBass 2014. The Netherlands did collect age samples of sea bass every year from 2005 to 2008. From 2010 onwards, age samples are collected only once every three year. In the IMARES market sampling data on length, age, sex and weight are collected for several commercially important species. For sea bass this is done on an irregular basis and data are only available for some years. Market sampling is done since 2005. The age sampling frequency is now set triennially (2010, 2013, etc.) Every three years four samples of 15 fish (60 fish in total) are aged, and every year the lengths of 24 samples of 15 fish (360 fish in total) are taken. Otoliths and scales that are retrieved from the fish are sent to Cefas in the UK for age reading. Length samples are collected every year. All samples are collected in the auctions where most sea bass is landed, in the south of the Netherlands. The quality of the data is good enough to use them in assessments. However, both the length and age data need processing before they can be inserted in an assessment.

Effective sample sizes for length and age compositions

The effective sample size for annual estimates of length or age composition lie between the number of trips sampled and the number of fish measured or aged, due to cluster sampling effects. Effective sample sizes have not been computed yet for UK and French sampling data for sea bass. In the meantime, ESS for the combined UK trawls, nets and lines fleet are set at 100 for each year (20 for 1985–1990), and for the French combined-fleet LFDs, the ESS is set at 200 for each year.

Accuracy and validation of age estimates

Age-reading consistency

Consistency in age reading of sea bass between four operators in Cefas and Ifremer was examined during a limited exchange of otolith and scale images between laboratories in 2011, organised by the ICES Planning Group on Commercial Catches, Discards and Biological Sampling (Mahé *et al*., 2012). A total of 155 fish of 17–74 cm was sampled on board French research vessels during two international surveys. The precision of ageing was similar for scales and otoliths. The coefficient of variation of age readings for individual fish was around 12% implying a standard deviation of +/- 1 year for a ten year-old fish, with relatively few fish having identical readings by all four operators. However it was noted by the operators that photographic images were more difficult to evaluate than original age material, which was likely to have a negative effect on the consistency of ageing. These results provide no indication of the validity of ages, only the consistency between operators, and cannot indicate data quality in earlier years when different operators provided the age data. A more extensive age exchange is to be carried out in 2015.

Age validation

WGCSE and IBPBass were not aware of specific studies to validate absolute ages of sea bass derived from otolith or scale readings. Strong and weak year classes can be followed clearly to over 20 years of age in UK sample data although it is not known to what extent the elevated numbers of sampled fish in immediately adjacent year classes is a true reflection of year-class strength or a consequence of age errors discussed in the previous section. Year-class tracking is less clear in the younger ages 3–5 although this will be affected by gear selectivity and changes in fish behaviour.

Sea bass show relatively broad length-at-age distributions, and it has been noted in French data (Laurec *et al.*, 2012 WD to IBP-NEW) that the length-at-age distributions can have unusual patterns including some multiple modes that could indicate age errors. This will result in some smoothing of age data across neighbouring year classes. In the UK data, unusual patterns in length-at-age distributions for some younger ages appear related more to effects of minimum landing size on data from the fishery.

Inclusion of age error parameters in Stock Synthesis model

CVs for ageing error by age class can be input to Stock Synthesis. Based on the ICES sea bass scale exchange in 2002, the CVs of ~12% can be specified as increasing values per age class to give a standard error of ~1 year per age class.

B2.2 Growth parameters

Pickett and Pawson (1994) provide plots of growth curves for female and male bass based on samples collected in the 1980s in Areas IV and VII. The samples used by Pickett and Pawson (1994) for growth and maturity analysis were obtained from a range of fishery and other sources.

A re-analysis of UK historical age–length data including more recent samples was conducted in 2012, using data for the full UK sampling series from 1985 to 2010 (Armstrong and Walmsley, 2012b). The data are derived from sampling of UK fishery catches around England and Wales as well as from trawls surveys of young bass in the Solent and Thames estuary. More than 90 000 sea bass have been aged since 1985. The inshore surveys are mainly young sea bass up to 3–5 years of age, whereas the fishery samples include fish up to 28 years of age.

All ageing is done from scales, excluding scales considered to be re-grown. On surveys, scales are collected in a length-stratified manner from individual hauls with a view to building age–length keys. A similar approach has historically been adopted for catch sampling. This may lead to non-random sampling of individual age groups when the catch numbers are well in excess of numbers sampled from an individual catch. It will also lead to some overestimation of the standard deviation of lengths-at-age.

All ages for fitting growth curves are referred to a nominal January 1 birthdate, according to month of capture. Parameters of the von Bertalanffy growth curve were fitted in Excel Solver using non-linear minimisation of $\sum(\text{obs-exp})^2$ for lengths-at-age of individual fish, by area and for all data combined.

Von Bertalanffy model parameters were as follows:

AREA	IVBC	VIID	VIIE	VIIAFG	ALL AREAS
Linf (cm)	82.98	87.22	92.27	81.87	84.55
K	0.1104	0.09298	0.07697	0.09246	0.09699
t_0 (years)	-0.608	-0.592	-1.693	-1.066	-0.730

Standard deviation of length-at-age distributions increases linearly with age according to:

SD (age) = 0.1166*age + 3.5609

The sampled sea bass show some sexual dimorphism of growth from about seven years of age onwards. It is currently not possible to implement a sex-disaggregated Stock Synthesis assessment, therefore a combined-sex growth curve is adopted. Mean length-at-age has not shown any trend over time, and length-at-age is also very similar in strong and weak year classes (Armstrong and Walmsley, 2012b). Hence data have been combined over the full series to estimate growth parameters.

B2.3 Maturity

Spawning grounds and season

Ripe adult bass have been caught by pelagic trawling in the south of Division VIIIa and in the north of Division VIIIb in the Bay of Biscay during January–March (Morizur, unpublished data), and planktonic egg surveys (Thompson and Harrop, 1987; Jennings and Pawson, 1992) have shown that bass spawn offshore in the English Channel and eastern Celtic Sea from February to May. Spawning started in the Midwestern Channel when the temperature range associated with bass egg distributions was 8.5–11°C, and appeared to spread east through the Channel as the surface water temperature exceeded 9°C. Seasonal patterns of occurrence of advanced maturity stages in UK samples also indicate spawning mainly January to May in ICES Areas IV and VII (Armstrong and Walmsley, 2012c). Spawning and ripe bass are also found in the southern North Sea (information from commercial fisheries and angler reports in Netherlands supplied to IBP-NEW 2012 by F. Quirijns).

Previous estimates of maturity at length/age, and data available for re-analysis

SGBASS (ICES 2004) reported that around Britain and Ireland, male bass mature at a length of 31–35 cm, aged 4–7 years, and females at 40–45 cm, aged 5–8 years, (Kennedy and Fitzmaurice, 1972; Pawson and Pickett, 1996), and data from the southern part of the Bay of Biscay (Lam Hoai, 1970; Stequert, 1972) indicate that male matures at a length of 35 cm (age 4) and females at 42 cm (age 6). Data provided by Masski (1998) from samples taken from VIIe bottom trawlers (41 females) indicate that 40% and 82% of females were mature at-age 6 and 7 respectively, with a very small percentage mature at-age 5.

Collection of maturity data are difficult as few adult bass are caught in surveys and bass are typically landed whole and are extremely expensive to purchase. Samples collected by the UK (Cefas) during 1982–2003 and 2009 in ICES Areas IV and VII were reanalysed for ICES IBP-NEW 2012 (Armstrong and Walmsley, 2012c). Samples have come from all around the coast of England and Wales, though few fish have been sampled in the Irish Sea (VIIa).

Defining a maturity marker for sea bass

Sea bass are multiple batch spawners, as indicated by size distributions of oocytes (eggs) in ovaries (Mayer *et al.*, 1990). This means that the ovary will start to mature oocytes through to vitellogenic stages during the months immediately prior to the spawning season. Historical maturity staging of sea bass by the UK has used the maturity key given in Pawson and Pickett (1996; Table B2-1). In their analyses, they treated stage 2 as mature, and stage 3 as immature. Their reasoning was that stage 3 ovaries (early maturing) were found in smaller bass than later stages (4+) indicating that many of these fish may not proceed to spawning. Sea bass migrate offshore to spawning grounds, and it is likely that early maturing fish could be over-represented, and advanced maturing fish under-represented in inshore catches sampled during the period of spawning migrations. An additional spent stage (VIII) has been occasionally recorded.

The identification of a suitable marker to identify maturity has to take into account the probability of finding a fish at any maturity stage in different months, the duration of a stage, and the availability/catchability of fish at that stage of maturity. When the majority of mature sea bass have entered the batch spawning cycle in spring, all stages represented in batch spawning (III to VII) will be evident and should be distinct from immature fish. Hence, the best markers for maturity are the maturity stages representing different stages in the batch spawning cycle, sampled at a time when spawning is taking place (or immediately before), provided fish in all stages are equally catchable. This is the conclusion of recent ICES workshops on maturity staging of gadoids and flatfish, which recommends sampling within a month or so of the beginning and end of the spawning season. Experience with other roundfish and flatfish stocks is that it can be very difficult to distinguish between virgin females and fish that have spawned previously, when sampled in the non-spawning period. The UK data were therefore re-analysed using samples from December to April, treating all fish of maturity stages 3 to 7 as mature.

Re-estimation of maturity ogives from UK data

Maturity was modelled using a binomial error structure and logit link function, fitted in R to individual observations. The logistic model describing proportion mature by 1 cm length class *L* was formulated as:

$$\text{Pmat}(L) = 1/(1+e^{-(a+bL)})$$

defined by the parameters slope *b* and length intecept*a*. These parameters were estimated separately for females and males.This can also be expressed as:

$$\text{Pmat}(L) = 1/(1+e^{-b(L+c)}) \text{where } c = a/b$$

Stock Synthesis uses the second formulation, and the parameters required are the slope (b = 0.3335: entered as a negative value) and the length inflection, which is the estimated length at 50% maturity ($L^{50\%}$ = 40.65 cm).

The 2009 data come from a large sample of sea bass taken in spring from a few trips specifically to revisit bass maturity, but this sample dominates the time-series of sampling which is spread over very many more trips and months than in 2009 and therefore has better coverage. Maturity ogives were therefore fitted including and excluding 2009 data. The inclusion of 2009 data, which were for a relatively restricted length range of fish around 40 cm, has the effect of improving the fit of the model near the top of the ascending limb of the maturity ogive for females (Figure B2-1). However the very high weighting for these lengths compared to the data for lengths <35 cm results in the model fitting very poorly to the smaller length classes. Excluding the 2009 data allow the length classes <35 cm to carry more weight, and the ogive appears to fit the data for 30–40 cm sea bass more closely, although the fit for lengths >40 cm is poorer. Addition of the 2009 data effectively shifts the L50% from around 41 cm to 35 cm. In contrast, inclusion or exclusion of the 2009 data has less effect on the model fit for males (Figure B2-1). On balance, it was considered undesirable for a few large hauls in a recent year to have excessive leverage in the model fit, and the model excluding 2009 was considered preferable as a long-term maturity ogive for use in assessments.

Table B2-1. Macroscopic characteristics of the maturity stages of the gonads of bass. (Pawson and Pickett, 1996)

Maturity stage		Ovary	Testis
I	Immature	Small thread-like ovary, reddish-pink	Small, colourless, thread-like; testis not practical to differentiate macroscopically <TL 20 cm
II	Recovering spent	Ovaries one-third length of ventral cavity, opaque, pink with thickened walls and may have atretic eggs	Testis one-third length of ventral cavity, often bloodshot with parts dark grey
III	Developing (early)	Ovaries up to one-half length of ventral cavity, orange-red, slight granular appearance, thin, translucent walls	Testes thickness 10–20% of length, dirty white, tinged grey or pink
IV	Developing (late)	Ovaries greater than one-third length of ventral cavity, orange-red; eggs clearly visible, but none hyaline	Testes flat-oval in cross-section and thickness >20% of length, half to two-thirds of ventral cavity. White colour and milt expressed from vent if pressure applied to abdomen
V	Gravid (ripe)	Swollen ovaries two-thirds length of ventral cavity, pale yellow-orange; opaque eggs clearly visible with some hyaline	Testes bright white and more rounded-oval in cross-section. Only light pressure required to cause milt to flow from vent
VI	Running	Ovaries very swollen; both opaque and larger hyaline eggs clearly visible beneath thin almost transparent ovary wall, and expressed freely with light pressure	Testes becoming grey-white and less turgid. Milt extruded spontaneously
VII	Spent	Ovary flaccid but not empty, deep red; very thick ovary wall; dense yellow atretic eggs may be visible	Testes flattened and grey, flushed with red or pink, larger than those at stage II or III

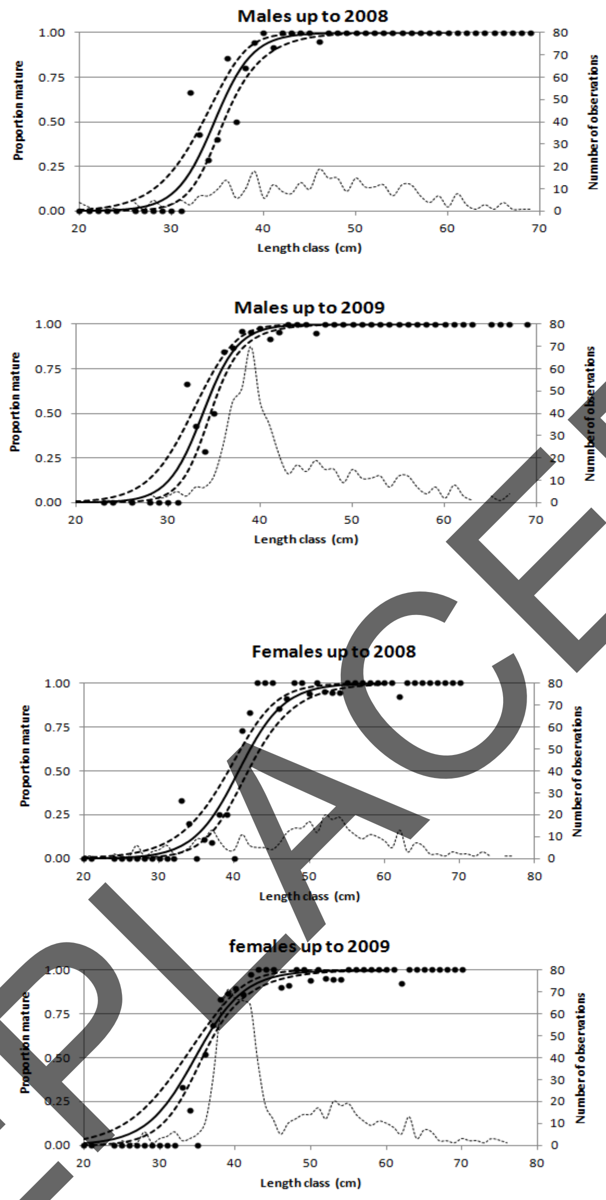


Figure B2.1. Logistic maturity ogives (with 95% confidence intervals) fitted to individual maturity records for sea bass during December–April. Top plot: excluding 2009 data (top); bottom plot: including 2009 data. Points are proportion mature in the raw data. Dotted line is the number of observations per length class.

The parameters of the model $Pmat(L) = 1/(1+e^{-b(L+c)})$ are given below:

	FEMALES	MALES
Intercept (a)	-13.556	-16.851
Slope (b)	0.3335	0.4861
c = a/b	-40.6488	-34.6652
L25%	37.35	32.41
L50%	40.65	34.67
L75%	43.95	36.93

The logistic model for females and males is:

Pmat(L) = 1/(1+e-0.3335(L-40.6488)) (females)
Pmat(L) = 1/(1+e-0.4861(L-34.6652)) (males)

The maturation range for females occurs at-ages 4 to 7, and for males at ages 3–6, as shown by the proportion mature at-age in the same samples used for estimation of length-based maturity ogives (Table B2-2).

Table B2-2. Raw proportion mature at-age in 1982–2003 UK samples from all areas.

	Females	Males
age 2	0.00	0.00
age 3	0.00	0.27
age 4	0.17	0.54
age 5	0.21	0.61
age 6	0.55	0.91
age 7	0.95	0.98
age 8	1.00	1.00
age 9	0.95	0.98
age 10+	1.00	1.00

Data on sea bass maturity have also been collected in the Netherlands since 2005. Methods and data are described by Quirijns and Bierman (2012). For male fish, too few specimens were measured to estimate maturity. Maturity-at-age and length are plotted in Figure B2-2. Note that only few fish were measured in the lowest age and length groups. At age 4, 50% of the females are mature. This is substantially lower than the age at 50% maturity in the Cefas 1982–2003 samples (Table B2-2), and closer to the ogive from Cefas data including the large 2009 sample (Figure B2-1), for which L50 was around 35 cm (~4 years old). This may confirm that sea bass could now be maturing earlier than in the 1980s–early 2000s, at least for the North Sea. The plot showing maturity-at-length for Netherlands samples is not based on enough measurements to show a reliable maturity ogive.

Figure B2-2. Proportion of mature at-age and length (length in m) for female sea bass sampled in the southern North Sea by the Netherlands during 2005 (thick line). The thin line shows the number of fish measured on which the proportion of maturity is based.

B2.4 Larval dispersal, nursery grounds and recruitment

Bass larvae resulting from offshore spawning move steadily inshore towards the coast as they grow and, when they reach a specific developmental stage at around 11–15 mm in length (at 30–50 days old), it is thought that they respond to an environmental cue and actively swim into estuarine nursery habitats (Jennings and Pawson, 1992). From June onwards, 0-group bass in excess of 15 mm long are found almost exclusively in creeks, estuaries, backwaters, and shallow bays all along the southeast, south, and west coasts of England and Wales, where they remain through their first and second years, after which they migrate to over-wintering areas in deeper water, returning to the larger estuaries in summer. Several studies indicate the existence of similar bass nursery areas in bays and estuaries on the French coasts of the Channel and Bay of Biscay and southern Ireland.

During the winter, juvenile bass move into deeper channels or into open water, and return in spring to the larger estuaries and shallow bays on the open coast, where they remain for the next 2–3 years.

On the south and west coasts of the UK, juvenile bass emigrate from these nursery areas at around 36 cm TL (age 3–6 years, depending on growth rate), often dispersing well outside the 'home' range, and not necessarily recruiting to their specific parent spawning stock (Pawson *et al.*, 1987; Pickett and Pawson, 2004). It appears that there is substantial mixing of bass at this stage throughout large parts of the populations' distribution range. When they reach four or five years of age their movements become more wide-ranging and they eventually adopt the adult feeding/spawning migration patterns (Pawson *et al*., 1994).

Sea temperature has a strong influence on sea bass dynamics, affecting spatial distributions, and also the growth and survival of young bass in nursery areas during the first years of life (Pawson, 1992; WGCSE, 2014).

B2.5 Natural mortality M

There are no direct estimates of natural mortality available for Northeast Atlantic sea bass. Predation up to around age 4 will be in and near estuaries and bays. As with other fish species it is expected that M will be relatively high at the youngest ages, particularly given the slow growth rate in bass. A variety of methods are given in the literature relating natural mortality rate M to life history parameters such as von Bertalanffy growth parameters k and Linf (asymptotic length), length or age at 50% maturity and apparent longevity particularly in an unexploited or very lightly exploited population. The probability of encountering very old bass is partly a function of the interaction of year class strength and sampling rates, as well as mortality, however the occurrence of sea bass to almost 30 years of age suggests low rates of mortality. The observed maximum age of 28 years in sea bass samples in the UK was recorded in the early 1980s, following a period of relatively low fishery landings. Age compositions of recreational fishery caught bass in southern Ireland, presented by stakeholders at IBP-NEW 2012, also show ages up to 26 years (Figure B2-3). This stock has been subject to a commercial fishery ban for many years.

