Loss of megafauna and regional discrepancy in status of Europe's marine fishes

Paul G. Fernandes[1], Gina M. Ralph[2], Ana Nieto[3], Mariana García Criado[3], Paraskevas Vasilakopoulos[4], Christos D. Maravelias[4], Robin Cook[5], Nick Dulvy[6], Riley A. Pollom[7], Marcelo Kovačić[8], David Pollard[9], Edward D. Farrell[10], Ann-Britt Florin[11], Beth A. Polidoro[12], Julia M. Lawson[6], Pascal Lorance[13], Franz Uiblein[14], Matthew Craig[15], David J. Allen[3], Sarah Fowler[16], Rachel Walls[6], Mia T. Comeros-Raynal[2,17], Michael S. Harvey[2], Manuel Dureuil[18], Manuel J Conceicao Biscoito[19], Caroline Pollock[3], Jørgen Nielsen[20], Sophy R. McCully Phillips[21], Jim R. Ellis[20], Constantinos Papaconstantinou[4], Alen Soldo[22], Çetin Keskin[23], Simona Clo[24], Steen Wilhelm Knudsen[25], Luís Gil de Sola[26], Fabrizio Serena[27], Bruce Collette[28], Kjell Nedreaas[14], Emilie Stump[2,7], Alvaro Abella[27], Ning Chao[29], Barry C. Russell[30], Silvia Garcia[31], Pedro Afonso[32], Jung Armelle[33], Helena Alvarez[33], Joao Manuel Mendes Henriques Delgado[34] & Kent E. Carpenter[35].

[1]Institute of Biological and Environmental Sciences, University of Aberdeen, Aberdeen, AB24 2TZ, UK.
[2]IUCN Marine Biodiversity Unit, Department of Biological Sciences, Old Dominion University, Norfolk, VA 23529-0266 USA.
[3]Global Species Programme & Key Biodiversity Areas, IUCN, Rue Mauverney 28, 1196 Gland, Switzerland.
[4] Hellenic Centre for Marine Research (HCMR), 46.7km Athens-Sounio ave., 19013 Anavyssos, Greece
[5]Dept. of Mathematics and Statistics, University of Strathclyde, 26 Richmond Street, Glasgow, G1 1XH,UK
[6] Department of Biology, Simon Fraser University, 8888 University Drive, Burnaby, British Columbia, Canada, V5A 1S6
[7] Institute for the Oceans and Fisheries, The University of British Columbia, 2202 Main Mall, Vancouver, BC, Canada V6T 1Z4
[8] Natural History Museum Rijeka, Lorenzov prolaz 1, HR-51000 Rijeka, Croatia
[9] The Australian Museum, Six College Street, Sydney, NSW 2010, Australia
[10] Marine Institute, Rinville, Oranmore, Co., Galway, Ireland
[11] Department of Aquatic Resources, Swedish University of Agricultural Sciences, Skolgatan 6, 742 42 Öregrund, Sweden
[12] School of Mathematics and Natural Sciences, Arizona State University, Glendale AZ, 85306, USA
[13] Institut Français de Recherche pour l'Exploitation de la Mer (Ifremer), Nantes cedex 3, France
[14] Institute of Marine Research,Nordnesgaten 33, P.O. Box 1870 Nordnes, N-5817 Bergen, Norway
[15]National Marine Fisheries Service, Southwest Fisheries Science Center, 8901 La Jolla Shores Drive, La Jolla, CA 92037, USA
[16] IUCN Shark Specialist Group, Newbury, UK
[17] American Samoa Environmental Protection Agency, Pago Pago, AS 96799
[18] Department of Biology, Dalhousie University, Halifax, NS B3H 4R2, Canada
[19] Museu de História Natural do Funchal, Rua da Mouraria, 31 9004-546 Funchal, Madeira
[20] Natural History Museum of Denmark, University of Copenhagen, Universitetsparken 15, DK-2100 Copenhagen Ø, Denmark
[21] Centre for Environment, Fisheries & Aquaculture Science (Cefas), Lowestoft, UK
[22] Department of Marine Studies, University of Split, Livanjska 5, 21000 Split, Croatia
[23] Faculty of Fisheries, University of Istanbul, Ordu St. No: 200, 34470 Laleli, İstanbul, Turkey
[24] Medsharks, via Ruggero Fauro 82, 00197 Roma, Italy
[25] Natural History Museum of Denmark, University of Copenhagen, Universitetsparken 15, 2100-DK Copenhagen Ø, Denmark
[26] Instituto Español de Oceanografía, Centro Costero de Málaga, 29640 Fuengirola, Spain
[27] Agenzia Regionale per la Protezione Ambientale della Toscana, Via Marradi 114, 57100 Livorno, Italy
[28] National Marine Fisheries Service Systematics Laboratory, National Museum of Natural History, Washington, DC 20560, USA
[29] National Museum of Marine Biology and Aquarium, 2 Houwan Road, Checheng, Pingtung, 944, Taiwan
[30] Museum & Art Gallery of the Northern Territory, Darwin, NT 0810, Australia
[31] Oceana Europe, Leganitos 47, 28013, Madrid, España
[32] Institute of Marine Research. Department of Oceanography and Fisheries, University of the Azores, Horta, Portugal
[33] APECS, Rue de Liège BP 51151 29211 Brest, France.
[34] Secretaria Regional do Ambiente e Recursos Naturais, Rua Dr. Pestana Júnior, nº 6 - 5º Andar 9064-506 Funchal, Madeira, Portugal

Summary

Europe has a long tradition of exploiting marine fish and is embarking on a Blue Growth agenda[1] to promote marine economic activity; this, along with climate change[2], will increase anthropogenic pressures at sea, threatening the biodiversity of fishes[3] and the food security[4] derived from them. Here we examine the conservation status of 1,020 species of European marine fish and identify factors that contribute to their extinction risk. The 'megafauna' amongst them (i.e. those fish species that attain lengths greater than or equal to 1.5 m), are those most at risk: half of these species are threatened with extinction, predominantly sharks, rays, and sturgeons. This analysis was based on the latest International Union for Conservation of Nature (IUCN) European regional Red List of marine fishes[5], which was found to be consistent with assessments of fish stocks carried out by fisheries management agencies: no species classified by IUCN as threatened were considered sustainable by these agencies. Further examination of stock assessments revealed a remarkable geographic contrast in the state of commercially fished stocks between northern Europe, where most stocks are not overfished, and the Mediterranean Sea, where almost all stocks are overfished, some by more than an order of magnitude relative to sustainable levels. As Europe proceeds with its Blue Growth agenda, two main issues stand out as needing priority actions in relation to its marine fish: the conservation of marine fish megafauna and the sustainability of Mediterranean fished stocks.

Main text

Marine fish exhibit high biodiversity[6] and have been culturally and nutritionally important throughout human history[7]. Europe, in particular, has a well-documented history of exploiting

[35] Department of Biological Sciences, Old Dominion University, Norfolk, VA 23529-0266 USA

marine fish populations, written records of which commence in the classical works of ancient Greece. Although this historical exploitation has undoubtedly altered populations[8,9] and changed many seascapes[10], marine defaunation in the region has not been as great as in terrestrial systems[11]. However, the use of ocean space and resources is increasing[1], the nutritional requirements of an expanding human population are growing[12], and marine ecosystems will experience unusually rapid changes in future due to climate change[2,13]. Consequently there are imminent threats to both European marine biodiversity and fish resources[14]. It is important, therefore, to assess the threats of extinction to fish species and to ensure consistency in the approach to management by the various agencies involved.

We analysed data on the conservation status of 1,020 species of Europe's marine fishes from the recent IUCN Red List assessments[5] to identify characteristics which make Europe's fishes most susceptible to extinction risk. We then compared the Red List to 112 fish stock assessments (of 28 species) made by intergovernmental agencies charged with providing advice on the exploitation of commercial fish. Previous comparisons of this sort applied criteria under various modelling assumptions[15-17] or limited the comparison to biomass reference points[18]. Of the 1,020 European marine fish species, 8.2% are threatened with extinction. However, 202 species (19.8%) were assessed as Data Deficient (DD), so the proportion of threatened species could lie between 6.6% and 26.4% (see Methods). Of the 67 threatened species, 2.1% (21 species) were Critically Endangered (CR), 2.3% (23 species) were Endangered (EN), and 2.3% (23 species) were Vulnerable (VU, see Extended Data Table 1). A further 2.5% (26 species) were considered Near Threatened (NT). The vast majority of species (71.1%, 725 species) were considered to be Least Concern (LC). Extinction risk in European marine fishes falls within the medium to low range compared to terrestrial and aquatic species' extinction risk in the region[5]. In the Eastern Tropical Pacific, the only other region of the world where all marine fishes of the continental shelf were assessed, 12% were classified as threatened[19]. Most species were assessed as threatened based on the reduction in population size (measured over the longer of 10 years or three generations), while some were threatened due to restricted geographic range, combined with a severely fragmented population and a continuing decline. Others were classed as threatened due to their very small population size. Fishing, both in targeted fisheries and as bycatch, was the most common threat to marine fishes, affecting 401 species. Other threats include pollution, coastal development, climate change, energy production and mining[5].

