How vulnerable is the European seafood production to climate warming?

Marie-Anne Blanchet [a,*], Raul Primicerio [a], Aslak Smalås [a], Juliana Arias-Hansen [b],
Michaela Aschan [a]
a Norwegian College of Fishery Science, UiT The Arctic University of Norway, 9037, Tromsø, Norway
b Syntesa sp/f, Fyri Oman Brúgv 2, 513 Syðrugøta, Faroe Islands

ABSTRACT

The main challenge for the European seafood industry is to ensure sustainable production volume while adapting to climate warming. Marine fisheries mainly target 41 species which account for 80% of the seafood production in Europe. The remaining 20% comes from marine and freshwater aquaculture, which harvest mainly 5 and 11 species, respectively. European seafood production volume (2004–2014) recorded by FAO was combined with indices of temperature sensitivity and biological sensitivity (BS) based on the life histories of the main exploited species. We found that the marine sectors are more vulnerable to global warming than the freshwater sector. The vulnerability to warming of a country's production is defined by the temperature sensitivity and the BS of the main exploited seafood species, weighted by their production volume. Production vulnerability in the marine sector increases with latitude due to the temperature sensitivity of the harvested species and their high production volume. No such gradient is found in the freshwater sector because most of the production is based on two species with opposite temperature sensitivity. To ensure a sustainable European seafood production, national climate strategies and action plans should include both fisheries and aquaculture and be integrated at a regional level.

1. Introduction

Climate warming is currently one of the main long-term drivers of economic, social and environmental change (Delworth et al., 2016; Williams et al., 2016; Weatherdon et al., 2016). Recent climate projections indicate that warming will affect economies relying on the production of seafood exploiting marine and freshwater ecosystems (Hollowed et al., 2013 and references therein, Barange et al., 2014; Breitburg et al., 2018). The word 'seafood' in this context encompasses farmed and captured fish, shellfish and seaweed products from marine and freshwater ecosystems that directly or indirectly (as feed) are meant for human consumption (EU-2020 project ClimeFish Description of Actions www.climefish.eu). Although many physical and biological factors affect aquatic species, warming of the environment is often considered as the main driving force of changes in their distribution and life history characteristics (Lenoir et al., 2008; Waples and Audzijonyte, 2016; Pecl et al., 2017) through changes in habitats (Cochrane et al., 2009; Cheung et al., 2012, 2013; Mazziotta et al., 2016; Waples and Audzijonyte, 2016; ICES, 2016). Marine life is sensitive to temperature changes (Poloczanska et al., 2016) and most species perform poorly outside their optimal temperature range (Angilletta et al., 2004; Peck et al., 2004; Hiddink et al., 2015). Deviations from this range affect growth rate, harvest or catch size and cause stock displacement of commercial species (Cochrane et al., 2009; Rose, 2005; ICES, 2016). According to recent reviews (Cheung et al., 2011, 2012; Heath et al., 2012; Hobday et al., 2018), marine aquaculture will also be affected by ocean warming: for instance, shell-borne organisms that represent over half of the European marine aquaculture production (FAO, 2016). The aquaculture sector is not limited to the marine environment and a large part of the world's aquatic food production results from culture in freshwater systems, such as lakes and ponds. Warming in these freshwater systems will affect access to water that is the main constraint on these land-based production systems. Thus, warmer temperatures will also affect the economy of landlocked countries (Poff et al., 2002; Ormerod et al., 2010). In Europe, temperatures on land and in water have been increasing over the past 25 years, particularly in the northeast Atlantic where changes have been up to six times larger than the global average (Heath et al., 2012; Cheung et al., 2012). The warming occurring in this region will undeniably have far-reaching impacts on the future prospects for fisheries and aquaculture in Europe (Heath et al., 2012; Cheung et al.,2012). We expect that European seafood production will experience changes related to the temperature affinity and the volume of the species produced. With an increasing demand for seafood products worldwide (Barange et al., 2014; FAO, 2016), efforts to identify the direct effects of warming should be implemented in Europe. The combined European Union (EU) and European Economic Area (EEA) seafood production volume is ranked third in the world (FAO, 2016) with marine fisheries accounting for 80% of the total. Europe has the largest trade of aquatic food in the world amounting 49.3 billion EUR in 2015 and European consumers are now spending more than ever on seafood products (EUMOFA, 2016). European seafood production has been constantly increasing, particularly in the aquaculture sector during the past 50 years (FAO, 2016) but the direct effects of warming on the production volume are largely uncertain. By 2030 the European aquaculture industry is expected to provide 4.5 million tons of food worth 14.0 billion EUR and more than 150,000 jobs (EUMOFA, 2016). This implies environmental, economic and social challenges for the European seafood production across the three sectors: marine fisheries, marine aquaculture and freshwater production. Global indicators of vulnerability usually place European countries among the least at risk compared to other fishing nations (Allison et al.,2009; Blasiak et al., 2017). This is mainly due to well-performing socioeconomic indicators and lower rates of fishing dependency among European economies. However, the impacts of climate change on seafood production vary greatly within Europe (Allison et al., 2009; Blasiak et al., 2017). Comparisons between European seafood-producing nations are seldom undertaken, which might place some nations at higher risk due to lack of disaggregation of the European Region. In order to improve the sustainability of the European seafood production, it is necessary to identify the potential challenges and opportunities caused by climate change for each of the producing nations within the three production sectors. A vulnerability assessment at regional and sectorial level is recommended in this context (Paukert et al., 2017). We explore and discuss the vulnerability of seafood production volume to climate warming within three production sectors in each European country, by combining information on the seafood's affinity to temperature, its life history characteristics, and production volumes of the main species. Furthermore, we wish to kindle a discussion on this approach and suggest how Europe may better prepare itself for climate related challenges in its seafood industry.

2. Concepts and methods

2.1. Vulnerability to warming

The vulnerability of seafood production volume in Europe was reviewed by sector and by each country. Seafood production was divided into three sectors; marine fisheries, marine aquaculture (including brackish water) and freshwater production (including both wild capture and aquaculture). Each sector is influenced by different climatic processes, contributes differently to the total European production and is under a variety of management regimes. Marine fisheries are typically affected by large scale oceanic processes, while marine aquaculture and freshwater systems are more affected by local processes such as precipitation and topography (Brander, 2007). A broadly recognised method of defining and measuring vulnerability of a productive system to climate change, is to define its exposure, its sensitivity, and its adaptive capacity. A function of these components will measure the extent of damage that a system will experience due to climate change, according to the framework used by the Intergovernmental Panel on Climate Change (IPCC) and described by Allison et al. (2005). In this context, exposure was defined as warming of the harvested organisms' ambient water (Allison et al., 2009; Blasiak et al., 2017). Sensitivity of the seafood production volume was defined based on two metrics characterising the harvested species: an index of their biological sensitivity (BS) and the maximum temperature (Tmax), that they are currently experiencing. The BS was extracted from FishBase (Froese and Pauly, 2018) and SealifeBase (Palomares and Pauly, 2018) following Cheung et al. (2005). This index is a combination of ecological and life history traits that influences a species' sensitivity to removal (Cheung et al., 2005). Although these traits are traditionally used when evaluating the intrinsic sensitivity of a species to fisheries, they also provide relevant information for aquaculture species, since their life history traits directly influence production. Each species' temperature preference is based on its modelled distribution from Cheung et al., (2013). This temperature preference encompasses the temperature spread under which each commercial species is functional and profitably exploited by fisheries (for details, see Cheung et al., 2013). Tmax is defined as the 75th percentile of this temperature preference. The adaptive capacity of the seafood production of each country or sector was defined as a combination of the number of main species exploited and the temperature range of each species. Species with a wide thermic range are able to withstand a wider variety of temperatures and are therefore potentially more adaptable to warming (Lloret et al., 2016). The higher this number of species, the better the potential adaptive capacity of a sector or country; this helps ensure economic diversification by providing the ability to shift from one species to another according to relative abundance (Hilborn et al., 2001; Cai et al., 2016; Lloret et al., 2016). Each species' temperature range was defined as the interquartile temperature range of its distribution. For species not included in Cheung et al. (2013) the temperature range was extracted from the online databases FishBase, SealifeBase or peer-reviewed papers (See Table S1 for details). Tmax is combined with the temperature range of each species, both weighted by their production volume, using principal component analysis (PCA). We use values from the first PCA axis (which summarises most of the exhibited variance) to obtain an index of temperature sensitivity. Thus, the vulnerability of seafood production volume of each country and sector can be evaluated based on temperature sensitivity and BS.

2.2. Production data

To explore the vulnerability to warming of each country by sector, we weighted the indices presented above by the production volume by sector and country. Data was extracted from the FAO database using the custom-made interface FishStatJ (http://www.fao.org/fishery/statistics/software/fishstatj/en). Similarly, the vulnerability to warming of the European production volume by sector was explored by weighing these indices by each species' production volume. We defined Europe as EU-28, EAA (Iceland, Norway, Lichtenstein), Turkey and the Faroe Islands. Data from the Channel Islands, the Isle of Man and Gibraltar were integrated in the UK production; data from Monaco was integrated in the French production and data from San Marino was integrated in the Italian production. Production volume values were averaged over an 11-year period (2004–2014) in order to smooth out the yearly variations and cope with the poor quality of data for some countries in certain years (Table 1). Species representing 90% of the production volume for each country were included in the calculations (Table 1 and S1). In some cases, several species were pooled together by FAO, thus representing a large production volume. These groups of species are included in Table S1 but not in the calculations presented in the main text. However, if one species was dominant in a group, we assigned the characteristics of that species to the group. A species production volume is only recorded by FAO if it is greater than 0.5 t; therefore, production volumes below 0.5 t are recorded as 0 in Table S1. Species with a low production volume appear in Table S1 but were not included in the calculations.

Table 1: Yearly average seafood volume (2004-2014) within three production sectors for each European country. Each country's weighted average maximum temperature (wTmax), biological sensitivity (wBS) and temperature range (wRange) is based on the species representing 90% of the country's production. A null production means no production, no data or a production volume below 0.5t.

	Country	**Marine fisheries**				**Marine Aquaculture**				**Freshwater production**			
		Average production (t)	wTmax	wBS	wRange	Average production (t)	wTmax	wBS	wRange	Average production (t)	wTmax	wBS	wRange
1	Austria	0	-	-	-	0	-	-	-	2969	17.09	0.42	8.91
2	Belgium	23685	15.45	0.49	6.25	0	-	-	-	738	19.49	0.52	10.22
3	Bulgaria	7437	16.20	0.26	6.75	797	19.00	0.10	5.00	6662	23.49	0.48	14.32
4	Croatia	53538	20.17	0.28	6.56	8531	22.11	0.44	6.50	4736	24.17	0.45	13.75
5	Cyprus	1604	24.61	0.50	6.94	3541	24.73	0.43	6.30	0	-	-	-
6	Czech Republic	0	-	-	-	0	-	-	-	24390	31.57	0.46	16.79
7	Denmark	764326	14.44	0.31	5.59	12399	11.92	0.36	6.08	24530	12.00	0.36	6.00
8	Estonia	74653	14.07	0.30	5.46	0	-	-	-	3407	20.91	0.55	12.60
9	Faroe Islands	479248	14.72	0.41	7.02	51977	12.00	0.62	6.00	0	-	-	-
10	Finland	124519	11.80	0.37	3.64	10878	12.00	0.36	6.00	32310	20.41	0.56	11.49
11	France	419836	17.12	0.42	6.56	183399	14.51	0.33	6.26	43886	14.47	0.38	7.25
12	Germany	213127	14.07	0.41	5.83	8284	11.00	0.36	7.00	46414	19.04	0.40	9.87
13	Greece	76253	22.46	0.36	6.64	108784	22.65	0.37	6.12	4139	15.77	0.39	8.79
14	Hungary	0	-	-	-	0	-	-	-	21797	31.25	0.51	18.02
15	Iceland	1341047	10.46	0.42	5.39	6371	8.30	0.67	4.93	535	8.73	0.59	4.58
16	Ireland	271032	17.77	0.43	7.53	45832	12.04	0.43	6.58	1063	12.38	0.42	6.48
17	Italy	233788	21.84	0.29	6.15	123221	19.22	0.12	4.78	41575	11.95	0.38	5.87
18	Latvia	76631	14.09	0.32	5.73	0	-	-	-	915	28.24	0.53	16.27
19	Lichenstein	0	-	-	-	0	-	-	-	0	-	-	-
20	Lithuania	29103	14.49	0.37	6.37	0	-	-	-	4678	28.34	0.48	15.02
21	Luxembourg	0	-	-	-	0	-	-	-	0	-	-	-

22	Malta	1710	26.94	0.55	5.16	2853	27.63	0.56	6.74	0	-	-	-
23	Netherlands	319984	16.38	0.44	6.34	50705	11.00	0.36	7.00	8818	25.33	0.66	18.82
24	Norway	2440131	12.22	0.43	5.58	975196	12.00	0.62	6.00	512	11.46	0.61	4.65
25	Poland	125902	13.96	0.35	5.86	0	-	-	-	54056	22.98	0.42	12.08
26	Portugal	179755	21.07	0.41	6.64	7614	20.15	0.36	6.76	742	12.00	0.36	6.00
27	Romania	1015	16.34	0.28	6.50	3	15.03	0.36	5.00	13611	25.65	0.45	15.98
28	Slovakia	0	-	-	-	0	-	-	-	2850	25.76	0.45	13.98
29	Slovenia	689	20.17	0.27	6.64	320	18.69	0.16	5.31	1155	25.95	0.43	13.70
30	Spain	442573	19.84	0.45	6.39	238053	19.69	0.12	5.08	27229	11.84	0.38	5.60
31	Sweden	213515	13.43	0.33	5.02	3744	11.58	0.36	6.42	8968	13.43	0.47	7.35
32	Turkey	433273	21.54	0.27	7.06	87375	21.22	0.46	6.62	0	-	-	-
33	United Kingdom	621371	14.86	0.40	6.14	180500	11.85	0.58	6.15	14464	11.92	0.37	5.80