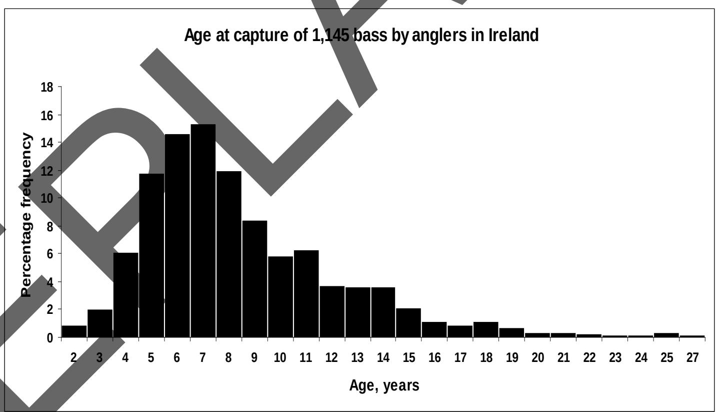


Figure B2-3. Age composition of bass from samples collected from recreational catches in southern Ireland (data courtesy Ed Fahy, IBP-NEW 2012 meeting).

Inferences on sea bass natural mortality based on some life-history models in the literature are given in IBP-NEW 2012 benchmark assessment section. The inferred values of M, with the exception of the Beverton method, are in the range 0.15–0.22 (Armstrong, 2012).

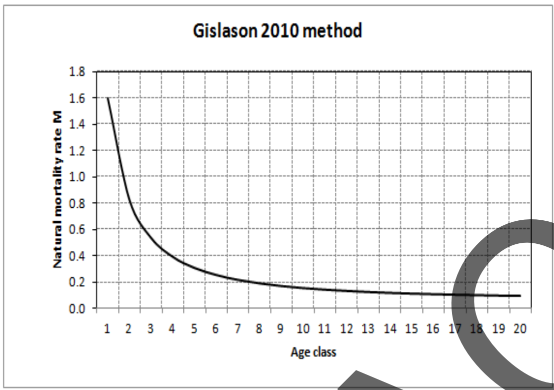
A variety of methods are given in the literature relating natural mortality rate M to life-history parameters such as von Bertalanffy growth parameters k and L_{inf} (asymptotic length), length or age at 50% maturity and apparent longevity particularly in an unexploited or very lightly exploited population. The method of Gislason *et al*. (2010) generates age-varying M values. These methods were applied to the following sea bass life-history parameters by Armstrong (2012):

LIFE-HISTORY PARAMETERS	
VBGF K (combined sex)	0.097
VBGF Linf (combined sex)	84.55
VBGF to (combined sex	-0.73
Age at 50% maturity females (L50% converted to age)	6
Age at 50% maturity males (L50% converted to age)	4
Max age (combined sex)	28
Length at 50% mat females	40.65
Length at 50% mat males	34.67

The probability of encountering very old bass is partly a function of the interaction of year-class strength and sampling rates, as well as mortality, however the occurrence of seabass to almost 30 years of age suggests low rates of mortality. The observed maximum age of 28 years in sea bass samples in the UK was recorded in the early 1980s, following a period of relatively low fishery landings although recreational fishing was occurring throughout this period. Age compositions of recreational fishery caught bass in southern Ireland, presented by stakeholders at IBPNew 2012, show ages up to 26 years. This stock has been subject to a commercial fishery ban for many years.

Inferences on natural mortality rates are given below:

Source	Formulation	Combined sex M		
Hoenig 1983	variety of taxa ln(M) = 1.44-0.982*ln(tmax);	0.160		
	teleosts ln(M) = 1.46-1.01*ln(tmax)	**0.149**		
Alverson and Carney 1975	M = 3k/(exp(0.38*tmax*k)-1)	**0.161**		
Pauly 1980	M=exp(-0.0152+0.6543*ln(k)-0.279*ln(Linf,cm)+0.4634*lnT(oC))	0.196	temperature C	12
		0.211		14
		0.224		16
Ralston 1987	M=0.0189+2.06*k	**0.219**		
Beverton 1992	M=3k/(exp(*am* *k)-1) am = age at 50% maturity	0.369	female *am* ; comb sex k	
		0.614	male *am* , comb sex k	
Jensen (1997)	M=1.5K	**0.146**		
Gislason 2010	M = exp(0.55-1.61*Ln(L) + 1.44* Ln (Linf)+ Ln(K))	**Age class**	Length	M
		1	13.1	1.599
		2	19.7	0.827
		3	25.7	0.539
		4	31.1	0.395
		5	36.1	0.312
		6	40.5	0.258
		7	44.6	0.221
		8	48.3	0.195
		9	51.6	0.175
		10	54.7	0.159
		11	57.5	0.147
		12	60.0	0.138
		13	62.2	0.130
		14	64.3	0.123
		15	66.2	0.117
		16	67.9	0.113
		17	69.4	0.109
		18	70.8	0.105
		19	72.1	0.102
		20	73.2	0.100



The inferred values of M, with the exception of the Beverton method, are in the range 0.15–0.22. The average of the Gislason estimates for ages 3–20 is 0.19, and the estimates fall below 0.15 by age 11. The value M=0.2 was adopted by WGCSE 2013

B.3 Surveys

B3.1 UK Solent and Thames pre-recruit surveys

The UK has conducted pre-recruit trawl surveys in the Solent and the Thames Estuary since 1981 and 1997 respectively. These surveys all ended in 2009 although the Solent survey was repeated as a one-off survey in autumn 2011 to help provide recruitment indices for the bass benchmark assessment. The location of the surveys and the tow positions are shown in Figure B3-1. Both surveys use a high headline bass trawl, although in the Thames it is deployed as a twin rig and in the Solent as a single rig.

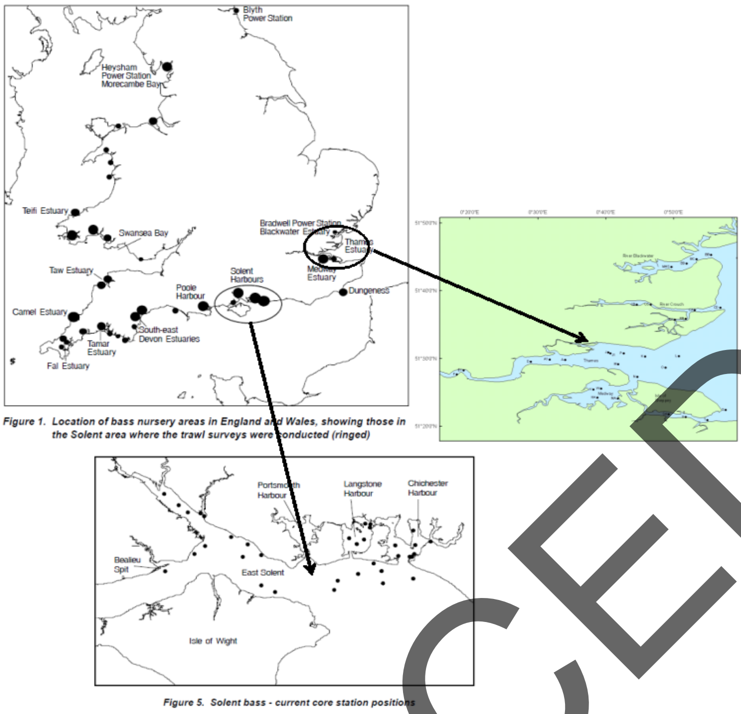


Figure B3-1. Location and tow positions for UK(England) Solent and Thames sea bass surveys.

The Solent survey has previously been presented to WGNEW as a combined index across ages in each year class. The index was derived by firstly rescaling the annual mean catch rate per age class to the mean for that age in the survey series, then taking the average of the rescaled values for ages 2–4 in each year class from surveys in May–July and September (i.e. up to six values represented in the annual combined index). The Thames survey data were worked up in the same way, although using a different age range for the combined index (ages 0–3). WGNEW 2012 provided the survey data in the more conventional tuning-file format, giving the standardised catch rates (arithmetic mean numbers per 10 minute tow) by year and age, separately for the two surveys (data in assessment report). These surveys have now been discontinued and will not be updated by future working groups unless new resources are allocated.

The spring and autumn Solent survey index series are updated to include the autumn 2013 survey and to amend an error in the autumn survey indices in 2000. The surveys do not show major year-effects, but as noted in previous assessments the autumn (September) survey shows a general increase in recruitment during the 1990s up to the mid-2000s, with very low indices for the 2008 onwards year classes, whilst the spring survey shows poor recruitment from around 2002 onwards. Previous Stock Synthesis runs show that the autumn survey is much better fitted than the spring survey. The spring survey is likely to be more strongly affected by weather and by temperature effects on distribution.

The Thames survey series indicates an increase in recruitment from the mid-1990s to early 2000s followed by some poor year classes, possibly a strong 2007 year class, then weak year classes in 2008 and 2009. A problem with the use of the Thames survey is that it may reflect recruitment from spawning that became established in the southern North Sea as the stock expanded in the 1990s under warmer sea conditions, and may therefore not reflect recruitment trends that influence the larger stock components in the Channel and Celtic Sea.

A justification of using the Solent survey as an index of recruitment over the full range of the stock was the results of a statistical, UK-only fleet-based separable model developed by Pawson *et al*. (2007) and updated by ICES WGNEW (Kupschus *et al*., 2008). The Pawson *et al*. model was fitted only using UK age compositions for trawls, midwater trawls, nets and lines, separately for ICES Divisions IVbc, VIId, VIIeh and VIIafg, and was intended mainly to estimate fleet selection patterns. Although it excluded any tuning data, the recruitment-series for each sea area closely resembled the Solent survey indices and to an extent the shorter Thames series, and was able to provide coherent selection patterns by fleet.

The full Solent survey series was subject to a change in gear design in 1993. Some comparative trawling was carried out to develop age-varying calibration factors, but these are poorly documented and the original raw data and calibration results are currently being sought at Cefas. Pending an evaluation of this, the benchmark Stock Synthesis runs included a sensitivity run with the series split into two periods around the gear change. Some additional issues with calibration factors applied to the spring survey were detected during the benchmark, and this is considered later in the sections on model development.

A precision estimate was calculated for the Solent and Thames surveys based on the between-tow variations in catch rate of all the age classes used in the index. For the Solent spring, Solent autumn and Thames surveys, the relative standard errors were 0.42, 0.25 and 0.43 respectively.

IBP-Bass 2014 reviewed the performance of the Solent and Thames surveys and decided to exclude the Solent spring and the Thames survey for the following reasons:

- The Solent spring survey (Table B.3.1) has performed poorly in the assessment, indicating trends in recruitment not in accord with other data. This may be related to temperature or other environmental effects on distribution of small bass in spring. Unusual calibration factors noted in some years in the Solent spring data files require investigation.
- The Thames survey (Table B.3.2) may reflect recruitment from spawning that became established in the southern North Sea as the stock expanded in the 1990s under warmer sea conditions, and may therefore not reflect recruitment trends that influence the larger stock components in the Channel and Celtic Sea.

The removal of these surveys has negligible impact on the estimated stock trends.

Table B.3.1. Time-series of relative abundance indices for seabass age groups 2, 3 and 4 from the UK Solent spring and autumn trawl surveys. A change in trawl design took place in 1993.

	May–July			September		
Year	age 2	age 3	age 4	age 2	age 3	age 4
1981	0.00	0.30	0.25	No survey		
1982	0.51	2.17	0.16	3.25	10.10	0.38
1983	No survey			9.87	0.91	1.88
1984	0.95	2.66	0.43	1.38	0.65	0.09
1985	0.00	10.33	2.56	No survey		
1986	No survey			0.27	4.26	1.31
1987	0.00	0.42	3.18	0.05	0.28	2.27
1988	0.00	0.02	0.47	No survey		
1989	No survey			6.68	0.37	0.00
1990	2.84	2.48	0.00	2.81	1.15	0.02
1991	5.78	0.62	0.09	3.08	0.21	0.03
1992	0.11	7.04	0.35	0.95	18.59	0.16
1993	0.05	7.33	14.02	6.65	3.59	4.39
1994	0.04	1.63	1.14	3.33	1.84	0.29
1995	0.05	1.57	0.97	4.83	4.69	0.72
1996	1.43	4.09	3.36	5.52	0.43	0.11
1997	0.27	1.94	0.11	33.62	4.52	0.06
1998	0.00	6.75	5.79	1.22	5.50	0.61
1999	0.61	0.95	12.30	19.37	0.67	0.87
2000	0.49	37.03	1.06	6.07	11.35	0.03
2001	1.71	6.33	3.43	34.42	3.92	1.57
2002	0.63	1.62	0.29	7.42	3.87	0.40
2003	0.06	0.32	0.38	8.37	4.60	0.59
2004	0.17	0.28	0.16	No survey		
2005	0.05	0.42	0.35	13.12	7.98	0.84
2006	0.44	2.47	1.03	9.51	9.21	1.02
2007	0.33	0.50	0.50	3.42	1.78	0.30
2008	No survey			18.52	6.66	0.34
2009	0.72	1.03	0.13	13.25	6.25	0.33
2010	No survey			No survey		
2011	No survey			2.25	1.39	0.42
2012	No survey			No survey		
2013	No survey			1.34	0.08	0.10

Note: September 2000 data amended.

Table B.3.2. Time-series of relative abundance indices for seabass age groups 0–3 from the UK Thames trawl survey.

Year	age 0	age 1	age 2	age 3
1997	7.737	0	0.048	0.41
1998	No survey			
1999	19.54	6.033	0.764	0
2000	4.015	14.74	0.832	0.089
2001	121.5	11.47	5.108	0.171
2002	469	20.71	2.716	1.093
2003	225.6	35.76	4.429	0.159
2004	238.92	44.99	7.32	1.03
2005	37.04	14.49	6.86	0.75
2006	245.54	11.26	3.46	0.94
2007	No survey			
2008	107.55	50.69	1.86	0.2
2009	95.43	7.79	13.59	0.91

B3.2 Other 0-gp & 1-gp surveys

The UK has undertaken a seine net survey in the Tamar Estuary, since 1985. Additional data are available from the Camel estuary and power stations in the Thames and Severn Estuary. These surveys are used as supporting information and not included in the assessment. Abundance indices for these surveys are given in Table B3.1. The Tamar survey abundance indices need to be updated to include more recent surveys. Seine net surveys in the UK estuaries Fal and Helford also have data on 0-gp and 1-gp bass.

Table B3-1. Abundance indices for 0-gp and 1-gp bass. († discontinued).

	Estuary seine surveys			Power station screen	
	Tamar (0-group)	Tamar (1-group)	Camel	Severn	Thames
	VIIe	VIIe	VIIf	VIIf	IVc
1972				3	
1973				4	
1974				1	
1975				15	78
1976				127	100
1977				-	6
1978				-	5
1979				-	5
1980				9	37
1981			2	216	21
1982			123	83	56
1983			30	226	83
1984			134	8	62
1985	0.663	0.385	22	11	76
1986	0.005	0.014	1	3	14
1987	0.032	0.062	31	96	116
1988	1.484	1.284	48	98	54
1989	2.348	2.389	112	446	610
1990	1.038	1.516	89	25	433
1991	0.076	0.058	50	300	64
1992	2.216	2.431	25	280	104
1993	1.013	0.913	22	202	131
1994	1.126	0.346	134	-	26
1995	2.356	1.294	-	-	27
1996	0.102	0.047	119	242	†
1997	1.119	1.299	102	†	
1998	2.082	3.170	264		
1999	1.215	0.937	56		
2000	0.340	1.185	133		
2001	0.351	0.129	†		
2002	2.098	3.179			
2003	0.965	1.067			
2004	1.453	0.261			
2005	0.522	0.169			
2006	0.186	0.203			
2007	0.475	1.308			
2008	1.275	1.229			
2009	0.460				

B3.3 Evhoe survey: France

Sea bass are caught in small numbers in the French Evhoe trawl survey, which extends to the shelf edge in Subareas VII and VIII but also extends into coastal areas of the Bay of Biscay and the Celtic Sea where bass may be caught (cf the station map). Less than 10% of the stations have bass catches in most years. A mean of 0.5 sea bass per trawl has been recorded from 1987. Abundance indices are calculated as stratified means.

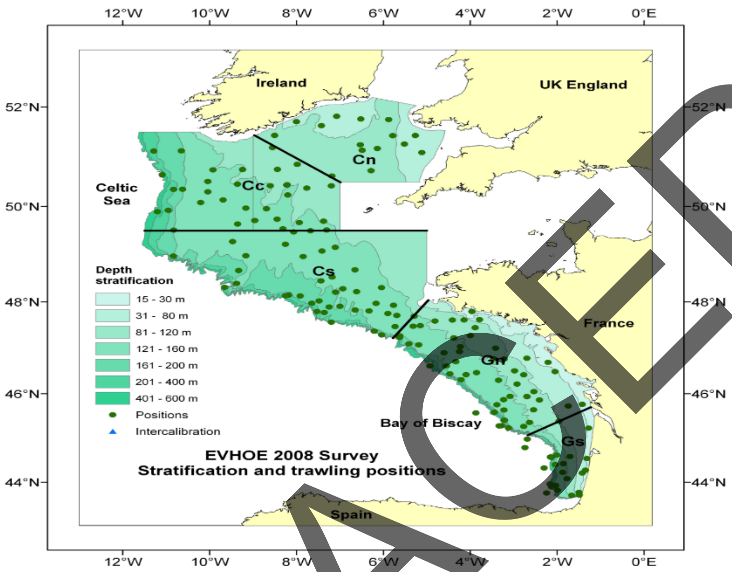


Figure B 3-2. Station positions for French Evhoe bottom-trawl survey (not used in assessment).

B3.4 Channel Ground Fish Survey (CGFS): France

Raw data on sea bass from the French scientific trawl survey "Channel Ground Fish Survey - CGFS" were not available for the previous benchmark in 2012 (IBPNEW, ICES, 2012). Details of the survey are given in Coppin *et al.* (2002), which includes a full description of the GOV trawl used in October each year at the 82 stations in ICES Division VIId shown in Figure B3.3. The majority of sea bass are caught in the coastal waters of England and France (Figure B3.3). The abundance indices from all the stations give similar trends as from a subset of stations in the main coastal areas, and trial runs with SS3 gave similar trends. Therefore, for further SS3 development, the indices calculated from all the area are used.

The abundance indices are calculated applying a stratified random swept-area based estimator. Strata correspond to ICES statistical rectangles. Swept-area is calculated using wingspread. As this is a stratified swept-area based indicator, uncertainty is based on between haul variance within a strata and summation of variances across strata. Full methodology is presented in the WD_01, available in Annex 2 of the IBPBass report 2014. The trends in both the index and in the proportion of stations with sea bass show some similarities to the trend in total biomass estimates from the ICES WGCSE 2013 update assessment using Stock Synthesis, which lent *a priori* support to the use of the index in the assessment. The swept-area indices of abundance, the percentage of stations with sea bass, and the variance of the estimates are included in the WGCSE 2014 report and will be updated annually. The length composition of the survey index is calculated and is also input to Stock Synthesis.

