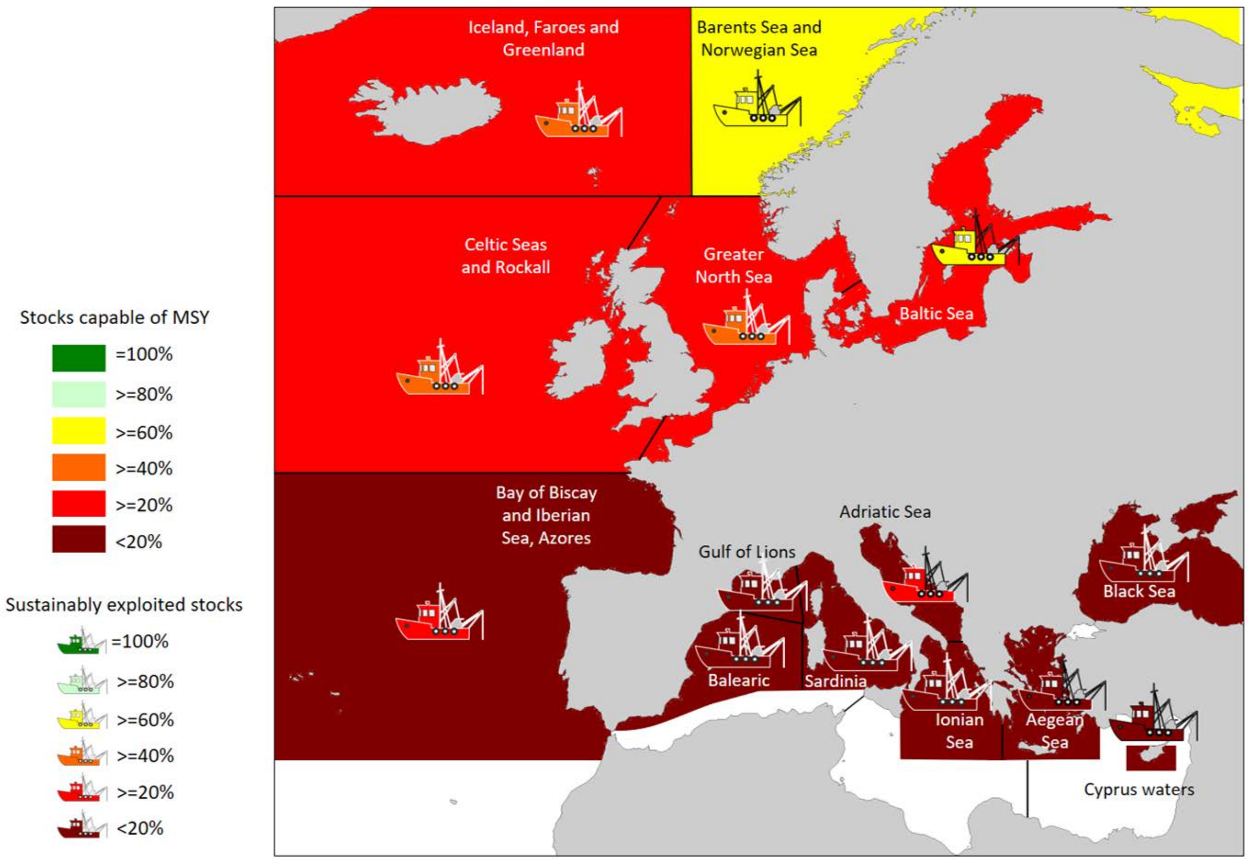
Exploitation and Status of European Stocks



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Exploitation and Status of European Stocks

Report about the outcome of four workshops in 2016, about the assessment of all European stocks. The final version of the report was prepared in October 2016 by

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Note: This is an updated version where the map on the title page and in Figure 5 has been replace with a corrected one where the color for the North Sea is red instead of dark red. Also, the equation for rebuilding time on page 11 has been replaced by a more precise one and the respective reference is given.

Legend for map on title page: *The map shows the compliance with the Common Fisheries Policy of the EU, for 357 stocks in 12 ecoregions, for the last years (2013-2015) with available data (excluding 40 wide-ranging stocks). The color of the areas indicates the percentage of stocks with sizes that are above the level that can produce maximum sustainable yields and the color of the fishing boats indicates the percentage of stocks that are exploited sustainably.*

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Executive Summary

Stock assessments are presented for 397 stocks in 14 European ecoregions, from the Barents Sea to the Black Sea. Surplus production modeling was used to estimate fisheries reference points in a maximum sustainable yield (*MSY*) framework. Fishing pressure and biomass were estimated from 2000 to the last year with available data (2013-2015). Results are presented by ecoregion and by main functional groups (benthic fish & invertebrates, large predators, pelagic plankton feeders). Cumulative biomass of exploited species was well below the level that can produce *MSY* in all ecoregions. Fishing pressure has decreased in some ecoregions but not in others. Barents Sea and Norwegian Sea have the highest percentage (> 60%) of sustainably exploited stocks that are capable of producing *MSY* and which thus fulfill the goals of the Common Fisheries Policy of the European Union. In contrast, in most ecoregions of the Mediterranean fewer than 20% of the stocks are exploited sustainably or are capable of producing *MSY*. Especially large predators have low biomass and were subject to strong overfishing in all ecoregions. In the last year with available data, 64% of the 397 stocks were subject to ongoing overfishing and 51% of the stocks were outside of safe biological limits, potentially suffering from impaired reproduction. Only 12% of the stocks fulfilled the requirement of the Common Fisheries Policy of Europe as being not subject to overexploitation and having a biomass above the level that can produce maximum sustainable yields.

Biomass in the ecoregions of the Mediterranean and Black Sea was on average less than half (44%) of the level that can produce *MSY*, whereas in the northern ecoregions (Barents Sea to Iberian coastal) biomass was about ¾ (73%) of that level. Rebuilding of biomass above the *MSY* level would require only a few years in most stocks, depending on the depletion level of the stocks and how far exploitation is reduced below the *MSY*-level during the rebuilding phase. For example, exploitation at half the *MSY*-level would rebuild most stocks in the northern ecoregions in 1-5 years whereas in the more depleted Mediterranean rebuilding of stocks would take 2-7 years.

Total catches across all stocks and regions were 8.8 million tonnes whereas the maximum sustainable yield (*MSY*) was estimated at 15.4 million tonnes. Because of trophic interactions it is not possible to achieve *MSY* simultaneously for all stocks, but after rebuilding of the stocks and assuming a precautionary target of 90% of *MSY*, substantial increases in catches could be possible. These potential increases differ widely between ecoregions, from 25% in the Baltic Sea to over 200% in some Mediterranean ecoregions. Across all stocks and ecoregions, potential increases in catch of over 50% could be possible.

Independent assessments of exploitation status were available for 93 (23%) of the examined stocks. For the stocks with different classifications, this study tended to underestimate exploitation.

Introduction

The Marine Strategy Framework Directive (MSFD 2008) and the reformed Common Fisheries Policy of the European Union (CFP 2013) demand that fishing pressure (*F*) on European stocks does not exceed the one (F_{msy}) that can produce maximum sustainable yields (*MSY*), generally in 2015 and under special circumstances latest in 2020. Also, the biomass (*B*) of European stocks has to be rebuilt above the level (B_{msy}) that can produce *MSY*. The purpose of this study was to examine all European stocks for which at least catch data are available and to determine status (B/B_{msy}) and exploitation (F/F_{msy}) in the context of the legal requirements.

More specifically, this study had the following terms of reference:

1.1 Estimation of total current fish biomass (in weight) in European waters, if possible differentiated between EU and non-EU waters. The biomass estimation will be differentiated, whenever feasible, by stocks in order to be able to provide the information also by species and/or main fishing areas independently.

1.2 Estimation of total current catches (in weight) in European waters by vessels of European countries and non-European countries. The catch data will be, whenever possible, differentiated by stocks in order to provide the information, by species and main fishing areas independently. Estimates of non-reported illegal catches and discards, will be included when available in peer reviewed literature or official reports. Note: For reporting the information of biomass and catches, select the last common reference year for which this information is accurate and available, and a time series of years when available) showing the evolution in the medium term.

1.3 Estimation of total potential fish biomass that can produce the maximum sustainable yield, if possible differentiate between EU and non-EU waters. Information of potential biomass will be presented, whenever possible, by stocks in order to be able to provide the information also by species and/or main areas independently.

1.4 Calculation of the difference between current biomass and potential biomass (recover ability) by stocks, species, main fishing areas and total. Selection of relevant case studies in terms of absolute (weight) and relative (%) recovery potential.

1.5 Estimation of total potential catches that can produce the maximum sustainable yield. Information of potential catches will be presented, whenever possible, by stocks in order to be able to provide the information also by species and for main areas independently.

1.6 Calculation of the difference between current catches and potential catches and biomass by stocks, species, main fishing areas, and total. Selection of relevant case studies in terms of absolute (weight) and relative (%) catches. Note: Stocks for which MSY levels are not determined other MSY proxy or precautionary reference point will be used.

1.7 It is understood that the findings of this project will be summarized in a scientific publication, to be submitted to a peer-reviewed Journal after the end of the project.

Four workshops were convened in Kiel, Germany (18-22 April, 4-8 July and 14-16 September 2016) and in Kavala, Greece (6-7 October 2016) where most of the authors met, improved the assessment tools, and analyzed the stocks. This report presents the outcomes of the exercise.

Material and Methods

The assessments presented in this report are based on the most recent data as available in August 2016. For the Northeast Atlantic, the advice documents published by the International Council for the Exploration of the Seas (ICES) and the International Commission for the Conservation of Atlantic Tunas (ICCAT) were used. For the Mediterranean, the landings were acquired from the Food and Agriculture Organization-General Fisheries Commission for the Mediterranean (FAO-GFCM) database (1970-2013) for each ecoregion (western Mediterranean, Adriatic Sea, Ionian Sea and central Mediterranean, Aegean Sea, Levantine Sea) and the biomass or abundance data from Data Collection Framework (DCF) reports. Data from the regular assessments of the Joint Research Center-Scientific, Technical and Economic Committee for Fisheries (JRC-STECF) were also used in some cases. For the Black Sea, latest stock assessment reports published by the JRC-STECF were used.

The sources are indicated in the respective Appendices for every stock. If catch and abundance data were available, these were analyzed with an advanced Bayesian implementation of a state-space surplus production model (BSM). Surplus production models are regularly used by assessment bodies such as ICES, ICCAT or GFCM if no information about age structure is available. The advantage of BSM over other implementations of surplus production models is its use of informative priors derived from population dynamics theory and its acceptance of incomplete and interrupted time series for abundance. Also, a simple stock-recruitment model was incorporated in the surplus production modeling to account for reduced productivity at severely depleted stock sizes (Froese et al. 2016).

If no abundance data were available or if these data were deemed unreliable, the CMSY method of Froese et al. (2016) was applied, using catch data and priors for productivity and stock status as inputs. The source code in R together with a short description and user’s guide for CMSY and BSM is available in Appendix 4.

All files submitted with this report are listed in Table 1, each with a short desciption of its contents and its directory location.

Table 1. List of supplementary files submitted with this report, with a short description of its content and its directory location.

File	Content	Directory
StockStatusReport.pdf	Exploitation and Status of European Stocks	/
Appendix_1.pdf	Detailed results for stocks in the ICES area	/
Appendix_2.pdf	Detailed results for Mediterranean stocks	/
Appendix_3.pdf	Detailed results for wide-ranging stocks	/
Appendix_4.pdf	User's Guide to CMSY and BSM	/
BlackSea_Catch.csv	Catch and abundance data for Black Sea stocks	/R-Code&Data
BlackSea_ID.csv	Settings for analysis of Black Sea stocks	/R-Code&Data
CMSY_O_7m.R	Version of R-code used in Appendices	/R-Code&Data
CMSY_O_7q.R	Version of R-code in User's Guide	/R-Code&Data

File	Content	Directory
O_ICES_Catches_13.csv	Catch and abundance data for ICES stocks	/R-Code&Data
O_ICES_ID_17.csv	Settings for analysis of ICES stocks	/R-Code&Data
O_Stocks_Catch_15_Med.csv	Catch and abundance data for MED stocks	/R-Code&Data
O_Stocks_ID_18_Med.csv	Settings for analysis of MED stocks	/R-Code&Data
Adriatic_Oct14_16.xlsx	Analyses and graphs for stocks in the Adreatic Sea	/Spreadsheets
AegeanSea_Oct04_16.xlsx	Analyses and graphs for stocks in the Aegean Sea	/Spreadsheets
AllStocks_Oct14_16.xlsx	Analyses and graphs across all ecoregions and stocks	/Spreadsheets
Balearic_Oct12_16.xlsx	Analyses and graphs for stocks in the Balearic Sea	/Spreadsheets
Baltic_Sep21_2016_4.xlsx	Analyses and graphs for stocks in the Baltic Sea	/Spreadsheets
BarentsSea_Sep26_2016.xlsx	Analyses and graphs for stocks in the Barents and Norwegian Seas	/Spreadsheets
BlackSea_Oct14_16.xlsx	Analyses and graphs for stocks in the Black Sea	/Spreadsheets
CelticSeas_Sep27_2016.xlsx	Analyses and graphs for stocks in the Celtic Seas and Rockall	/Spreadsheets
Cyprus_Oct13_16.xlsx	Analyses and graphs for stocks around Cyprus	/Spreadsheets
Iberian_Sep28_2016.xlsx	Analyses and graphs for stocks in the Iberian Sea and Azores	/Spreadsheets
ICCAT_Oct05_16.xlsx	Analyses and graphs for ICCAT stocks in European Seas	/Spreadsheets
Iceland_Sep27_2016.xlsx	Analyses and graphs for stocks in the Icelandic and Greenland Seas	/Spreadsheets
Ionian_Oct13_16.xlsx	Analyses and graphs for stocks in the Ionian Seas	/Spreadsheets
Lions_Gulf_Oct12_16.xlsx	Analyses and graphs for stocks in the Gulf of Lions	/Spreadsheets
NorthSea_Sep23_2016.xlsx	Analyses and graphs for stocks in the Greater North Sea	/Spreadsheets
Sardinia_Oct14_16.xlsx	Analyses and graphs for stocks around Sardinia	/Spreadsheets
Wide_Sep29_16.xlsx	Analyses and graphs for wide-ranging stocks in the ICES area	/Spreadsheets
CMSY_UserGuide_27Oct16.pdf	CMSY/BSM User's Guide version of 27 October 2016	/UserGuide
CMSY_O_7q.R	Version of R_code referred to in the User's Guide	/UserGuide
O_Stocks_ID_18_Med.csv	Example settings for User's Guide	/UserGuide
O_Stocks_Catch_15_Med.csv	Example catch and abundance data for User's Guide	/UserGuide

Getting continuous priors for r

A new tool was developed to derive prior estimates for the probability distribution of the intrinsic rate of population increase from life history traits in FishBase (www.fishbase.org). The tool uses the empirical relations proposed in Froese et al. (2016), namely

$$r \approx 2M \ \approx 3\ K \ \approx 3.3/t_{gen} \approx 9/t_{max}$$

where r ($year^{-1}$) is the maximum intrinsic rate of population increase, M ($year^{-1}$) is the rate of natural mortality, K ($year^{-1}$) is the von Bertalanffy growth parameter indicating how fast asymptotic length is reached, t_{gen} (years) is the mean age of spawners or generation time, and t_{max} (years) is maximum age. These relationships work because r is a function of generation time, which is highly correlated with maximum age, which in turn is determined by the mortality rate. In species with indeterminate growth, such as all species treated in this study, maximum age coincides with asymptotic length, and since K determines how fast that length is reached, it is related to maximum age as ($t_{max} = 3/K$; Taylor 1958). But r is also a function of annual fecundity, which can act as a bottleneck to population growth if, e.g., only few pups are produced every other year, such as in some sharks. A simple preliminary function was therefore fitted to r and fecundity data presented in Musick (1999).

$$r \approx 0.5\ e^{-4.6/Fec^{0.3}}$$

This equation will be improved once more estimates of r and fecundity are available.

To give more influence to life history traits which may act as bottleneck for population increase (Musick 1999), r values were sorted from highest to lowest and weighted by their rank, so that the lowest estimate got the highest weight.

If no life history information was available for a species, the resilience classification in FishBase was used to apply the default r-ranges suggested in Froese et al. (2016). Similarly, for invertebrates, r-ranges were derived from assumed resilience of the species.

The priors derived in this manner for the species examined in this study are shown in Table 2.

Table 2. List of 120 species examined in this study, arranged by functional group and alphabetically within groups, including scientific name, common name, and their priors for r based on life history traits recorded in FishBase (www.fishbase.ca, accessed 14 October 2016). Where r is NA, the 2 SD range values represent the defaults used for resilience categories in Froese et al. (2016), see also O_ICES_ID_15.csv and O_Stocks_ID_17_Med.csv.

Functional Group	Common Name	Species	r	2 SD Range			Based on
Benthic fish & inv.	Small sandeel	*Ammodytes tobianus*	1.26	0.80	-	1.98	3 M, 8 K, 6 tgen, 2 tmax
	European eel	*Anguilla anguilla*	0.32	0.16	-	0.65	23 K, 12 tgen, 8 tmax, 2 Fec
	Black scabbardfish	*Aphanopus carbo*	NA	0.05	-	0.50	Low resilience
	Greater argentine	*Argentina silus*	0.29	0.13	-	0.67	18 K, 13 tgen, 1 tmax, 1 Fec
	Giant red shrimp	*Aristeomorpha foliacea*	NA	0.20	-	0.80	Medium resilience
	Blue and red shrimp	*Aristeus antennatus*	NA	0.20	-	0.80	Medium resilience
	Alfonsino (Redfish)	*Beryx* spp.	NA	0.05	-	0.50	Low resilience
	Purple dye murex	*Bolinus brandaris*	NA	0.60	-	1.50	High resilience
	Tusk	*Brosme brosme*	0.36	0.21	-	0.62	1 M, 9 K, 3 tgen, 1 tmax, 7 Fec
	Boarfish	*Capros aper*	0.55	0.18	-	1.69	3 K, 4 tgen, 3 tmax
	Leafscale gulper shark	*Centrophorus squamosus*	NA	0.05	-	0.50	Low resilience
	Portuguese dogfish	*Centroscymnus coelolepis*	NA	0.015	-	0.10	Very low resilience
	Striped Venus clam	*Chamelea gallina*	NA	0.20	-	0.80	Medium resilience
	Red gurnard	*Chelidonichthys cuculus*	0.65	0.28	-	1.51	6 K, 5 tgen, 3 tmax
	European conger	*Conger conger*	0.27	0.16	-	0.46	2 K, 2 tgen, 2 Fec
	Roundnose grenadier	*Coryphaenoides rupestris*	0.28	0.11	-	0.71	3 K, 4 tgen, 1 tmax, 15 Fec
	Kitefin shark	*Dalatias licha*	NA	0.05	-	0.50	Low resilience
	Common dentex	*Dentex dentex*	0.33	0.15	-	0.73	3 K, 5 tgen, 1 tmax
	Large-eye dentex	*Dentex macrophthalmus*	0.71	0.38	-	1.34	1 M, 6 K, 2 tgen, 1 tmax
	Annular seabream	*Diplodus annularis*	0.68	0.38	-	1.22	2 M, 16 K, 9 tgen, 1 tmax, 3 Fec
	White seabream	*Diplodus sargus*	0.44	0.23	-	0.85	5 K, 8 tgen, 2 tmax, 4 Fec
	Horned octopus	*Eledone cirrosa*	NA	0.20	-	0.80	Medium resilience
	Musky octopus	*Eledone moschata*	NA	0.20	-	0.80	Medium resilience
	Witch flounder	*Glyptocephalus cynoglossus*	0.33	0.18	-	0.62	10 K, 16 tgen, 1 tmax, 2 Fec
	Euopean lobster	*Homarus gammarus*	NA	0.20	-	0.80	Medium resilience
	Orange roughy	*Hoplostethus atlanticus*	0.20	0.05	-	0.80	4 K, 13 tgen, 1 tmax, 20 Fec

Functional Group	Common Name	Species	r	2 SD Range			Based on
Benthic fish & inv.	Shortfin squid	*Illex coindetii*	NA	0.20	-	0.80	Medium resilience
	Four-spot megrim	*Lepidorhombus boscii*	NA	0.05	-	0.50	Low resilience
	Megrims	*Lepidorhombus* spp.	NA	0.2	-	0.8	Medium resilience
	Megrim	*Lepidorhombus whiffiagonis*	0.58	0.34	-	1.00	24 K, 5 tgen, 7 tmax
	Cuckoo ray	*Leucoraja naevus*	0.26	0.09	-	0.71	1 M, 3 K, 2 tgen, 1 tmax, 5 Fec
	Common dab	*Limanda limanda*	0.49	0.24	-	0.98	2 M, 13 K, 13 tgen, 4 tmax, 14 Fec
	European squid	*Loligo vulgaris*	NA	0.20	-	0.80	Medium resilience
	Blackbellied angler	*Lophius budegassa*	0.33	0.20	-	0.54	8 K, 5 tgen, 2 tmax, 3 Fec
	Angler	*Lophius piscatorius*	0.31	0.15	-	0.64	10 K, 3 tgen, 2 tmax, 1 Fec
	Anglerfishes	*Lophius* spp.	NA	0.05	-	0.50	Low resilience
	Roughhead grenadier	*Macrourus berglax*	0.20	0.08	-	0.51	1 K, 2 tgen, 1 tmax, 8 Fec
	Lemon sole	*Microstomus kitt*	0.42	0.20	-	0.86	7 K, 4 tgen, 1 tmax, 4 Fec
	Blue ling	*Molva dypterygia*	0.31	0.20	-	0.48	1 M, 3 K, 12 tgen, 1 tmax
	Ling	*Molva molva*	0.38	0.22	-	0.66	1 M, 8 K, 4 tgen, 1 tmax, 3 Fec
	Red mullet	*Mullus barbatus (barbatus)*	0.52	0.22	-	1.25	1 M, 50 K, 3 tgen, 7 tmax, 8 Fec
	Surmullet	*Mullus surmuletus*	0.85	0.46	-	1.58	2 M, 25 K, 9 tgen, 7 tmax
	Norway lobster	*Nephrops norvegicus*	NA	0.20	-	0.80	Medium resilience
	Saddled seabream	*Oblada melanura*	0.78	0.68	-	0.88	1 M, 3 K, 2 tgen
	Common octopus	*Octopus vulgaris*	NA	0.20	-	0.80	Medium resilience
	Axillary seabream	*Pagellus acarne*	0.55	0.28	-	1.08	1 M, 8 K, 8 tgen, 2 tmax, 10 Fec
	Blackspot seabream	*Pagellus bogaraveo*	0.45	0.26	-	0.76	13 K, 2 tgen, 3 tmax, 2 Fec
	Common pandora	*Pagellus erythrinus*	0.46	0.22	-	0.97	1 M, 17 K, 9 tgen, 6 Fec
	Red porgy	*Pagrus pagrus*	0.48	0.27	-	0.86	1 M, 12 K, 5 tgen, 1 tmax, 2 Fec
	Common spiny lobster	*Palinurus elephas*	NA	0.05	-	0.50	Low resilience
	Northern shrimp	*Pandalus borealis*	NA	0.20	-	0.80	Medium resilience
	Deep-water rose shrimp	*Parapenaeus longirostris*	NA	0.60	-	1.50	High resilience
	Great Mediterranean scallop	*Pecten jacobeus*	NA	0.20	-	0.80	Medium resilience
	Caramote prawn	*Penaeus kerathurus*	NA	0.60	-	1.50	High resilience

Functional Group	Common Name	Species	r	2 SD Range			Based on
Benthic fish & inv.	Greater forkbeard	*Phycis blennoides*	0.46	0.28	-	0.76	1 M, 2 K, 2 tgen, 1 tmax
	European flounder	*Platichthys flesus*	0.47	0.22	-	0.97	2 M, 9 K, 29 tgen, 1 tmax, 16 Fec
	European plaice	*Pleuronectes platessa*	0.39	0.20	-	0.77	4 M, 15 K, 42 tgen, 3 tmax, 26 Fec
	Blonde ray	*Raja brachyura*	0.21	0.05	-	0.85	1 M, 2 K, 1 tgen, 1 tmax, 3 Fec
	Thornback ray	*Raja clavata*	0.15	0.02	-	0.90	1 M, 9 K, 8 tgen, 2 tmax, 8 Fec
	Spotted ray	*Raja montagui*	0.26	0.08	-	0.85	1 M, 4 K, 3 tgen, 3 tmax, 2 Fec
	Greenland halibut	*Reinhardtius hippoglossoides*	0.33	0.16	-	0.68	5 K, 14 tgen, 1 tmax, 18 Fec
	Salema	*Sarpa salpa*	NA	0.20	-	0.80	Medium resilience
	Turbot	*Scophthalmus maximus*	0.45	0.25	-	0.82	16 K, 3 tgen, 1 tmax, 2 Fec
	Brill	*Scophthalmus rhombus*	NA	0.20	-	0.80	Medium resilience
	Lesser spotted dogfish	*Scyliorhinus canicula*	0.11	0.01	-	1.05	2 K, 3 tgen, 1 tmax, 10 Fec
	Beaked redfish	*Sebastes mentella*	0.21	0.11	-	0.43	9 K, 3 tgen, 2 tmax, 10 Fec
	Golden redfish	*Sebastes norvegicus*	0.25	0.13	-	0.48	5 K, 6 tgen, 2 tmax, 9 Fec
	Common cuttlefish	*Sepia officinalis*	NA	0.20	-	0.80	Medium resilience
	Common sole	*Solea solea*	0.46	0.21	-	1.02	2 M, 26 K, 17 tgen, 2 tmax, 13 Fec
	Soles	*Solea* spp.	NA	0.20	-	0.80	Medium resilience
	Black seabream	*Spondyliosoma cantharus*	0.50	0.24	-	1.05	9 K, 9 tgen, 6 tmax, 6 Fec
	Picked dogfish	*Squalus acanthias*	NA	0.05	-	0.50	Low resilience
	Angelshark	*Squatina squatina*	NA	0.05	-	0.50	Low resilience
	Spottail mantis shrimp	*Squilla mantis*	NA	0.20	-	0.80	Medium resilience
	Poor cod	*Trisopterus minutus*	0.77	0.37	-	1.59	2 M, 10 K, 6 tgen, 1 tmax, 2 Fec
	Shi drum	*Umbrina cirrosa*	NA	0.20	-	0.80	Medium resilience
Large predators	Garfish	*Belone belone*	0.44	0.19	-	1.00	2 K, 2 tgen, 10 Fec
	Common dolphinfish	*Coryphaena hippurus*	0.77	0.39	-	1.54	11 K, 9 tgen, 3 tmax, 8 Fec
	European seabass	*Dicentrarchus labrax*	0.38	0.17	-	0.88	1 M, 16 K, 11 tgen, 9 tmax, 2 Fec
	Dusky grouper	*Epinephelus marginatus*	0.25	0.11	-	0.57	1 M, 4 K, 7 tgen, 2 tmax, 4 Fec
	Little tunny	*Euthynnus alletteratus*	0.64	0.36	-	1.14	1 M, 7 K, 2 tgen, 2 tmax, 2 Fec
	Atlantic cod	*Gadus morhua*	0.47	0.23	-	0.96	15 M, 56 K, 98 tgen, 2 tmax, 37 Fec

Functional Group	Common Name	Species	r	2 SD Range			Based on
Large predators	Tope shark	*Galeorhinus galeus*	NA	0.015	-	0.10	Very low resilience
	Shortfin mako	*Isurus oxyrinchus*	0.11	0.02	-	0.55	1 M, 6 K, 12 tgen, 3 tmax, 2 Fec
	Porbeagle	*Lamna nasus*	NA	0.015	-	0.10	Very low resilience
	Haddock	*Melanogrammus aeglefinus*	0.48	0.23	-	1.00	2 M, 33 K, 47 tgen, 4 tmax, 29 Fec
	Whiting	*Merlangius merlangus*	0.51	0.25	-	1.01	1 M, 83 K, 13 tgen, 1 tmax, 11 Fec
	European hake	*Merluccius merluccius*	0.46	0.22	-	0.95	3 M, 76 K, 24 tgen, 7 tmax, 38 Fec
	Blue whiting	*Micromesistius poutassou*	0.48	0.21	-	1.09	1 M, 23 K, 11 tgen, 3 tmax, 8 Fec
	Smoothhounds	*Mustelus* spp.	NA	0.05	-	0.50	Low resilience
	Pollack	*Pollachius pollachius*	0.71	0.50	-	1.01	1 M, 1 K, 3 tgen, 1 tmax
	Saithe	*Pollachius virens*	0.40	0.21	-	0.75	2 M, 11 K, 19 tgen, 3 tmax, 4 Fec
	Bluefish	*Pomatomus saltatrix*	0.58	0.37	-	0.90	1 M, 6 K, 3 tgen, 2 tmax, 3 Fec
	Blue shark	*Prionace glauca*	NA	0.015	-	0.10	Very low resilience
	Atlantic salmon	*Salmo salar*	0.37	0.13	-	1.03	4 K, 30 tgen, 1 tmax, 20 Fec
	Sea trout	*Salmo trutta*	0.27	0.06	-	1.17	14 K, 78 tgen, 2 tmax, 16 Fec
	Atlantic bonito	*Sarda sarda*	1.62	0.84	-	3.11	1 M, 13 K, 4 tgen, 4 tmax, questionable, too high
	Greater amberjack	*Seriola dumerili*	NA	0.20	-	0.80	Medium resilience
	Albacore	*Thunnus alalunga*	0.46	0.26	-	0.80	4 M, 35 K, 6 tgen, 3 tmax, 8 Fec
	Atlantic bluefin tuna	*Thunnus thynnus*	0.36	0.21	-	0.64	4 M, 23 K, 7 tgen, 6 tmax, 5 Fec
	Swordfish	*Xiphias gladius*	0.43	0.24	-	0.77	12 K, 2 tgen, 3 tmax, 4 Fec
	John dory	*Zeus faber*	0.54	0.29	-	1.00	3 K, 8 tgen, 2 tmax
Pelagic plankton feeders	Big-scale sand smelt	*Atherina boyeri*	0.76	0.33	-	1.74	6 K, 2 tgen, 1 tmax, 2 Fec
	Bogue	*Boops boops*	0.59	0.31	-	1.10	1 M, 18 K, 6 tgen, 1 tmax, 3 Fec
	Basking shark	*Cetorhinus maximus*	NA	0.015	-	0.10	Very low resilience
	Atlantic herring	*Clupea harengus*	0.39	0.16	-	1.00	11 M, 100 K, 71 tgen, 28 tmax, 46 Fec
	European anchovy	*Engraulis encrasicolus*	0.55	0.26	-	1.16	3 M, 43 K, 15 tgen, 8 tmax, 25 Fec
	Capelin	*Mallotus villosus*	0.43	0.17	-	1.11	1 M, 2 K, 13 tgen, 3 tmax, 21 Fec
	European pilchard	*Sardina pilchardus*	0.54	0.27	-	1.10	3 M, 50 K, 5 tgen, 5 tmax, 11 Fec

Functional Group	Common Name	Species	r	2 SD Range			Based on
Pelagic plankton feeders	Round sardinella	*Sardinella aurita*	0.55	0.24	-	1.26	30 K, 8 tgen, 2 tmax, 9 Fec
	Atlantic chub mackerel	*Scomber colias*	NA	0.60	-	1.50	High resilience
	Atlantic mackerel	*Scomber scombrus*	0.48	0.23	-	1.00	1 M, 16 K, 13 tgen, 1 tmax, 25 Fec
	Blotched picarel	*Spicara maena*	NA	0.20	-	0.80	Medium resilience
	Picarel	*Spicara smaris*	NA	0.20	-	0.80	Medium resilience
	European sprat	*Sprattus sprattus*	0.49	0.21	-	1.11	2 M, 19 K, 9 tgen, 3 tmax, 23 Fec
	Mediterranean horse mackerel	*Trachurus mediterraneus*	NA	0.20	-	0.80	Medium resilience
	Blue jack mackerel	*Trachurus picturatus*	0.51	0.27	-	0.96	8 K, 4 tgen, 1 tmax
	Horse mackerels	*Trachurus* spp.	NA	0.20	-	0.80	Medium resilience
	Atlantic horse mackerel	*Trachurus trachurus*	0.47	0.22	-	0.98	25 K, 17 tgen, 19 Fec
	Norway pout	*Trisopterus esmarkii*	0.88	0.48	-	1.60	2 M, 6 K, 7 tgen, 1 tmax, 3 Fec

Estimation of rebuilding time

For stocks that are not suffering from impaired recruitment, and assuming a logistic curve of population increase, the average time needed to reach the biomass level (B_{msy}) that can produce *MSY* is a function of depletion (B/B_{msy}), of the intrinsic rate of population increase r and of remaining exploitation F (Quinn and Deriso 1999)

$$\Delta t = \frac{1}{r-F} \, LN(\frac{\frac{B_{msy}}{B} \, 2\left(1-\frac{F}{r}\right)-1}{2\left(1-\frac{F}{r}\right)-1}$$

For example, if depletion is 0.75 B_{msy}, F_{msy} = 0.3 and remaining exploitation is F = 0.15, then the time needed by the population to reach B_{msy} is 1.5 years. If depletion is 0.5 B_{msy}, F_{msy} = 0.2 and remaining exploitation is F = 0.1, then the time needed by the population to reach B_{msy} is 4.6 years. These two examples bracket the typical depletion levels and F_{msy} values for many stocks in northern European ecoregions (Barents Sea to Iberian Sea).

If depletion is 0.25 B_{msy}, F_{msy} = 0.3 and remaining exploitation is F = 0.15, then the time needed by the population to reach B_{msy} is 5.1 years. This example reflects the higher depletion but also higher productivity in Mediterranean stocks. But note that recruitement and thus productivity may be impaired at 0.25 B_{msy} and in such cases stock recovery may take much longer and may require much stronger reduction of exploitation. [AllStocks_Oct14_16.xlsx, TAB Exploitation scenarios]

Results

Results across all ecoregions and stocks

ICES, GFCM and ICCAT assessment reports with data until 2015 were analyzed for 397 stocks in European waters, from the Barents Sea to the Black Sea. Results are presented by ecoregion below. The graphs in this chapter summarize the status and exploitation level of all 397 stocks within an MSY-framework. Detailed assessments for every stock are available in Appendix 1 for the ICES area, Appendix 2 for the Mediterranean and Black Sea, and Appendix 3 for ICCAT stocks and wide-ranging ICES stocks. The numbers and graphs presented in this chapter were created with spreadsheet AllStocks_Nov09_16b.xlsx, which is part of the supplementary material.

Of the 397 stocks, 254 (64%) were subject to ongoing overfishing ($F > F_{msy}$) and 202 stocks (51%) were outside of safe biological limits ($B < 0.5\ B_{msy}$). In 45 stocks (11%) catches exceeded the maximum sustainable yield ($C/MSY > 1$). Two hundred eight stocks (52%) were in critical condition, defined by being outside of safe biological limits and subject to overfishing or severely depleted ($B < 0.2\ B_{msy}$) and still subject to exploitation. Altogether, 267 stocks (67%) were subject to unsustainable exploitation ($C/MSY > 1$ or $F > F_{msy}$ or $B < 0.2\ B_{msy}$). In contrast, only 47 stocks (12%) could be considered as being well managed and in good condition sensu CFP (2013), defined by not being subject to overfishing ($F > F_{msy}$ or Catch > *MSY*) and having a biomass above the one that can produce the maximum sustainable yield.

Summed biomass of the 397 stocks of 51 million tonnes in the last year with available data was below (80%) the biomass level of 64 million tonnes that can produce maximum yields. Summed catches of 8.8 million tonnes were well below the summed maximum sustainable yield of 15.4 million tonnes. Because of trophic interactions it is not possible to achieve *MSY* simultaneously for all stocks, but sustained catches of near the lower confidence limit or near 90% of *MSY* (whichever is lower) would be possible if all stocks have recovered above B_{msy}. Because of more fish in the water, such catches could be obtained with much less fishing effort and much less impact on the ecosystem. See legends of Figures for more comments.

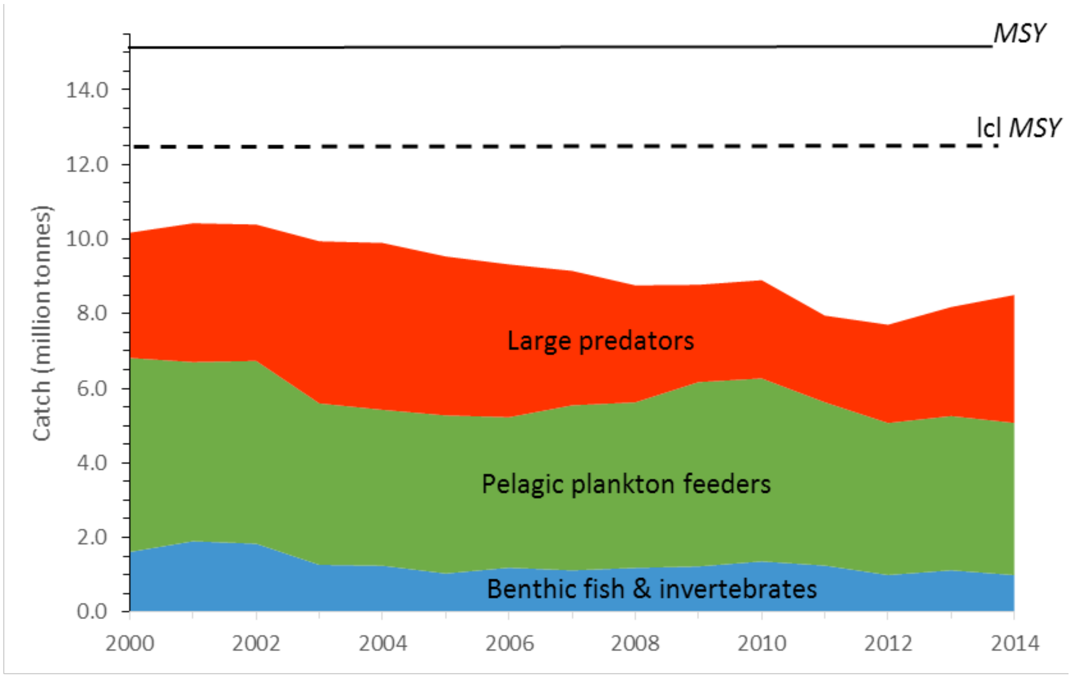


Figure 1. Cumulative catches for 397 stocks in European Seas, with indication of main functional groups. The black line indicates the cumulative maximum sustainable yield (MSY) for the ecoregion and the dashed line indicates the lower 95% confidence limit as a precautionary target. Total catches have been declining since 2000, but large predators had increasing catches since 2012 [AllStocks_Nov09_16b.xlsx]

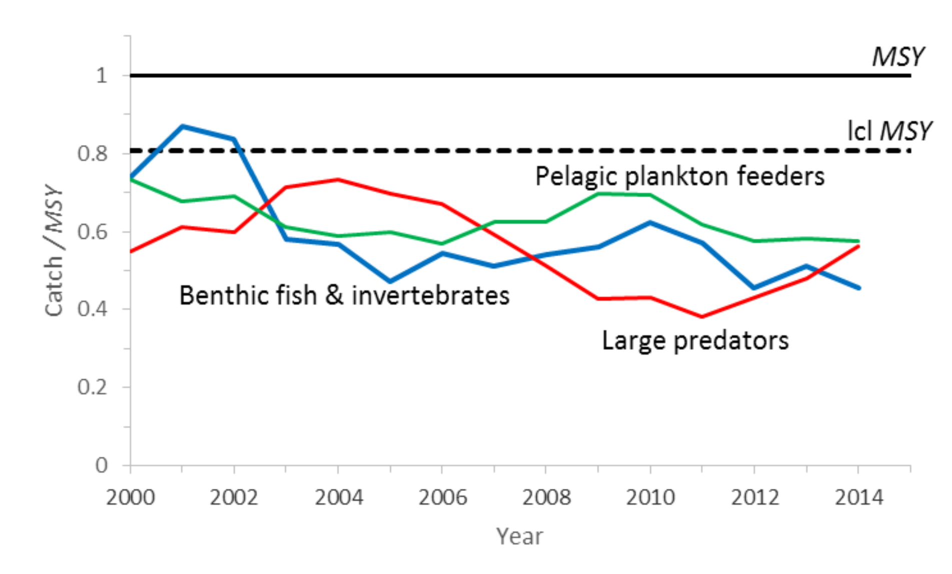


Figure 2. Catches by main functional group relative to their maximum sustainable yield (MSY, black line), for 397 stocks in the European Seas. All catches are well below the precautionary level since 2003, but are taken mostly with high effort from too small stocks (see biomass graphs below). [AllStocks_Nov09_16b.xlsx]

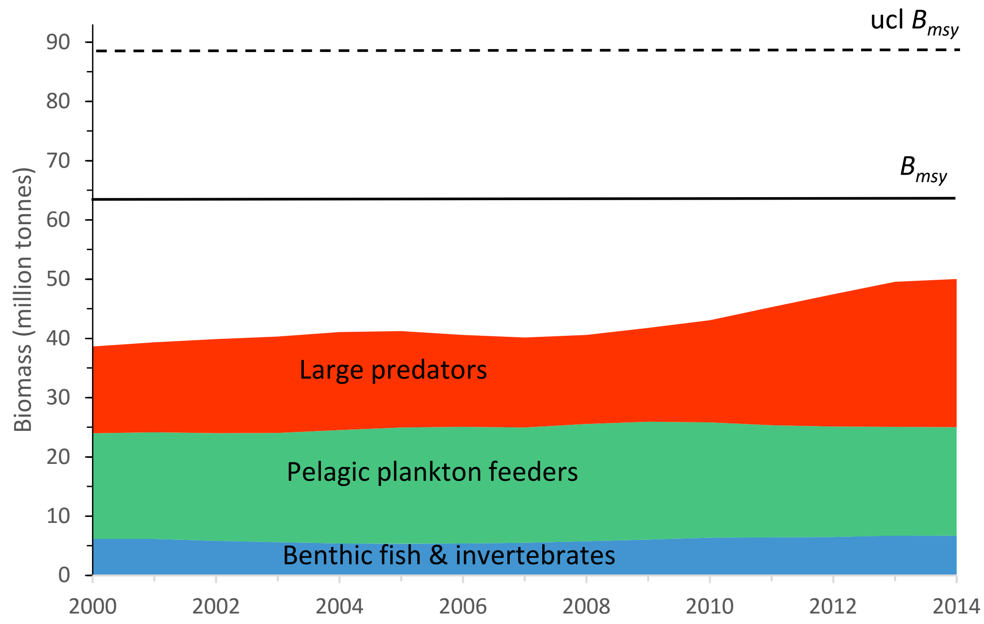


Figure 3. Cumulative total biomass of 397 stocks in the European Seas relative to the biomass that can produce the maximum sustainable yield (B_{msy} = black line). The upper 95% confidence limit of Bmsy (dashed line) would present a precautionary target biomass above B_{msy}. This is also the area where the maximum economic yield could be obtained. The functional groups of large predators (red), pelagic plankton feeders (green), and benthic organisms (blue) are indicated. Summed biomass of large predators has increased in recent years. [AllStocks_Nov09_16b.xlsx]

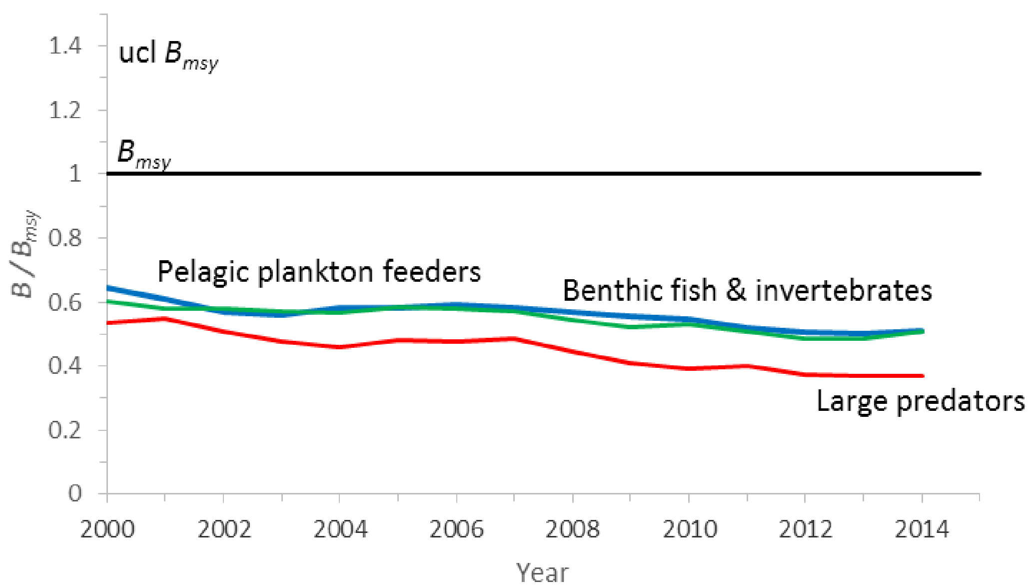


Figure 4. Median biomass relative to the level that can produce the maximum sustainable yield (B/B_{msy}) for 397 stocks in the European Seas assigned to main functional groups. Note that median biomass of large predators has not increased, in contrast to the summed biomass across all stocks. This suggests that the increase stems only from few stocks. [AllStocks_Nov09_16b.xlsx]

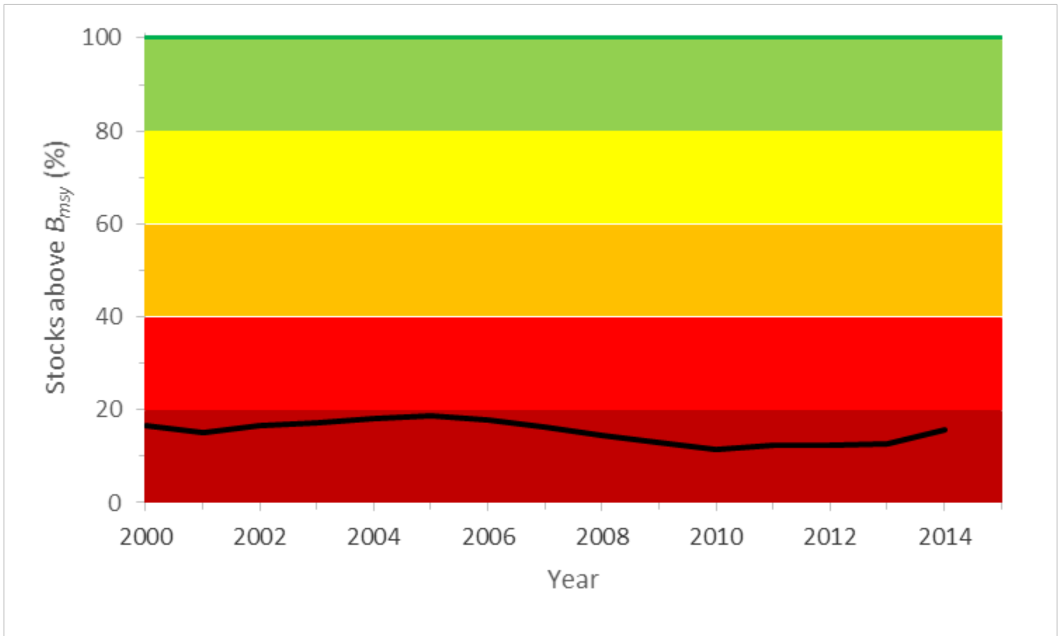


Figure 5. Percentage of stocks where biomass is above the level that can produce the maximum sustainable yield (B_{msy}) for 397 stocks in the European Seas (black curve). The colors indicate visually the compliance with the goals of the Common Fisheries Policy, where all stocks (100%) shall be above B_{msy} eventually. In 2014, only 16% of the stocks fulfilled that requirement. [AllStocks_Nov09_16b.xlsx]

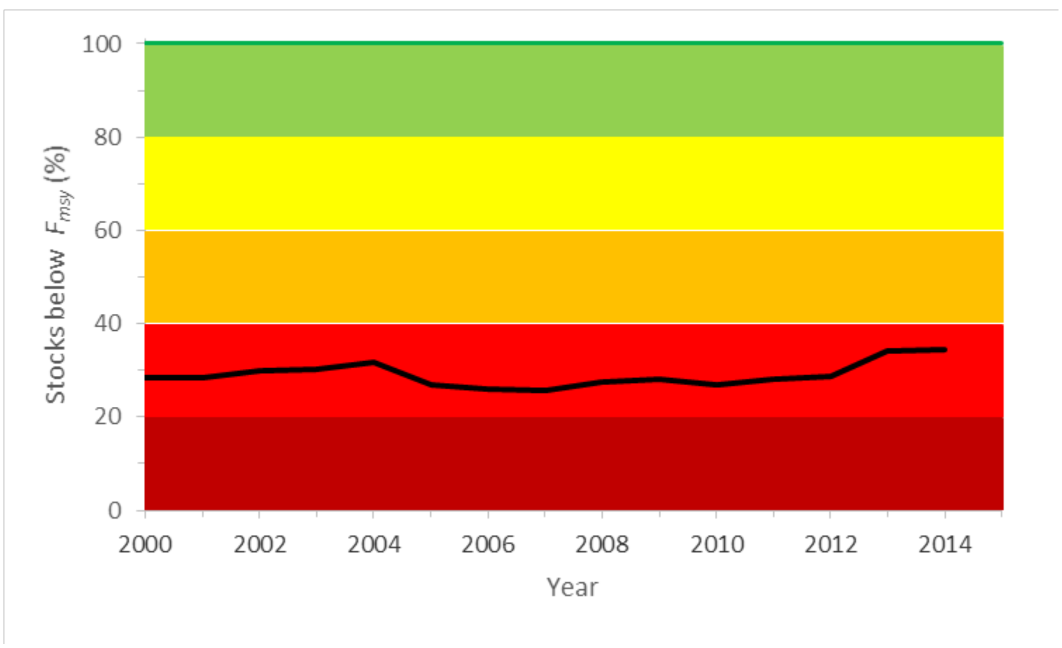


Figure 6. Percentage of stocks where fishing mortality F is at or below the level that can produce the maximum sustainable yield (F_{msy}) for 397 stocks in the European Seas (black curve). The colors indicate visually the compliance with the goals of the Common Fisheries Policy, where all stocks (100%) shall be at or below F_{msy} in 2015, latest in 2020. In 2014, only 34% of the stocks fulfilled that requirement. [AllStocks_Nov09_16b.xlsx]

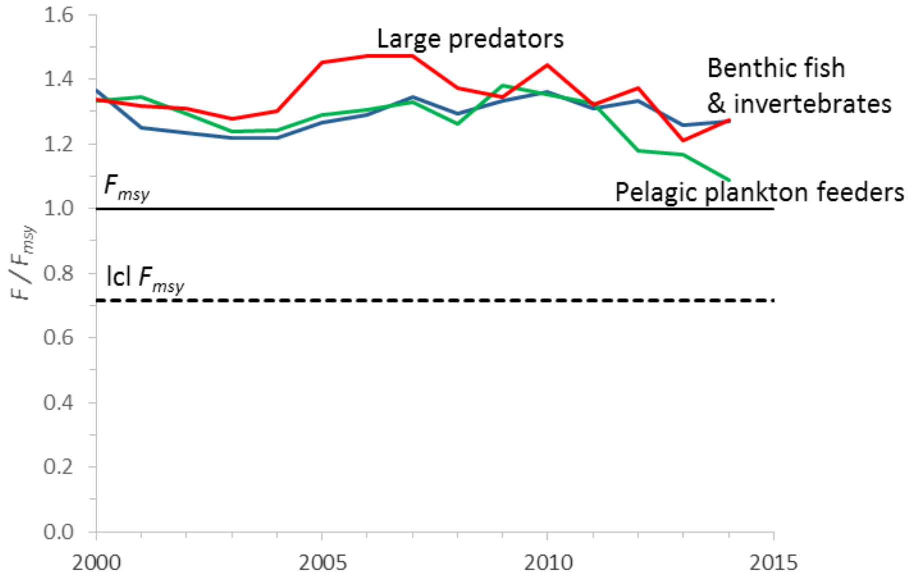


Figure 7. Median fishing pressure relative to the maximum sustainable level (F/F_{msy}) for 397 stocks in the European Seas assigned to main functional groups. Median fishing pressure is above the maximum sustainable level in all groups, with plankton feeders showing a decreasing trend in recent years. [AllStocks_Nov09_16b.xlsx]

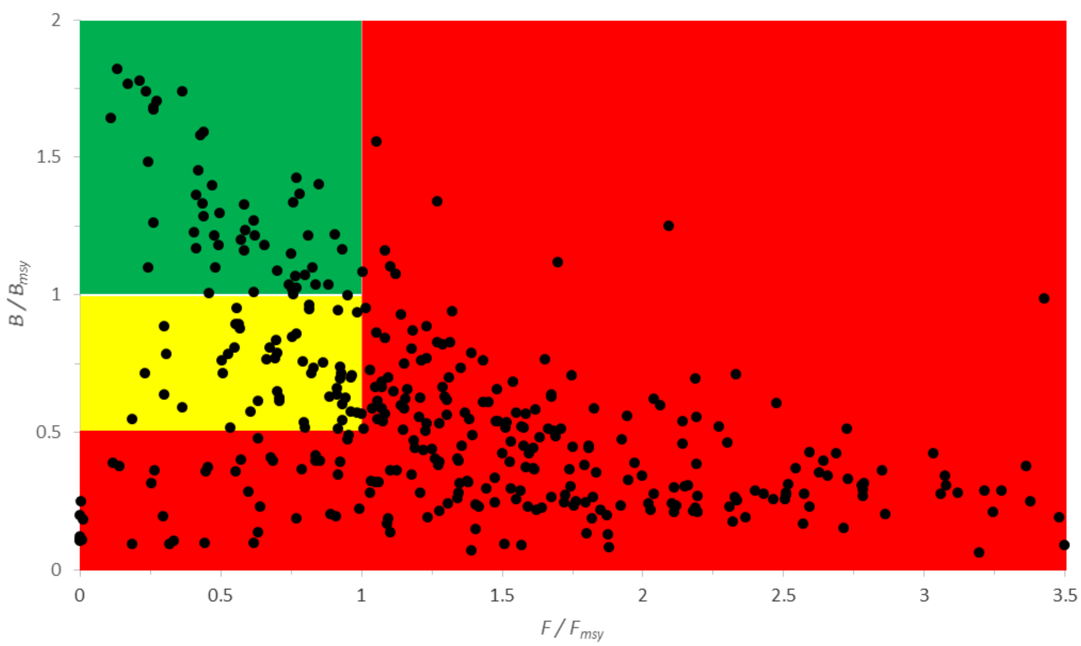


Figure 8. Presentation of 397 stocks in European Seas in a pressure (F/F_{msy}) – state (B/B_{msy}) plot. The red area indicates stocks that are being overfished or are outside of safe biological limits. The yellow area indicates recovering stocks. The green area indicates stocks subject to sustainable fishing pressure and of a healthy stock size that can produce high yields close to MSY. Several stocks are not shown because their fishing pressure was beyond the upper end of the X-axis. Note that several depleted stocks are not recovering despite zero commercial catches (lower left corner). [AllStocks_Nov09_16b.xlsx]

The results are summarized by ecoregion in Table 3. The number of stocks with available data in an ecoregion ranges from 7 in the Black Sea to 47 in the Celtic Seas. Barents Sea and Norwegian Sea have the highest percentage (50%) of stocks that comply with the goals of the Common Fisheries Policy (CFP 2013) by having a biomass above the level that can produce *MSY* and being subject to sustainable exploitation. Biomass and catches are also highest in this ecoregion, followed by wide-ranging stocks and by the Greater North Sea. The Mediterranean and Black Sea are still far away from the goals of the CFP, with only 2 out of 176 stocks in compliance.

Biomass in the ecoregions of the Mediterranean and Black Sea was on average less than half (44%) of the level that can produce *MSY*, whereas in the northern ecoregions (Barents Sea to Iberian Sea) biomass was about ¾ (73%) of that level. Consequently, rebuilding of biomass above the *MSY* level will require only 1-6 years in many stocks in the northern region, depending on the depletion level of the stocks and how far F is reduced below F_{msy} during the rebuilding phase. For example, $F = 0.5\ F_{msy}$ should lead to rebuilding in 1-5 years in most stocks. In contrast, rebuilding in the Mediterranean and Black Sea may take 1-7 years under similar conditions. Note that with $F = F_{msy}$ no rebuilding above *MSY* levels is possible because with such fishing pressure, by definition, B_{msy} is approached asymptotically in infinite time.

Detailed assessments by ecoregion are given in the next chapter.

Table 3. Stock numbers, stocks subject to sustainable exploitation ($F <= F_{msy}$), stock size above the level capable of producing MSY ($B > B_{msy}$), stocks outside of safe biological limits ($B < 0.5\ B_{msy}$), severely depleted stocks ($B < 0.2\ B_{msy}$), number and percentage of stocks that are sustainably exploited ($F <= F_{msy}$, catch < MSY, $B > 0.2\ B_{msy}$), total biomass, total biomass level capable of producing MSY, total catch, total MSY level, and compliance with CFP targets, for 397 stocks in 14 European ecoregions and two wide-ranging regions. Note that totals of columns in this table may be different from totals mentioned in the text because of rounding. [AllStocks_Nov09_16b.xlsx]

Ecoregion	Stocks n	$F <= F_{msy}$ n (%)	$B > B_{msy}$ n (%)	$B < 0.5\ B_{msy}$ n (%)	$B < 0.2\ B_{msy}$ n (%)	Sustainable n (%)	Biomass million tonnes	B_{msy} million tonnes	Catch million tonnes	*MSY* million tonnes	CFP conform n (%)
Barents Sea and Norwegian Sea	12	10 (83)	8 (67)	2 (17)	1 (8)	8 (67)	19	21	1.9	4.6	6 (50)
Iceland, Faroes and Greenland	26	15 (58)	5 (23)	11 (42)	5 (19)	12 (50)	3.7	6.8	0.6	1.6	4 (15)
Greater North Sea	45	25 (56)	9 (20)	21 (47)	6 (13)	23 (51)	9.9	11	1.6	3.4	9 (20)
Baltic Sea	20	12 (60)	6 (30)	9 (45)	1 (5)	12 (60)	3.1	4.0	0.69	0.96	5 (25)
Celtic Seas and Rockall	47	25 (53)	11 (23)	19 (40)	7 (15)	22 (47)	1.3	2.1	0.23	0.48	10 (21)
Bay of Biscay, Iberian Coast and Azores	31	13 (42)	5 (16)	7 (23)	3 (10)	12 (39)	0.86	1.3	0.20	0.34	4 (13)
Gulf of Lions	15	2 (13)	0 (0)	13 (87)	0 (0)	2 (13)	0.044	0.11	0.009	0.033	0 (0)
Balearic Sea	22	1 (5)	0 (0)	14 (64)	0 (0)	1 (5)	0.36	0.72	0.13	0.21	0 (0)
Sardinia	19	1 (5)	0 (0)	13 (68)	4 (21)	0 (0)	0.075	0.17	0.015	0.057	0 (0)
Adriatic Sea	30	11 (37)	4 (13)	20 (67)	4 (13)	7 (23)	0.41	0.77	0.14	0.19	1 (3)
Ionian Sea	31	5 (16)	0 (0)	19 (61)	4 (13)	5 (16)	0.14	0.36	0.046	0.099	0 (0)
Aegean Sea	42	5 (12)	0 (0)	23 (55)	3 (7)	5 (12)	0.19	0.38	0.070	0.112	0 (0)
Cyprus	10	0 (0)	0 (0)	9 (90)	1 (10)	0 (0)	0.0013	0.0052	0.00037	0.0015	0 (0)
Black Sea	7	1 (14)	1 (14)	3 (43)	2 (29)	1 (14)	0.68	1.3	0.24	0.40	1 (14)
Wide-ranging ICCAT	10	5 (50)	5 (50)	1 (10)	1 (10)	5 (50)	1.0	0.96	0.13	0.19	4 (40)
Wide-ranging ICES	30	13 (43)	5 (17)	18 (60)	8 (27)	8 (27)	10.6	11.9	2.8	2.7	2 (7)

Comparison of independent F/F_{msy} estimates with those obtained in this study

Out of the 397 stocks examined in this study, 93 (23%) had independent stock assessment estimates of F_{msy} and F in in the final year with available data (Table 4). A comparison with the estimates derived in this study shows that 62 (67%) were less than 50% different from the independent stock assessment estimates. More importantly, in 76 stocks (82%) the F/F_{msy} estimates derived in this study came to the same classification of overfishing (F larger than F_{msy}) than the independent estimates. In 14 of the 17 diverging cases (82%), the independent stock assessments diagnosed overfishing while this study proposed sustainable exploitation levels. These differences often occurred in severely depleted stocks, where the surplus production models applied in this study slightly overestimated final biomass and thus underestimated exploitation. Also, the independent assessments often used the fishing mortality of higher age groups to determine the F/F_{msy} ratio, whereas surplus production models do not know about age structure and instead derive the F/F_{msy} ratio across all age groups, weighted by their contribution to the catch. Since lower age groups are not yet fully selected by the gear, their fishing mortality is lower than that of higher age groups, and hence the F/F_{msy} ratio estimated by surplus production models may be lower than that of age-structured assessments. In summary, with regard to exploitation there is good agreement between the estimates done in this study and the estimates derived by independent stock assessment groups, with the caveat that the F/F_{msy} estimates in this study may underestimate the exploitation of severely depleted stocks or of stocks with many age classes.

Table 4. Comparison of exploitation estimates obtained in this study with 93 estimates in independent stock assessment documents. See respective Appendix for the ecoregion for indication of sources. Cases where estimates from this study deviate more than 50% from the "official" estimates are marked in bold in the F/F_{msy} cur column. Cases where the independent classification of overfishing is different from this study are marked bold in the F/F_{msy} indep column.

Region	Species	Stock	F/F_{msy} cur	F/F_{msy} indep
Barents Sea and Norwegian Sea	*Gadus morhua*	cod-arct	0.58	0.96
	Melanogrammus aeglefinus	had-arct	**0.24**	0.59
	Clupea harengus	her-noss	0.66	0.73
Iceland, Faroes and Greenland	*Argentina silus*	arg-icel	0.70	0.77
	Molva molva	lin-icel	0.59	**1.17**
	Sebastes norvegicus	smr-5614	0.74	0.99
	Brosme brosme	usk-icel	0.58	**1.1**
	Gadus morhua	cod-farp	1.38	1.44
	Melanogrammus aeglefinus	had-faro	1.34	1.02
	Pollachius virens	sai-faro	0.75	0.84
	Clupea harengus	her-vasu	0.92	1.0
Greater North Sea	*Solea solea*	sol-eche	**0.81**	**1.73**
		sol-kask	0.30	0.49
		sol-nsea	0.69	**1.01**
	Gadus morhua	cod-347d	**0.30**	**1.17**
	Melanogrammus aeglefinus	had-346a	**2.11**	0.65

Region	**Species**	**Stock**	***F/F$_{msy}$* cur**	***F/F$_{msy}$* indep**
Greater North Sea	*Merlangius merlangus*	whg-47d	1.18	1.51
	Clupea harengus	her-47d3	0.43	0.73
	Sprattus sprattus	spr-nsea	**0.75**	**1.81**
Baltic Sea	*Gadus morhua*	cod-2224	**1.67**	3.37
	Clupea harengus	her-2532-gor	0.82	0.83
		her-30	1.05	**0.97**
		her-3a22	0.63	0.80
		her-riga	1.14	1.32
	Sprattus sprattus	spr-2232	1.29	1.03
Celtic Seas and Rockall	*Molva dypterygia*	bli-5b67	0.31	0.28
	Lepidorhombus whiffiagonis	mgw-78	0.57	**1.13**
	Pleuronectes platessa	ple-7h-k	4.95	4.44
		ple-echw	0.44	0.62
		ple-iris	**0.21**	0.55
	Solea solea	sol-7h-k	**0.55**	**2.88**
		sol-celt	**3.70**	1.13
		sol-echw	0.70	0.68
		sol-iris	**0.63**	0.38
	Gadus morhua	cod-7e-k	1.35	1.51
		cod-iris	**0.14**	**2.91**
		cod-scow	**8.16**	4.69
	Melanogrammus aeglefinus	had-7b-k	0.88	1.30
		had-rock	1.47	1.07
	Merlangius merlangus	whg-7e-k	0.62	0.73
		whg-scow	**0.91**	0.32
	Clupea harengus	her-67bc	0.36	0.44
		her-irls	0.65	0.73
		her-nirs	0.63	**1.01**
Bay of Biscay and Iberian Sea, including Azores	*Lophius piscatorius*	anp-8c9a	**0.24**	0.68
	Lepidorhombus boscii	mgb-8c9a	**0.98**	**2.14**
	Lepidorhombus whiffiagonis	mgw-8c9a	1.28	1.38
	Solea solea	sol-bisc	1.05	1.34
	Merluccius merluccius	hke-soth	**0.77**	**2.10**
	Trachurus trachurus	hom-soth	**0.78**	0.40
Gulf of Lions	*Merluccius merluccius*	MERLMER_LI	**2.54**	14.9
	Engraulis encrasicolus	ENGRENC_LI	**0.53**	0.21
Balearic Sea	*Aristeus antennatus*	ARITANT_BA	**1.71**	4.2
	Mullus barbatus	MULLBAR_BA	1.48	2.78
	Mullus surmuletus	MULLSUR_BA	**2.16**	**0.63**
	Nephrops norvegicus	NEPRNOR_BA	**1.23**	3.46

Region	Species	Stock	F/F_{msy} cur	F/F_{msy} indep
Balearic Sea	*Parapenaeus longirostris*	PAPELON_BA	3.38	3.06
	Merluccius merluccius	MERLMER_BA	4.79	7.47
	Micromesistius poutassou	MICMPOU_BA	**2.12**	3.28
	Engraulis encrasicolus	ENGRENC_BA	**1.20**	2.54
Sardinia	*Mullus barbatus*	MULLBAR_SA	2.33	3.19
	Nephrops norvegicus	NEPRNOR_SA	**2.50**	1.38
	Pagellus erythrinus	PAGEERY_SA	2.59	2.38
	Parapenaeus longirostris	PAPELON_SA	1.32	1.06
	Merluccius merluccius	MERLMER_SA	**1.66**	7
	Micromesistius poutassou	MICMPOU_SA	1.62	2.11
	Engraulis encrasicolus	ENGRENC_SA	1.69	2.6
Adriatic Sea	*Mullus barbatus*	Mull_bar_AD	1.68	1.32
	Solea solea	Sole_sol_AD	2.06	1.42
	Squilla mantis	Squi_man_AD	1.09	1.23
	Merluccius merluccius	Merl_mer_AD	4.05	5.56
	Engraulis encrasicolus	Engr_enc_AD	**1.31**	2.9
	Sardina pilchardus	Sard_pil_AD	1.58	1.47
Ionian Sea	*Aristeomorpha foliacea*	ARISFOL_IS	1.67	2.28
	Mullus barbatus	MULLBAR_IS	**3.48**	2.2
Ionian Sea	*Parapeneaus longirostris*	PARELON_IS	0.91	**1.63**
	Merluccius merluccius	MERLMER_IS	3.24	4.83
	Mullus barbatus	MULLBAR_AL	**1.97**	1.08
	Nephrops norvegicus	NEPRNOR_AL	4.01	2.67
Cyprus	*Mullus barbatus*	MULLBAR_CY	1.53	2.09
	Mullus surmuletus	MULLSUR_CY	2.19	2.13
	Boops boops	BOOPBOO_CY	2.00	1.54
	Spicara smaris	SPICSMA_CY	1.59	1.54
Black Sea	*Mullus barbatus barbatus*	RMullet_BS	2.19	1.67
	Squalus acanthias	PDogfish_BS	**1.51**	3.0
	Scophthalmus maximus	Tur_BS	5.31	5.38
	Merlangius merlangus	Whiting_BS	1.49	1.37
	Sprattus sprattus	Spr_BS	0.83	0.95
	Trachurus mediterraneus	MHMackerel_BS	7.57	5.56
	Engraulis encrasicolus	BS_anch	**1.23**	2.65
Wide-ranging ICES Stocks	*Merluccius merluccius*	hke-nrtn	1.12	**0.79**
	Micromesistius poutassou	whb-comb	0.77	**1.43**
	Scomber scombrus	mac-nea	1.70	1.54

Results by ecoregion

Northeast Atlantic

Barents Sea and Norwegian Sea

The following paragraph describing the Barents Sea was taken from the ICES Advice 2016, Book 9,

http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2016/2016/Barents_Sea_Ecoregion-Ecosystem_overview.pdf.