To assess which characteristics were most important in determining the vulnerability of Europe's fishes to extinction risk we used a conditional Random Forest (RF)[20] model which was able to predict IUCN threat categories correctly in 762 of 818 cases (Extended Data Table 2). Taxonomic class and fish size were the variables of most importance (Fig. 1a). Extinction risk was greater in cartilaginous fishes (sharks, rays and chimaeras) and fishes that attained a large size. A simple classification tree (Extended Data Figure 1) indicated that a size cut-off of 149 cm was a significant distinguishing feature of threatened status. Of 734 fish species smaller than this size, 710 (97%) were not threatened (LC or NT); of the 84 species greater or equal to this size, over half (51%, 43 species) were threatened (CR, EN or VU), and of these, 32 were cartilaginous. Further examination revealed a significant trend in threat category with size (Fig. 1b): the larger the fish species the more highly threatened the category. Size in itself, however, is not the likely sole cause of extinction risk. Much like the terrestrial mammals of the late Quaternary[21], marine megafauna are susceptible to population decline because they are more sought after and the rate at which their populations can replace themselves is low[22]. Other variables in the RF were of lower importance (Fig. 1a). The binary variable "fished", indicating whether the species was subject to fishing (including bycatch) or not, did not feature as highly: this is because so many species (351) are "fished" and of these, only 60 (17%) are threatened. Fishing, especially by large nets, is not very selective, because all fish above a typically small size are caught regardless of species.

We explored the effect of commercial fishing in more detail by examining 112 stock assessments of 28 commercially exploited marine fish species in European waters. Of these, 92 assessments had enough information to determine their status (see Methods). Only 19 stocks were sustainable, with 46 being overfished; 18 were declining and 9 were recovering. There was a significant geographical discrepancy: more fish stocks in the Mediterranean were overexploited (Fig. 2), and depleted in biomass (Fig. 3), compared to the North East Atlantic. Similar observations have been reported before[23,24], albeit separately and in different formats for the two areas: examining both simultaneously and using the same criteria demonstrates the relative magnitude of the overfishing problem in the Mediterranean. Not one of the 39 assessed Mediterranean fish stocks examined here which was classed as “sustainable” (Supplementary Table 2). Hake (*Merluccius merluccius*) is particularly problematic: of the 12 examined hake stocks in the Mediterranean, 9 have exploitation rates that are more than 5 times the rate that is consistent with Maximum Sustainable Yield (MSY). Biomass estimates show a similar discrepancy: only one Mediterranean stock has more than half the biomass that would be consistent with providing the MSY; and 15 Mediterranean stocks have less than 5% of that [sustainable] biomass. In the North East Atlantic the situation continues to improve[23]: of the 53 stocks there, almost twice as many stocks are sustainable (19) as overfished (10); 6 stocks are recovering, but 18 are declining. The stocks in most peril are those of Atlantic cod (*Gadus morhua*), with some of these still having relatively low biomass and high exploitation rates, although there has been an improvement in North Sea cod in recent years[25]. The problems here are of a different nature, with recovering stocks likely to present challenges under the new landings obligation[26] (discard ban): e.g. previously scarce species with low quotas are rapidly caught, closing the mixed fishery and "choking" quotas of other species[27].

The IUCN Red List and fish stock assessments address different issues: IUCN is concerned with extinction risk while fisheries assessments are concerned with sustainable exploitation. Clearly if a fish stock is classified as "sustainable" it may appear contradictory (though theoretically possible) for IUCN to place the species in a threatened category. In our analysis none of the stocks classified as sustainable were placed by IUCN in a threatened category (Extended Data Fig. 2). Hence sustainable fishery criteria appear consistent with low extinction risk. With very few exceptions, even stocks classed as overfished or subject to overfishing were placed by IUCN in low risk categories. Only sardine (*Sardina pilchardus*) and turbot (*Scophthalmus maximus*) reached higher IUCN threat categories (NT and VU respectively) and where stock assessments exist for these species they are classed as not sustainable. The two classification schemes can, therefore, be seen as complementary graduated indicators of status, with the stock sustainability representing the first line of concern. If a stock is overfished then further examination under the IUCN framework is merited to determine if there is an extinction risk. Conversely, if a species is deemed to have a low risk of extinction (LC) it is not to say that certain local stocks may not be at risk. An important feature of the IUCN system is that it can be applied to species for which there is no analytical stock assessment.

Most of Europe's commercial fish stocks are not threatened with extinction. However, most of the larger fish species, particularly of sharks and rays, are. In addition to these cartilaginous fishes, the large fishes that are threatened include six species of sturgeon, the northern wolffish (*Anarhichas denticulatus*), blue ling (*Molva dipterygia*), the dusky grouper (*Epinephelus marginatus*), the Atlantic halibut (*Hippoglossus hippoglossus*) and [wild] Atlantic salmon (*Salmo salar*), although, of these, only the sturgeons are Critically

Endangered. In terms of the conservation of commercially fished species, management agencies in northern Europe have succeeded in reducing fishing pressure[23], and, in some cases, populations are recovering[27]. The food security, economic performance, and political importance of the fisheries of northern Europe are clearly significant enough to merit the substantial effort required in scientific assessment and effective compliance. Such efforts are not effective in the Mediterranean[24] and are insufficient for the megafauna. Greater efforts to conserve our large fish species are essential prior to the imminent expansion of anthropogenic activity in marine space (mineral exploitation, aquaculture, renewable energy, blue biotechnology and tourism), the so called Blue Growth[1]. Loss of these large ecologically important species could have extended consequences that cascade to other trophic levels[7] that include important commercial species, particularly in overfished southern European stocks, and ultimately undermines Blue Growth.

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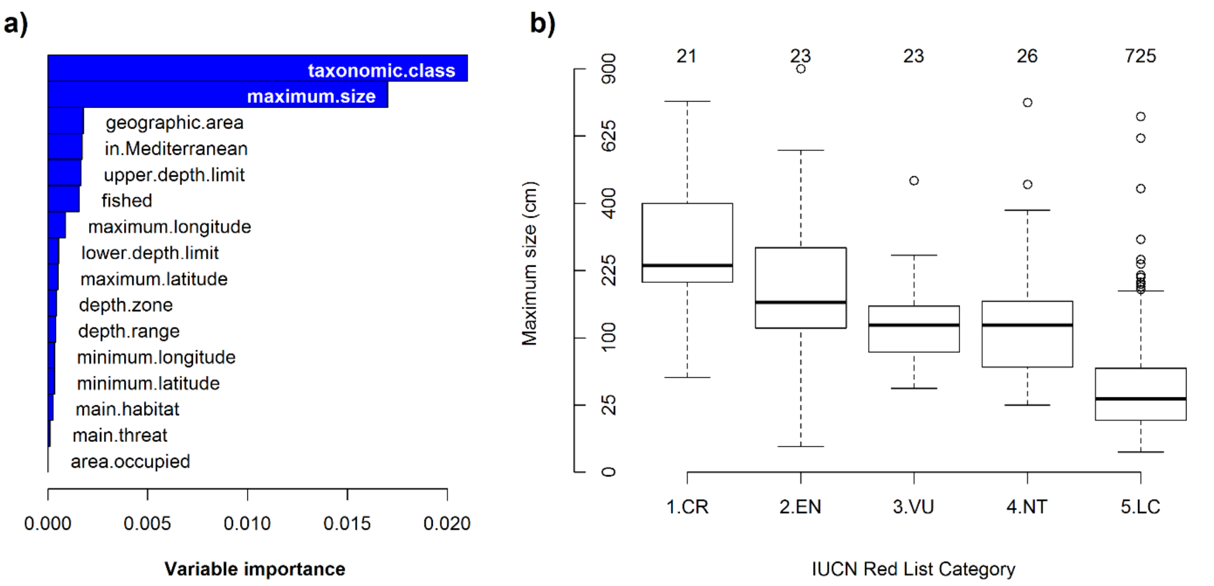

Figure 1 | Factors which affect the conservation status of European fish. a. Variable importance plot for the conditional random forest which modelled the IUCN Red List Category as a function of the factors as labelled. **b.** Box plots of IUCN Red List Category against size, middle band is the median, boxes indicate the interquartile range (IQR), whiskers min(max(x), Q_3 + 1.5 * IQR) and max(min(x), Q_1 - 1.5 * IQR), dots are outliers from the whiskers. The Least Concern (LC) Category was bootstrapped 1,000 times down sampling 26 species at random from the 726 in that category: all 1,000 bootstraps of a general linear model were significant at $p<0.0001$. Y axis is on a square root scale.