The precision of the swept-area indices appears unrealistically high in some years (e.g. 0.025 in 1991), which may indicate that the index trends are driven largely by the incidence of positive catches. Modelling of the data using delta lognormal models may provide more realistic precision. During trial Stock Synthesis runs, the use of the CVs resulted in an inability to fit the selection curve for the survey due to individual years being given far too much weight. Relaxing the CVs to 0.30 for all years except the first three years (set to 0.6 given the very low incidence of positive stations) allowed the model to fit the length compositions more closely over the series. The annual indices are therefore input to Stock Synthesis with a CV of 0.30 for all years. The effective sample sizes for the annual survey length composition data are set at the number of stations with sea bass length data. The length compositions for the first three years (1988–1990) are excluded from the assessment due to very small sample sizes although the aggregate indices are retained.

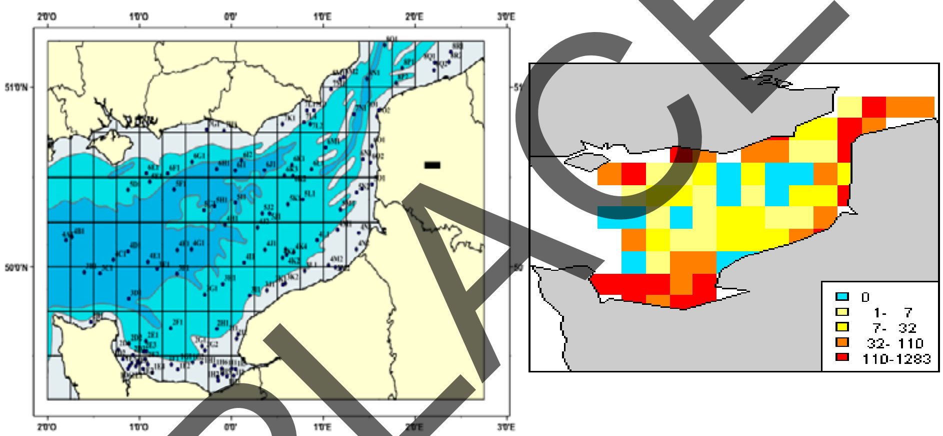


Figure B.3.3. Left: stations fished during the Channel Groundfish Survey carried out annually by France. Right: distribution of total catches of sea bass over the survey series.

B.4 Commercial lpue

ICES IBPNew2012 evaluated a range of commercial fishery lpue series for French and UK fleets operating in Areas IV and VII. The UK analysis of official catch statistics involved filtering individual trip data to include only trips in ICES rectangles where bass catches have been recorded historically. UK vessels of 10m and under, for which historical landings data are very uncertain, were found to have a wide range of lpue trends depending on gear and area fished, often showing a very steep increase since the mid-2000s (Armstrong and Maxwell, 2012). This may be partly a consequence of more accurate reporting caused by the Registration of Buyers and Sellers regulations after its introduction in 2005, but may also represent a bias caused by increased targeting of sea bass by vessels with insufficient quotas for other stocks or trying to develop track record.

With some exceptions (e.g. trawlers in VIId), UK >10m vessels tended to show different lpue trends to 10m and under vessels. Relative trends of seabass lpue for 70–99 mm mesh UK otter trawls (1985–2011) and French otter trawlers (2000–2010) operating in IVbc,VIId, VIIeh and VIIafg showed a general trend of increase in the 1980s and 1990s, followed by a levelling off and a decline after 2009 (Figure 10.1.2.7, from WGCSE 2013).

The trends for >10m UK and French trawlers in IV&VIId and in VIIe closely matched the trend in total stock biomass estimates from the final WGCSE 2013 Stock Synthesis assessment whereas the UK trawlers in VIIa,f,&g had a much lower lpuein the early part of the time-series. These results indicated a potential for development of fishery lpue series for inclusion in future development of SS3 for sea bass, using more sophisticated trip filtering and using more statistical approaches such as delta-lognormal modelling with GLMs to develop standardised series. However, IBP-Bass focused more on developing the survey data inputs and did not progress the development of the fishery lpue series which remains a task for the future.

B4.1 UK bass logbook scheme

The UK bass logbook scheme is described in Section B1.1. Although the survey has severe limitations for estimation of total bass landings for UK vessels, individual logbooks provide time-series of varying duration on catch-rates of individual vessels using specific gears. The logbooks with sufficient data cover eight gear types within trawls, nets and lines, covering mainly 10 m and under vessels, excluding recreational vessels. The total numbers of logbooks have declined from 50–60 in earlier years to below 20 in recent years. No logbooks were issued in 2008:

	Year														
Region	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1	7	9	11	19	9	8	15	16	15	22	16	14	18	16	16
2	0	10	10	15	17	14	13	23	10	25	24	20	24	19	17
3	2	4	6	5	7	7	4	6	7	6	9	3	8	5	3
4	5	5	7	9	7	8	7	11	11	4	6	4	4	4	4
5	7	6	10	13	9	9	10	18	8	10	9	7	11	12	11

	Year									
Region	2000	2001	2002	2003	2004	2005	2006	2007	2009	2010
1	16	19	14	12	13	8	6	0	3	3
2	15	15	13	14	7	10	5	0	3	2
3	2	5	3	5	5	5	7	0	3	3
4	4	5	6	7	1	3	4	0	3	1
5	9	10	9	4	2	5	6	2	1	1

(Region 1: North Sea IVbc, 2: eastern Channel VIId; 3: western Channel VIIeh; 4: Celtic Sea (VIIfg); Irish Sea (VIIa). The trend in number of records per year shows roughly the same pattern across gears:

An exploratory GAM method was developed (Armstrong and Maxwell, 2012) to extract a common temporal trend in lpue from the individual series for ICES Areas IVbc&VIId, VIIeh and VIIafg (referred in the models as areas 1&2, 3 and 4&5). This is analogous to combining series of tree ring counts from timbers of various ages to give a single series describing climate changes. The general method involves estimating logbook factors and year factors (and interactions) to minimise residual model error. Following initial model development and evaluation, a negative binomial error distribution with log link was selected. This can accommodate zero values and allows for the variance to increase with the mean. Working with a log link implies that the estimated trend with year is multiplicative not additive. The R command showing the exact options used for areas 1&2 combined (North Sea and VIId) is:

```
bass.gam3.12 = gam(lpue ~ factor(BookGear) + s(Year, k=10, bs="ts"), family=negbin(c(1,10)), optimizer="perf", data=bass.dat, subset=ARegion=="1and2")
```

Fitted trends and confidence intervals suggest an increasing lpue trend in regions 1&2 (North Sea & VIId), and 3 (VIIeh) (Figure B4-1). A relatively flat trend and possible recent decline is indicated in regions 4&5 (VIIafg) although the recent trend is highly imprecise. Residual checks indicate the model assumptions are reasonable. Model diagnostics and sensitivity to smoothing and other parameters are given in Armstrong and Maxwell (2012).

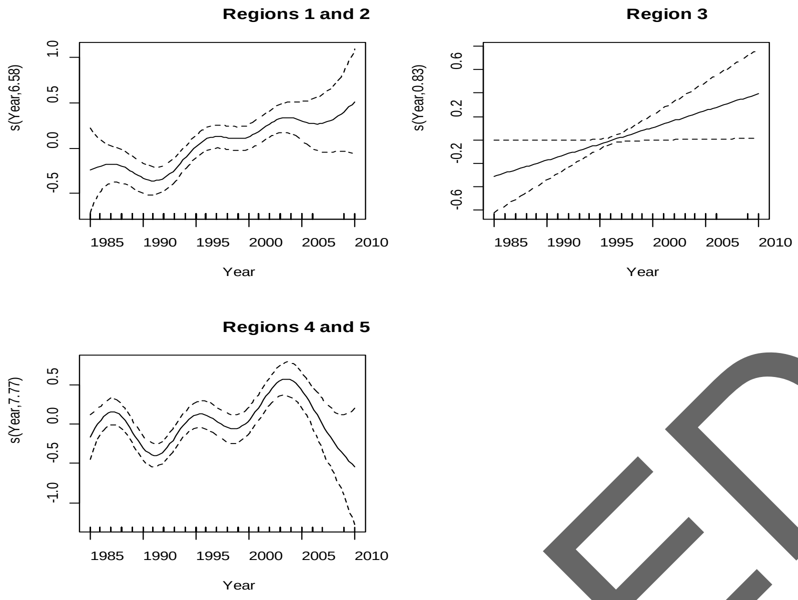


Figure B4-1. Cefas bass logbook lpue: Selected model for combined regions, plots showing year effects from a fitted model with separate mean value for each book number-gear combination and negative binomial error distribution, dashed lines are a 95% confidence interval.

B4.2 UK fleet lpue based on official catch dataseries

Armstrong and Maxwell (2012) review trends in UK commercial fishery lpue for sea bass in the North Sea (IV), eastern Channel (VIId), western Channel (VIIe) and Irish/Celtic Seas (VIIafg) from 1985–2011, and evaluate the possibility of using the time-series as relative abundance estimates for tuning stock assessment models.

Gears which catch bass are targeted at a variety of species, and the fishing effort is distributed across many areas where sea bass have zero or very low probability of capture. A number of approaches are possible to subset fishing trips to include only those that have a probability of catching the species for which lpue is to be estimated. One approach (Stephens and MacCall, 2004) is to cluster fishing trips according to species that occur in association, and use only the cluster with the species on interest for estimating lpue. This method has not yet been applied to UK data. An alternative method to subset trips was applied. This involved (a) selecting gear types that account for ~95% of the total bass landings in each area since 2005; (b) for the selected gears and areas, identify ICES rectangles accounting for ~95% of the total bass landings since 1985. Annual lpue was then estimated for each area and gear, separately for vessels of 10 m (LOA) and under and >10 m vessels. The LOA split is important because reporting of landings and effort of 10 m and under vessels has been very uncertain historically, particularly prior to the introduction of Buyers and Sellers regulations in 2005. Lpue of 10 m and under vessels may be very inaccurate prior to 1995.

It was not possible to evaluate the effect of any increase in targeting of bass by individual vessels using the selected gear types in the selected rectangles, or effects of technology creep. Increased targeting is likely to have happened for vessels with increasingly limited quotas for other species such as cod and which have switched to non-TAC species such as sea bass. For some gears, such as beam trawls, sea bass are not targeted and are purely a bycatch.

Too many lpue series have been examined to reproduce in the Stock Annex, but can be viewed in Armstrong and Maxwell, 2012.

B4.2 French lpue sets

Lpue of French trawlers in IVb,c, VIId and VIIeh is available from 2000 when Ifremer has estimated landings by ICES Divisions. A recent study has developed indices as kg/per day based on data from auction's sales. This study was carried out on French bottom trawlers (less than 18 m), having a fishing strategy with the least distant random sampling; this fleet usually doesn't target sea bass. Large bias can be caused where: 1. an auction sale corresponds to several days of fishing, 2. technological advances are not taken into account, and 3. changes in fishermen's strategies are not taken into account. Never the less, for information, those from the Channel and North Sea have been compared to the UK Otter trawls lpue, and similarities shown on Figure B4-2 are observed.

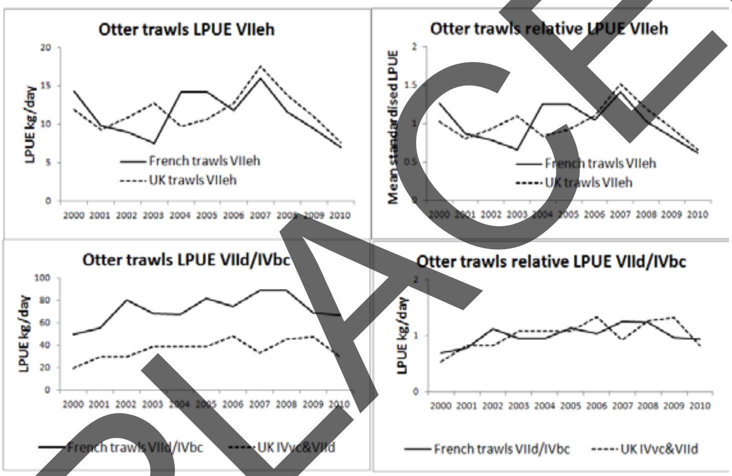


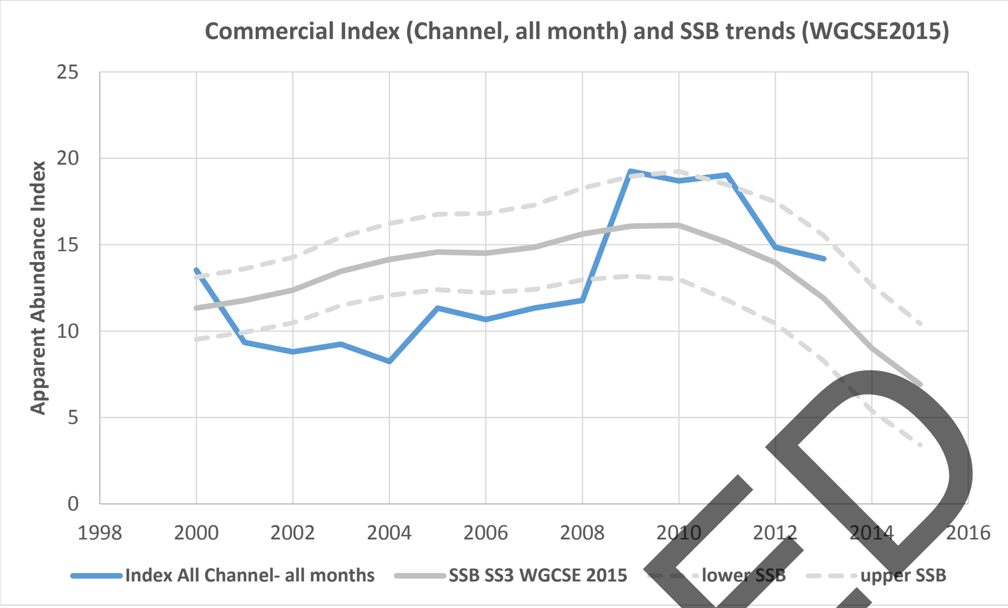
Figure B4-2. UK fleet lpue based on official catch dataseries, compared to the French lpue sets based on auction hall sales.

In 2015 for WGCSE, a study "French Logbook data analysis 2000–2013: possible contribution to the discussion of the sea bass stock(s) structure/annual abundance indices. Alain Laurec, M.Drogou"has been conducted and presented in a Working Document (WD_seabass_France_Abundance_Index.pdf: ICES, WGCSE 2015).

Daily catch rates per vessel, grouped within months and ICES squares, have been analysed basically through a multiplicative two factors model. The two factors, namely the fishing vessel effect and the stratum effect. A stratum corresponds to a so-called ICES square, a month and a year.

First conclusions provide a basic hypothesis about stock structures and spawning migrations, and directly related to this discussion apparent abundance index have been produced covering various option/areas.

The preliminary results of the study are considered promising by the group. Even if it's still under-development and should be benchmarked to use it directly in the assessment, some comparison of the Index from two various option with the SSB is presented in Figure B4-3. This shows similar trends in stock perception conforting results of the assessment (but question on the degree of the trends).



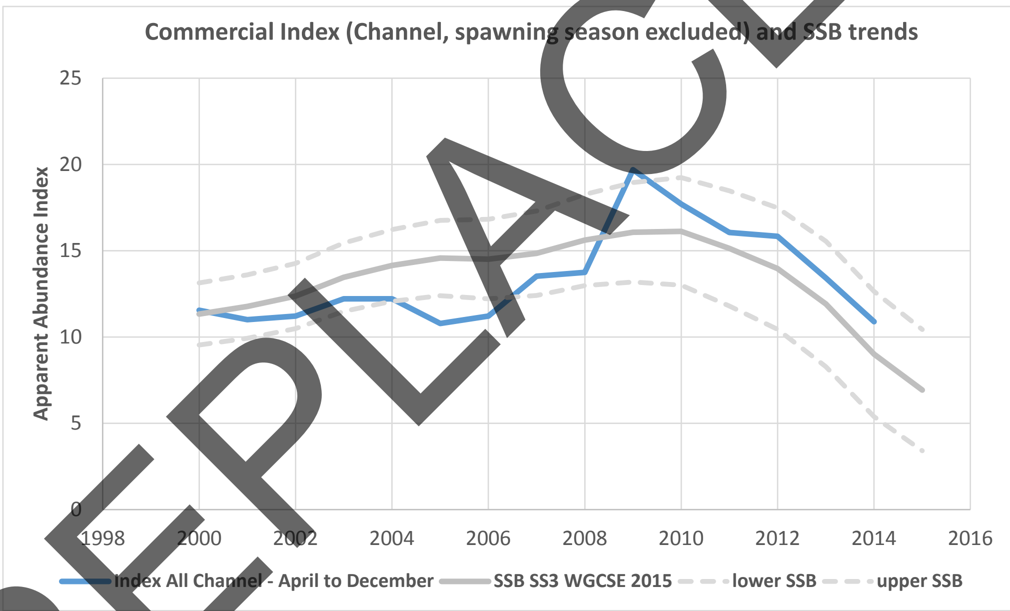


Figure B.4.3. Bass-47: Trends in commercial lpue index for French fleets overlaid on this year's update assessment estimates of spawning–stock biomass (+/- 2 standard errors). Top: index based on data from all twelve months; bottom: index excluding fishing trips during spring spawning season.

B.5. Other relevant data

None.

C. Assessment: data and method

Software used and model options chosen

Model used: Stock Synthesis 3 (SS3) (Methot, 2010)

Software used: Stock synthesis v3.23b (Methot, 2011)

WGCSE 2013 conducted an update assessment using Stock Synthesis 3 (SS3) (Methot, 2010). The software used was Stock synthesis v3.23b (Methot, 2011), according to the

Stock Annex developed by ICES IBPNEW 2012 with inclusion of fishery data for 2012. The assessment requires a modelling framework capable of handling a mixture of age and length data for fisheries and surveys (fleet-based landings; landings age or length compositions, age-based survey indices for young bass) and biological information on growth rates and maturity. Landings-at-age were available for four UK fleets from 1985 onwards, whereas French fleets had length composition data that were available only since the 2000s. The Stock Synthesis assessment model was chosen, primarily for its highly flexible statistical model framework allowing the building of simple to complex models using a mix of data compositions available. The model is written in ADMB (www.admb-project.org), is forward simulating and available at the NOAA toolbox: http://nft.nefsc.noaa.gov/SS3.html.

A mixed age–length model was fitted by WGCSE 2013 as the base case, with a length-only model for comparison. Some adjustments were made by WGCSE 2013 to the model: i) UK fishery compositions for 2012 were input to the age–length model as length compositions because age compositions were not available; ii) the UK midwater trawl series was reduced to 1996 onwards and was input as length compositions because unusual length-based selection curve parameters were obtained when inputting the data as age compositions; iii) recruit deviations were estimated back to 1965.