"The Barents Sea is one of the shelf seas surrounding the Polar basin. It connects with the deeper Norwegian Sea to the west, the Arctic Ocean to the north, and the Kara Sea to the east, and borders the Norwegian and Russian coasts to the south. The 500 m depth contour is used to delineate the continental slope to the west and the north. To the east the Novaya Zemlya archipelago separates the Barents Sea and the Kara Sea. The Barents Sea covers an area of approximately 1.6 million km^2, has an average depth of ca. 230 m, and a maximum depth of about 500 m at the western end of Bear Island Trough. Its topography is characterized by troughs and basins, separated by shallow bank areas. The three largest banks are Central Bank, Great Bank, and Spitsbergen Bank. Several troughs over 300 m deep run from the central Barents Sea to the northern (e.g. Franz Victoria Trough) and western (e.g. Bear Island Trough) continental shelf break. These western troughs allow influx of Atlantic waters to the central Barents Sea. Atlantic waters enter the Arctic Basin through the Barents Sea and the Fram Strait. Large-scale atmospheric pressure systems influence the volume flux, temperature, and salinity of Atlantic waters, in turn affecting oceanographic conditions both in the Barents Sea and in the Arctic Ocean."

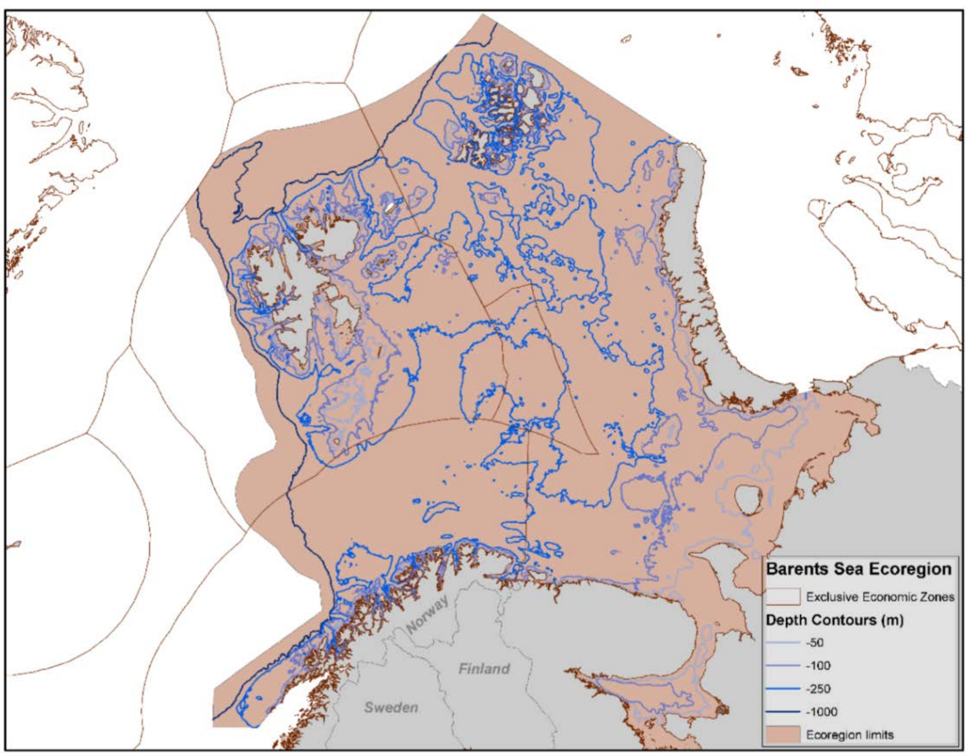


Figure 9. The Barents Sea ecoregion with EEZ delineations. Source: ICES Advice 2016, Book 9.

The following paragraph describing the Norwegian Sea was taken from the ICES Advice 2009, Book 3,

http://www.ices.dk/sites/pub/Publication%20Reports/ICES%20Advice/2009/ICES%20ADVICE%202009%20Book%203.pdf.

"The Norwegian Sea is traditionally defined as the ocean bounded by a line drawn from the Norwegian Coast at about 62°N to Shetland, farther to the Faroes-East Iceland-Jan Mayen-the southern tip of Spitsbergen-the Vesterålen at the Norwegian coast and the along the coast. In addition a wedge shaped strip along the western coast of Spitsbergen is included. The offshore boundaries follow in large part the mid Atlantic subsurface ridges. The Norwegian Sea has an area of 1.1 million km^2 and a volume of more than 2 million km^3, i.e. an average depth of about 2000 m. The Norwegian Sea is divided into two separate basins (the Lofoten Basin to the south and the Norwegian Basin in the north) of 3000 m to 4000 m depth, with a maximum depth 4020 m. Along the Norwegian coast there is a relatively narrow continental shelf, between 40 and 200 km wide with varied topography and geology. It has a relatively level sea bottom with depths between 100 and 400 m. The shelf is crossed by several troughs deeper than 300. Moraine deposits dominate the bottom substratum on the shelf, but soft layered clay is commonly found in the deeper parts. Gravelly and sandy bottoms are found near the shelf break and on ridges where the currents are strong and the sedimentation rates low."

ICES assessment reports with data until 2015 were analyzed for 12 stocks in the Barents Sea and Norwegian Sea. The graphs below summarize their status and exploitation level within an MSY-framework. The list of species and their current exploitation and status is summarized in Table 5. Detailed assessments for every stock are available in Appendix 1 and in the spreadsheet BarentsSea_Sep26_2016.xlsx.

Of the 12 stocks, 2 (17%) were subject to ongoing overfishing ($F > F_{msy}$) and 2 stocks (17%) were outside of safe biological limits ($B < 0.5\ B_{msy}$). In two stocks (17%) catches exceeded the maximum sustainable yield (*C/MSY* > 1). One stock of redfish (smr-arct) was in critical condition, defined by being outside of safe biological limits and subject to overfishing (marked red in Table 5). Altogether, 4 stocks (33%) were subject to unsustainable exploitation (catch > *MSY* or $F > F_{msy}$ or $B < 0.2\ B_{msy}$), with the too high catches marked red in Table 5. Six stocks (50%) could be considered as being well managed and in good condition sensu CFP (2013), defined by not being subject to overfishing ($F > F_{msy}$ or Catch > *MSY*) and having a biomass above the one that can produce the maximum sustainable yield.

Summed biomass of the 12 stocks of 19 million tonnes in the last year with available data was below but close to the biomass level of 21 million tonnes that can produce maximum yields. Summed catches of 1.9 million tonnes were well below the summed maximum sustainable yield of 4.6 million tonnes. Because of trophic interactions it is not possible to achieve *MSY* simultaneously for all stocks, but sustained catches of near the lower confidence limit or near 90% of *MSY* (whichever is lower) would be possible if all stocks have recovered above B_{msy}. Because of more fish in the water, such catches could be obtained with much less fishing effort and much less impact on the ecosystem. See legends of Figures for more comments.

Table 5. Analysis of 12 stocks in the Barents Sea and Norwegian Sea, with indication of last year with available data (Year), maximum sustainable yield (MSY), absolute and relative catch (Catch, C/MSY), maximum sustainable fishing mortality (F_{msy}) if the stock is within safe biological limits ($B/B_{msy} > 0.5$), F_{msy} for current stock size, F/F_{msy} for current stock size, biomass that can produce MSY (B_{msy}), relative biomass (B/B_{msy}). Scientific names of healthy stocks where F/Fmsy < 1 and B/Bmsy > 1 are marked green and stocks outside of safe biological limits ($B/B_{msy} < 0.5$) with ongoing overfishing ($F/F_{msy} > 1$) are marked red. Catches above MSY are marked bold (C/MSY > 1). Overfishing with $F/F_{msy} > 1$ is marked bold. Stock sizes outside safe biological limits (B/Bmsy < 0.5) are marked bold. Unsustainable catches (catch > MSY, F > Fmsy, B < 0.2 Bmsy) are marked red. Catches are given in tonnes per year. Biomass is given in tonnes as average total biomass during the year. Species are sorted by functional groups as indicated by the color of the stock IDs: benthic fish & invertebrates (blue), large predators (red) and pelagic plankton feeders (green). [BarentsSea_Sep26_2016.xlsx]

Scientific name	Stock	Year	*MSY*	Catch	*C/MSY*	F_{msy}	$F_{msy\ cur}$	*F*	$F/F_{msy\ cur}$	B_{msy}	*B*	B/B_{msy}
Reinhardtius hippoglossoides	ghl-arct	2014	18,674	22,244	**1.19**	0.19	0.19	0.16	0.85	97,494	136,757	1.40
Molva molva	lin-arct	2014	9,516	9,606	**1.01**	0.16	0.16	0.12	0.76	58,857	78,612	1.34
Pandalus borealis	pand-barn	2014	62,740	16,671	0.27	0.37	0.37	0.09	0.24	168,188	185,115	1.10
Sebastes mentella	smn-arct	2013	30,923	9,297	0.30	0.25	0.25	0.04	0.17	123,181	217,555	1.77
Sebastes norvegicus	smr-arct	2015	18,619	3,630	0.19	0.15	0.03	0.29	**9.37**	124,272	12,678	**0.10**
Brosme brosme	usk-arct	2014	13,965	8,734	0.63	0.28	0.28	0.17	0.62	50,642	51,223	1.01
Gadus morhua	cod-arct	2015	1,116,189	864,384	0.77	0.23	0.23	0.13	0.58	4,857,246	6,451,009	1.33
Gadus morhua	cod-coas	2015	64,205	52,154	0.81	0.28	0.28	0.43	**1.52**	226,986	121,657	0.54
Melanogrammus aeglefinus	had-arct	2015	474,993	194,756	0.41	0.21	0.21	0.05	0.24	2,311,421	4,020,476	1.74
Pollachius virens	sai-arct	2015	227,311	131,765	0.58	0.27	0.27	0.13	0.48	849,200	1,032,863	1.22
Mallotus villosus	cap-bars	2015	1,670,405	115,000	0.07	0.21	0.15	0.04	0.26	8,098,440	2,920,786	**0.36**
Clupea harengus	her-noss	2014	905,483	461,306	0.51	0.20	0.20	0.13	0.66	4,487,167	3,442,750	0.77

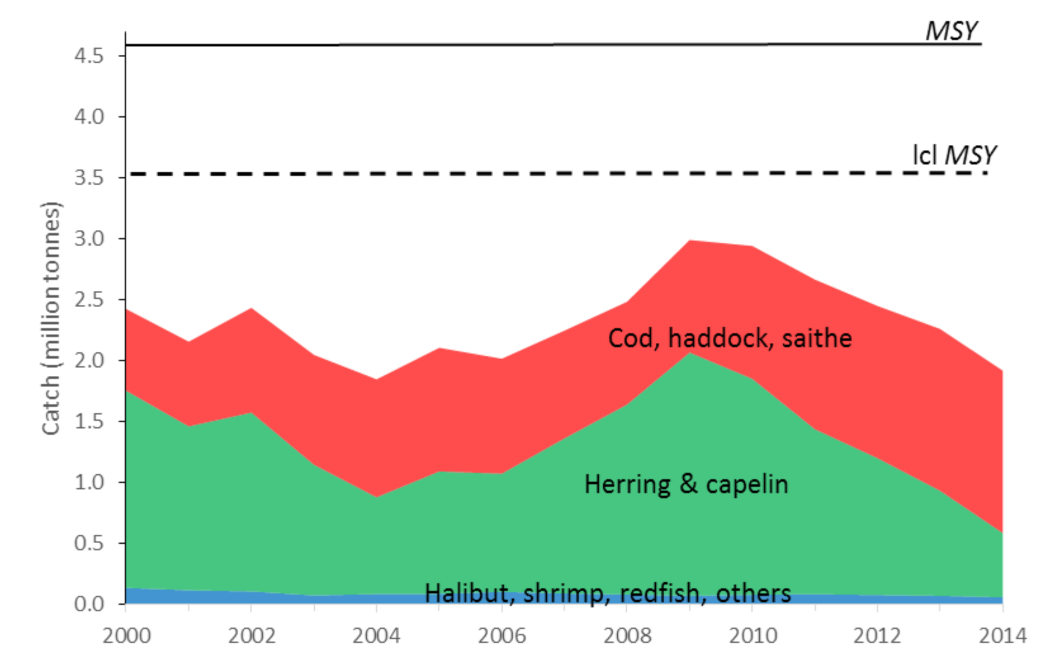


Figure 10. Cumulative catches for 12 stocks in the Barents Sea and Norwegian Sea, with indication of main functional groups. The black line indicates the maximum sustainable yield (MSY) for the ecoregion and the dashed line indicates the lower 95% confidence limit as a precautionary target. [BarentsSea_Sep26_2016.xlsx]

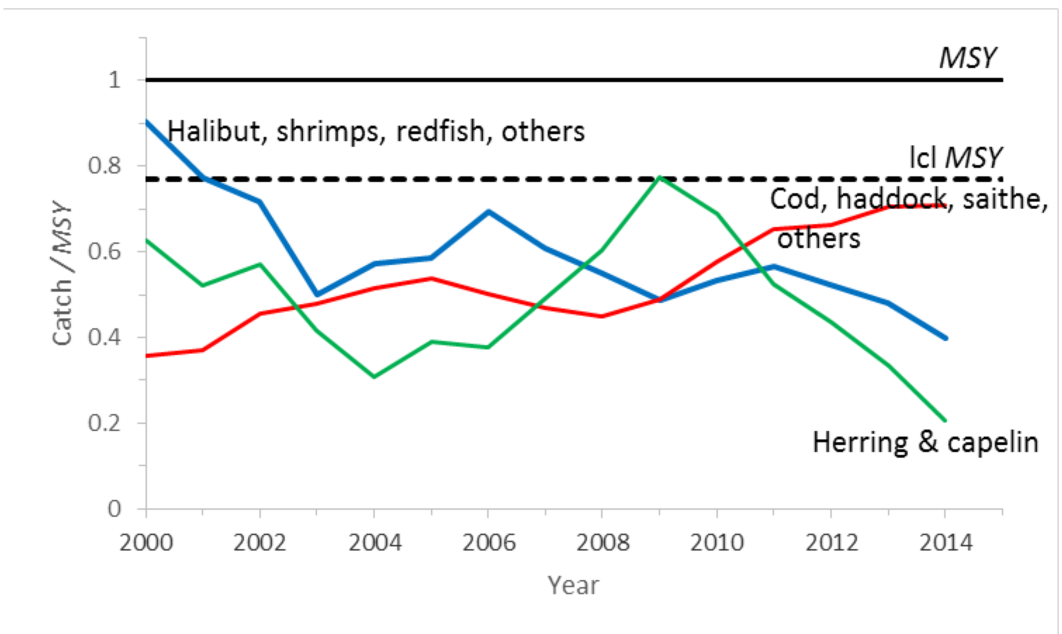


Figure 11. Catches by main functional group relative to their maximum sustainable yield (MSY, black line), for 12 stocks in the Barents Sea and Norwegian Sea. Catches for large predators (red curve) are near the precautionary maximum. Catches for pelagic plankton feeders (green curve) can be increased after the stocks have been rebuilt. [BarentsSea_Sep26_2016.xlsx]

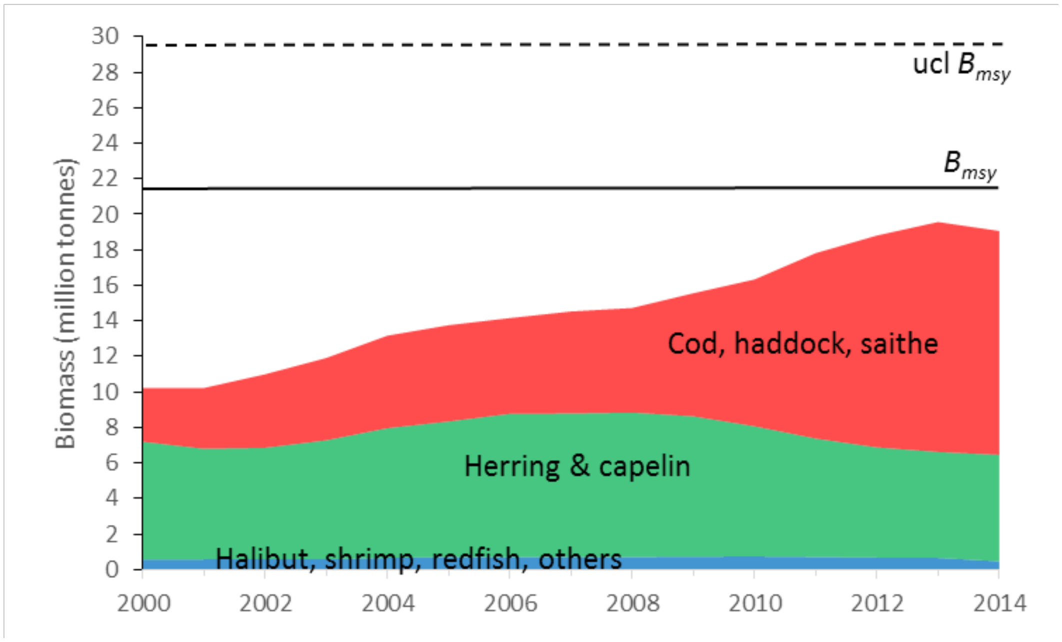


Figure 12. Cumulative total biomass of 12 stocks in the Barents Sea and Norwegian Sea relative to the biomass that can produce the maximum sustainable yield (Bmsy = black line). The upper 95% confidence limit of Bmsy (dashed line) would present a precautionary target biomass above Bmsy. This is also the area where the maximum economic yield could be obtained. The functional groups of large predators (red), pelagic plankton feeders (green), and benthic organisms (blue) are indicated, with listing of main species. [BarentsSea_Sep26_2016.xlsx]

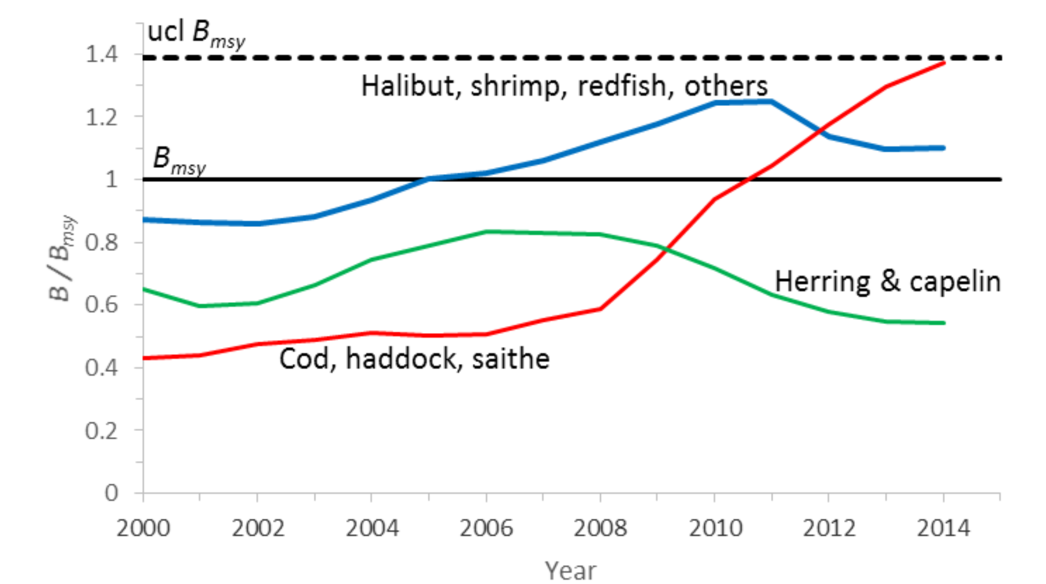


Figure 13. Median biomass relative to the level that can produce the maximum sustainable yield (B/Bmsy) for 12 stocks in the Barents Sea and Norwegian Sea assigned to main functional groups. Biomass of pelagic plankton feeders (green curve) needs rebuilding. [BarentsSea_Sep26_2016.xlsx]

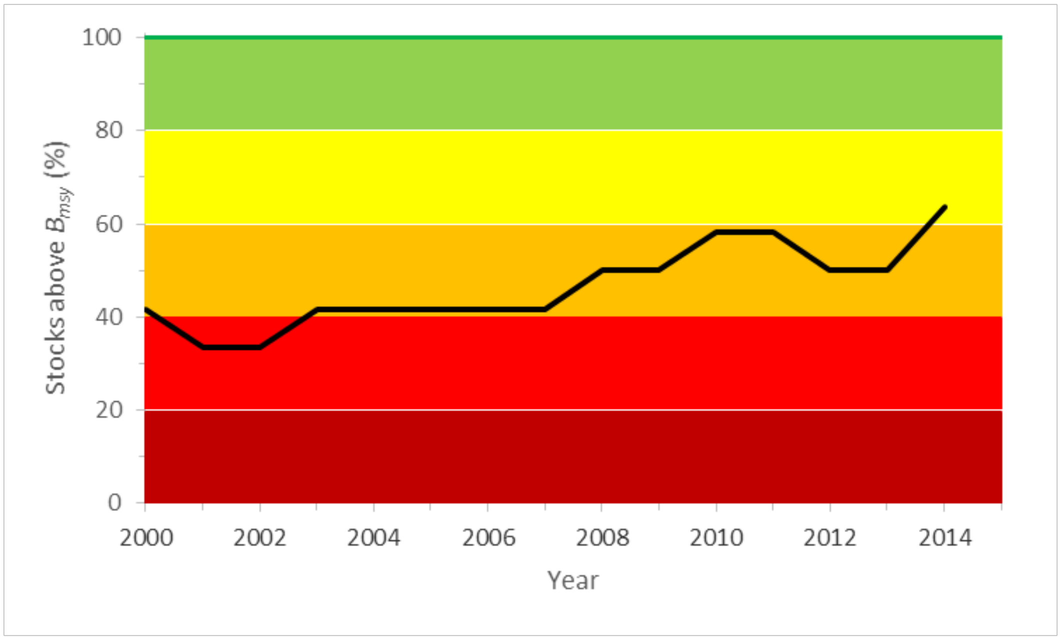


Figure 14. Percentage of stocks where biomass is above the level that can produce the maximum sustainable yield (B_{msy}) for 12 stocks in the Barents Sea and Norwegian Sea (black curve). The colors indicate visually the compliance with the goals of the Common Fisheries Policy, where all stocks (100%) shall be above B_{msy} eventually. In 2014, only 64% of the stocks fulfilled that requirement. [BarentsSea_Sep26_2016.xlsx]

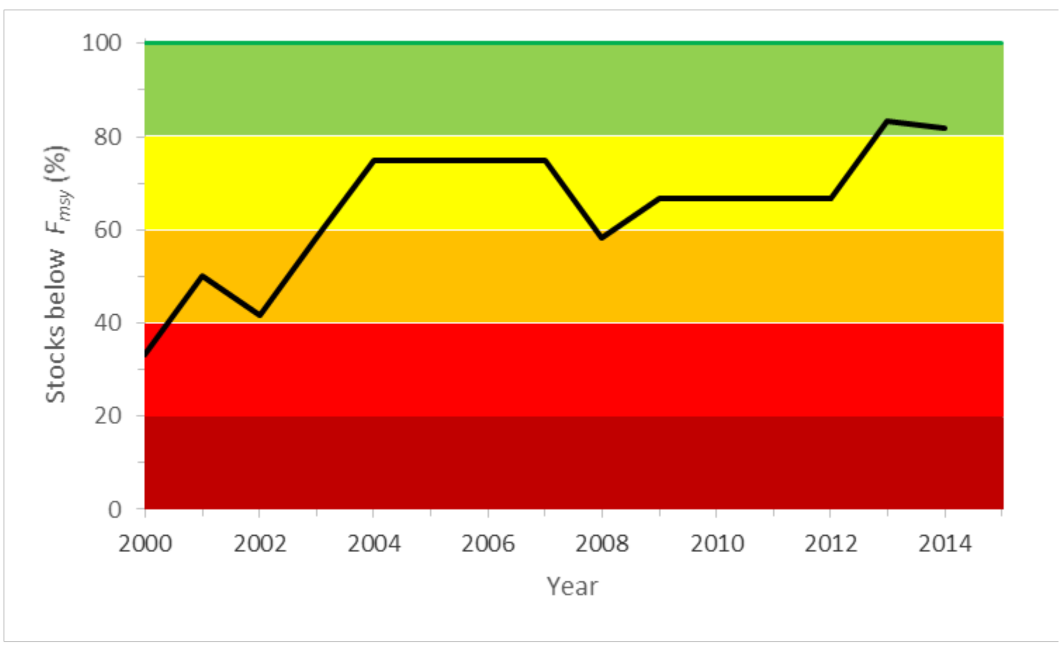


Figure 15. Percentage of stocks where fishing mortality F is at or below the level that can produce the maximum sustainable yield (F_{msy}) for 12 stocks in the Barents Sea and Norwegian Sea (black curve). The colors indicate visually the compliance with the goals of the Common Fisheries Policy, where all stocks (100%) shall be at or below F_{msy} in 2015, latest in 2020. In 2014, already 82% of the stocks fulfilled that requirement. [BarentsSea_Sep26_2016.xlsx]

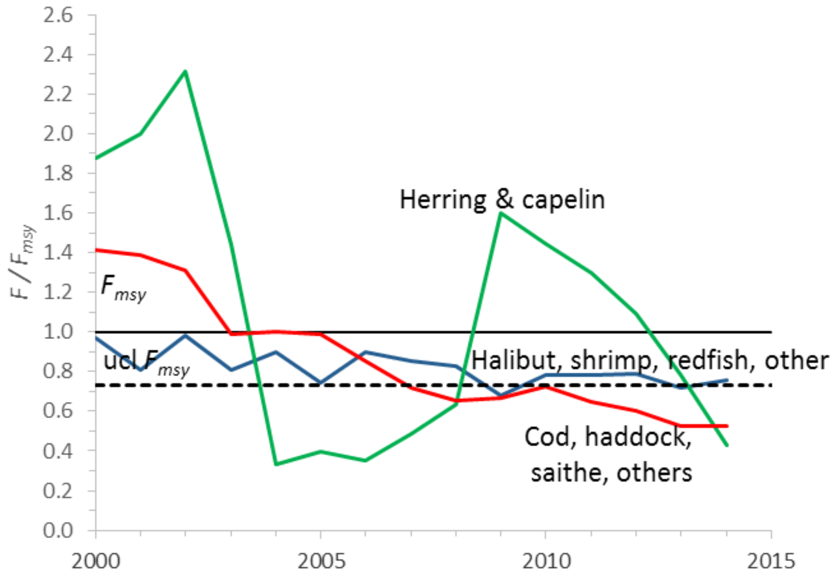


Figure 16. Fishing pressure relative to the maximum sustainable level (F/Fmsy) for 12 stocks in the Barents Sea and Norwegian Sea assigned to main functional groups. Median exploitation level of the functional groups seems adequate. [BarentsSea_Sep26_2016.xlsx]

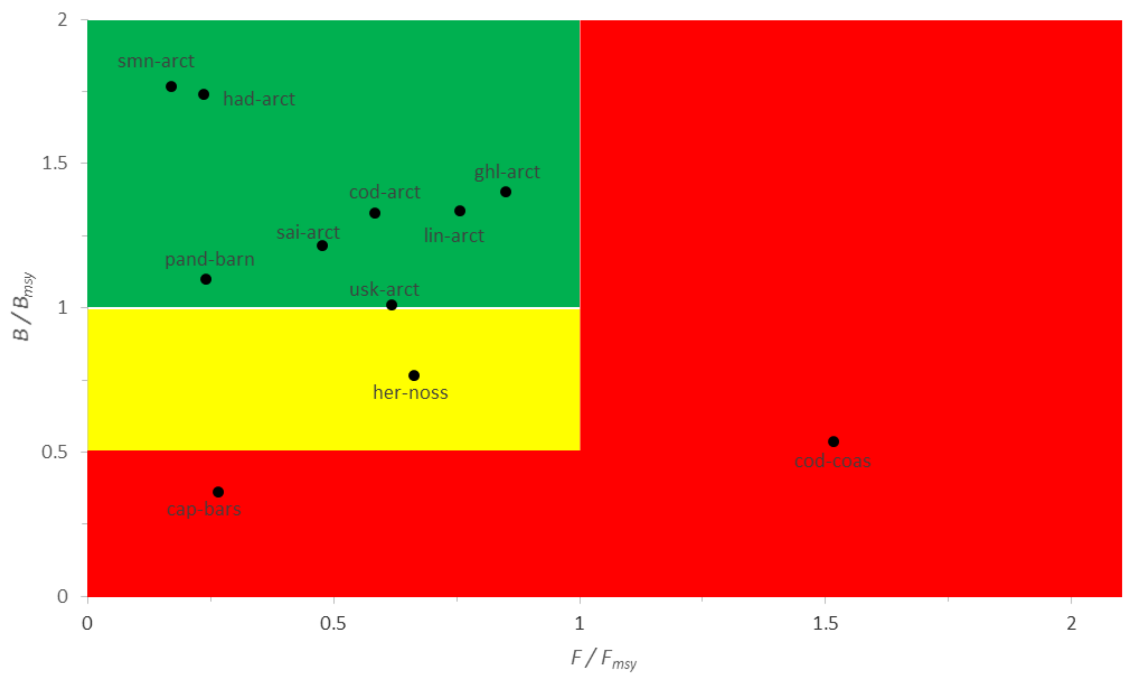


Figure 17. Presentation of 12 Barents Sea and Norwegian Sea stocks in a pressure (F/F_{msy}) – state (B/B_{msy}) plot. The red area indicates stocks that are being overfished or are outside of safe biological limits. The yellow area indicates recovering stocks. The green area indicates stocks subject to sustainable fishing pressure and of a healthy stock size that can produce high yields close to MSY. [BarentsSea_Sep26_2016.xlsx]

Iceland, Faroes and Greenland

The following paragraph describing Iceland was- taken from the ICES Advice 2008, Book 2,

http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2008/2008/2.1-2.2%20Greenland%20and%20Iceland%20ecosystem%20overview.pdf.

"Iceland is located at the junction of the Mid-Atlantic Ridge and the Greenland-Scotland Ridge just south of the Arctic Circle. Bottom topography in this region is generally irregular, with hard rocky bottom prevailing in most areas. The shelf around Iceland is cut by many sub-sea canyons. It is narrowest off the south coast where in places it extends out only a few km. From there, the continental slope falls away to over 1000 m. Off the west, north, and east coasts, however, the shelf is relatively broad and extends often over 150 km from the coast."

The next three paragraphs describing the Faroes were taken from the ICES Advice 2008, Book 4,

http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2008/2008/4.1-4.2%20Faroe%20plateau%20ecosystem%20overview.pdf.

"The upper layers of the waters surrounding the Faroes are dominated by 'Modified North Atlantic Water' which derives from the North Atlantic Current flowing towards the east and northeast. This water is typically around 8°C with salinities around 35.25. Deeper than 500–600 m, the water in most areas is dominated by cold water (T<0°C) with salinities close to 34.9, flowing out of the Nordic Seas through the deepest passages.

In shallow regions, there are strong tidal currents, which mix the shelf water very efficiently. This results in homogeneous water masses in the shallow shelf areas. The well-mixed shelf water is separated relatively well from the offshore water by a persistent tidal front, which surrounds the shelf at about the 100–130 m bottom depth. In addition, residual currents have a persistent clockwise circulation around the islands.

The shelf-front provides a fair, although variable, degree of isolation between the on-shelf and the off-shelf areas. This allows the on-shelf areas to support a relatively uniform shelf ecosystem, which in many ways is distinct from off-shelf waters. This ecosystem has distinct planktonic communities, benthic fauna, and several fish stocks. Furthermore, about 1.7 million pairs of seabirds breed on the Faroe Islands and take most of their food from the shelf water."

The following two paragraphs describing Greenland were taken from the ICES Advice 2008, Book 2,

http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2008/2008/2.1-2.2%20Greenland%20and%20Iceland%20ecosystem%20overview.pdf.

"The seafloor drops rapidly from the Greenland coast to depths over 1000 m. In the areas seasonally ice free, the shelf area is rarely more than 75 km wide. The coastline and sub-sea topography are heavily serrated with canyons, and the bottom topography is generally rough with hard bottom types.

The strong, cold East Greenland Current dominates the hydrographic conditions along the coast of Greenland. In some years, the warmer Irminger Current extends somewhat further west, transporting heat and organisms from Iceland into Greenland waters."

ICES assessment reports with data until 2015 were analyzed for 26 stocks in Iceland, Faroe and Greenland. The graphs below summarize their status and exploitation level within an MSY-framework. The list of species and their current exploitation and status is summarized in Table 6 Detailed assessments for every stock are available in the Appendix 1 and in the spreadsheet Iceland_Sep27_2016.xlsx.

Of the 26 stocks, 11 (42%) were subject to ongoing overfishing ($F > F_{msy}$) and 11 stocks (42%) were outside of safe biological limits ($B < 0.5\ B_{msy}$). In one stock (lin-faro, 4%) catches exceeded the maximum sustainable yield ($C/MSY > 1$). Nine stocks were in critical condition, defined by being outside of safe biological limits and subject to overfishing (marked red in Table 6). Altogether, 14 stocks (54%) were subject to unsustainable exploitation (catch > *MSY* or $F > F_{msy}$ or $B < 0.2\ B_{msy}$), with the too high catches marked red in Table 6. Four stocks (15%) could be considered as being well managed and in good condition sensu CFP (2013), defined by not being subject to overfishing and having a biomass above the one that can produce the maximum sustainable yield.

Summed biomass of the 26 stocks of 3.7 million tonnes in the last year with available data was below the summed biomass level of 6.8 million tonnes that can produce maximum yields. Summed catches of 0.6 million tonnes were well below the summed maximum sustainable yield of 1.6 million tonnes. Because of trophic interactions it is not possible to achieve *MSY* simultaneously for all stocks, but sustained catches of near the lower confidence limit or near 90% of *MSY* (whichever is lower) would be possible if all stocks have recovered above *Bmsy*. Because of more fish in the water, such catches could be obtained with much less fishing effort and much less impact on the ecosystem. See legends of Figures for more comments.

Table 6. Analysis of 26 stocks in Iceland, Faroes and Greenland, with indication of last year with available data (Year), maximum sustainable yield (MSY), absolute and relative catch (Catch, C/MSY), maximum sustainable fishing mortality (F_{msy}) if the stock is within safe biological limits ($B/B_{msy} > 0.5$) , F_{msy} for current stock size, F/F_{msy} for current stock size, biomass that can produce MSY (B_{msy}), relative biomass (B/B_{msy}). Scientific names of healthy stocks where F/Fmsy < 1 and B/Bmsy > 1 are marked green and stocks outside of safe biological limits ($B/B_{msy} < 0.5$) with ongoing overfishing ($F/F_{msy} > 1$) are marked red. Catches above MSY are marked bold (C/MSY > 1). Overfishing with $F/F_{msy} > 1$ is marked bold. Stock sizes outside safe biological limits (B/Bmsy < 0.5) are marked bold. Unsustainable catches (catch > MSY, F > Fmsy, B < 0.2 Bmsy) are marked red. Catches are given in tonnes per year. Biomass is given in tonnes as average total biomass during the year. Species are sorted by functional groups as indicated by the color of the stock IDs: benthic fish & invertebrates (blue), large predators (red) and pelagic plankton feeders (green). [Iceland_Sep27_2016.xlsx]

Scientific name	Stock	Year	MSY	Catch	C/MSY	F_{msy}	F_{msy} cur	F	F/F_{msy} cur	B_{msy}	B	B/B_{msy}
Argentina silus	arg-5b6a	2014	15,790	15,642	0.99	0.16	0.15	0.35	**2.30**	97,278	45,132	**0.46**
Argentina silus	arg-icel	2015	10,975	6,056	0.55	0.27	0.27	0.19	0.70	40,551	31,934	0.79
Molva dypterygia	bli-5a14	2015	4,096	1,813	0.44	0.20	0.20	0.14	0.71	20,732	12,942	0.62
Reinhardtius hippoglossoides	ghl-grn	2015	33,487	25,677	0.77	0.19	0.19	0.22	**1.16**	180,692	119,017	0.66
Molva molva	lin-faro	2014	6,098	6,684	**1.10**	0.17	0.17	0.13	0.77	35,220	50,217	1.43
Molva molva	lin-icel	2015	17,703	12,862	0.73	0.31	0.31	0.18	0.59	57,006	70,493	1.24
Pandalus borealis	Pan_bor_1	2013	686	201	0.29	0.30	0.22	0.24	**1.12**	2,290	827	**0.36**
Pandalus borealis	Pan_bor_2	2013	2,129	1,128	0.53	0.39	0.23	0.73	**3.21**	5,400	1,551	**0.29**
Sebastes mentella	smn-con	2015	20,511	9,311	0.45	0.14	0.14	0.10	0.70	144,371	93,744	0.65
Sebastes mentella	smn-dp	2014	49,284	23,755	0.48	0.09	0.06	0.15	**2.52**	528,467	163,536	**0.31**
Sebastes mentella	smn-grl	2015	15,898	5,977	0.38	0.08	0.01	0.74	**> 10**	191,446	8,043	**0.04**
Sebastes mentella	smn-sp	2015	42,617	5,595	0.13	0.08	0.01	0.34	**> 10**	521,252	16,419	**0.03**
Sebastes norvegicus	smr-5614	2015	67,027	51,601	0.77	0.18	0.18	0.13	0.74	372,227	385,982	1.04
Brosme brosme	usk-icel	2015	7,121	4,822	0.68	0.26	0.26	0.15	0.58	27,108	31,502	1.16
Gadus morhua	cod-farb	2015	2,056	17	0.01	0.28	0.06	0.02	0.44	7,221	699	**0.10**
Gadus morhua	cod-farp	2015	26,148	7,394	0.28	0.36	0.23	0.32	**1.38**	71,927	23,035	**0.32**
Gadus morhua	cod-iceg	2015	465,538	230,225	0.49	0.36	0.36	0.14	0.40	1,296,232	1,589,240	1.23
Gadus morhua	cod-ingr	2015	34,388	25,272	0.73	0.39	0.39	0.42	**1.07**	88,321	60,592	0.69
Gadus morhua	cod-segr	2015	36,777	15,755	0.43	0.22	0.05	0.80	**> 10**	166,528	19,687	**0.12**
Gadus morhua	cod-wgr	2015	423,139	4,860	0.01	0.23	0.04	0.03	0.62	1,818,646	175,517	**0.10**

Scientific name	Stock	Year	*MSY*	Catch	*C/MSY*	F_{msy}	$F_{msy\,cur}$	*F*	$F/F_{msy\,cur}$	B_{msy}	*B*	B/B_{msy}
Melanogrammus aeglefinus	had-faro	2015	18,461	3,395	0.18	0.33	0.17	0.23	**1.34**	56,333	14,744	**0.26**
Melanogrammus aeglefinus	had-iceg	2015	65,240	39,646	0.61	0.34	0.34	0.28	0.83	190,631	139,702	0.73
Pollachius virens	sai-faro	2015	39,389	25,128	0.64	0.22	0.22	0.17	0.75	175,104	148,482	0.85
Pollachius virens	sai-icel	2015	63,763	48,476	0.76	0.29	0.29	0.22	0.76	217,589	217,909	1.00
Mallotus villosus	cap-icel	2016	1,053	174	0.17	0.36	0.36	0.08	0.23	2,954	2,111	0.71
Clupea harengus	her-vasu	2015	108,626	69,729	0.64	0.24	0.24	0.22	0.92	447,668	310,874	0.69

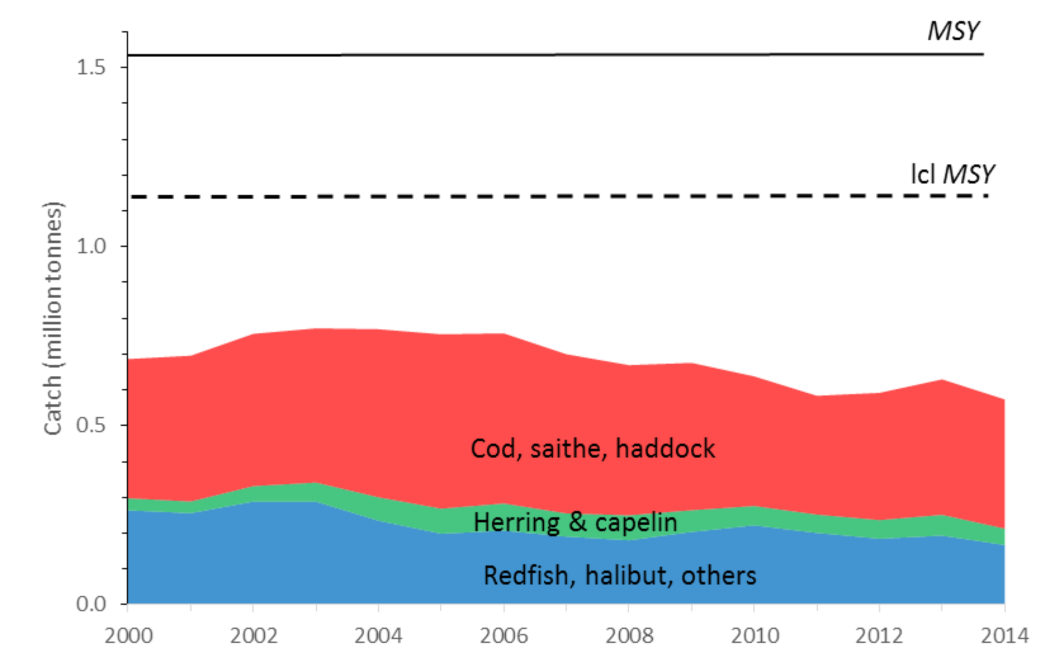


Figure 18. Cumulative catches for 26 stocks in Iceland, Faroes and Greenland, with indication of main functional groups. The black line indicates the maximum sustainable yield (MSY) for the ecoregion and the dashed line indicates the lower 95% confidence limit as a precautionary target. [Iceland_Sep27_2016.xlsx]

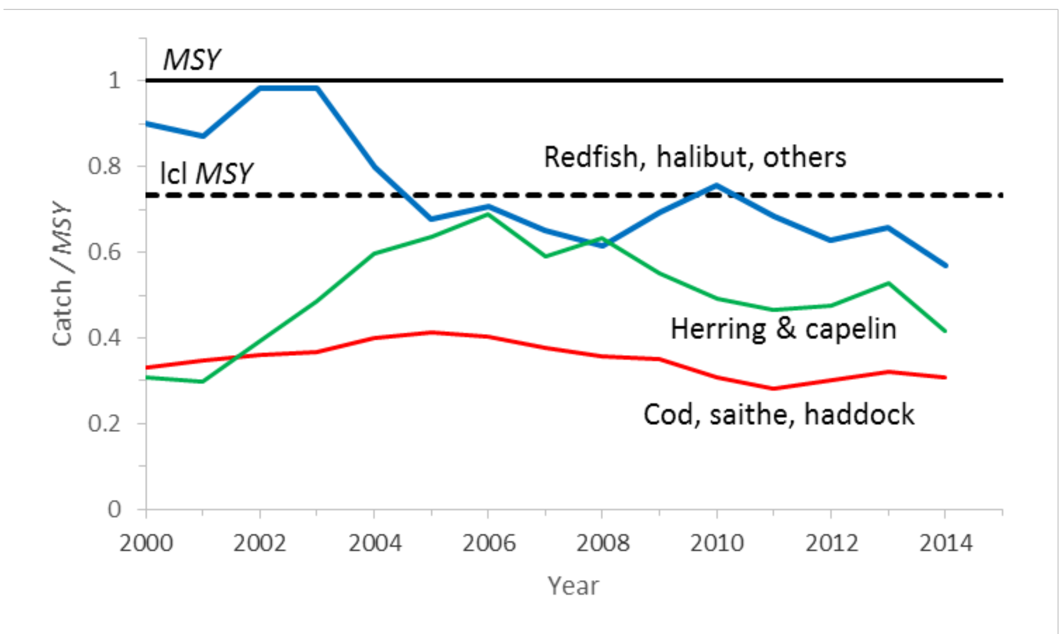


Figure 19. Catches by main functional group relative to their maximum sustainable yield (MSY, black line), for 26 stocks in Iceland, Faroes and Greenland. Catches of large predators (red curve) could be increased after stocks have been rebuilt. [Iceland_Sep27_2016.xlsx]

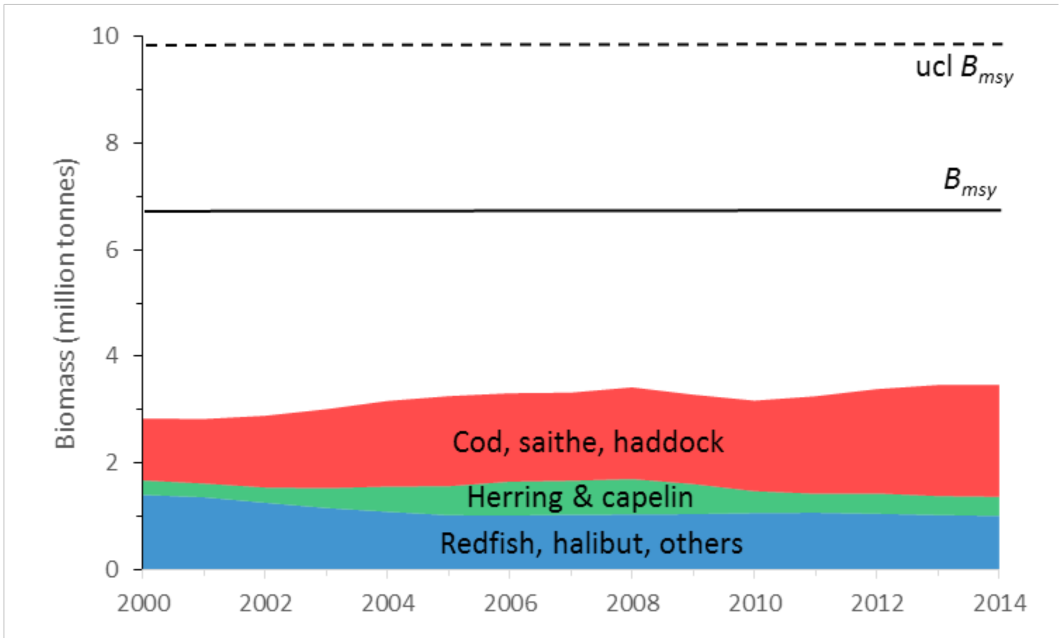


Figure 20. Cumulative total biomass of 26 stocks in Iceland, Faroes and Greenland relative to the biomass that can produce the maximum sustainable yield (Bmsy = black line). The upper 95% confidence limit of Bmsy (dashed line) would present a precautionary target biomass above Bmsy. This is also the area where the maximum economic yield could be obtained. The functional groups of large predators (red), pelagic plankton feeders (green), and benthic organisms (blue) are indicated, with listing of main species. Overall biomass of commercial species is much too low. [Iceland_Sep27_2016.xlsx]

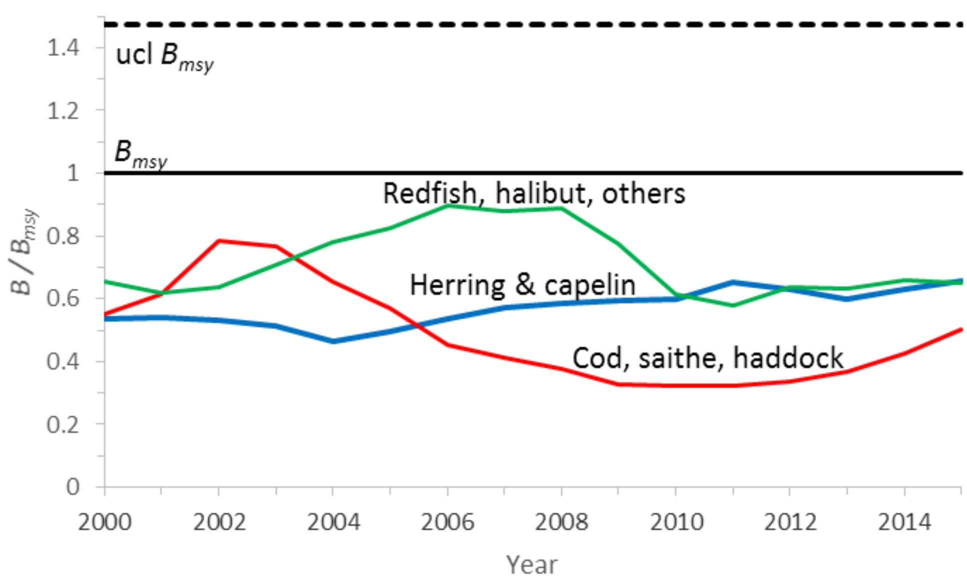


Figure 21. Median biomass relative to the level that can produce the maximum sustainable yield (B/Bmsy) for 26 stocks in Iceland, Faroes and Greenland assigned to main functional groups. Biomass of all functional groups is too low. Large predators (red curve) were even outside of safe biological limits in recent years. [Iceland_Sep27_2016.xlsx]

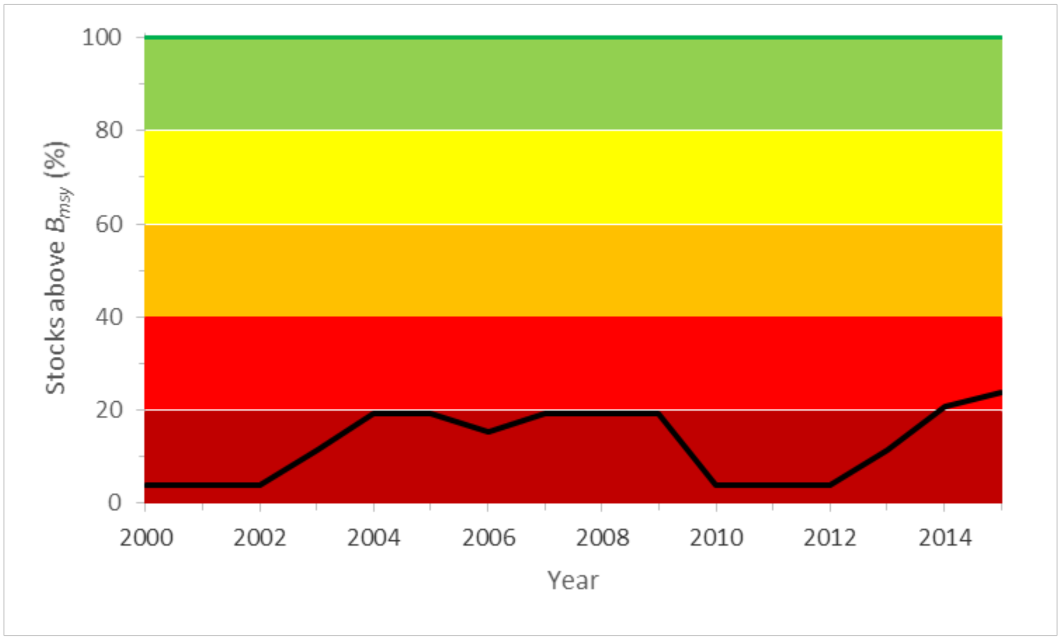


Figure 22. Percentage of stocks where biomass is above the level that can produce the maximum sustainable yield (B_{msy}) for 26 stocks in Iceland, Faroes and Greenland (black curve). The colors indicate visually the compliance with the goals of the Common Fisheries Policy, where all stocks (100%) shall be above B_{msy} eventually. In 2015, only 24% of the stocks fulfilled that requirement. [Iceland_Sep27_2016.xlsx]

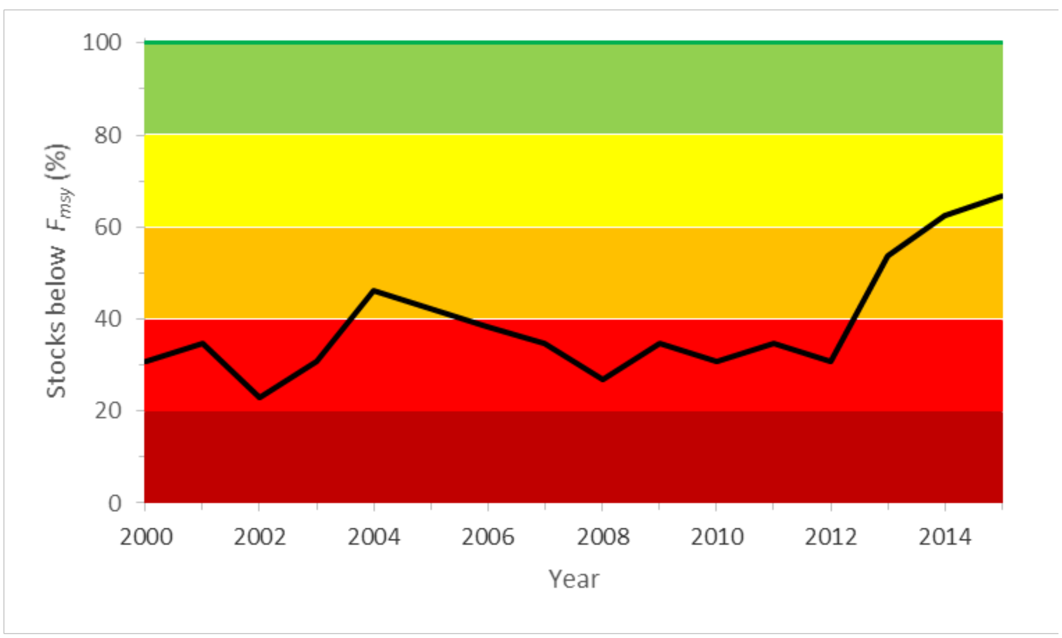


Figure 23. Percentage of stocks where fishing mortality F is at or below the level that can produce the maximum sustainable yield (F_{msy}) for 26 stocks in Iceland, Faroes and Greenland (black curve). The colors indicate visually the compliance with the goals of the Common Fisheries Policy, where all stocks (100%) shall be at or below F_{msy} in 2015, latest in 2020. In 2015, only 67% of the stocks fulfilled that requirement. [Iceland_Sep27_2016.xlsx]

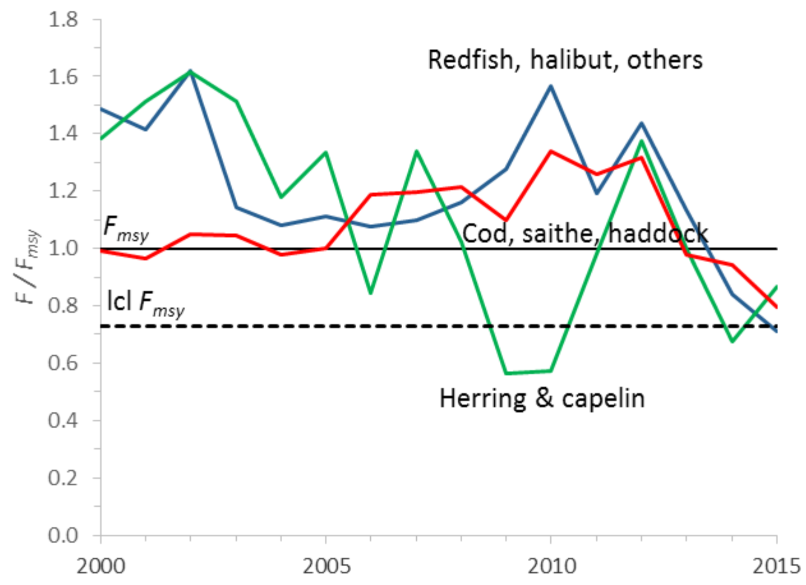


Figure 24. Median fishing pressure relative to the maximum sustainable level (F/F_{msy}) for 26 stocks in Iceland, Faroes and Greenland assigned to main functional groups. Median fishing pressure for the functional groups has decreased in recent years. [Iceland_Sep27_2016.xlsx]

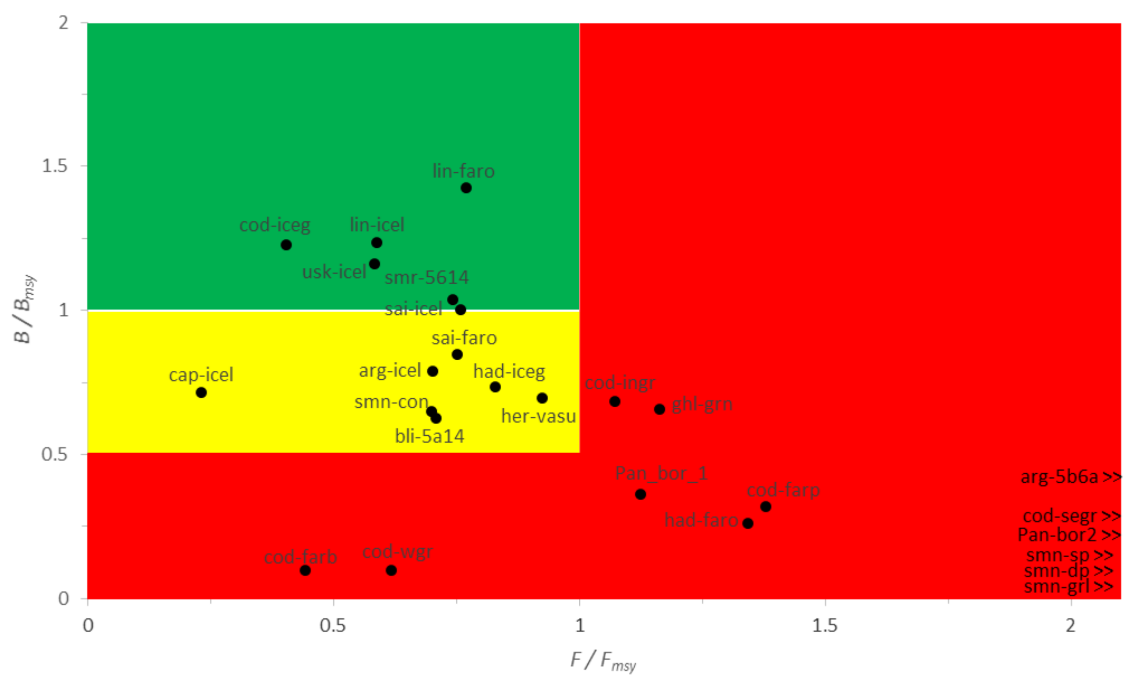


Figure 25. Presentation of 26 stocks in Iceland, Faroes and Greenland in a pressure (F/F_{msy}) – state (B/B_{msy}) plot. The red area indicates stocks that are being overfished or are outside of safe biological limits. The yellow area indicates recovering stocks. The green area indicates stocks subject to sustainable fishing pressure and of a healthy stock size that can produce high yields close to MSY. Several stocks (some indicated by ->>) are exploited beyond the upper limit of the X-axis. [Iceland_Sep27_2016.xlsx]

Greater North Sea

The following paragraph was taken from the ICES Advice 2016, Book 6,

http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2016/2016/Greater_North_Sea_Ecoregion-Ecosystem_overview.pdf.

“The Greater North Sea ecoregion includes the North Sea, English Channel, Skagerrak, and Kattegat. It is a temperate coastal shelf sea with a deep channel in the northwest, a permanently thermally mixed water column in the south and east, and seasonal stratification in the north.”

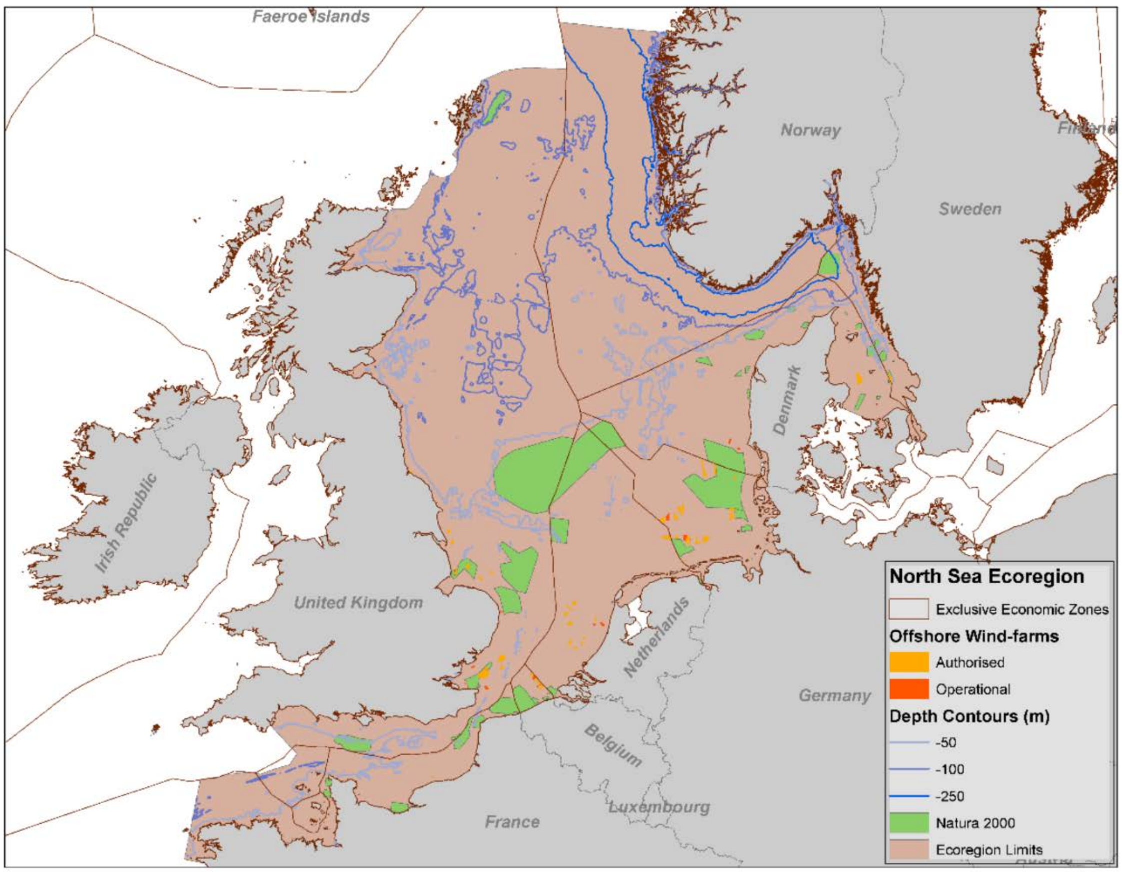


Figure 26. Greater North Sea ecoregion, showing EEZs, larger offshore Natura 2000 sites, and operational and authorized wind farms. Source: ICES Advice 2016, Book 6.

ICES assessment reports with data mostly until 2015 were analyzed for 45 stocks in the Greater North Sea. The graphs below summarize their status and exploitation level within an MSY-framework. Wide ranging species such as European eel (*Anguilla anguilla*) or Atlantic mackerel (*Scomber scombrus*) are not included and are analyzed separately. The list of species and their current exploitation and status is summarized in Table 7. Detailed assessments for every stock are available in Appendix 1 and in the spreadsheet NorthSea_Sep23_2016.xlsx.

Of the 45 stocks, 20 (44%) were subject to ongoing overfishing ($F > F_{msy}$) in the last year with available data and 21 stocks (47%) were outside of safe biological limits ($B < 0.5\ B_{msy}$). In two stocks (4%) catches exceeded the maximum sustainable yield (*C/MSY* > 1). Fifteen stocks (33%) were in critical condition, defined by being outside of safe biological limits and subject to overfishing (scientific names marked red in Table 7). Altogether, 22 stocks (49%) were subject to unsustainable exploitation (catch > *MSY* or $F > F_{msy}$ or $B < 0.2\ B_{msy}$), with the too high catches marked red in Table 7. Only nine stocks (20%) could be considered as being well managed and in good condition sensu CFP (2013), defined by not being subject to overfishing and having a biomass above the one that can produce the maximum sustainable yield (scientific names marked green in Table 7).

Summed biomass of the 45 stocks of 9.9 million tonnes in the last year with available data was below the summed biomass level of 11 million tonnes that can produce maximum yields. Summed catches of 1.6 million tonnes were well below (47%) the summed maximum sustainable yield of 3.4 million tonnes. Because of trophic interactions it is not possible to achieve *MSY* simultaneously for all stocks, but sustained catches of near the lower confidence limit or near 90% of *MSY* (whichever is lower) would be possible if all stocks have recovered above B_{msy}. Because of more fish in the water, such catches could be obtained with much less fishing effort and much less impact on the ecosystem. See legends of Figures for more comments.