3. Results and dicussion

3.1. Marine fisheries

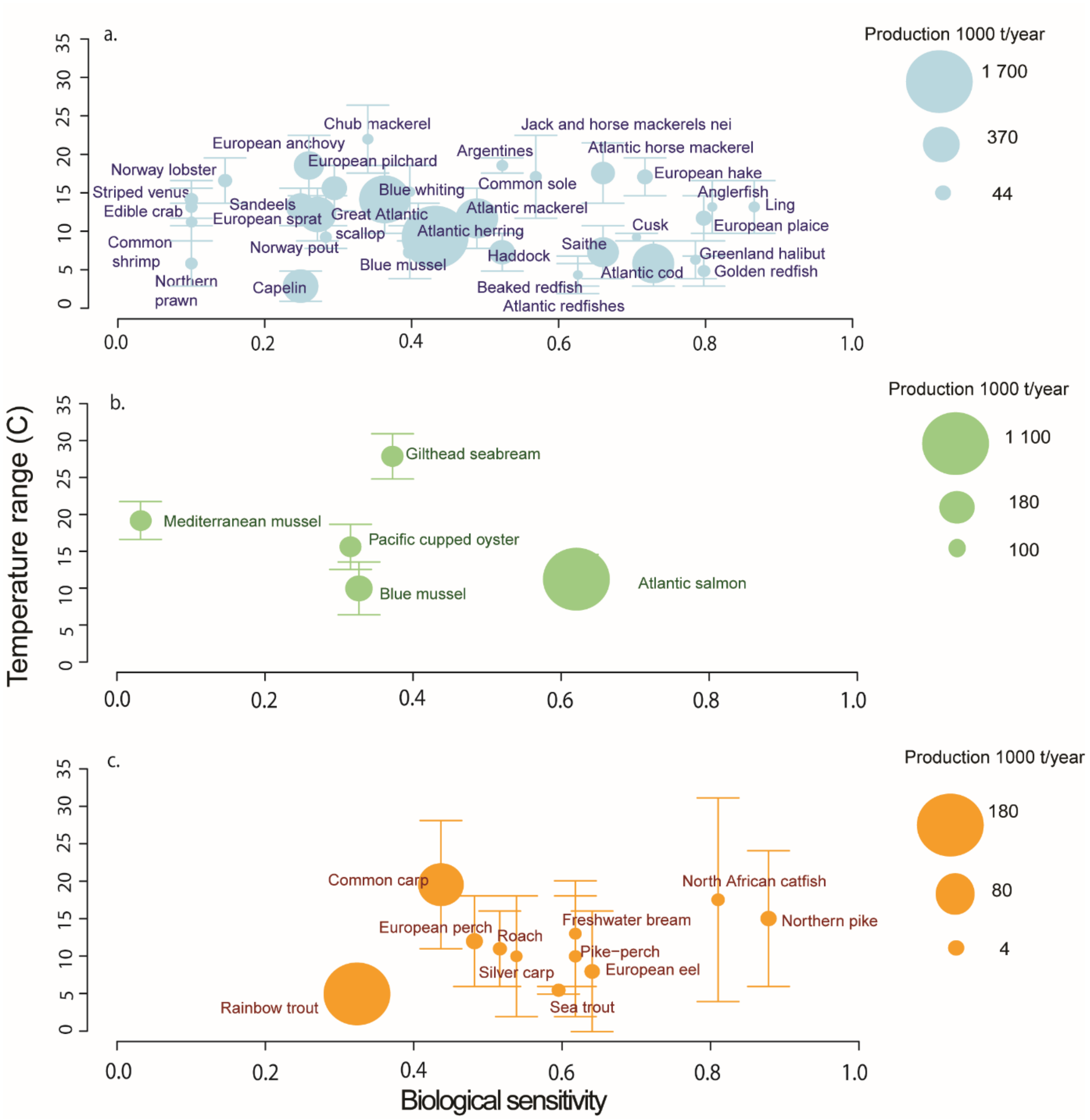
Marine fisheries contribute 80% of the European seafood production volume. This sector exploits a wide range of taxa with 30 fish species, eight crustacean species and three seaweed species representing 90% of the production volume (Table S1). Most of these species have low Tmax and narrow temperature range, which makes them sensitive to warming (Fig. 1) and prone to climate-driven distributional shifts (Perry et al.,2005; ICES, 2016). BS varies greatly, being low for crustaceans and high for long-lived, large fish such as Atlantic cod (Gadus morhua) (Fig. 1). Species landed in the greatest volume are pelagic fish with a low to moderate BS: Atlantic herring (Clupea harengus), blue whiting (Micromesistius poutassou), Atlantic mackerel (Scomber scombrus), European sprat (Sprattus sprattus) and capelin (Mallotus villosus) (Fig. 1). The species with the highest BS (> 0.5) represent less than 20% of the total production volume but have the highest economic value (eg. Atlantic cod, redfish and European hake (Merluccius merluccius)) (EUFOMA, 2016). In recent years a northwards expansion of the distributional range of several fish species has been driven by warming, sometimes also including a contraction of their southern distributional range (Perry et al., 2005; Fossheim et al., 2015; ICES, 2016). The change in distribution of stocks leads in turn to shifts in local fisheries (Barange et al., 2014; Bonanomi et al., 2015; Pecl et al., 2017). Countries in the southern part of the distributional range of a species may lose access to the resource while countries in the northern part might benefit from a northward shift of its distributional range. For example, the Atlantic mackerel has expanded its distribution northwards due both to increasing stock size and warmer sea temperatures. It has become a regular in the waters of Iceland and the Faroe Islands since 2007 and now supports a profitable fishery, which has led to conflicts with the European Union and Norway regarding fishing quotas (Astthorsson et al., 2012; Spijkers and Boonstra, 2017). International cooperation is essential in order to prepare ocean governance for shifting distributional ranges of commercial species and potentially reduced landings for some countries (Blasiak et al., 2017; Pinsky et al., 2018). Four countries produce nearly 60% of the volume of European marine fish: Norway, Iceland, Denmark and the UK. These countries mainly depend on species such as herring with a high temperature sensitivity and a moderate to high BS (Figs. 2 a and S1a) such as herring. This species is the most fished species in Europe and 15 countries rely on it. It thrives in cold-water, especially in its adult phase, and has a narrow temperature range of 3 °C (8° – 11 °C), which drives the high sensitivity to warming of northern countries (Figs. 2a and S1). If the fast-paced warming observed in the northeast Atlantic continues and some herring stocks retreat further north, they may not be exploitable even by the most northern countries of Europe (Rose, 2005). The seafood production volume in the Nordic countries, although presently benefiting from cooler temperatures, is likely to be more vulnerable to warming than countries in the south, due to stocks northwards displacement and socio-economic challenges (Niiranen et al., 2017). Southern countries, although losing the “cold water species”, mainly rely on “warm water” species and therefore may be more resilient to warming (Figs. 1a and 2a; Table S1). These countries may also benefit from the influx of tropical species that could reproduce and become a stable resource, such as Sardinella aurita along the Spanish coast (Lejeusne et al., 2010).

3.2. Marine aquaculture

Marine aquaculture represents nearly 18% of the European seafood production volume, accounts for EUR 4 billion and is the main industry in many European regions (EUMOFA, 2016). Marine aquaculture, comprising invertebrates and fish in almost equal amounts, relies on coastal habitats (Callaway et al., 2012; Bostock et al., 2016). Only five species account for 90% of the production with the most important species being the Mediterranean (Mytilus galloprovincialis) and blue (Mytilus edulis) mussels and

Atlantic salmon (Salmo salar). Mussels,especially Mediterranean mussels, have a high Tmax and intermediate temperature range that translates to low sensitivity to temperature changes. On the other hand, Atlantic salmon are more sensitive to warming with a low Tmax and an intermediate temperature range. The growth rate in Atlantic salmon depends on sea temperature and is highest at cool temperatures<13 °C (Thyholdt, 2014). Therefore, an increase in temperature will affect salmon farms at a regional scale with positive influence on growth in northern regions and a negative influence in southern regions as already experienced in Norway (Jonsson and Jonsson, 2009; Thyholdt, 2014). Furthermore, salmon has a higher BS (> 0.5) compared to sea mussels (< 0.35) due to very different life history trait characteristics, especially the generation time. There is a clear separation between the vulnerability of European countries' seafood production volume from north to south due to the characteristics of the main species exploited (Fig. 2b). Nordic countries, responsible for large volumes of salmonids, are more vulnerable to warming owing to the temperature sensitivity of their species and the low species diversity of their aquaculture sector (Figs. 2b and S1b). Mediterranean countries, on the other hand, harvest a large volume of sea mussels and temperate fish species such as the gilthead sea bream (Sparus aureatus) or European seabass (Dicentrarchus labrax). These show a high tolerance to warming (up to 28 °C) (Requena et al., 1997) and a moderate BS which makes these species interesting for further exploitation in Europe. Gilthead sea bream and seabass are already important in several southern European countries e.g. Greece where they represent over 80% of the aquaculture production rendering this country less vulnerable to warming than others.

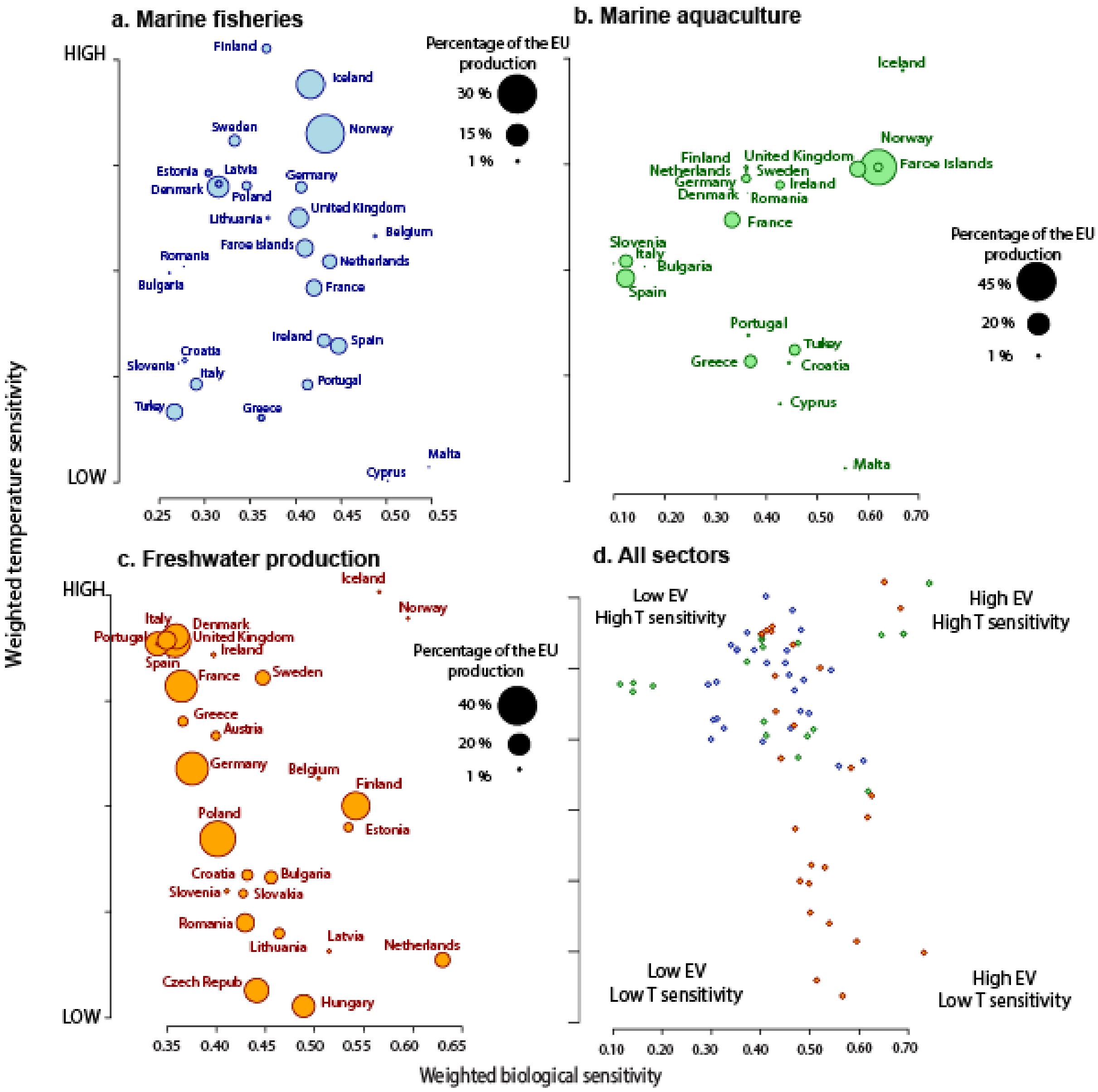
Figure 1: Bubble plot of the biological sensitivity index versus the temperature range for each of the species that represent 90% of the European production (in volume) for a) marine fisheries, b) marine aquaculture and c) freshwater production. The size of the bubble relates to the total volume (in 1000 t/year) produced for a particular species within a sector. The whiskers encompass the temperature range (Tmin and Tmax) for each species. For the larger bubbles, these whiskers can be hidden. Note that the size scale among the three production sectors is not the same due to large numerical differences.



3.3. Freshwater production

The freshwater sector, including wild captures and aquaculture, relies exclusively on fish and represents less than 3% of the total European seafood production volume. Aquaculture accounts for most of the production volume while wild captures are mainly taken in recreational fisheries. Rainbow trout (Oncorhynchus mykiss) and the common carp (Cyprinus carpio) represent 60% of the total production volume. These two species have very different temperature sensitivity (Fig. 1). The rainbow trout is stenothermal and thrives at low temperatures (Ebersole et al., 2001) while the common carp is eurythermal and tolerates high temperatures (Ficke et al., 2007). This high temperature tolerance is beneficial under warming conditions as wild freshwater ecosystems are usually closed, which prevents fish from moving to cooler waters (Ficke et al., 2007). However, temperature is not the sole driver of productivity in freshwater systems as several environmental factors act in synergy, e.g. dissolved oxygen levels and stratification of water masses (Ficke et al., 2007). Acclimated salmonids cultured in freshwater, although thriving at cold temperatures, can tolerate and even benefit from warming, within limits, as long as dissolved oxygen levels are sufficient (Anttila et al., 2015). Freshwater species produced in European aquaculture have an intrinsically high BS ranging from 0.5 to over 0.8 mainly due to a long-life span and a high age at sexual maturity (Fig. 1) (Morato et al., 2006). Yet, the rainbow trout and the common carp have moderate BS, which enhances their use in aquaculture (Fig. 1). Vulnerability of the seafood production volume in each European country reflects the sensitivity to warming of the main species produced. For example, Hungary and the Czech Republic show a low vulnerability to warming because most of their production is based on common carp (Figs. 2c and S1c). Nordic countries show a higher vulnerability because most of their production is based on cold-water salmonids. Production in freshwater systems representsan increasingly important protein resource with a large growth potential especially for landlocked countries such as Hungary and Czech Republic. Emerging eurythermal species e.g. the North African catfish (Clarias gariepinus) with a high temperature tolerance and a low BS represent an exploitation opportunity for these countries.