IBPBass (ICES 2014) addressed the following recommendations of WGCSE 2013 for developing the assessment during the inter-benchmark meeting. Work completed is indicated in parenthesis:

- Source and review information on historical catches and develop plausible scenarios including over the 20+ year burn-in period for the assessment [*some investigations were pursued in France but yielded no clear information on pre-1985 landings*];
- Review the derivation and quality of historical fishery length/age composition data [*not done beyond the information on sampling intensity and coverage already available*];
- Expand UK fishery age compositions to all true ages [*done, see below*];
- Rationalise the fleet definitions, and reduce to the minimum sufficient to provide robust SS3 stock trends [*done, see below*];
- Source and evaluate candidate lpue or effort series for tuning abundance or fishing mortality on older ages [*fishery-dependent abundance indices were not considered other than some information presented in Section 2 on lpue of fleets in the Netherlands*];
- Collate and evaluate other survey data on bass abundance that could be incorporated in the model [*French Channel Groundfish Survey was evaluated and incorporated in the assessment*];
- Determine the most robust approach to incorporating mean length-at-age and length-at-age distributions in SS3 [*Not done*];
- Investigate potential biases in using combined-sex growth parameters [*Not done*];
- Further explore the sensitivity of the assessment to decisions on model structure and inputs [*See model development and sensitivity analyses carried out below*];
- Consider if simpler assessment approaches are warranted [*IBPbass focused exclusively on Stock Synthesis to try and make best use of all available data*].

Deviations from Stock Annex

The Stock Annex has been revised to reflect the approaches developed by IBP-Bass. The update assessment follows exactly the IBP-Bass data inputs and methods.

The assessment requires a modelling framework capable of handling a mixture of age and length data for fisheries, including data for French fleets that have length composition data but no age composition data, and for which the length data were available only since the 2000s. The Stock Synthesis (SS) assessment model was chosen, primarily for its highly flexible statistical model framework allowing the building of simple to complex models using a mix of data compositions available. The model is written in ADMB (www.admb-project.org), is forward simulating and available at the NOAA toolbox: http://nft.nefsc.noaa.gov/SS3.html. For European sea bass a model was built using Stock Synthesis 3 (SS3) version 3.29b to integrate the mix of fisheries and survey data available (fleet-based landings; landings age or length compositions,ages-based survey indices for young bass and length-based CGFS survey indices) and biological information on growth rates and maturity.

Developments of the Stock Synthesis model by IBP-Bass including the following improvements:

- Increased the plus-group from 12+ to 16+.
- Combined UK trawl, net and line fleets into a single fleet with double-normal selectivity.
- Fitted age-based selectivity to all UK commercial fleets.
- Included the Channel Groundfish survey with length-based double-normal selectivity.
- Excluded the Thames and Solent spring juvenile surveys.
- Included a fixed vector of recreational fishing mortality at age, consistent with recreational fishery removals of around 1500t in 2012.
- Reduced the natural mortality rate from 0.20 to 0.15.

Full details of the reasons for these changes, and diagnostics of model fits with these changes included, can be viewed in the IBP-Bass report. Information is given below on some of the key decisions of IBP-Bass concerning the final structure of the assessment model.

Changes to the plus-group

UK fishery age composition data show year-class structure extending well beyond the previous oldest true age used in the assessment (eleven years). This includes year classes well before the first year of input data (see Figure 10.1.2.1). IBP-Bass carried out runs with plus groups set at 12+, 16+, 18+ and 20+. The 16+ setting appeared sufficient to improve estimation of early recruit deviations prior to 1985, without causing problems of zero catch estimates appearing in the data file at old ages. All further runs were conducted with 16+ group.

Selectivity patterns for UK commercial fleets

The WGCSE 2013 assessment treated all commercial fleets from the UK and France as having asymptotic length-based selectivity. This reduced the number of parameters per fleet to only two, an important consideration when four UK fleets and one French fleet were being modelled. Having collapsed the UK trawls, nets and lines to a single fleet, IBPBass explored the use of a double normal selectivity pattern, which appeared to be appropriate for trawls and nets from the results of the Pawson *et al*. (2007) and Kupschus *et al*. (2008) separable model applied to separate UK fleets.

The form of the selectivity pattern was investigated initially using a simple cohort analysis applied to the aggregated catch-at-age for the four UK fleets since 2013. The terminal F for this aggregate "pseudo cohort" was adjusted until the pattern of partial F's for the UK midwater trawl and lines fleets were as close as possible to asymptotic, as these fleets target a wide range of adult and juvenile bass in inshore and offshore waters. The pattern of partial F's for the trawls and nets fleets were then revealed as being strongly domed, confirming previous results in the Pawson *et al*. (2007) separable model (Figure 10.1.3.1). Input initial parameters and bounds for a double-normal selectivity function (a selectivity form recommended in the Stock Synthesis manual) were derived for UK trawls, nets and lines using the spreadsheet developed for Stock Synthesis. The fitted selectivity for this fleet and for the midwater trawl fleet in the update Stock Synthesis run closely match the selectivity patterns given by the empirical approach using cohort analysis (Figure 10.1.3.1).

The WGCSE 2014 update assessment uses the same selectivity models and input selectivity parameters as agreed by IBP-Bass, fitting the parameters using soft bounds rather than priors with hard bounds. This resulted in fitting ten selectivity parameters for commercial fleets (six for UK trawls, nets and lines, and two each for midwater trawls and combined French fleets. The "other fleet" was assumed to have the same selectivity as the French fleet).

Natural mortality and stock–recruit steepness

The value (or vector) of natural mortality used in an analytical assessment is a key parameter determining the estimated productivity, abundance and MSY or other reference points (RPs). The assumed shape of the stock–recruit curve acts with the assumed M to constrain any possible biological reference points (Mangel *et al*. 2013). A key parameter defining a stock–recruit curve is steepness, defined as the ratio of recruitment from an unfished population to recruitment when the spawning–stock biomass is at 20% of the unfished level.

IBP-Bass explored the performance of the Stock Synthesis model for a range of different values for natural mortality and stock–recruit steepness, using a similar model formulation to the WGCSE 2014 update but excluding the recreational fishing mortality vector. The total of negative log likelihood was compiled for the range of combinations, along with the SSB depletion in 2013 from the virgin SSB, and the relative standard error of the SSB in that year.

Total negative log likelihood tended to be lowest at steepness values approaching unity, with the greatest tendency at low values of M, and likelihood also decreased with increasing M (Figure 10.1.3.3. top left). Despite the lower value of negative log likelihood, the relative standard errors of the SSB estimates for 2012 (from the inverse Hessian) increased with increasing M but were almost unaffected by steepness (RSE values at steepness 0.999 were 0.158 at M=0.15; 0.164 at M=0.20; 0.175 at M=0.25 and 0.199 at M=0.30). The unusual value at steepness 0.8, M=0.3 in Figure 10.1.3.3 was a result of the selectivity curve for the combined UK trawls, nets and lines flipping from a domed to an asymptotic pattern. Otherwise, the values show smooth relationships with input M and steepness.

The depletion of SSB in 2013 compared with the virgin SSB was progressively lower as M was increased (Figure 10.1.3.3. top right), but was far less sensitive to steepness.

Recruitment in sea bass has varied widely in response to environmental factors including conditions in the estuarine and other inshore nursery habitats. There is almost no information to indicate declining recruitment at lower SSB and to discern the true value of steepness. A wide range of values appears plausible (Figure 10.1.3.3. lower plots), though the model fit slightly favours the (biologically implausible) steepness value of unity.

IBP-Bass decided to retain a fixed steepness value of 0.999 given the relative insensitivity of the assessment to this parameter. This means that F or biomass at MSY cannot be estimated, and that proxy F_{MSY} reference points have to be specified using yield-per-recruit and spawner biomass per recruit computations.

The tendency for likelihoods to improve with increasing M, despite the inferences that a relatively low M is consistent with sea bass life-history traits and maximum age approaching 30 years, however suggested that additional mortality associated with the recreational fishery could perhaps be accommodated within the model.

Incorporating information on recreational fishery catches

Recent surveys in France, England and the Netherlands have provided estimates of recreational fishery removals that are around a third of the reported commercial fishery landings in each country (see Section 2). Taking possible hooking mortality of released fish into account, the total recreational removals from the stock may be as high as 1500t. The relative standard error of this estimate is likely to be in the range 0.2–0.3 based on the information available on the component surveys. With only one combined survey estimate available, IBPBass could see no easy way to incorporate this directly into Stock Synthesis.

However, by not representing recreational fishery removals in the assessment, the estimates of total mortality derived from the commercial fishery age and length composition data are attributed only to natural mortality and to commercial fishing mortality. In reality, part of the observed total mortality is attributable to the unaccounted-for recreational fishery removals. This becomes a problem when forecasting stock size and yields based on multipliers applied to the apparent commercial fishing mortality, when in fact only part of the apparent F is due to the commercial fleet.

IBP-Bass explored an approach for evaluating the magnitude of recreational fishery F by including a fixed vector of recreational F-at-age in the assessment, added to the fixed natural mortality vector. The recreational F vector, with a plausible selectivity pattern for the harvest (kept component), was then scaled iteratively until the expected recreational removals in 2012 were around 1500 t; the recent total recreational removals estimate from the surveys in France, England and the Netherlands. This is equivalent to treating recreational fishers as a predator whose historical abundance and predation is largely unknown, but are assumed to impose a constant mortality in exactly the same was as all other predators are subsumed into a constant M vector.

There is some evidence from a series of surveys in England and Wales since 1970 that the number of people going sea angling has fluctuated without obvious increasing or decreasing trend (Table 10.1.3.1). Part of the observed variability will relate to differences in survey methodology, but all are based on some form of sampling of the population as a whole. Sea bass has been a prized target for recreational sea anglers in England and Wales (and southern Ireland) over a much longer period than the current assessment, and sea bass angling was developed to a high level of technical skill and knowledge of the species as far back as the 1970s. There is no information on the actual effort expended by the angling population on sea bass as the stock has changed in abundance, or on changes in efficiency, but an assumption of a constant recreational fishing mortality is a reasonable first approximation for evaluating recreational F.

Recreational fishery selectivity

It is first necessary to identify an appropriate selectivity function to characterise the selectivity of recreational fishing. The recreational fishery in England and Wales is predominantly rod-and-line, but it is known that other gears (especially fixed or driftnets, or seines) are deployed recreationally throughout Europe. However, in France around 80% of the recreational fishing catch is from sea angling.

The length frequency of retained sea bass recorded during the recent *Sea Angling 2012* survey in England (Anon, 2014) is very noisy due to small samples (many bass are released) and a clear tendency in some cases for lengths to have been reported to the nearest 5 cm (Figure 10.1.3.2). However, the distribution is clearly much more similar to that of the UK commercial line fishery than to the other commercial fishery gear groups. It was therefore decided to use the UK commercial line fishery selectivity (age-based) to represent the combined selectivity and retention of the recreational fishery for the whole of the bass stock. The line fishery selectivity-at-age was obtained from a Stock Synthesis run treating lines as a separate fleet with asymptotic selectivity estimated from UK age composition inputs. The assumption regarding selectivity may not hold beyond the UK, but was adopted in the absence of other information. Weights-at-age in the retained catch were assumed to be the same as in the UK commercial fishery landings given the strong influence of minimum landing size of 36 cm on retention in both fisheries.

Natural mortality component of combined mortality vector

A range of natural mortality values from 0.15 to over 0.20 can be inferred from life-history parameters and observed maximum age (see earlier). IBPNew 2012 adopted a value of 0.20 for all ages. The SS3 runs carried out by IBP-Bass at different values of M indicated that likelihoods improved as M was increased, but the precision of recent biomass estimates declined, and at M=0.30 some instability in fitting selectivity parameters was evident. IBP-Bass therefore set up a run using the lower bound of M inferences (M=0.15) in order to avoid the combined M and recreational F going too high, and scaled the recreational fishery selectivity so that the calculated recreational landings in 2012 were 1500t. The selectivity and recreational F vector achieving this are given in Table 10.1.3.2. The recreational F(5–11) is 0.09 derived from a multiplier of 1.0 applied to the selectivity curve. The combination of M=0.15 and recreational F leads to a combined mortality vector increasing from 0.15 at the youngest ages to 0.25 at-age 8 with a combined F(5–11) of 0.24, compared with the total M value of 0.20 used by WGCSE 2013. The sensitivity of the assessment to different absolute values of recreational fishery harvest in 2012, and to the choice of M=0.15 or 0.20, is explored later in this report

The structure and input data/ parameters of the IBPbass (2014) model, used for the update assessment by WGCSE 2014, are summarized below:

The structure and input data/ parameters of the IBPbass revised SS3 model are summarized below:

Model structure

- Temporal unit: annual based data (landings, survey indices, age frequency and length frequency);

- Spatial structure: One area;
- Sex: Both sexes combined.

Fleet definition

Four fleets defined: 1. UK bottom trawls, nets and lines; 2. UK midwater pair trawls; 3. French fleets (combined); 6. Other (other countries and other UK fleets combined). [WGCSE 2013 assessment modelled selectivity separately for UK trawls, midwater trawl, nets and lines].

Landed catches

Annual landings in tonnes from 1985 to final year for the four fleets from ICES Subdivisions IVb and c, VIIa, d–h. French data were as provided by Ifremer.

Abundance indices

Channel Groundfish Survey in VIId in autumn (France), 1988 to present: total swept-area abundance index and associated length composition data. Number of stations with sea bass is used as input effective sample size. Input CV for survey = 0.30 all years. First three years of composition data are excluded. [Survey not included in WGCSE 2013 assessment].

Cefas Solent survey in autumn (VIId). Years 1986 to 2011; 2013. Three independent abundance index series were defined, each being a single age group (2, 3, 4 years old). They are treated as three independent surveys (following a recommendation from R. Methot) to circumvent difficulties in estimating selectivity parameters for a survey series comprising only three young age groups, although this approach loses covariance information due to year-effects in the survey. [Solent spring and Thames survey included in WGCSE 2013 assessment].

Fishery landings age composition data: UK fleets

Age bins: 0 to 15 with a plus group for ages 16 and over. Age compositions for UK fleets are expressed as fleet-raised numbers-at-age, although they are treated as relative compositions in SS3. Year range for UK trawls/nets/lines: 1985 to present; UK midwater pair trawl: 1996 to present.

Length composition data: French fleets

The length bin was set from 4 to 100 cm by 2 cm intervals. Length compositions for the following fishing fleets were used: French all fleets combined: 2000 to present.

Model assumptions and parameters

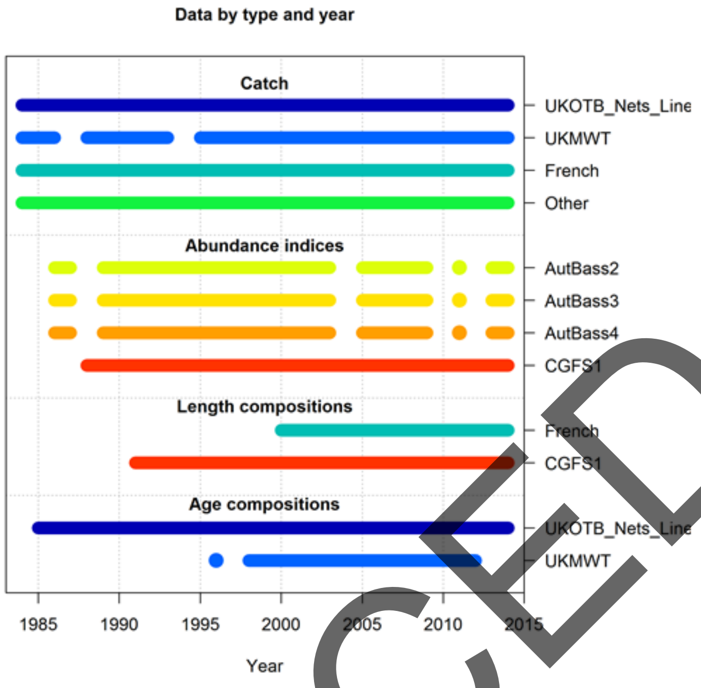
The following table summarises key model assumptions and parameters. Other parameter values and input data characteristics are defined in the SS3 control file BassIV-VII.ctl, the forecast file Forecast.SS and the data file BassIVVII.dat as used by IBPBass 2014 and by WGCSE 2013. Model inputs and year ranges (for WGCSE 2015) are in Figure C1.

Key model assumptions and parameters from the WGCSE 2014 update assessment.

CHARACTERISTIC	SETTINGS
Starting year	1985
Ending year	2013
Equilibrium catch for starting year	0.82* landings in 1985 by fleet.
Number of areas	1
Number of seasons	1
Number of fishing fleets	4
Number of surveys	two surveys: CGFS; Solent autumn survey (Solent spring and Thames survey removed).
Individual growth	von Bertalanffy, parameters fixed, combined sex
Number of active parameters	68
Population characteristics	
Maximum age	30
Genders	1
Population length bins	4–100, 2 cm bins
Ages for summary total biomass	0–30
Data characteristics	
Data length bins (for length structured fleets)	14–94, 2 cm bins
Data age bins (for age structured fleets)	0–16+
Minimum age for growth model	2
Maximum age for growth model	30
Maturity	Logistic 2-parameter – females; L50 = 40.65 cm
Fishery characteristics	
Fishery timing	-1 (whole year)
Fishing mortality method	Hybrid
Maximum F	2.9
Fleet 1: UK Trawl/nets/lines selectivity	Double normal, age-based
Fleet 2: UK Midwater trawl selectivity	Asymptotic, age-based
Fleet 3: Combined French fleet selectivity	Asymptotic, length-based
Fleet 4: Other fleets/gears selectivity	Asymptotic: mirrors French fleet
Year-invariant recreational fishing mortality vector (F(5-11) = 0.09)	Asymptotic, age-based (fixed, not estimated). Added to M vector
Survey characteristics	
Solent autumn survey timing (yr)	0.83
CGFS survey timing (yr)	0.75
Catchabilities (all surveys)	Analytical solution
Survey selectivities: Solent autumn:	[all survey data entered as single ages; sel = 1]
Survey selectivities: CGFS	Double normal, length based
Fixed biological characteristics	
Natural mortality	0.15
Beverton–Holt steepness	0.999
Recruitment variability (σR)	0.9
Weight–length coefficient	0.00001296
Weight–length exponent	2.969

Characteristic	Settings
Maturity inflection (L50%)	40.649 cm
Maturity slope	-0.33349
Length-at-age Amin	19.6 cm at Amin=2[1]
Length-at-Amax	80.26 cm
von Bertalanffy k	0.09699
von Bertalanffy Linf	84.55 cm
von Bertalanffy t0	-0.730 yr
Std. Deviation length-at-age (cm)	SD = 0.1166 * age + 3.5609
Age error matrix	CV 12% at-age
Other model settings	
First year for main recruitment deviations for burn-in period	1965
Last year for recruit deviations	2011 (last year class with survey indices)

[1] as recommended by R. Methot after scrutinizing earlier SS3 runs during IBPNEW 2012, and used by IBPNEW and WGCSE. The WGCSE 2013 tabulated the original value of 5.78 cm at-age 0 in error.



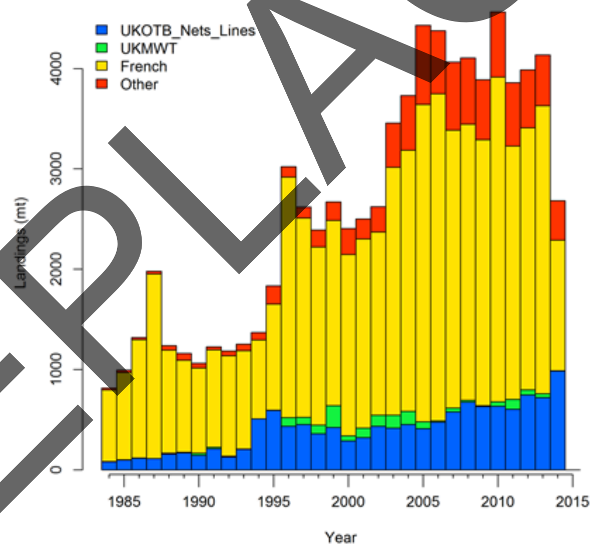


Figure C1. Summary of inputs and year ranges for Stock Synthesis assessment (as at 2015).