Table 7. Analysis of 45 stocks in the Greater North Sea, with indication of last year with available data (Year), maximum sustainable yield (MSY), absolute and relative catch (Catch, C/MSY), maximum sustainable fishing mortality (F_{msy}) if the stock is within safe biological limits ($B/B_{msy} > 0.5$), $F_{msy\ cur}$ applicable for current stock size, relative $F/F_{msy\ cur}$ for current stock size, biomass that can produce MSY (B_{msy}), and relative biomass (B/B_{msy}). Scientific names of healthy stocks where $F/F_{msy\ cur} < 1$ and $B/B_{msy} > 1$ are marked green and stocks outside of safe biological limits ($B/B_{msy} < 0.5$) with ongoing overfishing ($F/F_{msy} > 1$) are marked red. Unsustainable catches above MSY are marked bold (C/MSY > 1). Overfishing with $F/F_{msy\ cur} > 1$ is marked bold. Stock sizes outside safe biological limits (B/Bmsy < 0.5) are marked bold. Unsustainable catches (catch > MSY, F > Fmsy, B < 0.2 Bmsy) are marked red. Catches are given in tonnes per year. Biomass is given in tonnes as average total biomass during the year. Species are sorted by functional groups as indicated by the color of the stock IDs: benthic fish & invertebrates (blue), large predators (red) and pelagic plankton feeders (green). [NorthSea_Sep23_2016.xlsx]

Scientific name	Stock	Year	*MSY*	Catch	*C/MSY*	F_{msy}	$F_{msy\ cur}$	*F*	$F/F_{msy\ cur}$	B_{msy}	*B*	B/B_{msy}
Scophthalmus rhombus	bll-nsea	2014	2,142	1,942	0.91	0.32	0.32	0.34	**1.05**	6,707	5,777	0.86
Limanda limanda	dab-nsea	2014	11,260	4,955	0.44	0.29	0.29	0.08	0.26	39,172	65,830	1.68
Platichthys flesus	fle-nsea	2014	4,134	2,062	0.50	0.44	0.44	0.25	0.57	9,502	8,359	0.88
Microstomus kitt	lem-nsea	2014	6,773	3,689	0.54	0.36	0.36	0.24	0.67	18,972	15,353	0.81
Lepidorhombus spp.	meg-4a6a	2014	4,829	2,809	0.58	0.32	0.32	0.16	0.49	15,262	18,005	1.18
Mullus surmuletus	mur-347d	2014	3,270	1,732	0.53	0.41	0.25	0.70	**2.78**	8,062	2,489	**0.31**
Nephrops norvegicus	nep-10	2015	237	15	0.06	0.26	0.08	0.11	**1.41**	916	138	**0.15**
Nephrops norvegicus	nep-32	2015	852	192	0.23	0.18	0.15	0.10	0.68	4,692	1,913	**0.41**
Nephrops norvegicus	nep-33	2015	924	1,003	**1.09**	0.28	0.28	0.55	**1.94**	3,252	1,815	0.56
Nephrops norvegicus	nep-34	2015	541	439	0.81	0.28	0.28	0.44	**1.57**	1,926	994	0.52
Nephrops norvegicus	nep-3-4	2015	8,719	4,388	0.50	0.31	0.31	0.17	0.56	28,224	25,186	0.89
Nephrops norvegicus	nep-5	2015	1,051	3,551	**3.38**	0.28	0.28	0.97	**3.42**	3,717	3,667	0.99
Nephrops norvegicus	nep-6	2015	3,324	1,561	0.47	0.26	0.19	0.34	**1.74**	12,550	4,612	**0.37**
Nephrops norvegicus	nep-7	2015	9,657	1,786	0.18	0.24	0.19	0.11	0.57	40,152	16,166	**0.40**

Scientific name	Stock	Year	*MSY*	Catch	*C/MSY*	F_{msy}	$F_{msy\ cur}$	*F*	$F/F_{msy\ cur}$	B_{msy}	*B*	B/B_{msy}
Nephrops norvegicus	nep-8	2015	2,205	1,892	0.86	0.36	0.36	0.29	0.80	6,100	6,537	1.07
Nephrops norvegicus	nep-9	2015	1,412	830	0.59	0.26	0.26	0.22	0.82	5,381	3,858	0.72
Pandalus borealis	pand-sknd	2014	12,769	12,340	0.97	0.31	0.26	0.70	**2.69**	41,307	17,519	**0.42**
Pleuronectes platessa	ple-eche	2015	12,417	5,787	0.47	0.28	0.28	0.08	0.27	44,363	75,710	1.71
Pleuronectes platessa	ple-nsea	2015	211,567	134,460	0.64	0.14	0.14	0.05	0.36	1,543,865	2,688,623	1.74
Coryphaenoides rupestris	rng-kask	2015	5,397	1	0.00	0.19	0.04	0.00	0.01	28,310	3,093	**0.11**
Ammodytes tobianus	san-ns1	2015	379,740	162,054	0.43	0.48	0.38	0.51	**1.34**	796,105	317,334	**0.40**
Ammodytes tobianus	san-ns3	2015	326,408	118,541	0.36	0.50	0.50	0.25	0.51	654,448	468,803	0.72
Ammodytes tobianus	san-ns4	2015	78,217	4,384	0.06	0.44	0.08	0.27	**3.50**	178,960	16,019	**0.09**
Ammodytes tobianus	san-ns6	2015	2,380	229	0.10	0.50	0.28	0.17	0.60	4,807	1,365	**0.28**
Ammodytes tobianus	san-ns7	2015	3,044	0	0.00	0.77	0.18	0.00	0.00	3,941	471	**0.12**
Solea solea	sol-eche	2015	4,449	3,441	0.77	0.41	0.41	0.33	0.81	10,828	10,284	0.95
Solea solea	sol-kask	2015	850	224	0.26	0.34	0.34	0.10	0.30	2,531	2,243	0.89
Solea solea	sol-nsea	2015	26,788	14,293	0.53	0.35	0.35	0.24	0.69	76,948	59,119	0.77
Scyliorhinus canicula	syc-347d	2014	4,669	2,704	0.58	0.18	0.18	0.08	0.43	26,648	35,507	1.33
Scophthalmus maximus	tur-kask	2014	177	120	0.68	0.27	0.27	0.34	**1.28**	655	349	0.53
Scophthalmus maximus	tur-nsea	2014	4,376	2,834	0.65	0.23	0.18	0.38	**2.19**	19,156	7,364	**0.38**

Scientific name	Stock	Year	*MSY*	Catch	*C/MSY*	F_{msy}	$F_{msy\ cur}$	*F*	$F/F_{msy\ cur}$	B_{msy}	*B*	B/B_{msy}
Glyptocephalus cynoglossus	wit-nsea	2014	3,234	2,646	0.82	0.24	0.24	0.19	0.77	13,265	14,171	1.07
Dicentrarchus labrax	Bss-47	2015	4,427	2,839	0.64	0.21	0.19	0.29	**1.57**	21,576	9,739	**0.45**
Gadus morhua	cod-347d	2015	275,129	52,313	0.19	0.22	0.22	0.07	0.30	1,243,858	793,185	0.64
Gadus morhua	cod-kat	2015	14,268	508	0.04	0.26	0.20	0.02	0.12	54,347	21,117	**0.39**
Melanogrammus aeglefinus	had-346a	2014	250,593	46,320	0.18	0.22	0.09	0.19	**2.11**	1,145,354	239,806	**0.21**
Pollachius pollachius	pol-nsea	2015	4,226	1,980	0.47	0.31	0.24	0.37	**1.53**	13,796	5,403	**0.39**
Pollachius virens	sai-3a46	2015	201,609	83,310	0.41	0.26	0.26	0.14	0.53	773,953	607,491	0.78
Merlangius merlangus	whg-47d	2015	116,483	33,188	0.28	0.37	0.26	0.30	**1.18**	314,073	109,250	**0.35**
Merlangius merlangus	whg-kask	2014	25,254	1,018	0.04	0.23	0.06	0.07	**1.10**	109,631	14,830	**0.14**
Clupea harengus	her-47d3	2015	728,525	494,099	0.68	0.49	0.49	0.21	0.43	1,487,603	2,352,568	1.58
Trachurus trachurus	hom-nsea	2014	28,197	13,388	0.47	0.24	0.14	0.39	**2.78**	118,403	34,588	**0.29**
Trisopterus esmarkii	nop-34-oct	2014	203,852	44,200	0.22	0.45	0.29	0.31	**1.06**	452,751	144,669	**0.32**
Sprattus sprattus	spr-kask	2015	67,260	13,276	0.20	0.23	0.05	0.43	**9.14**	295,039	30,653	**0.10**
Sprattus sprattus	spr-nsea	2015	336,761	290,380	0.86	0.23	0.23	0.17	0.75	1,454,168	1,671,853	1.15

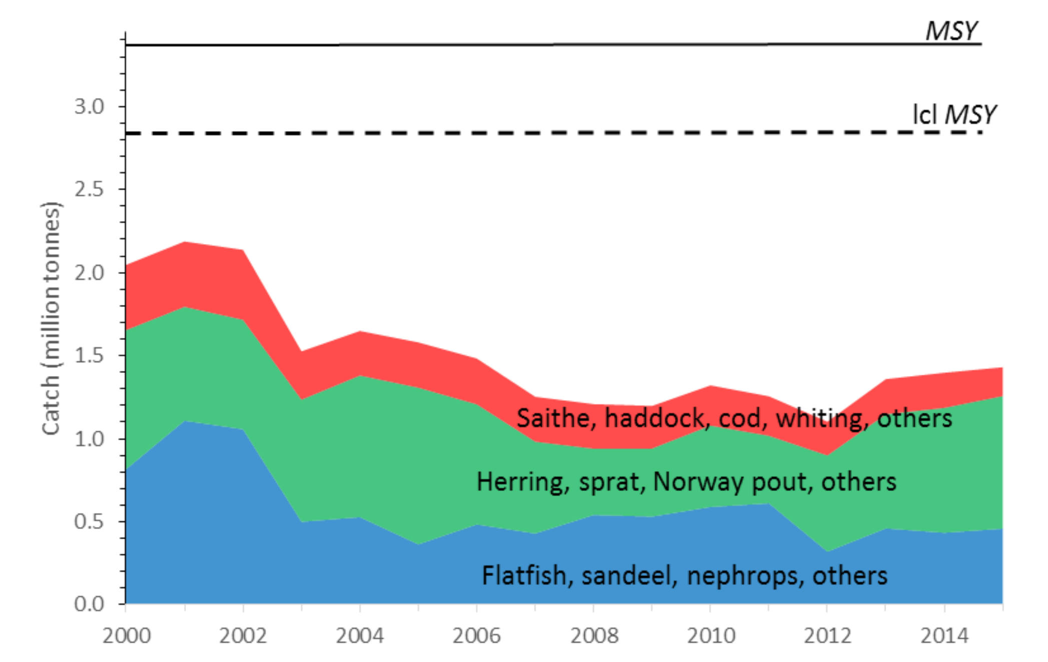


Figure 27. Cumulative catches, including discards and recreational catch if available, for 45 stocks in the Greater North Sea, with indication of main functional groups. The black line indicates the maximum sustainable yield (MSY) for the ecoregion and the dashed line indicates the lower 95% confidence limit as a precautionary target. [NorthSea_Sep23_2016.xlsx]

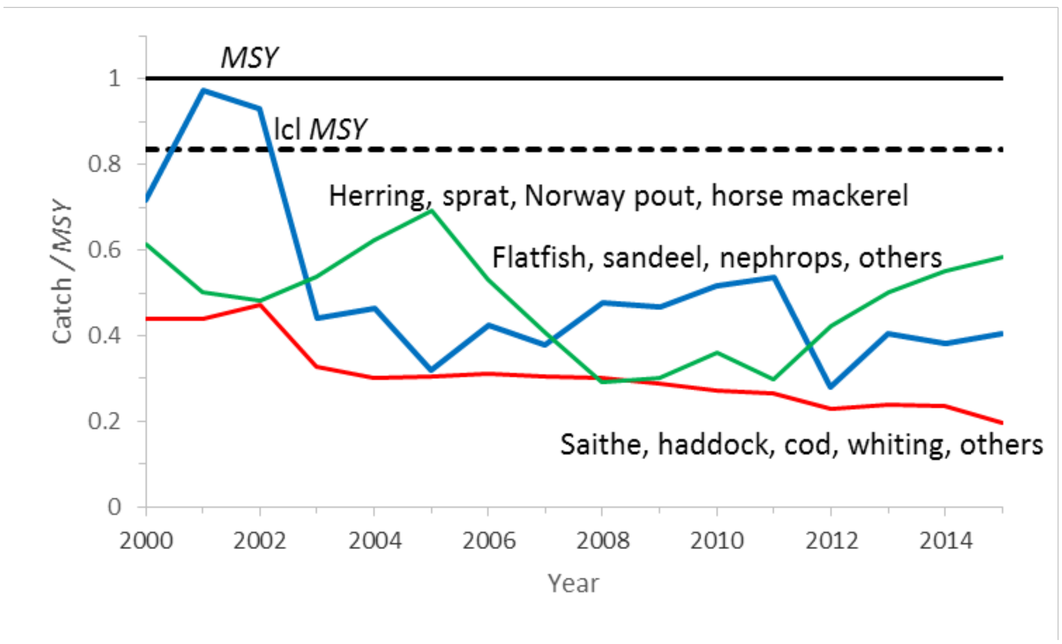


Figure 28. Catches by main functional group relative to their maximum sustainable yield (MSY, black line), for 45 stocks in the Greater North Sea. All groups could provide higher catches under sustainable management. [NorthSea_Sep23_2016.xlsx]

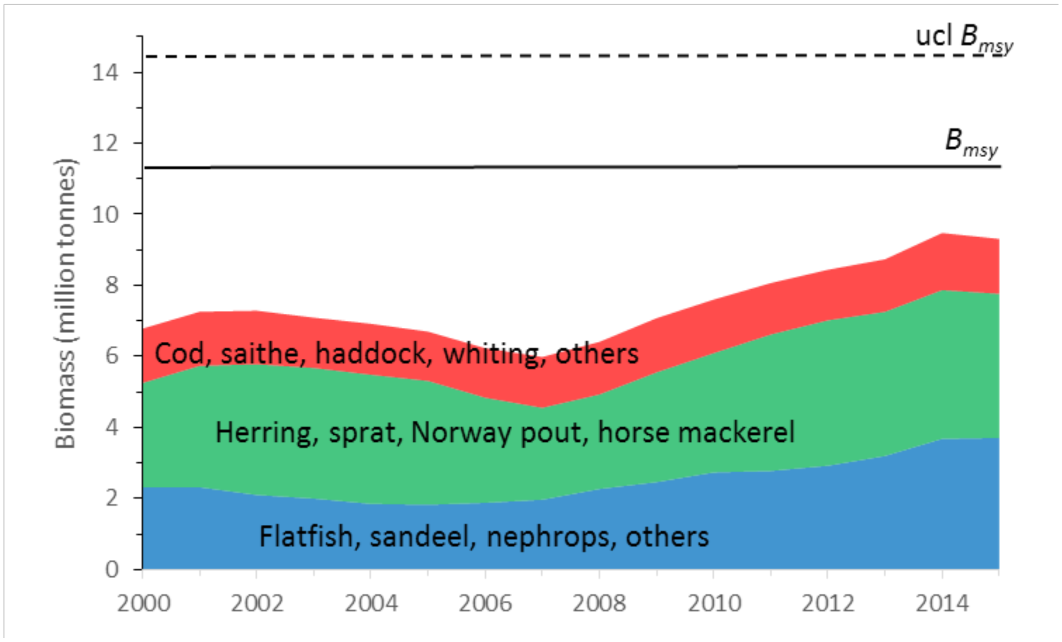


Figure 29. Cumulative total biomass of 45 stocks in the Greater North Sea relative to the biomass that can produce the maximum sustainable yield (B_{msy} = black line). The upper 95% confidence limit of B_{msy} (dashed line) would present a precautionary target biomass above B_{msy}. This is also the area where the maximum economic yield could be obtained. The functional groups of large predators (red), pelagic plankton feeders (green), and benthic organisms (blue) are indicated, with listing of main species. [NorthSea_Sep23_2016.xlsx]

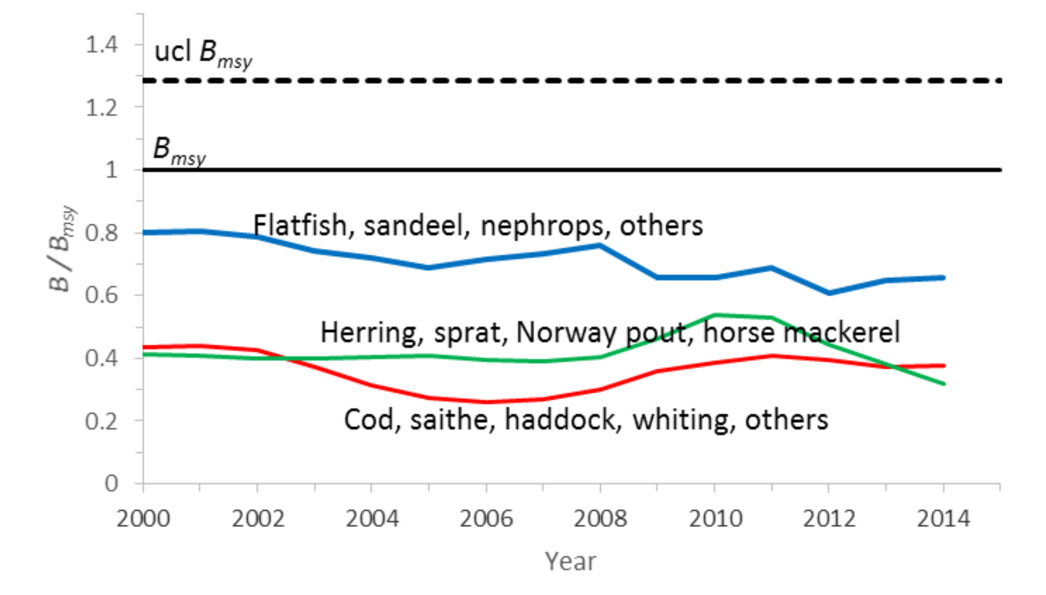


Figure 30. Median biomass relative to the level that can produce the maximum sustainable yield (B/B_{msy}) for 45 stocks in the Greater North Sea assigned to main functional groups. All functional groups are well below the MSY-level, with no visible trend of increase. [NorthSea_Sep23_2016.xlsx]

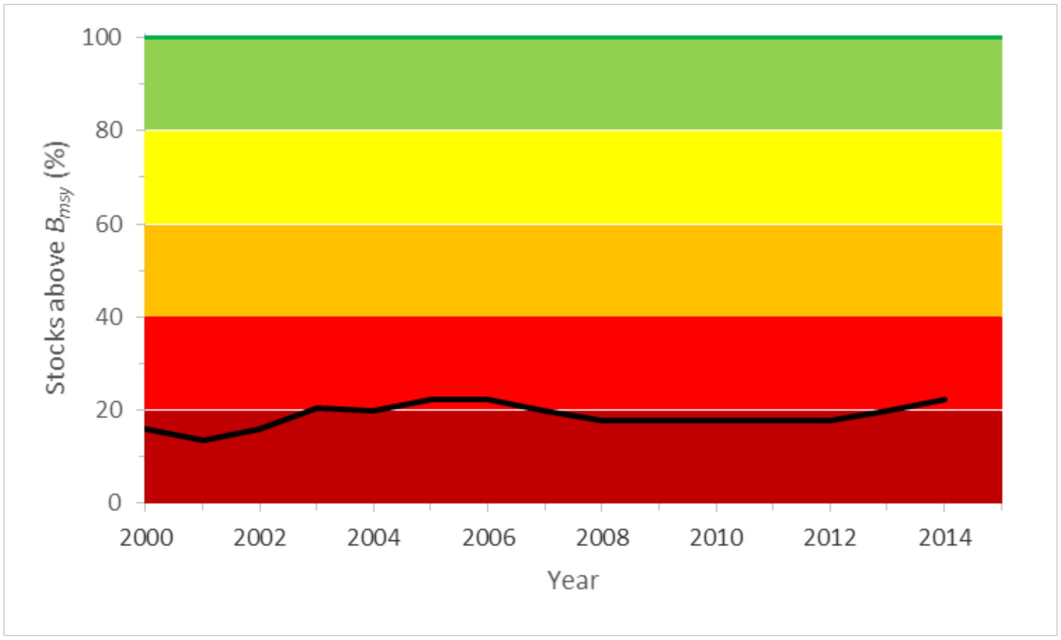


Figure 31. Percentage of stocks where biomass is above the level that can produce the maximum sustainable yield (B_{msy}) for 45 stocks in the Greater North Sea (black curve). The colors indicate visually the compliance with the goals of the Common Fisheries Policy, where all stocks shall be above 100% B_{msy} eventually. In 2014, only 22% of the stocks fulfilled that requirement. [NorthSea_Sep23_2016.xlsx]

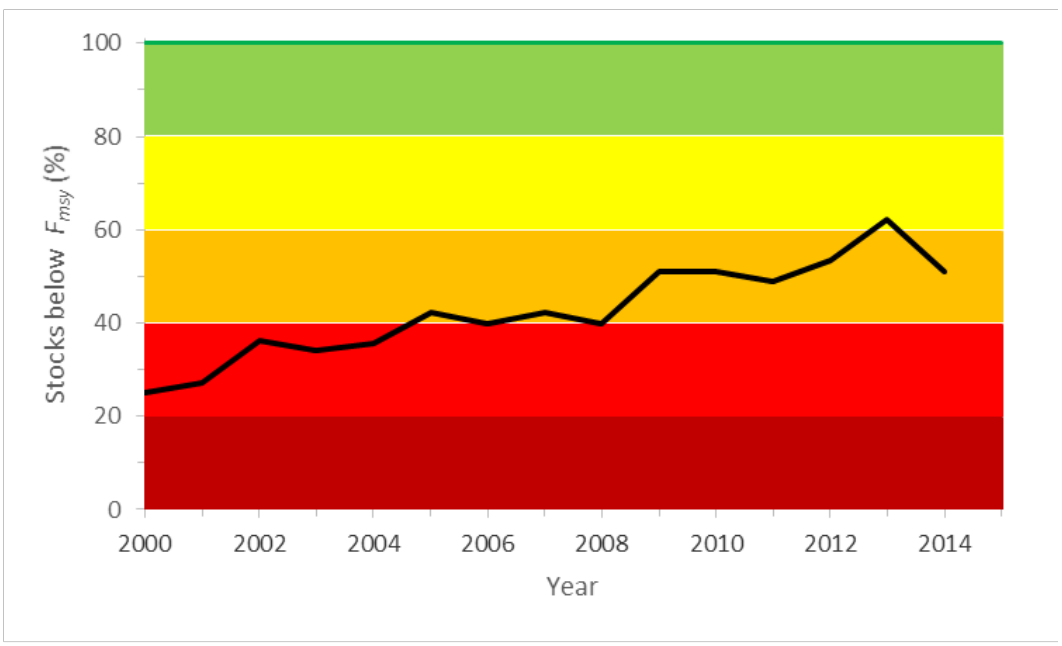


Figure 32. Percentage of stocks where fishing pressure is at or below the maximum sustainable level (F_{msy}) for 45 stocks in the Greater North Sea (black curve). The colors indicate visually the compliance with the goals of the Common Fisheries Policy, where all stocks (100%) shall be fished at or below F_{ms} in 2015, latest in 2020. In 2014, 50% of the stocks fulfilled that requirement. [NorthSea_Sep23_2016.xlsx]

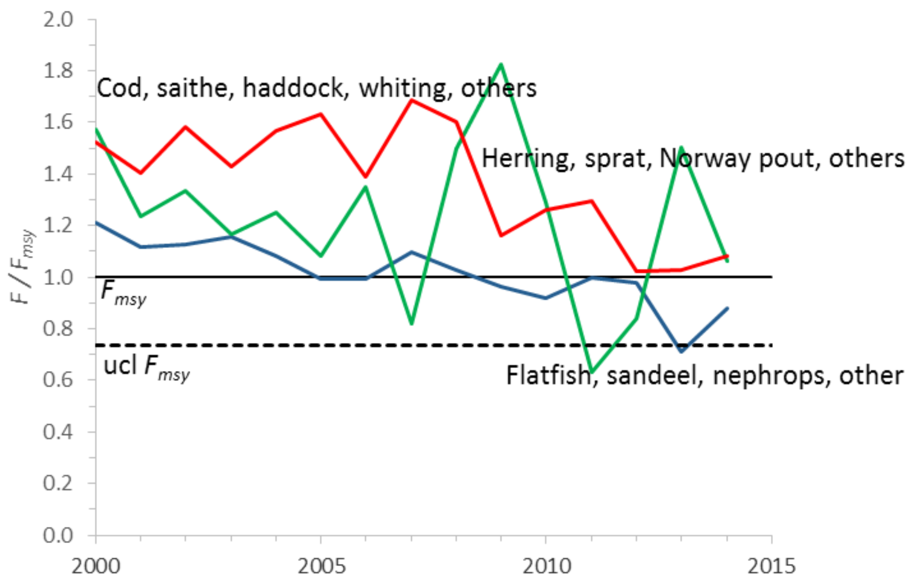


Figure 33. Median fishing pressure relative to the maximum sustainable level (F/F_{msy}) for 45 stocks in the Greater North Sea assigned to main functional groups. The median fishing pressure for these groups is near the MSY-level in recent years, with about 50% of the stocks continuing to be overfished. [NorthSea_Sep23_2016.xlsx]

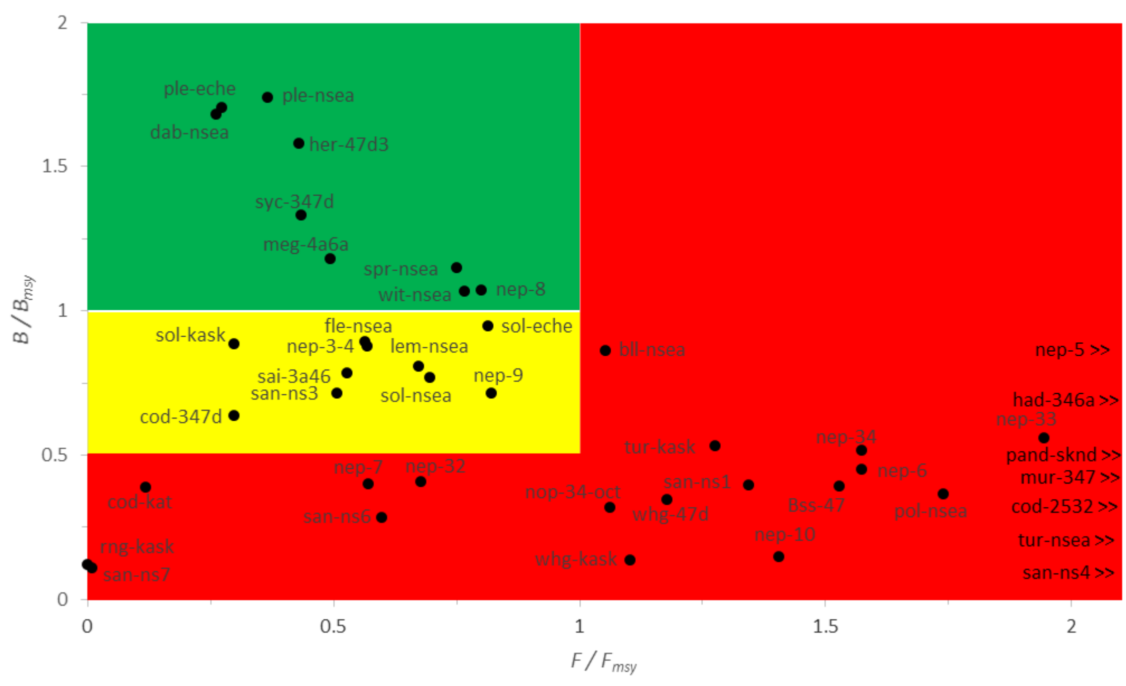


Figure 34. Presentation of 45 Greater North Sea stocks in a pressure (F/F_{msy}) – state (B/B_{msy}) plot. The red area indicates stocks that are being overfished or are outside of safe biological limits. The yellow area indicates recovering stocks. The green area indicates stocks subject to sustainable fishing pressure and of a healthy stock size. Several stocks (some indicated by ->>) are not displayed because they are fished beyond the upper limit of the X-axis. *[NorthSea_Sep23_2016.xlsx]*

Baltic Sea

The following two paragraphs were taken from the ICES Advice 2008, Book 8,

http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2008/2008/8%201-8%202%20Baltic%20ecosystem%20overview.pdf.

"The Baltic Sea is one of the largest brackish areas in the world. It receives fresh water from a number of larger and smaller rivers while salt water enters from the North Sea along the bottom of the narrow straits between Denmark and Sweden. This creates a salinity gradient from southwest to northeast and a water circulation characterized by the inflow of saline bottom water and a surface current of brackish water flowing out of the area.

The Baltic Sea is characterized by large areas (ca 30%) that are less than 25 m deep, interspersed by a number of deeper basins with a maximum depth of 459 m. The Gulf of Bothnia and the Gulf of Riga are internal fjords, while the Baltic Proper and the Gulf of Finland feature several deep basins separated by sills. The western and northern parts of the Baltic have rocky bottoms and extended archipelagos, while the bottom in the central, southern, and eastern parts consists mostly of sandy or muddy sediment."

ICES assessment reports published in 2016 and with data until 2015 were analyzed for 20 stocks in the Baltic Sea. The graphs below summarize their status and exploitation level within an MSY-framework. Wide ranging species such as European eel (*Anguilla anguilla*) or summer guests such as Atlantic mackerel (*Scomber scombrus*) are not included and are analyzed separately. The list of species and their current exploitation and status is summarized in Table 8. Detailed assessments for every stock are available in Appendix 1 and in the spreadsheet Baltic_Sep21_2016_4.xlsx.

Of the 20 stocks, 8 (40%) were subject to ongoing overfishing ($F > F_{msy}$) and 9 stocks (45%) were outside of safe biological limits ($B < 0.5\ B_{msy}$). In three stocks (15%) catches exceeded the maximum sustainable yield ($C/MSY > 1$). Five stocks (25%) were in critical condition, defined by being outside of safe biological limits and subject to overfishing (marked red in Table 8). Altogether, 8 stocks (40%) were subject to unsustainable exploitation (catch > *MSY* or $F > F_{msy}$ or $B < 0.2\ B_{msy}$), with the too high catches marked red in Table 8. Five stocks (25%) could be considered healthy, defined by not being subject to overfishing and having a biomass above the one that can produce the maximum sustainable yield.

Summed biomass of the 20 stocks of 3 million tonnes in 2015 was well below the biomass level of 4 million tonnes that can produce maximum yields. Summed catches of 685 thousand tonnes were well below (72%) the summed maximum sustainable yield of 958 thousand tonnes. Because of trophic interactions it is not possible to achieve *MSY* simultaneously for all stocks, but sustained catches of near the lower confidence limit or near 90% of *MSY* (whichever is lower) would be possible if all stocks have recovered above *Bmsy*. Because of more fish in the water, such catches could be obtained with much less fishing effort and much less impact on the ecosystem. See legends of Figures for more comments.

Table 8. Analysis of 20 stocks in the Baltic Sea, with indication of last year with available data (Year), maximum sustainable yield (MSY), absolute and relative catch (Catch, C/MSY), maximum sustainable fishing mortality (F_{msy}) if the stock is within safe biological limits ($B/B_{msy} > 0.5$), $F_{msy\ cur}$ applicable for current stock size, relative $F/F_{msy\ cur}$ for current stock size, biomass that can produce MSY (B_{msy}), and relative biomass (B/B_{msy}). Scientific names of healthy stocks where $F/F_{msy\ cur} < 1$ and $B/B_{msy} > 1$ are marked green and stocks outside of safe biological limits ($B/B_{msy} < 0.5$) with ongoing overfishing ($F/F_{msy} > 1$) are marked red. Unsustainable catches above MSY are marked bold (C/MSY > 1). Overfishing with $F/F_{msy\ cur} > 1$ is marked bold. Stock sizes outside safe biological limits (B/Bmsy < 0.5) are marked bold. Unsustainable catches (catch > MSY, F > Fmsy, B < 0.2 Bmsy) are marked red. Catches are given in tonnes per year. Biomass is given in tonnes as average total biomass during the year. Species are sorted by functional groups as indicated by the color of the stock IDs: benthic fish & invertebrates (blue), large predators (red) and pelagic plankton feeders (green). [Baltic_Sep21_2016_4.xlsx]

Scientific name	Stock	Year	*MSY*	Catch	*C/MSY*	F_{msy}	$F_{msy\ cur}$	*F*	$F/F_{msy\ cur}$	B_{msy}	*B*	B/B_{msy}
Scophthalmus rhombus	bll-2232	2015	79	40	0.51	0.24	0.24	0.22	0.93	335	182	0.54
Limanda limanda	dab-2232	2015	1,975	1,268	0.64	0.44	0.44	0.22	0.49	4,523	5,873	1.30
Platichthys flesus	fle-2223	2015	2,571	1,130	0.44	0.22	0.22	0.06	0.26	11,676	19,547	1.67
Platichthys flesus	fle-2425	2015	18,253	11,090	0.61	0.32	0.32	0.14	0.42	56,464	81,976	1.45
Platichthys flesus	fle-2628	2015	4,080	4,443	**1.09**	0.25	0.21	0.65	**3.03**	16,091	6,821	**0.42**
Platichthys flesus	fle-2732	2015	1,394	176	0.13	0.28	0.08	0.23	**2.71**	5,022	766	**0.15**
Pleuronectes platessa	ple-2123	2015	4,752	2,687	0.57	0.38	0.38	0.17	0.44	12,585	16,183	1.29
Pleuronectes platessa	ple-2432	2015	3,567	647	0.18	0.25	0.25	0.03	0.11	14,323	23,561	1.65
Scophthalmus maximus	tur-2232	2015	891	234	0.26	0.34	0.27	0.23	0.84	2,608	1,034	**0.40**
Gadus morhua	cod-2224	2015	51,624	11,982	0.23	0.29	0.15	0.25	**1.67**	179,401	47,258	**0.26**
Gadus morhua	cod-2532	2015	117,100	43,670	0.37	0.30	0.17	0.40	**2.43**	392,575	108,788	**0.28**
Salmo salar	sal-2231	2015	2,968	790	0.27	0.20	0.16	0.13	0.85	15,123	5,978	**0.40**
Salmo salar	sal-32	2015	416	62	0.15	0.21	0.10	0.14	**1.42**	1,973	452	**0.23**
Salmo trutta	trt-bal	2015	1,902	189	0.10	0.23	0.10	0.10	0.99	8,342	1,865	**0.22**
Clupea harengus	her-2532-gor	2015	222,165	174,433	0.79	0.23	0.23	0.18	0.82	983,367	947,051	0.96
Clupea harengus	her-30	2015	67,302	110,415	**1.64**	0.18	0.18	0.19	**1.05**	367,702	573,209	1.56
Clupea harengus	her-31	2015	6,734	4,527	0.67	0.27	0.27	0.26	0.96	24,655	17,249	0.70
Clupea harengus	her-3a22	2015	130,784	37,491	0.29	0.22	0.21	0.13	0.63	600,298	286,158	**0.48**
Clupea harengus	her-riga	2015	31,023	32,851	**1.06**	0.23	0.23	0.27	**1.14**	132,836	123,315	0.93
Sprattus sprattus	spr-2232	2015	288,905	247,000	0.85	0.24	0.24	0.31	**1.29**	1,200,389	795,911	0.66

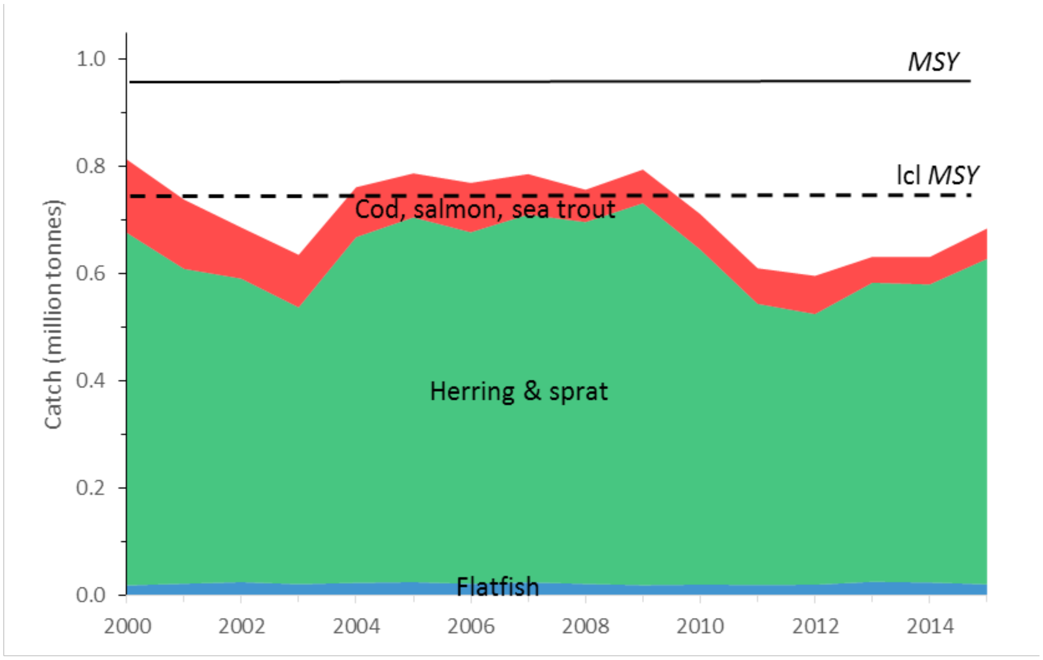


Figure 35. Cumulative catches, including discards and recreational catch if available, for 20 stocks in the Baltic Sea, with indication of main functional groups of large predators (red), pelagic plankton feeders (green) and benthic fish and invertebrates (blue), with indication of main species in this area. The black line indicates the cumulative maximum sustainable yield (MSY) for the ecoregion and the dashed line indicates the lower 95% confidence limit as a precautionary target. [Baltic_Sep21_2016_4.xlsx]

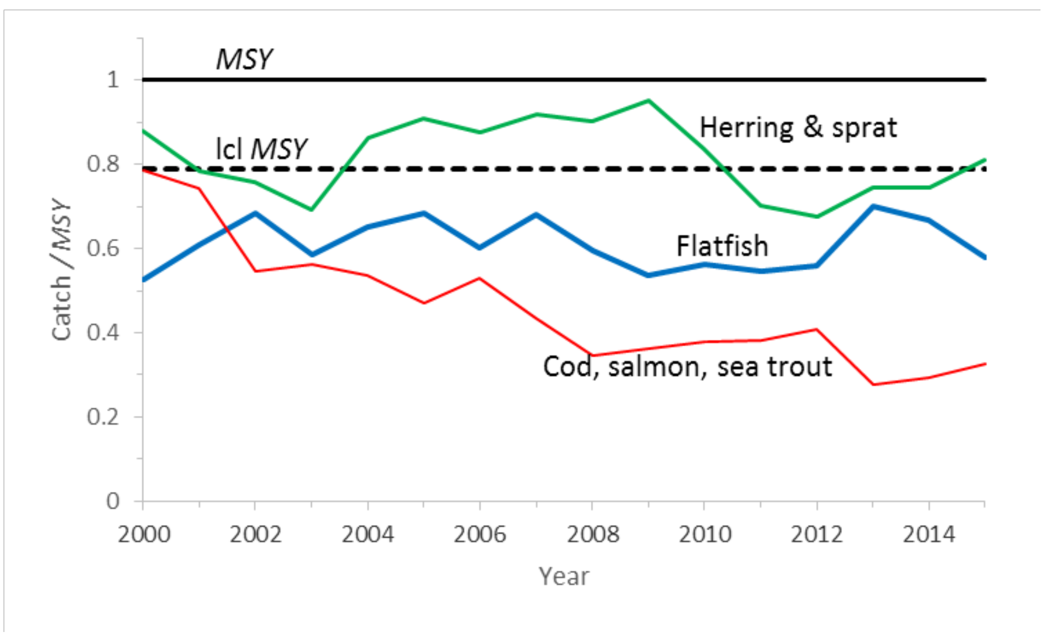


Figure 36. Catches by main functional group relative to their maximum sustainable yield (MSY, black line), for 20 stocks in the Baltic Sea. Pelagic plankton feeders (here only sprat and herring, green curve) supported catches around the precautionary over all lower 95% confidence limit of MSY (dashed line). Benthic organisms (here only flatfish, blue curve) supported catches below but near the precautionary level. Since 2002, the low biomass (see below) of large predators (here cod, salmon and sea trout, red curve) produced catches well below precautionary sustainable levels. [Baltic_Sep21_2016_4.xlsx]

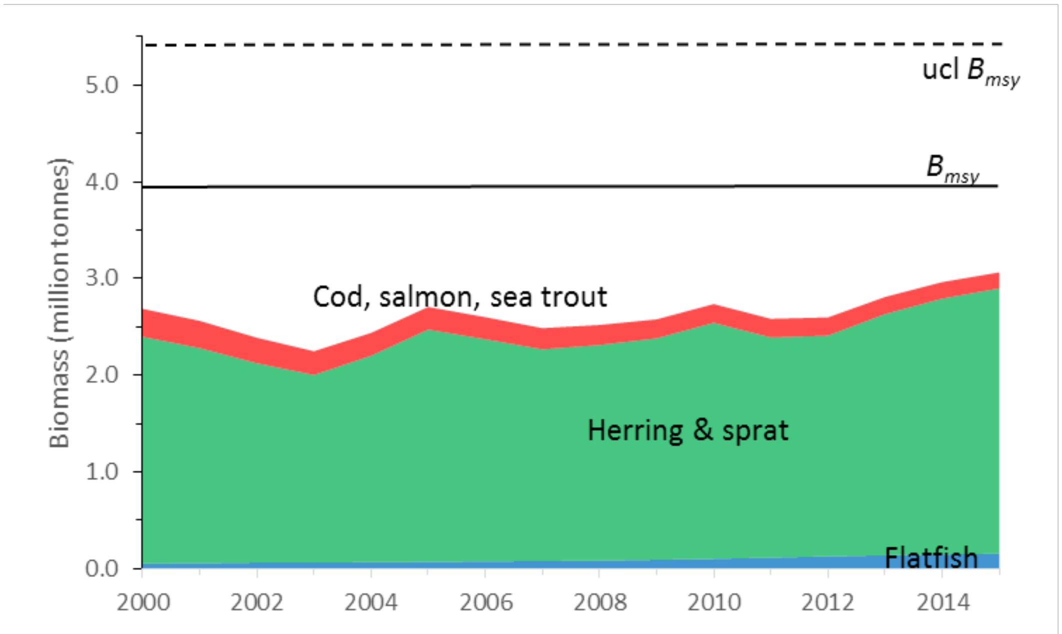


Figure 37. Cumulative total biomass of 20 stocks in the Baltic Sea relative to the biomass that can produce the maximum sustainable yield (B_{msy} = black line). The upper 95% confidence limit of B_{msy} (dashed green line) would present a precautionary target biomass above B_{msy}. This is also the area where the maximum economic yield could be obtained. The functional groups of large predators (red), pelagic plankton feeders (green), and benthic organisms (blue) are indicated, with listing of main species. Note that flatfish have nearly tripled their biomass from 56,000 tonnes in 2000 to 152,000 tonnes in 2014. [Baltic_Sep21_2016_4.xlsx]

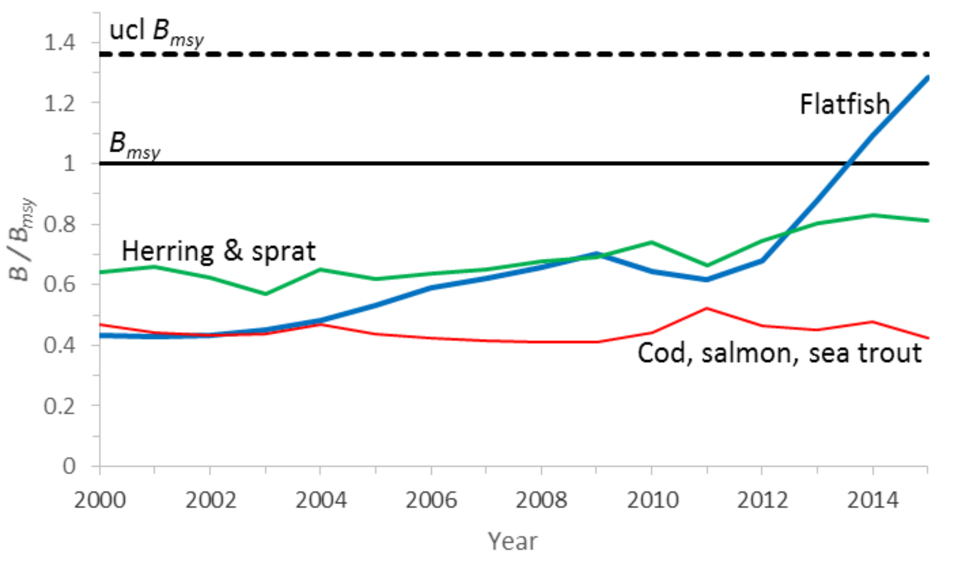


Figure 38. Median biomass relative to the level that can produce the maximum sustainable yield (B/B_{msy}) for 20 stocks in the Baltic Sea assigned to main functional groups. Large predators (red curve) and pelagic plankton feeders (green curve) have biomass levels well below B_{msy}, without a clear upward trend. In contrast, benthic organisms (here only flatfish, blue curve) have recovered well in recent years and are approaching the precautionary biomass level (over all upper 95% confidence level of B_{msy}, green line). [Baltic_Sep21_2016_4.xlsx]

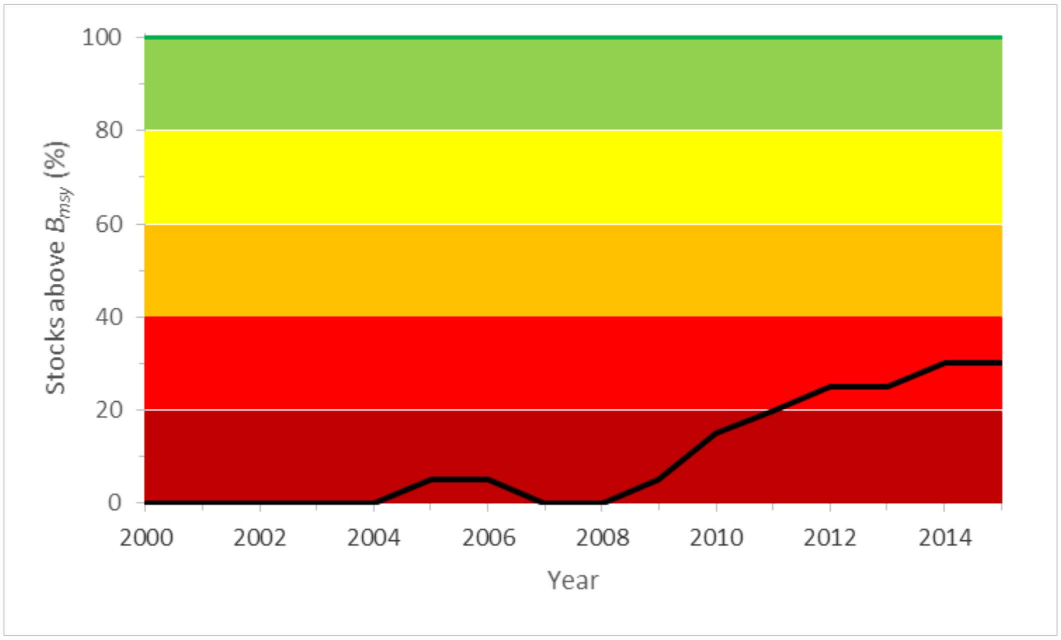


Figure 39. Percentage of stocks where biomass is above the level that can produce the maximum sustainable yield (B_{msy}) for 20 stocks in the Baltic Sea (black curve). The colors indicate visually the compliance with the goals of the Common Fisheries Policy, where all stocks shall be above 100% B_{msy} eventually. In 2015, only 30% of the stocks fulfilled that requirement. [Baltic_Sep21_2016_4.xlsx]

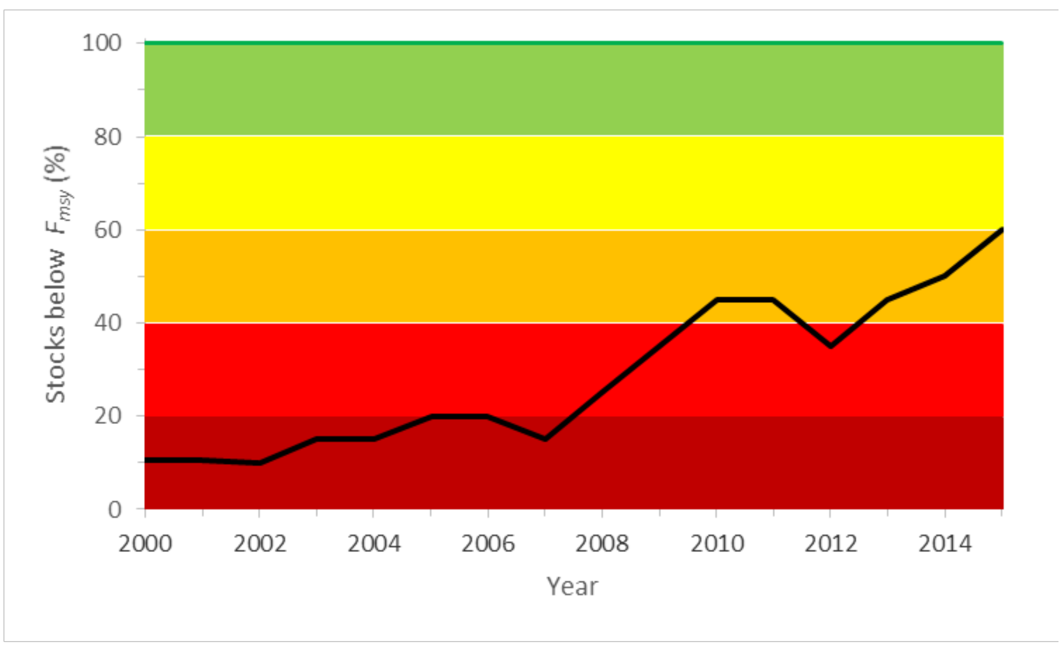


Figure 40. Percentage of stocks where fishing pressure is at or below the maximum sustainable level (F_{msy}) for 20 stocks in the Baltic Sea (black curve). The colors indicate visually the compliance with the goals of the Common Fisheries Policy, where all stocks (100%) shall be fished at or below F_{msy} in 2015, latest in 2020. In 2015, 60% of the stocks fulfilled that requirement. [Baltic_Sep21_2016_4.xlsx]

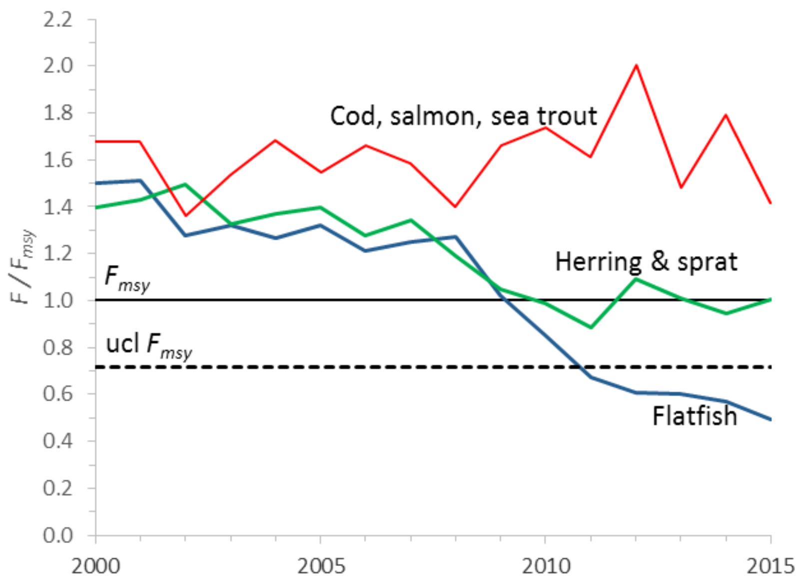


Figure 41. Median fishing pressure relative to the maximum sustainable level (F/F_{msy}, black line) for 20 stocks in the Baltic Sea assigned to main functional groups. Large predators (red curve) are subject to severe overfishing. Pelagic plankton feeders (green curve) were overfished before 2010 and were exploited at the maximum sustainable level afterwards. Flatfish were overfished until 2008 but were exploited below the precautionary sustainable level (median lower 95% confidence limit of F_{msy} across all stocks) since 2011, allowing for the strong increase in biomass after 2012 (see above). [Baltic_Sep21_2016_4.xlsx]

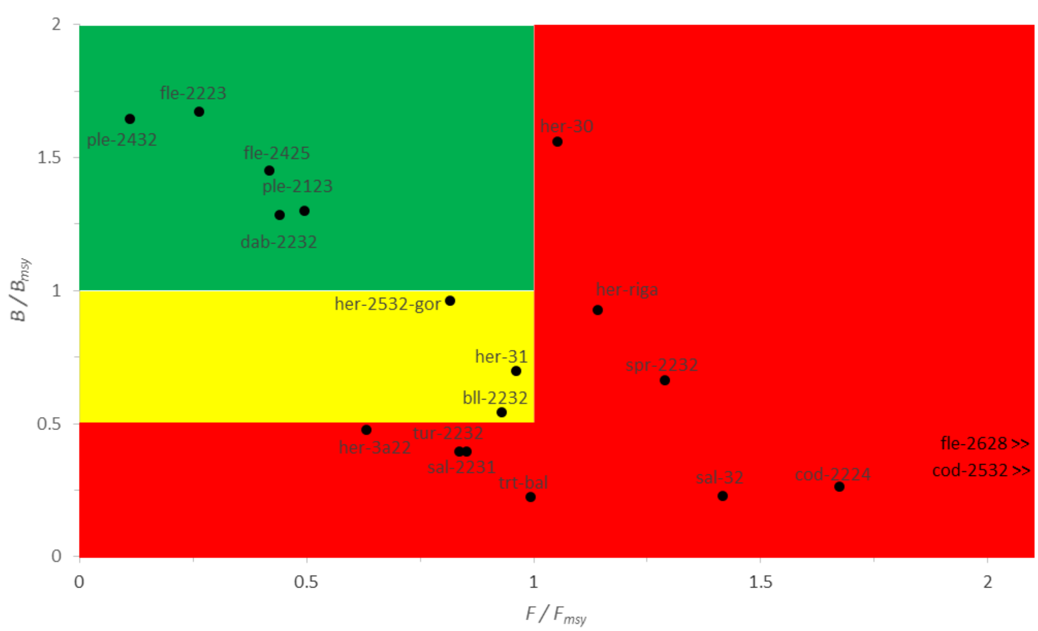


Figure 42. Presentation of 20 Baltic Sea stocks in a pressure (F/F_{msy}) – state (B/B_{msy}) plot. The red area indicates stocks that are being overfished or are outside of safe biological limits. The yellow area indicates recovering stocks. The green area indicates stocks subject to sustainable fishing pressure and of a healthy stock size that can produce high yields close to MSY. Two stocks are off the F/F_{msy} scale, indicated by >>. [Baltic_Sep21_2016_4.xlsx]

Celtic Seas and Rockall

The following paragraph was taken from the ICES Advice 2016, Book 5,

http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2016/2016/Celtic_Sea_Ecoregion-Ecosystem_overview.pdf.

"The Celtic Seas ecoregion covers the northwestern shelf seas of the EU. It includes areas of the deeper eastern Atlantic Ocean and coastal seas that are heavily influenced by oceanic inputs. The ecoregion ranges from north of Shetland to Brittany in the south. Three key areas constitute this ecoregion: the Malin shelf; the Celtic Sea and west of Ireland; the Irish Sea."

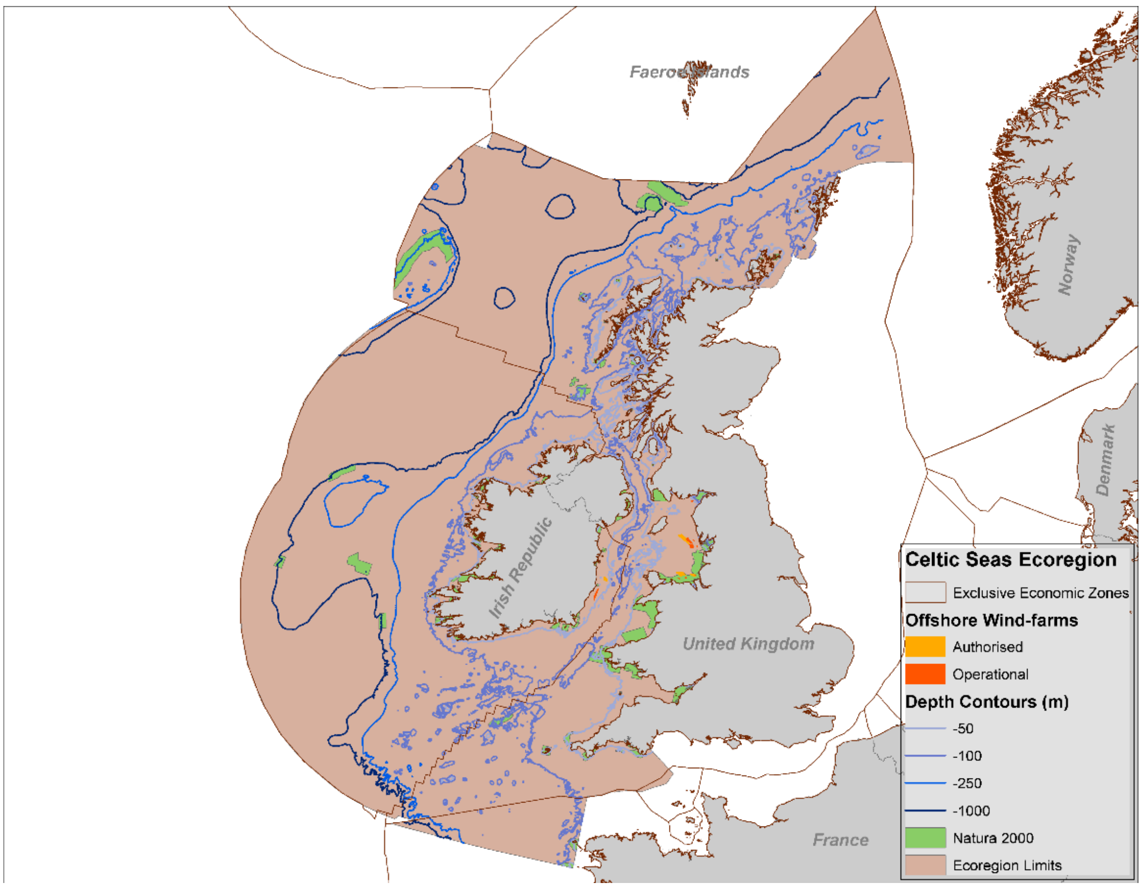


Figure 43. The Celtic Seas ecoregion, showing EEZs, larger offshore Natura 2000 sites, and operational and authorized wind farms. Source: ICES Advice 2016, Book 5.

ICES aassessment reports with data from 2014/2015 were analyzed for 47 stocks in the Celtic Seas and Rockall. The graphs below summarize their status and exploitation level within an MSY-framework. The list of species and their current exploitation and status is summarized in Table 9. Detailed assessments for every stock are available in Appendix 1 and in the spreadsheet CelticSeas_Sep27_2016.xlsx.

Of the 47 stocks, 22 (47%) were subject to ongoing overfishing ($F > F_{msy}$) and 19 stocks (40%) were outside of safe biological limits ($B < 0.5\ B_{msy}$). In three stocks (6%) catches exceeded the maximum sustainable yield (*C/MSY* > 1). Fourteen stocks (30%) were in critical condition, defined by being outside of safe biological limits and subject to overfishing (marked red in Table9). Altogether, 25 stocks (53%) were subject to unsustainable exploitation (catch > *MSY* or $F > F_{msy}$ or $B < 0.2\ B_{msy}$), with the too high catches marked red in Table 9. Only 10 stocks (21%) could be considered as being well managed and in good condition sensu CFP (2013), defined by not being subject to overfishing and having a biomass above the one that can produce the maximum sustainable yield.

Summed biomass of the 47 stocks of 1.3 million tonnes in the last year with available data was below the biomass level of 2.1 million tonnes that can produce maximum yields. Summed catches of 228 thousand tonnes were well below the summed maximum sustainable yield of 475 thousand tonnes. Because of trophic interactions it is not possible to achieve *MSY* simultaneously for all stocks, but sustained catches of near the lower confidence limit or near 90% of *MSY* (whichever is lower) would be possible if all stocks have recovered above *Bmsy*. Because of more fish in the water, such catches could be obtained with much less fishing effort and much less impact on the ecosystem. See legends of Figures for more comments.