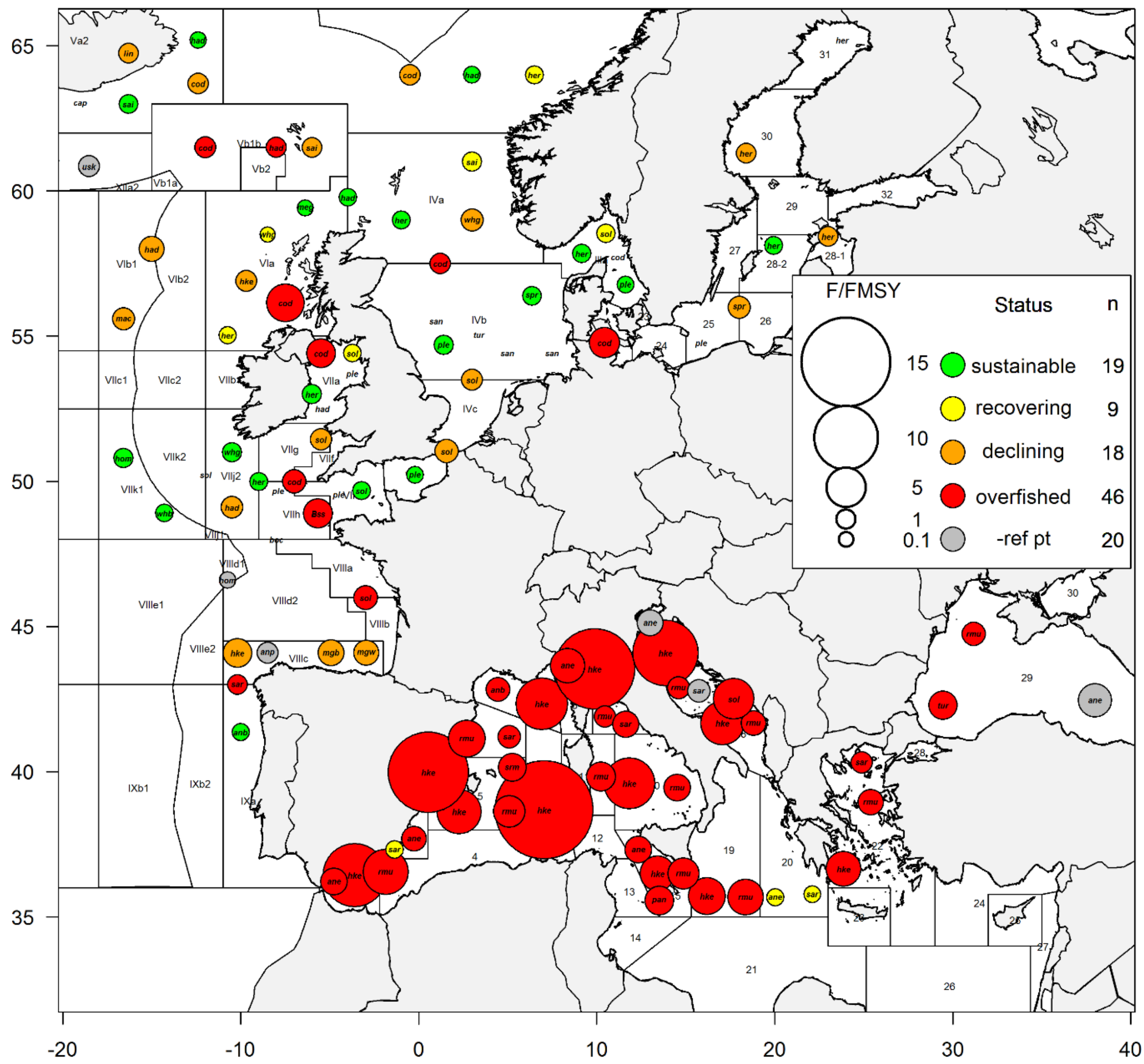

Figure 2 | The geographical distribution of the relative exploitation rate for 112 European Fish Stocks. The relative exploitation rate is the exploitation rate in the most recent year available (F_{year}) divided by the exploitation rate consistent with Maximum Sustainable Yield (F_{MSY}). The size of the circle is proportional to F_{year}/F_{MSY} and colour-coded according to status. Stocks in green are fished within sustainable limits, stocks in red are overexploited, stocks in orange are declining, whilst stocks in yellow are recovering: hence, the larger the red circle the more the stock is overfished; the larger the green circle the more the stock is underfished; grey circles indicate data on biomass is lacking. The circles are positioned approximately according to the centre of the stock location in the GFCM sub-areas and ICES divisions (numbers and roman numerals respectively) with the exception of the

ICES widely distributed stocks which are positioned to the western edge of the continental shelf. An abbreviation for the species name is provided in the centre of each circle: anb = *Lophius budegassa*; ane = *Engraulis encrasicolus*; anp = *Lophius piscatorius*; boc = *Boops boops*; Bss = *Dicentrarchus labrax*; cap = *Mallotus villosus*; cod = *Gadus morhua*; had = *Melanogrammus aeglefinus*; her = *Clupea harengus*; hke = *Merluccius merluccius*; hom = *Trachurus trachurus*; lin= *Molva molva*; mac = *Scomber scombrus*; meg = *Lepidorhombus spp.;* mgb = *Lepidorhombus boscii*; mgw = *Lepidorhombus whiffiagonis*; pan = *Pagellus erythrinus*; ple = *Pleuronectes platessa*; rmu= *Mullus barbatus*; sai = *Pollachius virens*; san = Ammodytidae; sar = *Sardina pilchardus*; sol = *Solea solea*; spr = *Sprattus sprattus*; srm = *Mullus surmuletus*; tur = *Scophthalmus maximus; usk = Brosme brosme;* whb = *Micromesistius poutassou*; whg = *Merlangius merlangus*. Stocks for which there are no reference points are abbreviated as text alone. x and y axis are longitude and latitude respectively.

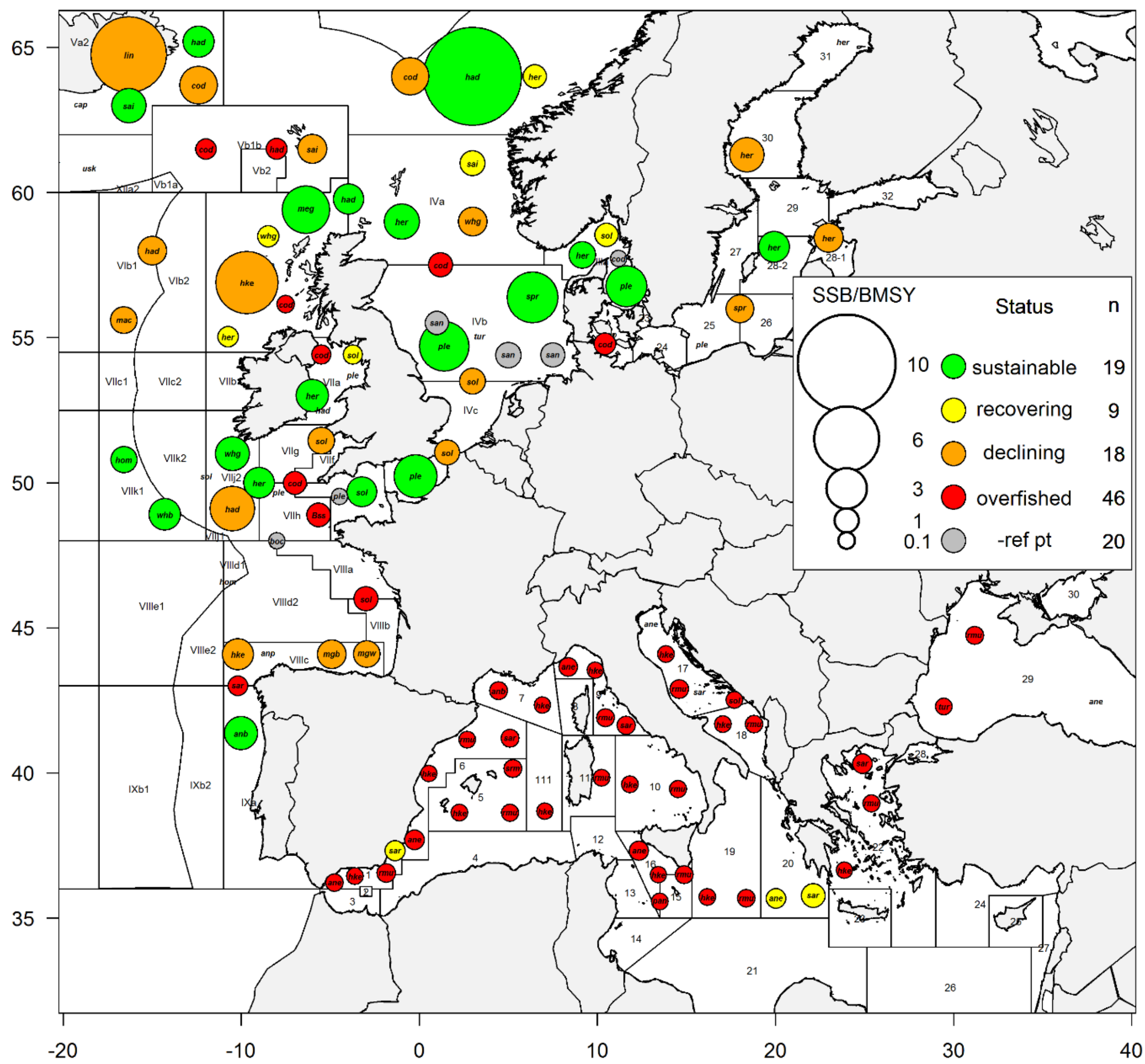

Figure 3 | The geographical distribution of the relative biomass for 112 European Fish Stocks. The relative biomass is the spawning stock biomass in the most recent year available (total weight of adults, SSB_{year}) divided by the biomass consistent with Maximum Sustainable Yield ($MSYB_{trigger}$). The size of the circle is proportional to $SSB_{year}/MSYB_{trigger}$ and colour-coded according to status as per Figure 2; grey circles indicate missing data (reference point and/or fishing mortality). An abbreviation for the species is provided in the centre of each circle (as per Figure 2 along with other common elements).

Methods

Red List assessment to assess risk of extinction. In this paper we considered the Red List assessments of 1,020 species of Europe's marine fishes[28] that were assessed as part of the IUCN Red List of marine and freshwater fishes[5, 29]. The areas considered included the Mediterranean Sea, the Black Sea, the Baltic Sea, the North Sea and the European part of the Atlantic Ocean, including the EEZs of the Macaronesian islands belonging to Portugal and Spain. Marine and anadromous fishes with breeding populations native to or naturalised in Europe before AD 1500 were included. However, species that are primarily freshwater or catadromous were excluded as the major threats affecting these species occur in the freshwater, rather than marine, environment[29]. Species for which occurrence within European waters could not be verified and rarely documented species, presumably waifs of populations primarily occurring outside of Europe, were also excluded; as were species with a marginal occurrence within European waters.