C.2 Assessment procedure

The model is run with the executable file SS3.exe in the same folder as the following files:

BassIVVII.ctl	SS3 configuration file
BassIVVII.dat	SS3 data inputs
Starter.SS	SS3 startup file
Forecast.SS	SS3 forecast file

Results are ouput in the same folder (key results file is "results.sso"). Plots can be generated using r4ss after calling library(r4ss), using the following code (adjusted with correct path name):

```
age <- SS_output(dir= 'C:/Users/ma02/Documents/ICES/WGCSE2014/Bass47/SS3
update assessment')
SS_plots(replist=age,pdf=F,png=T,dir='C:/Users/ma02/Docu-
ments/ICES/WGCSE2014/Bass47/SS3update assessment')#,uncertainty=F)
```

Retrospective analysis is done with the output files from the base run in the same folder as the file retro.bat. For five retrospectives, six Starter files are included. The base file Starter.SS includes the following code nine lines from the bottom:

```
-5 # retrospective year relative to end year (e.g. -4)
```

The five retrospective Starter files use the name convention Starter-5; Starter-4; Starter-3; Starter-2; Starter-1, amending the command -5 # retrospective year relative to end year (e.g. -4) to reflect the year peel stated in the file name. A piece of code "Retro-Plots_R4SS" is available to plot the retrospectives although an Excel file is currently used to read the results from each of the Report.sso files imported into worksheets.

For the WGCSE 2014 assessment, a year-invariant recreational fishing mortality vector (F(5–11) = 0.09) was added to the annual M of 0.15, specified as age-specific values in the .ctl file in the line:

```
3 #_natM_type:_0=1Parm; 1=N_breakpoints;_2=Lorenzen;_3=agespecific;_4=ag-
espec_withseasinterpolate
0.150   0.150   0.150   0.152   0.163   0.204   0.241   0.249   0.250   0.250
        0.250   0.250   0.250   0.250   0.250   0.250   0.250   0.250   0.250
        0.250   0.250   0.250   0.250   0.250   0.250   0.250   0.250   0.250
        0.250   0.250   0.250
```

The recreational component was arrived at iteratively to generate a total recreational fishery landing close to 1500 t for 2012.

Future runs may need to revise this to generate the same recreational catch.

When the end year for the Stock Synthesis run is specified as the last year with fishery data, the Report.sso file contains estimates of biomass and numbers only to the start of the final year with data, and Zs only to the year before the final one. A work-around to get biomass and numbers for survivors at the end of the last year with data, and Zs for the final year with data, the end year can be specified as the year after the last with data. F values, as used by ICES, are not generated automatically by Stock Synthesis but can be computed from the Zs after subtracting M.

D. Forecast

Due to the additional complexity of adding a fixed recreational fishing mortality vector for removals (harvest), and the time required to configure Stock Synthesis to mirror the ICES procedures for short-term forecasts, IBPBass decided not to try and develop a forecast procedure within Stock Synthesis for use by WGCSE. This unfortunately loses the ability to provide MCMC confidence intervals around the assessment and forecasted variables, and the forecasts are entirely deterministic. Management options involving biological reference points (BRPs) adopt BRPs conditional on the assumptions in the assessment regarding M, selectivity, maturity, weights-at-age, etc. The procedures for deriving inputs for the short-term forecast are described below.

D.1 Estimating year-class abundance

Stock Synthesis should be set up to estimate recruit deviations only until the last year that has survey data to make the estimates. E.g. including the Solent survey indices for ages 2–4 in 2013 means that the last year class tuned by a survey index is 2011 (two year-olds in 2013). SS3 will put a value from the fitted stock–recruit curve for later year classes. WGCSE overwrites these later year classes using the long-term (1985 onwards) geometric mean, or a short-term GM if there is a persistent reduction in recent recruitment. The numbers-at-age for the starting year of the forecast are also over-written for these year classes by reducing the GM recruitment by the appropriate number of years of M (as there is no catch for the first few years of age).

WGCSE (2013) reviewed some information on environmental influences on sea bass recruitment which supported a recent reduction in recruitment. Survival of 0-gp and 1-gp sea bass in nursery areas in estuaries and salt-marshes is thought to be enhanced by warmer conditions promoting survival through the first two winters, and increasing the growth rates (Pawson, 1992). WGCSE 2014 presented an argument for choosing a particular recruitment value for the 2012 year class for inclusion in forecasts, based on a consideration of past recruitment in relation to temperature. The data and arguments in WGCSE 2014 should be consulted for an explanation of the logic used.

The format for reporting the recruitment values for the short-term forecast are summarised using an example in Table D1.1., and an example of a short-term forecast input file is given in Table D.1.2.

Table D.1.1. Example of recruitment estimates included in a short-term forecast for sea bass, from IBPBass 2013.

Year class	SS3 (age 0)	GM 2008–2011	GM 2008–2011
2011	2648 thousand		
2012		1815 thousand	
2013			6057 thousand
2014			6057 thousand

Example input for the short-term catch predictions is in Table D 1.2. The derivation of the inputs is described in Table D 1.3.

Table D.1.2. Example inputs for sea bass short-term forecast, from WGCSE 2014. Inputs for short-term forecast. F(5–11) is mean for years 2011–2013. Numbers-at-ages 0–2 in 2014 are adjusted by replacing Stock Synthesis average values in 2012–2014 (years with no recruit deviations estimated) with the short-term (2008–2011) GM in 2012 and the long-term GM in 2013 and 2014, with adjustments for natural mortality. Rules are below table.

age	No. at age in 2014	weight in stock	Proportion mature (female)	H.Cons mean F (2011-2013)	H.Cons mean weights	Recreational F	Recreational removals mean weight	M
0	**6057**	0.002	0.000	0.000	0.007	0.000	0.007	0.15
1	**5213**	0.022	0.000	0.000	0.076	0.000	0.052	0.15
2	**1345**	0.101	0.000	0.000	0.388	0.000	0.154	0.15
3	1687	0.218	0.000	0.014	0.584	0.002	0.295	0.15
4	225	0.382	0.186	0.070	0.715	0.013	0.480	0.15
5	1433	0.587	0.419	0.161	0.877	0.054	0.702	0.15
6	830	0.825	0.638	0.220	1.093	0.091	0.954	0.15
7	1749	1.088	0.792	0.247	1.331	0.099	1.228	0.15
8	1491	1.370	0.885	0.256	1.588	0.100	1.517	0.15
9	808	1.664	0.937	0.266	1.860	0.100	1.815	0.15
10	625	1.964	0.965	0.271	2.143	0.100	2.116	0.15
11	519	2.264	0.980	0.274	2.431	0.100	2.416	0.15
12	312	2.562	0.989	0.275	2.719	0.100	2.711	0.15
13	140	2.853	0.993	0.276	3.002	0.100	2.998	0.15
14	60	3.135	0.996	0.276	3.276	0.100	3.275	0.15
15	77	3.406	0.998	0.276	3.540	0.100	3.540	0.15
16+	76	4.017	0.998	0.276	4.069	0.100	4.134	0.15

Age 0,1,2 over-written as follows

2014 yc 2014 age 0 replaced by 1985-2011 LTGM (6057);
2013 yc 2014 age 1 replaced by SS3 survivor estimate at age 1, 2014 * LTGM / SS3 estimate of age 0 in 2013
2012 yc 2014 age 2 replaced by SS3 survivor estimate at age 2, 2014 * STGM (1815) / SS3 estimate of age 0 in 2012 (weak y
2011 yc estimated from Solent survey in 2013, age 2

Table D 1.3. Derivation of short-term forecast inputs (based on example from IBPBass 2014).

Input data	Derivation
Starting numbers-at-age 0–16+ in first year (intermediate year)	SS3 output. (N age zero overwritten where necessary by long-term GM, short-term GM or other predicition, reduced by M=0.15 the the require number of years (if no commercial catches) or multiply N at-age in starting year from the assessment by ratio of the replaced recruit value with the SS3 estimate.
Recruitment 2014 onwards	Long-term GM, short-termGM or other predictor.
Mean wt-at-age in stock	SS3 output
Proportion mature (female)	SS3 output
Commercial fishery (H-cons) mean F at-age	Average last three years: SS3 output Zs minus M=0.15 and recreational F at-age
Commercial fishery (H-cons) mean weight-at-age	SS3 output figures on mean weight in UK, French and other fleets, weighted by SS3 model estimates of landings numbers-at-age for the fleets
Recreational removals F at-age	Input values to SS3 (year-invariant), based on commercial lines selectivity)
Recreational removals weights-at-age	Output values for UK commercial fleets from final SS3 Run
M	0.15 at all ages

An example detailed forecast is given in Table D1.4 for the *status quo* F option, which is the most likely forecast given the absence of any restrictive management controls on effort or landings of sea bass. See WGCSE 2014 for examples of management options tables.

Future forecast routines may be configured in Stock Syntheses, allowing MCMC estimation of confidence limits.

Table D 1.4. Example of detailed short-term forecast (WGCSE 2014).

Year:	2014			
	H.cons F mult:	1	F(5-11):	0.242
	Recreational F mult	1	F(5-11):	0.092

Age	F(5-11): Commercial	F(5-11): Recreational	Catch Nos: Commercial	Yield: Commercial	Catch Nos: Recreational	Yield: Recreational	Stock Nos	Biomass	SSB nos. Jan 1	SSB tonnes Jan 1
0	0.000	0.000	0.0	0.0	0.0	0.0	6057	9	0	0
1	0.000	0.000	0.0	0.0	0.1	0.0	5213	117	0	0
2	0.000	0.000	0.0	0.0	0.3	0.0	1345	135	0	0
3	0.014	0.002	21.1	12.3	2.8	0.8	1687	369	0	0
4	0.070	0.013	14.1	10.1	2.6	1.2	225	86	42	16
5	0.161	0.054	193.1	169.4	65.3	45.9	1433	841	601	352
6	0.220	0.091	146.3	159.9	60.3	57.5	830	684	530	437
7	0.247	0.099	340.7	453.4	136.2	167.2	1749	1903	1385	1507
8	0.256	0.100	300.2	476.7	116.8	177.3	1491	2044	1319	1808
9	0.266	0.100	168.0	312.5	63.1	114.5	808	1345	757	1260
10	0.271	0.100	132.1	283.1	48.7	103.0	625	1227	603	1184
11	0.274	0.100	110.7	269.1	40.4	97.6	519	1176	509	1153
12	0.275	0.100	66.7	181.3	24.2	65.7	312	798	308	789
13	0.276	0.100	30.1	90.2	10.9	32.7	140	400	139	397
14	0.276	0.100	12.9	42.3	4.7	15.3	60	188	60	188
15	0.276	0.100	16.5	58.4	6.0	21.1	77	261	77	261
16+	0.276	0.100	16.3	66.2	5.9	24.3	76	304	76	303
Total			1569	2585	588	924	22647	11887	6404	9654

Year:	2015			
	H.cons F mult:	1	F(5-11):	0.242
	Recreational F mult	1	F(5-11):	0.092

Age	F(5-11): Commercial	F(5-11): Recreational	Catch Nos: Commercial	Yield: Commercial	Catch Nos: Recreational	Yield: Recreational	Stock Nos	Biomass	SSB nos. Jan 1	SSB tonnes Jan 1
0	0.000	0.000	0.0	0.0	0.0	0.0	6057	9	0	0
1	0.000	0.000	0.0	0.0	0.1	0.0	5213	117	0	0
2	0.000	0.000	0.0	0.0	0.9	0.1	4487	452	0	0
3	0.014	0.002	14.5	8.4	1.9	0.6	1157	253	0	0
4	0.070	0.013	89.6	64.1	16.4	7.9	1430	547	266	102
5	0.161	0.054	24.0	21.1	8.1	5.7	178	105	75	44
6	0.220	0.091	175.2	191.4	72.2	68.9	994	820	634	523
7	0.247	0.099	102.0	135.8	40.8	50.1	524	570	415	451
8	0.256	0.100	214.4	340.5	83.5	126.6	1065	1460	942	1291
9	0.266	0.100	186.9	347.6	70.2	127.4	899	1496	842	1401
10	0.271	0.100	102.0	218.5	37.6	79.5	482	947	465	914
11	0.274	0.100	79.1	192.3	28.9	69.8	371	840	364	824
12	0.275	0.100	65.8	178.9	23.9	64.8	307	788	304	779
13	0.276	0.100	39.5	118.7	14.3	43.0	184	526	183	522
14	0.276	0.100	17.8	58.3	6.4	21.1	83	260	82	259
15	0.276	0.100	7.6	27.0	2.8	9.8	36	121	35	121
16+	0.276	0.100	19.4	78.7	7.0	28.9	90	362	90	361
Total			1138	1981	415	704	23559	9670	4698	7591

Year:	2016			
	H.cons F mult:	1	F(5-11):	0.242
	Recreational F mult	1	F(5-11):	0.092

Age	F(5-11): Commercial	F(5-11): Recreational	Catch Nos: Commercial	Yield: Commercial	Catch Nos: Recreational	Yield: Recreational	Stock Nos	Biomass	SSB nos. Jan 1	SSB tonnes Jan 1
0	0.000	0.000	0.0	0.0	0.0	0.0	6057	9	0	0
1	0.000	0.000	0.0	0.0	0.1	0.0	5213	117	0	0
2	0.000	0.000	0.0	0.0	0.9	0.1	4487	452	0	0
3	0.014	0.002	48.3	28.2	6.4	1.9	3861	844	0	0
4	0.070	0.013	61.5	44.0	11.3	5.4	981	375	183	70
5	0.161	0.054	152.7	133.9	51.7	36.3	1133	665	475	279
6	0.220	0.091	21.8	23.8	9.0	8.6	124	102	79	65
7	0.247	0.099	122.2	162.6	48.8	60.0	627	683	497	540
8	0.256	0.100	64.2	102.0	25.0	37.9	319	437	282	387
9	0.266	0.100	133.5	248.3	50.1	91.0	642	1068	601	1001
10	0.271	0.100	113.4	243.0	41.8	88.4	536	1053	518	1017
11	0.274	0.100	61.0	148.4	22.3	53.8	286	648	281	636
12	0.275	0.100	47.0	127.9	17.1	46.3	220	563	217	557
13	0.276	0.100	39.0	117.1	14.1	42.4	182	519	181	515
14	0.276	0.100	23.4	76.6	8.5	27.7	109	341	108	340
15	0.276	0.100	10.5	37.2	3.8	13.5	49	167	49	166
16+	0.276	0.100	15.9	64.9	5.8	23.8	74	298	74	297
Total			914	1558	317	537	24901	8341	3544	5869

E. Biological reference points

E.1 Background

The Stock synthesis model currently used fixes stock–recruit steepness at 0.999. There are insufficient observations at low SSB to suggest the possible steepness of the relationship. This means that MSY reference points cannot be obtained from a plausible stock–recruit relationship and have to be derived from yield-per-recruit. WGCSE 2013 and 2014, and IBPBass 2014 computed yield-per-recruit based biological reference points $F_{0.1}$ and $F_{35\%spr}$ based on the inputs and outputs of the stock synthesis update assessment. In 2013, with an input M of 0.20, the F(5–11) value for $F_{35\%spr}$ was 0.17 and the $F_{0.1}$ was 0.18. In 2014, WGCSE reduced the M to 0.15, and this caused a reduction in the $F_{35\%spr}$ to 0.13 for combined commercial and recreational landings, and the $F_{0.1}$ was 0.12. The F reference points therefore scale directly with M, as expected, with some effect of changes in estimated fishery selection patterns and weights-at-age.

The revised SS3 model proposed by IBPBass and applied at WGCSE 2014 now includes an explicit recognition of the possible recreational fishing mortality, albeit as a fixed vector of F at-age following the same selectivity as the commercial line fishery. This leads to a more complex problem in defining BRPs based on yield-per-recruit because the fishing mortality now has separate commercial and recreational F components which can be manipulated separately or simultaneously in a yield-per-recruit analysis. The recreational F vector is indicative only, in the sense that it is conditioned on a total annual recreational removals estimate of ~1500 t for recent years, which can be considered as a "plausible scenario" rather than an explicit estimate of recreational F with recreational fishery survey data and their precision included in the model fitting. Different scenarios for total recreational removals affect how total fishing mortality is split between commercial and recreational F, but the combined F estimates are minimally affected as they are driven by the fishery composition data.

E.2 MSY BRPs or proxies for sea bass

BRPs for this assessment based on advice from ICES WKMSYREF2 (ICES, 2014), and recognising that F_{MSY} cannot be obtained from a fitted stock–recruit curve include:

1) Setting an F_{MSY} proxy as $F_{0.1}$ or $F_{xx\%spr}$ based either on the commercial fishery only, or the combined commercial and recreational F.

2) Setting a B_{MSY} trigger around a low percentile of the expected range of SSB when fishing at F_{MSY}.

Unfortunately it has not been possible yet to carry out a full MCMC bootstrap of the sea bass assessment and to propagate this into a forecast period to evaluate the percentiles of expected SSB whilst fishing at F_{MSY}. A concern with sea bass is that recruitment has shown longer term changes in mean recruitment (and hence stock productivity) that appear related to changes in sea temperature at decadal scales. For a biomass reference point, WGCSE 2014 selected the lowest observed SSB (B_{loss}) of 5250 t as a value for B_{lim}, the limit reference point for SSB. There is therefore no MSY or precautionary reference point for biomass (Table E.2.1).

WGCSE chose $F_{35\%spr}$ as a proxy for F_{MSY} (value: F(5–11) = 0.13 for combined commercial and recreational fishery). As for many stocks, this value is close to $F_{0.1}$ (F=0.12). (Table E.2.1).

The yield per recruit curve is flat-topped and F_{MSY} in sea bass is poorly defined (Figure E.2.1). Fishing at F_{MAX} implies a yield-per-recruit only marginally higher than at $F_{35\%SPR}$ but requires much higher F, with much larger fishing costs where these are proportional to F.

E.3 Inclusion of BRP in short-term forecast

For the estimation of Yield-per-recruit and Spawner biomass per recruit, WGCSE 2014 varied the multipliers on both fisheries by the same amount. The resulting yield-per-recruit curve therefore reflects total F and total yield, but does not assume a particular allocation between any fisheries.

For short-term forecasts, WGCSE agreed that the multiplier on the recreational F vector should be maintained at 1.0 for all management options except zero F, and only the commercial fishery vector is altered in management options. The relative contribution of commercial and recreational F to the total F will not be the same as the contribution used in calculating the F_{MSY} based on the mean F for 2011 to 2013. However, the selectivity and weights-at-age for the two fisheries are sufficiently close that the agreed F_{MSY} can be applied for different combinations of commercial and recreational F with relatively minor differences. This allows managers to select an F relative to F_{MSY} for a forecast year but decide how the resultant catch forecast can be allocated between the different fishery sectors. This is no different to management of different commercial fishery fleets.

Table E.2.1. BRPs proposed by WGCSE 2014 for sea bass in Areas IV and VII.

	Type	Value	Technical basis
Precautionary approach	B_{lim}	5250 t	Lowest observed SSB
	B_{pa}	Undefined	
	F_{lim}	Undefined	
	F_{pa}	Undefined	
MSY approach	F_{MSY}	0.13	Based on F giving SSB per recruit 35% of value at zero F.
	$MSY_{btrigger}$	Undefined	

F_{MAX} is not definable.