Table 9. Analysis of 47 stocks in the Celtic Seas and Rockall waters, with indication of last year with available data (Year), maximum sustainable yield (MSY), absolute and relative catch (Catch, C/MSY), maximum sustainable fishing mortality (F_{msy}) if the stock is within safe biological limits ($B/B_{msy} > 0.5$) , F_{msy} for current stock size, F/F_{msy} for current stock size, biomass that can produce MSY (B_{msy}), relative biomass (B/B_{msy}). Scientific names of healthy stocks where F/Fmsy < 1 and B/Bmsy > 1 are marked green and stocks outside of safe biological limits ($B/B_{msy} < 0.5$) with ongoing overfishing ($F/F_{msy} > 1$) are marked red. Catches above MSY are marked bold (C/MSY > 1). Overfishing with $F/F_{msy} > 1$ is marked bold. Stock sizes outside safe biological limits (B/Bmsy < 0.5) are marked bold. Unsustainable catches (catch > MSY, F > Fmsy, B < 0.2 Bmsy) are marked red. Catches are given in tonnes per year. Biomass is given in tonnes as average total biomass during the year. Species are sorted by functional groups as indicated by the color of the stock IDs: benthic fish & invertebrates (blue), large predators (red) and pelagic plankton feeders (green). [CelticSeas_Sep27_2016.xlsx]

Scientific name	Stock	Year	MSY	Catch	C/MSY	F_{msy}	F_{msy} cur	F	F/F_{msy} cur	B_{msy}	B	B/B_{msy}
Lophius budegassa	anb-78ab	2015	8,174	10,319	**1.26**	0.23	0.23	0.39	**1.65**	34,826	26,630	0.76
Lophius spp.	ang-ivvi	2014	18,276	13,203	0.72	0.19	0.19	0.21	**1.12**	97,171	62,941	0.65
Molva dypterygia	bli-5b67	2015	11,417	2,758	0.24	0.15	0.15	0.05	0.31	74,667	58,573	0.78
Capros aper	boc-nea	2014	89,359	45,231	0.51	0.22	0.11	0.45	**4.03**	403,051	100,983	**0.25**
Lepidorhombus spp.	meg-rock	2014	897	343	0.38	0.33	0.33	0.17	0.50	2,696	2,052	0.76
Lepidorhombus whiffiagonis	mgw-78	2015	19,038	13,076	0.69	0.32	0.32	0.18	0.57	60,180	72,346	1.20
Nephrops norvegicus	nep-11	2014	3,745	3,312	0.88	0.03	0.03	0.04	**1.55**	147,272	84,042	0.57
Nephrops norvegicus	nep-12	2014	4,966	3,394	0.68	0.31	0.31	0.30	0.97	16,032	11,327	0.71
Nephrops norvegicus	nep-13	2014	6,319	6,881	**1.09**	0.30	0.30	0.30	1.00	21,150	22,957	1.09
Nephrops norvegicus	nep-14	2014	750	711	0.95	0.25	0.25	0.29	**1.18**	3,013	2,423	0.80
Nephrops norvegicus	nep-15	2014	10,577	10,013	0.95	0.31	0.31	0.30	0.95	33,947	33,869	1.00
Nephrops norvegicus	nep-16	2014	2,441	1,189	0.49	0.20	0.11	0.35	**3.12**	12,294	3,436	**0.28**
Nephrops norvegicus	nep-17	2014	839	800	0.95	0.19	0.14	0.48	**3.36**	4,446	1,675	**0.38**
Nephrops norvegicus	nep-19	2014	834	468	0.56	0.26	0.26	0.24	0.93	3,208	1,929	0.60
Nephrops norvegicus	nep-2021	2014	2,403	1,837	0.76	0.26	0.26	0.42	**1.63**	9,093	4,398	**0.48**
Nephrops norvegicus	nep-22	2014	2,660	2,615	0.98	0.24	0.24	0.19	0.81	11,120	13,504	1.21
Nephrops norvegicus	nep-oth-6a	2014	362	245	0.68	0.28	0.28	0.32	**1.15**	1,310	770	0.59
Nephrops norvegicus	nep-oth-7	2014	424	174	0.41	0.23	0.18	0.23	**1.26**	1,851	746	**0.40**
Pleuronectes platessa	ple-7b-c	2014	196	23	0.12	0.17	0.07	0.09	**1.28**	1,136	243	**0.21**
Pleuronectes platessa	ple-7h-k	2015	288	33	0.11	0.23	0.05	0.25	**4.95**	1,232	133	**0.11**
Pleuronectes platessa	ple-celt	2015	1,590	381	0.24	0.36	0.36	0.05	0.13	4,413	8,039	1.82
Pleuronectes platessa	ple-echw	2015	2,030	1,424	0.70	0.17	0.17	0.08	0.44	11,718	18,665	1.59
Pleuronectes platessa	ple-iris	2015	2,646	1,004	0.38	0.26	0.26	0.06	0.21	10,005	17,817	1.78

Scientific name	Stock	Year	*MSY*	Catch	*C/MSY*	F_{msy}	$F_{msy\ cur}$	*F*	$F/F_{msy\ cur}$	B_{msy}	*B*	B/B_{msy}
Coryphaenoides rupestris	rng-5b67	2015	6,866	701	0.10	0.12	0.12	0.02	0.19	56,716	31,189	0.55
Pagellus bogaraveo	sbr-678	2015	548	177	0.32	0.22	0.08	0.42	**5.43**	2,441	421	**0.17**
Solea solea	sol-7b-c	2014	57	26	0.46	0.16	0.16	0.15	0.95	349	171	**0.49**
Solea solea	sol-7h-k	2015	548	244	0.44	0.25	0.25	0.14	0.55	2,209	1,788	0.81
Solea solea	sol-celt	2015	1,147	2,714	**2.37**	0.22	0.22	0.83	**3.70**	5,117	3,273	0.64
Solea solea	sol-echw	2015	1,012	772	0.76	0.21	0.21	0.14	0.70	4,934	5,371	1.09
Solea solea	sol-iris	2015	3,145	76	0.02	0.26	0.07	0.05	0.63	12,091	1,670	**0.14**
Brosme brosme	usk-rock	2015	1,100	226	0.21	0.23	0.11	0.19	**1.72**	4,847	1,185	**0.24**
Gadus morhua	cod-7e-k	2015	8,546	4,719	0.55	0.29	0.26	0.36	**1.35**	29,407	13,276	**0.45**
Gadus morhua	cod-iris	2015	9,706	385	0.04	0.32	0.24	0.03	0.14	30,448	11,467	**0.38**
Gadus morhua	cod-rock	2014	1,223	15	0.01	0.29	0.01	0.15	**>10**	4,281	101	**0.02**
Gadus morhua	cod-scow	2014	17,055	1,668	0.10	0.23	0.04	0.30	**8.16**	72,666	5,625	**0.08**
Melanogrammus aeglefinus	had-7b-k	2015	16,690	15,239	0.91	0.22	0.22	0.19	0.88	75,764	78,572	1.04
Melanogrammus aeglefinus	had-iris	2015	3,856	833	0.22	0.39	0.31	0.21	0.69	9,931	3,938	**0.40**
Melanogrammus aeglefinus	had-rock	2015	16,961	2,972	0.18	0.43	0.21	0.31	**1.47**	39,882	9,731	**0.24**
Pollachius pollachius	pol-celt	2014	7,294	5,255	0.72	0.32	0.32	0.37	**1.16**	23,050	14,364	0.62
Merlangius merlangus	whg-7e-k	2015	24,675	19,275	0.78	0.22	0.22	0.13	0.62	113,101	143,529	1.27
Merlangius merlangus	whg-iris	2015	10,212	1,922	0.19	0.29	0.04	0.70	**>10**	35,418	2,749	**0.08**
Merlangius merlangus	whg-scow	2015	15,492	1,062	0.07	0.44	0.17	0.15	0.91	35,568	6,911	**0.19**
Clupea harengus	her-67bc	2015	92,343	19,885	0.22	0.23	0.23	0.08	0.36	404,031	239,415	0.59
Clupea harengus	her-irls	2015	23,754	18,355	0.77	0.31	0.31	0.21	0.65	75,637	89,398	1.18
Clupea harengus	her-nirs	2015	12,512	4,869	0.39	0.26	0.26	0.16	0.63	48,676	29,971	0.62
Sprattus sprattus	spr-celt	2014	5,785	4,392	0.76	0.35	0.35	0.42	**1.21**	16,749	10,514	0.63
Sprattus sprattus	spr-ech	2015	4,577	3,003	0.66	0.29	0.29	0.14	0.47	15,583	21,810	1.40

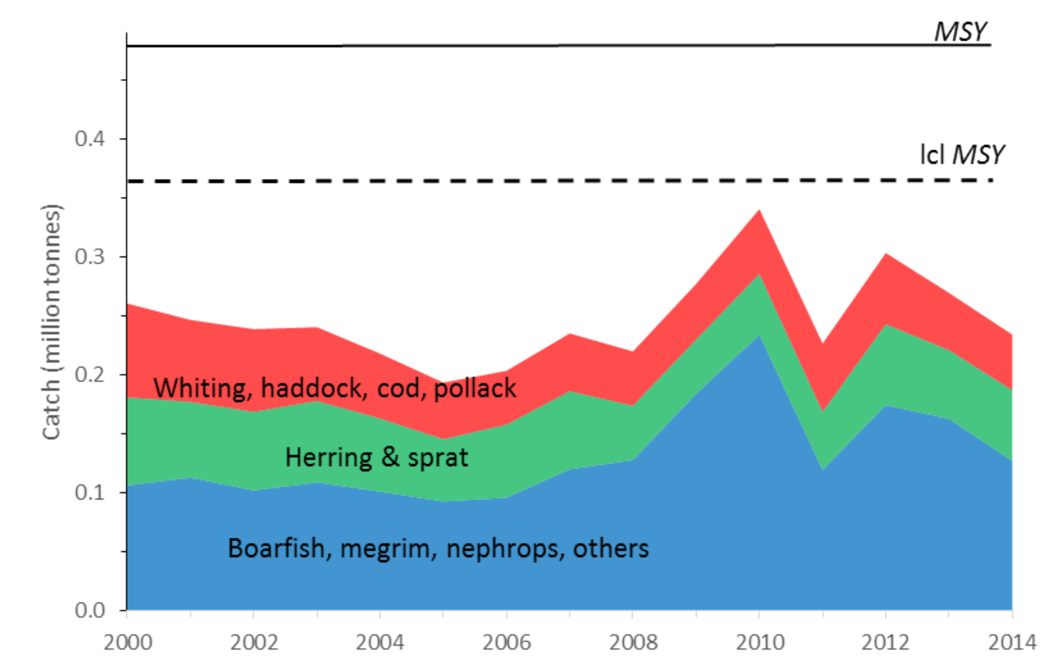


Figure 44. Cumulative catches, including discards and recreational catch if available, for 47 stocks in the Celtic Seas and Rockall, with indication of main functional groups. The black line indicates the maximum sustainable yield (MSY) for the ecoregion and the dashed line indicates the lower 95% confidence limit as a precautionary target. [CelticSeas_Sep27_2016.xlsx]

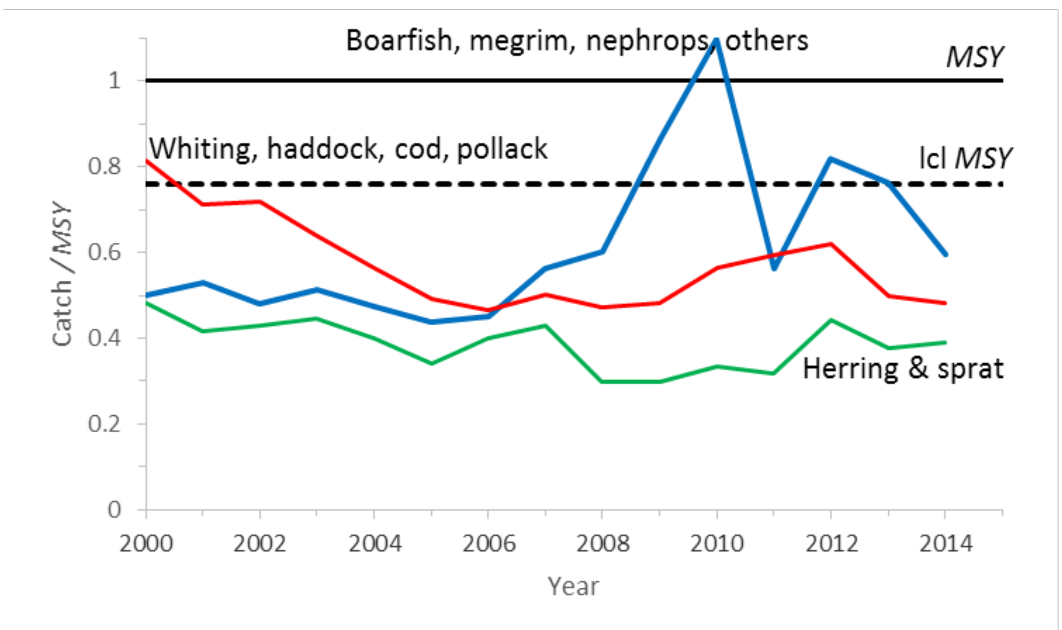


Figure 45. Catches by main functional group relative to their maximum sustainable yield (MSY, black line), for 47 stocks in the Celtic Seas and Rockall. Large predators (red line) could support higher catches after rebuilding of the stocks. [CelticSeas_Sep27_2016.xlsx]

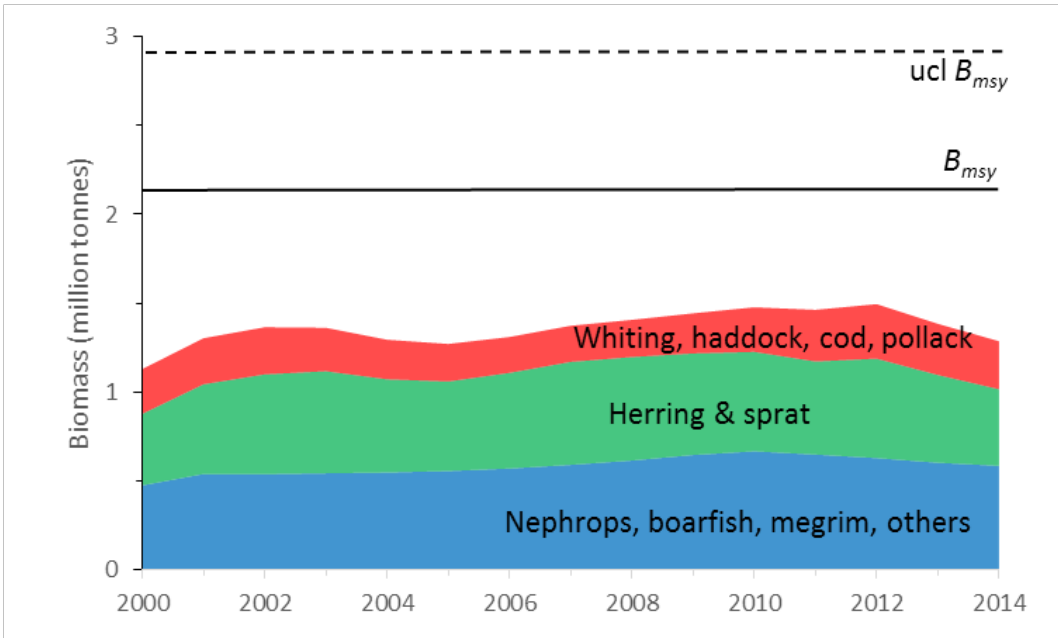


Figure 46. Cumulative total biomass of 47 stocks in the Celtic Seas and Rockall relative to the biomass that can produce the maximum sustainable yield (B_{msy} = black line). The upper 95% confidence limit of B_{msy} (dashed line) would present a precautionary target biomass above B_{msy}. This is also the area where the maximum economic yield could be obtained. The functional groups of benthic organisms (blue), pelagic plankton feeders (green) and large predators (red), are indicated, with listing of main species. Exploited biomass in the ecoregion is well below the MSY level. [CelticSeas_Sep27_2016.xlsx]

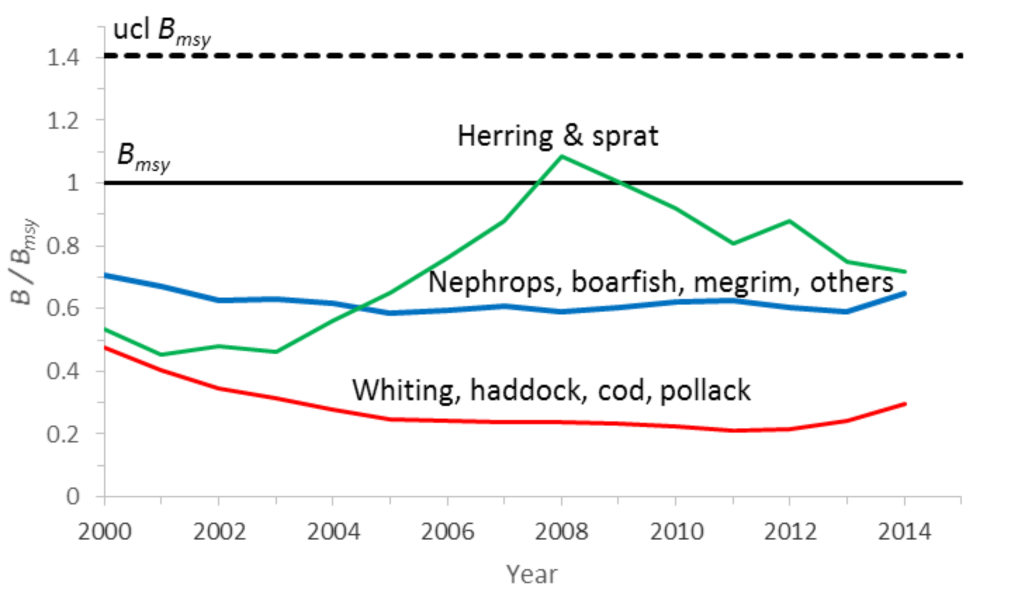


Figure 47. Median biomass relative to the level that can produce the maximum sustainable yield (B/B_{msy}) for 47 stocks in the Celtic Seas and Rockall assigned to main functional groups. Biomass of all functional groups is well below the MSY-level in recent years. [CelticSeas_Sep27_2016.xlsx]

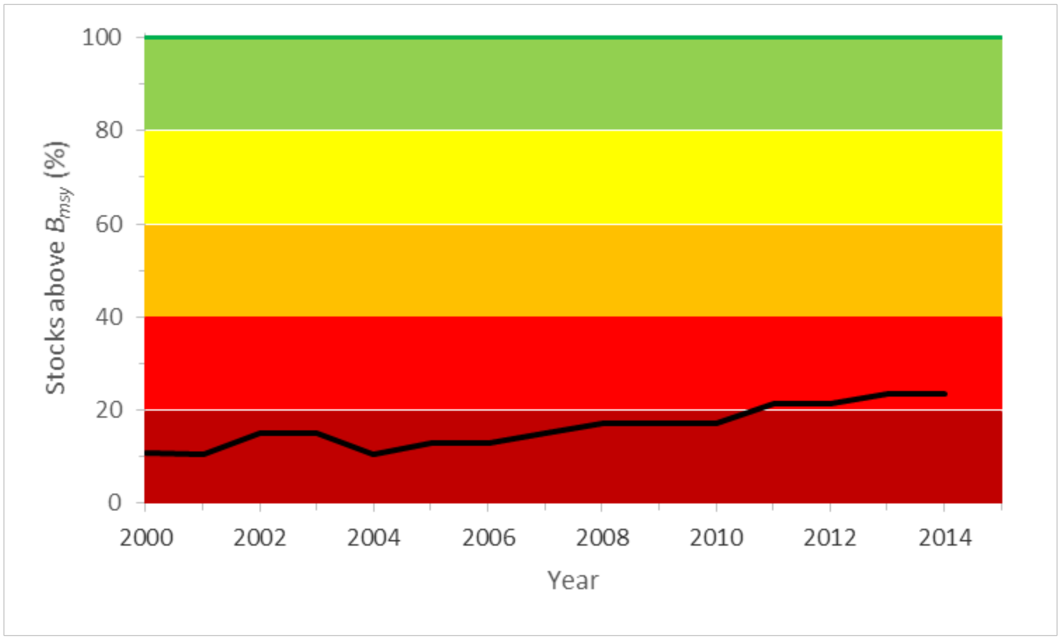


Figure 48. Percentage of stocks where biomass is above the level that can produce the maximum sustainable yield (B_{msy}) for 47 stocks in the Celtic Seas and Rockall (black curve). The colors indicate visually the compliance with the goals of the Common Fisheries Policy, where all stocks (100%) shall be above B_{msy} eventually. In 2014, only 23% of the stocks fulfilled that requirement. [CelticSeas_Sep27_2016.xlsx]

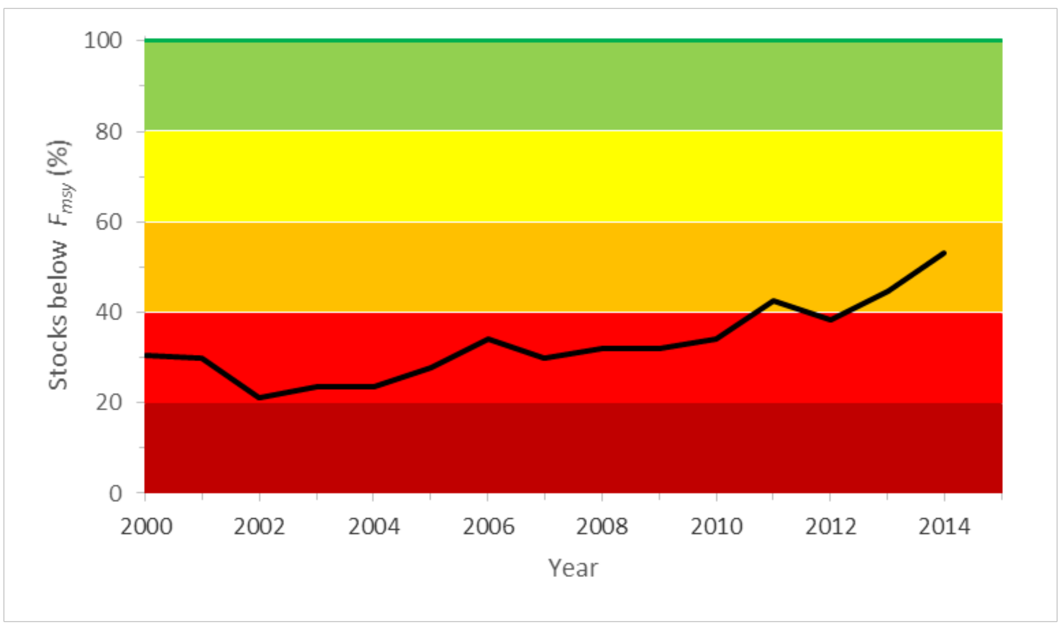


Figure 49. Percentage of stocks where fishing pressure is at or below the maximum sustainable level (F_{msy}) for 47 stocks in the Celtic Seas and Rockall (black curve). The colors indicate visually the compliance with the goals of the Common Fisheries Policy, where all stocks (100%) shall be fished at or below F_{msy} in 2015, latest in 2020. In 2014, 53% of the stocks fulfilled that requirement. [CelticSeas_Sep27_2016.xlsx]

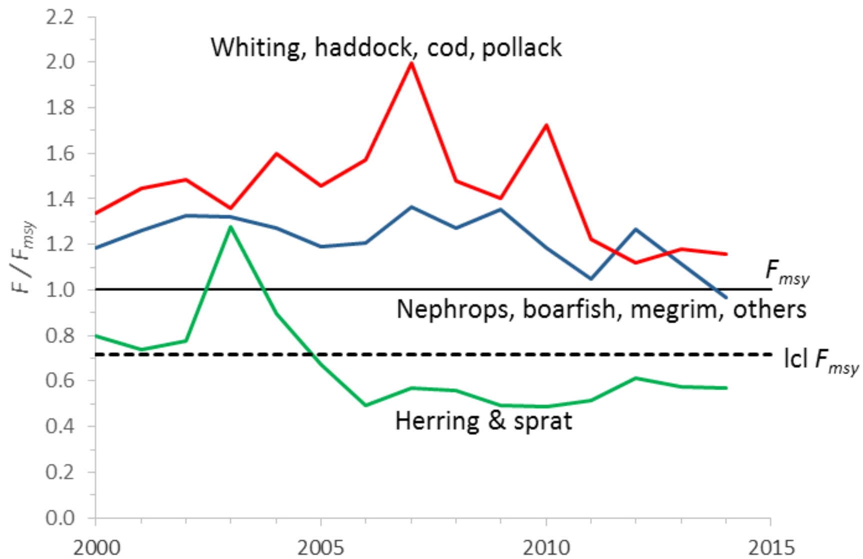


Figure 50. Median fishing pressure relative to the maximum sustainable level (F/F_{msy}) for 47 stocks in the Celtic Seas and Rockall assigned to main functional groups. While the fishing pressure on pelagic plankton feeders (green curve) seems adequate for these key-stone species, the fishing pressure for large predators and benthic organisms is still above the MSY-level in recent years. [CelticSeas_Sep27_2016.xlsx]

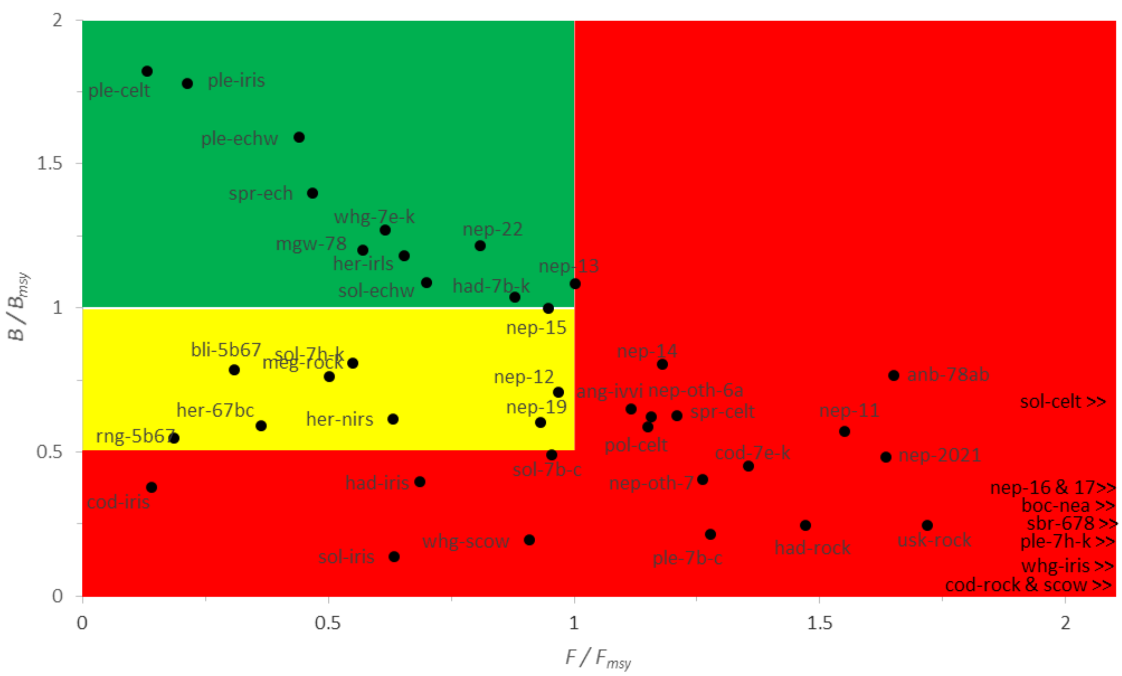


Figure 51. Presentation of 47 stocks from the Celtic Seas and Rockall in a pressure (F/F_{msy}) – state (B/B_{msy}) plot. The red area indicates stocks that are being overfished or are outside of safe biological limits. The yellow area indicates recovering stocks. The green area indicates stocks subject to sustainable fishing pressure and of a healthy stock size. Several stocks (indicated by ->>) are exploited above the upper limit of the X-axis. [CelticSeas_Sep27_2016.xlsx]

Bay of Biscay and Iberian Sea, including Azores

The following paragraph describing the Bay of Biscay and the Iberian Coast Sea was taken from the ICES Advice 2016, Book 7,

http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2016/2016/Bay_of_Biscay_and_the%20Iberian%20Coast%20Ecoregion%20-Ecosystem%20overview.pdf.

"The ICES Bay of Biscay and the Iberian Coast ecoregion covers the southwestern shelf seas and adjacent deeper eastern Atlantic Ocean waters of the EU. The ecoregion includes waters from Brittany to the Gulf of Cadiz; four key areas constitute the ecoregion:

- the Bay of Biscay, characterized by a wide shelf extending west of France. Upwelling events occur in summer off southern Brittany and low-salinity water lenses are associated with the river outflows of the Landes coastline;
- the northern Iberian Shelf, characterized by a narrow shelf with summer upwelling events off Galicia;
- the western Iberian Shelf, characterized by a narrow shelf west of Portugal with summer upwelling events;
- the Gulf of Cadiz, characterized by a wider shelf strongly influenced by input of warm Mediterranean waters."

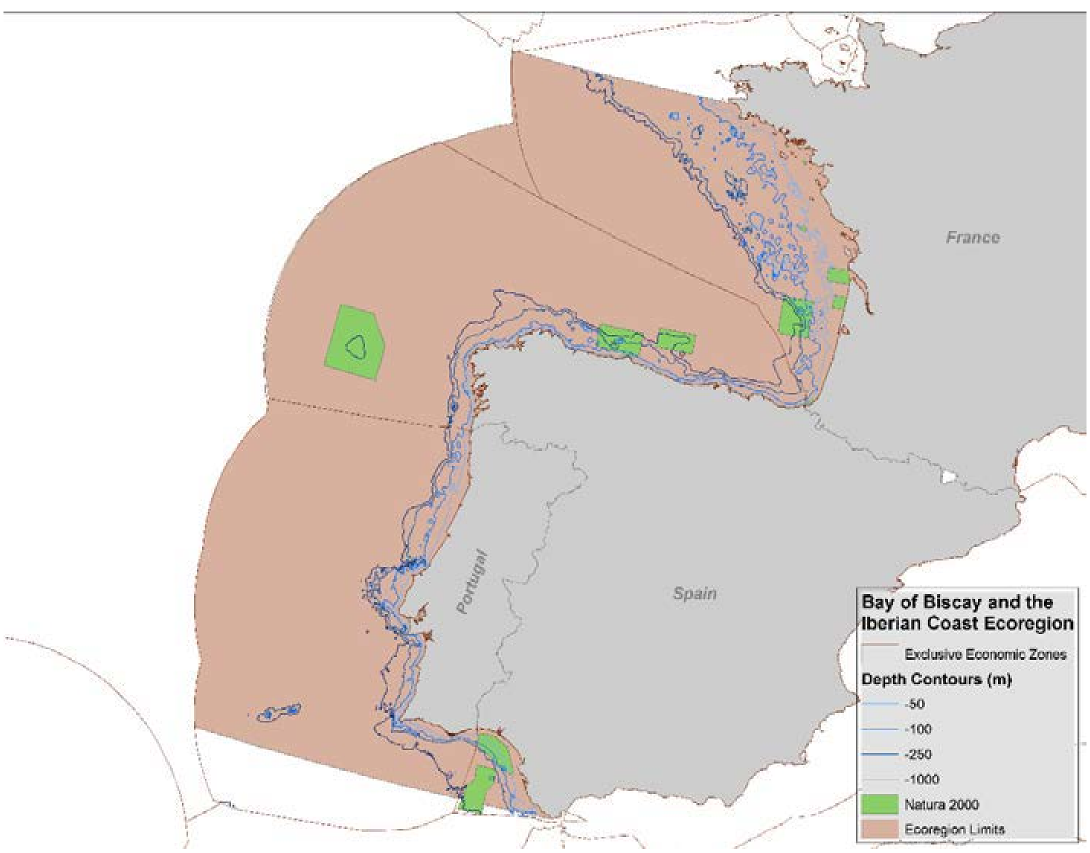


Figure 52. The Bay of Biscay and the Iberian Coast ecoregion, showing EEZs and larger offshore Natura 2000 sites.

ICES assessment reports with data until 2015 were analyzed for 31 stocks in the Bay of Biscay, Iberian Coast and Azores. The graphs below summarize their status and exploitation level within an MSY-framework. The list of species and their current exploitation and status is summarized in Table 10. Detailed assessments for every stock are available in Appendix 1 and in the spreadsheet Iberian_Sep28_2016.xlsx.

Of the 31 stocks, 18 (58%) were subject to ongoing overfishing ($F > F_{msy}$) and 7 stocks (23%) were outside of safe biological limits ($B < 0.5\ B_{msy}$). In 7 stocks (23%) catches exceeded the maximum sustainable yield (*C/MSY* > 1). Seven stocks (23%) were in critical condition, defined by being outside of safe biological limits and subject to overfishing, or being severely depleted ($B < 0.2\ B_{msy}$). The scientific names of these stocks are marked red in Table 10. Altogether, 19 stocks (61%) were subject to unsustainable exploitation (catch > MSY or F > Fmsy or B < 0.2 Bmsy), with the too high catches marked red in Table 10. Only 4 stocks (13%) could be considered as being well managed and in good condition sensu CFP (2013), defined by not being subject to overfishing and having a biomass above the one that can produce the maximum sustainable yield.

Summed biomass of the 31 stocks of 0.86 million tonnes in the last year with available data was well below the biomass level of 1.3 million tonnes that can produce maximum yields. Summed catches of 202 thousand tonnes were well below the summed maximum sustainable yield of 344 thousand tonnes. Because of trophic interactions it is not possible to achieve *MSY* simultaneously for all stocks, but sustained catches of near the lower confidence limit or near 90% of *MSY* (whichever is lower) would be possible if all stocks have recovered above B_{msy}. Because of more fish in the water, such catches could be obtained with much less fishing effort and much less impact on the ecosystem. See legends of Figures for more comments.

Table 10. Analysis of 31 stocks in the Bay of Biscay, Iberian Coast and Azores, with indication of last year with available data (Year), maximum sustainable yield (MSY), absolute and relative catch (Catch, C/MSY), maximum sustainable fishing mortality (F_{msy}) if the stock is within safe biological limits (B/B_{msy} > 0.5), F_{msy} for current stock size, F/F_{msy} for current stock size, biomass that can produce MSY (B_{msy}), relative biomass (B/B_{msy}). Scientific names of healthy stocks where F/Fmsy < 1 and B/Bmsy > 1 are marked green and stocks outside of safe biological limits (B/B_{msy} < 0.5) with ongoing overfishing (F/F_{msy} > 1) are marked red. Catches above MSY are marked bold (C/MSY > 1). Overfishing with F/F_{msy} > 1 is marked bold. Stock sizes outside safe biological limits (B/Bmsy < 0.5) are marked bold. Unsustainable catches (catch > MSY, F > Fmsy, B < 0.2 Bmsy) are marked red. Catches are given in tonnes per year. Biomass is given in tonnes as average total biomass during the year. Species are sorted by functional groups as indicated by the color of the stock IDs: benthic fish & invertebrates (blue), large predators (red), and pelagic plankton feeders (green). [Iberian_Sep28_2016.xlsx]

Scientific name	**Stock**	**Year**	***MSY***	**Catch**	***C/MSY***	***F_{msy}***	***F_{msy} cur***	***F***	***F/F_{msy} cur***	***B_{msy}***	***B***	***B/B_{msy}***
Beryx spp.	alf-comb	2015	661	365	0.55	0.13	0.13	0.13	0.96	4,977	2,856	0.57
Lophius budegassa	anb-8c9a	2015	1,966	1,040	0.53	0.19	0.19	0.09	0.48	10,182	11,207	1.10
Lophius piscatorius	anp-78ab	2015	23,956	25,266	**1.05**	0.25	0.25	0.32	**1.29**	97,563	79,958	0.82
Lophius piscatorius	anp-8c9a	2015	4,844	1,748	0.36	0.23	0.23	0.05	0.24	21,430	31,815	1.48
Lepidorhombus boscii	mgb-8c9a	2015	1,897	1,745	0.92	0.15	0.15	0.15	0.98	12,592	11,783	0.94
Lepidorhombus whiffiagonis	mgw-8c9a	2015	755	297	0.39	0.41	0.32	0.41	**1.28**	1,851	727	**0.39**
Nephrops norvegicus	nep-2829	2015	424	247	0.58	0.31	0.31	0.29	0.91	1,352	862	0.64
Nephrops norvegicus	Neph-IXa	2013	1,591	238	0.15	0.11	0.01	0.70	**>10**	14,328	340	**0.02**
Nephrops norvegicus	Neph-VIIIab	2013	11,932	7,344	0.62	0.28	0.28	0.30	**1.08**	43,160	24,545	0.57
Nephrops norvegicus	Neph-VIIIc	2013	428	20	0.05	0.21	0.03	0.15	**5.82**	2,046	130	**0.06**
Pleuronectes platessa	ple-89a	2014	286	220	0.77	0.27	0.27	0.21	0.75	1,041	1,065	1.02
Raja clavata	rjc-bisc	2013	305	299	0.98	0.09	0.03	0.62	**>10**	3,287	483	**0.15**
Raja clavata	rjc-pore	2013	1,031	703	0.68	0.18	0.18	0.17	0.92	5,626	4,154	0.74
Raja brachyura	rjh-pore	2013	352	275	0.78	0.10	0.10	0.15	**1.51**	3,555	1,835	0.52
Raja montagui	rjm-pore	2013	231	165	0.71	0.20	0.18	0.32	**1.81**	1,144	508	**0.44**
Leucoraja naevus	rjn-pore	2013	67	37	0.56	0.20	0.20	0.18	0.89	327	206	0.63
Pagellus bogaraveo	sbr-ix	2015	683	295	0.43	0.25	0.24	0.23	0.95	2,688	1,280	**0.48**
Pagellus bogaraveo	sbr-x	2015	1,028	701	0.68	0.29	0.29	0.33	**1.14**	3,537	2,116	0.60
Solea spp.	sol-8c9a	2014	1,131	829	0.73	0.28	0.28	0.37	**1.30**	4,028	2,269	0.56
Solea solea	sol-bisc	2015	5,220	3,641	0.70	0.29	0.29	0.30	**1.05**	18,084	12,022	0.66
Dicentrarchus labrax	Bss-8ab	2014	2,740	2,991	**1.09**	0.29	0.29	0.36	**1.23**	9,444	8,382	0.89

Scientific name	Stock	Year	*MSY*	Catch	*C/MSY*	F_{msy}	$F_{msy\ cur}$	*F*	$F/F_{msy\ cur}$	B_{msy}	*B*	B/B_{msy}
Dicentrarchus labrax	Bss-8c9a	2014	740	917	**1.24**	0.29	0.29	0.50	**1.75**	2,579	1,828	0.71
Merluccius merluccius	hke-soth	2015	20,974	13,839	0.66	0.27	0.27	0.21	0.77	78,080	67,164	0.86
Pollachius pollachius	pol-89a	2014	1,880	1,983	**1.05**	0.36	0.36	0.60	**1.67**	5,269	3,321	0.63
Merlangius merlangus	whg-89a	2014	2,167	1,690	0.78	0.33	0.33	0.45	**1.37**	6,629	3,786	0.57
Engraulis encrasicolus	ane-bisc	2015	50,731	25,134	0.50	0.43	0.43	0.24	0.55	118,983	106,462	0.89
Engraulis encrasicolus	ane-pore	2015	6,315	9,597	**1.52**	0.37	0.37	0.80	**2.19**	17,294	12,014	0.69
Trachurus trachurus	hom-soth	2015	30,710	32,723	**1.07**	0.23	0.23	0.18	0.78	132,501	181,103	1.37
Trachurus picturatus	jaa-10	2015	2,746	1,136	0.41	0.29	0.29	0.23	0.80	9,449	4,897	0.52
Sardina pilchardus	sar-78	2014	35,966	45,312	**1.26**	0.31	0.31	0.34	**1.08**	114,522	133,106	1.16
Sardina pilchardus	sar-soth	2015	130,667	21,000	0.16	0.25	0.14	0.14	**1.03**	526,426	146,960	**0.28**

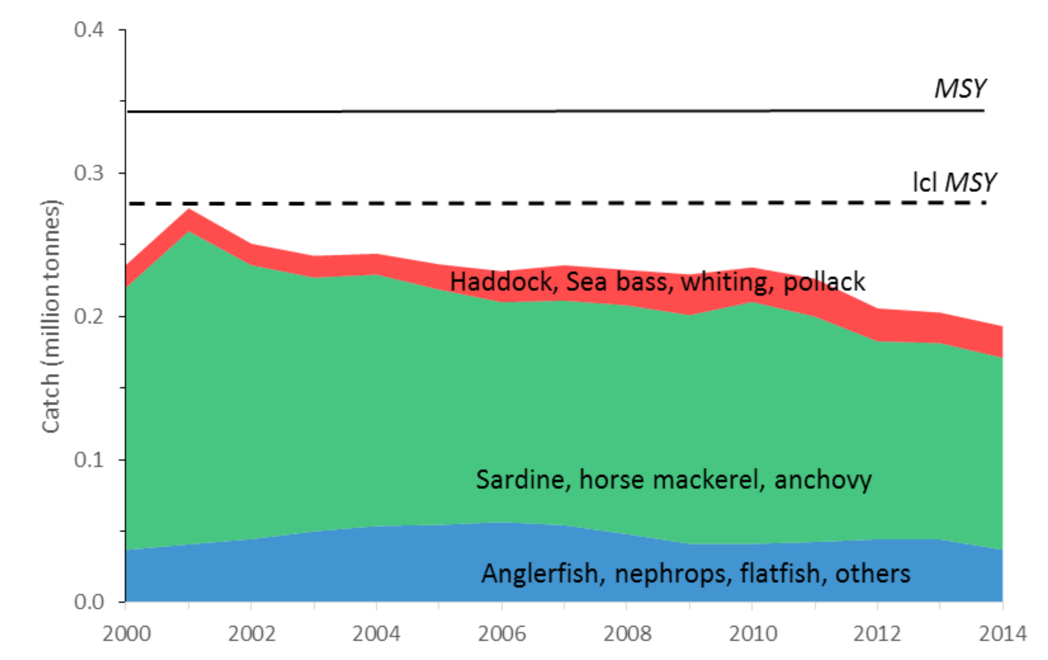


Figure 53. Cumulative catches for 31 stocks in the Bay of Biscay, Iberian Coast and Azores, with indication of main functional groups. The black line indicates the maximum sustainable yield (MSY) for the ecoregion and the dashed line indicates the lower 95% confidence limit as a precautionary target. [Iberian_Sep28_2016.xlsx]

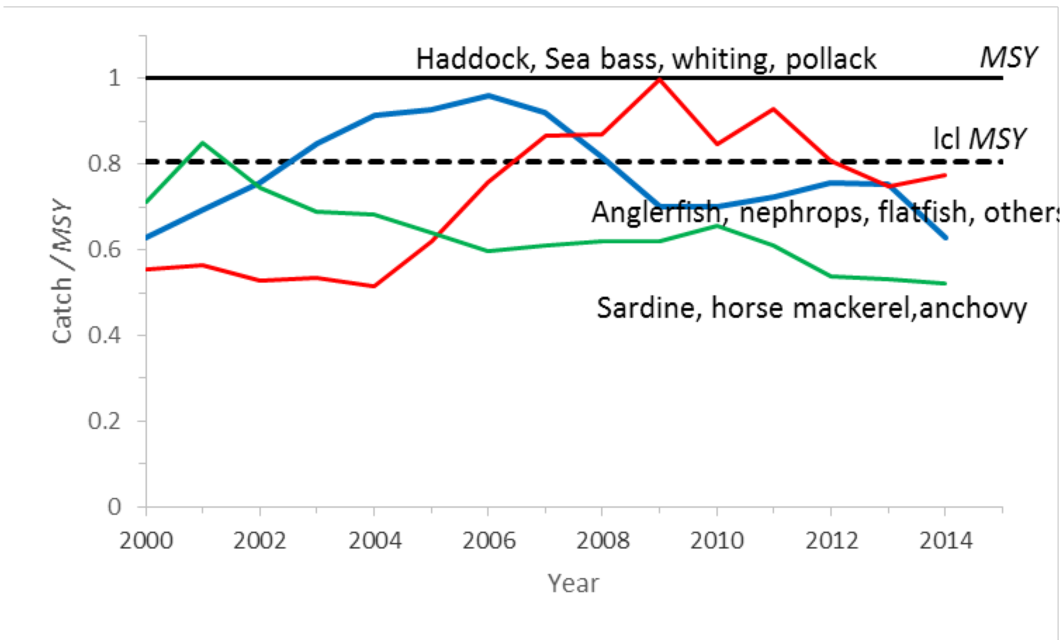


Figure 54. Catches by main functional group relative to their maximum sustainable yield (MSY, black line), for 31 stocks in the Bay of Biscay, Iberian Coast and Azores. Median catches for large predators (red curve) are near their long-term target, albeit taken at high cost from too small stocks. [Iberian_Sep28_2016.xlsx]

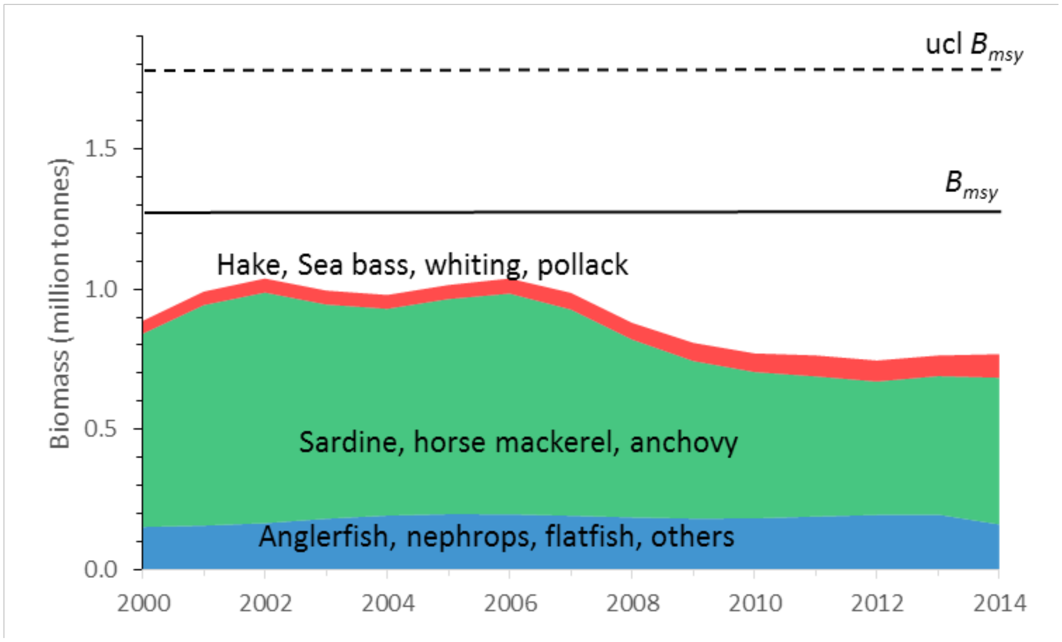


Figure 55. Cumulative total biomass of 31 stocks in the Bay of Biscay, Iberian Coast and Azores relative to the biomass that can produce the maximum sustainable yield (B_{msy} = black line). The upper 95% confidence limit of Bmsy (dashed green line) would present a precautionary target biomass above B_{msy}. This is also the area where the maximum economic yield could be obtained. The functional groups of large predators (red), pelagic plankton feeders (green), and benthic organisms (blue) are indicated, with listing of main species. The overall biomass of exploited species in this ecoregion is much too low. [Iberian_Sep28_2016.xlsx]

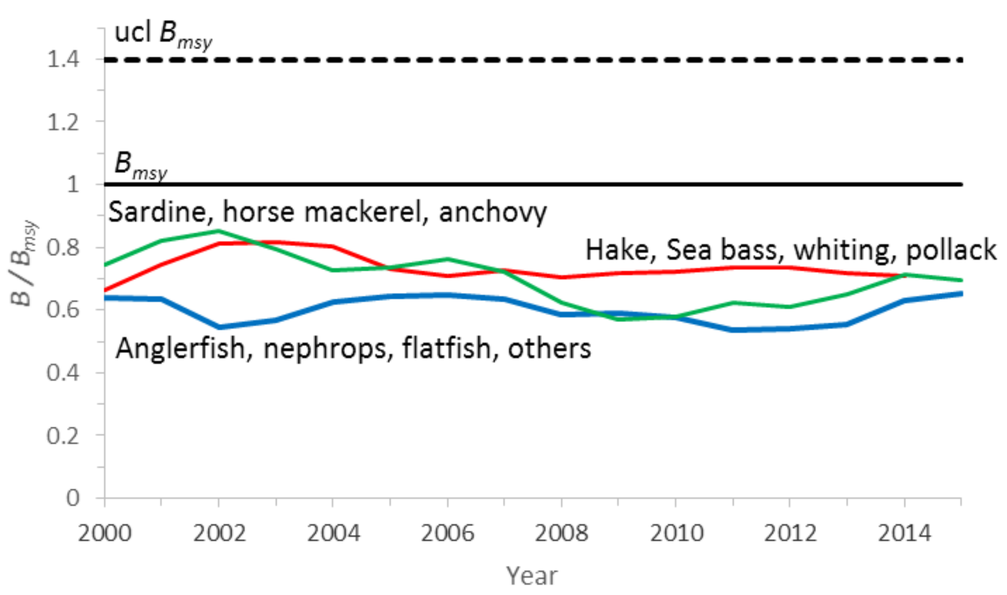


Figure 56. Median biomass relative to the level that can produce the maximum sustainable yield (B/B_{msy}) for 31 stocks in the Bay of Biscay, Iberian Coast and Azores assigned to main functional groups. Median biomass of functional groups is much too low in this ecoregion. [Iberian_Sep28_2016.xlsx]

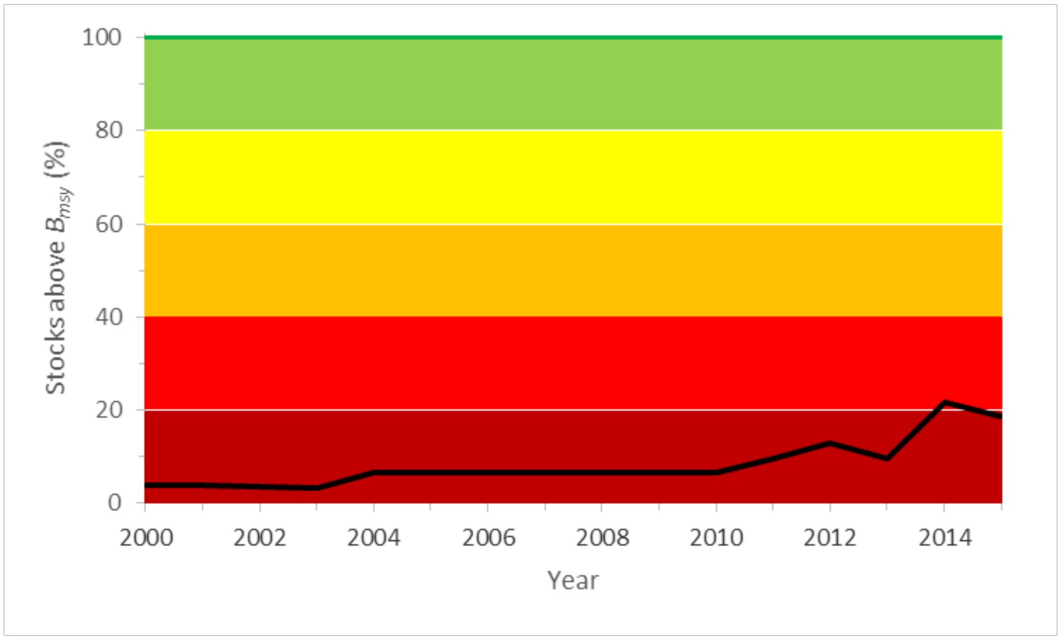


Figure 57. Percentage of stocks where biomass is above the level that can produce the maximum sustainable yield (B_{msy}) for 31 stocks in the Bay of Biscay, Iberian Coast and Azores (black curve). The colors indicate visually the compliance with the goals of the Common Fisheries Policy, where all stocks (100%) shall be above B_{msy} eventually. In 2015, only 19% of the stocks fulfilled that requirement. [Iberian_Sep28_2016.xlsx]

Figure 58. Percentage of stocks where fishing pressure is at or below the maximum sustainable level (F_{msy}) for 31 stocks in the Bay of Biscay, Iberian Coast and Azores (black curve). The colors indicate visually the compliance with the goals of the Common Fisheries Policy, where all stocks (100%) shall be fished at or below F_{msy} in 2015, latest in 2020. In 2014, 35% of the stocks fulfilled that requirement. [Iberian_Sep28_2016.xlsx]

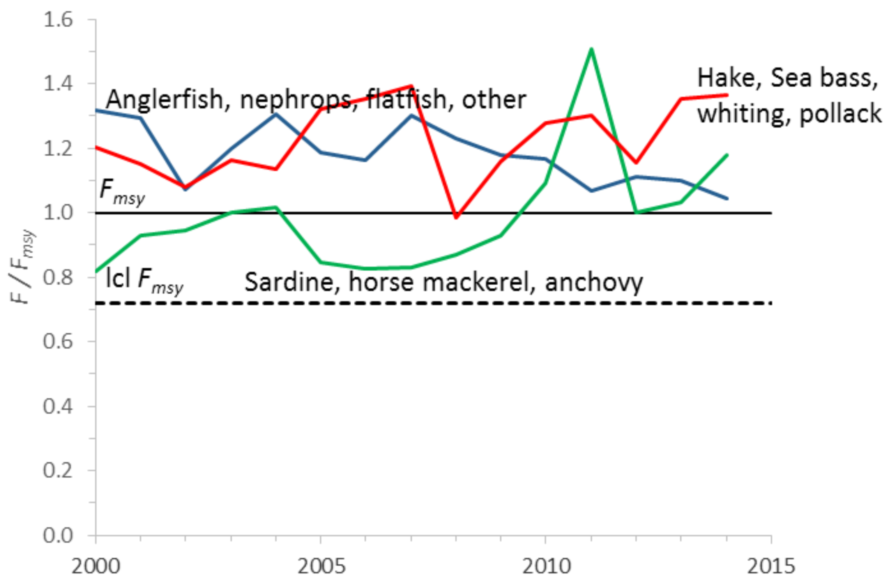


Figure 59. Median fishing pressure relative to the maximum sustainable level (F/F_{msy}) for 31 stocks in the Bay of Biscay, Iberian Coast and Azores assigned to main functional groups. Median fishing pressure is above the maximum sustainable level in all functional groups in this ecoregion. [Iberian_Sep28_2016.xlsx]

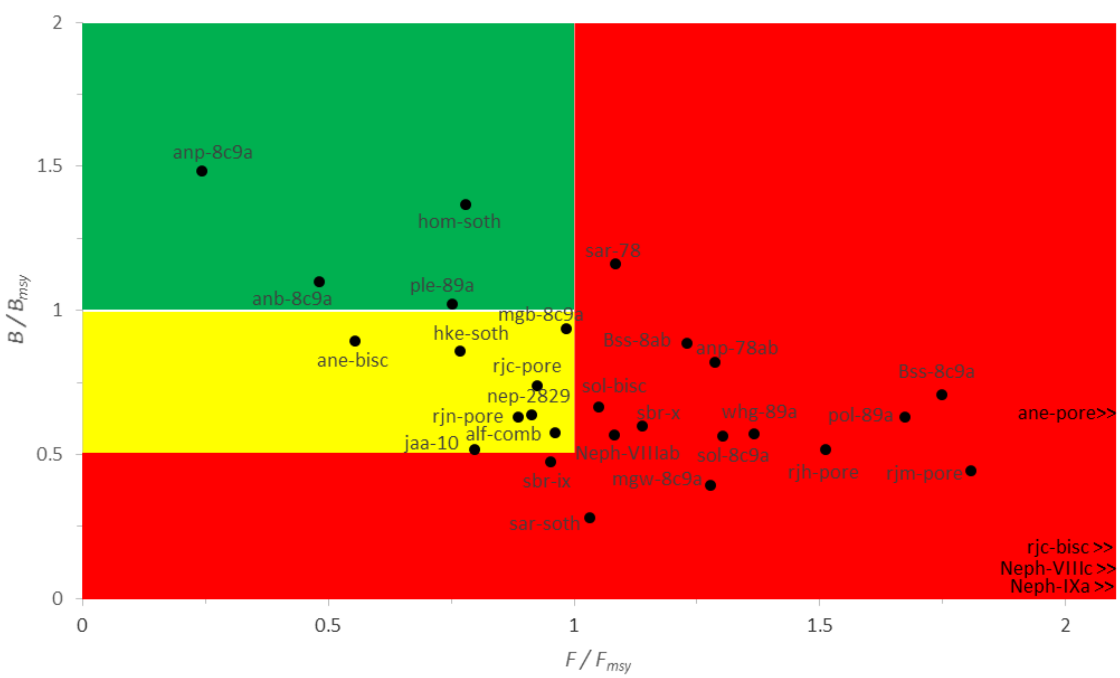
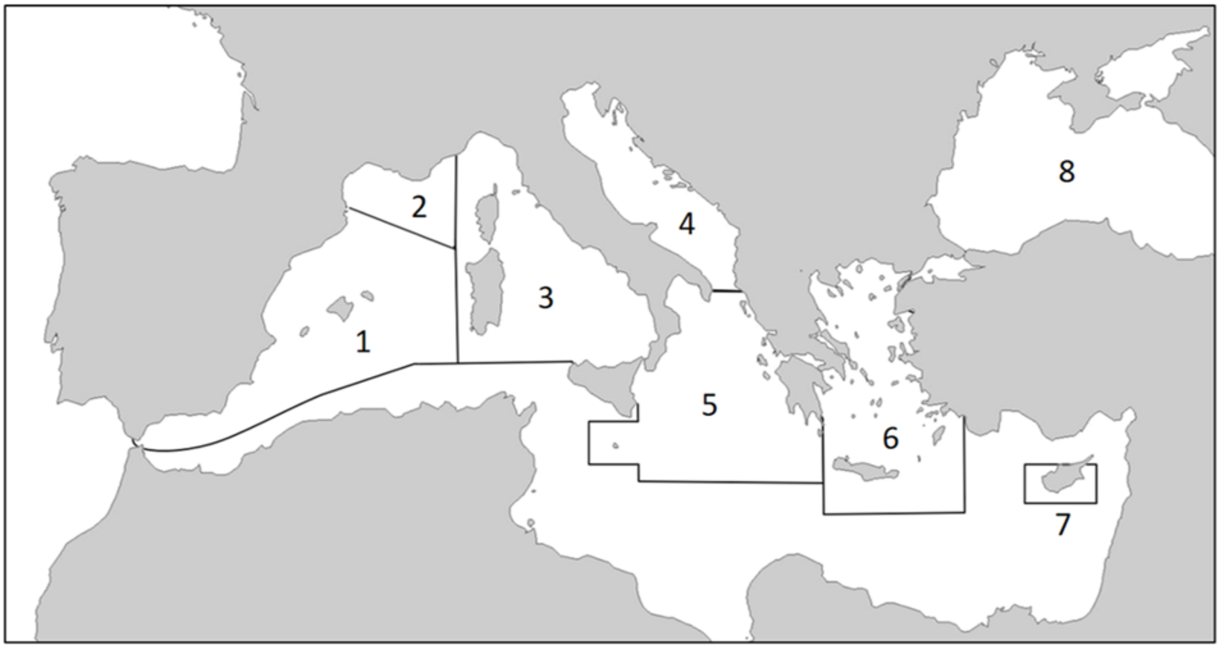


Figure 60. Presentation of 31 stocks in the Bay of Biscay, Iberian Coast and Azores in a pressure (F/F_{msy}) – state (B/B_{msy}) plot. The red area indicates stocks that are being overfished or are outside of safe biological limits. The yellow area indicates recovering stocks. The green area indicates stocks subject to sustainable fishing pressure and of a healthy stock size that can produce high yields close to MSY. Fishing pressure for several stocks (->>) is beyond the upper limit of the X-axis. [Iberian_Sep28_2016.xlsx]

MEDITERRANEAN AND BLACK SEA

The following map shows the geographical limits of the studied subareas in the Mediterranean and Black Sea.



1 – Balearic Sea	3 – Sardinia	5 – Ionian Sea	7 – Cyprus
2 – Gulf of Lions	4 – Adriatic Sea	6 – Aegean Sea	8 – Black Sea

Figure 61. Map of the Mediterranean and Black Sea. 1: Balearic, GFCM subdivision 1.1 excluding African coasts; 2: Gulf of Lions, GFCM subdivision 1.2; 3: Sardinia, GFCM subdivision 1.3 excluding African coasts; 4: Adriatic Sea, GFCM subdivision 2.1, includes GSAs 17&18; 5. Ionian Sea, GFCM subdivision 2.2, only GSAs 19&20; 6. Aegean Sea, GFCM subdivision 3.1, GSAs 22&23; 7: Cyprus, GFCM subdivision 3.2, only GSA 25; 8: Black Sea, GFCM subdivision 4.2, GSA 29.

Gulf of Lions

The following two paragraphs describing the Gulf of Lions (GSA 7) were taken from

http://www.indiseas.org/ecosystems/gulf-of-lions/environment.

“The Gulf of Lions is located in the north-western Mediterranean Sea (42°26.3’N, 3°9.9’E; 43°12.6’N, 5°27.5’E) covering a total area of 20,000 km^2 from the coastal area up to 2500 m depth.

The Gulf of Lions is a continental margin in the north-west Mediterranean Sea, with a large crescent-shaped continental shelf. Along the continental slope, the main mesoscale circulation feature is the Northern Current, a strong geostrophic current, which generally flows along the continental slope. More than ten rivers with a total watershed area of about 125,000 km^2 discharge significant volumes of water into the gulf. The dominant drivers in the area are the strong north-western (tramontane) and northern (mistral) winds which induce strong coastal upwelling activity, the western Mediterranean mesoscale circulation, and the fresh water input from the Rhone River. These drivers generate important primary and secondary production in the Gulf. The substrate is characterized by muddy and sandy bottoms. The Gulf of Lions is host to a high diversity of pelagic, demersal and benthic organisms, including top predators such as sea birds, dolphins, hake and Atlantic bluefin tuna. The most important species in term of fishery landings are European pilchard and European anchovy; they are also key trophic groups in the food web, linking pelagic primary producers to consumers through their consumption of phytoplankton and their role as prey to consumers. Other important fish species are Atlantic mackerel and blue whiting: Atlantic mackerel is a demersal top predator important in coupling between pelagic and benthic compartments; blue whiting is a forage species, highly abundant on the continental slope and important in the diet of top predators such as hake and dolphins. Sea birds, dolphins and cuttlefish represent keystone species."

JRC-STEFC assessment reports and FAO-GFCM landings with data until 2014 were analyzed for 15 stocks in the Gulf of Lions. The graphs below summarize their status and exploitation level within an MSY-framework. The list of species and their current exploitation and status is summarized in Table 11. Detailed assessments for every stock are available in Appendix 2 and in the spreadsheet Lions_Gulf_Oct12_16.xlsx.

Of the 15 stocks, 13 (87%) were subject to ongoing overfishing (F > Fmsy) and 13 stocks (87%) were outside of safe biological limits (B < 0.5 Bmsy). Twelve stocks in the Gulf of Lions (80%) were in critical condition, defined by being outside of safe biological limits and subject to overfishing or being severely depleted ($B < 0.2 B_{msy}$). The scientific names of these stocks are marked red in Table 11. Altogether, 13 stocks (87%) were subject to unsustainable exploitation (catch > MSY or F > Fmsy or B < 0.2 Bmsy), with the too high catches marked red in Table 11. In contrast, no stock could be considered healthy, defined by not being subject to overfishing and having a biomass above the one that can produce the maximum sustainable yield.

Summed biomass of the 15 stocks of 43.7 thousand tonnes in 2014 was well below the biomass level of 113 thousand tonnes that can produce maximum yields. Summed catches of 8,551 tonnes were below (26%) the summed maximum sustainable yield of 32,637 tonnes. This is mainly caused by a sharp decline in pelagic plankton feeders since 2000. Because of trophic interactions it is not possible to achieve *MSY* simultaneously for all stocks, but sustained catches of near the lower confidence limit or near 90% of *MSY* (whichever is lower) would be possible if all stocks have recovered above B_{msy}. Because of more fish in the water, such catches could be obtained with much less fishing effort and much less impact on the ecosystem. See legends of Figures for more comments.