To assess the extinction risk of each species, the IUCN Red List Categories and Criteria[30] and the IUCN Regional Guidelines[31] were applied. There are nine IUCN Red List categories: Extinct (EX); Extinct in the Wild (EW); Critically Endangered (CR); Endangered (EN); Vulnerable (VU); Near Threatened (NT); Least Concern (LC); Data Deficient (DD); and Not Evaluated (NE); two additional categories, Regionally Extinct (RE) and Not Applicable (NA) are used in regional Red List assessments. Species are classed as threatened if they fall within the categories CR, EN or VU. To classify as threatened, one or more of five quantitative criteria (A to E) related to population reduction (Criterion A), geographic range (Criterion B), population size and decline (Criterion C), very small or restricted population (Criterion D) and probability of extinction (Criterion E) are examined for each species. Separate thresholds then allocate species to the individual categories based on the risk of extinction; with CR indicating an extremely high risk; EN a very high risk; and VU a high risk. The NT Category is for those species close to qualifying, or likely to qualify in future as threatened. The LC Category has a low risk of extinction.

Nearly all of the threatened European marine fishes were listed on the basis of population declines: 56 species were listed as threatened exclusively under Criterion A, most of which were based on past population declines (Criterion A2). Only seven species were listed exclusively under any other Criterion, with four listed under Criterion B (*Alosa immaculata, Mycteroperca fusca, Pomatoschistus tortonesei, Bodianus scrofa*), two under criterion C (*Carcharodon carcharias* and *Carcharias taurus*), one under Criterion D (*Raja maderensis*) and none under Criterion E. Four species were listed under two Criteria: two sturgeons (*Acipenser naccarii* and *A. sturio*) were listed as CR under Criteria A and B and the two sawfishes (*Pristis pectinata* and *P. pristis*) were listed as EN under Criteria A and D.

The uncertainty over the degree of threat to DD species propagates to estimates of the proportion of species threatened. IUCN generally reports three values: the lower bound, the mid-point and the upper bound. The best estimate of the proportion of threatened species (i.e. the mid-point) was calculated according to: (CR+EN+VU) / (assessed – EX – DD). This assumes that DD species are equally as threatened as those for which there are sufficient data (i.e., all non-DD species). The lower bound formula applied is (CR+EN+VU) / (assessed – EX) and corresponds to the assumption that none of the DD species are threatened. The upper bound formula is (CR+EN+VU+DD) / (assessed – EX) and assumes that all of the DD species are threatened.

Random forest model to identify factors which affect risk of extinction. In addition to assessing the regional extinction risk, the following data were compiled: taxonomic classification; habitat preferences and primary ecological requirements, including pertinent biological information where available (e.g., size and age at maturity, generation length, maximum size and age, etc.); major threats; conservation measures (in place, and needed);

and species utilisation. These data were entered into the IUCN Species Information Service (SIS) during the Red List assessment process based on the scientific literature, published reports and expert opinion. Classification schemes are in development to improve consistency across taxa and regions in documenting species information; the habitat classification scheme version 3.1 and threats classification scheme version 3.2 were followed here (http://www.iucnredlist.org/technical-documents/classification-schemes). The relative importance of these variables in determining regional extinction risk was explored using a random forest[32] (RF). A random forest algorithm is a development of the classification tree whereby bootstrapped samples of data and predictors are drawn to build many trees, with the class being determined by majority votes from all trees. Classification trees are used to predict membership of objects (in this case, species) in the classes (IUCN Red List Categories) of a categorical dependent variable (extinction risk) from their measurements on one or more predictor variables[33]. The predictor variables were drawn from the list of compiled data described above. Classification trees are often used to analyse ecological data and have many desirable properties that are suited to such data: they deal well with nonlinear relationships between variables, high-order interactions, missing values, and lack of balance; and they deliver easy graphical interpretations of complex results[34]. A classification tree is built by recursive partitioning of data from a "training" sub-set of the data (approximately 2/3 of the data depending on the specific algorithm). The data in the training set are split into two groups on the basis of a binary threshold value for a particular variable; the variable and threshold that best splits the data into two groups is chosen. This process is repeated on the remaining sub groups and repeated again until no improvement can be made to the partitioning (i.e. all classes have been accounted for). In the RF, each permutation (tree) compares the true classification of the remaining 1/3 "test" dataset true classification comparing it with the tree based classification in a confusion matrix: this "out of bag" (OOB) comparison gives an estimate of the prediction error rate. The importance of each variable is also assessed by looking at how much the prediction error increases when (OOB) data for that variable is permuted while all others are left unchanged. The difference between a classification tree and a random forest is that the forest takes the majority vote prediction of class from many (>1,000) trees which are randomly permuted from the number of variables and the data from each variable. A further elaboration was to use a conditional random forest[20] to account for imbalance in the classes, and to allow for predictor variables to vary in their scale of measurement or their number of categories. The latter is particularly important to determine the variable importance (the output statistic which ranks the importance of each variable in predicting the class).

The RF model was built using the Party package[20] in the R statistical software language[35]. The model took the form:

IUCN category = maximum size + depth zone + main habitat + main threat + geographic area + in Mediterranean + area occupied + lower depth limit + upper depth limit + depth range + minimum longitude + minimum latitude + maximum longitude + maximum latitude + taxonomic class + fished (S1)

where:

maximum size = continuous variable of maximum fish size in cm (range of 2.3 to 900 cm)

depth zone = categorical variable: Shallow photic (0-50m); Deep Photic (51-200m); Bathyl (201-4,000m); Abyssal (4,001-6,000m).

main habitat = categorical variable: Marine Neritic; Marine Oceanic; Marine Deep Benthic; Marine Coastal/Supratidal: Wetlands (inland); Artificial/Aquatic & Marine; Marine Intertidal; Unknown.

main threat = categorical variable: Unknown; Pollution; Biological resource use; Natural system modifications; Climate change & severe weather; Invasive and other problematic species, genes & diseases; Residential & commercial development; Human intrusions & disturbance; Agriculture & aquaculture; Energy production & mining.

geographic area = categorical variable: occurs in Mediterranean (Med) only; Eastern Central Atlantic (ECA) + Med + North East Atlantic (NEA); ECA only; ECA + NEA; Med + NEA; Arctic (Arc) + NEA; NEA only; ECA + Med; Arc+ECA+Med+NEA

in Mediterranean = binary variable: occurs in Mediterranean or not

area occupied = continuous variable: areal extent of generalised distribution in square metres (range $1x10^9$ to $3.3x10^{13}$ m^2), estimated in ArcGIS 10.1.

lower depth limit = continuous variable (range from to 1 to 5998 m)

upper depth limit = continuous variable (range from to 0 to 3639 m)

depth range = upper depth limit- lower depth limit (range from 0 to 5998 m)

minimum longitude and latitude; maximum longitude and latitude = continuous variables in decimal degrees

taxonomic class = categorical variable of taxonomic class (Actinopterygii, Cephalaspidomorphi, Chondrichthyes or Myxini)

fished = binary variable: fished (target or bycatch) or not

The model was run with 10,000 trees and weighted to account for the imbalanced dataset. Weights on each observation were 1/number of the appropriate IUCN classification: i.e. all species in LC categories were weighted 1/725, those in CR 1/21, EN 1/23, VU 1/23 and NT 1/26. The results of the random forest were examined using a confusion matrix (cross–tabulation of the observed and predicted classes), the derived kappa and normalized mutual information statistics[36], and a plot of variable importance. Variable importance is a measure of how much the prediction error increases when data for that variable is permuted while all other variables are left unchanged[37]: we used the decrease in mean accuracy, a.k.a.

permutation importance[20]. We also constructed a simple classification tree with the same formulation as the random forest (Eqn. S1).

Stock assessments. We examined 112 analytical stock assessments conducted by the International Council for the Exploration of the Sea (ICES) and the Scientific, Technical and Economic Committee for Fisheries (STECF) of the European Commission (EC), the recognised authorities that provide scientific advice to managers. Assessment data for the North East Atlantic were provided by ICES at http://www.ices.dk/datacentre/StdGraphDB.asp and data from the Mediterranean were compiled from individual STECF reports found at https://stecf.jrc.ec.europa.eu/reports/medbs[24]. We obtained additional data from individual expert group reports of assessments of Irish Sea cod. We consulted the reports of STECF and ICES expert groups to obtain estimates of the two principal reference points used in providing advice. These reference points, based on the theory of Maximum Sustainable Yield (MSY)[38], were: i) Fishing mortality at Maximum Sustainable Yield (F_{MSY}, the exploitation rate that is consistent with achieving Maximum Sustainable Yield); and ii) the spawning stock biomass (SSB) which triggers a cautious response (MSY $B_{trigger}$, the SSB which triggers advice to reduce exploitation rates below F_{MSY}). For most stocks these MSY reference points were available: where they weren't, we used target reference points from the management plan (MP) specific to the stock where appropriate, or the precautionary (pa) reference point. No MSY $B_{trigger}$ estimates were available for Mediterranean fish stocks, so 30% of the virgin biomass was used as a proxy of MSY $B_{trigger}$[24]. Out of the 112 stocks, this gave us 98 stocks with exploitation rate (F_{MSY}) and biomass (MSY $B_{trigger}$) reference points. We used the most recent assessments available: in the case of the ICES data in the North East Atlantic, 63 of the 70 assessments were carried out in 2015 reflecting the status in 2014; 7

were from 2014. The 42 Mediterranean assessments were earlier, with 8 reflecting status in 2012, 18 in 2011, 10 from 2010, 1 from 2009, 3 from 2008 and 2 from 2006.