Figure 2: Ranking of each European country's vulnerability to warming as a function of their weighted temperature sensitivity and the weighted biological sensitivity of the species representing 90% of the production volume between 2004 and 2014. Countries' vulnerability is shown for each of the three production sectors a) Marine fisheries; b) Marine aquaculture; c) Freshwater production. In (d) all production sectors are represented at the same scale for comparison purposes. The size of the bubble represents the relative contribution of each country to the European production volume within a sector. Note that the scale of the y-axis and the bubble size differ between panels (a, b and c) to help readability.



3.4. Risks and opportunities across sectors

The vulnerability to warming of the European seafood production depends on the sensitivity to temperature and the BS of each species exploited in each country. The seafood production volume per country is generally more vulnerable within the marine fisheries and aquaculture sectors, while the vulnerability in the freshwater sector varies a lot among the countries (Figs. 2 and S1). In the marine system (fisheries and aquaculture sectors) the vulnerability of European countries' seafood production is distributed along a south-north temperature sensitivity axis with the production volume of northern countries being more sensitive to warming than southern countries' (Figure S1a, b). The seafood production volume of countries in northern Europe is dependent on cold-water marine species with high BS and is therefore more vulnerable to warming, while countries in the south rely on warm water species with a lower BS. Changes in species distribution are the main challenge for marine fisheries and their management (ICES, 2016; Pinsky et al., 2018). Increasing temperature is leading to a general poleward shift of species changing the fishing opportunities and the composition, abundance, and availability of fished species (ICES, 2016). However, redistribution of stocks may create new opportunities if countries are able to adapt to changes and if well-functioning management plans are in place (Lam et al., 2014; Niiranen et al., 2017). This implies societal and economic adaptations as well as new governance, ensuring sound management of the new resource to ensure sustainable exploitation. For example, bluefin tuna (Thunnus thynnus) is nowadays fished for longer periods in the Mediterranean due to climate-induced behavioural changes (Lejeusne et al., 2010) and is tightly linked to warming-sensitive oceanographic features (Alvarez-Berastegui et al., 2016). However, potential mismatch between the local abundance, the quotas allowed by the Common Fisheries Policy and the landing/processing facilities need to be addressed at a regional level to ensure that species are appropriately exploited based on assessments of integrated ecological and economic data (Baudron and Fernandes, 2015; Pinksy et al., 2018). The south-north temperature sensitivity axis observed in the marine sectors is not present in the freshwater sector due to the production being based on two main species. Rainbow trout production may be significantly at risk from warming, especially in southern European countries. It is indeed predicted that aquaculture in temperate zones will be significantly at risk from warming conditions, if the ambient temperatures exceed the range of the currently cultured species (Cochrane et al., 2009). Rising temperatures might in addition reduce the level of dissolved oxygen, increase metabolic costs for fish and cause higher mortality rates and lower growth rate (FAO, 2009; Kroeker et al., 2013). For marine aquaculture, this situation is already a challenge for the Norwegian salmonids culture (Jonsson and Jonsson, 2009). The impact of diseases is likely to increase due to warming ifpathogens spread to regions previously too cold for them (Cochrane et al., 2009; Lafferty et al., 2015, Costello, 2006). In addition, aquaculture traditionally relies on piscivorous fish depending on fish meal and fish oil. This presents a substantial challenge as the availability of such feed relies on the productivity of small pelagic fisheries (such as sardines and anchovy) that are highly influenced by warming (Blanchard, 2017, Merino et al., 2012). The fewer species the country relies on, the lower its potential adaptive capacity and hence the higher its vulnerability to warming or any stochastic event such as disease outbreak. The low species diversity in aquaculture makes this sector extra vulnerable when exposed to rising temperatures. For example, in Hungary 95% of the production is based on common carp. In Europe most countries exploit the same few species, so the aquaculture sector is vulnerable. For example, the rainbow trout, which is exploited by 23 European countries, has a very narrow optimal range of temperature and is thus sensitive to warming especially in southern European countries. Yet there is a great potential for an increased production volume in the aquaculture sector that may represent significant opportunities at the European level. Aquaculture is even expected to relieve the fishing pressure on wild fish stocks (Mente and Smaal, 2016; Lafferty et al., 2015; Turchini and De Silva, 2008; Diana, 2009), especially if the sector manages to tackle its main challenges. Future production should focus on low trophic level species not dependent on fish meal and thermophile species with a low sensitivity to warming. In Hungary, emerging thermophile species such as the North African catfish (Clarias gariepinus) benefiting from an increase in temperature, could open new profitable production channels (Bostock et al., 2016). Landlocked countries such as the Czech Republic and Hungary are investing in multi-functional ponds to diversify and increase their production based on temperature and anoxia tolerant species (Bekefi and Varadi, 2007; Turchini and De Silva, 2008). Attention should also be paid to the technical solutions of the production systems, as freshwater aquaculture is traditionally water-intensive and changes in weather patterns through floods or droughts may affect production and its costs (Anyanwu et al., 2014; Ficke et al., 2007).

4. Towards adaptation to climate warming in seafood production

According to the IPCC, climate adaptation is "an adjustment in the natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harms or exploits beneficial opportunities associated with climate change" (IPCC, 2007). In this respect, the European Union strategy on adaptation to climate change aims at making Europe more climate-resilient as stated in the plan adopted by European countries in April 2013 (https://ec.europa.eu/clima/sites/clima/files/docs/eu_strategy_en.pdf) (Dewulf et al., 2015). Similarly, the new Common Fisheries Policy specifically aims at making fisheries and aquaculture environmentally, economically and socially sustainable (European Commission, 2016). Twenty-three countries have already adopted national climate adaptation strategies, and another eight are reported to be currently developing them. National action plans are adopted or currently under development in most European countries and all countries have on-going research programs into climate change and warming (Biesbroek et al., 2010). Some countries e.g. Germany, the UK and Finland, have taken the lead (Tompkins et al.,2010; Juhola and Westerhoff, 2011) and developed most of the subtasks (Biesbroek et al., 2010). However, these climate adaption ambitions are challenged by the uncertainty intrinsic in climate change science, by the lack of coordinated efforts in climate adaptation strategies among European countries, and by the non-inclusion of certain sectors in these strategies. For instance, fisheries and/or aquaculture are not always included in national action plans and some countries (e.g. Norway) have not yet implemented these plans. The impact of warming in Europe is region-dependent and goes beyond national borders. It is therefore essential that a coordinated effort across countries aims at identifying changes in seafood production on the regional level transcending national borders. Trans-national regions, defined by the European Union to promote better cooperation and tackle common issues, may serve as a base in order to increase the efficiency of climate adaptations strategies. In the aquaculture and freshwater sectors, management by member states may be sufficient, but in the marine fisheries sector, the regional conventions and the recently established regional groups in the Common Fisheries Policy (Coers et al., 2012) may play a central role in climate adaptation.

5. Future directions and recommendations

A sustainable increase in seafood production under climate warming warrants not only a substantial effort for the adaptive management of fish stocks and the development of responsible fish farming, but also for global strategies aimed at climate adaptation (Blanchard et al., 2017; Pinsky et al., 2018). These actions also need to be taken in Europe and should be harmonized and integrated at the regional level across European nations.

We recommend:

- To promote close dialogue between stakeholders and scientists in understanding adaptability of farmed and fished aquatic species.

- To prepare for reduced landings of the currently most important marine species.

- To diversify the exploited species across all sectors, by introducing new value chains.

- To explore the growth potential in the aquaculture sector, aiming for sustainable farming by implementing innovative techniques and resilient species such as eurythermal and anoxia tolerant species.

- To include fisheries and aquaculture in climate adaptation strategies and action plans in all European countries as soon as possible.

• To review and assess periodically these action plans to ensure their efficiency.

• To ensure transnational cooperation.

All of these goals will be attained by ensuring the active participation of stakeholders in decision-making processes, in the creation of new and viable markets and in the development of long-lasting coordination mechanisms.

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Supplementary material

Figure S1: Weighted average temperature range (first column), weighted average maximum temperature Tmax (second column) and weighted average biological sensitivity (third column) for each country based on the species representing 90% of the European production (in volume) between 2004 and 2014 across three production sectors (a) marine fisheries, (b) marine aquaculture, and (c) freshwater production. Darker hues indicate narrower temperature ranges (first column), higher Tmax (second column) or higher biological sensitivity index (third column). Note that the scale is different for each production sector in order to keep the maps readable due to large numerical differences across sectors.

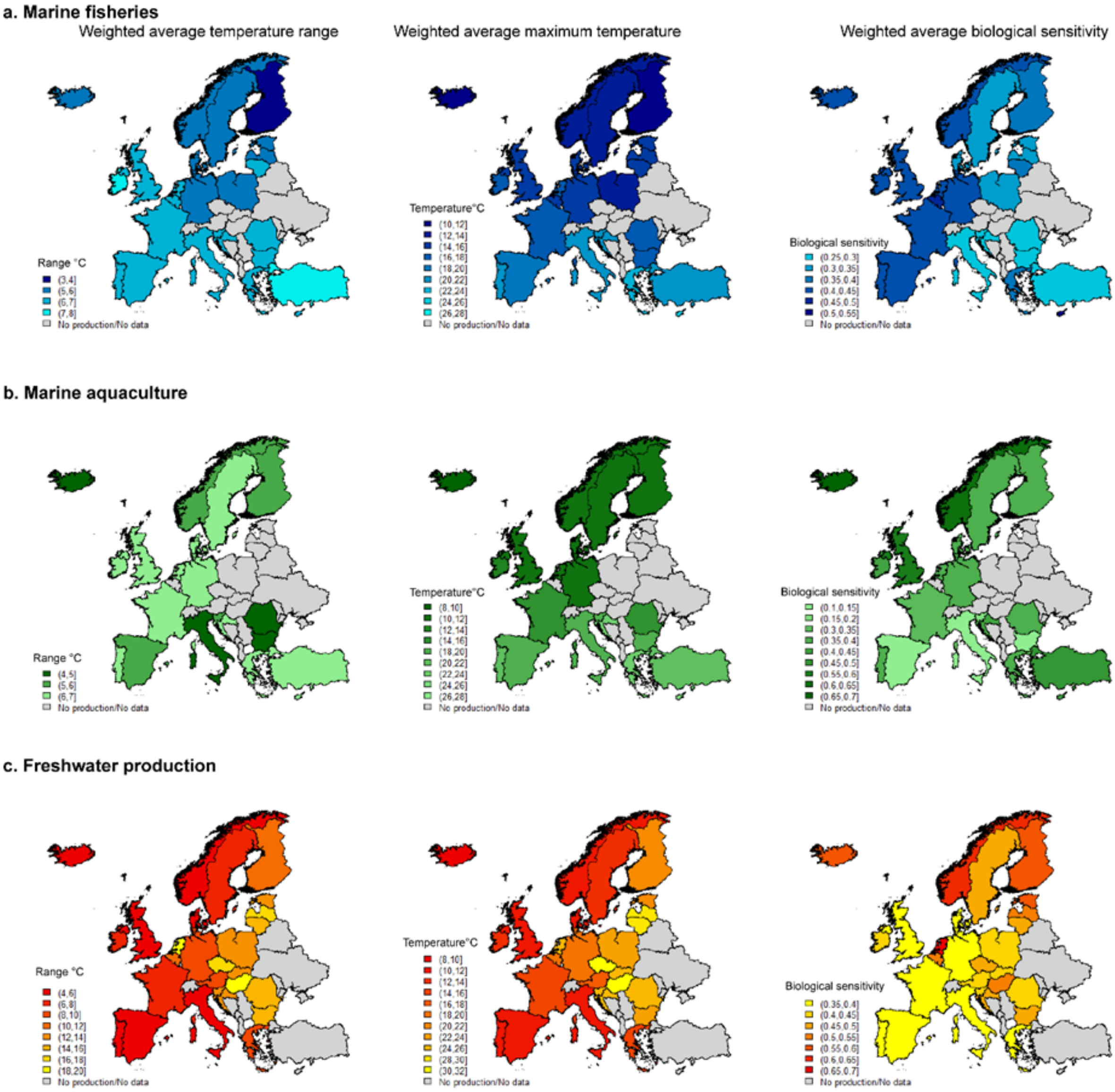
a. Marine fisheries
Weighted average temperature range
Weighted average maximum temperature
Weighted average biological sensitivity
Range °C
(3,4]
(5,6]
(6,7]
(7,8]
No production/No data
Temperature°C
(10,12]
(12,14]
(14,16]
(16,18]
(18,20]
(20,22]
(22,24]
(24,26]
(26,28]
No production/No data
Biological sensitivity
(0.25,0.3]
(0.3,0.35]
(0.35,0.4]
(0.4,0.45]
(0.45,0.5]
(0.5,0.55]
No production/No data
b. Marine aquaculture
Range °C
(4,5]
(5,6]
(6,7]
No production/No data
Temperature°C
(8,10]
(10,12]
(12,14]
(14,16]
(18,20]
(20,22]
(22,24]
(24,26]
(26,28]
No production/No data
Biological sensitivity
(0.1,0.15]
(0.15,0.2]
(0.3,0.35]
(0.35,0.4]
(0.4,0.45]
(0.45,0.5]
(0.55,0.6]
(0.6,0.65]
(0.65,0.7]
No production/No data
c. Freshwater production
Range °C
(4,6]
(6,8]
(8,10]
(10,12]
(12,14]
(14,16]
(16,18]
(18,20]
No production/No data
Temperature°C
(8,10]
(10,12]
(12,14]
(14,16]
(16,18]
(18,20]
(20,22]
(22,24]
(24,26]
(28,30]
(30,32]
No production/No data
Biological sensitivity
(0.35,0.4]
(0.4,0.45]
(0.45,0.5]
(0.5,0.55]
(0.55,0.6]
(0.6,0.65]
(0.65,0.7]
No production/No data

Table S1: Seafood species contributing to 90% of each country's production in volume per sector for the period 2004-2014. The average production volume is in tons. The sector column refers to M= marine fishery, A= marine aquaculture and F=freshwater. "nei" means "non included elsewhere" for species with a general name (ex: monkfish). The temperature range limits (Tmin and Tmax) are the 25th and 75th percentile of the temperature preference respectively while the central tendency in temperature preference (Tmed) is the 50th percentile, based on Cheung et al. 2013. The biological sensitivity is based on Cheung et al. (2005) and extracted from Fishbase or Sealifebase.