Table 11. Analysis of 15 stocks in the Gulf of Lions, with indication of last year with available data (Year), maximum sustainable yield (MSY), absolute and relative catch (Catch, C/MSY), maximum sustainable fishing mortality (F_{msy}) if the stock is within safe biological limits ($B/B_{msy} > 0.5$), F_{msy} for current stock size, F/F_{msy} for current stock size, biomass that can produce MSY (B_{msy}), relative biomass (B/B_{msy}). Scientific names of healthy stocks where F/Fmsy < 1 and B/Bmsy > 1 are marked green and stocks outside of safe biological limits ($B/B_{msy} < 0.5$) with ongoing overfishing ($F/F_{msy} > 1$) are marked red. Catches above MSY are marked bold (C/MSY > 1). Overfishing with $F/F_{msy} > 1$ is marked bold. Stock sizes outside safe biological limits (B/Bmsy < 0.5) are marked bold. Unsustainable catches (catch > MSY, F > Fmsy, B < 0.2 Bmsy) are marked red. Catches are given in tonnes per year. Biomass is given in tonnes as average total biomass during the year. Species are sorted by functional groups as indicated by the color of the stock IDs: benthic fish & invertebrates (blue), large predators (red) and pelagic plankton feeders (green). [Lions_Gulf_Oct12_16.xlsx]

Scientific name	Stock	Year	*MSY*	Catch	*C/MSY*	F_{msy}	$F_{msy\ cur}$	*F*	$F/F_{msy\ cur}$	B_{msy}	*B*	B/B_{msy}
Conger conger	CONGCON_LI	2014	543	115	0.21	0.18	0.10	0.13	**1.34**	3,072	863	**0.28**
Loligo vulgaris	LOLIVUL_LI	2014	389	225	0.58	0.18	0.11	0.35	**3.08**	2,103	645	**0.31**
Nephrops norvegicus	NEPRNOR_LI	2014	100	27	0.27	0.26	0.16	0.22	**1.35**	388	123	**0.32**
Octopus vulgaris	OCTOVUL_LI	2014	1,355	1,472	**1.09**	0.40	0.40	0.52	**1.31**	3,420	2,829	0.83
Pagellus erythrinus	PAGEERY_LI	2014	402	175	0.43	0.20	0.16	0.21	**1.34**	2,030	818	**0.40**
Sepia officinalis	SEPIOFF_LI	2014	262	120	0.46	0.18	0.13	0.23	**1.83**	1,459	516	**0.35**
Solea solea	SOLEVUL_LI	2014	517	130	0.25	0.16	0.10	0.14	**1.44**	3,185	941	**0.30**
Trisopterus minutus	TRISMIN_LI	2014	890	656	0.74	0.30	0.27	0.48	**1.81**	3,010	1,359	**0.45**
Dicentrarchus labrax	DICELAB_LI	2014	547	164	0.30	0.21	0.11	0.25	**2.33**	2,624	665	**0.25**
Merluccius merluccius	MERLMER_LI	2014	2,383	1,654	0.69	0.25	0.18	0.47	**2.54**	9,601	3,547	**0.37**
Micromesistius poutassou	MICMPOU_LI	2014	261	104	0.40	0.35	0.19	0.52	**2.78**	740	198	**0.27**
Boops boops	BOOPBOO_LI	2014	568	253	0.45	0.25	0.19	0.30	**1.58**	2,265	850	**0.38**
Engraulis encrasicolus	ENGRENC_LI	2014	6,835	1,891	0.28	0.29	0.29	0.16	0.53	23,465	12,178	0.52
Sardina pilchardus	SARDPIL_LI	2014	16,288	826	0.05	0.31	0.20	0.05	0.25	51,866	16,356	**0.32**
Scomber scombrus	SCOMSCO_LI	2014	1,297	739	0.57	0.31	0.26	0.42	**1.60**	4,193	1,771	**0.42**

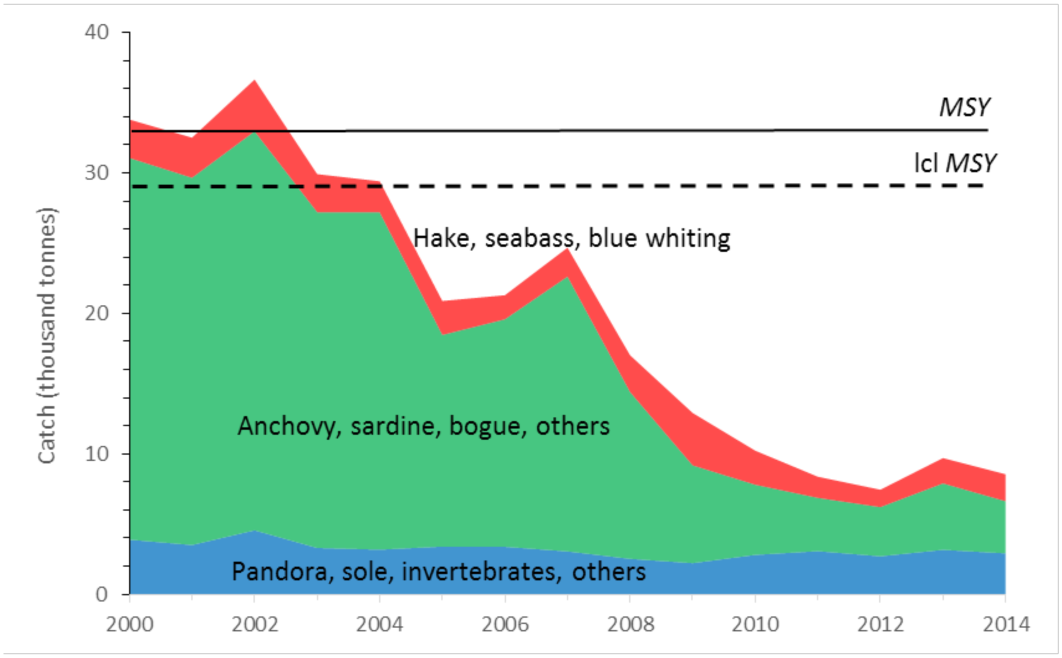


Figure 62. Cumulative catches, including discards and recreational catch if available, for 15 stocks in the Gulf of Lions, with indication of main functional groups. The black line indicates the maximum sustainable yield (MSY) for the ecoregion and the dashed line indicates the lower 95% confidence limit as a precautionary target. [Lions_Gulf_Oct12_16.xlsx]

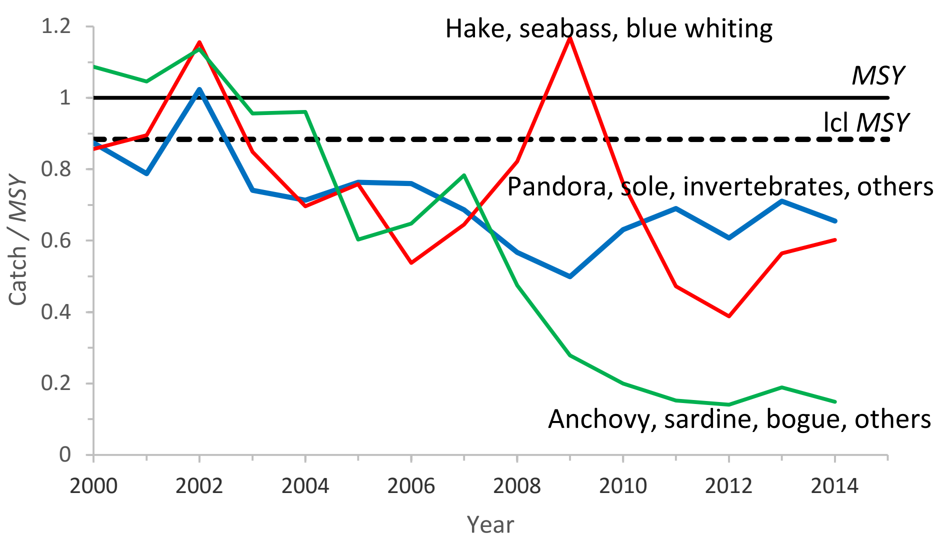


Figure 63. Catches by main functional group relative to their maximum sustainable yield (MSY, black line), for 15 stocks in the Gulf of Lions. Catches of large predators (red curve) and pelagic plankton feeders (green curve) were in sharp declining since 2000 because of too low biomass (see below). [Lions_Gulf_Oct12_16.xlsx]

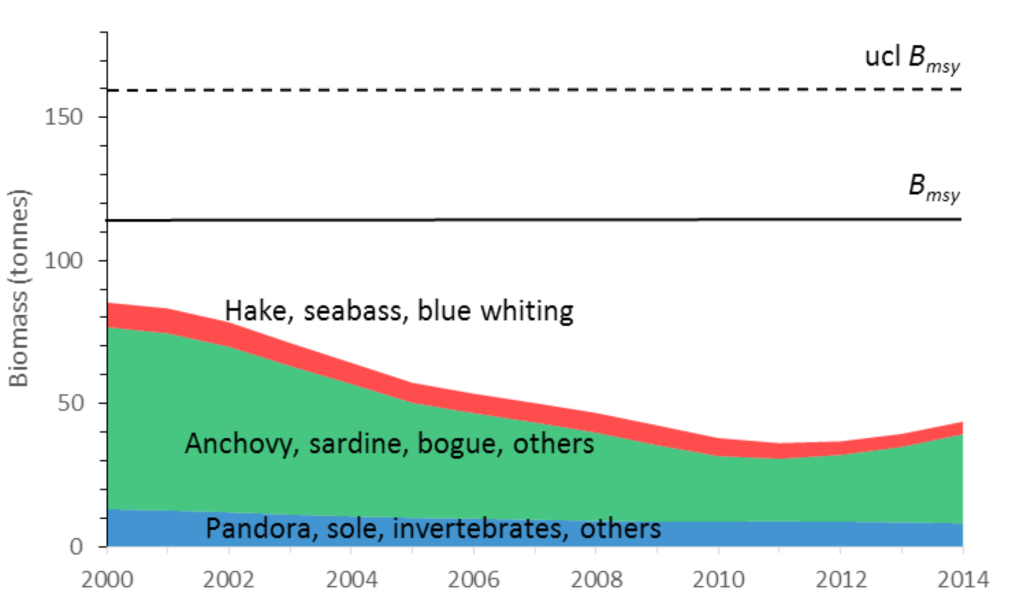


Figure 64. Cumulative total biomass of 15 stocks in the Gulf of Lions relative to the biomass that can produce the maximum sustainable yield (Bmsy = black line). The upper 95% confidence limit of Bmsy (dashed line) would present a precautionary target biomass above Bmsy. This is also the area where the maximum economic yield could be obtained. All functional groups were far below the Bmsy level. [Lions_Gulf_Oct12_16.xlsx]

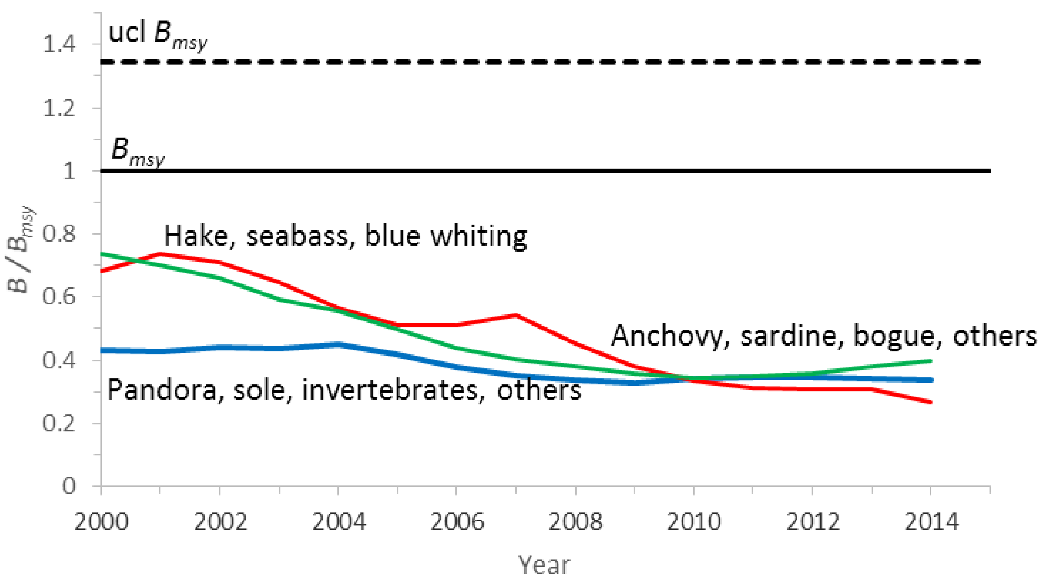


Figure 15. Median biomass relative to the level that can produce the maximum sustainable yield (B/B_{msy}) for 15 stocks in the Gulf of Lions assigned to main functional groups. All functional groups have biomass levels well below B_{msy}, without a clear upward trend. [Lions_Gulf_Oct12_16.xlsx]

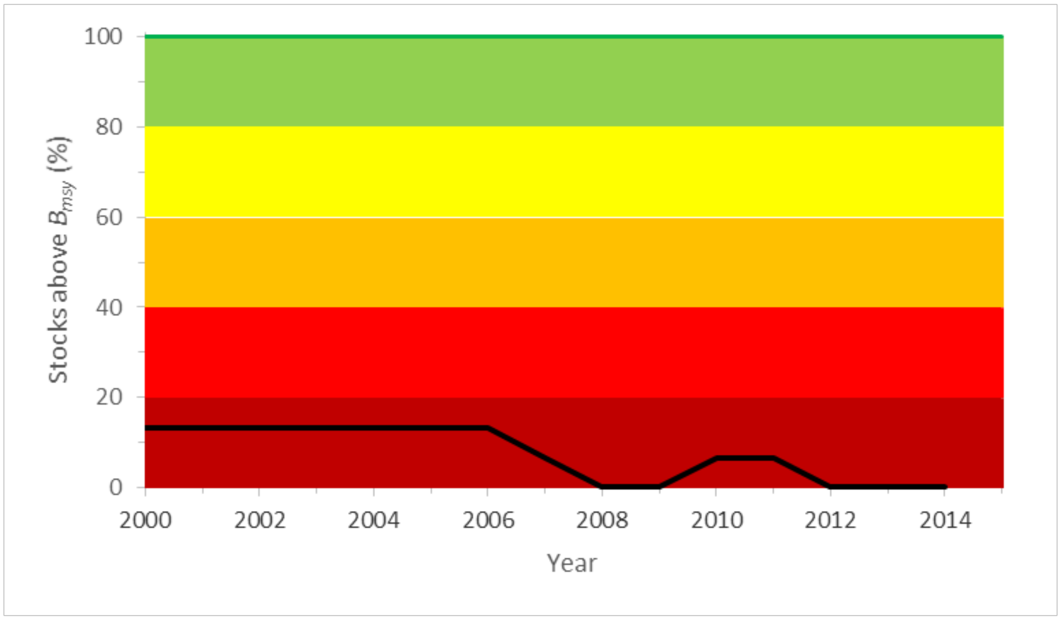


Figure 66. Percentage of stocks where biomass is above the level that can produce the maximum sustainable yield (B_{msy}) for 15 stocks in the Gulf of Lions (black curve). The colors indicate visually the compliance with the goals of the Common Fisheries Policy, where all stocks (100%) shall be above B_{msy} eventually. In 2014, no stocks fulfilled that requirement. [Lions_Gulf_Oct12_16.xlsx]

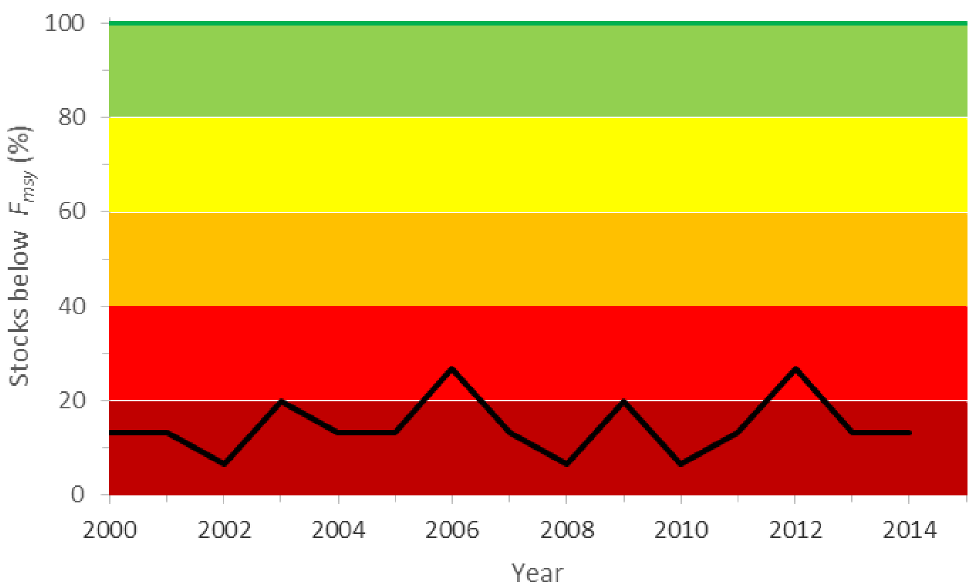


Figure 67. Percentage of stocks where fishing pressure is at or below the maximum sustainable level (F_{msy}) for 15 stocks in the Gulf of Lions (black curve). The colors indicate visually the compliance with the goals of the Common Fisheries Policy, where all stocks (100%) shall be fished at or below F_{msy} in 2015, latest in 2020. In 2014, only two stocks (13%) fulfilled that requirement. [Lions_Gulf_Oct12_16.xlsx]

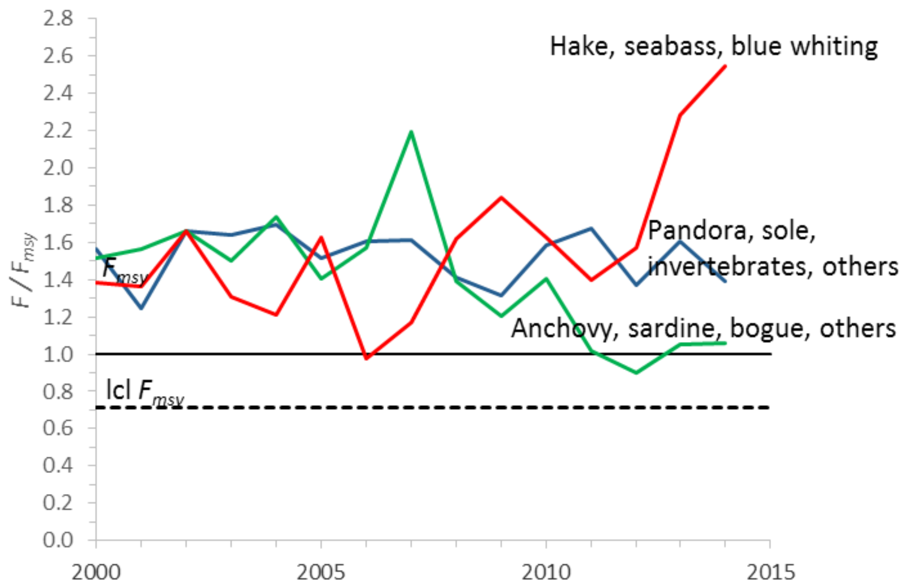


Figure 68. Median fishing pressure relative to the maximum sustainable level (F/F_{msy}) for 15 stocks in the Gulf of Lions assigned to main functional groups. Except for two pelagic plankton feeders, all stocks are subject to strong overfishing in 2014. [Lions_Gulf_Oct12_16.xlsx]

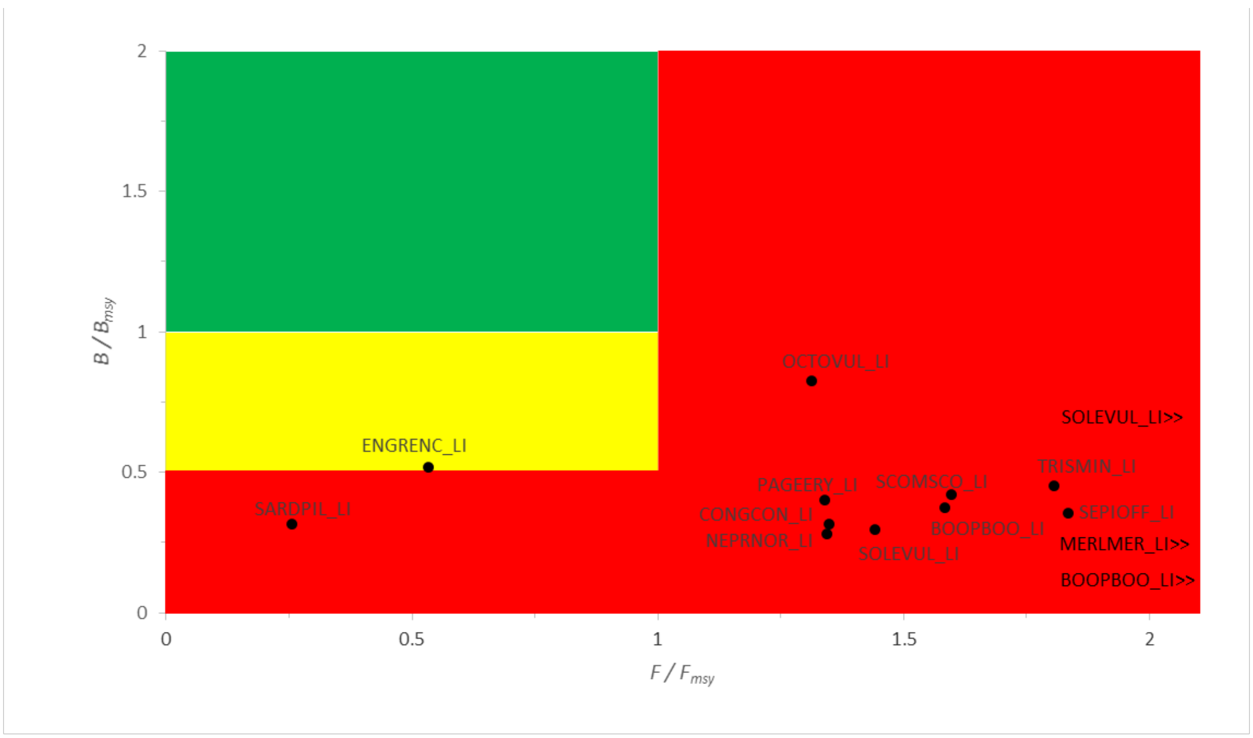


Figure 69. Presentation of 15 stocks in the Gulf of Lions in a pressure (F/F_{msy}) – state (B/B_{msy}) plot. The red area indicates stocks that are being overfished or are outside of safe biological limits. The yellow area indicates recovering stocks. The green area indicates stocks subject to sustainable fishing pressure and of a healthy stock size that can produce high yields close to MSY. Only one stock is in safe biological limits and presented in the green area. [Lions_Gulf_Oct12_16.xlsx]

Balearic Sea

The following two paragraphs describing the Balearic Sea (GSA 5) were taken from the website www.fao.org and modified from http://www.indiseas.org.

"The waters of the Balearic Sea (western Mediterranean) bounded by a line commencing on the coast of Africa at the Algerian/Tunisian frontier at 8°37'E longitude; thence running due north to 38°00' north latitude; thence due west to 8°00' east longitude; thence due north to 41°20' north latitude; thence westward along a rhumb line to the mainland coast at the eastern end of the frontier between France and Spain; thence following the Spanish coast to Punta Marroqui; thence due south along 5°36' west longitude to the coast of Africa; thence following in an eastwards direction along the coast of Africa to the starting point. For the purposes of this work only the landings and biomasses of the northern coastline were used.

The Balearic Sea is generally described as oligotrophic, but temporal enrichment occurs due to regional environmental events, mainly related to wind conditions, the existence of a temporal thermocline and a shelf-slope current and river discharges. These factors greatly influence the productivity and fishing activity of the area, which yields are mainly composed of small pelagic fishes."

JRC-STEFC assessment reports and FAO-GFCM landings with data until 2014 were analyzed for 22 stocks in the Balearic Sea (GFCM subarea 1.1). The graphs below summarize their status and exploitation level within an MSY-framework. The list of species and their current exploitation and status is summarized in Table 12. Detailed assessments for every stock are available in Appendix 2 and in the spreadsheet Balearic_Oct12_16.xlsx.

Of the 22 stocks, 21 (95%) were subject to ongoing overfishing ($F > F_{msy}$) and 14 stocks (64%) were outside of safe biological limits ($B < 0.5\ B_{msy}$). Catches did not exceed the maximum sustainable yield ($C/MSY > 1$) in any of the stocks. Fifteen stocks (68%) were in critical condition, defined by being outside of safe biological limits and subject to overfishing or being severely depleted ($B < 0.2\ B_{msy}$). The scientific names of these stocks are marked red in Table 12. Altogether, 21 stocks (95%) were subject to unsustainable exploitation (catch > MSY or F > Fmsy or B < 0.2 Bmsy), with the too high catches marked red in Table 12, and no stock could be considered healthy, defined by not being subject to overfishing and having a biomass above the one that can produce the maximum sustainable yield.

Summed biomass of the 22 stocks of 358 thousand tonnes in 2014 was well below the biomass level of 716 thousand tonnes that can produce maximum sustainable yields. Summed catches of 126,500 tonnes were below (59%) the summed maximum sustainable yield of 213,000 tonnes. Because of trophic interactions it is not possible to achieve *MSY* simultaneously for all stocks, but sustained catches of near the lower confidence limit or near 90% of *MSY* (whichever is lower) would be possible if all stocks have recovered above B_{msy}. Because of more fish in the water, such catches could be obtained with much less fishing effort and much less impact on the ecosystem. See legends of Figures for more comments.

Table 12. Analysis of 22 stocks in the Balearic Sea, with indication of last year with available data (Year), maximum sustainable yield (MSY), absolute and relative catch (Catch, C/MSY), maximum sustainable fishing mortality (F_{msy}) if the stock is within safe biological limits ($B/B_{msy} > 0.5$), F_{msy} for current stock size, F/F_{msy} for current stock size, biomass that can produce MSY (B_{msy}), relative biomass (B/B_{msy}). Scientific names of healthy stocks where F/Fmsy < 1 and B/Bmsy > 1 are marked green and stocks outside of safe biological limits ($B/B_{msy} < 0.5$) with ongoing overfishing ($F/F_{msy} > 1$) are marked red. Catches above MSY are marked bold (C/MSY > 1). Overfishing with $F/F_{msy} > 1$ is marked bold. Stock sizes outside safe biological limits (B/Bmsy < 0.5) are marked bold. Unsustainable catches (catch > MSY, F > Fmsy, B < 0.2 Bmsy) are marked red. Catches are given in tonnes per year. Biomass is given in tonnes as average total biomass during the year. Species are sorted by functional groups as indicated by the color of the stock IDs: benthic fish & invertebrates (blue), large predators (red), and pelagic plankton feeders (green). [Balearic_Oct12_16.xlsx]

Scientific name	Stock	Year	MSY	Catch	C/MSY	F_{msy}	F_{msy} cur	F	F/F_{msy} cur	B_{msy}	B	B/B_{msy}
Aristeomorpha foliacea	ARISFOL_BA	2014	38	10	0.26	0.25	0.14	0.23	**1.56**	153	44	**0.29**
Aristeus antennatus	ARITANT_BA	2014	1,855	1,629	0.88	0.28	0.28	0.48	**1.71**	6,593	3,389	0.51
Conger conger	CONGCON_BA	2014	566	131	0.23	0.18	0.07	0.20	**2.86**	3,216	647	**0.201**
Lepidorhombus whiffiagonis	LEPIWHI_BA	2014	113	19	0.17	0.34	0.15	0.25	**1.64**	335	76	**0.23**
Loligo vulgaris	LOLIVUL_BA	2014	1,260	361	0.29	0.16	0.11	0.12	**1.10**	8,118	2,925	**0.36**
Mullus barbatus	MULLBAR_BA	2014	652	634	0.97	0.40	0.40	0.59	**1.48**	1,626	1,066	0.66
Mullus surmuletus	MULLSUR_BA	2014	557	230	0.41	0.58	0.36	0.77	**2.16**	961	297	**0.31**
Nephrops norvegicus	NEPRNOR_BA	2014	605	397	0.66	0.28	0.28	0.34	**1.23**	2,199	1,174	0.53
Pagellus erythrinus	PAGEERY_BA	2014	2,084	1,811	0.87	0.34	0.34	0.31	0.92	6,219	5,885	0.95
Parapenaeus longirostris	PAPELON_BA	2014	2,482	1,043	0.42	0.47	0.24	0.80	**3.38**	5,244	1,308	**0.25**
Phycis blennoides	PHYCBLE_BA	2014	540	254	0.47	0.21	0.19	0.22	**1.19**	2,576	1,145	**0.44**
Sepia officinalis	SEPIOFF_BA	2014	432	270	0.63	0.26	0.18	0.47	**2.66**	1,687	579	**0.34**
Solea solea	SOLEVUL_BA	2014	969	308	0.32	0.23	0.12	0.27	**2.19**	4,207	1,132	**0.27**
Trisopterus minutus	TRISLUS_BA	2014	249	145	0.58	0.37	0.37	0.40	**1.07**	673	364	0.54
Merluccius merluccius	MERLMER_BA	2014	5,676	3,028	0.53	0.22	0.10	0.50	**4.79**	25,518	6,021	**0.24**
Micromesistius poutassou	MICMPOU_BA	2014	5,371	1,222	0.23	0.18	0.08	0.18	**2.12**	29,565	6,854	**0.23**
Boops boops	BOOPBOO_BA	2014	8,299	6,615	0.80	0.31	0.31	0.46	**1.48**	26,424	14,246	0.54
Engraulis encrasicolus	ENGRENC_BA	2014	33,132	22,203	0.67	0.19	0.19	0.23	**1.20**	171,342	95,368	0.56
Sardina pilchardus	SARDPIL_BA	2014	114,100	66,120	0.58	0.36	0.36	0.38	**1.06**	319,009	175,221	0.55
Sardinella aurita	SARIAUR_BA	2014	25,495	16,151	0.63	0.40	0.35	0.57	**1.61**	64,177	28,476	**0.44**
Scomber colias	SCOMPNE_BA	2014	3,193	2,383	0.75	0.39	0.29	0.81	**2.85**	8,097	2,931	**0.36**

Scientific name	Stock	Year	*MSY*	Catch	*C/MSY*	F_{msy}	$F_{msy\ cur}$	*F*	$F/F_{msy\ cur}$	B_{msy}	*B*	B/B_{msy}
Scomber scombrus	SCOMSCO_BA	2014	5,379	1,554	0.29	0.19	0.12	0.17	**1.38**	28,524	9,242	**0.32**

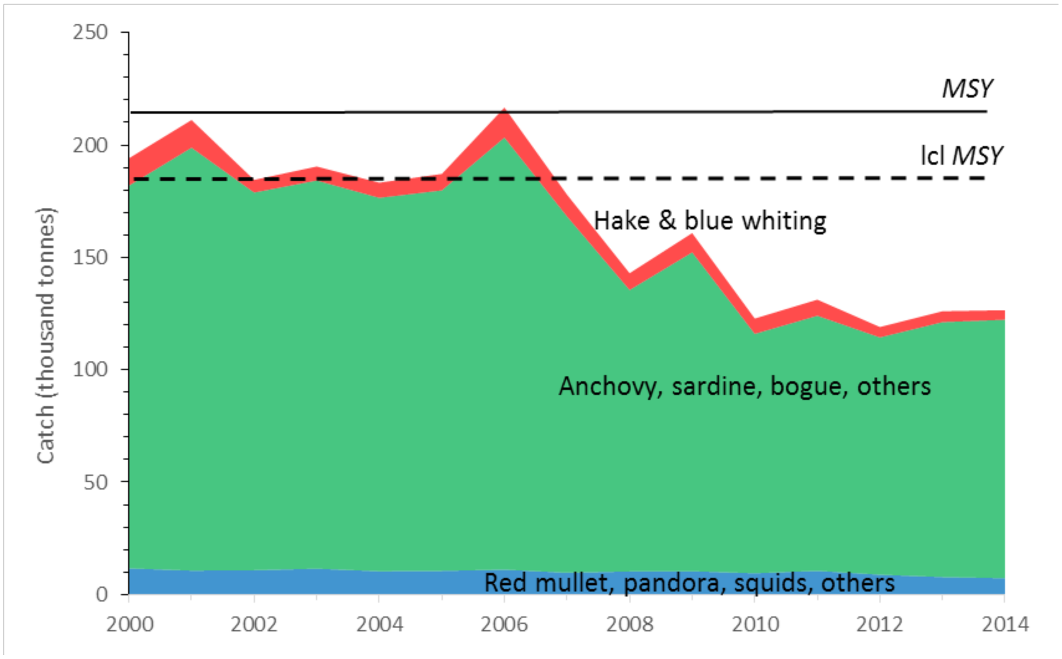


Figure 70. Cumulative catches for 22 stocks in the Balearic Sea, with indication of main functional groups. The black line indicates the maximum sustainable yield (MSY) for the ecoregion and the dashed line indicates the lower 95% confidence limit as a precautionary target. Catches of pelagic plankton feeders have declined drastically in recent years, due to overfishing (see graphs below). [Balearic_Oct12_16.xlsx]

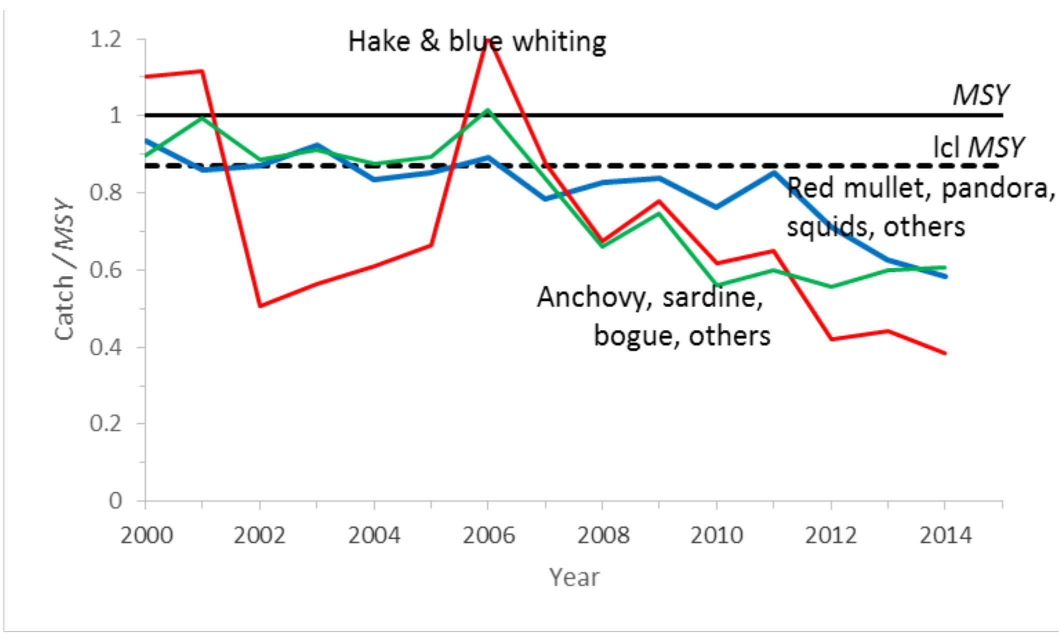


Figure 71. Catches by main functional group relative to their maximum sustainable yield (MSY, black line), for 22 stocks in the Balearic Sea. Pelagic plankton feeders (green curve) and large predators (red) supported catches below the precautionary lower 95% confidence limit of MSY (dashed line) and present declining levels since 2006. Benthic organisms (blue) supported catches near the precautionary level until 2011 and declined thereafter. Catches of large predators declined strongly since 2006. [Balearic_Oct12_16.xlsx]

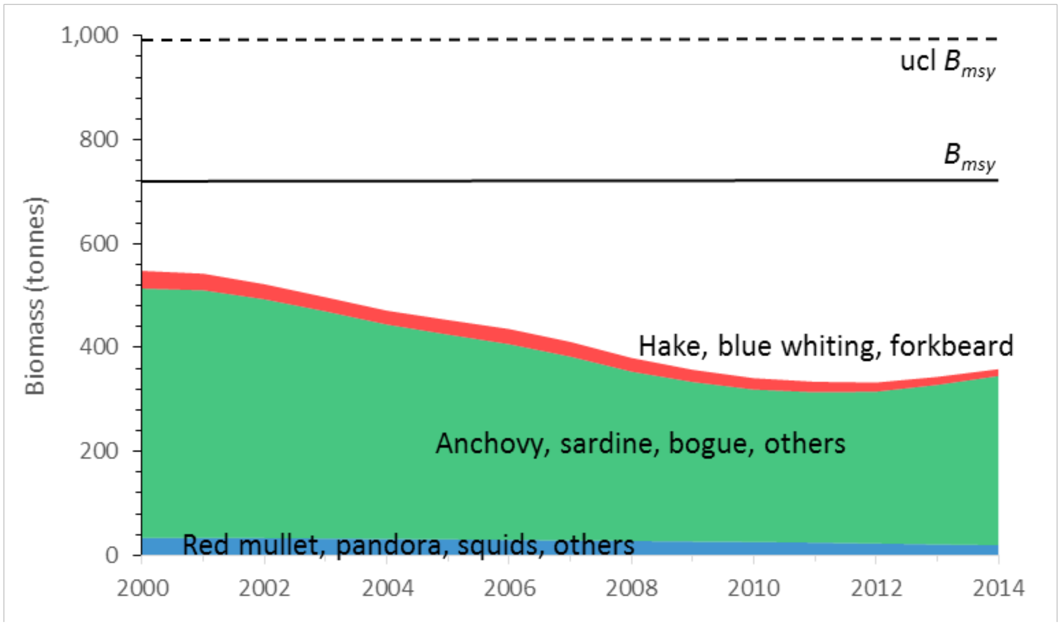


Figure 72. Cumulative total biomass of 22 stocks in the Balearic Sea relative to the biomass that can produce the maximum sustainable yield (B_{msy} = black line). The upper 95% confidence limit of Bmsy (dashed line) would present a precautionary target biomass above B_{msy}. This is also the area where the maximum economic yield could be obtained. The functional groups of large predators (red), pelagic plankton feeders (green), and benthic organisms (blue) are indicated. All functional groups were below the B_{msy} level in recent years. [Balearic_Oct12_16.xlsx]

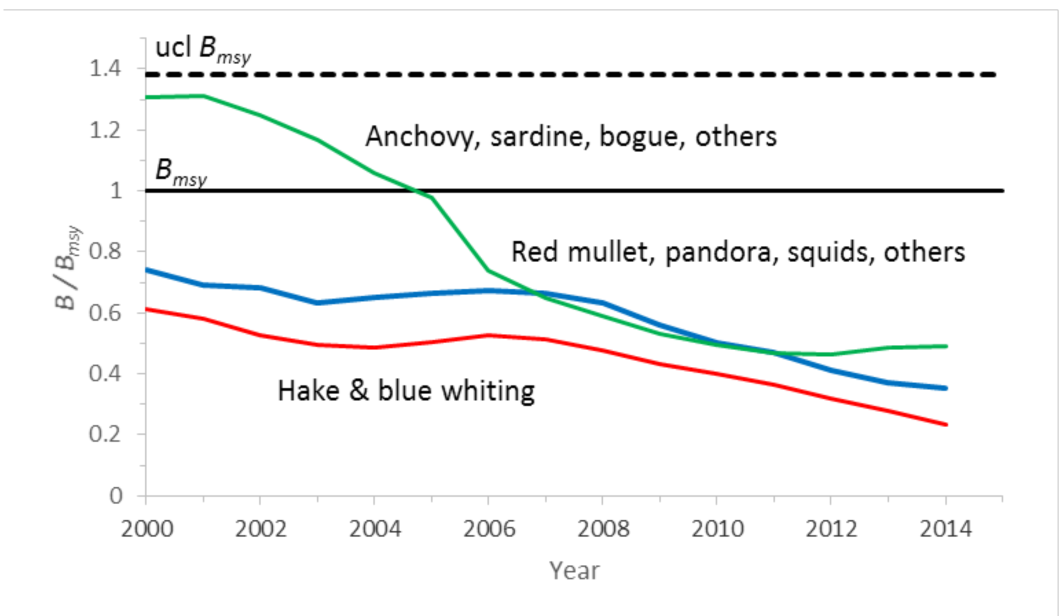


Figure 73. Median biomass relative to the level that can produce the maximum sustainable yield (B/B_{msy}) for 22 stocks in the Balearic Sea assigned to main functional groups. Large predators (red), pelagic plankton feeders (green) and benthic organisms (blue) have biomass levels well below B_{msy}, even outside of safe biological limits in recent years [Balearic_Oct12_16.xlsx].

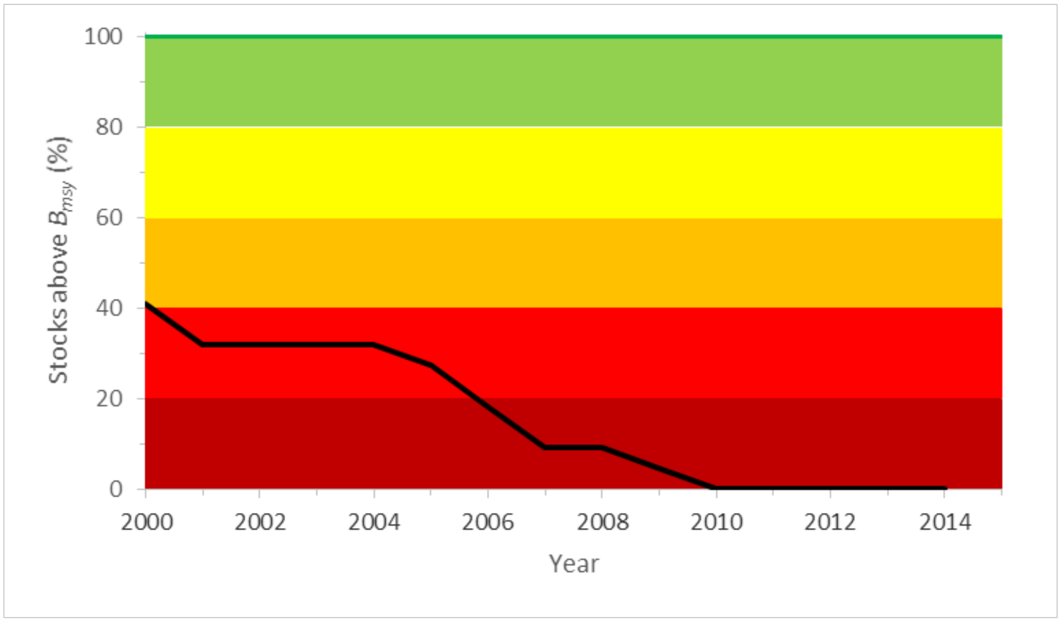


Figure 74. Percentage of stocks where biomass is above the level that can produce the maximum sustainable yield (B_{msy}) for 22 stocks in the Balearic Sea (black curve). The colors indicate visually the compliance with the goals of the Common Fisheries Policy, where all stocks (100%) shall be above B_{msy} eventually. In 2014, no stocks fulfilled that requirement. [Balearic_Oct12_16.xlsx]

Figure 75. Percentage of stocks where fishing pressure is at or below the maximum sustainable level (F_{msy}) for 22 stocks in the Balearic Sea (black curve). The colors indicate visually the compliance with the goals of the Common Fisheries Policy, where all stocks (100%) shall be fished at or below F_{msy} in 2015, latest in 2020. In 2014, only one stock (5%) fulfilled that requirement. [Balearic_Oct12_16.xlsx]

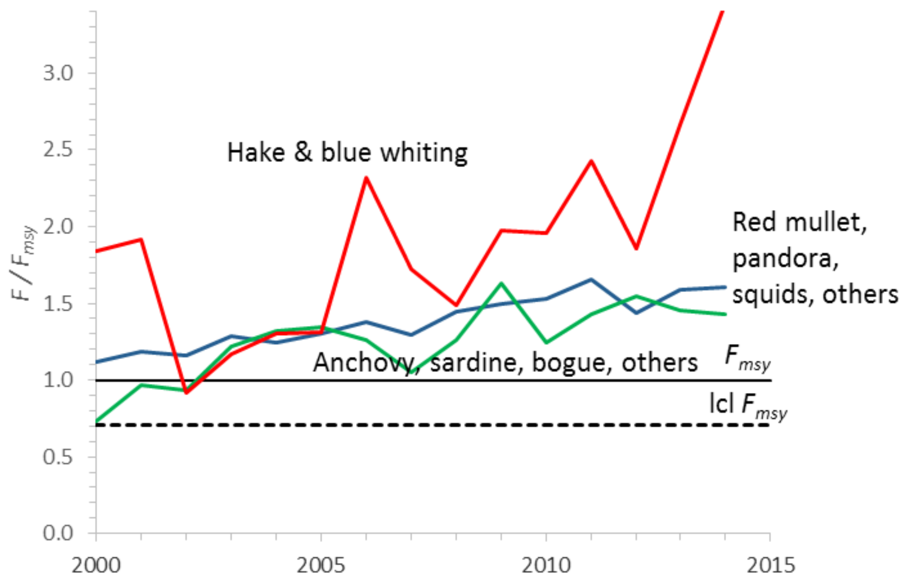


Figure 76. Median fishing pressure relative to the maximum sustainable level (F/Fmsy) for 22 stocks in the Balearic Sea assigned to main functional groups. All groups were subject to severe ongoing overfishing in 2014. [Balearic_Oct12_16.xlsx]

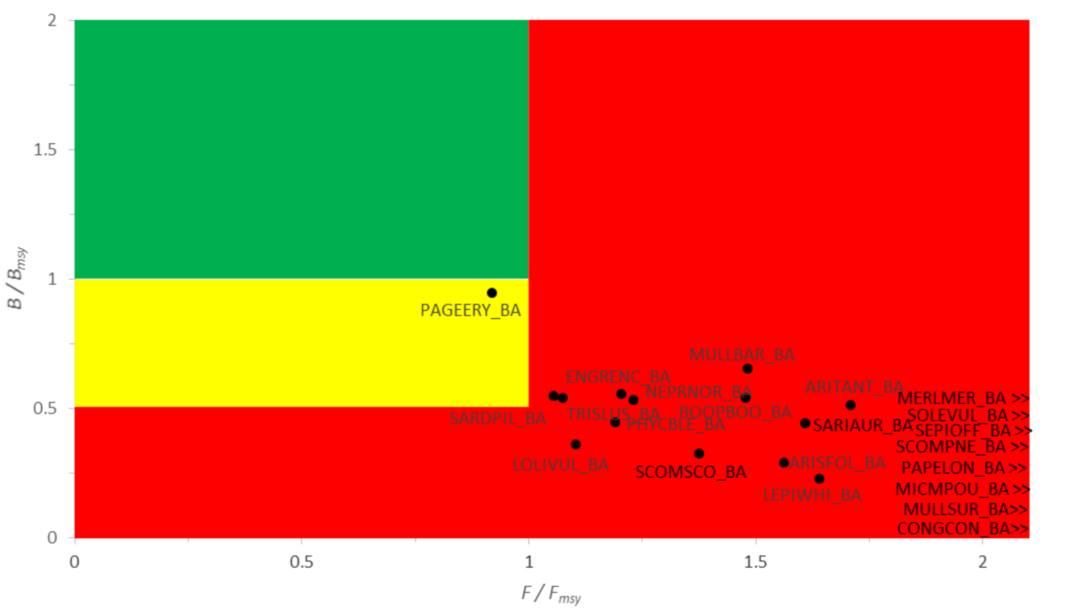


Figure 77. Presentation of 22 Balearic Sea stocks in a pressure (F/F_{msy}) – state (B/B_{msy}) plot. The red area indicates stocks that are being overfished or are outside of safe biological limits. The yellow area indicates recovering stocks. The green area indicates stocks subject to sustainable fishing pressure and of a healthy stock size that can produce high yields close to MSY. Several stocks were strongly depleted (B < 0.5 Bmsy) and outside of the range for F/Fmsy in this chart. They are indicated with >> at the lower right corner. [Balearic_Oct12_16.xlsx]

Sardinia

The following paragraph on the waters around Sardinia (GSA 11) was taken from the website www.fao.org and modified from http://www.indiseas.org.

"The waters of the Tyrrhenian Sea and adjacent waters bounded by a line commencing on the coast of Africa at the Algerian/Tunisian frontier at 8°37'E longitude; thence running due north to 38°00' north latitude; thence due west to 8°00' east longitude; thence due north to 41°20' north latitude; thence northward along a rhumb line to the mainland coast at the frontier between France and Italy; thence following the coast of Italy to 38°00' north latitude; thence due west along 38°00' north latitude to the coast of Sicily; thence following the northern coast of Sicily to Trapani (38°02' N latitude; and 12°32' E longitude); thence along a rhumb line to Cape Bon (Ras el Tib) at 37°08' N latitude; and 11°00' E longitude; thence westwards following the coast of Tunisia to the starting point. For the purposes of this work only the landings and biomasses of the northern coastline were used."

JRC-STEFC assessment reports and FAO-GFCM landings with data until 2014 were analyzed for 19 stocks in the Sardinia (GFCM subarea 1.3). The graphs below summarize their status and exploitation level within an MSY-framework. The list of species and their current exploitation and status is summarized in Table 13. Detailed assessments for every stock are available in Appendix 2 and in the spreadsheet Sardinia_Oct14_16.xlsx.

Of the 19 stocks, 18 (95%) were subject to ongoing overfishing ($F > F_{msy}$) and 13 stocks (68%) were outside of safe biological limits ($B < 0.5\ B_{msy}$). Catches exceed the maximum sustainable yield (*C/MSY* > 1) in two stocks. Thirteen stocks (68%) were in critical condition, defined by being outside of safe biological limits and subject to overfishing or being severely depleted ($B < 0.2\ B_{msy}$). The scientific names of these stocks are marked red in Table 13. All stocks (100%) were subject to unsustainable exploitation (catch > *MSY* or $F > F_{msy}$ or $B < 0.2\ B_{msy}$), with the too high catches marked red in Table 13. None of the stocks could be considered healthy, defined by not being subject to overfishing and having a biomass above the one that can produce the maximum sustainable yield.

Summed biomass of the 19 stocks of 74.6 thousand tonnes in 2014 was well below the biomass level of 174 thousand tonnes that can produce maximum sustainable yields. Summed catches of 30,113 tonnes were below the summed maximum sustainable yield of 43,500 tonnes. Because of trophic interactions it is not possible to achieve *MSY* simultaneously for all stocks, but sustained catches of near the lower confidence limit or near 90% of *MSY* (whichever is lower) would be possible if all stocks have recovered above B_{msy}. Because of more fish in the water, such catches could be obtained with much less fishing effort and much less impact on the ecosystem. See legends of Figures for more comments.

Table 13. Analysis of 19 stocks in Sardinia, with indication of last year with available data (Year), maximum sustainable yield (MSY), absolute and relative catch (Catch, C/MSY), maximum sustainable fishing mortality (F_{msy}) if the stock is within safe biological limits ($B/B_{msy} > 0.5$), F_{msy} for current stock size, F/F_{msy} for current stock size, biomass that can produce MSY (B_{msy}), relative biomass (B/B_{msy}). Scientific names of healthy stocks where F/Fmsy < 1 and B/Bmsy > 1 are marked green and stocks outside of safe biological limits ($B/B_{msy} < 0.5$) with ongoing overfishing ($F/F_{msy} > 1$) are marked red. Catches above MSY are marked bold (C/MSY > 1). Overfishing with $F/F_{msy} > 1$ is marked bold. Stock sizes outside safe biological limits (B/Bmsy < 0.5) are marked bold. Unsustainable catches (catch > MSY, F > Fmsy, B < 0.2 Bmsy) are marked red. Catches are given in tonnes per year. Biomass is given in tonnes as average total biomass during the year. Species are sorted by functional groups as indicated by the color of the stock IDs: benthic fish & invertebrates (blue), large predators (red), and pelagic plankton feeders (green). [Sardinia_Oct14_16.xlsx]

Scientific name	Stock	Year	*MSY*	Catch	*C/MSY*	F_{msy}	F_{msy} cur	*F*	F/F_{msy} cur	B_{msy}	*B*	B/B_{msy}
Chamelea gallina	CHAMGAL_SA	2014	2,023	11	0.01	0.28	0.05	0.02	0.32	7,300	674	**0.09**
Dentex dentex	DENTDEN_SA	2014	1,626	149	0.09	0.22	0.08	0.10	**1.23**	7,533	1,451	**0.19**
Illex coindettii	ILLECOI_SA	2014	990	624	0.63	0.20	0.20	0.21	**1.07**	5,046	2,970	0.59
Loligo vulgaris	LOLIVUL_SA	2014	1,452	806	0.56	0.15	0.09	0.26	**2.79**	9,986	3,152	**0.32**
Mullus barbatus	MULLBAR_SA	2014	1,589	2,631	**1.66**	0.36	0.36	0.85	**2.33**	4,372	3,109	0.71
Nephrops norvegicus	NEPRNOR_SA	2014	634	208	0.33	0.23	0.12	0.29	**2.50**	2,761	707	**0.26**
Pagellus erythrinus	PAGEERY_SA	2014	444	424	0.96	0.32	0.28	0.71	**2.59**	1,385	595	**0.43**
Palinurus elephas	PALIELE_SA	2014	528	93	0.18	0.09	0.04	0.07	**1.85**	5,999	1,310	**0.22**
Parapenaeus longirostris	PAPELON_SA	2014	2,457	3,056	**1.24**	0.53	0.53	0.70	**1.32**	4,611	4,337	0.94
Sepia officinalis	SEPIOFF_SA	2014	345	320	0.93	0.28	0.28	0.34	**1.21**	1,218	930	0.76
Belone belone	BELOBEL_SA	2014	217	28	0.13	0.22	0.08	0.15	**1.82**	1,001	189	**0.19**
Coryphaena hippurus	CORYHIP_SA	2014	866	449	0.52	0.55	0.42	0.75	**1.79**	1,582	602	**0.38**
Epinephelus marginatus	EPINGUA_SA	2014	277	48	0.17	0.18	0.07	0.16	**2.37**	1,523	291	**0.19**
Merluccius merluccius	MERLMER_SA	2014	5,266	4,482	0.85	0.23	0.23	0.38	**1.66**	23,193	11,868	0.51
Micromesistius poutassou	MICMPOU_SA	2014	1,130	175	0.15	0.18	0.08	0.13	**1.62**	6,145	1,343	**0.22**
Boops boops	BOOPBOO_SA	2014	2,593	1,397	0.54	0.30	0.17	0.56	**3.27**	8,722	2,502	**0.29**
Engraulis encrasicolus	ENGRENC_SA	2014	9,564	7,575	0.79	0.27	0.26	0.44	**1.69**	35,352	17,124	**0.48**
Sardina pilchardus	SARDPIL_SA	2014	11,269	7,460	0.66	0.25	0.23	0.35	**1.53**	45,387	21,111	**0.47**
Spicara maena	SPICMAE_SA	2014	290	177	0.61	0.50	0.50	0.52	**1.04**	575	339	0.59

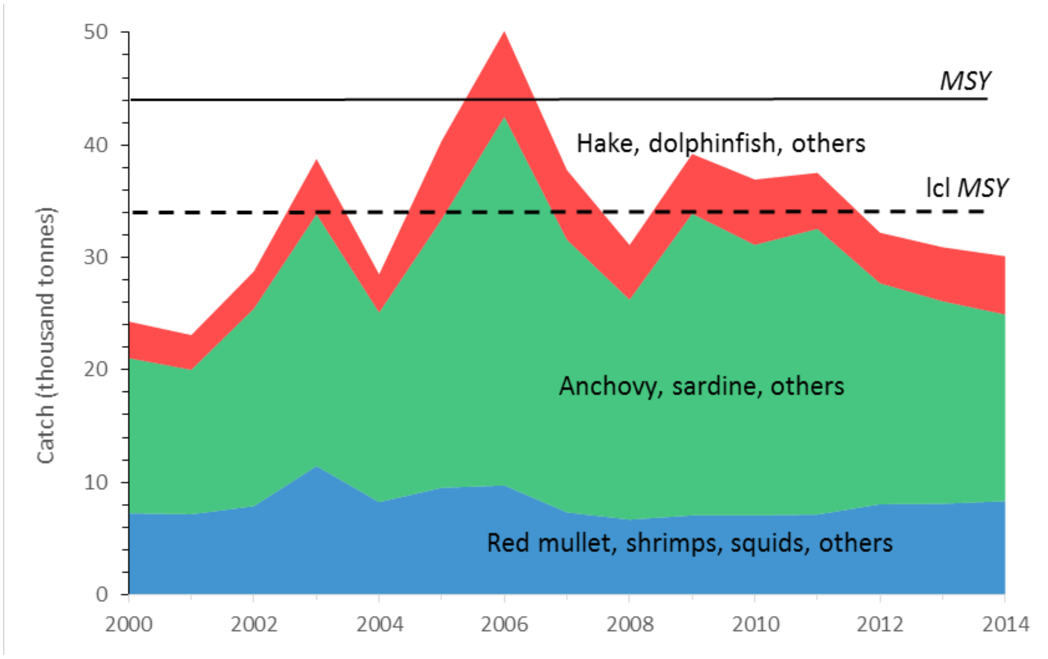


Figure 28. Cumulative catches, including discards and recreational catch if available, for 19 stocks in Sardinia, with indication of main functional groups. The black line indicates the maximum sustainable yield (MSY) for the ecoregion and the dashed line indicates the lower 95% confidence limit as a precautionary target. [Sardinia_Oct14_16.xlsx]

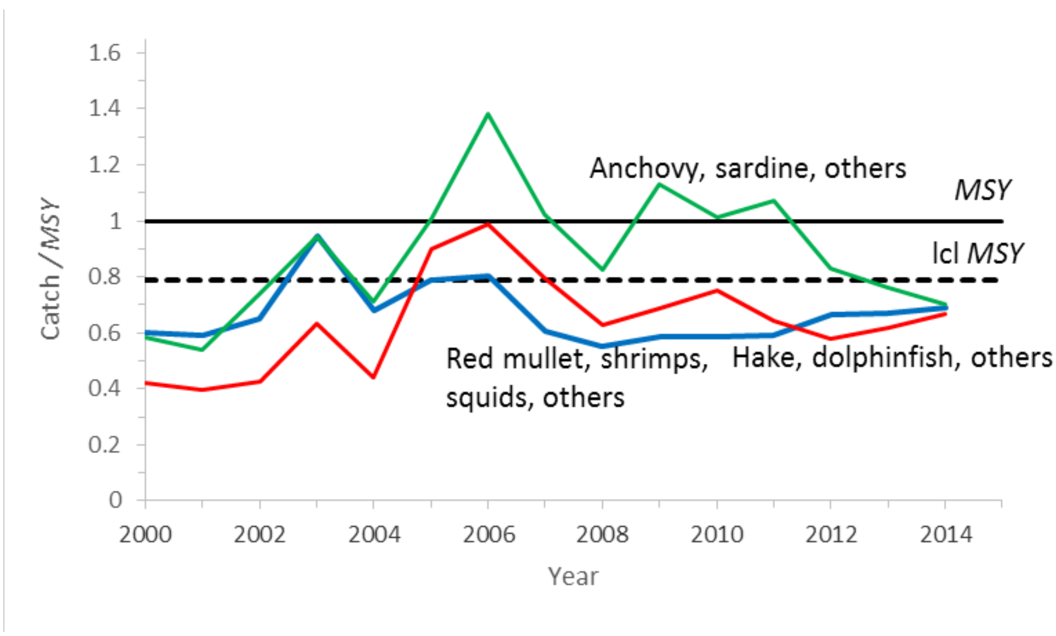


Figure 79. Catches by main functional group relative to their maximum sustainable yield (MSY, black line), for 19 stocks in Sardinia. Red mullet & shrimps (blue curve) were exploited unsustainably above MSY. Pelagic plankton feeders (green) and large predators (red) supported catches below the precautionary over all lower 95% confidence limit of MSY (dashed line). [Sardinia_Oct14_16.xlsx]

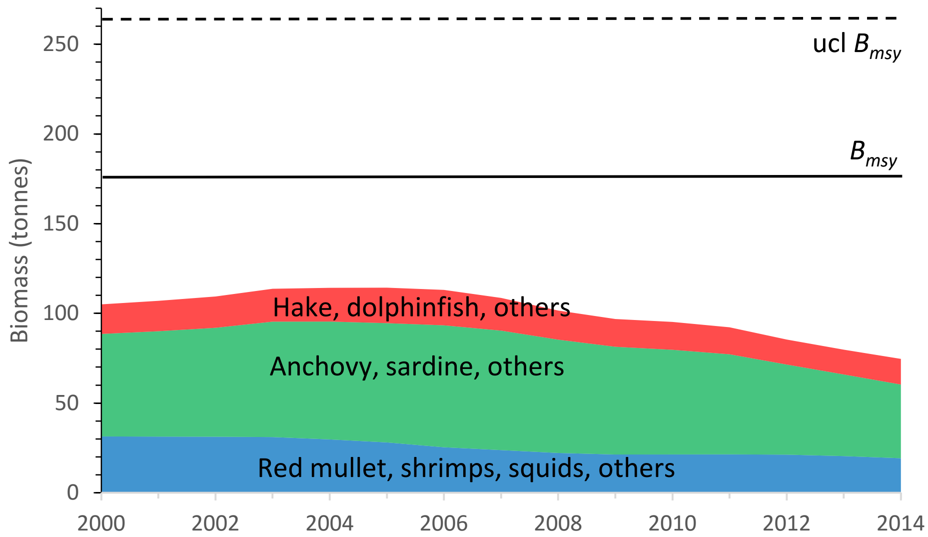


Figure 80. Cumulative total biomass of 19 stocks in the Sardinia area relative to the biomass that can produce the maximum sustainable yield (B_{msy} = black line). The upper 95% confidence limit of B_{msy} (dashed line) would present a precautionary target biomass above B_{msy}. This is also the area where the maximum economic yield could be obtained. The functional groups of large predators (red), pelagic plankton feeders (green), and benthic organisms (blue) are indicated. All functional groups were far below the Bmsy level. [Sardinia_Oct14_16.xlsx]

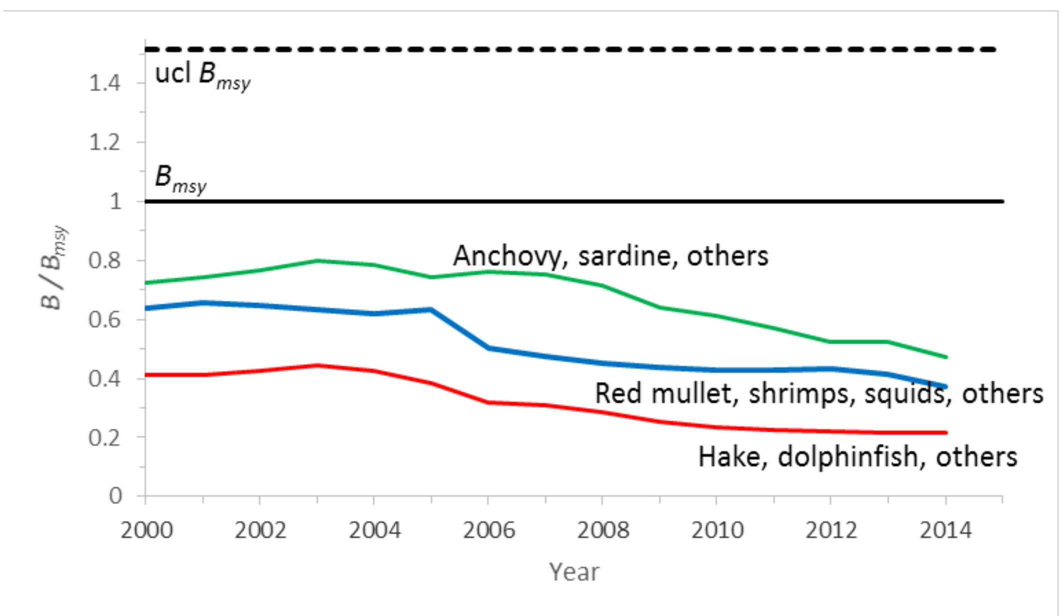


Figure 81. Median biomass relative to the level that can produce the maximum sustainable yield (B/B_{msy}) for 19 stocks in Sardinia assigned to main functional groups. Pelagic plankton feeders (green), and benthic organisms (blue) have biomass levels well below B_{msy}. Large predators (red) are outside of safe biological limits. [Sardinia_Oct14_16.xlsx]

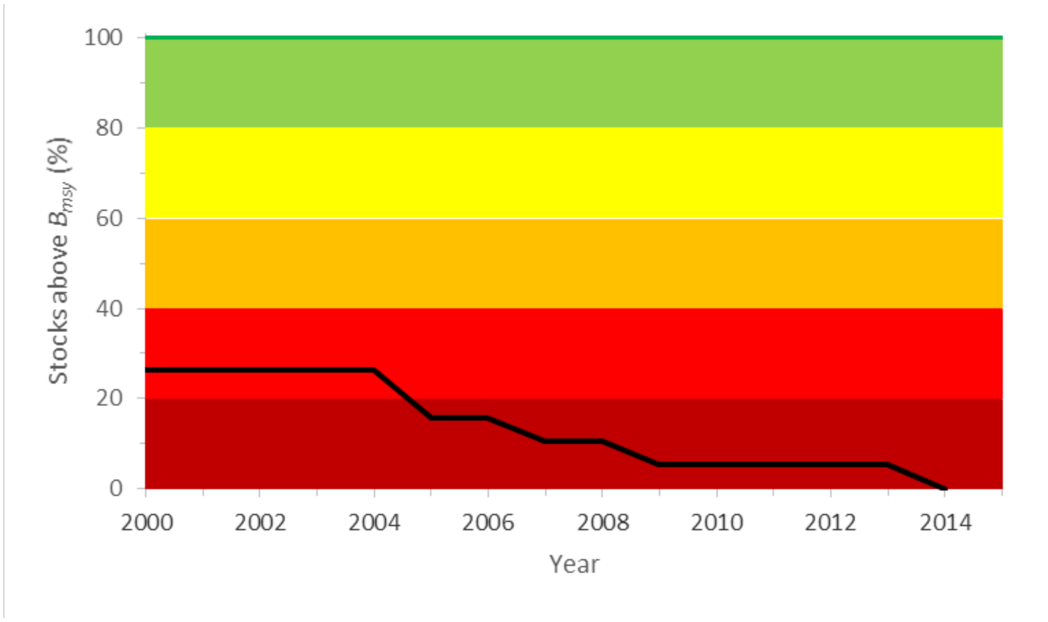


Figure 82. Percentage of stocks where biomass is above the level that can produce the maximum sustainable yield (B_{msy}) for 19 stocks in the Sardinia ecoregion (black curve). The colors indicate visually the compliance with the goals of the Common Fisheries Policy, where all stocks (100%) shall be above B_{msy} eventually. In 2014, no stocks fulfilled that requirement. [Sardinia_Oct14_16.xlsx]

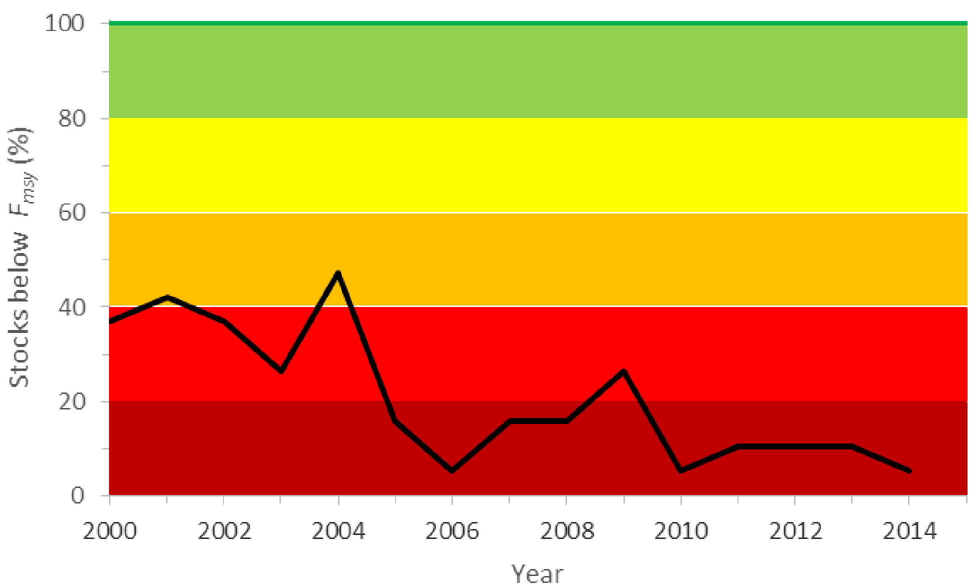


Figure 33. Percentage of stocks where fishing pressure is at or below the maximum sustainable level (F_{msy}) for 19 stocks in the Sardinia ecoregion (black curve). The colors indicate visually the compliance with the goals of the Common Fisheries Policy, where all stocks (100%) shall be fished at or below F_{msy} in 2015, latest in 2020. In 2014, only one stock (5%) fulfilled that requirement. [Sardinia_Oct14_16.xlsx]

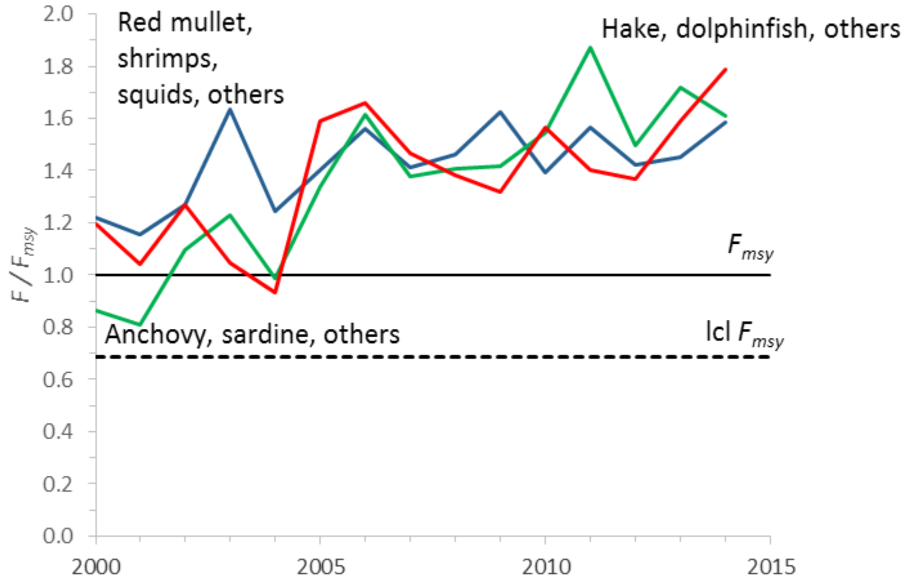


Figure 84. Median fishing pressure relative to the maximum sustainable level (F/F_{msy}) for 19 stocks in Sardinia assigned to main functional groups. Nearly all stocks and all functional groups were exploited well above the maximum sustainable fishing pressure. [Sardinia_Oct14_16.xlsx]

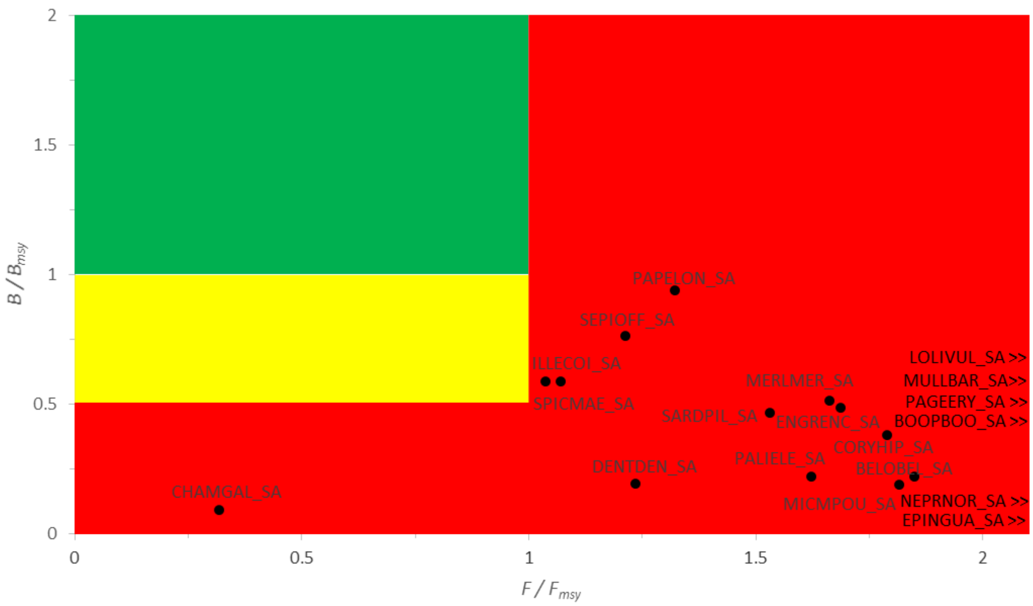


Figure 85. Presentation of 19 Sardinia stocks in a pressure (F/F_{msy}) – state (B/B_{msy}) plot. The red area indicates stocks that are being overfished or are outside of safe biological limits. The yellow area indicates recovering stocks. The green area indicates stocks subject to sustainable fishing pressure and of a healthy stock size that can produce high yields close to MSY. Several stocks were strongly depleted (B < 0.5 Bmsy) and outside of the range for F/Fmsy in this chart. They are indicated with >> at the lower right corner. [Sardinia_Oct14_16.xlsx]

Adriatic Sea

The following four paragraphs describing the Adriatic Sea (GSAs 17 & 18) were taken from the website www.fao.org and modified from http://www.indiseas.org.

"The waters of the Adriatic Sea north of a line running from the Albanian northern frontier on the east coast of the Adriatic Sea due west to Cape Gargano at 41°49'N latitude and 16°12'E longitude on the coast of Italy.