For the purposes of the assessment made here, we used the definition of stock status used by Australia[39] and adapted it to incorporate a knife-edge assessment of F and SSB relative to the MSY biological reference points described above. Since we consider two reference points there are four possible stock states depending on whether the reference point is exceeded or not: these are "sustainable", "recovering", "declining", "overfished"; and an "undefined" state (see Table S1). The desired state for a stock is for F to be at or below F_{MSY}, and for SSB to be at, or greater than, MSY $B_{trigger}$.

There are two main distinctions between the determination of status by agencies charged with assessing commercial fish stocks (e.g. ICES and STECF) and IUCN. In common with other estimates of the status of commercially exploited fishes, ICES and STECF carry out assessments on individual "stocks" of fishes rather than individual species. A "stock" is defined as "all the individuals of fish in an area, which are part of the same reproductive process"[40], so these supposedly represent biologically distinct units, but in practice they are generally distinguished by geographical management areas (Fig. 1). As described above, ICES and STECF then determine stock status by comparing estimates of the exploitation rate (fishing mortality, F) and abundance (spawning stock biomass, SSB) in relation to MSY reference points where available. IUCN, on the other hand, assesses extinction risk at the species level, which presents challenges for wide ranging species where data might be limited. For the Red List assessments analysed here, these species assessments have been confined to the larger geographical region of Europe. Previously there have been concerns that the IUCN Red List Criteria may have overestimated the extinction risk for many exploited marine species[15,16], potentially weakening the credibility of any recommendation arising from the Red List assessment to conserve those species that may be genuinely at risk.

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Supplementary Information. Methods, along with any Extended Data display items (Extended Data Figures 1 and 2; Tables 1 and 2) and Supplementary Tables (Tables S1 and S2), are available in the online version of the paper; references unique to these sections appear only in the online paper.

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Author Contributions. PGF drafted the text, conducted the RF analysis, and produced all the figures, Extended Data Table 2 and Tables S1 and S2. PGF, KEC, GMR, AN and MGC were responsible for determining content and discussion of analyses. AN coordinated the European Red List of marine fishes project and KEC manages IUCN's Marine Biodiversity Unit. GMR compiled the variables used in the RF analysis and drafted components of the main text and methods. AN and MGC drafted components of the main text and methods and together with GMR composed the Extended Data Table 1. PV, CDM, RC, ND, RAP, MK, DP, EDF, ABF, BAP, JML, PL, and FU edited drafts. All authors (except CDM and PV), participated in Red List workshops and/or contributed to the IUCN assessments. PV and CDM collated the Mediterranean stock assessment data.

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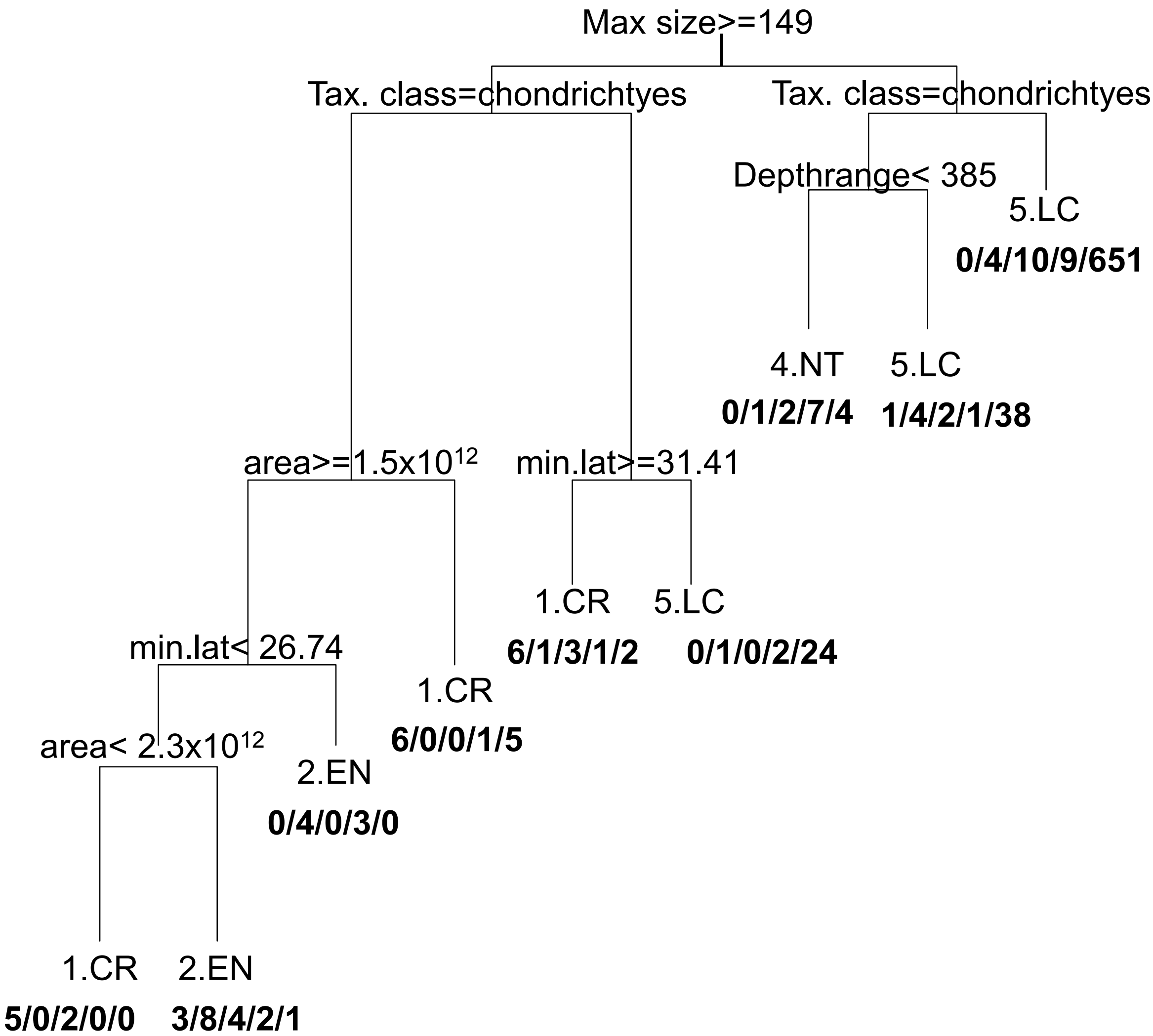
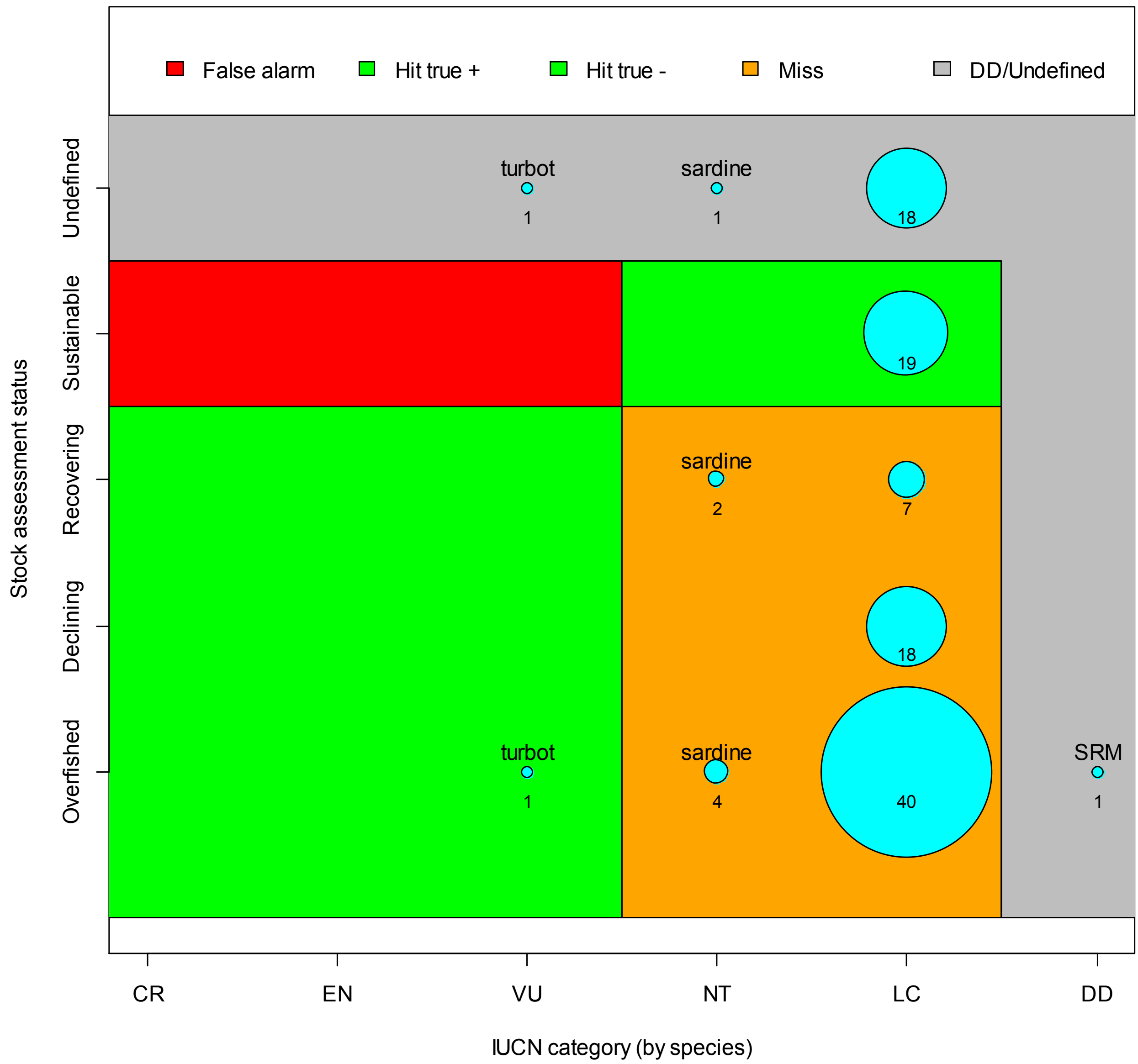
The authors declare no competing financial interests. Correspondence and requests for materials should be addressed to P.G.F. (fernandespg@abdn.ac.uk)