Country	Species	Latin	Average (t)	BS	Tmin	Tmax	Tmed	source	Sector
Belgium	European plaice	*Pleuronectes platessus*	6140	0.71	9	15	12	Cheung et al 2013	M
Belgium	Common sole	*Solea solea*	3789	0.36	12	19	16	Cheung et al 2013	M
Belgium	Atlantic cod	*Gadus morhua*	1341	0.65	3	9	6	Cheung et al 2013	M
Belgium	Monkfishes nei	*non specific*	1257	NA	NA	NA	NA	NA	M
Belgium	Common shrimp	*Crangon crangon*	1088	0.10	9	14	11	Cheung et al 2013	M
Belgium	Lemon sole	*Microstomus kitt*	962	0.34	3	10	6	Cheung et al 2013	M
Belgium	Rays and skates nei	*non specific*	904	NA	NA	NA	NA	NA	M
Belgium	Great Atlantic scallop	*Pecten maximus*	752	0.26	11	15	12	Cheung et al 2013	M
Belgium	Common cuttlefish	*Sepia officinalis*	657	0.30	15	23	19	Cheung et al 2013	M
Belgium	Common dab	*Limanda limanda*	573	0.26	9	12	10	Cheung et al 2013	M
Belgium	Tub gurnard	*Chelidonichthys lucerna*	565	0.40	8	22	15	Cheung et al 2013	M
Belgium	Dogfishes and hounds nei	*non specific*	499	NA	NA	NA	NA	NA	M
Belgium	Pouting(=Bib)	*Trisopterus luscus*	430	0.44	10	14	12	Cheung et al 2013	M
Belgium	Turbot	*Scophthalmus maximus*	389	0.43	9	14	11	Cheung et al 2013	M
Belgium	Brill	*Scophthalmus rhombus*	359	0.32	7	14	11	Cheung et al 2013	M
Belgium	European flounder	*Platichthys flesus*	339	0.42	10	15	12	Cheung et al 2013	M
Belgium	Whiting	*Merlangius merlangus*	323	0.37	9	14	11	Cheung et al 2013	M
Belgium	Thornback ray	*Raja clavata*	317	0.72	14	20	17	Cheung et al 2013	M
Belgium	Haddock	*Melanogrammus aeglefinus*	303	0.47	5	10	7	Cheung et al 2013	M
Belgium	Red gurnard	*Chelidonichthys cuculus*	293	0.45	NA	NA	NA	Fishbase	M
Belgium	Megrim	*Lepidorhombus whiffiagonis*	275	0.62	12	19	16	Cheung et al 2013	M
Bulgaria	European sprat	*Sprattus sprattus*	3352	0.25	9	16	12	Cheung et al 2013	M
Bulgaria	Sea snails	*non specific*	3311	NA	NA	NA	NA	NA	M
Bulgaria	Mediterranean horse mackerel	*Trachurus mediterraneus*	179	0.47	18	20	19	Cheung et al 2013	M

Croatia	European pilchard(=Sardine)	*Sardina pilchardus*	31670	0.27	13	19	16	Cheung et al 2013	M
Croatia	European anchovy	*Engraulis encrasicolus*	11228	0.24	15	23	21	Cheung et al 2013	M
Croatia	Marine fishes nei	*non specific*	3590	NA	NA	NA	NA	NA	M
Croatia	European hake	*Merluccius merluccius*	857	0.64	15	20	18	Cheung et al 2013	M
Croatia	Atlantic bluefin tuna	*Thunnus thynnus*	642	0.82	19	27	24	Cheung et al 2013	M
Croatia	Red mullet	*Mullus barbatus*	573	0.29	12	22	17	Cheung et al 2013	M
Cyprus	Albacore	*Thunnus alalunga*	356	0.58	20	26	23	Cheung et al 2013	M
Cyprus	Bogue	*Boops boops*	191	0.41	16	24	20	Cheung et al 2013	M
Cyprus	Picarels nei	*non specific*	189	NA	NA	NA	NA	NA	M
Cyprus	Marine fishes nei	*non specific*	139	NA	NA	NA	NA	NA	M
Cyprus	Surmullet	*Mullus surmuletus*	81	0.39	13	23	19	Cheung et al 2013	M
Cyprus	Octopuses, etc. nei	*non specific*	78	NA	NA	NA	NA	NA	M
Cyprus	Atlantic bluefin tuna	*Thunnus thynnus*	51	0.82	19	27	24	Cheung et al 2013	M
Cyprus	Swordfish	*Xiphias gladius*	47	0.72	23	27	26	Cheung et al 2013	M
Cyprus	Common cuttlefish	*Sepia officinalis*	41	0.30	15	23	19	Cheung et al 2013	M
Cyprus	Red mullet	*Mullus barbatus*	38	0.29	12	22	17	Cheung et al 2013	M
Cyprus	Parrotfish	*Sparisoma cretense*	37	0.36	NA	NA	26	Fishbase	M
Cyprus	Spinefeet(=Rabbitfishes) nei	*non specific*	36	NA	NA	NA	NA	NA	M
Cyprus	Blotched picarel	*Spicara maena*	25	0.45	12	19	16	Cheung et al 2013	M
Cyprus	Sargo breams nei	*non specific*	25	NA	NA	NA	NA	NA	M
Cyprus	European squid	*Loligo vulgaris vulgaris*	21	0.30	NA	NA	NA	Sealifebase	M
Cyprus	Axillary seabream	*Pagellus acarne*	19	0.43	18	20	19	Cheung et al 2013	M
Cyprus	Common pandora	*Pagellus erythrinus*	18	0.40	16	20	18	Cheung et al 2013	M
Cyprus	Comber	*Serranus cabrilla*	16	0.36	20	27	23	Cheung et al 2013	M
Cyprus	European hake	*Merluccius merluccius*	16	0.64	15	20	18	Cheung et al 2013	M
Cyprus	Scorpionfishes nei	*non specific*	16	NA	NA	NA	NA	NA	M
Cyprus	Red porgy	*Pagrus pagrus*	14	0.66	21	27	25	Cheung et al 2013	M
Denmark	Sandeels(=Sandlances) nei	*Ammodytes tobianus*	222004	0.23	11	16	13	Cheung et al 2013	M
Denmark	European sprat	*Sprattus sprattus*	181743	0.25	9	16	12	Cheung et al 2013	M

Denmark	Atlantic herring	*Clupea harengus*	120654	0.39	8	11	5	Cheung et al 2013	M
Denmark	Blue mussel	*Mytilus edulis*	48538	0.36	4	11	8	Cheung et al 2013	M
Denmark	Atlantic mackerel	*Scomber scombrus*	30531	0.44	8	16	12	Cheung et al 2013	M
Denmark	Blue whiting(=Poutassou)	*Micromesistius poutassou*	26846	0.33	10	19	15	Cheung et al 2013	M
Denmark	Atlantic cod	*Gadus morhua*	25956	0.65	3	9	6	Cheung et al 2013	M
Denmark	Norway pout	*Trisopterus esmarkii*	24895	0.26	8	11	9	Cheung et al 2013	M
Denmark	European plaice	*Pleuronectes platessus*	19429	0.71	9	15	12	Cheung et al 2013	M
Estonia	European sprat	*Sprattus sprattus*	41364	0.25	9	16	12	Cheung et al 2013	M
Estonia	Atlantic herring	*Clupea harengus*	25916	0.39	8	11	5	Cheung et al 2013	M
Faroe Islands	Blue whiting(=Poutassou)	*Micromesistius poutassou*	175053	0.33	10	19	15	Cheung et al 2013	M
Faroe Islands	Atlantic herring	*Clupea harengus*	72797	0.39	8	11	5	Cheung et al 2013	M
Faroe Islands	Atlantic mackerel	*Scomber scombrus*	61174	0.44	8	16	12	Cheung et al 2013	M
Faroe Islands	Saithe(=Pollock)	*Pollachius virens*	52295	0.59	4	11	6	Cheung et al 2013	M
Faroe Islands	Atlantic cod	*Gadus morhua*	31207	0.65	3	9	6	Cheung et al 2013	M
Faroe Islands	Capelin	*Mallotus villosus*	18720	0.23	1	5	3	Cheung et al 2013	M
Faroe Islands	Argentines	*Argentina sphyraena*	13486	0.36	12	19	16	Cheung et al 2013	M
Faroe Islands	Haddock	*Melanogrammus aeglefinus*	12770	0.47	5	10	7	Cheung et al 2013	M
Finland	Atlantic herring	*Clupea harengus*	94904	0.39	8	11	5	Cheung et al 2013	M
Finland	European sprat	*Sprattus sprattus*	17988	0.25	9	16	12	Cheung et al 2013	M
France	European pilchard(=Sardine)	*Sardina pilchardus*	31034	0.27	13	19	16	Cheung et al 2013	M
France	Tangle	*Laminaria digitata*	26833	NA	NA	22	10	Bolton and Lüning 1982	M
France	Great Atlantic scallop	*Pecten maximus*	25792	0.26	11	15	12	Cheung et al 2013	M
France	Atlantic herring	*Clupea harengus*	24352	0.39	8	11	5	Cheung et al 2013	M
France	European hake	*Merluccius merluccius*	21118	0.64	15	20	18	Cheung et al 2013	M
France	Monkfishes nei	*non specific*	20434	NA	NA	NA	NA	NA	M
France	Atlantic mackerel	*Scomber scombrus*	18019	0.44	8	16	12	Cheung et al 2013	M
France	Saithe(=Pollock)	*Pollachius virens*	15329	0.59	4	11	6	Cheung et al 2013	M
France	Whelk	*Buccinum undatum*	12327	NA	10	12	11	Cheung et al 2013	M
France	Whiting	*Merlangius merlangus*	12081	0.37	9	14	11	Cheung et al 2013	M

France	Blue whiting(=Poutassou)	*Micromesistius poutassou*	11769	0.33	10	19	15	Cheung et al 2013	M
France	Atlantic horse mackerel	*Trachurus trachurus*	9213	0.59	14	22	18	Cheung et al 2013	M
France	Atlantic cod	*Gadus morhua*	8346	0.65	3	9	6	Cheung et al 2013	M
France	Common sole	*Solea solea*	8083	0.36	12	19	16	Cheung et al 2013	M
France	North European kelp	*non specific*	7264	NA	NA	NA	NA	NA	M
France	Cuttlefish, bobtail squids nei	*non specific*	7202	0.10	NA	NA	NA	NA	M
France	Haddock	*Melanogrammus aeglefinus*	7085	0.47	5	10	7	Cheung et al 2013	M
France	European anchovy	*Engraulis encrasicolus*	6403	0.24	15	23	21	Cheung et al 2013	M
France	Common cuttlefish	*Sepia officinalis*	6337	0.30	15	23	19	Cheung et al 2013	M
France	Edible crab	*Cancer pagurus*	5686	0.10	11	16	14	Cheung et al 2013	M
France	Small-spotted catshark	*Scyliorhinus canicula*	5418	0.62	10	22	17	Cheung et al 2013	M
France	Various squids nei	*European common squid*	5258	0.10	NA	NA	NA	Sealifebase	M
France	European seabass	*Dicentrarchus labrax*	5125	0.49	10	17	14	Cheung et al 2013	M
France	Pouting(=Bib)	*Trisopterus luscus*	4979	0.44	10	14	12	Cheung et al 2013	M
France	European conger	*Conger conger*	4952	0.86	9	22	16	Cheung et al 2013	M
France	Norway lobster	*Nephrops norvegicus*	4881	0.14	14	20	17	Cheung et al 2013	M
France	Atlantic bluefin tuna	*Thunnus thynnus*	4657	0.82	19	27	24	Cheung et al 2013	M
France	Seaweeds nei	*non specific*	4483	NA	NA	NA	NA	NA	M
France	Spinous spider crab	*Maja squinado*	4322	0.12	17	23	20	Cheung et al 2013	M
France	Common European bittersweet	*Glycymeris glycymeris*	4183	NA	NA	NA	11	Sealifebase	M
France	Red gurnard	*Chelidonichthys cuculus*	4135	0.45	NA	NA	NA	Fishbase	M
France	Albacore	*Thunnus alalunga*	3903	0.58	20	26	23	Cheung et al 2013	M
France	Blue mussel	*Mytilus edulis*	3663	0.36	4	11	8	Cheung et al 2013	M
France	Black seabream	*Spondyliosoma cantharus*	3472	0.37	14	23	19	Cheung et al 2013	M
France	Megrim	*Lepidorhombus whiffiagonis*	3395	0.62	12	19	16	Cheung et al 2013	M
France	Pollack	*Pollachius pollachius*	3236	0.59	9	12	10	Cheung et al 2013	M
France	Surmullet	*Mullus surmuletus*	3182	0.39	13	23	19	Cheung et al 2013	M
France	Queen scallop	*Chlamys opercularis*	3135	0.22	11	13	12	Cheung et al 2013	M
France	European plaice	*Pleuronectes platessus*	2964	0.71	9	15	12	Cheung et al 2013	M

France	Smooth-hounds nei	*non specific*	2814	NA	NA	NA	NA	NA	M
France	Roundnose grenadier	*Coryphaenoides rupestris*	2742	0.67	6	13	10	Cheung et al 2013	M
France	Blue ling	*Molva dypterygia*	2589	0.75	5	17	11	Cheung et al 2013	M
France	Cuckoo ray	*Leucoraja naevus*	2478	0.62	11	22	17	Cheung et al 2013	M
France	Black scabbardfish	*Aphanopus carbo*	2382	0.64	7	15	11	Cheung et al 2013	M
France	Ling	*Molva molva*	2193	0.77	10	17	14	Cheung et al 2013	M
Germany	Atlantic herring	*Clupea harengus*	57122	0.39	8	11	5	Cheung et al 2013	M
Germany	European sprat	*Sprattus sprattus*	22587	0.25	9	16	12	Cheung et al 2013	M
Germany	Atlantic mackerel	*Scomber scombrus*	20619	0.44	8	16	12	Cheung et al 2013	M
Germany	Atlantic horse mackerel	*Trachurus trachurus*	18697	0.59	14	22	18	Cheung et al 2013	M
Germany	Common shrimp	*Crangon crangon*	17779	0.10	9	14	11	Cheung et al 2013	M
Germany	Blue whiting(=Poutassou)	*Micromesistius poutassou*	17366	0.33	10	19	15	Cheung et al 2013	M
Germany	Atlantic cod	*Gadus morhua*	16974	0.65	3	9	6	Cheung et al 2013	M
Germany	Saithe(=Pollock)	*Pollachius virens*	13412	0.59	4	11	6	Cheung et al 2013	M
Germany	Sandeels(=Sandlances) nei	*Ammodytes tobianus*	5669	0.23	11	16	13	Cheung et al 2013	M
Germany	Greenland halibut	*Reinhardtius hippoglossoides*	4807	0.70	4	9	6	Cheung et al 2013	M
Greece	European anchovy	*Engraulis encrasicolus*	12220	0.24	15	23	21	Cheung et al 2013	M
Greece	European pilchard(=Sardine)	*Sardina pilchardus*	8582	0.27	13	19	16	Cheung et al 2013	M
Greece	Marine fishes nei	*non specific*	8090	NA	NA	NA	NA	NA	M
Greece	European hake	*Merluccius merluccius*	4479	0.64	15	20	18	Cheung et al 2013	M
Greece	Bogue	*Boops boops*	3584	0.41	16	24	20	Cheung et al 2013	M
Greece	Picarels nei	*non specific*	2584	NA	NA	NA	NA	NA	M
Greece	Mediterranean horse mackerel	*Trachurus mediterraneus*	2564	0.47	18	20	19	Cheung et al 2013	M
Greece	Chub mackerel	*Scomber japonicus*	2421	0.31	18	27	23	Cheung et al 2013	M
Greece	Caramote prawn	*Penaeus kerathurus*	2305	0.17	20	26	23	Cheung et al 2013	M
Greece	Common octopus	*Octopus vulgaris*	1899	0.78	23	26	28	Cheung et al 2013	M
Greece	Red mullet	*Mullus barbatus*	1892	0.29	12	22	17	Cheung et al 2013	M
Greece	Shads nei	*non specific*	1868	NA	NA	NA	NA	NA	M
Greece	Flathead grey mullet	*Mugil cephalus*	1599	0.50	25	28	27	Cheung et al 2013	M