Three main water types have been identified in the Adriatic Sea: the Surface Water (SW), the Deep Water (DW) and the Modified Levantine Intermediate Waters (MLIW), and the general circulation is baroclinic. Owing to river runoff (mainly by the Po River located in the northwest) and the oceanographic conditions, the region exhibits a decreasing trend in nutrient concentration and production from north to south and from west to east. The substrate is characterized by muddy to sandy bottoms. The area has a mean depth of 75 m, with 30 m depth in the north, and its maximum depth is registered in the Pomo Pit as 280 m deep.

On the continental shelf from 10-50 m depth, the dominant fish species in terms of biomass are red mullet (*Mullus barbatus*), poor cod (*Trisopterus minutus*), various species of triglids, sole (*Solea solea*), various species of flatfishes, gobies and pandoras (*Pagellus* spp.). From 50 to 100 m deep, anglerfish (*Lophius* spp.), European hake (*Merluccius merluccius*), greater forkbeard (*Phycis blennoides*) and red bandfish (*Cepola macrophthalma*) are also abundant, as well as blue whiting (*Micromesistius poutassou*) at 100 to 200 m deep. In the pelagic domain, main fish species are sardine (*Sardina pilchardus*), anchovy (*Engraulis encrasicolus*), horse mackerel (*Trachurus* spp.) and mackerel (*Scomber* spp.). In the northern area, sprat (*Sprattus sprattus*) is found, although it was more abundant during the 1960s and 1970s than nowadays.

Several studies have highlighted the important relationship between environmental factors and primary and secondary production dynamics in the Mediterranean Sea and, especially in the north-central Adriatic Sea, such as wind mixing, river runoff, eutrophication and increase in water temperature. The wind mixing index has been positively related with recruitment of various demersal species most likely due to enhancement of fertilization and local planktonic production."

JRC-STEFC assessment reports and FAO-GFCM landings with data until 2013 or 2014 were analyzed for 30 stocks in the Adriatic Sea (GFCM subarea 2.1). The graphs below summarize their status and exploitation level within an MSY-framework. The list of species and their current exploitation and status is summarized in Table 14. Detailed assessments for every stock are available in Appendix 2 and in the spreadsheet Adriatic_Oct14_16.xlsx.

Of the 30 stocks, 19 (63%) were subject to ongoing overfishing ($F > F_{msy}$) and 20 stocks (67%) were outside of safe biological limits ($B < 0.5\ B_{msy}$). Catches exceeded the maximum sustainable yield ($C/MSY > 1$) in four stocks (13%). Fifteen stocks (50%) were in critical condition, defined by being outside of safe biological limits and subject to overfishing or being severely depleted ($B < 0.2\ B_{msy}$). The scientific names of these stocks are marked red in Table 14. Altogether, 24 stocks (80%) were subject to unsustainable exploitation (catch > MSY or F > Fmsy or B < 0.2 Bmsy), with the too high catches marked red in Table 14. Only one stock (Purple dye murex, *Bolinus brandaris*, 3%) could be considered healthy, defined by not being subject to overfishing ($F < F_{msy}$ and Catch < MSY) and having a biomass above the one that can produce the maximum sustainable yield (marked green in Table 14).

Summed biomass of the 30 stocks of 412 thousand tonnes in 2013 was well below the biomass level of 769 thousand tonnes that can produce maximum sustainable yields. Summed catches of 141 thousand tonnes were below the summed maximum sustainable yield of 187 thousand tonnes. Because of trophic interactions it is not possible to achieve *MSY* simultaneously for all stocks, but sustained catches of near the lower confidence limit or near 90% of *MSY* (whichever is lower) would be possible if all stocks have recovered above B_{msy}. Because of more fish in the water, such catches could be obtained with much less fishing effort and much less impact on the ecosystem. See legends of Figures for more comments.

Table 14. Analysis of 30 stocks in the Adriatic Sea, with indication of last year with available data (Year), maximum sustainable yield (MSY), absolute and relative catch (Catch, C/MSY), maximum sustainable fishing mortality (F_{msy}) if the stock is within safe biological limits (B/B_{msy} > 0.5), F_{msy} for current stock size, F/F_{msy} for current stock size, biomass that can produce MSY (B_{msy}), relative biomass (B/B_{msy}). Scientific names of healthy stocks where F/Fmsy < 1 and B/Bmsy > 1 are marked green and stocks outside of safe biological limits (B/B_{msy} < 0.5) with ongoing overfishing (F/F_{msy} > 1) or severe depletion (B < 0.2 Bmsy) are marked red. Catches above MSY are marked bold (C/MSY > 1). Overfishing with F/F_{msy} > 1 is marked bold. Stock sizes outside safe biological limits (B/Bmsy < 0.5) are marked bold. Unsustainable catches (catch > MSY, F > Fmsy, B < 0.2 Bmsy) are marked red. Catches are given in tonnes per year. Biomass is given in tonnes as average total biomass during the year. Species are sorted by functional groups as indicated by the color of the stock IDs: benthic fish & invertebrates (blue), large predators (red) and pelagic plankton feeders (green). [Adriatic_Oct14_16.xlsx]

Scientific name	Stock	Year	*MSY*	Catch	*C/MSY*	F_{msy}	F_{msy} cur	*F*	F/F_{msy} cur	B_{msy}	*B*	B/B_{msy}
Bolinus brandaris	Boli_bra_AD	2015	1,036	900	0.87	0.49	0.49	0.41	0.84	2,132	2,210	1.04
Chamelea gallina	Cham_gal_AD	2014	25,995	13,984	0.54	0.25	0.21	0.32	**1.50**	104,434	44,228	**0.42**
Conger conger	Cong_con_AD	2014	128	93	0.73	0.17	0.12	0.36	**3.07**	745	256	**0.34**
Dentex dentex	Dent_den_AD	2014	102	33	0.32	0.20	0.12	0.21	**1.74**	519	158	**0.30**
Homarus gammarus	Hom_gam_AD	2013	31	6	0.19	0.19	0.09	0.15	**1.75**	165	39	**0.24**
Illex coindettii	Ille_coi_AD	2013	3,201	688	0.22	0.30	0.19	0.20	**1.05**	10,538	3,375	**0.32**
Loligo vulgaris	Loli_vul_AD	2013	1,391	100	0.07	0.18	0.07	0.06	0.89	7,756	1,560	**0.201**
Lophius spp.	Lophius_AD	2013	377	250	0.66	0.21	0.21	0.20	0.93	1,786	1,279	0.72
Mullus barbatus	Mull_bar_AD	2013	3,953	3,373	0.85	0.25	0.25	0.42	**1.68**	15,921	8,074	0.51
Oblada melanura	Obla_mel_AD	2014	183	34	0.19	0.39	0.13	0.45	**3.60**	469	75	**0.16**
Pagellus erythrinus	Page_ery_AD	2013	359	79	0.22	0.18	0.09	0.16	**1.76**	1,951	488	**0.25**
Palinurus elephas	Pali_ele_AD	2014	48	10	0.21	0.11	0.08	0.06	0.79	424	154	**0.36**
Pecten jacobeus	Pect_jac_AD	2015	911	50	0.05	0.23	0.09	0.07	0.77	4,023	759	**0.19**
Penaeus kerathurus	Pena_ker_AD	2015	477	528	**1.11**	0.60	0.60	0.54	0.91	800	976	1.22
Scophthalmus maximus	Pset_max_AD	2013	7,487	8,134	**1.09**	0.23	0.23	0.21	0.93	32,880	38,371	1.17
Scophthalmus rhombus	Scop_rho_AD	2015	317	65	0.20	0.20	0.10	0.16	**1.55**	1,561	401	**0.26**
Sepia officinalis	Sepi_off_AD	2015	3,815	3,411	0.89	0.26	0.24	0.51	**2.14**	14,761	6,749	**0.46**
Solea solea	Sole_sol_AD	2015	1,740	2,151	**1.24**	0.31	0.31	0.63	**2.06**	5,651	3,391	0.60
Spondyliosoma cantharus	Spod_can_AD	2014	46	9	0.19	0.24	0.10	0.21	**2.03**	196	43	**0.22**
Squilla mantis	Squi_man_AD	2014	4,117	3,150	0.77	0.18	0.18	0.20	**1.09**	22,273	15,596	0.70
Trisopterus minutus	Tris_min_AD	2013	185	115	0.62	0.28	0.16	0.60	**3.67**	654	190	**0.29**

Scientific name	**Stock**	**Year**	***MSY***	**Catch**	***C/MSY***	***F_{msy}***	***$F_{msy\ cur}$***	***F***	***$F/F_{msy\ cur}$***	***B_{msy}***	***B***	***B/B_{msy}***
Belone belone	Belo_bel_AD	2014	182	4	0.02	0.21	0.08	0.02	0.29	862	166	**0.19**
Merluccius merluccius	Merl_mer_AD	2013	20,962	9,542	0.46	0.24	0.11	0.46	**4.05**	88,311	20,930	**0.24**
Micromesistius poutassou	Micr_pou_AD	2013	939	132	0.14	0.21	0.15	0.08	0.55	4,461	1,588	**0.36**
Seriola dumerili	Seri_dum_AD	2014	55	93	**1.70**	0.36	0.36	0.45	**1.27**	153	205	1.34
Atherina boyeri	Athe_boy_AD	2014	2,764	348	0.13	0.16	0.12	0.06	0.45	16,860	6,284	**0.37**
Boops boops	Boop_Boo_AD	2014	1,600	103	0.06	0.22	0.06	0.11	**1.80**	7,122	953	**0.13**
Engraulis encrasicolus	Engr_enc_AD	2013	35,722	32,761	0.92	0.27	0.27	0.35	**1.31**	131,913	92,384	0.70
Sardina pilchardus	Sard_pil_AD	2013	66,605	59,814	0.90	0.24	0.24	0.38	**1.58**	275,041	156,175	0.57
Trachurus spp.	Trachurus_AD	2014	2,362	680	0.29	0.17	0.13	0.12	0.92	14,192	5,599	**0.39**

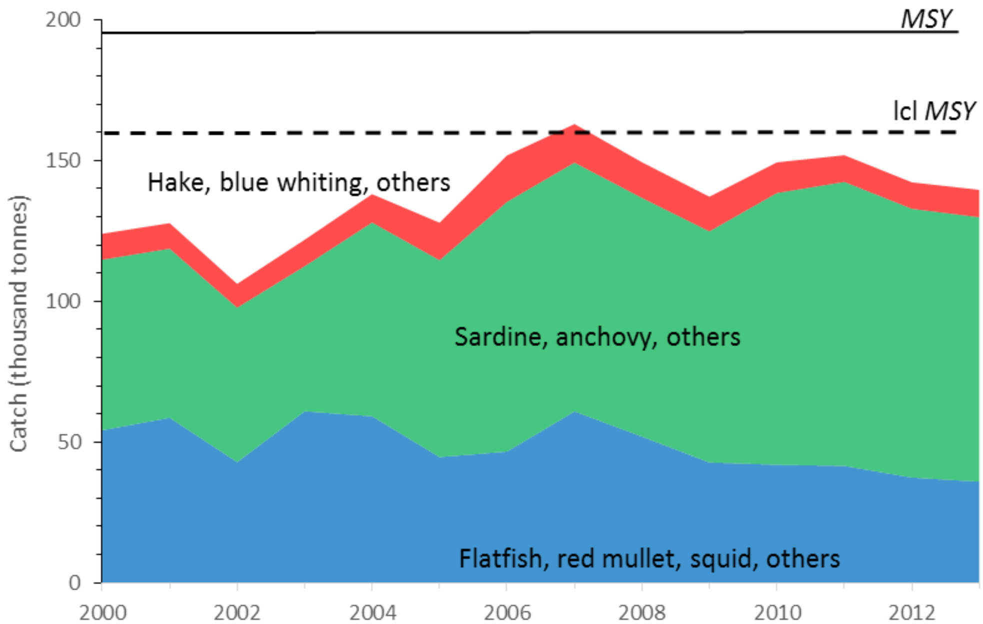


Figure 86. Cumulative catches, including discards and recreational catch if available, for 30 stocks in the Adriatic Sea, with indication of main functional groups. The black line indicates the maximum sustainable yield (MSY) for the ecoregion and the dashed line indicates the lower 95% confidence limit as a precautionary target. [Adriatic_Oct14_16.xlsx]

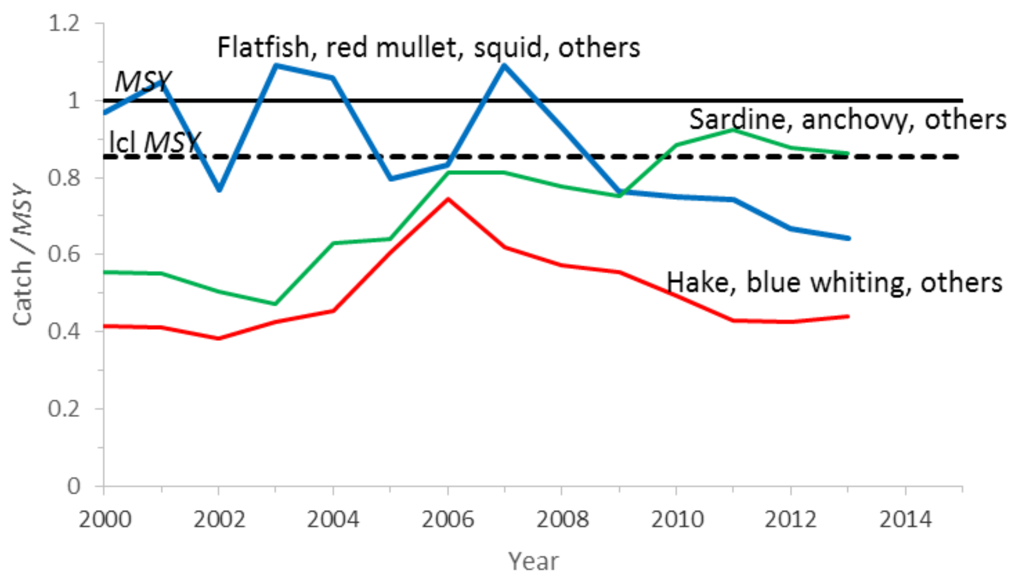


Figure 87. Catches by main functional group relative to their maximum sustainable yield (MSY, black line), for 30 stocks in the Adriatic Sea. Large predators (red) and benthic organisms (blue) supported catches below the precautionary over all lower 95% confidence limit of MSY (dashed line) and present declining trends. Pelagic plankton feeders (green line) supported catches near the precautionary level. [Adriatic_Oct14_16.xlsx]

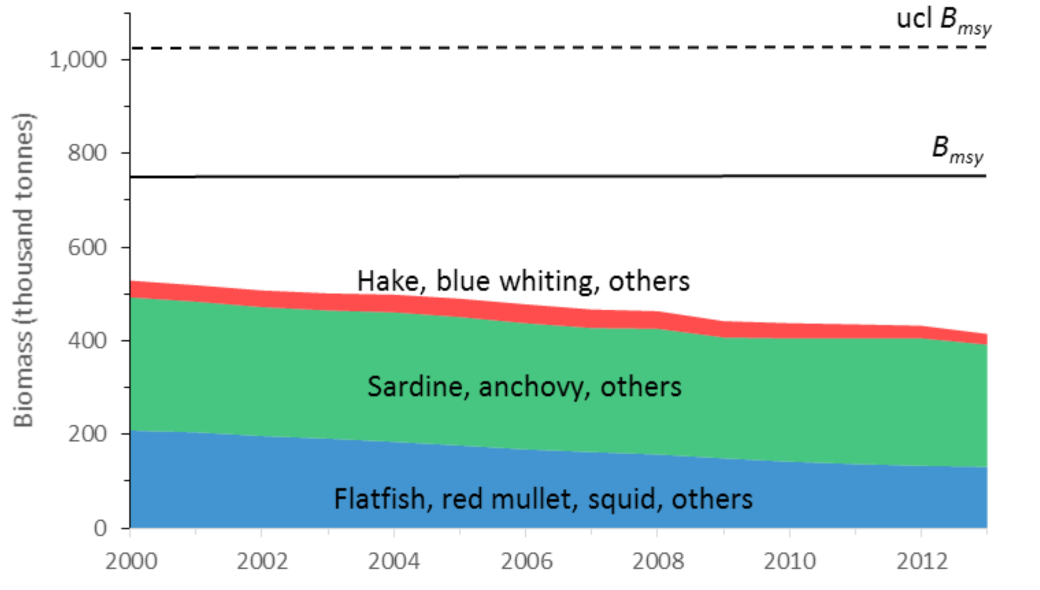


Figure 88. Cumulative total biomass of 30 stocks in the Adriatic Sea relative to the biomass that can produce the maximum sustainable yield (B_{msy} = black line). The upper 95% confidence limit of B_{msy} (dashed green line) would present a precautionary target biomass above B_{msy}. This is also the area where the maximum economic yield could be obtained. The functional groups of large predators (red), pelagic plankton feeders (green), and benthic organisms (blue) are indicated. [Adriatic_Oct14_16.xlsx]

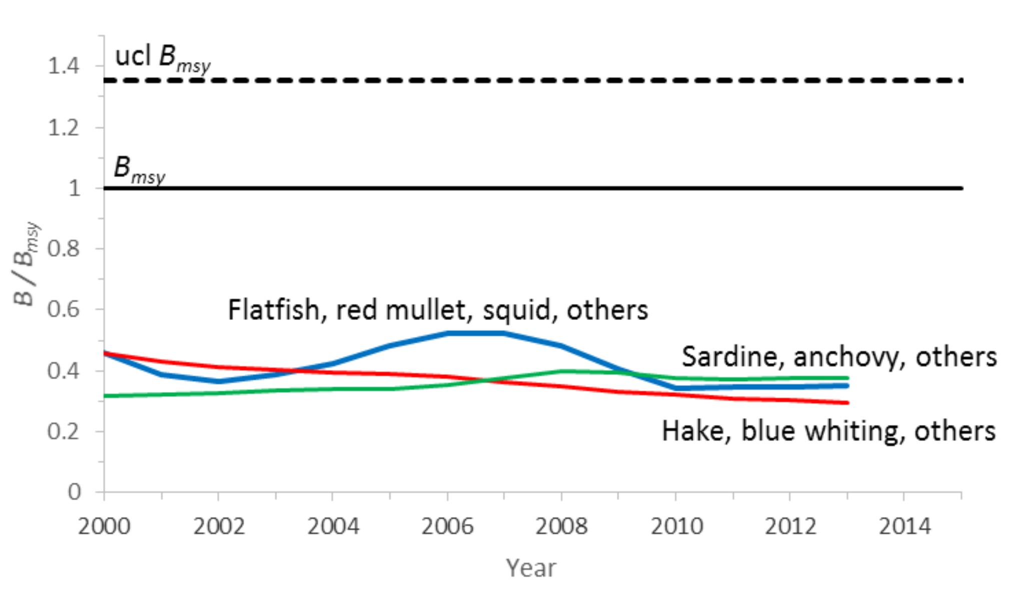


Figure 89. Median biomass relative to the level that can produce the maximum sustainable yield (B/B_{msy}) for 30 stocks in the Adriatic Sea assigned to main functional groups. Large predators (red), pelagic plankton feeders (green) and benthic organisms (blue) all have biomass levels well below Bmsy. *[Adriatic_Oct14_16.xlsx]*

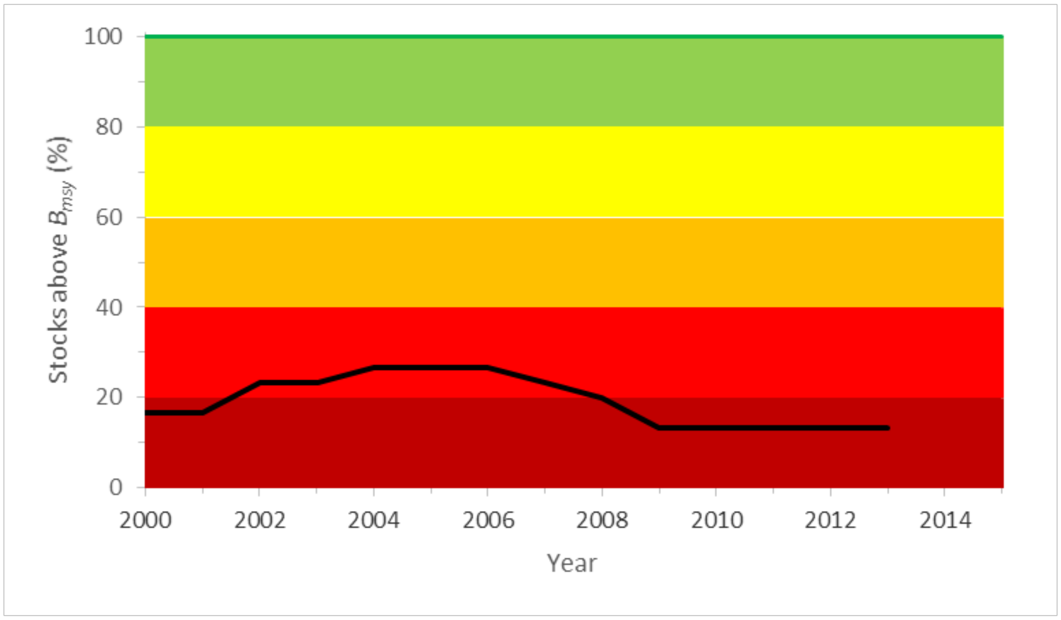


Figure 90. Percentage of stocks where biomass is above the level that can produce the maximum sustainable yield (B_{msy}) for 30 stocks in the Adriatic Sea (black curve). The colors indicate visually the compliance with the goals of the Common Fisheries Policy, where all stocks (100%) shall be above B_{msy} eventually. In 2013, four stocks (13%) fulfilled that requirement. [Adriatic_Oct14_16.xlsx]

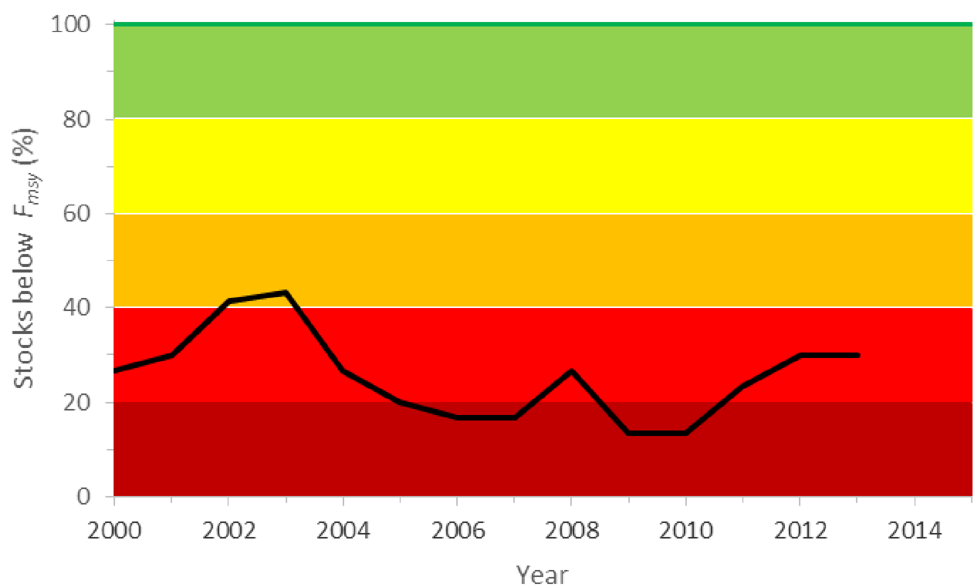


Figure 91. Percentage of stocks where fishing pressure is at or below the maximum sustainable level (F_{msy}) for 30 stocks in the Adriatic Sea (black curve). The colors indicate visually the compliance with the goals of the Common Fisheries Policy, where all stocks (100%) shall be fished at or below F_{msy} in 2015, latest in 2020. In 2013, nine stocks (30%) fulfilled that requirement. [Adriatic_Oct14_16.xlsx]

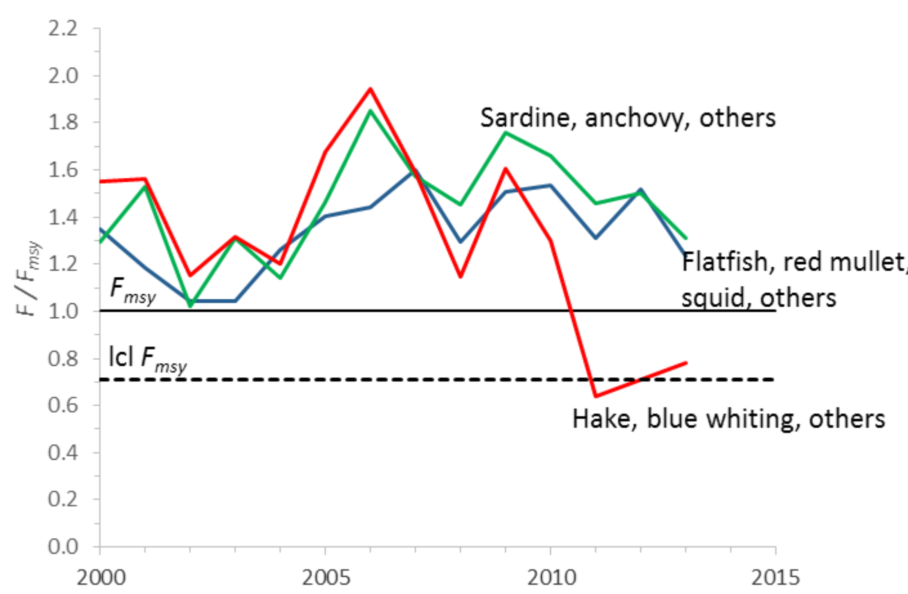


Figure 42. Median fishing pressure relative to the maximum sustainable level (F/F_{msy}) for 30 stocks in the Adriatic Sea assigned to main functional groups. The decline in fishing pressure for large predators (red) after 2010 is cause by reduced pressure on blue whiting and masks the increased pressure on hake [Adriatic_Oct14_16.xlsx]

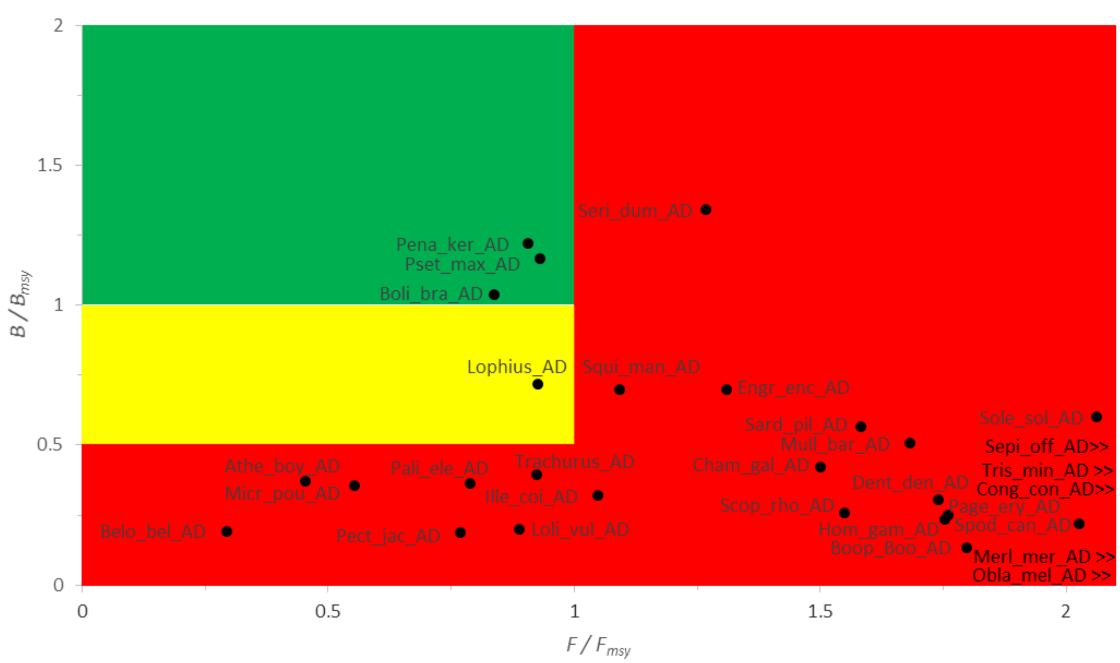


Figure 93. Presentation of 30 Adriatic Sea stocks in a pressure (F/F_{msy}) – state (B/B_{msy}) plot. The red area indicates stocks that are being overfished or are outside of safe biological limits. The yellow area indicates recovering stocks. The green area indicates stocks subject to sustainable fishing pressure and of a healthy stock size that can produce high yields close to MSY. Several stocks were exploited above the range of this chart indicated by >> at the lower right corner. [Adriatic_Oct14_16.xlsx]

Ionian Sea

The following four paragraphs describing the Ionian Sea (GSAs 19, 20) were taken from the website http://www.indiseas.org/ecosystems/ionian-sea-archipelago.

"The Inner Ionian Sea Archipelago is situated in the eastern Mediterranean Sea, on the Western part of Greece. The area covers approximately 1021 km^2 of sea surface and includes the islands of Meganisi, Kalamos and Kastos. The archipelago is delimited by the mainland of Greece, Lefkada Island and the northern tips of Kefalonia and Ithaca.

The Inner Ionian Sea Archipelago is extremely oligotrophic with values of Chlorophyll a, nutrients and particulate organic carbon among the lowest found in Mediterranean coastal waters. Most of the area is relatively shallow, ranging in depth between 100 and 200 m. The bottom is covered by seagrass meadows at depth between 1 and 30m. Such benthic macrophytes, despite being an important nursery ground for fish populations, in the last decades have suffered a tremendous decline in the area due to fishing operations (mainly by purse seiners, trawlers and beach seiners).

The European sardine (*Sardina pilcardus*) and anchovy (*Engraulis encrasicolus*) are the most important pelagic fish, in terms of biomass in the area, representing approximately 26% of the total Inner Ionian Sea Archipelago catch. Bogue (*Boops boops*), hake (*Merluccius merluccius*) and striped red mullet (*Mullus surmuletus*) dominate the demersal fish compartment. The area is an important spawning ground for European pilchard and hake.

An ecosystem model was built for the Inner Ionian Sea Archipelago to assess temporal changes (1964-2008) in abundance of the major marine organisms. Results of this study highlighted a clear decline of top predators and commercially important species (mainly European anchovy and European pilchard) due to overfishing and changes in ocean productivity."

JRC-STEFC assessment reports and FAO-GFCM landings with data until 2014 were analyzed for 31 stocks in the Ionian Sea (part of the GFCM subarea 2.2). The graphs below summarize their status and exploitation level within an MSY-framework. The list of species and their current exploitation and status is summarized in Table 15. Detailed assessments for every stock are available in Appendix 2 and in the spreadsheet Ionian_Oct13_16.xlsx.

Of the 31 stocks, 26 (84%) were subject to ongoing overfishing ($F > F_{msy}$) and 19 stocks (61%) were outside of safe biological limits ($B < 0.5\ B_{msy}$). In 7 stocks (23%) catches exceeded the maximum sustainable yield ($C/MSY > 1$). Seventeen stocks (55%) were in critical condition, defined by being outside of safe biological limits and subject to overfishing or being severely depleted ($B < 0.2\ B_{msy}$). The scientific names of these stocks are marked red in Table 15. Altogether, 26 stocks (84%) were subject to unsustainable exploitation (catch > MSY or F > Fmsy or B < 0.2 Bmsy), with the too high catches marked red in Table 15. In contrast, no stock could be considered healthy, defined by not being subject to overfishing and having a biomass above the one that can produce the maximum sustainable yield.

Summed biomass of the 31 stocks of 136 thousand tonnes in 2014 was well below the biomass level of 361 thousand tonnes that can produce maximum yields. Summed catches of 46 thousand tonnes were far below (46%) the summed maximum sustainable yield of 99 thousand tonnes. Because of trophic interactions it is not possible to achieve *MSY* simultaneously for all stocks, but sustained catches of near the lower confidence limit or near 90% of *MSY* (whichever is lower) would be possible if all stocks have recovered above B_{msy}. Because of more fish in the water, such catches could be obtained with much less fishing effort and much less impact on the ecosystem. See legends of Figures for more comments.

Table 15. Analysis of 31 stocks in the Ionian Sea, with indication of last year with available data (Year), maximum sustainable yield (MSY), absolute and relative catch (Catch, C/MSY), maximum sustainable fishing mortality (F_{msy}) if the stock is within safe biological limits ($B/B_{msy} > 0.5$), F_{msy} for current stock size, F/F_{msy} for current stock size, biomass that can produce MSY (B_{msy}), relative biomass (B/B_{msy}). Scientific names of healthy stocks where F/Fmsy < 1 and B/Bmsy > 1 are marked green and stocks outside of safe biological limits ($B/B_{msy} < 0.5$) with ongoing overfishing ($F/F_{msy} > 1$) or severe depletion (B < 0.2 Bmsy) are marked red. Catches above MSY are marked bold (C/MSY > 1). Overfishing with $F/F_{msy} > 1$ is marked bold. Stock sizes outside safe biological limits (B/Bmsy < 0.5) are marked bold. Unsustainable catches (catch > MSY, F > Fmsy, B < 0.2 Bmsy) are marked red. Catches are given in tonnes per year. Biomass is given in tonnes as average total biomass during the year. Species are sorted by functional groups as indicated by the color of the stock IDs: benthic fish & invertebrates (blue), large predators (red), and pelagic plankton feeders (green). [Ionian_Oct13_16.xlsx]

Scientific name	Stock	Year	*MSY*	Catch	*C/MSY*	F_{msy}	F_{msy} cur	*F*	F/F_{msy} cur	B_{msy}	*B*	B/B_{msy}
Aristeomorpha foliacea	ARISFOL_IS	2014	1,927	2,057	**1.07**	0.31	0.31	0.52	**1.67**	6,179	3,943	0.64
Conger conger	CONGCON_IS	2014	378	330	0.87	0.18	0.18	0.25	**1.43**	2,137	1,304	0.61
Dentex dentex	DENTDEN_IS	2014	1,742	813	0.47	0.22	0.19	0.23	**1.22**	7,952	3,477	**0.44**
Eledone cirrosa	ELEDCIR_IS	2014	1,148	1,934	**1.68**	0.12	0.10	0.46	**4.47**	9,742	4,229	**0.43**
Illex coindetii	ILLECOI_IS	2014	2,274	791	0.35	0.22	0.22	0.13	0.60	10,512	6,056	0.58
Mullus barbatus	MULLBAR_IS	2014	4,641	1,200	0.26	0.26	0.10	0.35	**3.48**	17,543	3,382	**0.19**
Mullus surmuletus	MULLSUR_IS	2014	276	71	0.26	0.44	0.24	0.41	**1.72**	632	173	**0.27**
Nephrops norvegicus	NEPRNOR_IS	2014	2,079	780	0.38	0.22	0.13	0.27	**2.11**	9,649	2,876	**0.30**
Octopus vulgaris	OCTOVUL_IS	2014	5,230	980	0.19	0.36	0.20	0.24	**1.21**	14,673	4,087	**0.28**
Pagrus pagrus	PAGRPAG_IS	2014	258	277	**1.07**	0.32	0.32	0.59	**1.83**	803	472	0.59
Palinurus elephas	PALIELE_IS	2014	333	79	0.24	0.11	0.05	0.10	**2.02**	3,137	761	**0.24**
Parapeneaus longirostris	PARELON_IS	2014	10,825	6,550	0.61	0.47	0.47	0.43	0.91	22,945	15,198	0.66
Penaeus kerathurus	PENAKER_IS	2014	202	767	**3.80**	0.19	0.19	1.17	**6.06**	1,045	655	0.63
Scophthalmus maximus	PSETMAX_IS	2013	409	161	0.39	0.19	0.11	0.27	**2.57**	2,125	588	**0.28**
Sepia officinalis	SEPIOFF_IS	2014	5,870	6,410	**1.09**	0.28	0.28	0.40	**1.43**	20,760	15,834	0.76
Solea solea	SOLEVUL_IS	2014	2,994	191	0.06	0.23	0.06	0.11	**1.88**	13,128	1,712	**0.13**
Squilla mantis	SQUIMAN_IS	2014	880	1,230	**1.40**	0.18	0.18	0.49	**2.72**	4,917	2,523	0.51
Umbrina cirrosa	UMBRCIR_IS	2013	1,181	1,172	0.99	0.50	0.50	0.68	**1.35**	2,345	1,719	0.73
Belone belone	BELOBEL_IS	2014	291	165	0.57	0.28	0.28	0.28	**1.001**	1,048	593	0.57
Coryphaena hippurus	CORYHIP_IS	2014	2,118	877	0.41	0.55	0.36	0.69	**1.95**	3,872	1,263	**0.33**
Dicentrarchus labrax	DICELAB_IS	2014	630	91	0.14	0.26	0.09	0.22	**2.57**	2,436	409	**0.17**

Scientific name	**Stock**	**Year**	***MSY***	**Catch**	***C/MSY***	***F_{msy}***	***$F_{msy\ cur}$***	***F***	***$F/F_{msy\ cur}$***	***B_{msy}***	***B***	***B/B_{msy}***
Epinephelus marginatus	EPINGUA_IS	2014	1,770	44	0.02	0.18	0.03	0.06	**1.88**	9,718	791	**0.08**
Merluccius merluccius	MERLMER_IS	2014	16,888	4,882	0.29	0.22	0.09	0.30	**3.24**	76,686	16,186	**0.21**
Micromesistius poutassou	MICRPOU_IS	2014	749	51	0.07	0.20	0.09	0.06	0.64	3,824	882	**0.23**
Atherina boyeri	ATHEBOY_IS	2014	391	85	0.22	0.28	0.18	0.19	**1.03**	1,372	445	**0.32**
Boops boops	BOOPBOO_IS	2014	4,520	1,312	0.29	0.29	0.25	0.21	0.84	15,327	6,383	**0.42**
Engraulis encrasicolus	ENGRENC_IS	2014	12,898	6,087	0.47	0.33	0.33	0.30	0.92	39,180	20,183	0.52
Sardina pilchardus	SARDPIL_IS	2014	12,013	5,160	0.43	0.29	0.21	0.34	**1.62**	42,041	15,331	**0.36**
Scomber colias	SCOMPNE_IS	2014	794	935	**1.18**	0.39	0.39	0.88	**2.27**	2,043	1,062	0.52
Scomber scombrus	SCOMSCO_IS	2014	3,222	489	0.15	0.26	0.13	0.17	**1.31**	12,284	2,961	**0.24**
Trachurus mediterraneus	TRACHMED_IS	2014	487	179	0.37	0.50	0.38	0.49	**1.27**	968	368	**0.38**

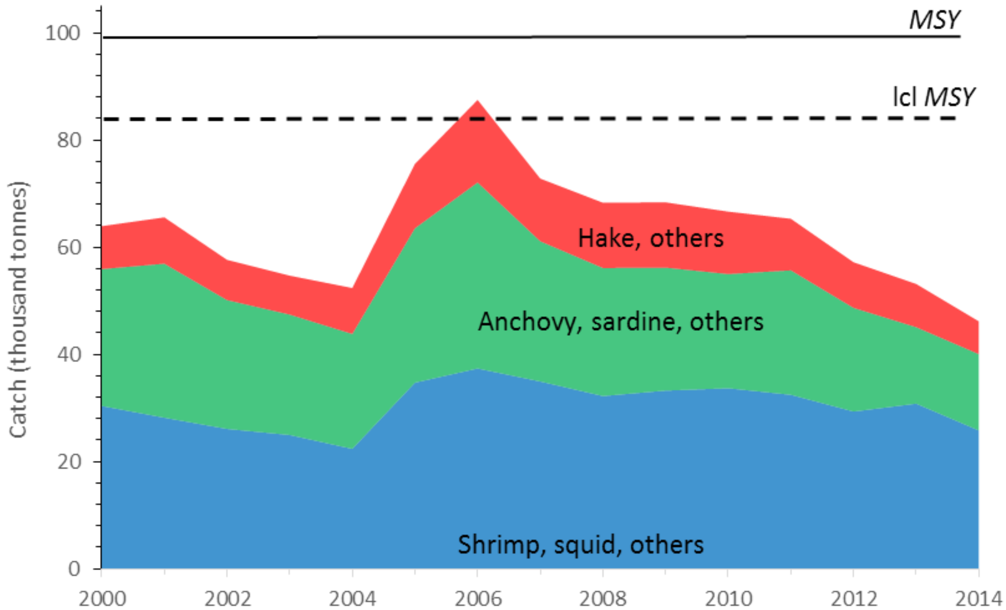


Figure 94. Cumulative catches, including discards and recreational catch if available, for 31 stocks in the Ionian Sea, with indication of main functional groups. The black line indicates the maximum sustainable yield (MSY) for the ecoregion and the dashed line indicates the lower 95% confidence limit as a precautionary target. [Ionian_Oct13_16.xlsx]

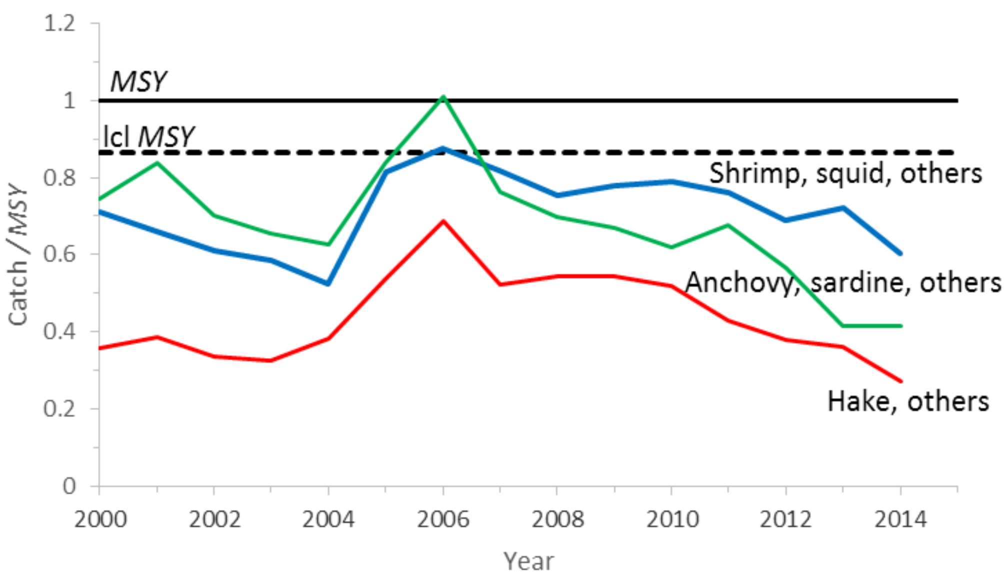


Figure 95. Catches by main functional group relative to their maximum sustainable yield (MSY, black), for 31 stocks in the Ionian Sea. Pelagic plankton feeders (green), benthic organisms (blue), and large predators (red) have all supported catches well below MSY, with a declining trend since 2010. [Ionian_Oct13_16.xlsx]

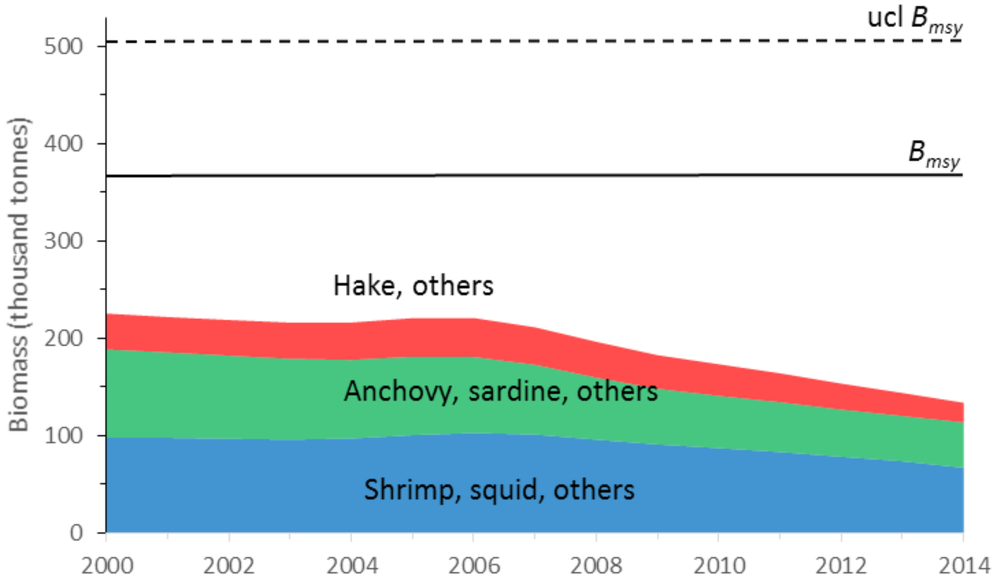


Figure 96. Cumulative total biomass of 31 stocks in the Ionian Sea relative to the biomass that can produce the maximum sustainable yield (B_{msy} = black line). The upper 95% confidence limit of B_{msy} (dashed line) would present a precautionary target biomass above B_{msy}. This is also the area where the maximum economic yield could be obtained. The low biomass is the reason for the low catches relative to MSY. [Ionian_Oct13_16.xlsx]

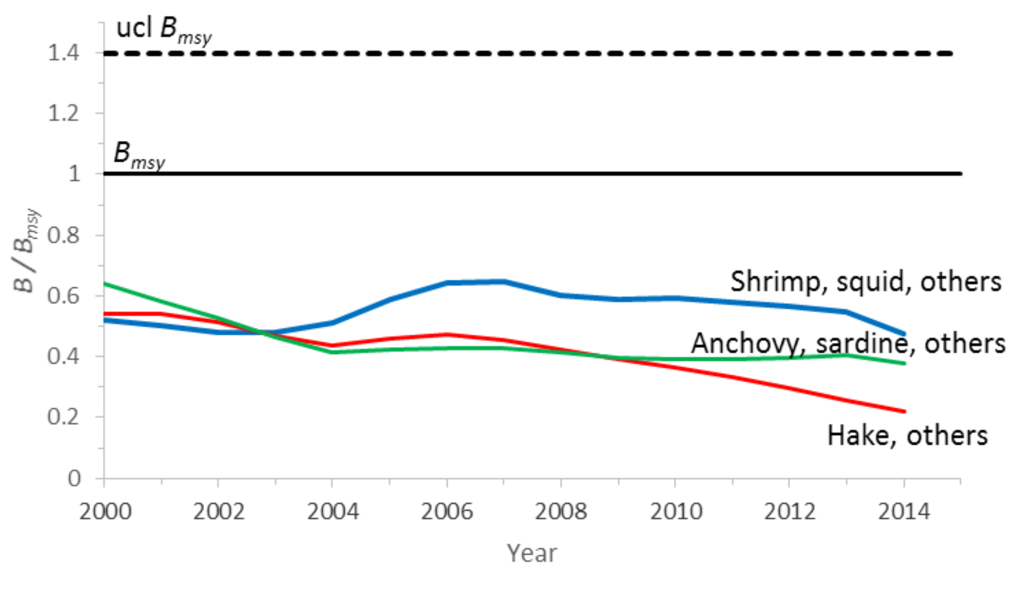


Figure 97. Median biomass relative to the level that can produce the maximum sustainable yield (B/B_{msy}) for 31 stocks in the Ionian Sea assigned to main functional groups. Pelagic plankton feeders (green) and benthic organisms (blue) have biomass levels well below B_{msy}. Large predators (red) are severely depleted and in danger of reduced recruitment. [Ionian_Oct13_16.xlsx]

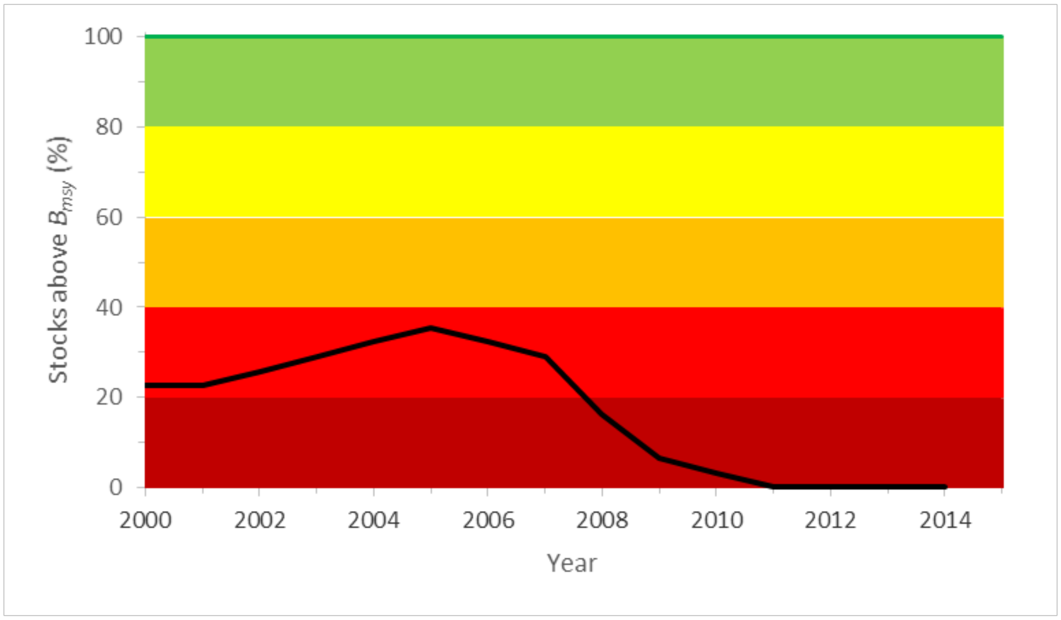


Figure 98. Percentage of stocks where biomass is above the level that can produce the maximum sustainable yield (B_{msy}) for 31 stocks in the Ionian Sea (black curve). The colors indicate visually the compliance with the goals of the Common Fisheries Policy, where all stocks (100%) shall be above B_{msy} eventually. In 2014, no stocks fulfilled that requirement. [Ionian_Oct13_16.xlsx]

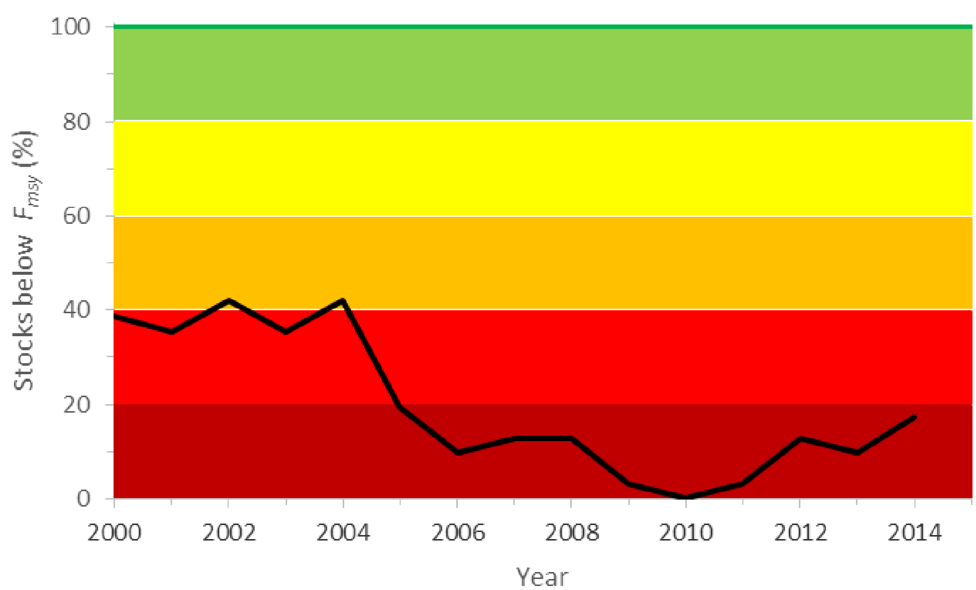


Figure 99. Percentage of stocks where fishing pressure is at or below the maximum sustainable level (F_{msy}) for 31 stocks in the Ionian Sea (black curve). The colors indicate visually the compliance with the goals of the Common Fisheries Policy, where all stocks (100%) shall be fished at or below F_{msy} in 2015, latest in 2020. In 2014, five stocks (17%) fulfilled that requirement. [Ionian_Oct13_16.xlsx]

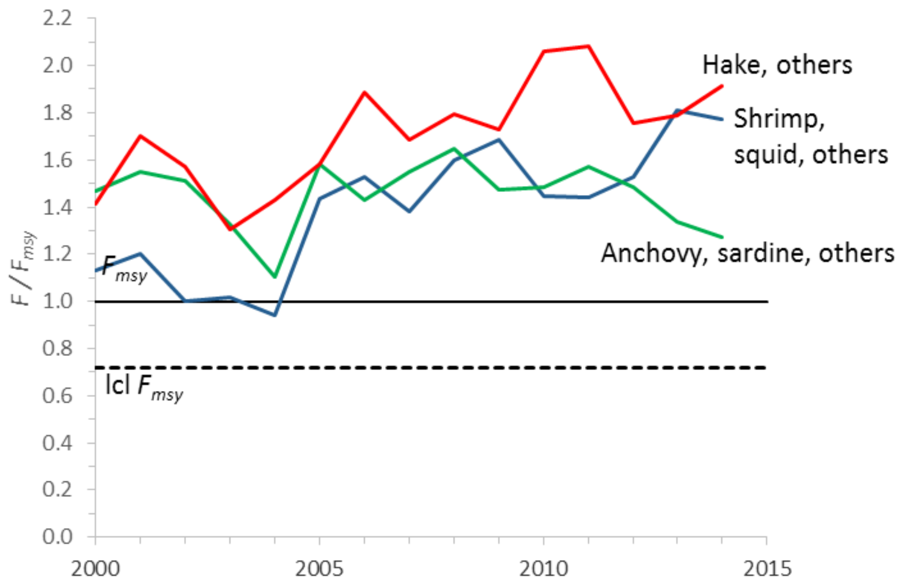


Figure 100. Median fishing pressure relative to the maximum sustainable level (F/F_{msy}) for 31 stocks in the Ionian Sea assigned to main functional groups. All groups were exploited far above the maximum sustainable level (black line indicating F_{msy}). [Ionian_Oct13_16.xlsx]

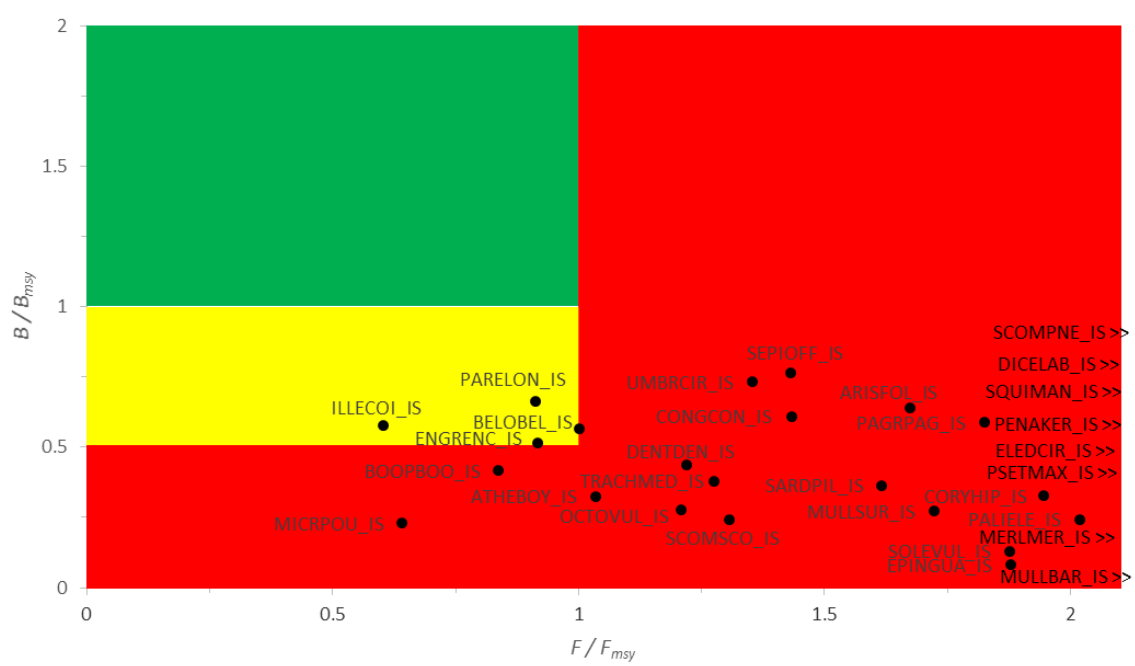


Figure 101. Presentation of 31 Ionian Sea stocks in a pressure (F/F_{msy}) – state (B/B_{msy}) plot. The red area indicates stocks that are being overfished or are outside of safe biological limits. The yellow area indicates recovering stocks. The green area indicates stocks subject to sustainable fishing pressure and of a healthy stock size that can produce high yields close to MSY. Several stocks were exploited above the range of this chart, indicated by >> along the right margin. [Ionian_Oct13_16.xlsx]

Aegean Sea

The following three paragraphs describing the Aegean Sea (GSA 22) were taken from the website http://www.indiseas.org/ecosystems/north-aegean-sea.

"The Aegean Sea is an oligotrophic region in the Eastern Mediterranean Sea. Despite the fact that the Aegean Sea is an oligotrophic region, it is among the most productive areas in the Eastern Mediterranean. This is due to (a) the influence of nutrient rich, low saline, Black Sea Water occupying the surface water layers, (b) river flows that locally enhance the productivity of the coastal zone, and (c) the extended continental shelf. Wide *Posidonia oceanica* meadows extend up to a maximum depth of 25 m while other macrophytes are also found at slightly deeper bottoms. Sand (approximately with 40-90% content) and mud (approximately with 10-60% content) dominate the surface sediments in the area.

In the oligotrophic environment of this area, the phytoplankton is dominated by small sized cells belonging to the pico- and nano- fractions, which are grazed by ciliates. Anchovy are the most abundant fish species. Several parts of the North Aegean Sea have been identified as important habitats, such as spawning and nursery grounds, for small pelagic and demersal fish.

The relatively high productivity of the area is reflected in its high fisheries catch. The fishing activity is dynamic and intense in the North Aegean Sea. Small pelagic fish (anchovy *Engraulis encrasicolus* and sardine *Sardina pilchardus*) dominate the landings of the area and are mainly caught by purse seiners. Several stocks are considered fully exploited, while the probability of the ecosystem being sustainably fished is low. Total catch has been relatively constant over the recent years."

JRC-STEFC assessment reports and FAO-GFCM landings with data until 2014 were analyzed for 42 stocks in the Aegean Sea (GFCM subarea 3.1). The graphs below summarize their status and exploitation level within an MSY-framework. The list of species and their current exploitation and status is summarized in Table 16. Detailed assessments for every stock are available in Appendix 2 and in the spreadsheet AegeanSea_Oct04_16.xlsx.

Of the 42 stocks, 37 (88%) were subject to ongoing overfishing ($F > F_{msy}$) and 23 stocks (55%) were outside of safe biological limits ($B < 0.5\ B_{msy}$). In two stocks (5%) catches exceeded the maximum sustainable yield ($C/MSY > 1$). Twenty-two stocks (52%) were in critical condition, defined by being outside of safe biological limits and subject to overfishing or being severely depleted ($B < 0.2\ B_{msy}$). The scientific names of these stocks are marked red in Table 16. Altogether, 37 stocks (88%) were subject to unsustainable exploitation (catch > *MSY* or $F > Fmsy$ or $B < 0.2\ Bmsy$), with the too high catches marked red in Table 16. No stocks could be considered healthy, defined by not being subject to overfishing and having a biomass above the one that can produce the maximum sustainable yield.

Summed biomass of the 42 stocks of 192 thousand tonnes in 2014 was well below the biomass level of 384 tonnes that can produce maximum yields. Summed catches of 70 thousand tonnes were below the summed maximum sustainable yield of 112 tonnes. Because of trophic interactions it is not possible to achieve *MSY* simultaneously for all stocks, but sustained catches of near the lower confidence limit or near 90% of *MSY* (whichever is lower) would be possible if all stocks have recovered above *Bmsy*. Because of more fish in the water, such catches could be obtained with much less fishing effort and much less impact on the ecosystem. See legends of Figures for more comments.