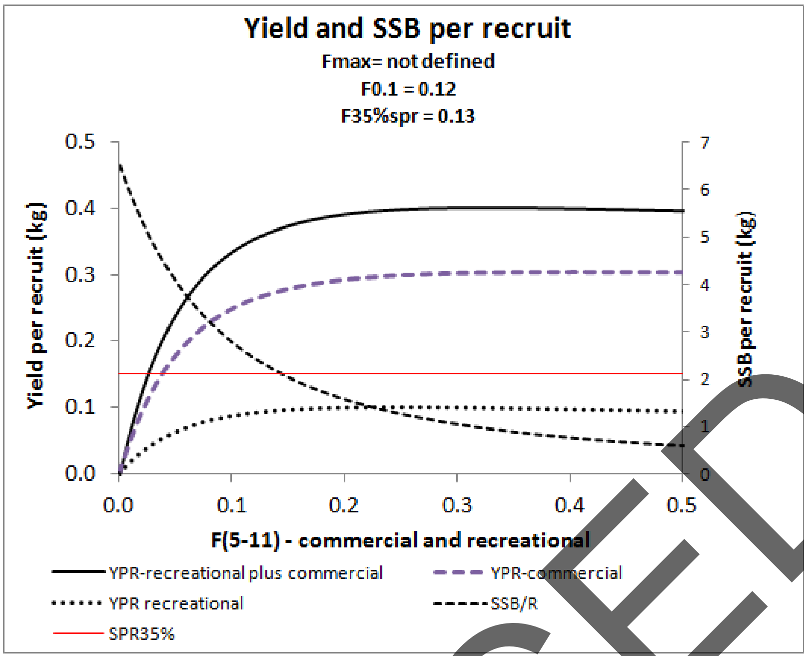


Figure E.2.1. Yield and biomass per recruit analysis from WGCSE 2014: conditional on mean pattern of F-at-age for 2011–2013 for the commercial fishery and the vector of F-at-age for recreational fishing, with the same F-multiplier applied to both. The partial YPR by fleet is shown conditional on the relative contribution of the F-at-age in the two fisheries to the combined F being the same as estimated for recent years in the assessment. The 35%spr is indicated (red line) to show where this occurs on the SPR curve.

E.4 Yield-per-recruit reference point calculations

Example inputs for a yield-per-recruit analysis are given in Table E.4.1.1. They are identical to the short-term forecast inputs except that the values are extended to 30 years of age. SS3 provides population estimates out to this age. It is assumed that no fish survive after the 30th year, as no fish older than 28 years have been observed historically. The input data are entered into the ICES Standard Plots system on SharePoint, which produces the YPR and SPR plots together with estimates of F_{MAX}, $F_{0.1}$ and F_{MED}. $F_{35\%SPR}$ is not output but can easily be computed using a spreadsheet, checking that the $F_{0.1}$ and SPR values are the same as the ones generated by the ICES Standard Plots software. (This software cannot at present display the partial YPR values for individual fleets).

Table E.4.1.1. Example inputs to yield-per-recruit analysis. F(5–11) and weights-at-age are the recent three year average. The values for a 16+ gp are indicated although using this prevents the mean stock weight to increase in the plus group as F is reduced, leading to a small bias in SSB per recruit at low or zero F. Bass in the wild have been recorded up to 28 years old.

Age	M	Pmat	stock wt (kg)	F(5-11): commercial fleets	F(5-11): recreational fishery	Catch wt (kg): commercial fleets	Catch wt (kg): recreational fleets
0	0.15	0.000	0.002	0.000	0.000	0.007	0.007
1	0.15	0.000	0.022	0.000	0.000	0.076	0.052
2	0.15	0.000	0.101	0.000	0.000	0.388	0.154
3	0.15	0.000	0.218	0.014	0.002	0.584	0.295
4	0.15	0.186	0.382	0.070	0.013	0.715	0.480
5	0.15	0.419	0.587	0.161	0.054	0.877	0.702
6	0.15	0.638	0.825	0.220	0.091	1.093	0.954
7	0.15	0.792	1.088	0.247	0.099	1.331	1.228
8	0.15	0.885	1.370	0.256	0.100	1.588	1.517
9	0.15	0.937	1.664	0.266	0.100	1.860	1.815
10	0.15	0.965	1.964	0.271	0.100	2.143	2.116
11	0.15	0.980	2.264	0.274	0.100	2.431	2.416
12	0.15	0.989	2.562	0.275	0.100	2.719	2.711
13	0.15	0.993	2.853	0.276	0.100	3.002	2.998
14	0.15	0.996	3.135	0.276	0.100	3.276	3.275
15	0.15	0.998	3.406	0.276	0.100	3.540	3.540
16	0.15	0.998	3.665	0.276	0.100	3.791	3.793
17	0.15	0.999	3.911	0.277	0.100	4.030	4.032
18	0.15	0.999	4.143	0.277	0.100	4.255	4.258
19	0.15	1.000	4.362	0.277	0.100	4.466	4.469
20	0.15	1.000	4.566	0.277	0.100	4.664	4.667
21	0.15	1.000	4.757	0.277	0.100	4.848	4.852
22	0.15	1.000	4.935	0.277	0.100	5.019	5.023
23	0.15	1.000	5.099	0.277	0.100	5.177	5.181
24	0.15	1.000	5.252	0.277	0.100	5.324	5.328
25	0.15	1.000	5.393	0.277	0.100	5.459	5.464
26	0.15	1.000	5.523	0.277	0.100	5.584	5.588
27	0.15	1.000	5.642	0.277	0.100	5.698	5.703
28	0.15	1.000	5.752	0.277	0.100	5.803	5.808
29	0.15	1.000	5.853	0.277	0.100	5.900	5.905
30	0.15	1.000	6.064	0.277	0.100	6.102	6.107
16+	0.15	1.000	4.017	0.277	0.100	4.069	4.134

There is currently no TAC for sea bass, and control of fishing mortality would have to be through other approaches to managing effort on sea bass, and including technical measures to alter selectivity and/or restrict fishing seasonally or spatially. Note that the inclusion of discards in the assessment would alter the reference points and historical series. In the absence of discards, it is difficult to infer benefits to YPR or SSB/R in improving the selectivity patterns of the fleets. There is currently no time-series of recreational fishing catches to monitor the impacts of any management measures, and the frequency and extent of future surveys remains uncertain.

F. Other Issues

F.1. Historical overview of previous assessment methods

Previous assessments of sea bass in the IV & VII area are summarised below.

2007: Pawson *et al*. 2007. ADMB separable model on UK data; updated 2008 at WGNEW (Kupschus *et al*., 2008).

2012: IBP-NEW (ICES, 2012). Development of age and length based Stock Synthesis assessment.

2013: WGCSE. Update assessment using IBP-NEW SS model. Recommended inter-benchmark to improve model.

2014: IBP-BASS. Added new CGFS surveys series; removed poorly performing surveys; improved fleet structure and selectivity model; incorporated recreational fishery information; developed forecast and BRPs.

2014: WGCSE. Update assessment using IBP-Bass model.

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Appendix 1

Content of Stock Synthesis Control File (BassIVVII.ctl) used at WGCSE 2014. The file was originally built from one used for other species, and some comments remain that are for those assessments. Rows preceded by # are skipped, and are greyed out.

#C growth parameters are estimated

#_SS-V3.04-safe;_09/09/09;_Stock_Synthesis_by_Richard_Methot_(NOAA);_using_ADMB_7.0.1

1 #_N_Growth_Patterns

1 #_N_Morphs_Within_GrowthPattern(GP)

#_Cond 1 #_Morph_between/within_stdev_ratio (no read if N_morphs=1)

#_Cond 1 #vector_Morphdist_(-1_in_first_val_gives_normal_approx)

#

##1 # N recruitment designs goes here if N_GP*nseas*area>1 #here 1 gp, 4 seasons, 1 area

##0 # placeholder for recruitment interaction request

#GP seas area for each recruitment assignment

##1 1 1 # example recruitment design element for GP=1, season=1, area=1

#

#_Cond 0 # N_movement_definitions goes here if N_areas > 1

#_Cond 1.0 # first age that moves (real age at begin of season, not integer) also cond on do_migration>0

#_Cond 1 1 1 2 4 10 # example move definition for seas=1, morph=1, source=1 dest=2, age1=4, age2=10

#

0 #_Nblock_Patterns

#_blocks_per_pattern

begin and end years of blocks in first pattern

#

0.5#_fracfemale #? Note sex ratio in bass increases with length.

3 #_natM_type:_0=1Parm; 1=N_breakpoints;_2=Lorenzen;_3=agespecific;_4=agespec_withseasinterpolate

0.150 0.150 0.150 0.152 0.163 0.204 0.241 0.249 0.250 0.250
0.250 0.250 0.250 0.250 0.250 0.250 0.250 0.250 0.250
0.250 0.250 0.250 0.250 0.250 0.250 0.250 0.250 0.250
0.250 0.250 0.250

#_no additional input for selected M option; read 1P per morph

1 # GrowthModel: 1=vonBert with L1&L2; 2=Richards with L1&L2; 3=not implemented; 4=not implemented #note - maguire et al 2008 pg 1270, Downloaded from icesjms.oxfordjournals.org at ICES on October 17, 2011

2 #_Growth_Age_for_L1

999 #_Growth_Age_for_L2 (999 to use as Linf)

0 #_SD_add_to_LAA (set to 0.1 for SS2 V1.x compatibility)

0 #_CV_Growth_Pattern: 0 CV=f(LAA); 1 CV=F(A); 2 SD=F(LAA); 3 SD=F(A)

1 #_maturity_option: 1=length logistic; 2=age logistic; 3=read age-maturity matrix by growth_pattern; 4=read age-fecundity; 5=read fec and wt from wtatage.ss

#_placeholder for empirical age-maturity by growth pattern

4 #_First_Mature_Age

1 #_fecundity option:(1)eggs=Wt*(a+b*Wt);(2)eggs=a*L^b;(3)eggs=a*Wt^b

0 #_hermaphroditism option: 0=none; 1=age-specific fxn

1 #_parameter_offset_approach (1=none, 2= M, G, CV_G as offset from female-GP1, 3=like SS2 V1.x)

1 #_env/block/dev_adjust_method (1=standard; 2=logistic transform keeps in base parm bounds; 3=standard w/ no bound check)

#

#_growth_parms

#_LO HI INIT PRIOR PR_type SD PHASE env-var use_dev dev_minyr dev_maxyr dev_stddev Block Block_Fxn

#0.01 0.5 0.2 0.2 -1 0.1 -3 0 0 0 0 0 0 0 0 # NatM_p_1_GP_1

-1 30 19.67 19.67 -1 0.5 -5 0 0 0 0 0 0 0 0 # L_at_Amin_GP_1

60 100 80.26 80.26 -1 15 4 0 0 0 0 0 0 0 0 # L_at_Amax_GP_1

0.01 0.2 0.09699 0.09699 -1 0.05 -3 0 0 0 0 0 0 0 0 # VonBert_K_GP_1

0.005 0.5 0.2 0.2 -1 0.8 -6 0 0 0 0 0 0 0 0 # CV_young_GP_1

0.005 0.5 0.1 0.1 -1 0.8 -6 0 0 0 0 0 0 0 0 # CV_old_GP_1

-1 1 0.00001296 0.00001296 -1 0.05 -3 0 0 0 0 0 0 0 0 # Wtlen_1

2 4 2.969 2.969 -1 0.05 -3 0 0 0 0 0 0 0 0 # Wtlen_2

30 50 40.649 40.649 -1 5 -3 0 0 0 0 0 0 0 0 # Mat50%

-5 1 -0.33349 -0.33349 -1 0.03764 -3 0 0 0 0 0 0 0 0 # Mat_slope

-3 3 1 1 -1 0.8 -3 0 0 0 0 0 0 0 0 # Eg/gm_inter

-3 3 0 0 -1 0.8 -3 0 0 0 0 0 0 0 0 # Eg/gm_slope_wt

0 0 0 0 -1 0 -3 0 0 0 0 0 0 0 0 # RecrDist_GP_1

0 0 0 0 -1 0 -3 0 0 0 0 0 0 0 0 # RecrDist_Area_1

0 0 0 0 -1 0 -4 0 0 0 0 0 0 0 0 # RecrDist_Seas_1

0 0 0 0 -1 0 -4 0 0 0 0 0 0 0 0 # CohortGrowDev

#

#_Cond 0 #custom_MG-env_setup (0/1)

#_Cond -2 2 0 0 -1 99 -2 #_placeholder when no MG-environ parameters

#

#_Cond 0 #custom_MG-block_setup (0/1)

#_Cond -2 2 0 0 -1 99 -2 #_placeholder when no MG-block parameters

#_Cond No MG parm trends

#

#_seasonal_effects_on_biology_parms

0 0 0 0 0 0 0 0 0 0 #_femwtlen1,femwtlen2,mat1,mat2,fec1,fec2,L1,K

#_Cond -2 2 0 0 -1 99 -2 #_placeholder when no seasonal MG parameters

#

#-6 #_MGparm_Dev_Phase

#

#_Spawner-Recruitment

3 #_SR_function

#_LO HI INIT PRIOR PR_type SD PHASE

1 16 10 5 -1 1 1 # SR_R0

0.2 0.999 0.999 0.999 -1 0.2 -1 # SR_steep

0.1 2 0.9 0.9 -1 0.2 -5 # SR_sigmaR

-5 5 0 0 -1 1 -3 # SR_envlink

-5 5 0 -0.7 -1 2 -2 # SR_R1_offset

0 0 0 0 -1 0 -99 # SR_autocorr

0 #_SR_env_link

0 #_SR_env_target_0=none;1=devs;_2=R0;_3=steepness

1 #do_recdev: 0=none; 1=devvector; 2=simple deviations

1965 # first year of main recr_devs; early devs can preceed this era

2011 # last year of main recr_devs; forecast devs start in following year 2013. Youngest survey age 2gp 2013

2 #_recdev phase

0 # (0/1) to read 13 advanced options

#0 #_recdev_early_start (0=none; neg value makes relative to recdev_start)

#-4 #_recdev_early_phase

#0 #_forecast_recruitment phase (incl. late recr) (0 value resets to maxphase+1)

#1 #_lambda for prior_fore_recr occurring before endyr+1

#985 #_last_early_yr_nobias_adj_in_MPD

#1955 #_first_yr_fullbias_adj_in_MPD

#2010 #_last_yr_fullbias_adj_in_MPD 2012

#2011 #_first_recent_yr_nobias_adj_in_MPD 2013

#1 #_max_bias_adj_in_MPD (1.0 to mimic pre-2009 models)

#0 #_period of cycles in recruitment (N parms read below)

#-5 #min rec_dev

#5 #max rec_dev

#0 # 3 #_read_recdevs

2009 -0.04979586

2010 -0.04979586

2011 -0.04979586

#_end of advanced SR options

#

#_placeholder for full parameter lines for recruitment cycles

read specified recr devs

#_Yr Input_value

#

#

#Fishing Mortality info

0.2 # F ballpark for tuning early phases

-2001 # F ballpark year (neg value to disable)

3 # F_Method: 1=Pope; 2=instan. F; 3=hybrid (hybrid is recommended)

2.9 # max F or harvest rate, depends on F_Method

no additional F input needed for Fmethod 1

if Fmethod=2; read overall start F value; overall phase; N detailed inputs to read

#0.3 3 0 # if Fmethod=3; read N iterations for tuning for Fmethod 3

5 # N iterations for tuning F in hybrid method (recommend 3 to 7)

#

#_initial_F_parms

#_LO HI INIT PRIOR PR_type SD PHASE

0.00001 2 0.03 0.3 -1 0.5 1 # InitF_OTB_Nets

0.00001 2 0.03 0.3 -1 0.5 1 # InitF_Midwater

0.0001 2 0.03 0.03 -1 0.5 1 # InitF_French

0.00001 2 0.03 0.03 -1 0.5 1 # InitF_Other

#

#_Q_setup

Q_type options: <0=mirror, 0/1=float, 2=parameter, 3=parm_w_random_dev, 4=parm_w_randwalk)

#_Den-dep env-var extra_se Q_type

0 0 0 0 # FISHERY1

0 0 0 0 # FISHERY2

0 0 0 0 # FISHERY3

0 0 0 0 # FISHERY4

0 0 0 0 # SURVEY AutBass 2

0 0 0 0 # survey AutBass 3

0 0 0 0 # Survey AutBass 4

0 0 0 0 # Survey CGFS1

#_Cond 0 #_If q has random component, then 0=read one parm for each fleet with random q; 1=read a parm for each year of index

#_Q_parms(if_any)

LO HI INIT PRIOR PR_type SD PHASE

#-15 5 0 0 -1 1 -1 # Q_base_2_SURVEY EVHOE

#

#_size_selex_types

0 0 0 0 # UKTrawl_Nets #_RDM now all fleets have size selectivity

0 0 0 0 # UKMidwater

1 0 0 0 # French

15 0 0 3 # Other

0 0 0 0 # AutBass2

0 0 0 0 # AutBass3

0 0 0 0 # AutBass4

24 0 0 0 # CGFS1

#

#_age_selex_types

#_Pattern ___ Male Special

20 0 0 0 # 1 UKTrawl

12 0 0 0 # 2 UKMidwater

10 0 0 0 # 3 French

15 0 0 3 # 4 Other

11 0 0 0 # 5 AutBass2

11 0 0 0 # 6 AutBass3

11 0 0 0 # 7 AutBass4

10 0 0 0 # 8 CGFS1

#_LO HI INIT PRIOR PR_type SD PHASE env-var use_dev dev_minyr dev_maxyr dev_stddev Block Block_Fxn

20 91 38.8836 30 -1 0.1 2 0 0 0 0 0 0 0 # SizeSel_5P_1_French

0.01 30 5.18514 5 -1 0.01 3 0 0 0 0 0 0 0 # SizeSel_5P_2_French

20 94.1 32 32 -1 0.05 2 0 0 0 0 0 0 0 # SizeSel_2P_1_CGFS1

-6.0 4.0 -6.0 -6.0 -1 0.05 3 0 0 0 0 0 0 0 # SizeSel_2P_2_CGFS1

1.0 5.0 3.3 3.3 -1 0.05 3 0 0 0 0 0 0 0 # SizeSel_2P_3_CGFS1

3.0 6.0 4.4 4.4 -1 0.05 3 0 0 0 0 0 0 0 # SizeSel_2P_4_CGFS1

-8.0 9.0 -8 -8 -1 0.05 2 0 0 0 0 0 0 0 # SizeSel_2P_5_CGFS1

-5.0 9.0 -1 -1 -1 0.05 2 0 0 0 0 0 0 0 # SizeSel_2P_6_CGFS1

0 15.8 7.4 7.4 -1 0.05 2 0 0 0 0 0 0 0 # PEAK value SizeSel_1P_1_OTB

-6.0 4.0 -6.0 -6.0 -1 0.05 3 0 0 0 0 0 0 0 # TOP logistic SizeSel_1P_1_OTB

-3 9.0 0.3 0.3 -1 0.05 3 0 0 0 0 0 0 0 # WIDTH exp SizeSel_1P_1_OTB

-1.0 9.0 -0.8 -0.8 -1 0.05 3 0 0 0 0 0 0 0 # WIDTH exp SizeSel_1P_1_OTB

-10.0 9.0 -5 -5 -1 0.05 2 0 0 0 0 0 0 0 # INIT logistic SizeSel_1P_1_OTB

-5.0 9.0 1.8 1.8 -1 0.05 2 0 0 0 0 0 0 0 # FINAL logistic SizeSel_1P_1_OTB

0 16 7.0 7.0 -1 0.05 2 0 0 0 0 0 0 0 # SizeSel_2P_1_MWT

0.01 30 7.02399 5 -1 0.05 3 0 0 0 0 0 0 0 # SizeSel_2P_2_MWT

2 2 2 2 -1 99 -3 0 0 0 0 0 0 0 # AgeSel_10P_1_Autumn 2 min age

2 2 2 2 -1 99 -3 0 0 0 0 0 0 0 # AgeSel_10P_2_Autumn 2 max age

3 3 3 3 -1 99 -3 0 0 0 0 0 0 0 # AgeSel_11P_1_Autumn 3 min age

3 3 3 3 -1 99 -3 0 0 0 0 0 0 0 # AgeSel_11P_2_Autumn 3 max age

4 4 4 4 -1 99 -3 0 0 0 0 0 0 0 # AgeSel_12P_1_Autumn 4 min age

4 4 4 4 -1 99 -3 0 0 0 0 0 0 0 # AgeSel_12P_2_Autumn 4 max age

#_Cond 0 #_custom_sel-env_setup (0/1)