Greece	Common cuttlefish	*Sepia officinalis*	1514	0.30	15	23	19	Cheung et al 2013	M
Greece	Swordfish	*Xiphias gladius*	1337	0.72	23	27	26	Cheung et al 2013	M
Greece	Surmullet	*Mullus surmuletus*	1278	0.39	13	23	19	Cheung et al 2013	M
Greece	Various squids nei	*European common squid*	1162	0.10	NA	NA	NA	Sealifebase	M
Greece	Natantian decapods nei	*non specific*	1125	NA	NA	NA	NA	NA	M
Greece	Monkfishes nei	*non specific*	1016	NA	NA	NA	NA	NA	M
Greece	Blue whiting(=Poutassou)	*Trachurus mediterraneus*	937	0.33	10	19	15	Cheung et al 2013	M
Greece	Atlantic bonito	*Sarda sarda*	858	0.33	18	26	23	Cheung et al 2013	M
Greece	Common sole	*Solea solea*	772	0.36	12	19	16	Cheung et al 2013	M
Greece	Common squids nei	*Loligo vulgaris*	703	0.19	17	19	18	Cheung et al 2013	M
Greece	Octopuses, etc. nei	*non specific*	679	NA	NA	NA	NA	NA	M
Greece	Pandoras nei	*non specific*	533	NA	NA	NA	NA	NA	M
Greece	European seabass	*Dicentrarchus labrax*	524	0.49	10	17	14	Cheung et al 2013	M
Greece	European conger	*Conger conger*	512	0.86	9	22	16	Cheung et al 2013	M
Greece	Scorpionfishes nei	*non specific*	504	NA	NA	NA	NA	NA	M
Greece	Large-eye dentex	*Dentex macrophthalmus*	483	0.33	20	25	23	Cheung et al 2013	M
Greece	Red porgy	*Pagrus pagrus*	413	0.66	21	27	25	Cheung et al 2013	M
Greece	Norway lobster	*Nephrops norvegicus*	401	0.14	14	20	17	Cheung et al 2013	M
Iceland	Capelin	*Mallotus villosus*	305926	0.23	1	5	3	Cheung et al 2013	M
Iceland	Atlantic herring	*Clupea harengus*	243897	0.39	8	11	5	Cheung et al 2013	M
Iceland	Atlantic cod	*Gadus morhua*	199385	0.65	3	9	6	Cheung et al 2013	M
Iceland	Blue whiting(=Poutassou)	*Micromesistius poutassou*	179015	0.33	10	19	15	Cheung et al 2013	M
Iceland	Atlantic mackerel	*Scomber scombrus*	93052	0.44	8	16	12	Cheung et al 2013	M
Iceland	Haddock	*Melanogrammus aeglefinus*	74237	0.47	5	10	7	Cheung et al 2013	M
Iceland	Saithe(=Pollock)	*Pollachius virens*	60061	0.59	4	11	6	Cheung et al 2013	M
Iceland	Golden redfish	*Sebastes norvegicus*	44344	0.71	3	7	5	Cheung et al 2013	M
Iceland	Beaked redfish	*Sebastes mentella*	16954	0.56	2	7	4	Fishbase	M
Ireland	Atlantic mackerel	*Scomber scombrus*	58654	0.44	8	16	12	Cheung et al 2013	M
Ireland	Atlantic horse mackerel	*Trachurus trachurus*	35744	0.59	14	22	18	Cheung et al 2013	M

Ireland	Boarfish	*Capros aper*	32993	0.51	12	23	19	Cheung et al 2013	M
Ireland	North Atlantic rockweed	*non specific*	28018	NA	NA	NA	NA	NA	M
Ireland	Atlantic herring	*Clupea harengus*	27176	0.39	8	11	5	Cheung et al 2013	M
Ireland	Blue whiting(=Poutassou)	*Micromesistius poutassou*	27085	0.33	10	19	15	Cheung et al 2013	M
Ireland	Norway lobster	*Nephrops norvegicus*	8132	0.14	14	20	17	Cheung et al 2013	M
Ireland	Edible crab	*Cancer pagurus*	8015	0.10	11	16	14	Cheung et al 2013	M
Ireland	Whiting	*Merlangius merlangus*	5097	0.37	9	14	11	Cheung et al 2013	M
Ireland	European sprat	*Sprattus sprattus*	4247	0.25	9	16	12	Cheung et al 2013	M
Ireland	Haddock	*Melanogrammus aeglefinus*	3591	0.47	5	10	7	Cheung et al 2013	M
Ireland	Angler(=Monk)	*Lophius piscatorius*	3419	0.72	10	17	14	Cheung et al 2013	M
Ireland	Whelk	*Buccinum undatum*	2892	NA	10	12	11	Cheung et al 2013	M
Italy	European anchovy	*Engraulis encrasicolus*	51643	0.24	15	23	21	Cheung et al 2013	M
Italy	Striped venus	*Venus gallina*	21011	0.10	12	17	14	Cheung et al 2013	M
Italy	European pilchard(=Sardine)	*Sardina pilchardus*	16261	0.27	13	19	16	Cheung et al 2013	M
Italy	European hake	*Merluccius merluccius*	12191	0.64	15	20	18	Cheung et al 2013	M
Italy	Marine fishes nei	*non specific*	10754	NA	NA	NA	NA	NA	M
Italy	Deep-water rose shrimp	*Parapenaeus longirostris*	9403	0.10	23	27	25	Cheung et al 2013	M
Italy	Cuttlefish, bobtail squids nei	*non specific*	8035	0.10	NA	NA	NA	NA	M
Italy	Red mullet	*Mullus barbatus*	6278	0.29	12	22	17	Cheung et al 2013	M
Italy	Spottail mantis squillid	*Squilla mantis*	5982	0.10	19	25	22	Cheung et al 2013	M
Italy	Horned and musky octopuses	*Eledone cirrhosa*	5712	0.30	16	20	18	Cheung et al 2013	M
Italy	Swordfish	*Xiphias gladius*	5476	0.72	23	27	26	Cheung et al 2013	M
Italy	Jack and horse mackerels nei	*Trachurus mediterraneus*	4116	0.47	18	20	19	Cheung et al 2013	M
Italy	Gastropods nei	*non specific*	3872	NA	NA	NA	NA	NA	M
Italy	Common octopus	*Octopus vulgaris*	3582	0.78	23	26	28	Cheung et al 2013	M
Italy	Broadtail shortfin squid	*Illex coindetii*	3421	NA	18	25	22	Cheung et al 2013	M
Italy	Mullets nei	*non specific*	3384	NA	NA	NA	NA	NA	M
Italy	Mediterranean mussel	*Mytilus galloprovincialis*	3188	0.10	14	19	15	Cheung et al 2013	M
Italy	Norway lobster	*Nephrops norvegicus*	3145	0.14	14	20	17	Cheung et al 2013	M

Italy	Atlantic bluefin tuna	*Thunnus thynnus*	2946	0.82	19	27	24	Cheung et al 2013	M
Italy	Aristeid shrimps nei	*Aristeus antennatus*	2942	NA	19	20	19	Sealifebase	M
Italy	Surmullet	*Mullus surmuletus*	2492	0.39	13	23	19	Cheung et al 2013	M
Italy	Albacore	*Thunnus alalunga*	2367	0.58	20	26	23	Cheung et al 2013	M
Italy	Bogue	*Boops boops*	2365	0.41	16	24	20	Cheung et al 2013	M
Italy	Common sole	*Solea solea*	2152	0.36	12	19	16	Cheung et al 2013	M
Italy	Silver scabbardfish	*Lepidopus caudatus*	2105	0.53	19	27	24	Cheung et al 2013	M
Italy	Common squids nei	*Loligo vulgaris*	1937	0.19	17	19	18	Cheung et al 2013	M
Italy	Monkfishes nei	*non specific*	1776	NA	NA	NA	NA	NA	M
Italy	Smooth callista	*Callista chione*	1642	0.10	10	14	12	Cheung et al 2013	M
Italy	Pandoras nei	*non specific*	1549	NA	NA	NA	NA	NA	M
Italy	Common dolphinfish	*Coryphaena hippurus*	1546	0.40	26	28	27	Cheung et al 2013	M
Italy	Gurnards, searobins nei	*non specific*	1540	NA	NA	NA	NA	NA	M
Italy	Marine molluscs nei	*non specific*	1522	NA	NA	NA	NA	NA	M
Italy	Picarels nei	*non specific*	1470	NA	NA	NA	NA	NA	M
Italy	Atlantic mackerel	*Scomber scombrus*	1343	0.44	8	16	12	Cheung et al 2013	M
Italy	Atlantic bonito	*Sarda sarda*	1269	0.33	18	26	23	Cheung et al 2013	M
Latvia	European sprat	*Sprattus sprattus*	46643	0.25	9	16	12	Cheung et al 2013	M
Latvia	Atlantic herring	*Clupea harengus*	22033	0.39	8	11	5	Cheung et al 2013	M
Latvia	Atlantic cod	*Gadus morhua*	4135	0.65	3	9	6	Cheung et al 2013	M
Lithuania	European sprat	*Sprattus sprattus*	12220	0.25	9	16	12	Cheung et al 2013	M
Lithuania	Atlantic herring	*Clupea harengus*	3189	0.39	8	11	5	Cheung et al 2013	M
Lithuania	Atlantic cod	*Gadus morhua*	2690	0.65	3	9	6	Cheung et al 2013	M
Lithuania	Atlantic horse mackerel	*Trachurus trachurus*	2376	0.59	14	22	18	Cheung et al 2013	M
Lithuania	Blue whiting(=Poutassou)	*Micromesistius poutassou*	2221	0.33	10	19	15	Cheung et al 2013	M
Lithuania	Atlantic redfishes nei	*Sebastes marinus*	1998	0.56	3	6	5	Cheung et al 2013	M
Lithuania	Northern prawn	*Pandalus borealis*	887	0.10	3	9	5	Cheung et al 2013	M
Lithuania	Atlantic mackerel	*Scomber scombrus*	878	0.44	8	16	12	Cheung et al 2013	M
Malta	Common dolphinfish	*Coryphaena hippurus*	382	0.40	26	28	27	Cheung et al 2013	M

Malta	Common dolphinfish	*Coryphaena hippurus*	382	0.40	26	28	27	Cheung et al 2013	M
Malta	Swordfish	*Xiphias gladius*	348	0.72	23	27	26	Cheung et al 2013	M
Malta	Swordfish	*Xiphias gladius*	348	0.72	23	27	26	Cheung et al 2013	M
Malta	Atlantic bluefin tuna	*Thunnus thynnus*	228	0.82	19	27	24	Cheung et al 2013	M
Malta	Atlantic bluefin tuna	*Thunnus thynnus*	227	0.82	19	27	24	Cheung et al 2013	M
Malta	Chub mackerel	*Scomber japonicus*	168	0.31	18	27	23	Cheung et al 2013	M
Malta	Chub mackerel	*Scomber japonicus*	168	0.31	18	27	23	Cheung et al 2013	M
Malta	Clupeoids nei	*non specific*	44	NA	NA	NA	NA	NA	M
Malta	Bogue	*Boops boops*	35	0.41	16	24	20	Cheung et al 2013	M
Malta	Bogue	*Boops boops*	35	0.41	16	24	20	Cheung et al 2013	M
Malta	Scorpionfishes nei	*non specific*	28	NA	NA	NA	NA	NA	M
Malta	Scorpionfishes nei	*non specific*	28	NA	NA	NA	NA	NA	M
Malta	Octopuses, etc. nei	*non specific*	27	NA	NA	NA	NA	NA	M
Malta	Octopuses, etc. nei	*non specific*	27	NA	NA	NA	NA	NA	M
Malta	Surmullet	*European common squid*	27	0.39	13	23	19	Cheung et al 2013	M
Malta	Surmullet	*Mullus surmuletus*	27	0.39	13	23	19	Cheung et al 2013	M
Malta	Giant red shrimp	*European common squid*	23	0.10	NA	NA	20	Sealifebase	M
Malta	Giant red shrimp	*Aristaeomorpha foliacea*	23	0.10	NA	NA	20	Cheung et al 2013	M
Malta	Marine fishes nei	*non specific*	21	NA	NA	NA	NA	NA	M
Malta	Frigate and bullet tunas	*Auxis rochei*	17	0.27	NA	NA	27	Fishbase	M
Malta	Silver scabbardfish	*Lepidopus caudatus*	17	0.53	19	27	24	Cheung et al 2013	M
Malta	Common cuttlefish	*Sepia officinalis*	16	0.30	15	23	19	Cheung et al 2013	M
Malta	Albacore	*Thunnus alalunga*	15	0.58	20	26	23	Cheung et al 2013	M
Malta	Longnose spurdog	*Squalus blainville*	15	0.67	11	18	13	Fishbase	M
Malta	Deep-water rose shrimp	*Parapenaeus longirostris*	14	0.10	23	27	25	Cheung et al 2013	M
Malta	Red porgy	*Pagrus pagrus*	13	0.66	21	27	25	Cheung et al 2013	M
Malta	Natantian decapods nei	*non specific*	12	NA	NA	NA	NA	NA	M
Malta	European hake	*Merluccius merluccius*	11	0.64	15	20	18	Cheung et al 2013	M
Malta	Thornback ray	*Raja clavata*	11	0.72	14	20	17	Cheung et al 2013	M