Table 16. Analysis of 42 stocks in the Aegean Sea, with indication of last year with available data (Year), maximum sustainable yield (MSY), absolute and relative catch (Catch, C/MSY), maximum sustainable fishing mortality (F_{msy}) if the stock is within safe biological limits ($B/B_{msy} > 0.5$), F_{msy} for current stock size, F/F_{msy} for current stock size, biomass that can produce MSY (B_{msy}), relative biomass (B/B_{msy}). Scientific names of healthy stocks where F/Fmsy < 1 and B/Bmsy > 1 are marked green and stocks outside of safe biological limits ($B/B_{msy} < 0.5$) with ongoing overfishing ($F/F_{msy} > 1$) are marked red. Catches above MSY are marked bold (C/MSY > 1). Overfishing with $F/F_{msy} > 1$ is marked bold. Stock sizes outside safe biological limits (B/Bmsy < 0.5) are marked bold. Unsustainable catches ($F > F_{msy}$ or catch > *MSY* or $B < 0.2\ B_{msy}$) are marked red. Catches are given in tonnes per year. Biomass is given in tonnes as average total biomass during the year. *Species are sorted by functional groups as indicated by the color of the stock IDs: benthic fish & invertebrates (blue), large predators (red) and pelagic plankton feeders (green). [AegeanSea_Oct04_16.xlsx]*

Scientific name	Stock	Year	*MSY*	Catch	*C/MSY*	F_{msy}	$F_{msy\ cur}$	*F*	$F/F_{msy\ cur}$	B_{msy}	*B*	B/B_{msy}
Dentex dentex	DENTDEN_AL	2014	233	123	0.53	0.15	0.14	0.16	**1.18**	1,608	758	**0.47**
Dentex macrophthalmus	DENTMAC_AL	2014	422	385	0.91	0.49	0.49	0.53	**1.08**	862	725	0.84
Diplodus annularis	DIPLANN_AL	2014	338	112	0.33	0.20	0.13	0.20	**1.47**	1,680	564	**0.34**
Diplodus sargus	DIPLSAR_AL	2014	366	136	0.37	0.27	0.15	0.37	**2.51**	1,368	372	**0.27**
Eledone moschata	ELEDMOS_AL	2014	661	430	0.65	0.27	0.27	0.23	0.86	2,461	1,852	0.75
Illex coindetii	ILLECOI_AL	2014	966	1,015	**1.05**	0.28	0.28	0.36	**1.27**	3,417	2,827	0.83
Loligo vulgaris	LOLIVUL_AL	2014	607	494	0.81	0.23	0.23	0.30	**1.29**	2,649	1,665	0.63
Lophius budegassa	LOPHBUD_AL	2014	826	557	0.67	0.21	0.21	0.29	**1.39**	3,942	1,938	**0.49**
Mullus barbatus	MULLBAR_AL	2014	3,199	1,920	0.60	0.26	0.21	0.40	**1.97**	12,159	4,747	**0.39**
Mullus surmuletus	MULLSUR_AL	2014	2,092	1,474	0.70	0.34	0.30	0.53	**1.75**	6,212	2,787	**0.45**
Nephrops norvegicus	NEPRNOR_AL	2014	798	228	0.29	0.19	0.07	0.29	**4.01**	4,127	778	**0.19**
Octopus vulgaris	OCTOVUL_AL	2014	3,420	1,992	0.58	0.35	0.35	0.40	**1.15**	9,731	4,939	0.51
Pagellus erythrinus	PAGEERY_AL	2014	648	421	0.65	0.23	0.23	0.24	**1.06**	2,808	1,727	0.62
Pagrus pagrus	PAGRPAG_AL	2014	783	630	0.80	0.26	0.26	0.34	**1.30**	3,031	1,869	0.62
Palinurus elephas	PALIELE_AL	2014	122	116	0.95	0.14	0.14	0.17	**1.23**	880	678	0.77
Parapeneaus longirostris	PARELON_AL	2014	1,145	749	0.65	0.50	0.35	0.93	**2.62**	2,289	808	**0.35**
Penaeus kerathurus	PENAKER_AL	2014	1,939	1,450	0.75	0.28	0.28	0.29	**1.03**	6,857	4,980	0.73
Scophthalmus maximus	PSETMAX_AL	2014	93	82	0.88	0.25	0.25	0.36	**1.45**	373	228	0.61
Raja clavata	RAJACLA_AL	2014	654	368	0.56	0.13	0.13	0.13	0.99	4,980	2,843	0.57
Sarpa salpa	SARPSAL_AL	2014	458	180	0.39	0.37	0.22	0.48	**2.15**	1,245	376	**0.30**
Sepia officinalis	SEPIOFF_AL	2014	1,749	1,031	0.59	0.28	0.28	0.27	0.94	6,200	3,872	0.62

Scientific name	Stock	Year	*MSY*	Catch	*C/MSY*	F_{msy}	$F_{msy\ cur}$	*F*	$F/F_{msy\ cur}$	B_{msy}	*B*	B/B_{msy}
Solea solea	SOLEVUL_AL	2014	1,279	420	0.33	0.25	0.13	0.31	**2.32**	5,151	1,369	**0.27**
Spondyliosoma cantharus	SPODCAN_AL	2014	294	80	0.27	0.26	0.12	0.31	**2.59**	1,136	260	**0.23**
Squalus acanthias	SQUAACA_AL	2014	135	103	0.76	0.13	0.13	0.18	**1.38**	1,050	577	0.55
Umbrina cirrosa	UMBRCIR_AL	2014	43	14	0.32	0.48	0.25	0.61	**2.46**	90	23	**0.26**
Belone belone	BELOBEL_AL	2014	259	57	0.22	0.24	0.11	0.23	**2.19**	1,102	247	**0.22**
Dicentrarchus labrax	DICELAB_AL	2014	470	221	0.47	0.29	0.16	0.49	**3.06**	1,612	447	**0.28**
Epinephelus marginatus	EPINGUA_AL	2014	82	49	0.60	0.17	0.11	0.31	**2.73**	479	158	**0.33**
Merluccius merluccius	MERLMER_AL	2014	3,196	2,610	0.82	0.33	0.33	0.52	**1.57**	9,680	5,041	0.52
Micromesistius poutassou	MICMPOU_AL	2014	1,324	524	0.40	0.22	0.12	0.31	**2.51**	6,011	1,688	**0.28**
Pomatomus saltatrix	POMTSAL_AL	2014	250	110	0.44	0.35	0.26	0.42	**1.61**	704	260	**0.37**
Zeus faber	ZEUSFAB_AL	2014	310	269	0.87	0.38	0.37	0.70	**1.92**	805	382	**0.48**
Atherina boyeri	ATHEBOY_AL	2014	595	45	0.08	0.34	0.13	0.14	**1.09**	1,731	322	**0.19**
Boops boops	BOOPBOO_AL	2014	8,500	4,387	0.52	0.29	0.29	0.29	**1.01**	29,074	14,880	0.51
Engraulis encrasicolus	ENGRENC_AL	2014	19,258	20,320	**1.06**	0.42	0.42	0.64	**1.54**	46,034	31,551	0.69
Sardina pilchardus	SARDPIL_AL	2014	25,401	18,130	0.71	0.29	0.29	0.32	**1.07**	86,308	57,380	0.66
Sardinella aurita	SARIAUR_AL	2014	2,784	2,407	0.86	0.42	0.42	0.48	**1.15**	6,699	5,029	0.75
Scomber colias	SCOMPNE_AL	2014	8,866	2,237	0.25	0.31	0.17	0.30	**1.82**	28,230	7,426	**0.26**
Scomber scombrus	SCOMSCO_AL	2014	1,808	109	0.06	0.25	0.08	0.09	**1.09**	7,319	1,216	**0.17**
Spicara smaris	SPICSMA_AL	2014	6,415	1,274	0.20	0.20	0.09	0.19	**2.18**	31,556	6,738	**0.21**
Trachurus mediterraneus	TRACHMED_AL	2014	7,750	1,720	0.22	0.22	0.15	0.14	0.92	35,370	12,299	**0.35**
Trachurus trachurus	TRACTRA_AL	2014	1,618	700	0.43	0.33	0.33	0.23	0.71	4,900	3,002	0.61

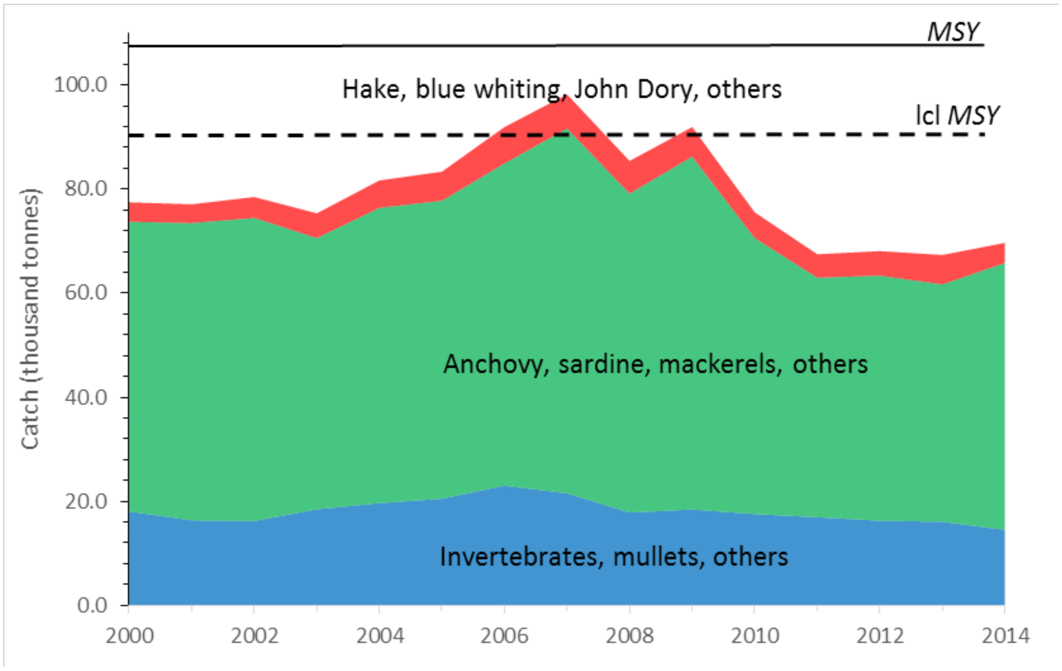


Figure 102. Cumulative catches for 42 stocks in the Aegean Sea, with indication of main functional groups. The continuous black line indicates the maximum sustainable yield (MSY) for the ecoregion and the dashed line indicates the lower 95% confidence limit as a precautionary target. [AegeanSea_Oct04_16.xlsx]

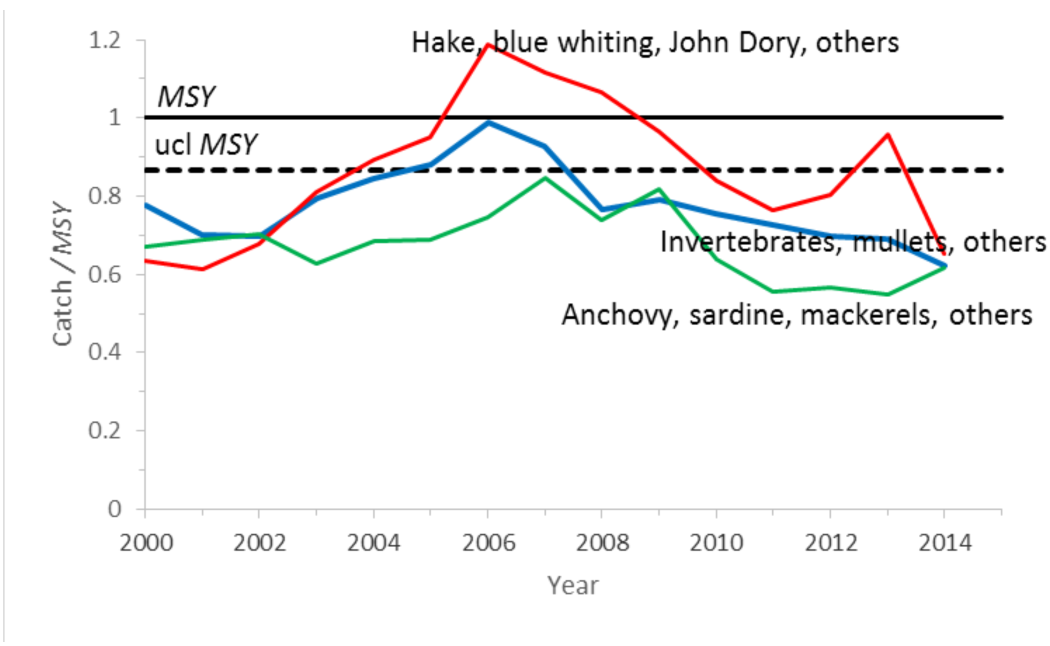


Figure 103. Catches by main functional group relative to their maximum sustainable yield (MSY, black), for 42 stocks in the Aegean Sea. All functional groups were exploited below MSY in 2014 with a declining trend since 2006. [AegeanSea_Oct04_16.xlsx]

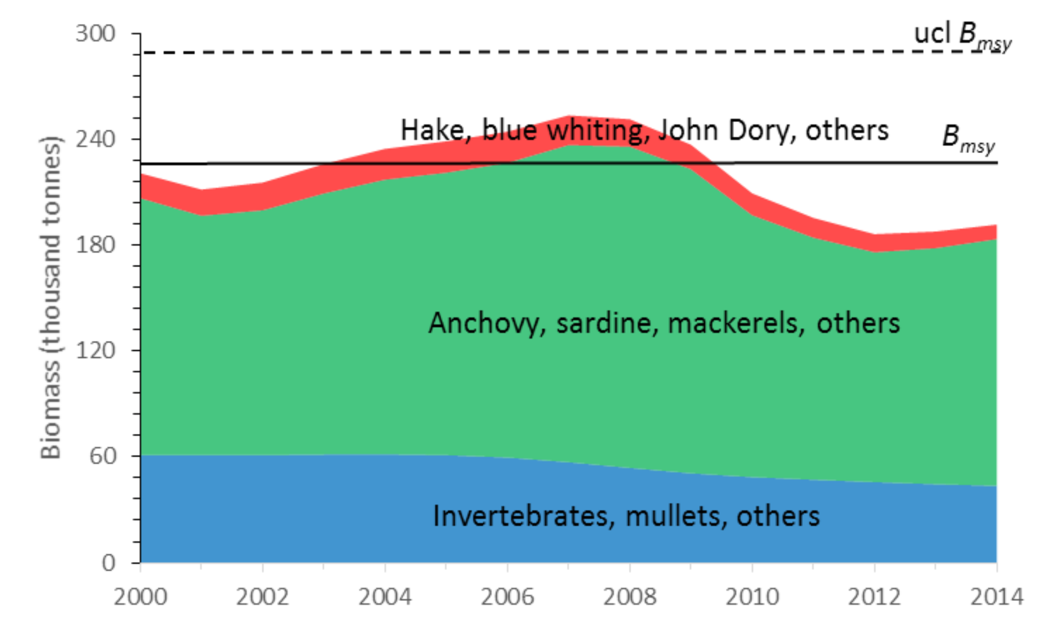


Figure 104. Cumulative total biomass of 42 stocks in the Aegean Sea relative to the biomass that can produce the maximum sustainable yield (B_{msy} = continuous black line). The upper 95% confidence limit of B_{msy} (dashed line) would present a precautionary target biomass above B_{msy}. This is also the area where the maximum economic yield could be obtained. All groups (blue: benthic organisms, green: pelagic plankton feeders, red: large predators) were below the B_{msy} level. [AegeanSea_Oct04_16.xlsx]

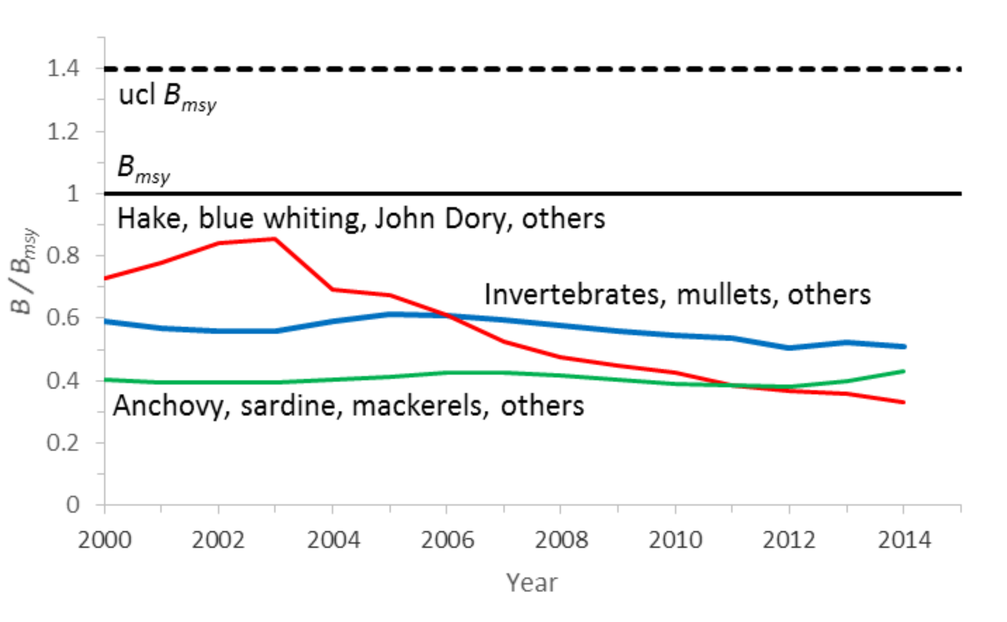


Figure 105. Median biomass relative to the level that can produce the maximum sustainable yield (B/B_{msy}) for 42 stocks in the Aegean Sea assigned to main functional groups. All functional groups (blue: benthic organisms, green: pelagic plankton feeders, red: large predators) have biomass levels well below B_{msy} in recent years. [AegeanSea_Oct04_16.xlsx]

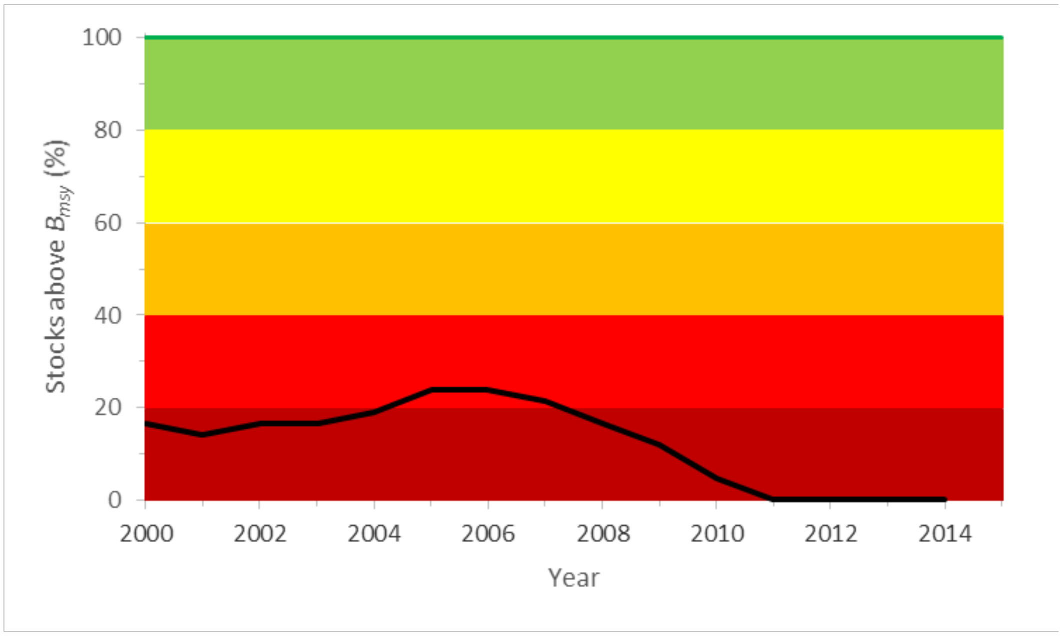


Figure 106. Percentage of stocks where biomass is above the level that can produce the maximum sustainable yield (B_{msy}) for 42 stocks in the Aegean Sea (black curve). The colors indicate visually the compliance with the goals of the Common Fisheries Policy, where all stocks (100%) shall be above B_{msy} eventually. In 2014, no stock fulfilled that requirement. [AegeanSea_Oct04_16.xlsx]

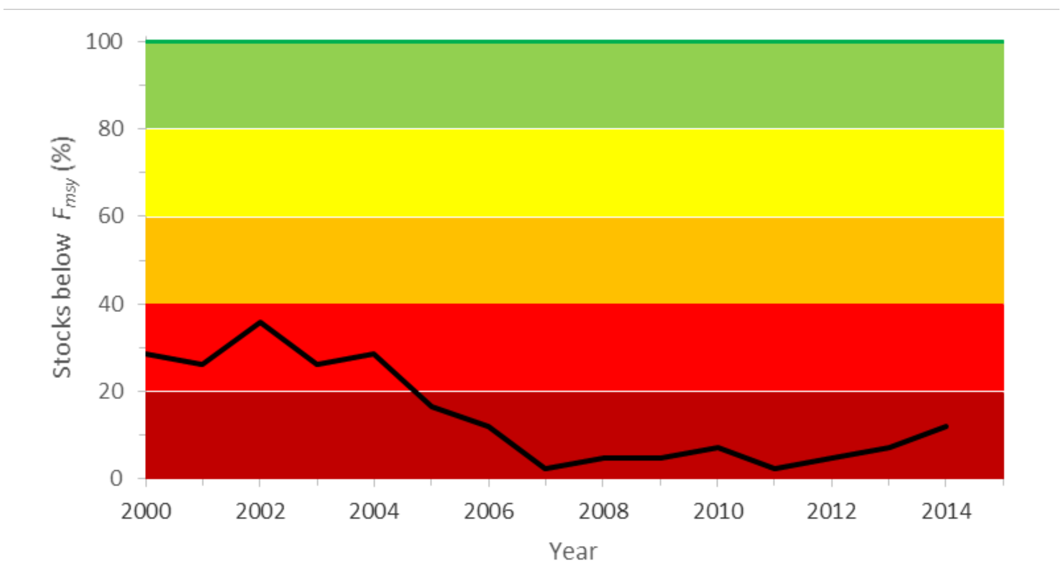


Figure 107. Percentage of stocks where fishing pressure is at or below the maximum sustainable level (F_{msy}) for 42 stocks in the Aegean Sea (black curve). The colors indicate visually the compliance with the goals of the Common Fisheries Policy, where all stocks (100%) shall be fished at or below F_{msy} in 2015, latest in 2020. In 2014, only 12% of the stocks fulfilled that requirement. [AegeanSea_Oct04_16.xlsx]

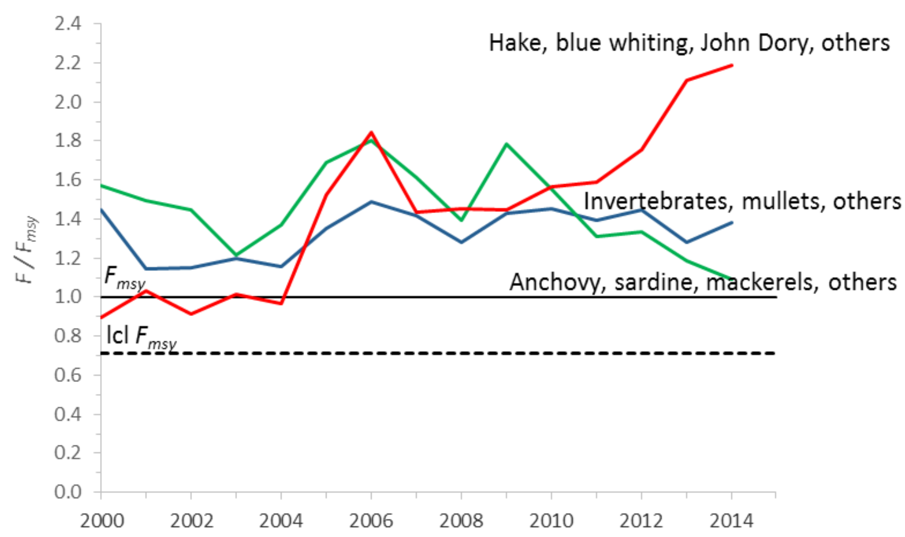


Figure 108. Median fishing pressure relative to the maximum sustainable level (F/F_{msy}) for 42 stocks in the Aegean Sea assigned to main functional groups. All functional groups have been strongly overfished since 2005. [AegeanSea_Oct04_16.xlsx]

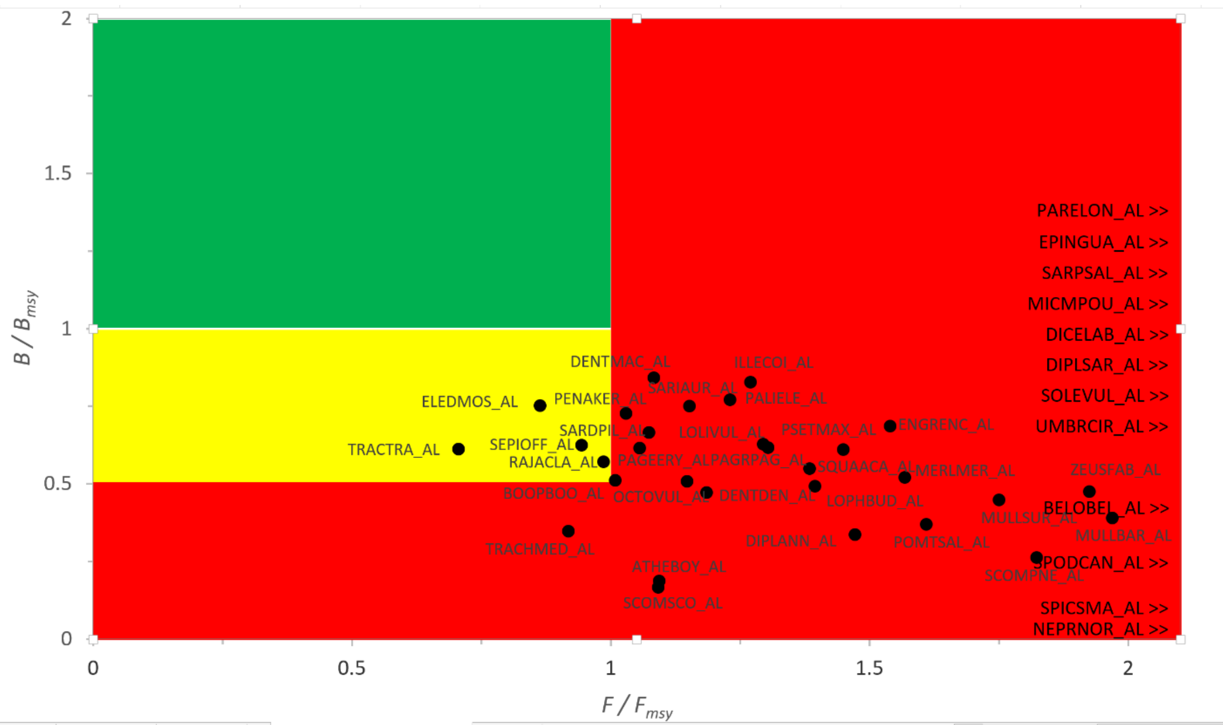


Figure 109. Presentation of 42 Aegean Sea stocks in a pressure (F/F_{msy}) – state (B/B_{msy}) plot. The red area indicates stocks that are being overfished or are outside of safe biological limits. The yellow area indicates recovering stocks. The green area indicates stocks subject to sustainable fishing pressure and of a healthy stock size that can produce high yields close to MSY. Several stocks were exploited above the range of this chart, indicated by >> along the right margin. [AegeanSea_Oct04_16.xlsx]

Cyprus

The following two paragraphs about the waters around Cyprus (GSA 25) were taken from

http://www.moa.gov.cy/moa/dfmr/dfmr.nsf/All/6561CB64C528ECFA42257F370041F296?OpenDocument.

"Cyprus is located in the Levantine Basin - Eastern Mediterranean which is one of the most oligotrophic seas in the world, characterized by very low nutrient availability and hence very low primary production. The special hydrological conditions of Levant Sea and the small width of the continental shelf in combination with low concentrations of available nutrients (in particular phosphorus), have as a result a very low primary production, that is low concentration of chlorophyll / phytoplankton in seawater. As a result of the oligotrophic character of the Eastern Mediterranean, the quantities of zooplankton and the larger invertebrate and vertebrate organisms (e.g. fish) that rely on it for their diet is also limited compared to other regions. The extended continental shelf, the higher productivity and lower temperature- less saline waters prevailing along the northern Aegean coast create favorable conditions for the dominance of anchovy (*Engraulis encrasicolus*) and sardine (S*ardina pilchardus*). In contrast, the demersal bogue (B*oops boops)* and picarel (Sp*icara smaris)* are generally characterized by a more southerly distribution than the aforementioned small pelagic species and dominate the landings of the southern Aegean Sea, Crete and Cyprus that are characterized by oligotrophic, more saline and higher temperature waters as well as narrower continental shelf (Stergiou et al. 2007).

Many marine species which are found in Cyprus, such as sea turtles (*Chelonia mydas, Caretta caretta*), the pen shell (*Pinna nobilis*), the Mediterranean monk seal (*Monachus monachus*) etc., are considered endangered and in need of protection, and therefore included in the list of high biodiversity and ecological importance for the Mediterranean. In addition, there are several important and sensitive bio-communities and habitats such as the meadows of the marine angiosperms *Posidonia oceanica* and *Cymodocea nodosa*, forests of the brown algae of the genus *Cystoseira*, underwater caves etc., which they are also objects of protection zone and conservation in the framework of European and national laws and international and regional conventions."

JRC-STEFC assessment reports and FAO-GFCM landings with data until 2014 were analyzed for 10 stocks in the Cyprus waters. The graphs below summarize their status and exploitation level within an MSY-framework. The list of species and their current exploitation and status is summarized in Table 17. Detailed assessments for every stock are available in Appendix 2 and in the spreadsheet Cyprus_Oct13_16.xlsx.

Of the 10 stocks, all (100%) were subject to ongoing overfishing ($F > Fmsy$) and 9 stocks (90%) were outside of safe biological limits ($B < 0.5\ Bmsy$). Nine stocks in the Cyprus waters (90%) were in critical condition, defined by being outside of safe biological limits and subject to overfishing (marked red in Table 17). All stocks (100%) were subject to unsustainable exploitation (catch > *MSY* or $F > Fmsy$ or $B < 0.2\ Bmsy$), with the too high catches marked red in Table 17. No stock could be considered healthy, defined by not being subject to overfishing and having a biomass above the one that can produce the maximum sustainable yield.

Summed biomass of the 10 stocks of 1,318 tonnes in 2014 was well below the biomass level of 5,210 tonnes that can produce maximum yields. Summed catches of 368 tonnes were below (25%) the summed maximum sustainable yield of 1,456 tonnes. See legends of Figures for more comments.

Table 17. Analysis of 10 stocks in the Cyprus waters, with indication of last year with available data (Year), maximum sustainable yield (MSY), absolute and relative catch (Catch, C/MSY), maximum sustainable fishing mortality (F_{msy}) if the stock is within safe biological limits ($B/B_{msy} > 0.5$) , F_{msy} for current stock size, F/F_{msy} for current stock size, biomass that can produce MSY (B_{msy}), relative biomass (B/B_{msy}). Scientific names of healthy stocks where F/Fmsy < 1 and B/Bmsy > 1 are marked green and stocks outside of safe biological limits ($B/B_{msy} < 0.5$) with ongoing overfishing ($F/F_{msy} > 1$) are marked red. Catches above MSY are marked bold (C/MSY > 1). Overfishing with $F/F_{msy} > 1$ is marked bold. Stock sizes outside safe biological limits (B/Bmsy < 0.5) are marked bold. Unsustainable catches (*F* > F_{msy} or catch > *MSY* or *B* < 0.2 B_{msy}) are marked red. *Catches are given in tonnes per year. Biomass is given in tonnes as average total biomass during the year. Species are sorted by functional groups as indicated by the color of the stock IDs: benthic fish & invertebrates (blue), large predators (red) and pelagic plankton feeders (green). [Cyprus_Oct13_16.xlsx]*

Scientific name	Stock	Year	MSY	Catch	C/MSY	F_{msy}	F_{msy} cur	F	F/F_{msy} cur	B_{msy}	B	B/B_{msy}
Dentex dentex	DENTDEN_CY	2014	27	4	0.15	0.17	0.06	0.14	**2.32**	164	29	**0.18**
Mullus barbatus	MULLBAR_CY	2014	118	32	0.27	0.31	0.18	0.28	**1.53**	385	115	**0.30**
Mullus surmuletus	MULLSUR_CY	2014	181	35	0.19	0.44	0.19	0.41	**2.19**	408	86	**0.21**
Pagellus acarne	PAGEACA_CY	2014	28	26	0.94	0.29	0.29	0.47	**1.62**	94	55	0.58
Pagellus erythrinus	PAGEERY_CY	2014	50	12	0.24	0.23	0.11	0.25	**2.31**	213	49	**0.23**
Pagrus pagrus	PAGRPAG_CY	2014	36	9	0.25	0.27	0.13	0.27	**2.10**	135	33	**0.24**
Sepia officinalis	SEPIOFF_CY	2014	106	22	0.21	0.27	0.12	0.24	**1.92**	398	93	**0.23**
Seriola dumerili	SERIDUM_CY	2014	20	8	0.40	0.31	0.18	0.43	**2.40**	65	19	**0.29**
Boops boops	BOOPBOO_CY	2014	240	111	0.46	0.36	0.24	0.49	**2.00**	670	228	**0.34**
Spicara smaris	SPICSMA_CY	2014	649	109	0.17	0.24	0.11	0.18	**1.59**	2,668	613	**0.23**

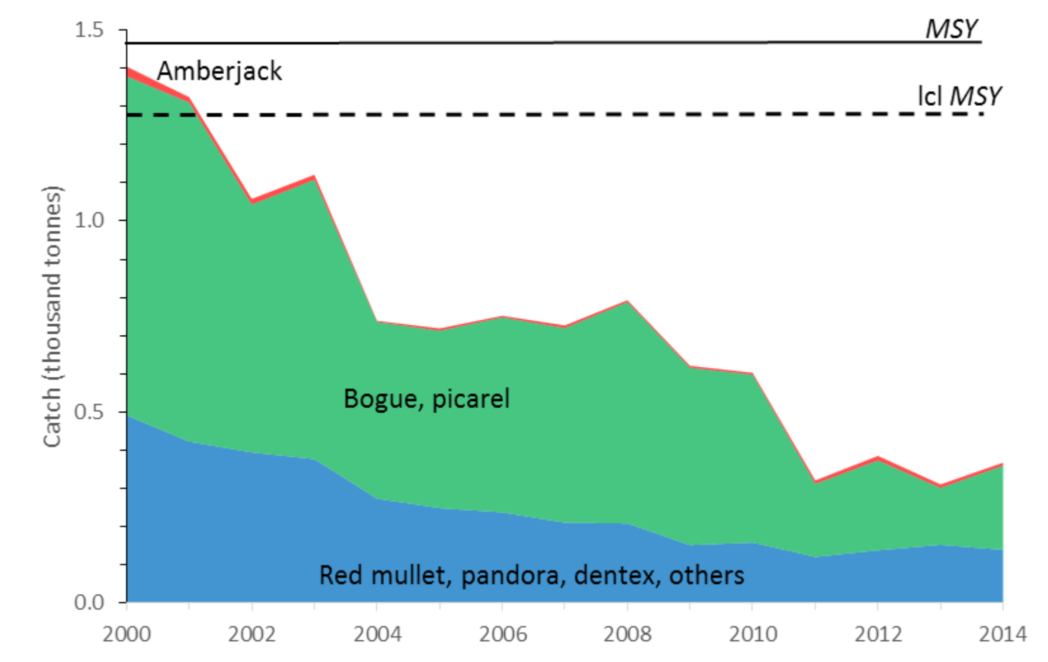


Figure 110. Cumulative catches for 10 stocks in the Cyprus waters, with indication of main functional groups. The black line indicates the maximum sustainable yield (MSY) for the ecoregion and the dashed line indicates the lower 95% confidence limit as a precautionary target. [Cyprus_Oct13_16.xlsx]

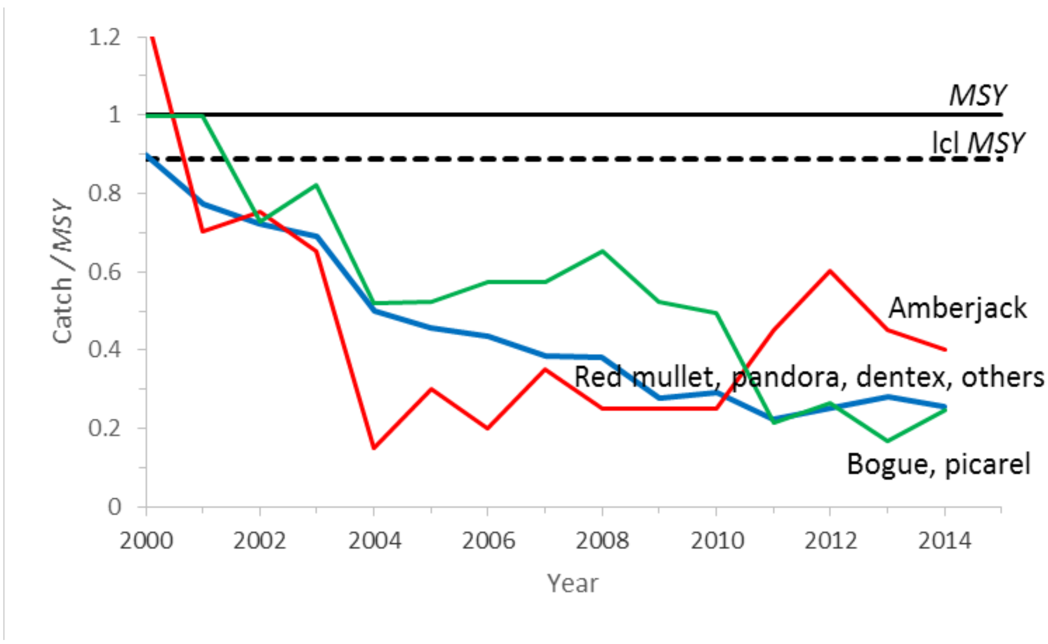


Figure 111. Catches by main functional group relative to their maximum sustainable yield (MSY, black line), for 10 stocks in the Cyprus waters. Due to low biomass (see below), catches of all groups are well below the precautionary over all lower 95% confidence limit of MSY (dashed line). [Cyprus_Oct13_16.xlsx]

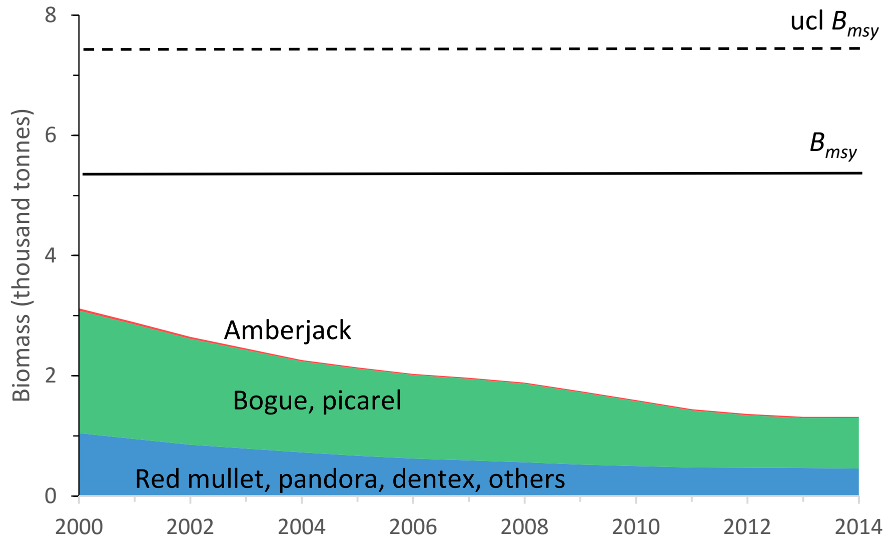


Figure 112. Cumulative total biomass of 10 stocks in the Cyprus waters relative to the biomass that can produce the maximum sustainable yield (B_{msy} = black line). The upper 95% confidence limit of B_{msy} (dashed line) would present a precautionary target biomass above B_{msy}. This is also the area where the maximum economic yield could be obtained. The functional groups of pelagic plankton feeders (green), large predators (red), and benthic organisms (blue) are indicated, with listing of main species. All functional groups were far below the B_{msy} level. [Cyprus_Oct13_16.xlsx]

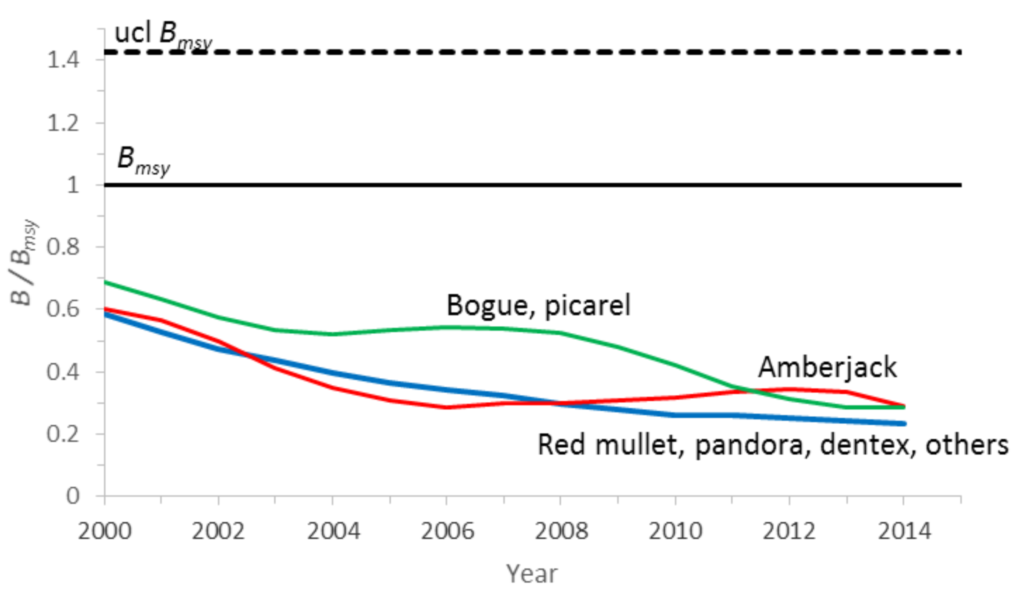


Figure 113. Median biomass relative to the level that can produce the maximum sustainable yield (B/B_{msy}) for 10 stocks in the Cyprus waters assigned to main functional groups. All functional groups have biomass levels well below B_{msy}, in the area where recruitment may be impaired, without a clear upward trend. [Cyprus_Oct13_16.xlsx]

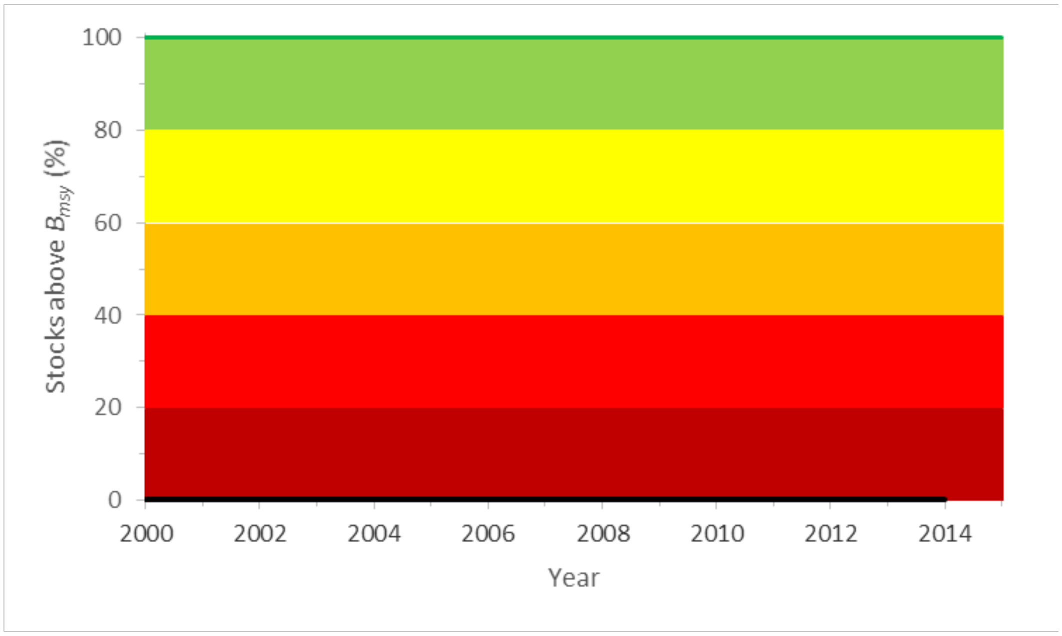


Figure 114. Percentage of stocks where biomass is above the level that can produce the maximum sustainable yield (B_{msy}) for 10 stocks in the Cyprus ecoregion (black curve at zero level). The colors indicate visually the compliance with the goals of the Common Fisheries Policy, where all stocks (100%) shall be above B_{msy} eventually. Throughout the time series, no stock fulfilled that requirement. [Cyprus_Oct13_16.xlsx]

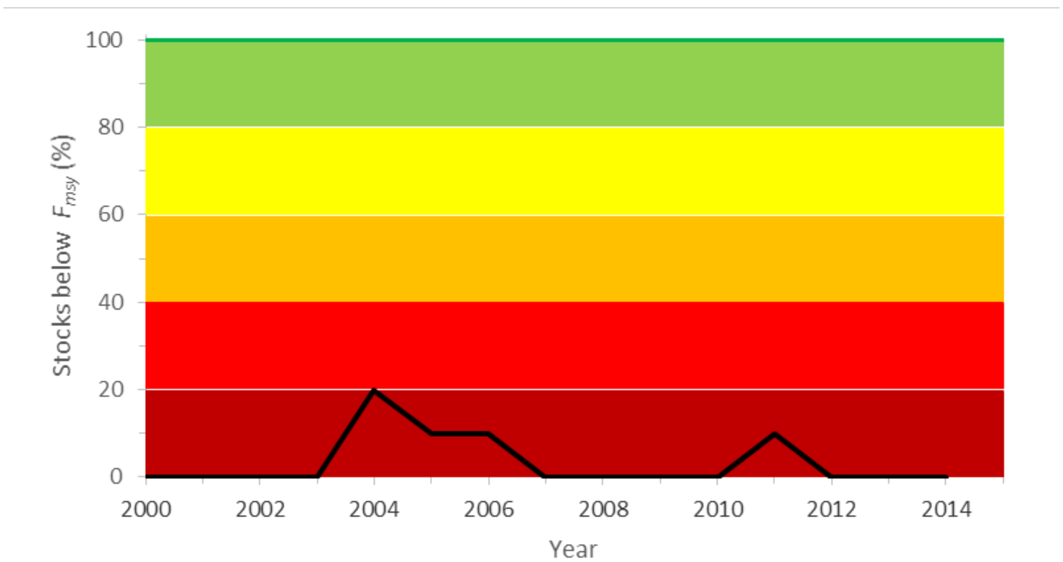


Figure 115. Percentage of stocks where fishing pressure is at or below the maximum sustainable level (F_{msy}) for 10 stocks in the Cyprus ecoregion (black curve). The colors indicate visually the compliance with the goals of the Common Fisheries Policy, where all stocks (100%) shall be fished at or below F_{msy} in 2015, latest in 2020. In 2014, no stock fulfilled that requirement. [Cyprus_Oct13_16.xlsx]

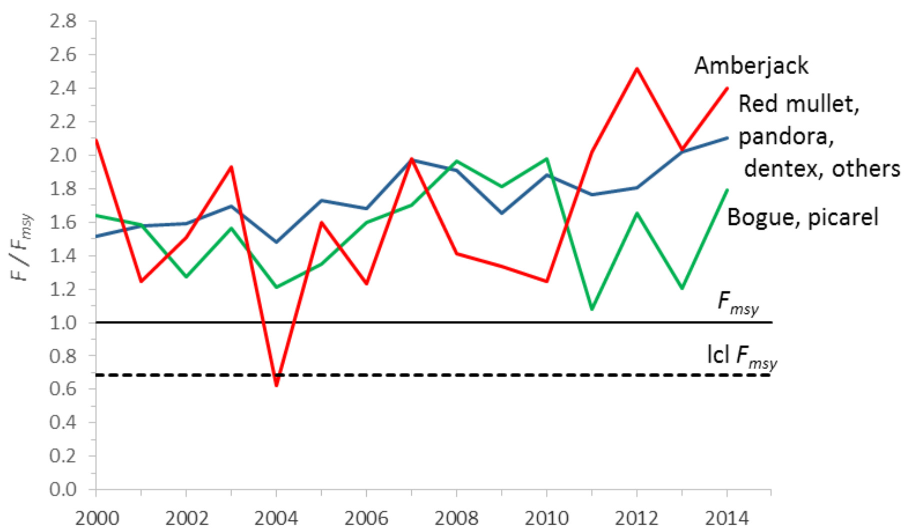


Figure 116. Median fishing pressure relative to the maximum sustainable level (F/F_{msy}) for 10 stocks in the Cyprus waters assigned to main functional groups. All groups were strongly overfished. [Cyprus_Oct13_16.xlsx]

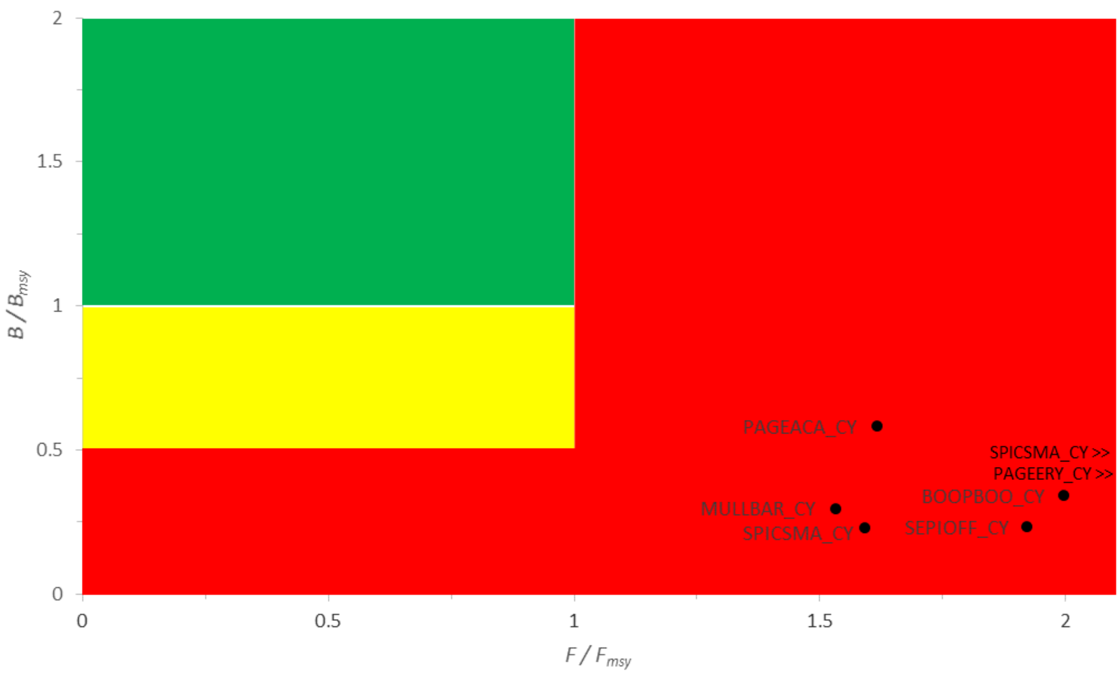


Figure 117. Presentation of 10 stocks from Cyprus waters in a pressure (F/F_{msy}) – state (B/B_{msy}) plot. The red area indicates stocks that are being overfished or are outside of safe biological limits. The yellow area indicates recovering stocks. The green area indicates stocks subject to sustainable fishing pressure and of a healthy stock size that can produce high yields close to MSY. Two stocks were exploited above the range of this chart, indicated by >> at the right margin. [Cyprus_Oct13_16.xlsx]

Black Sea

The following three paragraphs describing the Black Sea (GSAs 29 & 30) were taken from the website www.blacksea-commision.org.

"The Black Sea is the most isolated from the World Ocean - connected to the Oceans via the Mediterranean Sea through Istanbul, Canakkale (Turkish Straits) and Gibraltar straits and with the Sea of Azov in the northeast through the Kerch Strait. The ratio of its surface and its catchment area exceeds 6. For this reason, the Black Sea is very vulnerable to pressure from land based human activity and its health is equally dependent from the coastal and non-coastal states of its basin.

The seabed is divided into the shelf, the continental slope and the deep-sea depression. The shelf occupies a large area in the north-western part of the Black Sea, where it is over 200 km wide and has a depth ranging from 0 to 160 meters. In other parts of the sea it has a depth of less than 100 m and a width of 2.2 to 15 km. Near the Caucasian and Anatolian coasts the shelf is only a narrow intermittent strip.

The thin upper layer of marine water (up to 150 m) supports the unique biological life in the Black Sea ecosystem. The deeper and dense water layers are saturated with hydrogen sulfide, that over thousands years, accumulated from decaying organic matter in the Black Sea. Due to the unique geomorphological structure and specific hydro chemical conditions, specific organisms, basically on the level of protozoa, bacteria, and some multi-cellular invertebrates inhabit the deep-sea waters. Knowledge about biological forms of life in the deep waters of the Black Sea is very limited. The disturbance of the natural balance between the two layers could trigger irreversible damage to the people and ecosystem of the Black Sea."

JRC-STEFC assessment reports with data until 2014 were analyzed for 7 stocks in the Black Sea. The graphs below summarize their status and exploitation level within an MSY-framework. The list of species and their current exploitation and status is summarized in Table 18. Detailed assessments for every stock are available in Appendix 2 and in the spreadsheet BlackSea_Oct14_16.xlsx.

Of the 7 stocks, 6 (86%) were subject to ongoing overfishing ($F > F_{msy}$) and 3 stocks (43%) were outside of safe biological limits ($B < 0.5\ B_{msy}$). In one stock (14%) catches exceeded the maximum sustainable yield ($C/MSY > 1$). Three stocks (43%) were in critical condition, defined by being outside of safe biological limits and subject to overfishing (marked red in Table 18). Altogether, six stocks (86%) were subject to unsustainable exploitation (catch > *MSY* or $F > Fmsy$ or $B < 0.2\ Bmsy$), with the too high catches marked red in Table 18. In contrast, only one stock (Black Sea sprat, Spr_BS, 14%) could be considered healthy, defined by not being subject to overfishing and having a biomass above the one that can produce the maximum sustainable yield.

Summed biomass of the 7 stocks of 678 thousand tonnes in 2014 was well below the summed biomass level of 1.3 million tonnes that can produce maximum yields. Summed catches of 242 thousand tonnes were below the summed maximum sustainable yield of 403 thousand tonnes. This is mainly caused by the sharp decline in anchovy catch in the last year. Because of trophic interactions it is not possible to achieve *MSY* simultaneously for all stocks, but sustained catches of near the lower confidence limit or near 90% of *MSY* (whichever is lower) would be possible if all stocks have recovered above *Bmsy*. Because of more fish in the water, such catches could be obtained with much less fishing effort and much less impact on the ecosystem. See legends of Figures for more comments.

Table 18. Analysis of 7 stocks in the Black Sea, with indication of last year with available data (Year), maximum sustainable yield (MSY), absolute and relative catch (Catch, C/MSY), maximum sustainable fishing mortality (F_{msy}) if the stock is within safe biological limits ($B/B_{msy} > 0.5$) , F_{msy} for current stock size, F/F_{msy} for current stock size, biomass that can produce MSY (B_{msy}), and relative biomass (B/B_{msy}). Scientific names of healthy stocks where F/Fmsy < 1 and B/Bmsy > 1 are marked green and stocks outside of safe biological limits ($B/B_{msy} < 0.5$) with ongoing overfishing ($F/F_{msy} > 1$) or severe depletion (B < 0.2 Bmsy) are marked red. Catches above MSY are marked bold (C/MSY > 1). Overfishing with $F/F_{msy} > 1$ is marked bold. Stock sizes outside safe biological limits (B/Bmsy < 0.5) are marked bold. Unsustainable catches (*F* > F_{msy} or catch > *MSY* or *B* < 0.2 B_{msy}) are marked red. *Catches are given in tonnes per year. Biomass is given in tonnes as average total biomass during the year. Species are sorted by functional groups as indicated by the color of the stock IDs: benthic fish & invertebrates (blue), large predators (red) and pelagic plankton feeders (green). [BlackSea_Oct14_16.xlsx]*

SciName	**Stock**	**Year**	***MSY***	**Catch**	**C/*MSY***	F_{msy}	$F_{msy\ cur}$	***F***	$F/F_{msy\ cur}$	B_{msy}	***B***	B/B_{msy}
Mullus barbatus barbatus	RMullet_BS	2014	3,205	3,899	**1.22**	0.43	0.43	0.93	**2.19**	7,505	4,170	0.56
Squalus acanthias	PDogfish_BS	2014	2,804	75	0.03	0.07	0.01	0.02	**1.51**	39,817	3,752	**0.09**
Scophthalmus maximus	Tur_BS	2014	1,967	1,159	0.59	0.21	0.10	0.51	**5.31**	9,569	2,254	**0.24**
Merlangius merlangus	Whiting_BS	2014	11,033	8,861	0.80	0.28	0.28	0.42	**1.49**	38,999	21,080	0.54
Sprattus sprattus	Spr_BS	2014	64,277	58,380	0.91	0.40	0.40	0.33	0.83	161,197	177,005	1.10
Trachurus mediterraneus	MHMackerel_BS	2014	66,770	12,357	0.19	0.30	0.07	0.51	**7.57**	220,611	24,391	**0.11**
Engraulis encrasicolus	BS_anch	2014	253,599	157,462	0.62	0.29	0.29	0.35	**1.23**	878,375	444,922	0.51

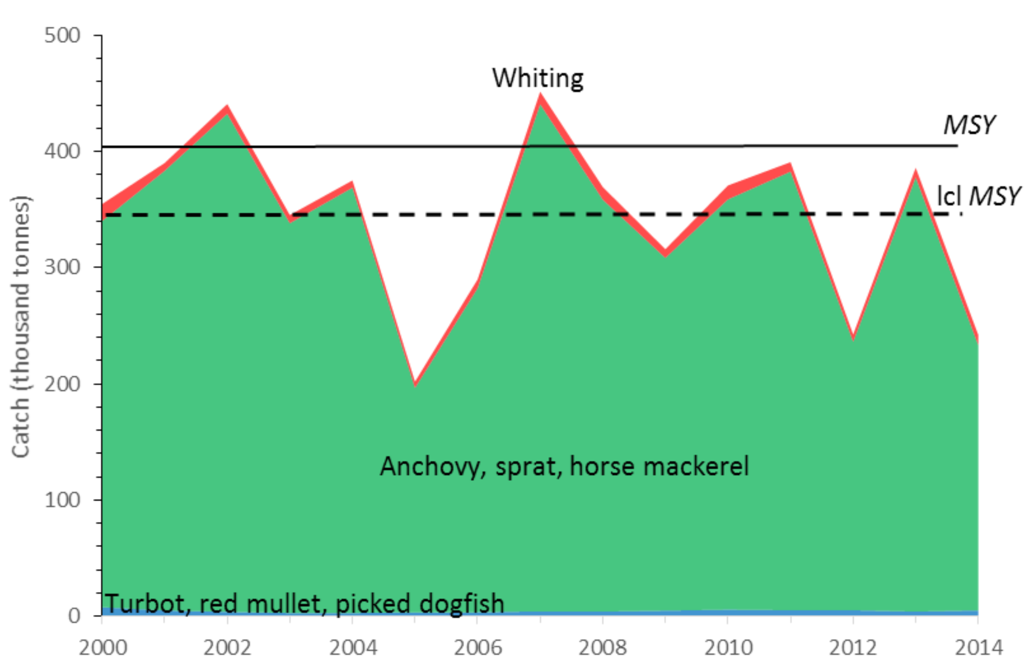


Figure 118. Cumulative catches for 7 stocks in the Black Sea, with indication of main functional groups. The black line indicates the maximum sustainable yield (MSY) for the ecoregion and the dashed line indicates the lower 95% confidence limit as a precautionary target. While total catches fluctuate around the precautionary target (lcl MSY), they are obtained with too much effort and cost and are unsustainable because of the reduced biomass of most stocks (see below). [BlackSea_Oct14_16.xlsx]

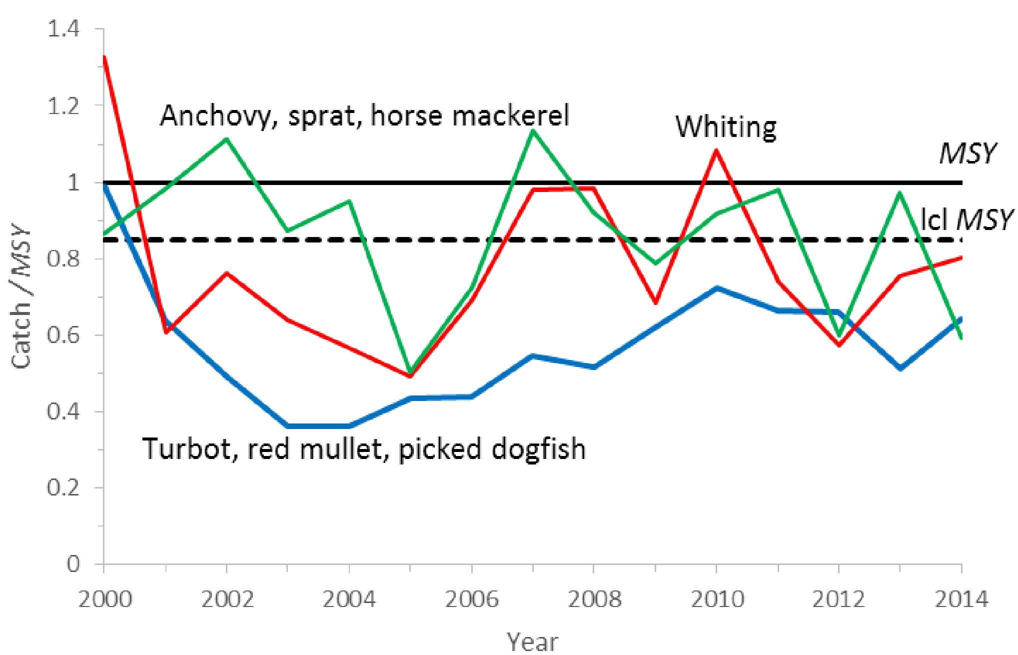


Figure 119. Catches by main functional group relative to their maximum sustainable yield (MSY, black line), for 7 stocks in the Black Sea. See legend of previous Figure for interpretation. [BlackSea_Oct14_16.xlsx]

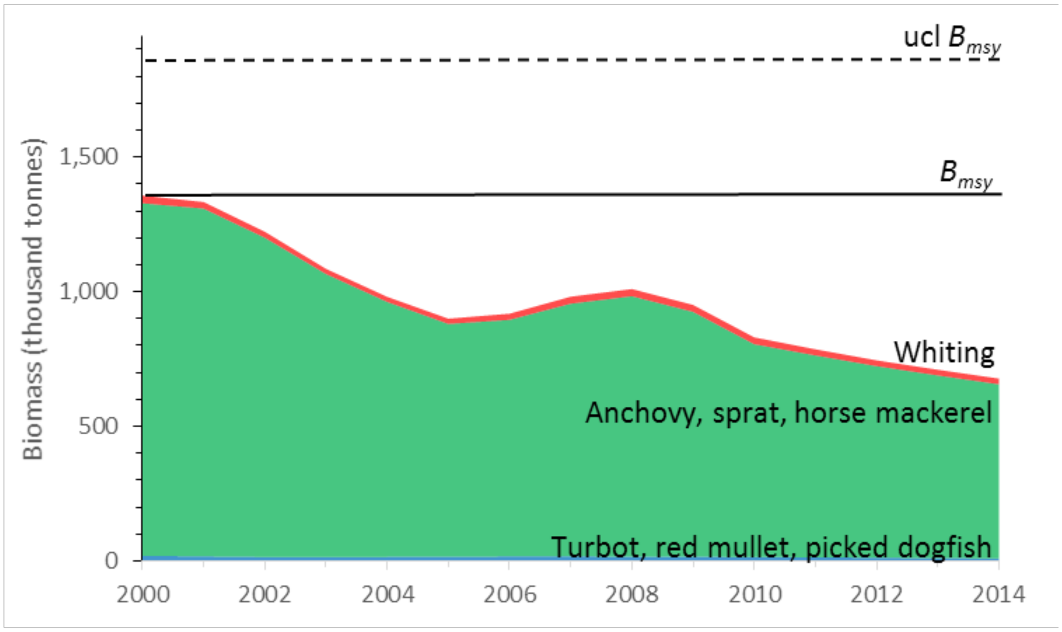


Figure 120. Cumulative total biomass of 7 stocks in the Black Sea relative to the biomass that can produce the maximum sustainable yield (B_{msy} = black line). The upper 95% confidence limit of B_{msy} (dashed line) would present a precautionary target biomass above Bmsy. This is also the area where the maximum economic yield could be obtained. The functional groups of large predators (red), pelagic plankton feeders (green), and benthic organisms (blue) are indicated, with listing of main species. All functional groups were far below the B_{msy} level. [BlackSea_Oct14_16.xlsx]

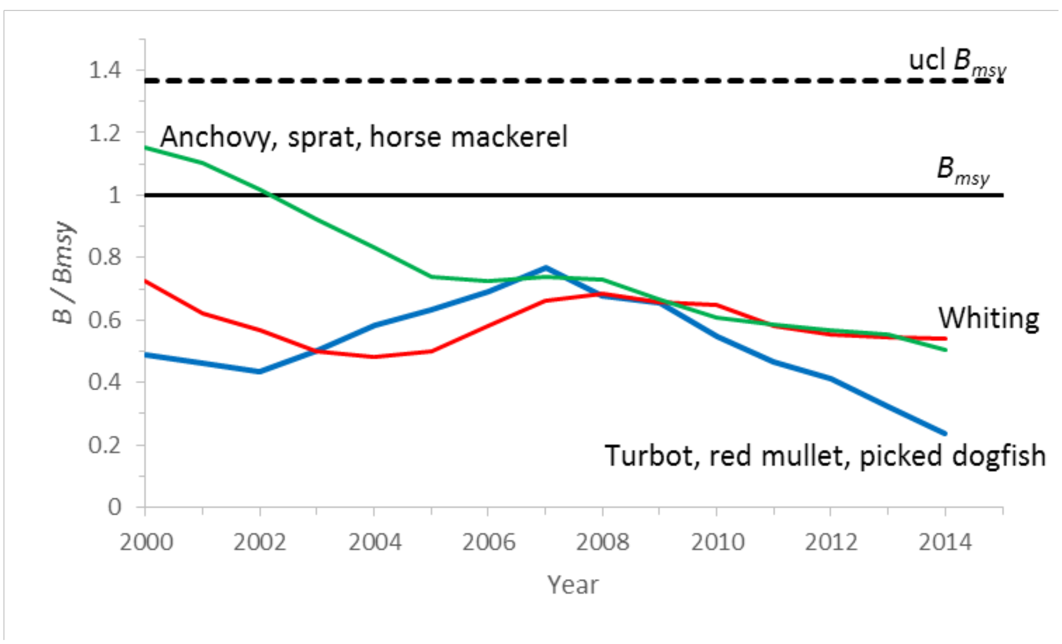


Figure 121. Median biomass relative to the level that can produce the maximum sustainable yield (B/B_{msy}) for 7 stocks in the Black Sea assigned to main functional groups. All functional groups have biomass levels well below B_{msy}, without a clear upward trend. Benthic organisms are far outside of safe biological limits ($B << 0.5\ B_{msy}$). [BlackSea_Oct14_16.xlsx]

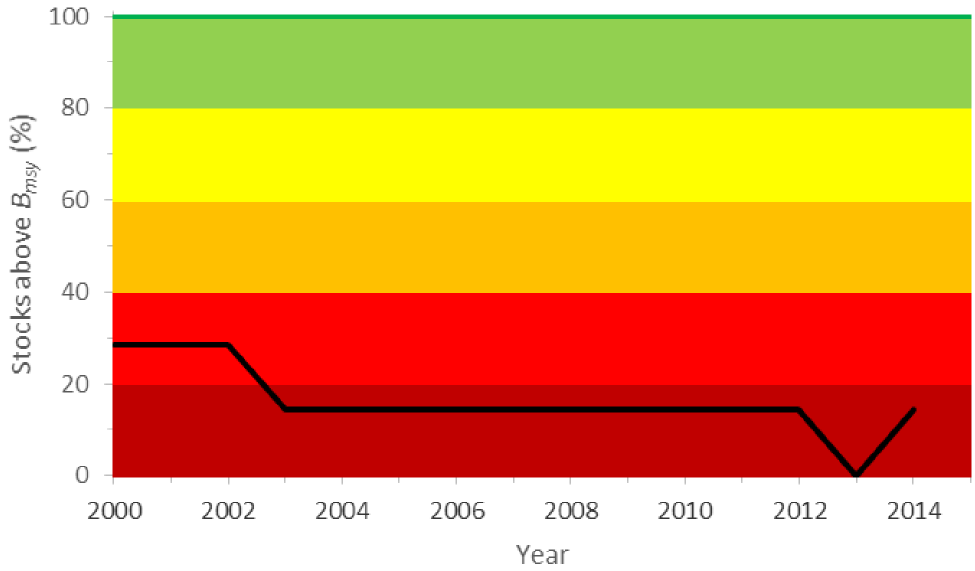


Figure 122. Percentage of stocks where biomass is above the level that can produce the maximum sustainable yield (B_{msy}) for 7 stocks in the Black Sea (black curve at zero level). The colors indicate visually the compliance with the goals of the Common Fisheries Policy, where all stocks (100%) shall be above B_{msy} eventually. In 2014, only one stock (Black Sea sprat, Spr_BS, 14%) fulfilled that requirement. [BlackSea_Oct14_16.xlsx]

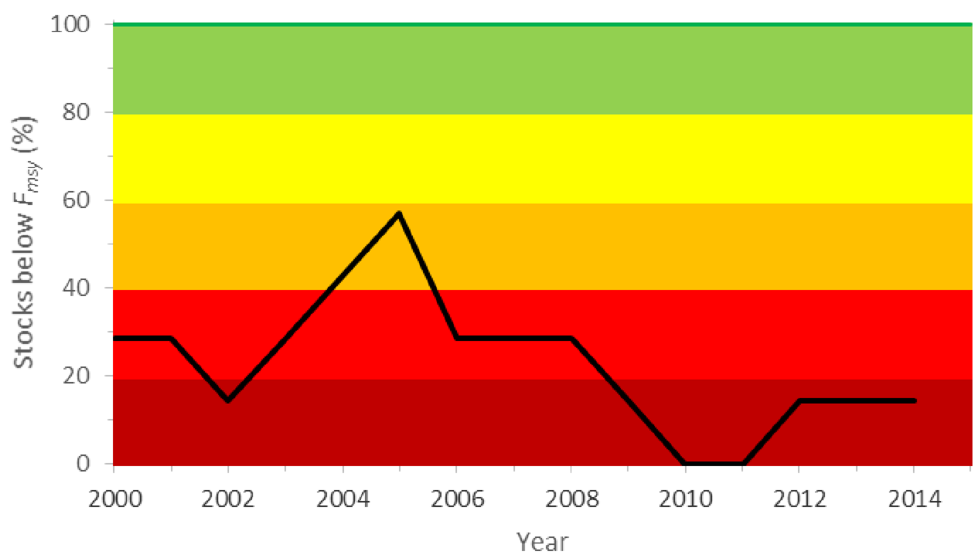


Figure 123. Percentage of stocks where fishing pressure is at or below the maximum sustainable level (F_{msy}) for 7 stocks in the Black Sea (black curve). The colors indicate visually the compliance with the goals of the Common Fisheries Policy, where all stocks (100%) shall be fished at or below F_{msy} in 2015, latest in 2020. In 2014, only one stock (Black Sea sprat, Spr_BS, 14%) fulfilled that requirement. [BlackSea_Oct14_16.xlsx]

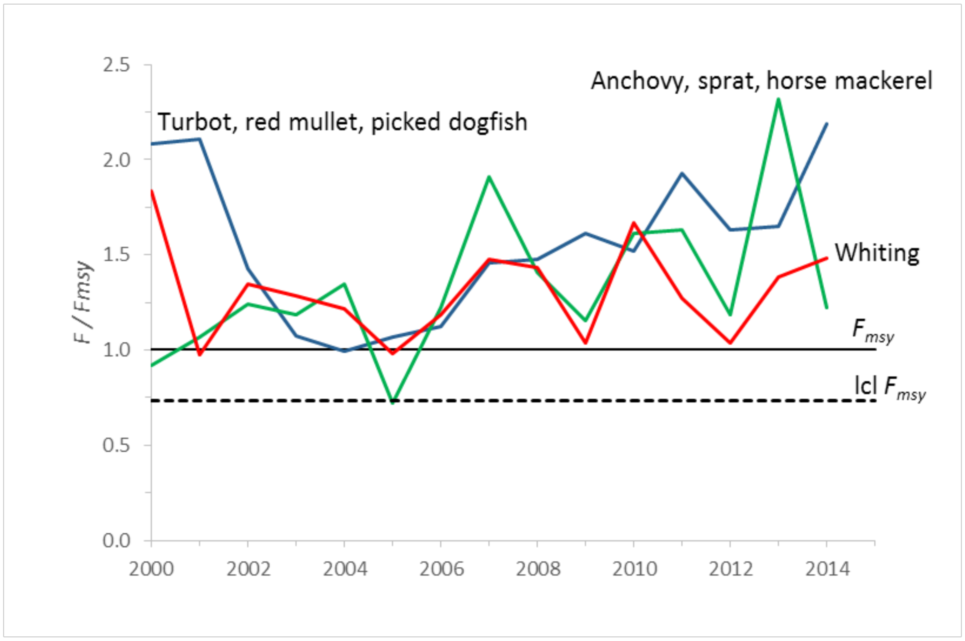


Figure 124. Median fishing pressure relative to the maximum sustainable level (F/F_{msy}) for 7 stocks in the Black Sea assigned to main functional groups. All groups were exploited far above the maximum sustainable level. [BlackSea_Oct14_16.xlsx]

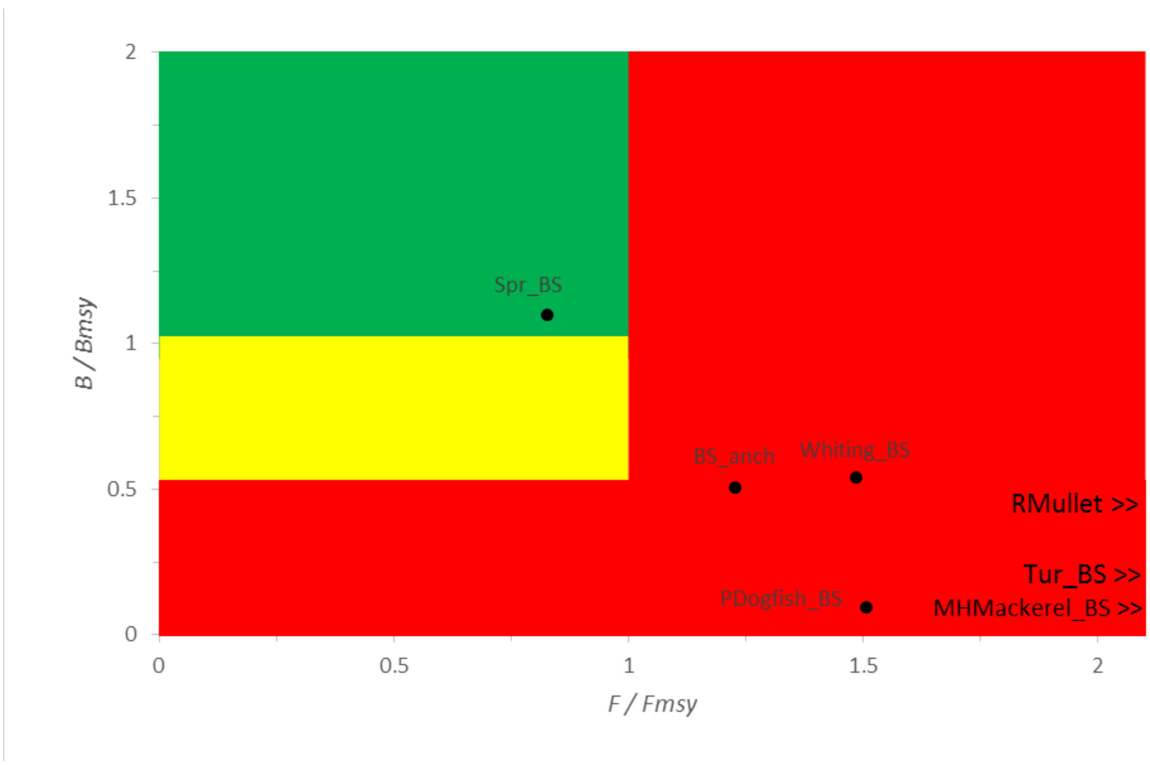


Figure 125. Presentation of 7 Black Sea stocks in a pressure (F/F_{msy}) – state (B/B_{msy}) plot. The red area indicates stocks that are being overfished or are outside of safe biological limits. The yellow area indicates recovering stocks. The green area indicates stocks subject to sustainable fishing pressure and of a healthy stock size that can produce high yields close to MSY. Three stocks were exploited beyond the scale of this graph, indicated by >> in the lower right corner. [BlackSea_Oct14_16.xlsx]

WIDE RANGING

ICCAT Stocks

As per legal definition, highly migratory species are listed in Annex 1 of UNCLOS. These species are generally capable of migrating relatively long distances, and stocks of these species are likely to occur both within EEZs and on the high seas (Maguire et al. 2006), straddling multiple ecoregions. The here assessed highly migratory species of the North-East Atlantic and the Mediterranean Sea include tuna, swordfish and oceanic sharks. Formal stock delamination was adapted from ICCAT (www.iccat.es).