Extended data



Extended Data Figure 1 | Classification tree for the determination of IUCN extinction risk category of 818 fish species in European waters. Underneath the designated category at the terminal node (in bold) are the numbers of species assigned to each category at that node (CR/EN/VU/NT/LC), where CR=Critically Endangered; EN=Endangered; VU=Vulnerable; NT=Near Threatened; LC=Least Concern. Splitting variables are (from top): maximum size (cm); taxonomic class, depth range, area occupied, minimum latitude. At each split, if the condition is true the tree proceeds to the left, if false to the right. For example, at the first node (maximum size >=149 cm), species for which this is false proceed to the right, they are then subject to the condition related to taxonomic class: chondricthyes pass to the left (true) and other [bony] fish classes to the right, resulting in 651 species of bony fish smaller than 150 cm which are classed as Least Concern (LC) at the rightmost terminal node.



Extended Data Figure 2 | Performance of the IUCN Red List in relation to stock status. Comparison of the number of stocks, classified as species according to the threat criteria of the IUCN Red List (x axis) with the stock assessment status as assessed by the International Council for the Exploration of the Sea and the General Fisheries Commission for the Mediterranean (y axis) and classed according to criteria in Table S2. Red List Categories are Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Near Threatened (NT), Least Concern (LC) and Data Deficient (DD). Shading indicates: Hits, in green, where the two system concur, either because a stock is not sustainable and threat criteria are met (true positive), or because a stock is sustainable and the threat criteria are not met (true negative); Misses, in orange, where a stock is exploited unsustainably but does not meet the threat criteria; and False Alarms, in red, where the stock is exploited sustainably but the threat criteria are met. Blue circle size proportion to number of stocks (number below) corresponding to each Category. Names above refer to the species (by common name, SRM=striped red mullet) in particular combinations where numbers were low (4 or less), which were all of the same species.

Extended Data Table 1 | List of European marine fish species listed as regionally threatened according to the Red List conducted by the International Union for Conservation of Nature. Cat = IUCN Red List Category, where CR=Critically Endangered, EN=Endangered; VU=Vulnerable. Criteria follow those of the IUCN (see Methods).

Class	Order	Species	Cat	Red List Criteria
Actinopterygii	Acipenseriformes	*Acipenser gueldenstaedtii*	CR	A2bcde
Actinopterygii	Acipenseriformes	*Acipenser naccarii*	CR	A2bcde; B2ab(i,ii,iii,iv,v)
Actinopterygii	Acipenseriformes	*Acipenser nudiventris*	CR	A2cd
Actinopterygii	Acipenseriformes	*Acipenser stellatus*	CR	A2cde
Actinopterygii	Acipenseriformes	*Acipenser sturio*	CR	A2cde; B2ab(ii,iii,v)
Actinopterygii	Acipenseriformes	*Huso huso*	CR	A2bcd
Chondrichthyes	Lamniformes	*Carcharodon carcharias*	CR	C2a(ii)
Chondrichthyes	Lamniformes	*Lamna nasus*	CR	A2bd
Chondrichthyes	Lamniformes	*Carcharias taurus*	CR	C2a(ii)
Chondrichthyes	Lamniformes	*Odontaspis ferox*	CR	A2bcd
Chondrichthyes	Rajiformes	*Gymnura altavela*	CR	A2bd
Chondrichthyes	Rajiformes	*Pteromylaeus bovinus*	CR	A2c
Chondrichthyes	Rajiformes	*Pristis pectinata*	CR	A2b; D
Chondrichthyes	Rajiformes	*Pristis pristis*	CR	A2b; D
Chondrichthyes	Rajiformes	*Dipturus batis*	CR	A2bcd+4bcd
Chondrichthyes	Rajiformes	*Leucoraja melitensis*	CR	A2bcd+3bcd
Chondrichthyes	Rajiformes	*Rostroraja alba*	CR	A2bd
Chondrichthyes	Squaliformes	*Centrophorus granulosus*	CR	A4b
Chondrichthyes	Squatiniformes	*Squatina aculeata*	CR	A2bcd
Chondrichthyes	Squatiniformes	*Squatina oculata*	CR	A2bcd+3cd
Chondrichthyes	Squatiniformes	*Squatina squatina*	CR	A2bcd+3d
Actinopterygii	Cyprinodontiformes	*Aphanius iberus*	EN	A2ce
Actinopterygii	Gadiformes	*Coryphaenoides rupestris*	EN	A1bd
Actinopterygii	Perciformes	*Anarhichas denticulatus*	EN	A2b
Actinopterygii	Perciformes	*Epinephelus marginatus*	EN	A2d
Actinopterygii	Perciformes	*Pomatoschistus tortonesei*	EN	B2ab(ii,iii)
Actinopterygii	Scorpaeniformes	*Sebastes mentella*	EN	A2bd
Chondrichthyes	Carcharhiniformes	*Carcharhinus longimanus*	EN	A2b
Chondrichthyes	Carcharhiniformes	*Carcharhinus plumbeus*	EN	A4d
Chondrichthyes	Lamniformes	*Alopias superciliosus*	EN	A2bd
Chondrichthyes	Lamniformes	*Alopias vulpinus*	EN	A2bd
Chondrichthyes	Lamniformes	*Cetorhinus maximus*	EN	A2abd
Chondrichthyes	Rajiformes	*Mobula mobular*	EN	A2d
Chondrichthyes	Rajiformes	*Leucoraja circularis*	EN	A2bcd
Chondrichthyes	Rajiformes	*Raja radula*	EN	A4b
Chondrichthyes	Rajiformes	*Glaucostegus cemiculus*	EN	A3bd

Class	Order	Species	Cat	Red List Criteria
Chondrichthyes	Rajiformes	*Rhinobatos rhinobatos*	EN	A2b
Chondrichthyes	Squaliformes	*Centrophorus lusitanicus*	EN	A4b
Chondrichthyes	Squaliformes	*Centrophorus squamosus*	EN	A4b
Chondrichthyes	Squaliformes	*Deania calcea*	EN	A4d
Chondrichthyes	Squaliformes	*Dalatias licha*	EN	A3d+4d
Chondrichthyes	Squaliformes	*Echinorhinus brucus*	EN	A2bcd
Chondrichthyes	Squaliformes	*Centroscymnus coelolepis*	EN	A2bd
Chondrichthyes	Squaliformes	*Squalus acanthias*	EN	A2bd
Actinopterygii	Beryciformes	*Hoplostethus atlanticus*	VU	A1bd
Actinopterygii	Clupeiformes	*Alosa immaculata*	VU	B2ab(v)
Actinopterygii	Gadiformes	*Molva dypterygia*	VU	A1bd
Actinopterygii	Perciformes	*Mycteroperca fusca*	VU	B2ab(v)
Actinopterygii	Perciformes	*Bodianus scrofa*	VU	B2ab(iv,v)
Actinopterygii	Perciformes	*Labrus viridis*	VU	A4ad
Actinopterygii	Perciformes	*Umbrina cirrosa*	VU	A2bc
Actinopterygii	Perciformes	*Orcynopsis unicolor*	VU	A2bde
Actinopterygii	Perciformes	*Dentex dentex*	VU	A2bd
Actinopterygii	Pleuronectiformes	*Hippoglossus hippoglossus*	VU	A2ce
Actinopterygii	Pleuronectiformes	*Scophthalmus maximus*	VU	A2bd
Actinopterygii	Salmoniformes	*Salmo salar*	VU	A2ace
Actinopterygii	Scorpaeniformes	*Sebastes norvegicus*	VU	A2bd
Chondrichthyes	Carcharhiniformes	*Galeorhinus galeus*	VU	A2bd
Chondrichthyes	Carcharhiniformes	*Mustelus mustelus*	VU	A2bd
Chondrichthyes	Carcharhiniformes	*Mustelus punctulatus*	VU	A4d
Chondrichthyes	Rajiformes	*Dasyatis centroura*	VU	A2d
Chondrichthyes	Rajiformes	*Dasyatis pastinaca*	VU	A2d
Chondrichthyes	Rajiformes	*Myliobatis aquila*	VU	A2b
Chondrichthyes	Rajiformes	*Leucoraja fullonica*	VU	A2bd
Chondrichthyes	Rajiformes	*Raja maderensis*	VU	D2
Chondrichthyes	Squaliformes	*Centrophorus uyato*	VU	A2b
Chondrichthyes	Squaliformes	*Oxynotus centrina*	VU	A2bd

Extended Data Table 2 | Confusion matrix for the conditional random forest predicting IUCN Red List Category. Predicted class in rows, actual class in columns. Shaded areas indicate agreed classes. The weighted kappa statistic, which is the proportion of specific agreement was 0.71, which is just short of 'excellent'[36] for such models; the normalized mutual information statistic was 0.47.