Malta	Groupers nei	*non specific*	10	NA	NA	NA	NA	NA	M
Malta	Common pandora	*Pagellus erythrinus*	10	0.40	16	20	18	Cheung et al 2013	M
Malta	Red mullet	*Mullus barbatus*	10	0.29	12	22	17	Cheung et al 2013	M
Malta	Surmullets(=Red mullets) nei	*Mullus surmuletus*	10	NA	NA	NA	NA	NA	M
Malta	European squid	*Loligo vulgaris vulgaris*	10	0.30	NA	NA	NA	Sealifebase	M
Malta	Shads nei	*non specific*	9	NA	NA	NA	NA	NA	M
Malta	Dogfish sharks nei	*non specific*	8	NA	NA	NA	NA	NA	M
Malta	Picarels nei	*non specific*	8	NA	NA	NA	NA	NA	M
Netherlands	Atlantic herring	*Clupea harengus*	84543	0.39	8	11	5	Cheung et al 2013	M
Netherlands	Atlantic horse mackerel	*Trachurus trachurus*	64287	0.59	14	22	18	Cheung et al 2013	M
Netherlands	Blue whiting(=Poutassou)	*Micromesistius poutassou*	59456	0.33	10	19	15	Cheung et al 2013	M
Netherlands	European plaice	*Pleuronectes platessus*	26535	0.71	9	15	12	Cheung et al 2013	M
Netherlands	Atlantic mackerel	*Scomber scombrus*	26452	0.44	8	16	12	Cheung et al 2013	M
Netherlands	Common shrimp	*Crangon crangon*	17759	0.10	9	14	11	Cheung et al 2013	M
Netherlands	Common sole	*Solea solea*	9683	0.36	12	19	16	Cheung et al 2013	M
Norway	Atlantic herring	*Clupea harengus*	740654	0.39	8	11	5	Cheung et al 2013	M
Norway	Blue whiting(=Poutassou)	*Micromesistius poutassou*	404772	0.33	10	19	15	Cheung et al 2013	M
Norway	Atlantic cod	*Gadus morhua*	297536	0.65	3	9	6	Cheung et al 2013	M
Norway	Saithe(=Pollock)	*Pollachius virens*	204567	0.59	4	11	6	Cheung et al 2013	M
Norway	Atlantic mackerel	*Scomber scombrus*	166748	0.44	8	16	12	Cheung et al 2013	M
Norway	Brown seaweeds	*Non specific*	150653	NA	NA	NA	NA	Cheung et al 2013	M
Norway	Capelin	*Mallotus villosus*	143363	0.23	1	5	3	Cheung et al 2013	M
Norway	Haddock	*Melanogrammus aeglefinus*	99473	0.47	5	10	7	Cheung et al 2013	M
Poland	European sprat	*Sprattus sprattus*	67605	0.25	9	16	12	Cheung et al 2013	M
Poland	Atlantic herring	*Clupea harengus*	24554	0.39	8	11	5	Cheung et al 2013	M
Poland	Atlantic cod	*Gadus morhua*	15248	0.65	3	9	6	Cheung et al 2013	M
Poland	European flounder	*Platichthys flesus*	10388	0.42	10	15	12	Cheung et al 2013	M
Portugal	European pilchard(=Sardine)	*Sardina pilchardus*	58617	0.27	13	19	16	Cheung et al 2013	M
Portugal	Chub mackerel	*Scomber japonicus*	25058	0.31	18	27	23	Cheung et al 2013	M

Portugal	Atlantic horse mackerel	*Trachurus trachurus*	15361	0.59	14	22	18	Cheung et al 2013	M
Portugal	Common octopus	*Octopus vulgaris*	7153	0.78	23	26	28	Cheung et al 2013	M
Portugal	Skipjack tuna	*Katsuwonus pelamis*	4647	0.40	24	27	26	Cheung et al 2013	M
Portugal	Atlantic cod	*Gadus morhua*	4235	0.65	3	9	6	Cheung et al 2013	M
Portugal	Blue jack mackerel	*Trachurus picturatus*	3967	0.68	18	24	21	Cheung et al 2013	M
Portugal	Atlantic mackerel	*Scomber scombrus*	3873	0.44	8	16	12	Cheung et al 2013	M
Portugal	Blue whiting(=Poutassou)	*Micromesistius poutassou*	3350	0.33	10	19	15	Cheung et al 2013	M
Portugal	Black scabbardfish	*Aphanopus carbo*	3103	0.64	7	15	11	Cheung et al 2013	M
Portugal	Pouting(=Bib)	*Trisopterus luscus*	2873	0.44	10	14	12	Cheung et al 2013	M
Portugal	Blue shark	*Prionace glauca*	2812	0.77	18	26	23	Cheung et al 2013	M
Portugal	Bigeye tuna	*Thunnus obesus*	2613	0.56	24	27	26	Cheung et al 2013	M
Portugal	Octopuses, etc. nei	*non specific*	2600	NA	NA	NA	NA	NA	M
Portugal	European hake	*Merluccius merluccius*	2375	0.64	15	20	18	Cheung et al 2013	M
Portugal	Common edible cockle	*Cerastoderma edule*	2322	0.24	8	23	15	Newel 1980	M
Portugal	European conger	*Conger conger*	1688	0.86	9	22	16	Cheung et al 2013	M
Portugal	Common cuttlefish	*Sepia officinalis*	1546	0.30	15	23	19	Cheung et al 2013	M
Portugal	Atlantic redfishes nei	*Sebastes marinus*	1441	0.56	3	6	5	Cheung et al 2013	M
Portugal	Blackspot(=red) seabream	*Pagellus bogaraveo*	1051	0.57	16	20	18	Cheung et al 2013	M
Portugal	Beaked redfish	*Sebastes mentella*	1042	0.56	2	7	4	Fishbase	M
Portugal	Solid surf clam	*Spisula solida*	1009	0.10	9	12	11	Cheung et al 2013	M
Portugal	Axillary seabream	*Pagellus acarne*	879	0.43	18	20	19	Cheung et al 2013	M
Portugal	Swordfish	*Xiphias gladius*	852	0.72	23	27	26	Cheung et al 2013	M
Portugal	Shortfin mako	*Isurus oxyrinchus*	794	0.83	22	28	25	Cheung et al 2013	M
Portugal	Deep-water rose shrimp	*Parapenaeus longirostris*	701	0.10	23	27	25	Cheung et al 2013	M
Portugal	European anchovy	*Engraulis encrasicolus*	658	0.24	15	23	21	Cheung et al 2013	M
Portugal	Mullets nei	*non specific*	651	NA	NA	NA	NA	NA	M
Portugal	Rays and skates nei	*non specific*	617	NA	NA	NA	NA	NA	M
Portugal	Thornback ray	*Raja clavata*	588	0.72	14	20	17	Cheung et al 2013	M
Portugal	Wreckfish	*Polyprion americanus*	558	0.72	15	21	18	Cheung et al 2013	M

Portugal	Finfishes nei	*non specific*	553	NA	NA	NA	NA	NA	M
Portugal	Red seaweeds	*non specific*	552	NA	NA	NA	NA	NA	M
Portugal	Forkbeard	*Phycis phycis*	535	0.45	19	20	19	Cheung et al 2013	M
Portugal	Frigate and bullet tunas	*Auxis rochei*	497	0.27	NA	NA	27	Fishbase	M
Portugal	Haddock	*Melanogrammus aeglefinus*	489	0.47	5	10	7	Cheung et al 2013	M
Portugal	Veined squid	*Loligo forbesii*	471	0.56	21	27	25	Cheung et al 2013	M
Romania	European sprat	*Sprattus sprattus*	389	0.25	9	16	12	Cheung et al 2013	M
Romania	Sea snails	*Non specific*	371	NA	NA	NA	NA	NA	M
Romania	European anchovy	*Engraulis encrasicolus*	59	0.24	15	23	21	Cheung et al 2013	M
Romania	Turbot	*Scophthalmus maximus*	44	0.43	9	14	11	Cheung et al 2013	M
Romania	Whiting	*Merlangius merlangus*	39	0.37	9	14	11	Cheung et al 2013	M
Romania	Pontic shad	*Alosa pontica*	29	0.35	13	14	13	Cheung et al 2013	M
Slovenia	European pilchard(=Sardine)	*Sardina pilchardus*	256	0.27	13	19	16	Cheung et al 2013	M
Slovenia	European anchovy	*Engraulis encrasicolus*	209	0.24	15	23	21	Cheung et al 2013	M
Slovenia	Whiting	*Merlangius merlangus*	49	0.37	9	14	11	Cheung et al 2013	M
Slovenia	Horned and musky octopuses	*Eledone cirrhosa*	19	0.30	16	20	18	Cheung et al 2013	M
Slovenia	Common cuttlefish	*Sepia officinalis*	17	0.30	15	23	19	Cheung et al 2013	M
Slovenia	European sprat	*Sprattus sprattus*	16	0.25	9	16	12	Cheung et al 2013	M
Slovenia	Mullets nei	*non specific*	14	NA	NA	NA	NA	NA	M
Slovenia	Various squids nei	*European common squid*	12	0.10	NA	NA	NA	Sealifebase	M
Slovenia	Common sole	*Solea solea*	10	0.36	12	19	16	Cheung et al 2013	M
Slovenia	Golden grey mullet	*Liza aurata*	7	0.35	13	19	16	Cheung et al 2013	M
Slovenia	Gilthead seabream	*Sparus auratus*	7	0.40	22	28	26	Cheung et al 2013	M
Slovenia	Common pandora	*Pagellus erythrinus*	6	0.40	16	20	18	Cheung et al 2013	M
Spain	European pilchard(=Sardine)	*Sardina pilchardus*	54018	0.27	13	19	16	Cheung et al 2013	M
Spain	Jack and horse mackerels nei	*Trachurus mediterraneus*	36088	0.47	18	20	19	Cheung et al 2013	M
Spain	European hake	*Merluccius merluccius*	27452	0.64	15	20	18	Cheung et al 2013	M
Spain	Blue whiting(=Poutassou)	*Micromesistius poutassou*	26470	0.33	10	19	15	Cheung et al 2013	M
Spain	Atlantic mackerel	*Scomber scombrus*	24394	0.44	8	16	12	Cheung et al 2013	M

Spain	Mackerels nei	*non specific*	23554	NA	NA	NA	NA	NA	M
Spain	European anchovy	*Engraulis encrasicolus*	20149	0.24	15	23	21	Cheung et al 2013	M
Spain	Albacore	*Thunnus alalunga*	13580	0.58	20	26	23	Cheung et al 2013	M
Spain	Pelagic fishes nei	*non specific*	11571	NA	NA	NA	NA	NA	M
Spain	Atlantic cod	*Gadus morhua*	11435	0.65	3	9	6	Cheung et al 2013	M
Spain	Groundfishes nei	*non specific*	9953	NA	NA	NA	NA	NA	M
Spain	Octopuses, etc. nei	*non specific*	9623	NA	NA	NA	NA	NA	M
Spain	Blue shark	*Prionace glauca*	9047	0.77	18	26	23	Cheung et al 2013	M
Spain	Marine fishes nei	*non specific*	8320	NA	NA	NA	NA	NA	M
Spain	Finfishes nei	*non specific*	7760	NA	NA	NA	NA	NA	M
Spain	Megrims nei	*non specific*	6137	NA	NA	NA	NA	NA	M
Spain	Monkfishes nei	*non specific*	6103	NA	NA	NA	NA	NA	M
Spain	Chub mackerel	*Scomber japonicus*	5679	0.31	18	27	23	Cheung et al 2013	M
Spain	Atlantic pomfret	*Brama brama*	5644	0.71	20	27	24	Cheung et al 2013	M
Spain	European conger	*Conger conger*	4905	0.86	9	22	16	Cheung et al 2013	M
Spain	Bogue	*Boops boops*	4868	0.41	16	24	20	Cheung et al 2013	M
Spain	Sardinellas nei	*non specific*	4032	NA	NA	NA	NA	NA	M
Spain	Atlantic bluefin tuna	*Thunnus thynnus*	3874	0.82	19	27	24	Cheung et al 2013	M
Spain	Atlantic horse mackerel	*Trachurus trachurus*	3803	0.59	14	22	18	Cheung et al 2013	M
Spain	Northern shortfin squid	*Illex illecebrosus*	3636	NA	12	21	17	Cheung et al 2013	M
Spain	Roundnose grenadier	*Coryphaenoides rupestris*	3375	0.67	6	13	10	Cheung et al 2013	M
Spain	Various squids nei	*European common squid*	3343	0.10	NA	NA	NA	Sealifebase	M
Spain	Gadiformes nei	*non specific*	3317	NA	NA	NA	NA	NA	M
Spain	Swordfish	*Xiphias gladius*	3229	0.72	23	27	26	Cheung et al 2013	M
Spain	Striped venus	*Venus gallina*	3219	0.10	12	17	14	Cheung et al 2013	M
Spain	Witch flounder	*Glyptocephalus cynoglossus*	2884	0.68	4	9	7	Cheung et al 2013	M
Spain	Clams, etc. nei	*non specific*	2698	NA	NA	NA	NA	NA	M
Spain	Frigate and bullet tunas	*Auxis rochei*	2694	0.27	NA	NA	27	Fishbase	M
Spain	Rays and skates nei	*non specific*	2611	NA	NA	NA	NA	NA	M