ICCAT databases and assessment reports with data until 2014 were analyzed for 10 stocks in the Northeast Atlantic and Mediterranean. The graphs below summarize their status and exploitation level within an MSY-framework. The list of species and their current exploitation and status is summarized in Table 19. Detailed assessments for every stock are available in Appendix 3 and in the spreadsheet ICCAT_Oct05_16.xlsx.

Of the 10 stocks, 5 (50%) were subject to ongoing overfishing (F > Fmsy) and 1 stock (POR_NEA, 10%) was outside of safe biological limits (B < 0.5 B_{msy}). Two stocks (20%) were in critical condition, defined by being outside of safe biological limits and/or subject to severe overfishing ($F/F_{msy} > 2$) (marked red in Table 19). In contrast, four stocks (40%) could be considered healthy, defined by not being subject to overfishing and having a biomass above the one that can produce the maximum sustainable yield. Additionally, one stock (10%) could be considered as recovering, defined by not being subject to overfishing and having a biomass close to the one that can produce the maximum sustainable yield.

Assessment of blue shark (*Prionace glauca*) may be too optimistic, as the Atlantic and Mediterranean stocks were still treated as one by the available data, and the Mediterranean stock is known to be in bad condition. Similarly, the very strong recovery of bluefin tuna (*Thunnus thynnus*) is surprising and stretches the limits of what seems plausible given the biology of this species. According to the available data, catches have not exceeded *MSY* since 2000 and exploitation was very light (17-31% of F_{msy}) since 2010. This is very much in contrast to the public perception of strong overfishing of bluefin tuna. Overall, there seems to have been notable improvement in the stock status since 2004, when all 10 stocks were overfished with $B/B_{MSY} < 1$.

Summed biomass of the 10 stocks of 1 million tonnes in 2014 was slightly above the biomass level of 0.96 million tonnes that can produce maximum yields. Summed catches of 128 thousand tonnes were below the summed maximum sustainable yield of 185 thousand tonnes. See legends of Figures for more comments.

Table 19. Analysis of 10 ICCAT stocks in the Northeast Atlantic and the Mediterranean, with indication of last year with available data (Year), maximum sustainable yield (MSY), absolute and relative catch (Catch, C/MSY), maximum sustainable fishing mortality (F_{msy}) if the stock is within safe biological limits ($B/B_{msy} > 0.5$) , F_{msy} for current stock size, F/F_{msy} for current stock size, biomass that can produce MSY (B_{msy}), relative biomass (B/B_{msy}). Scientific names of healthy stocks where F/Fmsy < 1 and B/Bmsy > 1 are marked green and stocks outside of safe biological limits ($B/B_{msy} < 0.5$) with ongoing overfishing ($F/F_{msy} > 1$) or severe overfishing ($F/F_{msy} > 2$) are marked red. Catches above MSY are marked bold (C/MSY > 1). Overfishing with $F/F_{msy} > 1$ is marked bold. Stock sizes outside safe biological limits (B/Bmsy < 0.5) are marked bold. Unsustainable catches (catch > MSY, F > Fmsy, B < 0.2 Bmsy) are marked red. Catches are given in tonnes per year. Biomass is given in tonnes as average total biomass during the year. Species are sorted by phylogenic groups as indicated by the color of the stock IDs: sharks (blue), swordfish (red), tunas & bonito (green). [ICCAT_Oct05_16.xlsx]

Scientific name	Stock	Year	MSY	Catch	C/MSY	F_{msy}	$F_{msy\ cur}$	F	$F/F_{msy\ cur}$	B_{msy}	B	B/B_{msy}
Prionace glauca	BSH_ATN	2014	30,050	36,516	**1.22**	0.10	0.10	0.11	**1.10**	314,635	346,979	1.10
Lamna nasus	POR_NEA	2014	711	18	0.03	0.01	0.00	0.01	**3.20**	48,075	3,051	**0.06**
Isurus oxyrinchus	SMA_ATN	2014	2,647	2,899	**1.10**	0.02	0.02	0.03	**1.39**	118,432	93,363	0.79
Thunnus thynnus	BFT_ATE	2014	40,488	13,250	0.33	0.32	0.32	0.08	0.26	126,851	160,029	1.26
Xiphias gladius	SWO_MED	2014	16,281	9,794	0.60	0.28	0.28	0.22	0.79	58,792	44,633	0.76
Xiphias gladius	SWO_ATN	2014	14,278	10,813	0.76	0.34	0.34	0.21	0.62	42,549	51,827	1.22
Thunnus alalunga	ALB_ATN	2014	47,223	26,539	0.56	0.38	0.38	0.16	0.41	124,129	169,220	1.36
Thunnus alalunga	ALB_MED	2014	4,909	2,373	0.48	0.37	0.37	0.15	0.41	13,144	15,380	1.17
Euthynnus alletteratus	LTA_MED	2014	2,290	3,443	**1.50**	0.42	0.42	1.03	**2.47**	5,497	3,343	0.61
Sarda sarda	BON_MED	2014	23,621	22,823	0.97	0.21	0.21	0.21	**1.01**	115,039	109,579	0.95

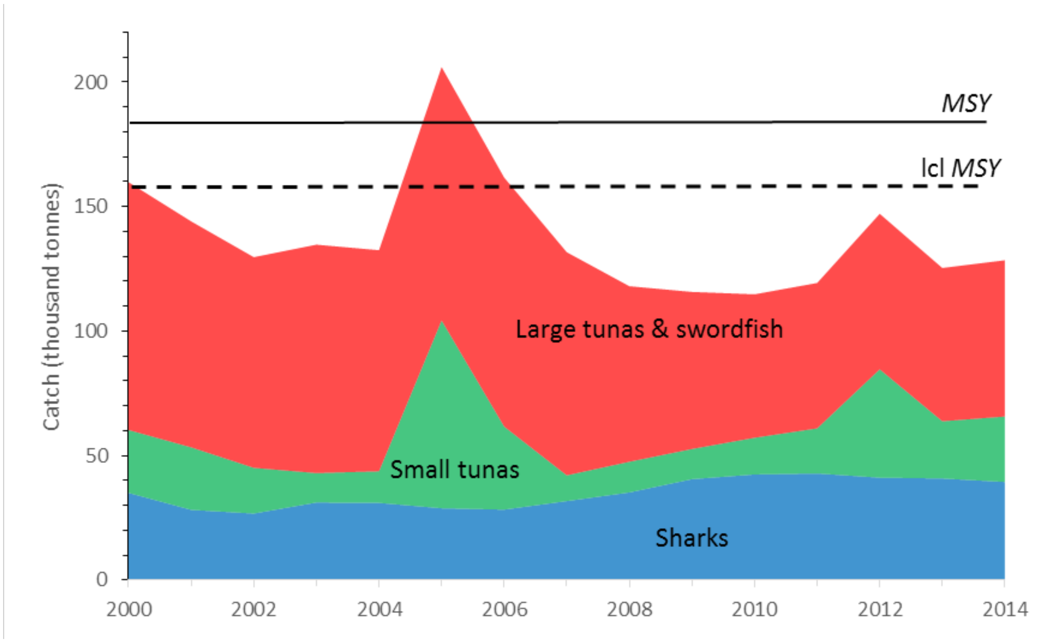


Figure 126. Cumulative catches, including discards and recreational catch if available, for 10 ICCAT stocks in the Northeast Atlantic and Mediterranean, with indication of phylogenic/functional groups. The black line indicates the maximum sustainable yield (MSY) for the ecoregion and the dashed line indicates the lower 95% confidence limit as a precautionary target. [ICCAT_Oct05_16.xlsx]

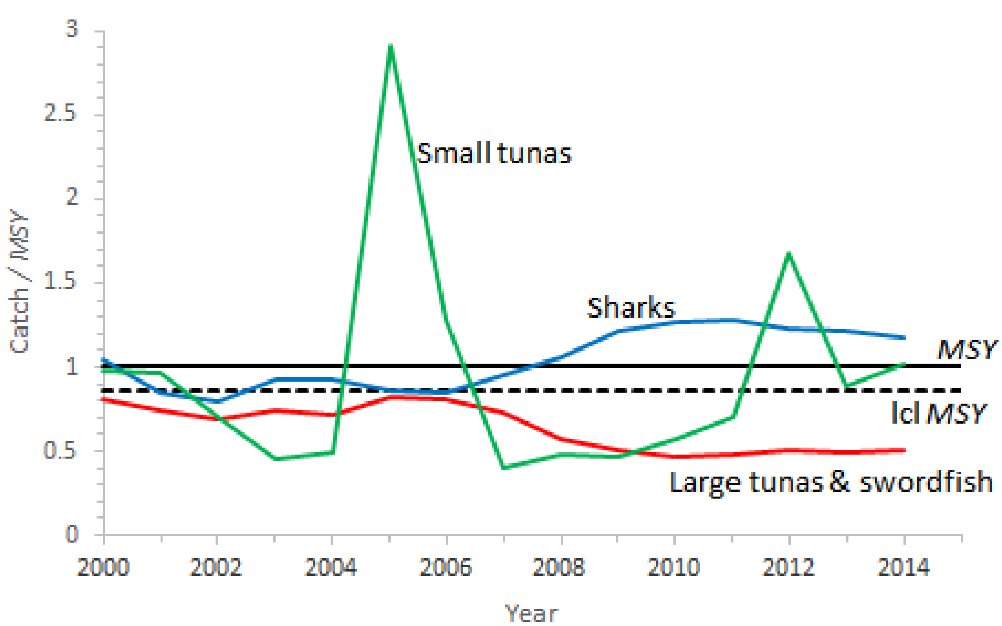


Figure 127. Median catches by phylogenic group relative to their maximum sustainable yield (MSY, black line), for 10 ICCAT stocks in the Northeast Atlantic and Mediterranean. Sharks (blue curve) were subject to catches above MSY level since 2008. Relative catches of tunas seem surprisingly low, see comment above. [ICCAT_Oct05_16.xlsx]

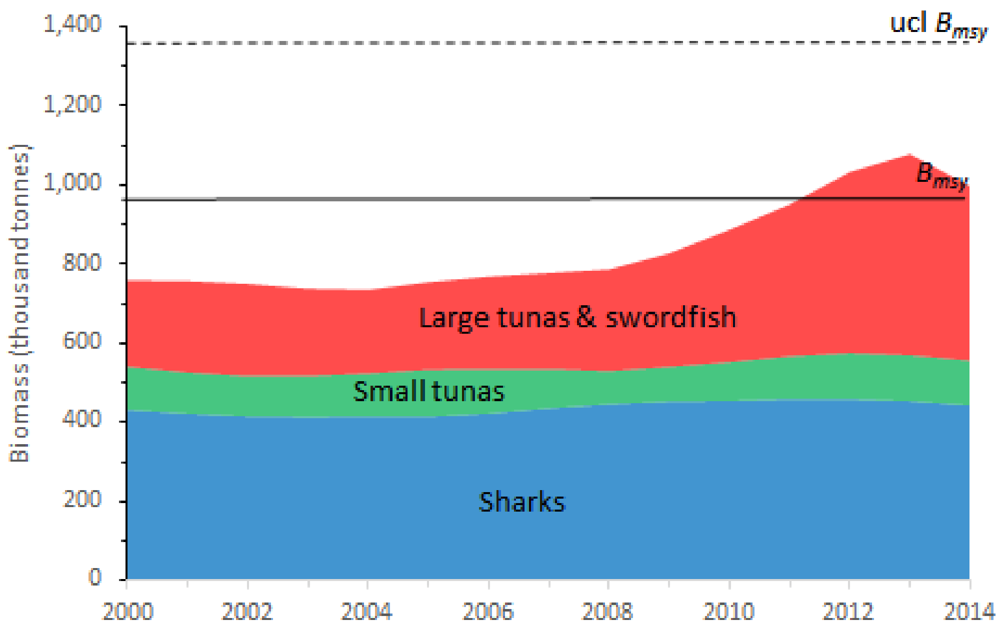


Figure 128. Cumulative total biomass of 10 ICCAT stocks in the Northeast Atlantic and Mediterranean, with indication of the biomass that can produce the maximum sustainable yield (B_{msy} = black line). The upper 95% confidence limit of B_{msy} (dashed line) would present a precautionary target biomass above B_{msy}. The strong increase in biomass of large tunas & swordfish after 2010 is surprising. [ICCAT_Oct05_16.xlsx]

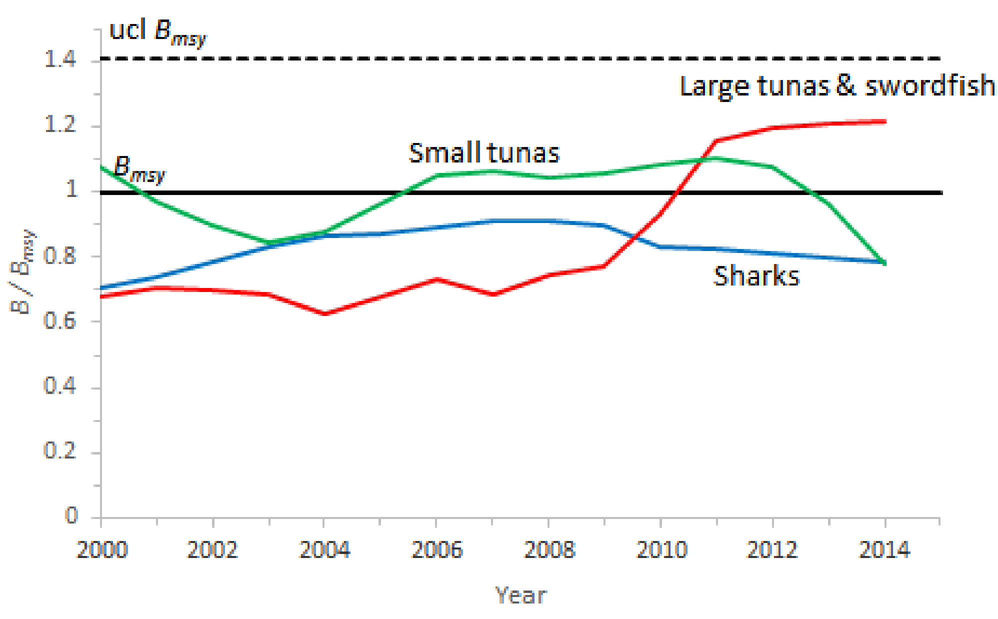


Figure 129. Median biomass relative to the level that can produce the maximum sustainable yield (B/B_{msy}) for 10 ICCAT stocks in the Northeast Atlantic and Mediterranean assigned to phylogenic groups. The strong increase of large tunas & swordfish above B_{msy} since 2010 and the stable high biomass of sharks are surprising, given the public perception of these stocks. [ICCAT_Oct05_16.xlsx]

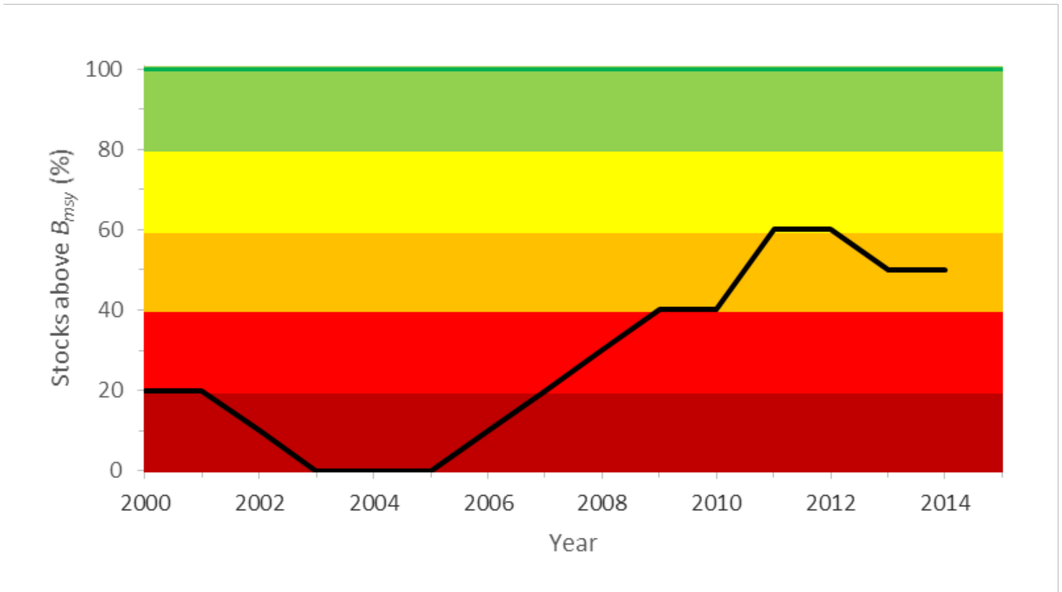


Figure 130. Percentage of stocks where biomass is above the level that can produce the maximum sustainable yield (B_{msy}) for 10 stocks in the Northeast Atlantic and Mediterranean (black curve). The colors indicate visually the compliance with the goals of the Common Fisheries Policy, where all stocks (100%) shall be above B_{msy} eventually. Based on the available data, 50% of the stocks fulfilled that requirement in 2014. [ICCAT_Oct05_16.xlsx]

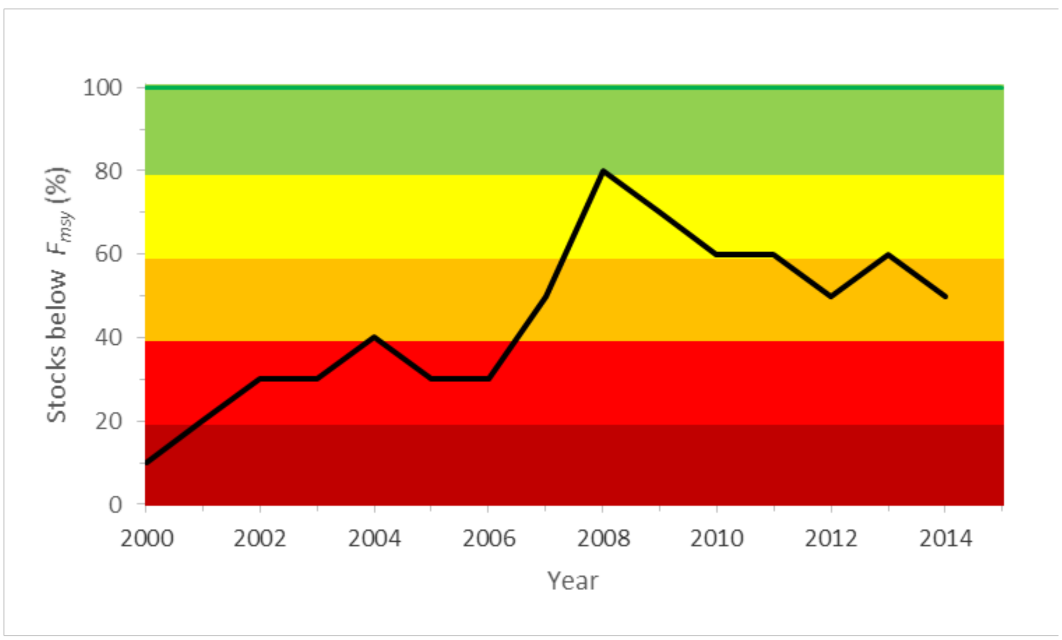


Figure 131. Percentage of stocks where fishing mortality F is at or below the level that can produce the maximum sustainable yield (F_{msy}) for 10 ICCAT stocks in the Northeast Atlantic and Mediterranean (black curve). The colors indicate visually the compliance with the goals of the Common Fisheries Policy, where all stocks (100%) shall be at or below F_{msy} in 2015, latest in 2020. In 2014, 50% of the stocks fulfilled that requirement. [ICCAT_Oct05_16.xlsx]

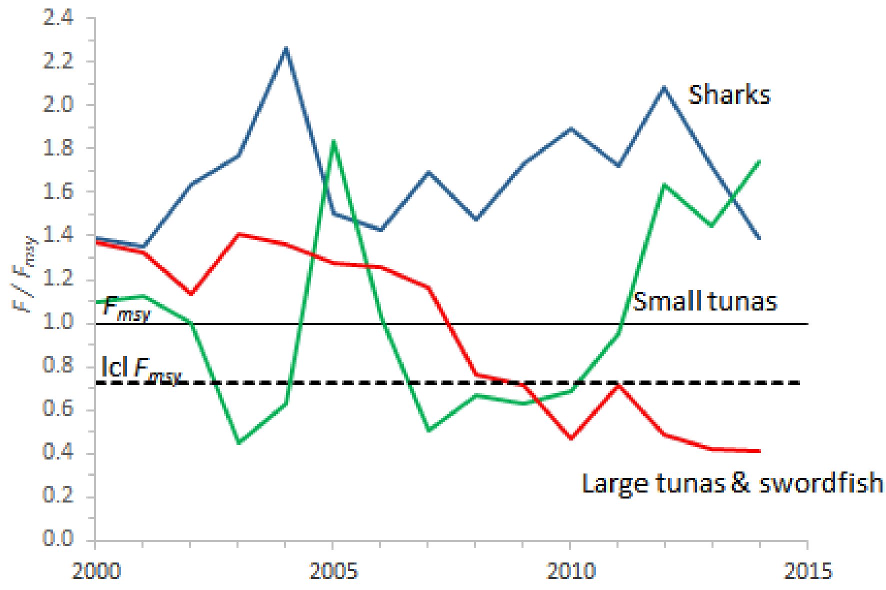


Figure 132. Median fishing pressure relative to the maximum sustainable level (F/F_{msy}) for 10 ICCAT stocks in the Northeast Atlantic and Mediterranean assigned to phylogenic groups. Sharks (blue curve) were strongly overfished before 2000 and they are still subject to overfishing throughout the shown time series. According to the available data, exploitation of large tunas & swordfish is much lighter than expected. [ICCAT_Oct05_16.xlsx]

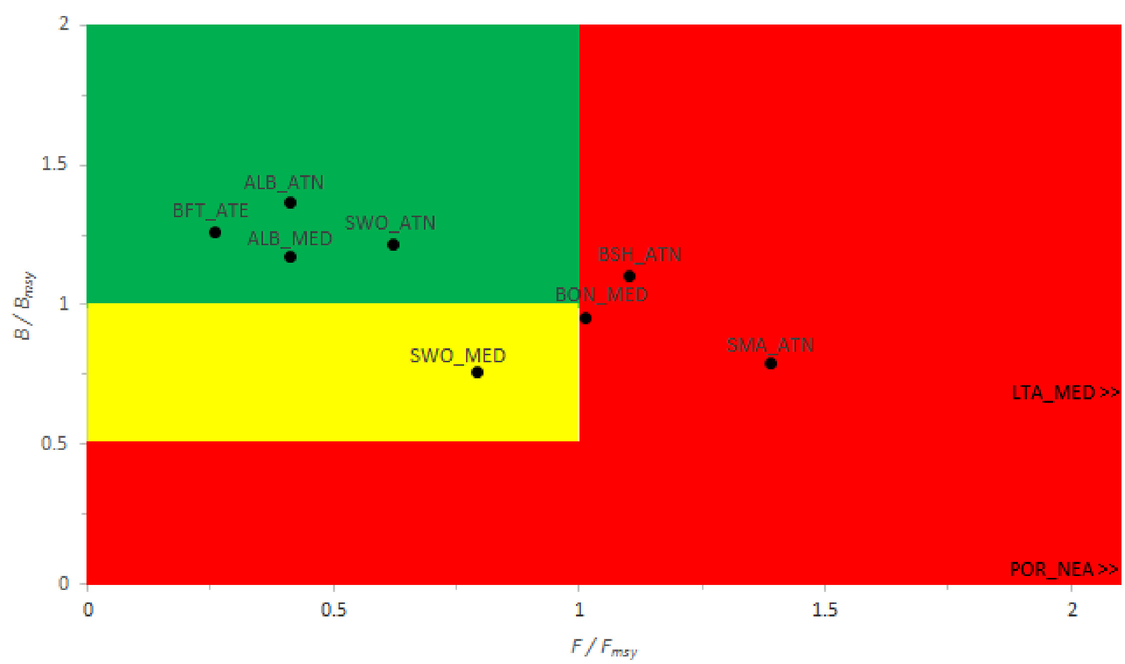


Figure 133. Presentation of 10 ICAAT stocks in the Northeast Atlantic and Mediterranean in a pressure (F/F_{msy}) – state (B/B_{msy}) pl ot. The red area indicates stocks that are being overfished or are outside of safe biological limits. The yellow area indicates recov ering stocks. The green area indicates stocks subject to sustainable fishing pressure and of a healthy stock size that can produce high yields close to MSY. [ICCAT_Oct05_16.xlsx]

ICES Stocks

The following three paragraphs describing the area utilized by widely distributed and migratory stocks within the ICES area were taken from the ICES Advice 2008, Book 9,

http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2008/2008/9.3.1%20Assessment%20and%20advice%20regarding%20fisheries.pdf.

"Due to the heterogeneous nature of the waters used by widely distributed and migratory stocks, the ecosystem descriptions are split into two between the continental shelf and its pelagic zone and the oceanic and deep sea area.

Most of the surface of the advisory region K [Oceanic northeast Atlantic] is abyssal plain with average depth >ca 4000 m. To the east the continental slope of Europe is mainly rocky and hard from the latitude of Ireland southwards, further north sediment cover occurs to the west of the British Isles. To the west of Scotland, topography is variable with two portions of detached continental shelf – Rockall and Hatton Banks – separated from the European continental shelf by the Rockall Trough. The northern part of this advisory region is marked by the Wyville Thomson and the Iceland–Faroe Ridges. In the west, the major topographical feature is the mid-Atlantic Ridge (MAR) that follows a sinuous course southwards from Iceland (where it is known as Reykjanes Ridge), to the Azores. At the ridge new oceanic floor is formed and the western and eastern parts of the North Atlantic basin are separating at a speed of 2–6 m/year. The MAR has a rugged topography with numerous peaks of variable height. Isolated seamounts occur over the whole basin. The European continental slope is comparatively gentle. The western part of the advisory region extends beyond the MAR over the northwestern Atlantic deep basin. Along the ridge, the Charlie Gibbs Fracture Zone (CGFZ) is a major transversal feature comprising a system of two main parallel deep rift valleys running perpendicular to the main MAR axis at about 52°N. The axis of the ridge south of the CGFZ is about 6° east of that of the ridge to the north. The main flow of deep-water between the western and eastern deep-sea basins of the North Atlantic occurs through these deep channels and affects the whole North Atlantic circulation (see http://www.mar-eco.no). If advisory region K were to be split in the future, the CGFZ might prove a suitable dividing feature.

The general circulation in the epipelagic zone (0–200 m) is well understood. A warm current flows from the southwestern North Atlantic towards the European coast with several side branches. Cold currents flow south from the Labrador Sea and Irminger Sea and also as a strong deep-water flow between Shetland and the Faroes."

ICES assessment reports with data until 2014 or 2015 were analyzed for 30 wide-ranging stocks in the Northeast Atlantic. The graphs below summarize their status and exploitation level within an MSY-framework. The list of species and their current exploitation and status is summarized in Table 20. Detailed assessments for every stock are available in Appendix 3 and in the spreadsheet Wide_Sep29_16.xlsx.

Of the 30 stocks, 17 (57%) were subject to ongoing overfishing ($F > F_{msy}$) and 18 stocks (60%) were outside of safe biological limits ($B < 0.5\ B_{msy}$). In seven stocks (23%) catches exceeded the maximum sustainable yield ($C/MSY > 1$). Ten stocks (33%) were in critical condition, defined by being outside of safe biological limits and subject to overfishing (marked red in Table 20). Altogether, 22 stocks (73%) were subject to unsustainable exploitation (catch > *MSY* or $F > F_{msy}$ or $B < 0.2\ B_{msy}$), with the too high catches marked red in Table 20. Of special concern are the nine severely depleted stocks ($B < 0.2\ B_{msy}$) which show no sign of recovery. Only two stocks (lin-oth, whb-comb) could be considered healthy, defined by not being subject to overfishing and having a biomass above the one that can produce the maximum sustainable yield.

Summed biomass of the 30 stocks of 10.6 million tonnes in the last year with available data was close to the biomass level of 11.9 million tonnes that can produce maximum yield. Note, however, that this was caused by the good biomass level of the two largest stocks and masks the very low biomass levels of the many small stocks. Summed catches of 2.8 million tonnes exceeded the summed maximum sustainable yield of 2.7 million tonnes and can therefore not be maintained. These catches stem mostly from Atlantic mackerel and Blue whiting, which exceed the catches of all other stocks by orders of magnitude. See legends of Figures for more comments.

Table 20. Analysis of 30 wide ranging ICES stocks, with indication of last year with available data (Year), maximum sustainable yield (MSY), absolute and relative catch (Catch, C/MSY), maximum sustainable fishing mortality (F_{msy}) if the stock is within safe biological limits ($B/B_{msy} > 0.5$) , F_{msy} for current stock size, F/F_{msy} for current stock size, biomass that can produce MSY (B_{msy}), relative biomass (B/B_{msy}). Scientific names of healthy stocks where F/Fmsy < 1 and B/Bmsy > 1 are marked green and stocks outside of safe biological limits ($B/B_{msy} < 0.5$) with ongoing overfishing ($F/F_{msy} > 1$) are marked red. Catches above MSY are marked bold (C/MSY > 1). Overfishing with $F/F_{msy} > 1$ is marked bold. Stock sizes outside safe biological limits (B/Bmsy < 0.5) are marked bold. Unsustainable catches (catch > MSY, F > Fmsy, B < 0.2 Bmsy) are marked red. Catches are given in tonnes per year. Biomass is given in tonnes as average total biomass during the year. Species are sorted by functional groups as indicated by the color of the stock IDs: benthic fish & invertebrates (blue), large predators (red) and pelagic plankton feeders (green). [Wide_Sep29_16.xlsx]

Scientific name	Stock	Year	*MSY*	Catch	*C/MSY*	F_{msy}	F_{msy} cur	*F*	F/F_{msy} cur	B_{msy}	*B*	B/B_{msy}
Squatina squatina	agn-nea	2011	69	1	0.01	0.14	0.02	0.03	**1.39**	504	36	**0.07**
Argentina silus	arg-123a4	2014	12,969	15,057	**1.16**	0.25	0.25	0.54	**2.14**	51,582	27,967	0.54
Argentina silus	arg-rest	2014	2,605	1	0.00	0.11	0.06	0.00	0.00	23,110	5,796	**0.25**
Molva dypterygia	bli-oth	2014	498	240	0.48	0.19	0.17	0.21	**1.25**	2,584	1,135	**0.44**
Aphanopus carbo	bsf-nea	2015	194	508	**2.62**	0.06	0.06	0.13	**2.09**	3,193	3,994	1.25
Centroscymnus coelolepis	cyo-nea	2014	7,953	5	0.00	0.02	0.01	0.00	0.01	525,521	96,273	**0.18**
Squalus acanthias	dgs-nea	2013	20,787	2,384	0.11	0.04	0.03	0.01	0.45	559,106	199,961	**0.36**
Anguilla anguilla	eel-eur	2014	14,721	3,329	0.23	0.15	0.05	0.22	**4.77**	96,538	14,859	**0.15**
Phycis blennoides	gfb-comb	2015	3,353	4,243	**1.27**	0.29	0.29	0.59	**2.04**	11,508	7,149	0.62
Centrophorus squamosus	guq-nea	2014	4,344	33	0.01	0.07	0.01	0.00	0.33	63,397	6,758	**0.11**
Chelidonichthys cuculus	gur-comb	2014	6,141	5,060	0.82	0.49	0.39	1.02	**2.64**	12,592	4,973	**0.39**
Molva molva	lin-oth	2014	36,934	17,024	0.46	0.21	0.21	0.10	0.46	173,693	174,951	1.01
Mullus surmuletus	mur-west	2014	2,414	1,402	0.58	0.58	0.58	0.40	0.70	4,197	3,501	0.83
Hoplostethus atlanticus	ory-comb	2015	3,569	90	0.03	0.14	0.03	0.04	**1.57**	24,913	2,233	**0.09**
Raja clavata	raj-mar	2014	75	187	**2.49**	0.17	0.17	0.79	**4.56**	435	238	0.55
Macrourus berglax	rhg-nea	2014	4,143	654	0.16	0.16	0.08	0.11	**1.40**	26,169	6,204	**0.24**
Coryphaenoides rupestris	rng-1012	2014	12,988	3,481	0.27	0.16	0.06	0.24	**4.32**	81,020	14,267	**0.18**
Coryphaenoides rupestris	rng-oth	2014	233	51	0.22	0.21	0.10	0.19	**1.80**	1,101	272	**0.25**

Scientific name	Stock	Year	*MSY*	Catch	*C/MSY*	F_{msy}	$F_{msy\ cur}$	*F*	$F/F_{msy\ cur}$	B_{msy}	*B*	B/B_{msy}
Dalatias licha	sck-nea	2014	594	0	0.00	0.13	0.05	0.00	0.00	4,405	882	**0.2002**
Brosme brosme	usk-mar	2013	26	0	0.00	0.18	0.04	0.00	0.00	149	16	**0.11**
Brosme brosme	usk-oth	2014	8,652	4,585	0.53	0.24	0.24	0.13	0.56	36,449	34,755	0.95
Galeorhinus galeus	gag-nea	2014	1,126	347	0.31	0.06	0.04	0.07	**2.04**	17,492	4,809	**0.27**
Merluccius merluccius	hke-nrtn	2015	83,946	101,066	**1.20**	0.19	0.19	0.21	**1.12**	449,584	483,134	1.07
Lamna nasus	por-nea	2014	2,085	7	0.00	0.03	0.01	0.00	0.18	67,218	6,413	**0.10**
Salmo salar	salmon-NEAC	2014	6,305	938	0.15	0.14	0.05	0.10	**1.87**	46,267	9,227	**0.199**
Mustelus spp.	trk-nea	2014	3,586	3,690	**1.03**	0.14	0.14	0.17	**1.18**	25,408	22,145	0.87
Micromesistius poutassou	whb-comb	2014	1,453,351	1,146,000	0.79	0.23	0.23	0.17	0.77	6,404,617	6,567,571	1.03
Cetorhinus maximus	bsk-nea	2014	1,025	0	0.00	0.03	0.01	0.00	0.00	29,740	3,132	**0.11**
Trachurus trachurus	hom-west	2014	303,148	129,025	0.43	0.26	0.26	0.21	0.79	1,149,830	615,697	0.54
Scomber scombrus	mac-nea	2014	735,937	1,394,454	**1.89**	0.36	0.36	0.61	**1.70**	2,057,592	2,299,822	1.12

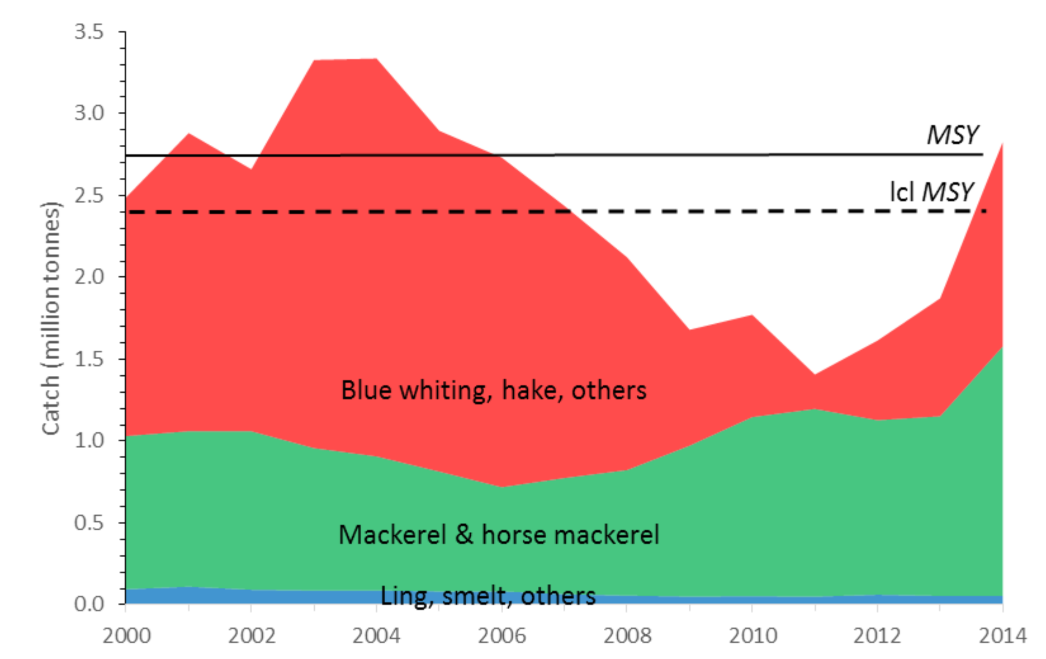


Figure 134. Cumulative catches, including discards and recreational catch if available, for 30 wide-ranging ICES stocks, with indication of main functional groups. The black line indicates the maximum sustainable yield (MSY) for the ecoregion and the dashed line indicates the lower 95% confidence limit as a precautionary target. Note that, by definition, catches above MSY cannot be maintained. [Wide_Sep29_16.xlsx]

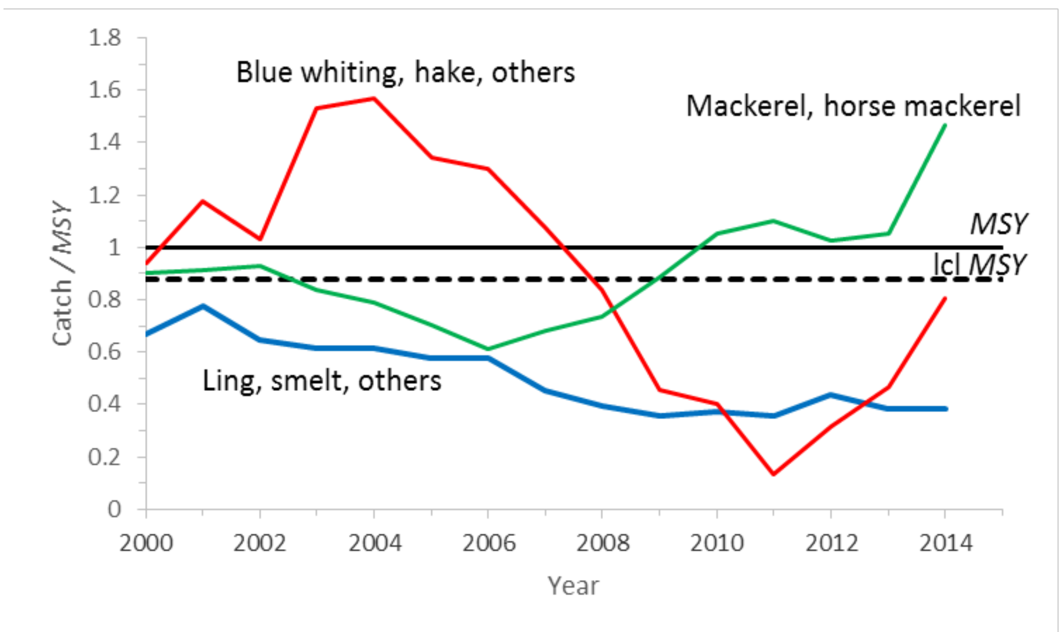


Figure 135. Catches by main functional group relative to their maximum sustainable yield (MSY, black line), for 30 wide-ranging ICES stocks. The mackerel catches above MSY cannot be maintained. [Wide_Sep29_16.xlsx]

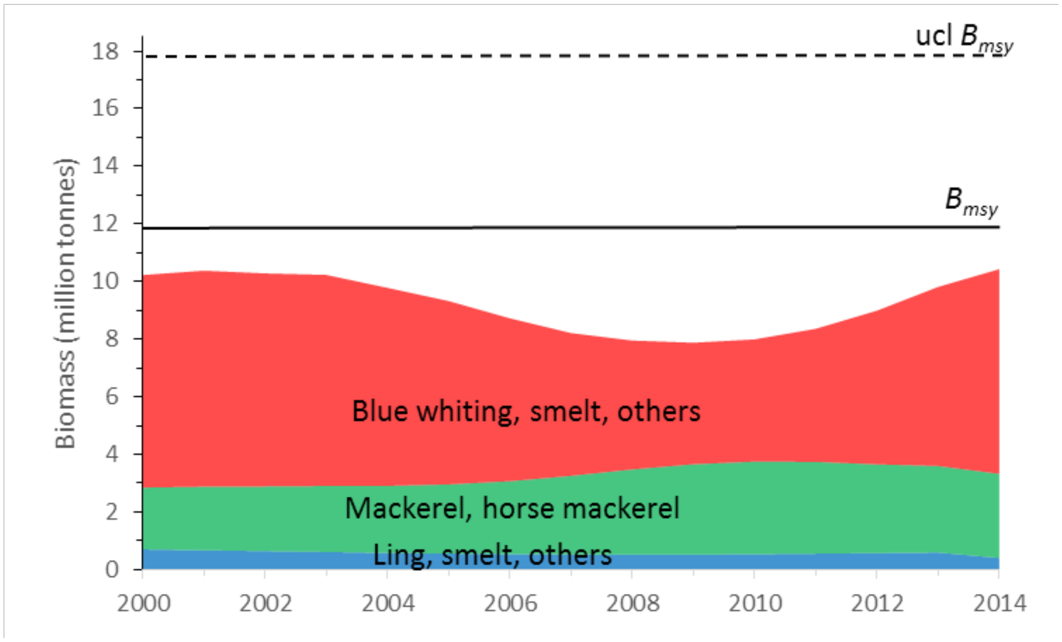


Figure 136. Cumulative total biomass of 30 wide-ranging ICES stocks relative to the biomass that can produce the maximum sustainable yield (B_{msy} = black line). The upper 95% confidence limit of B_{msy} (dashed line) would present a precautionary target biomass above B_{msy}. This is also the area where the maximum economic yield could be obtained. The functional groups of benthic fish (blue), pelagic plankton feeders (green) and large predators (red) are indicated, with listing of main species. The high biomass of blue whiting and mackerel masks the low biomass of the other stocks, see median biomass levels in next graph for comparison. [Wide_Sep29_16.xlsx]

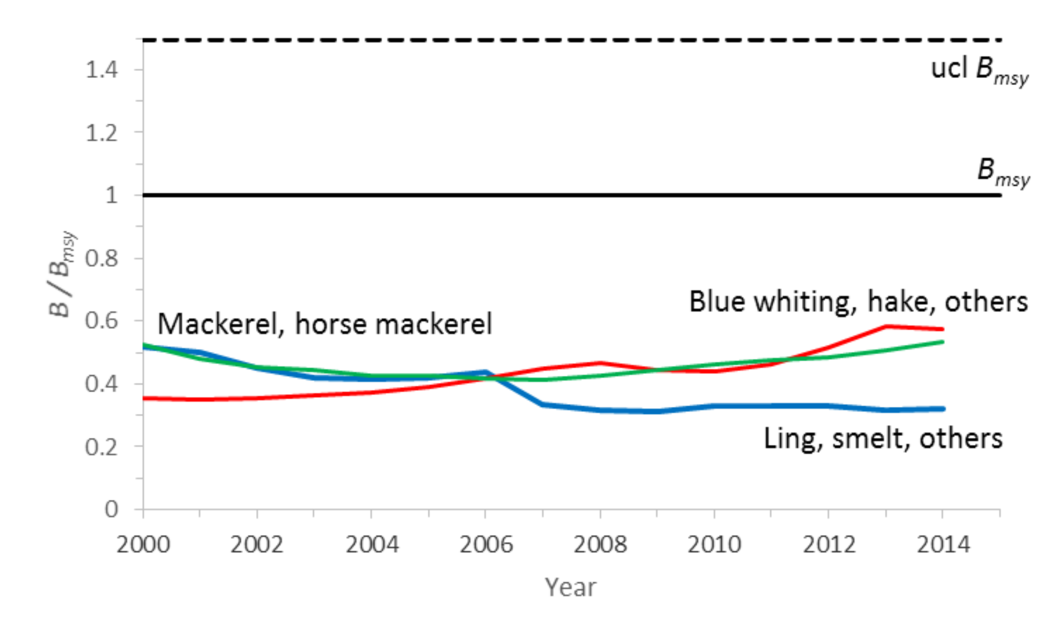


Figure 137. Median biomass relative to the level that can produce the maximum sustainable yield (B/B_{msy}) for 30 wide-ranging ICES stocks assigned to main functional groups. Biomass levels of benthic fish (blue curve) are outside of safe biological limits. [Wide_Sep29_16.xlsx]

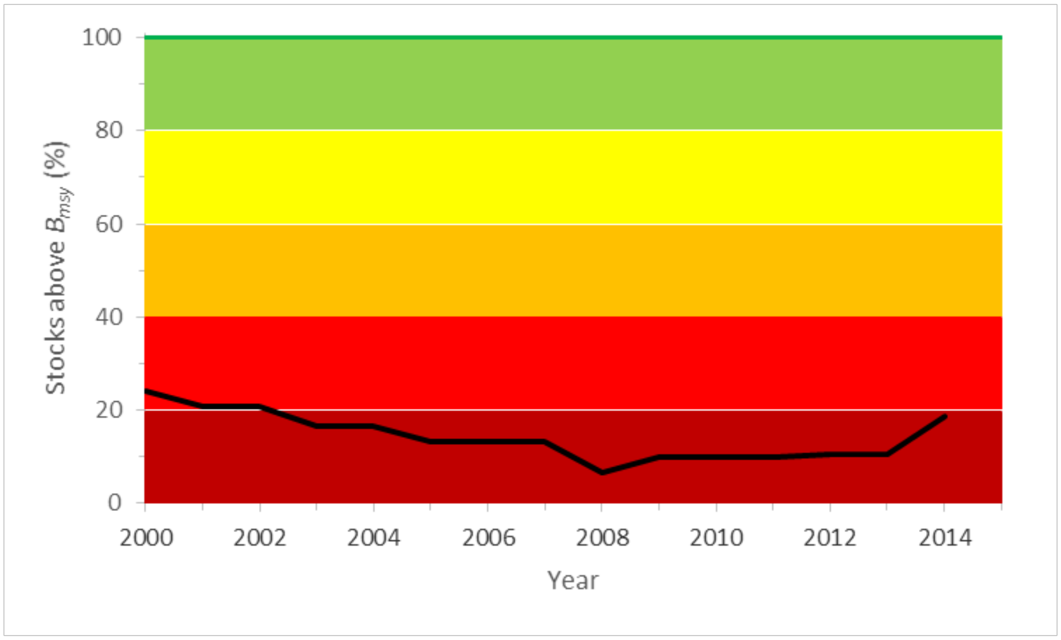


Figure 138. Percentage of stocks where biomass is above the level that can produce the maximum sustainable yield (B_{msy}) for 30 wide-ranging ICES stocks (black curve). The colors indicate visually the compliance with the goals of the Common Fisheries Policy, where all stocks (100%) shall be above B_{msy} eventually. In 2014, only 19% of the stocks fulfilled that requirement. [Wide_Sep29_16.xlsx]

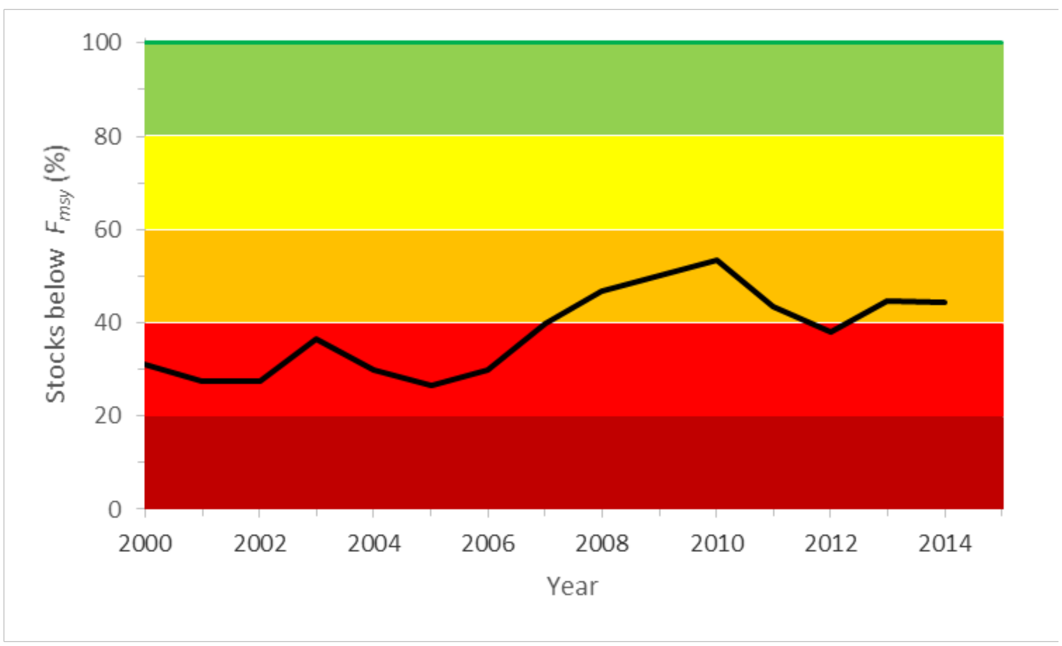


Figure 139. Percentage of stocks where fishing mortality F is at or below the level that can produce the maximum sustainable yield (F_{msy}) for 30 wide-ranging stocks in the ICES area (black curve). The colors indicate visually the compliance with the goals of the Common Fisheries Policy, where all stocks (100%) shall be at or below F_{msy} in 2015, latest in 2020. In 2014, only 44% of the stocks fulfilled that requirement. [Wide_Sep29_16.xlsx]

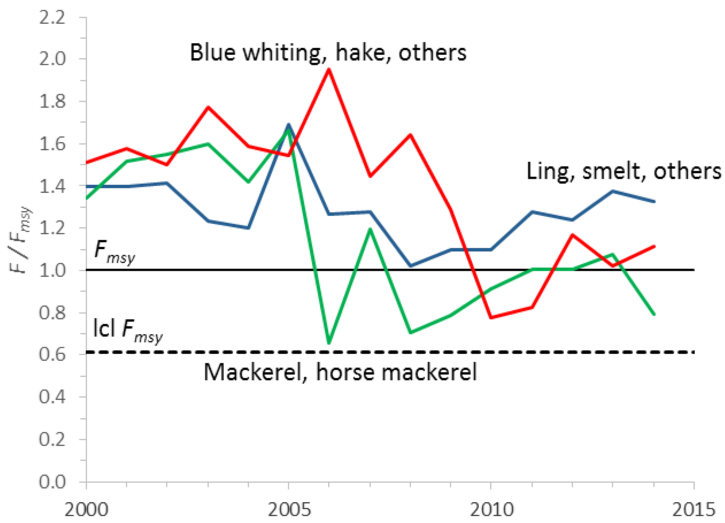


Figure 140. Median fishing pressure relative to the maximum sustainable level (F/F_{msy}) for 30 wide-ranging ICES stocks assigned to main functional groups. The strong decline in fishing pressure on large predators (red curve) is misleading because several of these stocks are depleted and show no signs of recovery despite low fishing pressure. The high fishing pressure on plankton feeders and benthic fish is not sustainable. [Wide_Sep29_16.xlsx]

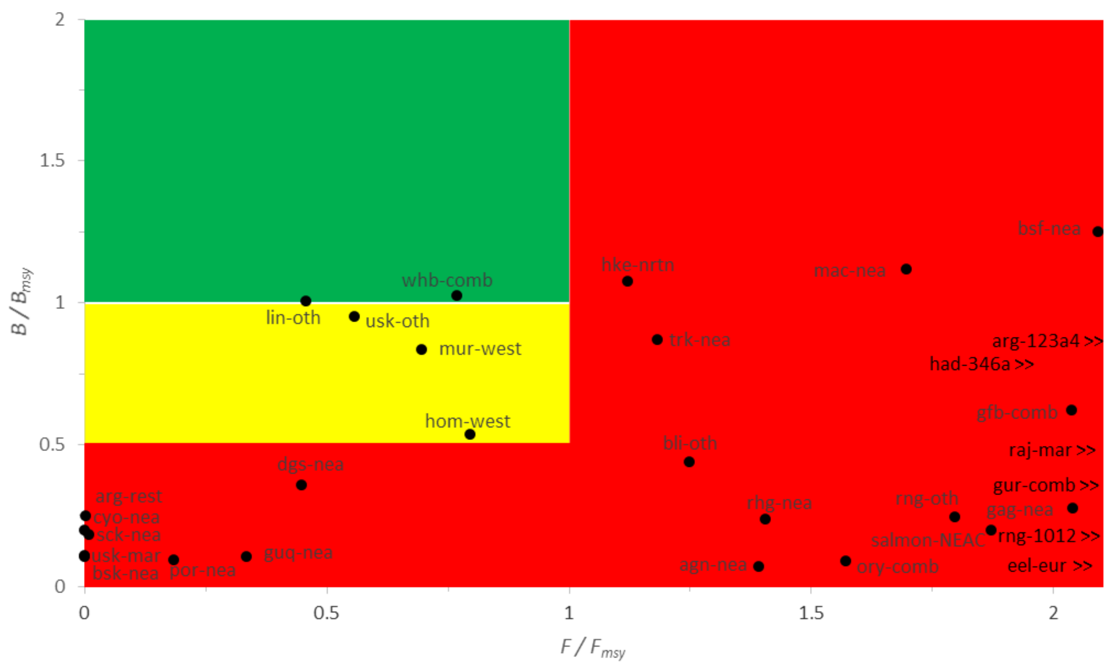


Figure 141. Presentation of 30 wide-ranging and migratory ICES stocks in a pressure (F/F_{msy}) – state (B/B_{msy}) plot. The red area indicates stocks that are being overfished or are outside of safe biological limits. The yellow area indicates recovering stocks. The green area indicates stocks subject to sustainable fishing pressure and of a healthy stock size that can produce high yields close to MSY. Several stocks (indicated with ->>) are exploited beyond the upper limit of the X-axis. [Wide_Sep29_16.xlsx]

Discussion

All stocks (397) in European Seas and adjacent waters with available catch data were analyzed with an advanced state-space Bayesian implementation (BSM) and with a simplified Monte-Carlo implementation (CMSY) of a surplus production model (Froese et al. 2016). A comparison of the F/F_{msy} ratios estimated by these models with those estimated by the respective stock assessment working groups showed good agreement, with 67% of the BSM/CMSY estimates deviating less than 50% from the ones of the working groups and with 82% of the BSM/CMSY estimates coming to the same conclusion with regard to overfishing ($F/F_{msy} > 1$). Thus, the results of this study can be considered comparable with the “official” estimates used in statistics by the European Commission. The advantage of the simplified models used in this study is their broad applicability (397 stocks vs 93 stocks with ”official” F/F_{msy} estimates) and the estimation of additional reference points (*MSY* and B_{msy}) that are crucial for the evaluation of progress towards the goals of the Common Fisheries Policy (CFP 2013).

The map below shows the percentage of stocks that fulfill the requirements of the CFP, by ecoregion. There is a remarkable North-South gradient, with over 60% of the stocks exploited sustainably with a biomass above the one that can produce *MSY* in the Barents Sea and Norwegian Sea, compared to less than 20% of stocks with these properties in most of the Mediterranean Sea.

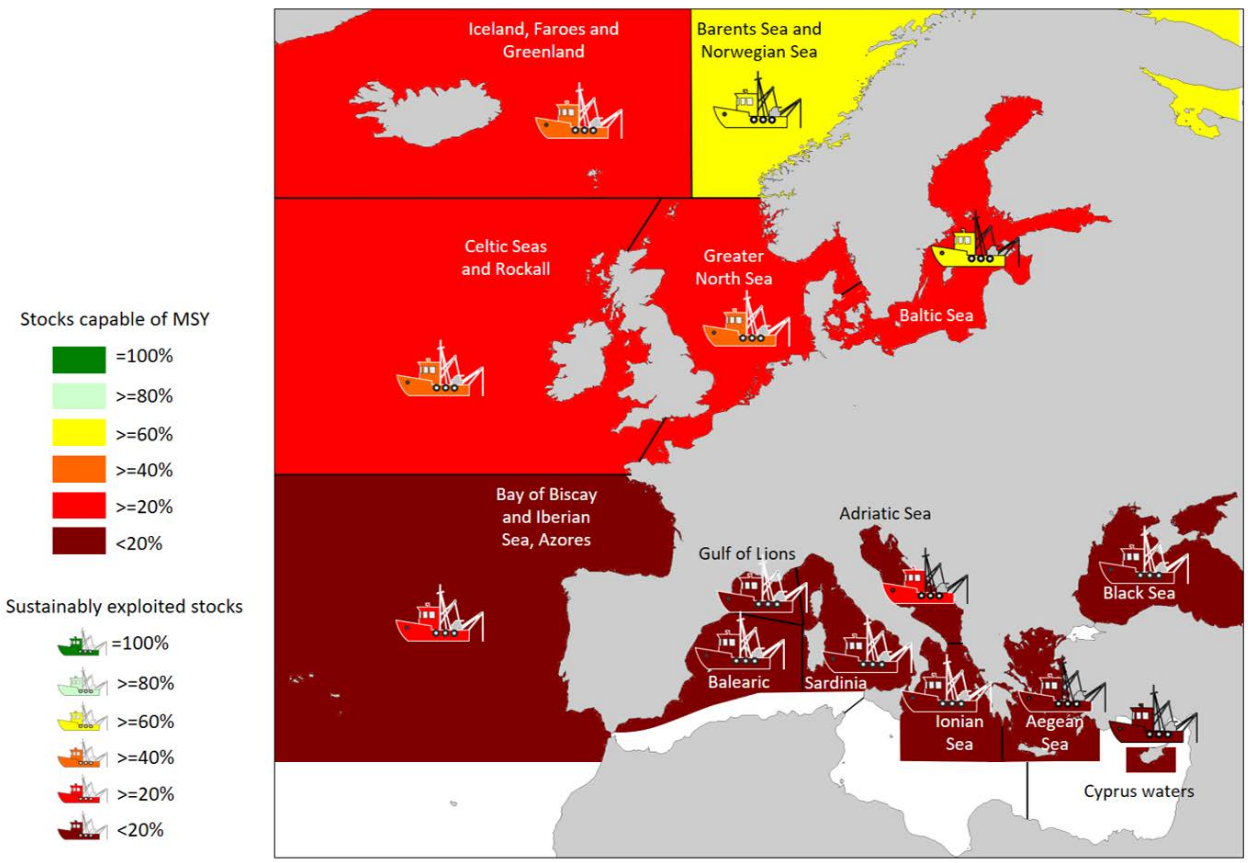


Figure 5. Map showing the compliance with the Common Fisheries Policy of the EU, for 357 stocks in 12 ecoregions, for the last years (2013-2015) with available data (excluding 40 wide-ranging stocks). The color of the areas indicates the percentage of stocks with sizes that are above the level that can produce maximum sustainable yields (B > Bmsy) and the color of the fishing boats indicates the percentage of stocks that are exploited sustainably ($F <= F_{msy}$, catch < MSY, $B > 0.2\ B_{msy}$).

Of the 397 stocks with available data, 64% were subject to ongoing overfishing and 51% were outside of safe biological limits, potentially suffering from impaired recruitment. Only 12% of the stocks fulfilled the requirement of the Common Fisheries Policy of Europe as being not subject to overexploitation and having a biomass above the level that can produce maximum sustainable yields.

Biomass in the ecoregions of the Mediterranean and Black Sea was on average less than half (44%) of the level that can produce *MSY*, whereas in the northern ecoregions (Barents Sea to Iberian Sea) biomass was on average about ¾ (73%) of that level. Rebuilding of biomass above the *MSY* level will require a few years in most stocks, depending on the depletion level of the stocks and how far exploitation is reduced below the *MSY*-level during the rebuilding phase. For example, exploitation at half the *MSY*-level should rebuild most stocks in the northern ecoregions in 1-5 years whereas in the more depleted Mediterranean stocks rebuilding may take 1-7 years.

Total catches across all stocks and regions were 8.8 million tonnes whereas the maximum sustainable yield (*MSY*) was estimated at 15.4 million tonnes. Because of trophic interactions it is not possible to achieve *MSY* simultaneously for all stocks, but after rebuilding of the stocks and assuming a precautionary target of 90% of *MSY*, substantial increases in catches could be possible. These potential increases differ widely between ecoregions, from 25% in the Baltic Sea to over 200% in some Mediterranean ecoregions. Across all stocks and ecoregions, potential increases in catch of over 50% would be possible.

Independent assessments of exploitation status were available for 93 (23%) of the examined stocks. A comparison of these exploitation estimates with the results of this study showed good agreement, with 82% of the stocks having the same classification of being overfished or being sustainably exploited. For the stocks with different classifications, this study tended to underestimate exploitation.

In summary, the goal of the Common Fisheries Policy of Europe to reduce exploitation to *MSY*-levels by 2015 (with exceptions until 2020) seems to have been missed by a large margin. Without reduction of exploitation below the *MSY*-level there will be no rebuilding of stocks above the level that can produce *MSY*. Especially the stocks in the Mediterranean need urgent action to stem the widespread collapse of largely unrestricted fisheries.

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