Predicted Red List Category	Actual IUCN Red List Category: CR	EN	VU	NT	LC
CR	17	3	1	0	0
EN	1	10	1	2	2
VU	0	1	6	1	0
NT	0	1	0	6	0
LC	3	8	15	17	723

Supplementary information

Table S1 | Definition of status of fish stocks from analytical stock assessments

Stock status	**Status indicator**	**Explanation**	**Definition**
Sustainable stock		Stock for which SSB (or a biomass proxy) is at or above MSY $B_{TRIGGER}$ and F is at or below F_{MSY}. The stock is at a level sufficient to ensure that, on average, the MSY can be obtained from the stock and for which fishing pressure is adequately controlled to avoid the stock becoming overfished. The appropriate management is in place.	SSB/ MSY $B_{TRIGGER}$ ≥ 1 and $F/F_{MSY} \leq 1$
Recovering stock		Biomass is below the level required to derive the MSY (SSB $<$ MSY $B_{TRIGGER}$) and F is at or below F_{MSY}, but management measures are in place to promote stock recovery, and recovery is expected to occur. The appropriate management is in place, and the stock biomass is expected to recover.	SSB/ MSY $B_{TRIGGER}$ <1 and $F/F_{MSY} \leq 1$
Declining stock		Biomass is above level required to derive the MSY (SSB $\geq$ MSY $B_{TRIGGER}$), but fishing pressure is too high ($F > F_{MSY}$) and moving the stock in the direction of becoming overfished. Management is needed to reduce F to ensure that biomass does not decline to an overfished state.	SSB/ MSY $B_{TRIGGER}$ ≥ 1 and $F/ F_{MSY} > 1$
Overfished stock		SSB is below level required to derive the MSY (MSY $B_{TRIGGER}$) and F is above F_{MSY}. The stock has been reduced by fishing, so that average recruitment levels are significantly reduced. Current management is not adequate to recover the stock, or adequate management measures have been put in place but have not yet resulted in measurable improvements. Management is needed to recover the stock.	SSB/MSY $B_{TRIGGER}$ <1 and $F/ F_{MSY} > 1$
Undefined		Not sufficient quantitative information exists to determine stock status	Data to assess the stock status is required

Table S2. Information on the assessment of fish stocks from ICES & STECF. Year refers to the year of assessment, so is an indication of the spawning stock biomass (SSB) at the start of that year and the fishing mortality (Mean F) experienced in the previous year. FishStockCode refers to the stock acronym as used by ICES for the European Union's North East Atlantic (UE.NEA) stocks (including Iceland and Norway). F_{MSY} is reference point value for the fishing mortality associated with maximum sustainable yield. MSY $B_{trigger}$ is reference point value for the spawning stock biomass which triggers management action to avoid stocks falling below biomasses that are inconsistent with levels that support the maximum sustainable yield. Area is the geographical management area; stock status is as per Table S1; IUCN Cat is the two letter acronym for IUCN's Red List Categories: where CR=Critically Endangered, EN=Endangered; VU=Vulnerable, NT=Near Threatened; LC=Least Concern; DD= Data Deficient.

Year	Species Name	Common name	FishStockCode	SSB	Mean F	F_{MSY}	MSY $B_{trigger}$	Area	Stock status	IUCN Cat
2015	*Ammodytes marinus*	Raitt's Sandeel	san-ns1	178,712	0.37	NA	215,000	EU.NEA	undefined	LC
2015	*Ammodytes marinus*	Raitt's Sandeel	san-ns2	91,545	0.07	NA	100,000	EU.NEA	undefined	LC
2015	*Ammodytes marinus*	Raitt's Sandeel	san-ns3	202,124	0.52	NA	195,000	EU.NEA	undefined	LC
2015	*Brosme brosme*	Torsk	usk-icel	6,027	0.26	0.20	NA	Iceland	undefined	LC
2015	*Capros aper*	Boar Fish	boc-nea	1	1.85	NA	347,063	EU.NEA	undefined	LC
2015	*Clupea harengus*	Herring	her-2532-gor	1,000,071	0.16	0.22	600,000	EU.NEA	sustainable	LC
2015	*Clupea harengus*	Herring	her-30	669,461	0.15	0.15	316,000	EU.NEA	declining	LC
2014	*Clupea harengus*	Herring	her-31	1	0.78	NA	NA	EU.NEA	undefined	LC
2015	*Clupea harengus*	Herring	her-3a22	129,845	0.26	0.32	110,000	EU.NEA	sustainable	LC
2015	*Clupea harengus*	Herring	her-47d3	2,215,525	0.20	0.27	1,000,000	EU.NEA	sustainable	LC
2015	*Clupea harengus*	Herring	her-67bc	194,194	0.09	0.16	410,000	EU.NEA	recovering	LC
2015	*Clupea harengus*	Herring	her-irls	89,937	0.19	0.26	54,000	EU.NEA	sustainable	LC
2015	*Clupea harengus*	Herring	her-nirs	17,633	0.25	0.26	9,500	EU.NEA	sustainable	LC
2015	*Clupea harengus*	Herring	her-noss	3,946,000	0.11	0.15	5,000,000	Norway	recovering	LC
2015	*Clupea harengus*	Herring	her-riga	90,347	0.34	0.32	60,000	EU.NEA	declining	LC
2015	*Dicentrarchus labrax*	Bass	Bss-47	6,925	0.38	0.13	8,000	EU.NEA	overfished	LC
2010	*Engraulis encrasicolus*	Anchovy	Anc-1	756	1.05	0.43	6,432	EU.Med	overfished	LC
2010	*Engraulis encrasicolus*	Anchovy	Anc-6	20,367	0.89	0.43	52,513	EU.Med	overfished	LC
2010	*Engraulis encrasicolus*	Anchovy	Anc-9	5,216	1.72	0.43	18,736	EU.Med	overfished	LC
2011	*Engraulis encrasicolus*	Anchovy	Anc-16	10,734	0.86	0.35	32,363	EU.Med	overfished	LC
2011	*Engraulis encrasicolus*	Anchovy	Anc-17	266,254	1.33	0.58	NA	EU.Med	undefined	LC
2008	*Engraulis encrasicolus*	Anchovy	Anc-20	1,191	0.28	0.53	3,259	EU.Med	recovering	LC
2011	*Engraulis encrasicolus*	Anchovy	Anc-29	669,282	1.55	0.41	NA	EU.Med	undefined	LC
2015	*Gadus morhua*	Cod	cod-2224	23,742	0.84	0.26	38,400	EU.NEA	overfished	LC
2015	*Gadus morhua*	Cod	cod-347d	148,896	0.39	0.33	165,000	EU.NEA	overfished	LC
2015	*Gadus morhua*	Cod	cod-7e-k	7,676	0.57	0.32	10,300	EU.NEA	overfished	LC
2015	*Gadus morhua*	Cod	cod-arct	1,139,000	0.48	0.40	460,000	Norway	declining	LC
2015	*Gadus morhua*	Cod	cod-farp	18,781	0.41	0.32	40,000	Faroe	overfished	LC
2015	*Gadus morhua*	Cod	cod-iceg	546,376	0.28	0.22	220,000	Iceland	declining	LC
2015	*Gadus morhua*	Cod	cod-kat	1	0.36	NA	10,500	EU.NEA	undefined	LC