#_Cond -2 2 0 0 -1 99 -2 #_placeholder when no enviro fxns

#_custom_sel-blk_setup (0/1)

#_Cond No selex parm trends

#_Cond -4 # placeholder for selparm_Dev_Phase

#_env/block/dev_adjust_method (1=standard; 2=logistic trans to keep in base parm bounds; 3=standard w/ no bound check)

#

Tag loss and Tag reporting parameters go next

0 # TG_custom: 0=no read; 1=read if tags exist

#_Cond -6 6 1 1 2 0.01 -4 0 0 0 0 0 0 0 #_placeholder if no parameters

#

1 #_Variance_adjustments_to_input_values

#_fleet/svy: 1 2 3 4 5 6 7 8

0 0 0 0 0 0 0 0 #_add_to_survey_CV

0 0 0 0 0 0 0 0 #_add_to_discard_stddev

0 0 0 0 0 0 0 0 #_add_to_bodywt_CV

1 1 1 1 1 1 1 1 #_mult_by_lencomp_N

1 1 1 1 1 1 1 1 #_mult_by_agecomp_N

1 1 1 1 1 1 1 1 #_mult_by_size-at-age_N

#

3 #_maxlambdaphase

1 #_sd_offset

#

0 #8 # number of changes to make to default Lambdas (default value is 1.0)

Like_comp codes: 1=surv; 2=disc; 3=mnwt; 4=length; 5=age; 6=SizeFreq; 7=sizeage; 8=catch;

9=init_equ_catch; 10=recrdev; 11=parm_prior; 12=parm_dev; 13=CrashPen; 14=Morphcomp; 15=Tag-comp; 16=Tag-negbin

#like_comp fleet/survey phase value sizefreq_method

5 1 1 0.1 1 #_RDM reduce emphasis on age comp and wt-at-age by 10x

5 2 1 0.1 1

5 3 1 0.1 1

5 4 1 0.1 1

7 1 1 0.1 1

7 2 1 0.1 1

7 3 1 0.1 1

7 4 1 0.1 1

#

lambdas (for info only; columns are phases)

0 0 0 0 #_CPUE/survey:_1

1 1 1 1 #_CPUE/survey:_2

1 1 1 1 #_CPUE/survey:_3

1 1 1 1 #_lencomp:_1

1 1 1 1 #_lencomp:_2

0 0 0 0 #_lencomp:_3

1 1 1 1 #_agecomp:_1

1 1 1 1 #_agecomp:_2

0 0 0 0 #_agecomp:_3

1 1 1 1 #_size-age:_1

1 1 1 1 #_size-age:_2

0 0 0 0 #_size-age:_3

1 1 1 1 #_init_equ_catch

1 1 1 1 #_recruitments

1 1 1 1 #_parameter-priors

```
#  1 1 1 1 #_parameter-dev-vectors
#  1 1 1 1 #_crashPenLambda
0 # (0/1) read specs for more stddev reporting
 # 1 1 -1 5 1 5 1 -1 5 # selex type, len/age, year, N selex bins, Growth pattern, N growth ages, NatAge_area(-1 for all), NatAge_yr, N Natages
 # 5 15 25 35 43 # vector with selex std bin picks (-1 in first bin to self-generate)
 # 1 2 14 26 40 # vector with growth std bin picks (-1 in first bin to self-generate)
 # 1 2 14 26 40 # vector with NatAge std bin picks (-1 in first bin to self-generate)
999
```

Appendix 2

Content of Stock Synthesis Data file (BassIVVII.dat) used at WGCSE 2014. The file was originally built from one used for other species, and some comments remain that are for those assessments. Rows preceded by # are skipped, and are greyed out.

#C Sea bass IV VII input data file

1985 # _styr lr

2014 # _endyr lr

1 # _nseasons lr number of quarters in a year

12 # _nmonths per season lr months in each quarter

1 # _spawn_seas ? which season is the spawning season

4 # _Nfleet #lr

4 # _Nsurveys #lr

1 # _N_areas # lr

UKOTB_Nets_Lines%UKMWT%French%Other%AutBass2%AutBass3%AutBass4%CGFS1

-1 -1 -1 -1 0.83 0.83 0.83 0.75 # _surveytiming_in_season

1 1 1 1 1 1 1 1 # _area_assignments_for_each_fishery_and_survey

1 1 1 1 # _units of catch: 1=bio; 2=num

0.1 0.1 0.1 0.1 # _se of log(catch) only used for init_eq_catch and for Fmethod 2 and 3

1 #_Ngenders # lr (?if split by male female then 2? lr)

30 #_Nages # lr

48.7 0.51 709.68 118.76 #CF _init_equil_catch_for_each_fishery (82% of 1985 value)

29 # _N_lines_of_catch_to_read #lr updated WGCSE 2014

_catch_biomass(tons):_columns_are_ fisheries units ,year,season Updated WGCSE 2014

59.72	0.62	870.38	145.61	1985	1
115.66	2.16	1180.34	17.27	1986	1
118.7	0.02	1839.69	20.9	1987	1
164.12	7.72	1027.77	38.61	1988	1
181.52	9.13	916.96	53.14	1989	1
136.47	22.79	849.03	25.2	1990	1
222.1	14.49	970.72	17.32	1991	1
138.88	7.93	1000.57	37.07	1992	1
222.63	1.01	979.35	48.26	1993	1
523.9	0.4	786.31	59.74	1994	1
609.6	1.32	1056.62	109.63	1995	1
458.36	87.29	2395.39	82.31	1996	1
473.06	71.4	1984.07	91.37	1997	1
386.89	84.73	1773.01	143.47	1998	1

434.08	219.55	1842.63	168.35	1999	1
311.96	52.13	1805.61	227.41	2000	1
340.31	95.47	1883.4	162.36	2001	1
495.71	109	1824.17	198.72	2002	1
440.53	126.81	2470.88	406.81	2003	1
480.31	130.76	2604.02	514.61	2004	1
394.77	78.29	3161.45	757.11	2005	1
506.03	32.8	3258.97	724.37	2006	1
607.42	63.93	2770.24	771.77	2007	1
714.21	19.71	2749.77	760.36	2008	1
643.13	11.09	2649.48	709.33	2009	1
634.15	41.93	3236.34	845.17	2010	1
611.2	97.5	2525.7	635.33	2011	1
755.1	49	2606.1	650	2012	1
726	39	2770.3	596	2013	1

################################

98 #_N_cpue_and_surveyabundance_observations #lr removed 2 lines was 92 instead of 90. Updated WGCSE 2014

#_Units: 0=numbers; 1=biomass; 2=F

#_Errtype: -1=normal; 0=lognormal; >0=T

#_Fleet Units Errtype

1	1	0	#	UK OTB_Nets
2	1	0	#	UK MWT
3	1	0	#	French fleets
4	1	0	#	Other
5	1	0	#	AutBass2
6	0	0	#	AutBass3
7	0	0	#	AutBass4
8	0	0	#	CGFS1

################################

yr qtr indexNumber(7-16) indexResult indexCV

AutBass (numbers 2):

1986	1	5	0.27	0.433295234
1987	1	5	0.05	0.433295234
1989	1	5	6.68	0.433295234
1990	1	5	2.81	0.433295234
1991	1	5	3.08	0.433295234
1992	1	5	0.95	0.433295234

1993	1	5	6.65	0.433295234
1994	1	5	3.33	0.433295234
1995	1	5	4.83	0.433295234
1996	1	5	5.52	0.433295234
1997	1	5	33.62	0.433295234
1998	1	5	1.22	0.433295234
1999	1	5	19.37	0.433295234
2000	1	5	6.07	0.433295234
2001	1	5	34.42	0.433295234
2002	1	5	7.42	0.433295234
2003	1	5	8.37	0.433295234
2005	1	5	13.12	0.433295234
2006	1	5	9.51	0.433295234
2007	1	5	3.42	0.433295234
2008	1	5	18.52	0.433295234
2009	1	5	13.25	0.433295234
2011	1	5	2.25	0.43
2013	1	5	1.34	0.43

AutBass (numbers 3):

1986	1	6	4.26	0.433295234
1987	1	6	0.28	0.433295234
1989	1	6	0.37	0.433295234
1990	1	6	1.15	0.433295234
1991	1	6	0.21	0.433295234
1992	1	6	18.59	0.433295234
1993	1	6	3.59	0.433295234
1994	1	6	1.84	0.433295234
1995	1	6	4.69	0.433295234
1996	1	6	0.43	0.433295234
1997	1	6	4.52	0.433295234
1998	1	6	5.5	0.433295234
1999	1	6	0.67	0.433295234
2000	1	6	11.35	0.433295234
2001	1	6	3.92	0.433295234
2002	1	6	3.87	0.433295234
2003	1	6	4.6	0.433295234
2005	1	6	7.98	0.433295234
2006	1	6	9.21	0.433295234

2007	1	6	1.78	0.433295234
2008	1	6	6.66	0.433295234
2009	1	6	6.25	0.433295234
2011	1	6	1.39	0.43
2013	1	6	0.08	0.43
##	AutBass	(numbers 4):		
1986	1	7	1.31	0.433295234
1987	1	7	2.27	0.433295234
1989	1	7	0.0037	0.433295234
1990	1	7	0.02	0.433295234
1991	1	7	0.03	0.433295234
1992	1	7	0.16	0.433295234
1993	1	7	4.39	0.433295234
1994	1	7	0.29	0.433295234
1995	1	7	0.72	0.433295234
1996	1	7	0.11	0.433295234
1997	1	7	0.06	0.433295234
1998	1	7	0.61	0.433295234
1999	1	7	0.87	0.433295234
2000	1	7	0.03	0.433295234
2001	1	7	1.57	0.433295234
2002	1	7	0.4	0.433295234
2003	1	7	0.59	0.433295234
2005	1	7	0.84	0.433295234
2006	1	7	1.02	0.433295234
2007	1	7	0.3	0.433295234
2008	1	7	0.34	0.433295234
2009	1	7	0.33	0.433295234
2011	1	7	0.42	0.43
2013	1	7	0.1	0.43
##	CGFS1:			
1988	1	8	245776	0.6
1989	1	8	77716	0.6
1990	1	8	1129914	0.6
1991	1	8	4250635	0.3
1992	1	8	2617984	0.3
1993	1	8	2299918	0.3
1994	1	8	1097829	0.3

1995	1	8	1021740	0.3
1996	1	8	1224238	0.3
1997	1	8	1817599	0.3
1998	1	8	2531044	0.3
1999	1	8	1642270	0.3
2000	1	8	2570996	0.3
2001	1	8	3150674	0.3
2002	1	8	3872427	0.3
2003	1	8	8739057	0.3
2004	1	8	3598440	0.3
2005	1	8	3005317	0.3
2006	1	8	5517999	0.3
2007	1	8	3661314	0.3
2008	1	8	6468841	0.3
2009	1	8	2564696	0.3
2010	1	8	1804537	0.3
2011	1	8	1513745	0.3
2012	1	8	2034554	0.3
2013	1	8	995987	0.3

0 # _N_fleets_with_discard

0 # N discard obs

0 # _N_meanbodywt_obs

30 #_DF_for_meanbodywt_T-distribution_like

3 # length bin method: 1=use databins; 2=generate from binwidth,min,max below; 3=read vector

49 # number of population length bins to be read

4	6	8	10	12	14	16	18	20	22	24	26
		28	30	32	34	36	38	40	42	44	46
		48	50	52	54	56	58	60	62	64	66
		68	70	72	74	76	78	80	82	84	86
		88	90	92	94	96	98	100			

-0.001 #_comp_tail_compression

1e-007 #_add_to_comp

0 #_combine males into females at or below this bin number

41 #_N_LengthBins

14	16	18	20	22	24	26	28	30	32	34	36
		38	40	42	44	46	48	50	52	54	56
		58	60	62	64	66	68	70	72	74	76
		78	80	82	84	86	88	90	92	94	

40 #_N_Length_obs #lr Updated WGCSE 2014

#Yr Season Flt/Svy Gender Part Nsamp datavector(female-male)

LANDINGS OF COMMERCIAL FLEETS (1 TO 5), ORDERED BY YEAR AND QUARTER:

##

2000	1	3	0	2	200	0	0	0	0	0
	0	0	0	0	0	9931	34932	85866	126730	
	102836	80478	93344	80934	55399	52948	42094	26460	27357	
	23581	14295	18044	10773	9903	5709	5721	2345	2595	2102
	888	1021	548	123	0	0	0	0		
2001	1	3	0	2	200	0	0	0	0	0
	0	0	0	0	0	17962	19809	68920	76594	
	98008	109595	106857	77694	57055	51658	36737	35839	22762	
	25834	18773	13532	11068	9120	11771	5733	5345	2782	1691
	583	296	204	0	61	0	0	0		
2002	1	3	0	2	200	0	0	0	0	0
	0	0	0	1015	0	12469	38249	46427	62503	
	82461	91064	86723	62163	55905	46180	35998	26001	19019	
	14210	11129	16771	11011	5447	4795	4559	1825	1260	357
	155	109	0	0	0	0	0	0		
2003	1	3	0	2	200	0	0	0	0	0
	0	0	3455	13054	58717	105655	125326	180475	119495	
	145456	104545	130023	115806	91915	93878	48742	60839	31614	
	33688	30691	18823	13230	7960	5374	5617	3275	1356	297
	783	112	148	0	0	0	0	0		
2004	1	3	0	2	200	0	0	0	0	0
	0	0	0	14	13057	78811	127801	124051	227214	
	282390	243107	188494	126685	72581	82331	50633	60284	31334	
	19126	23996	14799	10650	8569	4880	2974	2675	2567	548
	425	149	295	0	149	0	0	0		
2005	1	3	0	2	200	0	0	0	0	0
	0	0	0	0	9903	29872	97890	128022	231750	
	266905	344681	270532	239265	169478	115269	62106	67741	61132	
	43591	35774	25788	12456	13360	8908	8053	9811	5020	2378
	1365	107	0	0	0	0	0	0		
2006	1	3	0	2	200	0	0	0	0	0
	0	0	0	15689	32459	179130	285704	217657	178250	
	196868	289998	285451	263272	200874	119836	99509	99674	54522	
	45908	23763	20607	14969	13976	9653	4521	3424	2883	731
	201	261	30	0	0	0	0	0		
2007	1	3	0	2	200	0	0	0	0	0
	0	0	0	0	181	4715	39335	102714	146272	
	145122	164011	130859	100043	99210	75929	74405	55147	46087	
	28056	23057	18091	8715	8793	4835	2707	1962	1010	399
	158	37	59	0	0	0	0	0		
2008	1	3	0	2	200	0	0	0	0	0
	0	0	0	0	8250	28986	229758	263071	266408	
	237160	270810	228996	142650	112385	74336	66260	48853	39689	
	29840	28335	14420	12694	9039	6821	4714	1623	1257	534
	261	8	0	0	0	0	0	0		
2009	1	3	0	2	200	0	0	0	0	0
	0	0	292	473	2239	10714	124925	211881	225545	
	193030	222613	238849	155222	159658	114530	84649	96257	51578	

	36547	57472	24016	21415	27466	20198	12083	7551	979	1765
	264	1004	0	0	0	0	0	0		
2010	1	3	0	2	200	0	0	0	717	0
	0	0	0	0	9811	28290	169311	177571	182105	
	283064	251956	230227	188149	186310	109212	120550	71590	62211	
	31544	19076	62005	26388	9340	8541	29128	1884	2114	182
	5525	6097	863	0	1207	0	0	0		
2011	1	3	0	2	200	0	0	0	0	0
	0	0	0	0	1976	13885	57121	87842	128838	
	187586	201447	199487	194697	145447	124239	92526	72471	46869	
	31690	19998	17624	14720	7906	6114	2082	1163	1096	476
	148	104	0	0	0	0	0	0		
2012	1	3	0	2	200	0	0	0	0	0
	0	0	1219	0	1583	6518	85760	172510	140273	
	147895	162333	180752	158490	130759	107214	90638	78934	54869	
	35387	33085	17714	15170	9374	8114	4147	2313	1540	1134
	282	451	29	27	0	0	0	0		
2013	1	3	0	2	200	0	0	0	0	0
	0	0	0	239	0	1617	26153	130687	272401	
	311983	234498	270538	187922	166217	140323	115326	118018	78259	
	132959	61538	79165	46759	31584	32919	21221	11918	3418	2153
	236	2743	0	193	0	0	0	0		
-1988		1	8	0	0	6	0	0	0	0
	0	0	0	0	0	0	0	58885	0	
	76121	20143	0	0	0	20143	0	39616	0	
	15434	15434	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	
-1989		1	8	0	0	3	0	0	0	0
	0	0	0	0	0	22235	0	22235	0	
	11011	0	0	0	0	22235	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0		
-1990		1	8	0	0	8	0	0	32733	
	98199	120021	96615	222797	345962	107244	0	0	18463	0
	6106	0	6106	23906	0	17254	17254	17254	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0		
1991	1	8	0	0	19	0	0	0	0	0
	304624	1719409	1119677	531390	110365	162253	126980	45607	16723	
	16703	10625	0	16885	0	5352	30272	16885	0	0
	0	0	0	16885	0	0	0	0	0	0
	0	0	0	0	0	0	0			
1992	1	8	0	0	23	0	0	0	0	0
	0	0	63079	287513	510612	638459	530944	309090	78328	
	79289	26490	42201	0	0	15138	5247	0	10494	0
	0	0	15853	0	0	5247	0	0	0	0
	0	0	0	0	0	0	0			
1993	1	8	0	0	21	0	0	0	0	0
	5551	38106	121556	170213	347228	237317	321637	247396	266632	
	204261	133186	158039	17036	0	0	14798	0	0	
	16962	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0		