Spain	Pouting(=Bib)	*Trisopterus luscus*	2368	0.44	10	14	12	Cheung et al 2013	M
Spain	Common edible cockle	*Cerastoderma edule*	2337	0.24	8	23	15	Newel 1980	M
Spain	Beaked redfish	*Sebastes mentella*	1967	0.56	2	7	4	Fishbase	M
Spain	Blackbelly rosefish	*Helicolenus dactylopterus*	1933	0.54	18	26	22	Cheung et al 2013	M
Spain	Lemon sole	*Microstomus kitt*	1828	0.34	3	10	6	Cheung et al 2013	M
Spain	Ling	*Molva molva*	1748	0.77	10	17	14	Cheung et al 2013	M
Spain	John dory	*Zeus faber*	1662	0.68	19	26	23	Cheung et al 2013	M
Spain	Forkbeard	*Phycis phycis*	1645	0.45	19	20	19	Cheung et al 2013	M
Spain	Common squids nei	*Loligo vulgaris*	1608	0.19	17	19	18	Cheung et al 2013	M
Spain	Surmullets(=Red mullets) nei	*non specific*	1607	NA	NA	NA	NA	NA	M
Spain	Common cuttlefish	*Sepia officinalis*	1509	0.30	15	23	19	Cheung et al 2013	M
Spain	Atlantic redfishes nei	*Sebastes marinus*	1481	0.56	3	6	5	Cheung et al 2013	M
Spain	Baird's slickhead	*Alepocephalus bairdii*	1441	0.70	7	17	12	Cheung et al 2013	M
Spain	Gurnards, searobins nei	*non specific*	1369	NA	NA	NA	NA	NA	M
Spain	Deep-water rose shrimp	*Parapenaeus longirostris*	1308	0.10	23	27	25	Cheung et al 2013	M
Spain	Atlantic saury	*Scomberesox saurus*	1244	0.25	14	24	20	Cheung et al 2013	M
Spain	Greater forkbeard	*Phycis blennoides*	1202	0.63	12	19	16	Cheung et al 2013	M
Spain	Norway lobster	*Nephrops norvegicus*	1166	0.14	14	20	17	Cheung et al 2013	M
Sweden	Atlantic herring	*Clupea harengus*	84126	0.39	8	11	5	Cheung et al 2013	M
Sweden	European sprat	*Sprattus sprattus*	79901	0.25	9	16	12	Cheung et al 2013	M
Sweden	Sandeels(=Sandlances) nei	*Ammodytes tobianus*	20554	0.23	11	16	13	Cheung et al 2013	M
Sweden	Atlantic cod	*Gadus morhua*	12270	0.65	3	9	6	Cheung et al 2013	M
Turkey	European anchovy	*Engraulis encrasicolus*	226136	0.24	15	23	21	Cheung et al 2013	M
Turkey	Striped venus	*Venus gallina*	32088	0.10	12	17	14	Cheung et al 2013	M
Turkey	European sprat	*Sprattus sprattus*	30045	0.25	9	16	12	Cheung et al 2013	M
Turkey	European pilchard(=Sardine)	*Sardina pilchardus*	22753	0.27	13	19	16	Cheung et al 2013	M
Turkey	Atlantic bonito	*Sarda sarda*	19365	0.33	18	26	23	Cheung et al 2013	M
Turkey	Mediterranean horse mackerel	*Trachurus mediterraneus*	18396	0.47	18	20	19	Cheung et al 2013	M
Turkey	Marine molluscs nei	*non specific*	10310	NA	NA	NA	NA	NA	M

Turkey	Whiting	*Merlangius merlangus*	10116	0.37	9	14	11	Cheung et al 2013	M
Turkey	Bluefish	*Pomatomus saltatrix/saltator*	8403	0.63	25	28	27	Cheung et al 2013	M
Turkey	Atlantic horse mackerel	*Trachurus trachurus*	8374	0.59	14	22	18	Cheung et al 2013	M
Turkey	Mullets nei	*non specific*	5490	NA	NA	NA	NA	NA	M
United Kingdom	Atlantic mackerel	*Scomber scombrus*	163413	0.44	8	16	12	Cheung et al 2013	M
United Kingdom	Atlantic herring	*Clupea harengus*	88384	0.39	8	11	5	Cheung et al 2013	M
United Kingdom	Blue whiting(=Poutassou)	*Micromesistius poutassou*	38992	0.33	10	19	15	Cheung et al 2013	M
United Kingdom	Haddock	*Melanogrammus aeglefinus*	35913	0.47	5	10	7	Cheung et al 2013	M
United Kingdom	Norway lobster	*Nephrops norvegicus*	35898	0.14	14	20	17	Cheung et al 2013	M
United Kingdom	Great Atlantic scallop	*Pecten maximus*	27204	0.26	11	15	12	Cheung et al 2013	M
United Kingdom	Edible crab	*Cancer pagurus*	26267	0.10	11	16	14	Cheung et al 2013	M
United Kingdom	Atlantic cod	*Gadus morhua*	23064	0.65	3	9	6	Cheung et al 2013	M
United Kingdom	European plaice	*Pleuronectes platessus*	16174	0.71	9	15	12	Cheung et al 2013	M
United Kingdom	Whelk	*Buccinum undatum*	14819	NA	10	12	11	Cheung et al 2013	M
United Kingdom	Angler(=Monk)	*Lophius piscatorius*	14230	0.72	10	17	14	Cheung et al 2013	M
United Kingdom	Saithe(=Pollock)	*Pollachius virens*	14200	0.59	4	11	6	Cheung et al 2013	M
United Kingdom	Atlantic horse mackerel	*Trachurus trachurus*	13725	0.59	14	22	18	Cheung et al 2013	M
United Kingdom	Queen scallop	*Chlamys opercularis*	12316	0.22	11	13	12	Cheung et al 2013	M
United Kingdom	Whiting	*Merlangius merlangus*	10579	0.37	9	14	11	Cheung et al 2013	M
United Kingdom	Common edible cockle	*Cerastoderma edule*	8395	0.24	8	23	15	Newel 1980	M
United Kingdom	Blue mussel	*Mytilus edulis*	6903	0.36	4	11	8	Cheung et al 2013	M
United Kingdom	European hake	*Merluccius merluccius*	6717	0.64	15	20	18	Cheung et al 2013	M

United Kingdom	European sprat	*Sprattus sprattus*	4878	0.25	9	16	12	Cheung et al 2013	M
Bulgaria	Mediterranean mussel	*Mytilus galloprovincialis*	797	0.10	14	19	15	Cheung et al 2013	A
Croatia	European seabass	*Dicentrarchus labrax*	2643	0.49	10	17	14	Cheung et al 2013	A
Croatia	Mediterranean mussel	*Mytilus galloprovincialis*	2091	0.10	14	19	15	Cheung et al 2013	A
Croatia	Gilthead seabream	*Sparus auratus*	1893	0.40	22	28	26	Cheung et al 2013	A
Cyprus	Gilthead seabream	*Sparus auratus*	2390	0.40	22	28	26	Cheung et al 2013	A
Cyprus	European seabass	*Dicentrarchus labrax*	1009	0.49	10	17	14	Cheung et al 2013	A
Denmark	Rainbow trout	*Oncorhynchus mykiss*	10190	0.36	6	12	9	Cheung et al 2013	A
Denmark	Blue mussel	*Mytilus edulis*	941	0.36	4	11	8	Cheung et al 2013	A
Denmark	Brown seaweeds	*non specific*	627	NA	NA	NA	NA	NA	A
Estonia	Rainbow trout	*Oncorhynchus mykiss*	0	0.36	6	12	9	Cheung et al 2013	A
Faroe Islands	Atlantic salmon	*Salmo salar*	48174	0.62	6	12	9	Cheung et al 2013	A
Finland	Rainbow trout	*Oncorhynchus mykiss*	10171	0.36	6	12	9	Cheung et al 2013	A
France	Pacific cupped oyster	*Crassostrea gigas*	97753	0.35	10	16	13	Cheung et al 2013	A
France	Blue mussel	*Mytilus edulis*	59799	0.36	4	11	8	Cheung et al 2013	A
France	Mediterranean mussel	*Mytilus galloprovincialis*	14337	0.10	14	19	15	Cheung et al 2013	A
Germany	Blue mussel	*Mytilus edulis*	8149	0.36	4	11	8	Cheung et al 2013	A
Greece	Gilthead seabream	*Sparus auratus*	50547	0.40	22	28	26	Cheung et al 2013	A
Greece	European seabass	*Dicentrarchus labrax*	34003	0.49	10	17	14	Cheung et al 2013	A
Greece	Mediterranean mussel	*Mytilus galloprovincialis*	21359	0.10	14	19	15	Cheung et al 2013	A
Iceland	Atlantic salmon	*Salmo salar*	2966	0.62	6	12	9	Cheung et al 2013	A
Iceland	Arctic char	*Salvelinus alpinus alpinus*	2209	0.74	0	3	10	Cheung et al 2013	A
Iceland	Atlantic cod	*Gadus morhua*	1048	0.65	3	9	6	Cheung et al 2013	A
Ireland	Blue mussel	*Mytilus edulis*	26086	0.36	4	11	8	Cheung et al 2013	A
Ireland	Atlantic salmon	*Salmo salar*	11743	0.62	6	12	9	Cheung et al 2013	A
Ireland	Pacific cupped oyster	*Crassostrea gigas*	6977	0.35	10	16	13	Cheung et al 2013	A
Italy	Mediterranean mussel	*Mytilus galloprovincialis*	68308	0.10	14	19	15	Cheung et al 2013	A
Italy	Japanese carpet shell	*Ruditapes philippinarum*	39004	0.10	16	20	18	Cheung et al 2013	A

Italy	European seabass	*Dicentrarchus labrax*	6972	0.49	10	17	14	Cheung et al 2013	A
Malta	Gilthead seabream	*Sparus auratus*	1595	0.40	22	28	26	Cheung et al 2013	A
Malta	Atlantic bluefin tuna	*Thunnus thynnus*	934	0.82	19	27	24	Cheung et al 2013	A
Malta	Marine fishes nei	*non specific*	206	NA	NA	NA	NA	NA	A
Malta	European seabass	*Dicentrarchus labrax*	118	0.49	10	17	14	Cheung et al 2013	A
Malta	European seabass	*Dicentrarchus labrax*	118	0.49	10	17	14	Cheung et al 2013	A
Malta	Turbot	*Scophthalmus maximus*	0	0.43	9	14	11	Cheung et al 2013	A
Netherlands	Blue mussel	*Mytilus edulis*	47723	0.36	4	11	8	Cheung et al 2013	A
Norway	Atlantic salmon	*Salmo salar*	889838	0.62	6	12	9	Cheung et al 2013	A
Portugal	Grooved carpet shell	*Ruditapes decussatus*	2213	0.30	13	22	17	Cheung et al 2013	A
Portugal	Turbot	*Scophthalmus maximus*	1675	0.43	9	14	11	Cheung et al 2013	A
Portugal	Gilthead seabream	*Sparus auratus*	1413	0.40	22	28	26	Cheung et al 2013	A
Portugal	European seabass	*Dicentrarchus labrax*	859	0.49	10	17	14	Cheung et al 2013	A
Portugal	Mediterranean mussel	*Mytilus galloprovincialis*	462	0.1	14	19	15	Cheung et al 2013	A
Portugal	Pacific cupped oyster	*Crassostrea gigas*	398	0.35	10	16	13	Cheung et al 2013	A
Romania	Turbot	*Engraulis encrasicolus*	3	0.43	9	14	11	Cheung et al 2013	A
Romania	Mediterranean mussel	*Mytilus galloprovincialis*	1	0.10	14	19	15	Cheung et al 2013	A
Slovenia	Mediterranean mussel	*Mytilus galloprovincialis*	267	0.10	14	19	15	Cheung et al 2013	A
Slovenia	European seabass	*Dicentrarchus labrax*	49	0.49	10	17	14	Cheung et al 2013	A
Spain	Mediterranean mussel	*Mytilus galloprovincialis*	199169	0.1	14	19	15	Cheung et al 2013	A
Spain	Gilthead seabream	*Sparus auratus*	16546	0.40	22	28	26	Cheung et al 2013	A
Sweden	Rainbow trout	*Oncorhynchus mykiss*	2188	0.36	6	12	9	Cheung et al 2013	A
Sweden	Blue mussel	*Mytilus edulis*	1555	0.36	4	11	8	Cheung et al 2013	A
Turkey	European seabass	*Dicentrarchus labrax*	49619	0.49	10	17	14	Cheung et al 2013	A
Turkey	Gilthead seabream	*Sparus auratus*	30857	0.40	22	28	26	Cheung et al 2013	A
United Kingdom	Atlantic salmon	*Salmo salar*	147944	0.62	6	12	9	Cheung et al 2013	A
United Kingdom	Blue mussel	*Mytilus edulis*	27024	0.36	4	11	8	Cheung et al 2013	A
Austria	Rainbow trout	*Oncorhynchus mykiss*	1413	0.36	6	12	9	Cheung et al 2013	F

Austria	Common carp	*Cyprinus carpio*	435	0.46	15	32	18	Tank et al. 2000	F
Austria	Freshwater fishes nei	*non specific*	353	NA	NA	NA	NA	NA	F
Austria	Brook trout	*Salvelinus fontinalis*	314	0.43	NA	NA	13	Cheung et al 2013	F
Austria	Sea trout	*Salmo trutta*	148	0.60	9	10	9	Cheung et al 2013	F
Austria	North African catfish	*Clarias gariepinus*	98	0.79	8	35	21	Fishbase	F
Belgium	Roach	*Rutilus rutilus*	111	0.53	10	20	15	Fishbase	F
Belgium	Freshwater fishes nei	*non specific*	93	NA	NA	NA	NA	NA	F
Belgium	Sea trout	*Salmo trutta*	84	0.60	9	10	9	Cheung et al 2013	F
Belgium	Rainbow trout	*Oncorhynchus mykiss*	79	0.36	6	12	9	Cheung et al 2013	F
Belgium	Common carp	*Cyprinus carpio*	78	0.46	15	32	18	Tank et al. 2000	F
Belgium	Aquatic invertebrates nei	*non specific*	53	NA	NA	NA	NA	NA	F
Belgium	Freshwater bream	*Abramis Brama*	44	0.62	10	24	16	Fishbase	F
Belgium	Pike-perch	*Sander lucioperca*	40	0.62	6	22	14	Fishbase	F
Belgium	Cyprinids nei	*non specific*	36	NA	NA	NA	NA	NA	F
Belgium	European eel	*Anguilla anguilla*	30	0.64	4	20	12	Fishbase	F
Belgium	European perch	*Perca fluviatilis*	20	0.50	10	22	16	Fishbase	F
Bulgaria	Common carp	*Cyprinus carpio*	2150	0.46	15	32	18	Tank et al. 2000	F
Bulgaria	Rainbow trout	*Oncorhynchus mykiss*	2064	0.36	6	12	9	Cheung et al 2013	F
Bulgaria	Bighead carp	*Hypophthalmichthys nobilis*	1180	0.66	4	26	15	Fishbase	F
Bulgaria	Goldfish	*Carassius auratus*	240	0.24	10	30	20	Kneprath and Meade 1968	F
Bulgaria	Danube sturgeon(=Osetr)	*Acipenser gueldenstaedtii*	201	0.87	10	20	11	Fishbase	F
Bulgaria	Grass carp(=White amur)	*Ctenopharyngodon idella*	150	0.65	NA	35	NA	Fishbase	F
Bulgaria	Silver carp	*Hypophthalmichthys molitrix*	79	0.55	6	22	15	Cheung et al 2013	F
Croatia	Common carp	*Cyprinus carpio*	2068	0.46	15	32	18	Tank et al. 2000	F
Croatia	Rainbow trout	*Oncorhynchus mykiss*	1546	0.36	6	12	9	Cheung et al 2013	F
Croatia	Bighead carp	*Hypophthalmichthys nobilis*	253	0.66	4	26	15	Fishbase	F
Croatia	Grass carp(=White amur)	*Ctenopharyngodon idella*	246	0.65	NA	35	NA	Fishbase	F
Croatia	Silver carp	*Hypophthalmichthys molitrix*	225	0.55	6	22	15	Cheung et al 2013	F