Year	Species Name	Common name	FishStockCode	SSB	Mean F	F_{MSY}	MSY $B_{trigger}$	Area	Stock status	IUCN Cat
2015	*Gadus morhua*	Cod	cod-scow	3,363	0.89	0.19	22,000	EU.NEA	overfished	LC
2014	*Gadus morhua*	Cod	cod-iris	3,037	1.15	0.40	8,800	EU.NEA	overfished	LC
2015	*Lepidorhombus boscii*	Four-spot Megrim	mgb-8c9a	6,573	0.39	0.17	4,600	EU.NEA	declining	LC
2014	*Lepidorhombus whiffiagonis*	Megrim	meg-4a6a	2	0.32	1.00	1	EU.NEA	sustainable	LC
2015	*Lepidorhombus whiffiagonis*	Megrim	mgw-8c9a	1,089	0.36	0.17	910	EU.NEA	declining	LC
2015	*Lophius budegassa*	Black-bellied Angler	anb-8c9a	1	0.59	1.00	1	EU.NEA	sustainable	LC
2011	*Lophius budegassa*	Black-bellied Angler	Ang-7	1,570	0.54	0.29	10,051	EU.Med	overfished	LC
2015	*Lophius piscatorius*	Monk fish (Angler)	anp-8c9a	7,546	0.25	0.19	NA	EU.NEA	undefined	LC
2015	*Mallotus villosus*	Capelin	cap-icel	460,000	NA	NA	NA	Norway	undefined	LC
2015	*Melanogrammus aeglefinus*	Haddock	had-346a	145,650	0.24	0.37	88,000	EU.NEA	sustainable	LC
2015	*Melanogrammus aeglefinus*	Haddock	had-7b-k	33,387	0.60	0.40	10,000	EU.NEA	declining	LC
2015	*Melanogrammus aeglefinus*	Haddock	had-arct	770,000	0.15	0.35	80,000	Norway	sustainable	LC
2015	*Melanogrammus aeglefinus*	Haddock	had-faro	18,133	0.29	0.25	35,000	Faroe	overfished	LC
2015	*Melanogrammus aeglefinus*	Haddock	had-iceg	78,357	0.31	0.73	45,000	Iceland	sustainable	LC
2015	*Melanogrammus aeglefinus*	Haddock	had-iris	3	0.65	NA	NA	EU.NEA	undefined	LC
2015	*Melanogrammus aeglefinus*	Haddock	had-rock	13,052	0.42	0.20	9,000	EU.NEA	declining	LC
2015	*Merlangius merlangus*	Whiting	whg-47d	263,195	0.23	0.15	184,000	EU.NEA	declining	LC
2015	*Merlangius merlangus*	Whiting	whg-7e-k	83,052	0.32	0.32	40,000	EU.NEA	sustainable	LC
2015	*Merlangius merlangus*	Whiting	whg-scow	23,058	0.03	0.22	39,900	EU.NEA	recovering	LC
2015	*Merluccius merluccius*	Hake	hke-nrtn	249,017	0.34	0.27	46,200	EU.NEA	declining	LC
2015	*Merluccius merluccius*	Hake	hke-soth	18,856	0.68	0.24	11,000	EU.NEA	declining	LC
2012	*Merluccius merluccius*	Hake	Hak-1	266	2.17	0.22	10,376	EU.Med	overfished	LC
2011	*Merluccius merluccius*	Hake	Hak-5	25	1.33	0.22	2,392	EU.Med	overfished	LC
2011	*Merluccius merluccius*	Hake	Hak-6	2,376	1.33	0.10	284,386	EU.Med	overfished	LC
2012	*Merluccius merluccius*	Hake	Hak-7	685	2.03	0.27	191,691	EU.Med	overfished	LC
2011	*Merluccius merluccius*	Hake	Hak-9	731	2.00	0.15	146,206	EU.Med	overfished	LC
2012	*Merluccius merluccius*	Hake	Hak-10	978	1.03	0.14	79,417	EU.Med	overfished	LC
2012	*Merluccius merluccius*	Hake	Hak-11	318	4.21	0.25	60,191	EU.Med	overfished	LC
2010	*Merluccius merluccius*	Hake	Hak-15.16	1,041	0.61	0.15	146,176	EU.Med	overfished	LC
2011	*Merluccius merluccius*	Hake	Hak-17	2,145	2.06	0.20	171,274	EU.Med	overfished	LC
2012	*Merluccius merluccius*	Hake	Hak-18	2,502	1.11	0.19	227,827	EU.Med	overfished	LC
2011	*Merluccius merluccius*	Hake	Hak-19	701	1.00	0.22	57,675	EU.Med	overfished	LC
2006	*Merluccius merluccius*	Hake	Hak-22.23	2,086	1.63	0.40	541,698	EU.Med	overfished	LC
2014	*Micromesistius poutassou*	Blue Whiting	whb-comb	3,965,000	0.20	0.30	2,250,000	EU.NEA	sustainable	LC
2015	*Molva molva*	Ling	lin-icel	66,421	0.25	0.24	9,500	EU.NEA	declining	LC
2011	*Mullus barbatus*	Striped Mullet	Rmu-1	805	1.86	0.30	2,766	EU.Med	overfished	LC
2010	*Mullus barbatus*	Striped Mullet	Rmu-5	18	1.08	0.31	199	EU.Med	overfished	LC
2010	*Mullus barbatus*	Striped Mullet	Rmu-6	1,432	1.72	0.38	26,762	EU.Med	overfished	LC
2009	*Mullus barbatus*	Striped Mullet	Rmu-9	1,168	0.57	0.40	6,339	EU.Med	overfished	LC
2010	*Mullus barbatus*	Striped Mullet	Rmu-10	230	0.98	0.40	2,804	EU.Med	overfished	LC
2010	*Mullus barbatus*	Striped Mullet	Rmu-11	356	1.43	0.48	6,721	EU.Med	overfished	LC
2011	*Mullus barbatus*	Striped Mullet	Rmu-15.16	1,147	1.50	0.45	6,507	EU.Med	overfished	LC
2011	*Mullus barbatus*	Striped Mullet	Rmu-17	16,508	0.55	0.36	60,926	EU.Med	overfished	LC
2011	*Mullus barbatus*	Striped Mullet	Rmu-18	844	1.03	0.50	6,446	EU.Med	overfished	LC
2011	*Mullus barbatus*	Striped Mullet	Rmu-19	714	1.28	0.30	5,759	EU.Med	overfished	LC
2006	*Mullus barbatus*	Striped Mullet	Rmu-22.23	5,286	1.18	0.53	51,883	EU.Med	overfished	LC
2012	*Mullus barbatus*	Striped Mullet	Rmu-29	1,290	0.81	0.46	7,754	EU.Med	overfished	LC
2011	*Mullus surmuletus*	Red Mullet	Srm-5	192	0.79	0.29	1,123	EU.Med	overfished	DD

Year	Species Name	Common name	FishStockCode	SSB	Mean F	F_{MSY}	MSY $B_{trigger}$	Area	Stock status	IUCN Cat
2011	*Pagellus erythrinus*	Pandora	Pan-15.16	1,146	0.87	0.30	26,729	EU.Med	overfished	LC
2015	*Pleuronectes platessa*	Plaice	ple-2123	16,133	0.19	0.37	5,553	EU.NEA	sustainable	LC
2015	*Pleuronectes platessa*	Plaice	ple-2432	2	0.88	NA	NA	EU.NEA	undefined	LC
2015	*Pleuronectes platessa*	Plaice	ple-7h-k	1	1.06	NA	NA	EU.NEA	undefined	LC
2015	*Pleuronectes platessa*	Plaice	ple-eche	81,191	0.11	0.25	25,826	EU.NEA	sustainable	LC
2014	*Pleuronectes platessa*	Plaice	ple-echw	2	0.50	NA	1,745	EU.NEA	undefined	LC
2014	*Pleuronectes platessa*	Plaice	ple-iris	2	NA	NA	NA	EU.NEA	undefined	LC
2015	*Pleuronectes platessa*	Plaice	ple-nsea	901,694	0.18	0.19	230,000	EU.NEA	sustainable	LC
2015	*Pollachius virens*	Saithe	sai-3a46	199,270	0.31	0.32	200,000	EU.NEA	recovering	LC
2015	*Pollachius virens*	Saithe	sai-faro	82,089	0.32	0.30	55,000	Faroe	declining	LC
2015	*Pollachius virens*	Saithe	sai-icel	138,502	0.19	0.22	65,000	Iceland	sustainable	LC
2015	*Sardina pilchardus*	Pilchard	sar-soth	139,409	0.27	0.26	368,400	EU.NEA	overfished	NT
2010	*Sardina pilchardus*	Pilchard	Sar-1	44,993	0.15	0.23	109,553	EU.Med	recovering	NT
2010	*Sardina pilchardus*	Pilchard	Sar-6	36,816	0.74	0.44	218,955	EU.Med	overfished	NT
2011	*Sardina pilchardus*	Pilchard	Sar-9	20,204	0.47	0.20	95,450	EU.Med	overfished	NT
2011	*Sardina pilchardus*	Pilchard	Sar-17	156,071	0.85	0.51	NA	EU.Med	undefined	NT
2008	*Sardina pilchardus*	Pilchard	Sar-20	5,630	0.23	0.50	6,416	EU.Med	recovering	NT
2008	*Sardina pilchardus*	Pilchard	Sar-22.23	18,280	0.69	0.50	46,984	EU.Med	overfished	NT
2015	*Scomber scombrus*	Mackerel	mac-nea	3,620,056	0.34	0.22	3,000,000	EU.NEA	declining	LC
2014	*Scophthalmus maximus*	Turbot	tur-nsea	0	1.14	NA	NA	EU.NEA	undefined	VU
2012	*Scophthalmus maximus*	Turbot	Tur-29	1,121	0.73	0.26	33,143	EU.Med	overfished	VU
2015	*Solea solea*	Dover Sole	sol-7h-k	1	0.75	NA	NA	EU.NEA	undefined	LC
2015	*Solea solea*	Dover Sole	sol-bisc	12,012	0.48	0.26	13,000	EU.NEA	overfished	LC
2015	*Solea solea*	Dover Sole	sol-celt	2,620	0.44	0.31	2,200	EU.NEA	declining	LC
2015	*Solea solea*	Dover Sole	sol-eche	8,143	0.55	0.30	8,000	EU.NEA	declining	LC
2015	*Solea solea*	Dover Sole	sol-echw	4,452	0.19	0.27	2,800	EU.NEA	sustainable	LC
2015	*Solea solea*	Dover Sole	sol-iris	992	0.11	0.16	3,100	EU.NEA	recovering	LC
2015	*Solea solea*	Dover Sole	sol-kask	2,162	0.18	0.23	2,600	EU.NEA	recovering	LC
2015	*Solea solea*	Dover Sole	sol-nsea	41,137	0.26	0.20	37,000	EU.NEA	declining	LC
2012	*Solea solea*	Dover Sole	Sol-17	702	1.38	0.26	20,191	EU.Med	overfished	LC
2015	*Sprattus sprattus*	Sprat	spr-2232	753,000	0.41	0.26	570,000	EU.NEA	declining	LC
2015	*Sprattus sprattus*	Sprat	spr-nsea	576,000	0.65	0.70	142,000	EU.NEA	sustainable	LC
2015	*Trachurus trachurus*	Horse Mackerel (Scad)	hom-soth	529,830	0.04	0.11	NA	EU.NEA	undefined	LC
2015	*Trachurus trachurus*	Horse Mackerel (Scad)	hom-west	723,560	0.12	0.13	634,577	EU.NEA	sustainable	LC

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