1994	1	8	0	0	19	0	0	0	18458	0
	5108	71094	30647	64428	59303	79319	77545	139680	69887	
	157500	113756	52799	63325	37992	18996	18996	0	0	0
	0	18996	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0			
1995	1	8	0	0	17	0	0	0	0	0
	65628	182886	191483	118285	68606	94174	58735	62595	72147	8650
	15487	10698	0	20034	15487	0	0	17299	0	0
	0	19546	0	0	0	0	0	0	0	0
	0	0	0	0	0	0				
1996	1	8	0	0	26	0	0	0	0	
	10096	71187	198585	162449	209883	102756	137006	50619	60715	0
	46710	0	25805	38406	67089	0	0	0	21710	0
	0	0	0	0	0	0	21222	0	0	0
	0	0	0	0	0	0	0			
1997	1	8	0	0	31	0	0	0	0	0
	52420	172277	157267	364320	311146	265276	102658	136668	71024	
	62096	42836	3198	27070	0	36775	0	0	0	0
	0	0	0	0	12568	0	0	0	0	0
	0	0	0	0	0	0	0			
1998	1	8	0	0	38	0	0	0	0	0
	0	10254	42156	199875	248028	445903	469290	406992	271169	
	77307	56211	109682	49306	13620	13620	0	25037	27240	
	13620	13620	0	0	0	11417	0	26697	0	0
	0	0	0	0	0	0	0	0		
1999	1	8	0	0	37	0	0	0	0	
	18433	15128	83225	167646	146928	90595	177558	153662	195992	
	214407	105858	79810	47256	78075	7863	17639	0	9059	0
	9059	0	15018	0	0	0	0	0	0	0
	0	9059	0	0	0	0	0	0		
2000	1	8	0	0	36	0	0	0	18644	
	65257	62040	125296	417455	440978	309620	338993	204879	181687	
	95559	108703	70962	23940	21506	14766	0	24695	0	
	14306	0	9307	13096	0	9307	0	0	0	0
	0	0	0	0	0	0	0	0	0	
2001	1	8	0	0	39	0	0	0	0	0
	59740	413187	767358	518235	300493	248669	158653	247952	66992	
	125042	43191	37193	10236	24597	0	14837	24648	13083	
	52462	0	0	12053	0	0	12053	0	0	0
	0	0	0	0	0	0	0	0		
2002	1	8	0	0	44	0	0	0	0	0
	10739	67655	197986	381355	832988	623508	439729	380196	270697	
	189153	102893	112164	50660	44892	16171	27189	21612	15932	
	12167	0	27484	12167	25511	0	0	9579	0	0
	0	0	0	0	0	0	0	0		
2003	1	8	0	0	41	0	0	0	0	
	22663	13218	161174	795498	720874	802826	1375758	1218315	1251975	
	623889	464021	274147	207776	203176	72670	136756	185043	89875	
	52508	26254	27514	0	13127	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	
2004	1	8	0	0	44	0	0	0	0	0
	2692	0	122879	403673	714884	730822	416792	287359	324966	

	129278	137035	115126	31042	39375	29156	18125	9347	0	
	61811	2692	2692	9347	0	0	0	0	0	0
	9347	0	0	0	0	0	0	0		
2005	1	8	0	0	40	0	0	0	0	
	15565	0	210994	418270	315562	267295	354515	215506	225666	
	181642	106404	138927	146271	109108	98370	34142	9487	52772	
	51553	21543	10751	10751	0	0	10223	0	0	0
	0	0	0	0	0	0	0	0	0	
2006	1	8	0	0	36	0	0	0	0	0
	9814	197122	866753	893641	788190	1120577	531053	311464	137430	
	190156	96298	71441	84223	86273	31873	22996	25308	19628	9814
	3032	0	9814	0	0	11099	0	0	0	0
	0	0	0	0	0	0	0			
2007	1	8	0	0	33	0	0	0	0	0
	0	47391	407308	386452	394375	609358	479157	314000	219897	
	169994	170481	111148	80056	57131	123245	25737	18311	0	
	11929	0	10662	5331	19351	0	0	0	0	0
	0	0	0	0	0	0	0	0		
2008	1	8	0	0	40	0	0	0	0	
	10729	52876	128066	266412	229414	731914	1661470	931172	880632	
	758996	224765	208707	112521	79753	13259	72807	14967	28587	
	19628	0	0	0	42166	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	
2009	1	8	0	0	26	0	0	0	0	0
	0	21413	77225	253598	386804	279160	234313	217371	238780	
	238652	168707	110777	82775	99010	56555	38480	0	21413	
	12158	0	0	0	12249	0	0	15256	0	0
	0	0	0	0	0	0	0	0		
2010	1	8	0	0	30	0	0	0	0	0
	0	20661	79020	106240	232673	118288	117886	316567	207944	
	97593	110810	191255	62479	14580	62090	0	22711	0	
	14580	0	14580	0	0	0	0	14580	0	0
	0	0	0	0	0	0	0	0		
2011	1	8	0	0	27	0	0	0	0	0
	0	13881	0	45451	95055	204438	227355	208472	118040	
	120428	68027	88143	90627	60054	47411	9869	0	33403	
	36907	46184	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0		
2012	1	8	0	0	25	0	0	0	0	0
	0	29922	15009	161369	400458	247182	200887	183315	84361	
	197280	103031	86442	77382	31957	43195	19956	39781	11851	
	40610	19956	20305	20305	0	0	0	0	0	0
	0	0	0	0	0	0	0	0		
2013	1	8	0	0	19	0	0	0	0	0
	0	42825	113195	62476	113528	127750	96177	135950	70592	
	33717	44279	61410	11237	17382	17382	48087	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0			

###

17 #_N_age_bins

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16

1 #_N_ageerror_definitions

0.5	1.5	2.5	3.5	4.5	5.5	6.5	7.5	8.5	9.5	10.5	11.5
		12.5	13.5	14.5	15.5	16.5	17.5	18.5	19.5	20.5	21.5
		22.5	23.5	24.5	25.5	26.5	27.5	28.5	29.5	30.5	
0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	

45 #_N_Agecomp_obs Updated WGCSE 2014

1 #_Lbin_method: 1=poplenbins; 2=datalenbins; 3=lengths

0 #_combine males into females at or below this bin number

#Yr Seas Flt/Svy Gender Part Ageerr Lbin_lo Lbin_hi Nsamp datavector(female-male)

1985	1	1	0	0	1	-1	-1	20	0	0
	39	11855	24729	4971	7840	1115	2464	8117	1957	1998
	1274	388	940	290	881					
1986	1	1	0	0	1	-1	-1	20	0	0
	0	4884	27887	15561	3502	9222	1468	5205	16306	2422
	2496	3194	962	1339	3200					
1987	1	1	0	0	1	-1	-1	20	0	0
	0	538	36640	58747	16002	2398	3049	921	1349	7020
	2644	1661	680	854	3144					
1988	1	1	0	0	1	-1	-1	20	0	0
	0	2002	22412	63428	41135	13637	2189	3383	1028	973
	8536	3208	1898	1323	3962					
1989	1	1	0	0	1	-1	-1	20	0	0
	36098	5449	1940	13675	52948	30807	11658	4352	4018	2310
	3753	10735	1659	1452	3893					
1990	1	1	0	0	1	-1	-1	20	0	0
	0	2211	2456	2443	10075	32009	22045	5886	2407	1726
	1059	1388	5816	451	3327					
1991	1	1	0	0	1	-1	-1	100	0	0
	3297	14161	46666	2441	2480	9079	27634	22309	8985	912
	3381	3336	1399	9320	4874					
1992	1	1	0	0	1	-1	-1	100	0	0
	0	17906	60212	38948	2021	985	2539	6440	6535	1759
	546	529	258	581	4676					
1993	1	1	0	0	1	-1	-1	100	0	0
	20	1116	102649	83638	30222	1624	860	2851	8286	6615
	2316	960	1453	1231	5544					
1994	1	1	0	0	1	-1	-1	100	0	0
	2	1296	33559	441976	57214	26998	2078	432	3844	
	10956	8893	2830	1341	983	6488				
1995	1	1	0	0	1	-1	-1	100	0	0
	0	5739	38805	91413	431628	28024	13059	1411	1040	2136
	8541	7158	3551	4314	7272					

1996	1	1	0	0	1	-1	-1	100	0	0
	145	9340	41876	32357	89255	251801	12051	6450	352	794
	970	4055	2652	1238	3457					
1997	1	1	0	0	1	-1	-1	100	0	0
	330	4027	10393	73598	50958	51074	186353	11996	5953	927
	955	589	4462	3208	4262					
1998	1	1	0	0	1	-1	-1	100	0	0
	0	13955	58518	55500	105347	35312	26571	71835	5360	1616
	202	329	1167	1931	2542					
1999	1	1	0	0	1	-1	-1	100	0	0
	346	140	97612	160695	56563	50986	15824	13035	43407	3277
	2153	260	807	548	3431					
2000	1	1	0	0	1	-1	-1	100	0	0
	0	9389	2804	168794	84314	17784	18662	7809	8269	
	15820	1410	379	26	90	1105				
2001	1	1	0	0	1	-1	-1	100	0	0
	488	9410	80244	32923	123218	30484	10730	12972	8458	
	12042	13359	1464	1157	112	1196				
2002	1	1	0	0	1	-1	-1	100	0	0
	522	15068	55187	284390	21080	92341	24876	10798	12961	4029
	5697	14855	823	348	876					
2003	1	1	0	0	1	-1	-1	100	0	0
	0	6054	71838	68737	181978	11049	53668	19350	6287	4653
	3870	2998	6685	1071	911					
2004	1	1	0	0	1	-1	-1	100	0	0
	0	4868	44567	223462	84721	117748	4530	16798	8033	3022
	2016	2195	728	2747	410					
2005	1	1	0	0	1	-1	-1	100	0	0
	0	13942	107126	69643	117337	40220	59321	6590	15664	2820
	1599	2379	703	676	933					
2006	1	1	0	0	1	-1	-1	100	0	0
	0	18742	133803	158129	61442	88113	25791	41969	3889	6116
	3389	1138	591	930	3977					
2007	1	1	0	0	1	-1	-1	100	0	0
	0	947	41363	208202	127765	59388	51729	20972	23751	
	15466	7284	5952	87	535	849				
2008	1	1	0	0	1	-1	-1	100	0	0
	0	10123	119526	326706	183313	69770	31832	29029	13352	
	10641	2043	1730	4019	478	1703				
2009	1	1	0	0	1	-1	-1	100	0	0
	0	2816	78121	183363	197627	86301	29037	22777	12978	
	12790	7765	2962	2268	0	225				
2010	1	1	0	0	1	-1	-1	100	0	0
	0	1067	77792	188027	162311	111066	42029	15853	8777	8349
	3153	2497	2515	577	1761					
2011	1	1	0	0	1	-1	-1	100	0	0
	0	841	32410	131931	111148	84747	67313	41381	15244	
	16038	8388	4829	4086	1212	2092				

2012	1	1	0	0	1	-1	-1	100	0	0
	0	1690	15902	187155	248719	82602	59754	47075	24028	
	16085	6655	6120	4371	1056	1634				
2013	1	1	0	0	1	-1	-1	100	0	0
	0	0	46413	67860	219457	150956	51911	45186	33248	
	28066	17913	6654	5558	4380	4008				
1996	1	2	0	0	1	-1	-1	50	0	0
	0	0	289	796	3892	71665	5583	1648	21	334
	154	622	485	199	560					
1998	1	2	0	0	1	-1	-1	50	0	0
	0	0	264	6405	12691	9161	8714	26925	2696	370
	100	57	128	957	614					
1999	1	2	0	0	1	-1	-1	50	0	0
	0	0	2988	18438	15167	27342	13892	18263	43646	4481
	1695	324	387	308	2762					
2000	1	2	0	0	1	-1	-1	50	0	0
	0	15	60	2475	7585	3269	4496	1459	2829	7075
	633	174	39	96	421					
2001	1	2	0	0	1	-1	-1	50	0	0
	0	0	176	884	19449	19953	6925	5181	3072	2797
	9505	843	625	121	258					
2002	1	2	0	0	1	-1	-1	50	0	0
	0	3	37	2349	1558	23776	9568	6215	5901	444
	5591	9096	0	0	524					
2003	1	2	0	0	1	-1	-1	50	0	0
	0	0	2503	9885	36543	7420	37748	9582	2943	3029
	576	157	3764	72	262					
2004	1	2	0	0	1	-1	-1	50	0	0
	0	7	1310	13054	15006	50232	3340	21608	8363	369
	1876	1192	95	1011	20					
2005	1	2	0	0	1	-1	-1	50	0	0
	0	0	130	2404	17514	16457	19899	2180	5924	0
	2093	113	0	45	686					
2006	1	2	0	0	1	-1	-1	50	0	0
	0	0	105	263	282	1892	660	1432	118	82
	52	0	0	0	26					
2007	1	2	0	0	1	-1	-1	50	0	0
	0	0	659	4305	12037	9213	11685	4780	3249	1079
	1380	21	64	32	207					
2008	1	2	0	0	1	-1	-1	50	0	0
	0	52	513	1775	3779	2060	1627	1794	870	1106
	35	211	565	0	47					
2009	1	2	0	0	1	-1	-1	50	0	0
	0	0	101	712	2439	2911	945	880	189	334
	194	12	190	0	1					
2010	1	2	0	0	1	-1	-1	50	0	0
	0	9	36	1741	5545	8261	6677	4755	403	3786
	152	294	313	551	51					

2011	1	2	0	0	1	-1	-1	50	0	0
	0	0	255	4397	10231	13639	15908	13641	4424	4232
	2773	1688	1003	264	424					
2012	1	2	0	0	1	-1	-1	50	0	0
	0	0	391	4456	10762	10003	8746	5782	2738	1133
	289	433	143	127	226					

0 #_N_MeanSize-at-Age_obs

#Yr Seas Flt/Svy Gender Part Ageerr Ignore datavector(female-male)

samplesize(female-male)

0 #_N_environ_variables

0 #_N_environ_obs

0 # N sizefreq methods to read

0 # no tag data

0 # no morphcomp data

999 # end of data file marker

Appendix 3

Content of Stock Synthesis Starter file (Starter.SS) used at WGCSE 2014.

#V3.23b

#C Bass initial assessment

BassIVVII.dat

BassIVVII.ctl

0 # 0=use init values in control file; 1=use ss3.par

1 # run display detail (0,1,2)

1 # detailed age-structured reports in REPORT.SSO (0,1)

0 # write detailed checkup.sso file (0,1)

4 # write parm values to ParmTrace.sso (0=no,1=good,active; 2=good,all; 3=every_iter,all_parms; 4=every,active)

1 # write to cumreport.sso (0=no,1=like&timeseries; 2=add survey fits)

1 # Include prior_like for non-estimated parameters (0,1)

1 # Use Soft Boundaries to aid convergence (0,1) (recommended)

2 # Number of bootstrap datafiles to produce

8 # Turn off estimation for parameters entering after this phase

10 # MCMC burn interval

2 # MCMC thin interval

0 # jitter initial parm value by this fraction

-1 # min yr for sdreport outputs (-1 for styr)

-1 # max yr for sdreport outputs (-1 for endyr; -2 for endyr+Nforecastyrs

0 # N individual STD years

#vector of year values

0.0001 #0.0001 # final convergence criteria (e.g. 1.0e-04)

0 # retrospective year relative to end year (e.g. -4)

0 # min age for calc of summary biomass

2 # Depletion basis: denom is: 0=skip; 1=rel X*B0; 2=rel X*Bmsy; 3=rel X*B_styr

0.4 # Fraction (X) for Depletion denominator (e.g. 0.4)

2 # SPR_report_basis: 0=skip; 1=(1-SPR)/(1-SPR_tgt); 2=(1-SPR)/(1-SPR_MSY); 3=(1-SPR)/(1-SPR_Btarget); 4=rawSPR

2 # F_report_units: 0=skip; 1=exploitation(Bio); 2=exploitation(Num); 3=sum(Frates)

#COND 3 10 #_min and max age over which average F will be calculated with F_reporting=4

0 # F_report_basis: 0=raw; 1=F/F_{spr}; 2=F/F_{MSY} ; 3=F/F_{btgt}
999 # check value for end of file

Appendix 4

Content of Stock Synthesis Forecast file (Forecast.SS) used at WGCSE 2014. This is not used for creating forecasts yet, but has to be available.

#V3.23b

for all year entries except rebuilder; enter either: actual year, -999 for styr, 0 for endyr, neg number for rel. endyr

1 # Benchmarks: 0=skip; 1=calc F_spr,F_btgt,F_msy

1 # MSY: 1= set to F(SPR); 2=calc F(MSY); 3=set to F(Btgt); 4=set to F(endyr)

0.4 # SPR target (e.g. 0.40)

0.4 # Biomass target (e.g. 0.40)

#_Bmark_years: beg_bio, end_bio, beg_selex, end_selex, beg_relF, end_relF (enter actual year, or values of 0 or -integer to be rel. endyr)

0 0 0 0 0 0

2010 2010 2010 2010 2010 2010 # after processing

1 #Bmark_relF_Basis: 1 = use year range; 2 = set relF same as forecast below

#

0 # Forecast: 0=none; 1=F(SPR); 2=F(MSY) 3=F(Btgt); 4=Ave F (uses first-last relF yrs); 5=input annual F scalar

3 # N forecast years

1 # F scalar (only used for Do_Forecast==5)

#_Fcast_years: beg_selex, end_selex, beg_relF, end_relF (enter actual year, or values of 0 or -integer to be rel. endyr)

0 0 0 0

1180696575 1667592815 7631713 0 # after processing

1 # Control rule method (1=catch=f(SSB) west coast; 2=F=f(SSB))

0.4 # Control rule Biomass level for constant F (as frac of Bzero, e.g. 0.40); (Must be > the no F level below)

0.1 # Control rule Biomass level for no F (as frac of Bzero, e.g. 0.10)

0.75 # Control rule target as fraction of Flimit (e.g. 0.75)

3 #_N forecast loops (1=OFL only; 2=ABC; 3=get F from forecast ABC catch with allocations applied)

3 #_First forecast loop with stochastic recruitment

0 #_Forecast loop control #3 (reserved for future bells&whistles)

0 #_Forecast loop control #4 (reserved for future bells&whistles)

0 #_Forecast loop control #5 (reserved for future bells&whistles)

2011 #FirstYear for caps and allocations (should be after years with fixed inputs)

0 # stddev of log(realized catch/target catch) in forecast (set value>0.0 to cause active impl_error)

0 # Do West Coast gfish rebuilder output (0/1)

-1 # Rebuilder: first year catch could have been set to zero (Ydecl)(-1 to set to 1999)

-1 # Rebuilder: year for current age structure (Yinit) (-1 to set to endyear+1)

1 # fleet relative F: 1=use first-last alloc year; 2=read seas(row) x fleet(col) below

Note that fleet allocation is used directly as average F if Do_Forecast=4

0 # basis for fcast catch tuning and for fcast catch caps and allocation (2=deadbio; 3=retainbio; 5=deadnum; 6=retainnum)

Conditional input if relative F choice = 2

Fleet relative F: rows are seasons, columns are fleets

#_Fleet:

0 0 0 0

0 0 0 0

0 0 0 0

0 0 0 0

max totalcatch by fleet (-1 to have no max) must enter value for each fleet

-1

max totalcatch by area (-1 to have no max); must enter value for each fleet

-1

fleet assignment to allocation group (enter group ID# for each fleet, 0 for not included in an alloc group)

0

#_Conditional on >1 allocation group

allocation fraction for each of: 0 allocation groups

no allocation groups

0 # Number of forecast catch levels to input (else calc catch from forecast F)

2 # basis for input Fcast catch: 2=dead catch; 3=retained catch; 99=input Hrate(F) (units are from fleetunits; note new codes in SSV3.20)

Input fixed catch values

#Year Seas Fleet Catch(or_F)

#

999 # verify end of input