Czech Republic	Common carp	*Cyprinus carpio*	20865	0.46	15	32	18	Tank et al. 2000	F
Czech Republic	Rainbow trout	*Oncorhynchus mykiss*	527	0.36	6	12	9	Cheung et al 2013	F
Czech Republic	Freshwater fishes nei	*non specific*	510	NA	NA	NA	NA	NA	F
Czech Republic	Grass carp(=White amur)	*Ctenopharyngodon idella*	381	0.65	NA	35	NA	Fishbase	F
Denmark	Rainbow trout	*Oncorhynchus mykiss*	23108	0.36	6	12	9	Cheung et al 2013	F
Estonia	Pike-perch	*Sander lucioperca*	761	0.62	6	22	14	Fishbase	F
Estonia	European perch	*Perca fluviatilis*	744	0.50	10	22	16	Fishbase	F
Estonia	Freshwater bream	*Abramis Brama*	619	0.62	10	24	16	Fishbase	F
Estonia	Rainbow trout	*Oncorhynchus mykiss*	481	0.36	6	12	9	Cheung et al 2013	F
Estonia	Roach	*Rutilus rutilus*	268	0.53	10	20	15	Fishbase	F
Estonia	Northern pike	*Esox lucius*	157	0.85	10	28	19	Fishbase	F
Estonia	River lamprey	*Lampetra fluviatilis*	49	0.62	5	18	11	Fishbase	F
Faroe Islands	Freshwater fishes nei	*non specific*	0	NA	NA	NA	NA	NA	F
Finland	European perch	*Perca fluviatilis*	7582	0.50	10	22	16	Fishbase	F
Finland	Northern pike	*Esox lucius*	6723	0.85	10	28	19	Fishbase	F
Finland	Vendace	*Coregonus albula*	4203	0.27	8	10	9	Cheung et al 2013	F
Finland	Roach	*Rutilus rutilus*	3345	0.53	10	20	15	Fishbase	F
Finland	Pike-perch	*Sander lucioperca*	2433	0.62	6	22	14	Fishbase	F
Finland	Rainbow trout	*Oncorhynchus mykiss*	1858	0.36	6	12	9	Cheung et al 2013	F
Finland	Freshwater bream	*Abramis Brama*	1564	0.62	10	24	16	Fishbase	F
Finland	European whitefish	*Coregonus lavaretus*	1208	0.51	8	12	10	Cheung et al 2013	F
Finland	Burbot	*Lota lota*	680	0.66	4	18	11	Fishbase	F
France	Rainbow trout	*Oncorhynchus mykiss*	32244	0.36	6	12	9	Cheung et al 2013	F
France	Common carp	*Cyprinus carpio*	4173	0.46	15	32	18	Tank et al. 2000	F
France	Roach	*Rutilus rutilus*	1900	0.53	10	20	15	Fishbase	F
France	Freshwater fishes nei	*non specific*	1174	NA	NA	NA	NA	NA	F
France	Sea trout	*Salmo trutta*	910	0.60	9	10	9	Cheung et al 2013	F

Germany	Rainbow trout	*Oncorhynchus mykiss*	16692	0.36	6	12	9	Cheung et al 2013	F
Germany	Freshwater fishes nei	*non specific*	15584	NA	NA	NA	NA	NA	F
Germany	Common carp	*Cyprinus carpio*	9076	0.46	15	32	18	Tank et al. 2000	F
Germany	Cyprinids nei	*non specific*	1180	NA	NA	NA	NA	NA	F
Greece	Rainbow trout	*Oncorhynchus mykiss*	2432	0.36	6	12	9	Cheung et al 2013	F
Greece	European eel	*Anguilla anguilla*	306	0.64	4	20	12	Fishbase	F
Greece	Goldfish	*Carassius auratus*	278	0.24	10	30	20	Kneprath and Meade 1968	F
Greece	Common carp	*Cyprinus carpio*	230	0.46	15	32	18	Tank et al. 2000	F
Greece	Freshwater fishes nei	*non specific*	215	NA	NA	NA	NA	NA	F
Greece	Big-scale sand smelt	*Atherina boyeri*	155	0.44	11	17	14	Cheung et al 2013	F
Greece	Roaches nei	*Non specific*	136	NA	NA	NA	NA	NA	F
Hungary	Common carp	*Cyprinus carpio*	13629	0.46	15	32	18	Tank et al. 2000	F
Hungary	North African catfish	*Clarias gariepinus*	1786	0.79	8	35	21	Fishbase	F
Hungary	Silver carp	*Hypophthalmichthys molitrix*	1526	0.55	6	22	15	Cheung et al 2013	F
Hungary	Cyprinids nei	*non specific*	1378	NA	NA	NA	NA	NA	F
Hungary	Freshwater fishes nei	*non specific*	633	NA	NA	NA	NA	NA	F
Hungary	Grass carp(=White amur)	*Ctenopharyngodon idella*	532	0.65	NA	35	NA	Fishbase	F
Hungary	Silver carp	*Hypophthalmichthys molitrix*	519	0.55	6	22	15	Cheung et al 2013	F
Iceland	Arctic char	*Salvelinus alpinus alpinus*	175	0.74	0	3	10	Cheung et al 2013	F
Iceland	Atlantic salmon	*Salmo salar*	146	0.62	6	12	9	Cheung et al 2013	F
Iceland	Rainbow trout	*Oncorhynchus mykiss*	144	0.36	6	12	9	Cheung et al 2013	F
Iceland	Sea trout	*Salmo trutta*	39	0.60	9	10	9	Cheung et al 2013	F
Ireland	Rainbow trout	*Oncorhynchus mykiss*	783	0.36	6	12	9	Cheung et al 2013	F
Ireland	Atlantic salmon	*Salmo salar*	168	0.62	6	12	9	Cheung et al 2013	F
Ireland	European eel	*Anguilla anguilla*	48	0.64	4	20	12	Fishbase	F
Italy	Rainbow trout	*Oncorhynchus mykiss*	33631	0.36	6	12	9	Cheung et al 2013	F
Italy	Freshwater fishes nei	*non specific*	2794	NA	NA	NA	NA	NA	F
Italy	Sea trout	*Salmo trutta*	916	0.60	9	10	9	Cheung et al 2013	F
Italy	Sturgeons nei	*Acipenser sturio*	835	0.86	NA	NA	NA	Fishbase	F

Latvia	Common carp	*Cyprinus carpio*	488	0.46	15	32	18	Tank et al. 2000	F
Latvia	River lamprey	*Lampetra fluviatilis*	89	0.62	5	18	11	Fishbase	F
Latvia	Freshwater bream	*Abramis Brama*	64	0.62	10	24	16	Fishbase	F
Latvia	Northern pike	*Esox lucius*	41	0.85	10	28	19	Fishbase	F
Latvia	Tench	*Tinca tinca*	36	0.65	4	24	14	Fishbase	F
Latvia	Pike-perch	*Sander lucioperca*	28	0.62	6	22	14	Fishbase	F
Latvia	Sturgeons nei	*Acipenser sturio*	20	0.86	NA	NA	NA	Fishbase	F
Latvia	Roach	*Rutilus rutilus*	17	0.53	10	20	15	Fishbase	F
Latvia	European perch	*Perca fluviatilis*	14	0.50	10	22	16	Fishbase	F
Latvia	Crucian carp	*Carassius carassius*	14	0.38	2	22	13	Fishbase	F
Latvia	Freshwater fishes nei	*Non specific*	14	NA	NA	NA	NA	NA	F
Lithuania	Common carp	*Cyprinus carpio*	2930	0.46	15	32	18	Fishbase	F
Lithuania	Roach	*Rutilus rutilus*	432	0.53	10	20	15	Fishbase	F
Lithuania	Freshwater bream	*Abramis Brama*	423	0.62	10	24	16	Fishbase	F
Lithuania	European smelt	*Osmerus eperlanus*	206	0.43	9	11	10	Cheung et al 2013	F
Lithuania	Pike-perch	*Sander lucioperca*	96	0.62	6	22	14	Cheung et al 2013	F
Lithuania	Vimba bream	*Vimba vimba*	88	0.37	10	20	15	Fishbase	F
Lithuania	European perch	*Perca fluviatilis*	60	0.50	10	22	16	Fishbase	F
Malta	Freshwater fishes nei	*non specific*	0	NA	NA	NA	NA	NA	F
Netherlands	European eel	*Anguilla anguilla*	3432	0.64	4	20	12	Fishbase	F
Netherlands	North African catfish	*Clarias gariepinus*	3061	0.79	8	35	21	Fishbase	F
Netherlands	European smelt	*Osmerus eperlanus*	818	0.43	9	11	10	Cheung et al 2013	F
Netherlands	Nile tilapia	*Oreochromis niloticus*	386	0.30	14	33	24	Fishbase	F
Netherlands	European eel	*Anguilla anguilla*	300	0.64	4	20	12	Fishbase	F
Netherlands	Pike-perch	*Sander lucioperca*	294	0.62	6	22	14	Fishbase	F
Norway	Atlantic salmon	*Salmo salar*	362	0.62	6	12	9	Cheung et al 2013	F
Norway	Sea trout	*Salmo trutta*	76	0.60	9	10	9	Cheung et al 2013	F
Poland	Common carp	*Cyprinus carpio*	17314	0.46	15	32	18	Tank et al. 2000	F
Poland	Freshwater fishes nei	*non specific*	16026	NA	NA	NA	NA	NA	F

Poland	Rainbow trout	*Oncorhynchus mykiss*	14330	0.36	6	12	9	Cheung et al 2013	F
Poland	Freshwater bream	*Abramis Brama*	1057	0.62	10	24	16	Fishbase	F
Portugal	Rainbow trout	*Oncorhynchus mykiss*	737	0.36	6	12	9	Cheung et al 2013	F
Romania	Common carp	*Cyprinus carpio*	3138	0.46	15	32	18	Tank et al. 2000	F
Romania	Goldfish	*Carassius auratus*	2782	0.24	10	30	20	Kneprath and Meade 1968	F
Romania	Silver carp	*Hypophthalmichthys molitrix*	1855	0.55	6	22	15	Cheung et al 2013	F
Romania	Bighead carp	*Hypophthalmichthys nobilis*	1384	0.66	4	26	15	Fishbase	F
Romania	Rainbow trout	*Oncorhynchus mykiss*	1166	0.36	6	12	9	Cheung et al 2013	F
Romania	Freshwater bream	*Abramis Brama*	605	0.62	10	24	16	Fishbase	F
Romania	Pontic shad	*Alosa pontica*	371	0.35	13	14	13	Cheung et al 2013	F
Romania	Sea trout	*Salmo trutta*	303	0.60	9	10	9	Cheung et al 2013	F
Romania	Roaches nei	*Non specific*	218	NA	NA	NA	NA	NA	F
Romania	Common carp	*Cyprinus carpio*	170	0.46	15	32	18	Tank et al. 2000	F
Romania	Cyprinids nei	*non specific*	164	NA	NA	NA	NA	NA	F
Romania	Wels(=Som) catfish	*Silurus glanis*	153	0.84	4	20	12	Fishbase	F
Slovakia	Common carp	*Cyprinus carpio*	1527	0.46	15	32	18	Tank et al. 2000	F
Slovakia	Rainbow trout	*Oncorhynchus mykiss*	726	0.36	6	12	9	Cheung et al 2013	F
Slovakia	Freshwater breams nei	*Taken values from Freshwater bream*	81	0.62	10	24	16	Fishbase	F
Slovakia	Goldfish	*Carassius auratus*	65	0.24	10	30	20	Kneprath and Meade 1968	F
Slovakia	Pike-perch	*Sander lucioperca*	64	0.62	6	22	14	Fishbase	F
Slovakia	Northern pike	*Esox lucius*	57	0.85	10	28	19	Cheung et al 2013	F
Slovakia	Grass carp(=White amur)	*Ctenopharyngodon idella*	47	0.65	NA	35	NA	Fishbase	F
Slovenia	Common carp	*Cyprinus carpio*	2253	0.46	15	32	18	Tank et al. 2000	F
Slovenia	Rainbow trout	*Oncorhynchus mykiss*	708	0.36	6	12	9	Cheung et al 2013	F
Slovenia	Salmonids nei	*non specific*	37	NA	NA	NA	NA	NA	F
Slovenia	Rainbow trout	*Oncorhynchus mykiss*	21	0.36	6	12	9	Cheung et al 2013	F
Slovenia	Silver carp	*Hypophthalmichthys molitrix*	13	0.55	6	22	15	Cheung et al 2013	F
Slovenia	Brook trout	*Salvelinus fontinalis*	12	0.43	NA	NA	13	Cunjak and Green 1986	F
Slovenia	Cyprinids nei	*non specific*	11	NA	NA	NA	NA	NA	F

Spain	Rainbow trout	*Oncorhynchus mykiss*	20612	0.36	6	12	9	Cheung et al 2013	F
Spain	Freshwater fishes nei	*non specific*	2650	NA	NA	NA	NA	NA	F
Spain	Sea trout	*Salmo trutta*	1800	0.60	9	10	9	Cheung et al 2013	F
Sweden	Rainbow trout	*Oncorhynchus mykiss*	4796	0.36	6	12	9	Cheung et al 2013	F
Sweden	Chars nei	*Salvelinus alpinus alpinus*	879	0.74	0	3	10	Cheung et al 2013	F
Sweden	European perch	*Perca fluviatilis*	681	0.50	10	22	16	Fishbase	F
Sweden	Pike-perch	*Sander lucioperca*	578	0.62	6	22	14	Fishbase	F
Sweden	Northern pike	*Esox lucius*	483	0.85	10	28	19	Fishbase	F
Sweden	Vendace	*Coregonus albula*	271	0.27	8	10	9	Cheung et al 2013	F
Sweden	Euro-American crayfishes nei	*Homarus gammarus*	260	0.46	NA	NA	6	Sealifebase	F
Sweden	Sea trout	*Salmo trutta*	252	0.60	9	10	9	Cheung et al 2013	F
United Kingdom	Rainbow trout	*Oncorhynchus mykiss*	12800	0.36	6	12	9	Cheung et al 2013	F
United Kingdom	Sea trout	*Salmo trutta*	520	0.60	9	10	9	Cheung et al 2013	F