**BLACK SEA: UPDATED CATCH RECONSTRUCTIONS TO 2018**

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**Abstract**

Marine fisheries catches for the countries around the Black Sea were initially reconstructed for the years 1950 to 2010. This contribution updates these reconstructions to 2018 for Bulgaria, Romania, Russia (Black Sea) and Ukraine (including Crimea) but omits Georgia and Turkey, which are dealt with elsewhere. The updating was done in two steps, i.e., an update to 2014 that considered a wide range of data sources and a carry-forward to 2018 constrained by landing statistics reported for 2018 by the Food and Agriculture Organization of the United Nations (FAO).

**Introduction**

The Black Sea is a semi-enclosed (marginal) sea situated in the northeast of the Mediterranean basin between Eastern Europe and Western Asia. It is surrounded by Ukraine, Romania, Bulgaria, Turkey, Georgia, and Russia. Since the end of WWII, the Black Sea Large Marine Ecosystem (Sherman and Hempel 2008), which supported extensive fisheries (Pauly et al. 2008), has experienced major ecological upheavals which, combined with massive overfishing, have led to the decline of many of its exploited fish and invertebrate populations (Daskalov 2002; Tsikliras et al. 2013).

Marine fisheries catches for the Exclusive Economic Zones (EEZs) of countries of the Black Sea were initially reconstructed for the years 1950 to 2010. This contribution updates these reconstructions to 2018 for Bulgaria, Romania, Russia (Black Sea) and Ukraine (including Crimea), but omits Georgia and Turkey, which are dealt with in Brown and Noël (2020) and Brown and Cashion (2020), respectively. Note that this updating was done in two steps, i.e., a ‘manual’ update to 2014 that in some cases considered a range of data sources and a carry-forward to 2018 constrained by landing statistics reported for 2018 by the Food and Agriculture Organization of the United Nations (FAO). Taxonomic resolution of reported catches of Elasmobranchii were evaluated and improved upon as documented by Cashion et al. (2019).

**Methods (by country)**

**Bulgaria**

Bulgaria is a southeastern European country that borders the Black Sea. It is characterized by a fishing industry that was already being modernized in the 1950s. A reconstruction of Bulgaria’s marine fisheries catches covering the years 1950-2010 was completed by Keskin et al. (2015, 2016) and updated to 2013 by Keskin et al. (2017). Here, we briefly mention how this reconstruction was updated to 2014, then carried forward to 2018.

**Baseline data**

Reported landings data for Bulgaria were available by year and taxon for 2011-2014 from the FAO Fishstat database. They were used here as the reported baseline to which unreported commercial, subsistence and

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recreational catches as well as discards were added. The methods applied to update the catches for 2011-2013 are summarized in Keskin et al. (2017b) and were used for the 2014 update.

**Transition from 2014 to 2018**
The catch reconstructed to 2014 was carried forward to 2018 using the semi-automated procedures outlined in Noël (2020), based on FAO landings data to 2018. Semi-automated reconstructed catch data will later be replaced by a more detailed, research-intensive update.

**Marine biodiversity protection**
Bulgaria has agreed to protect its biological diversity through the international Convention on Biological Diversity (Aichi). The country is also a signatory to Regional Treaties and Agreements such as the Natura 2000 (Marine Conservation Institute 2020). The Natura 2000 sites implementation is coordinated and managed by the Ministry of Environment and Water (Stancheva et al. 2016).

Bulgaria has 54 MPAs and four marine managed areas; the MPAs’ extent is 512 km², which occupies 1.46% of the entire EEZ (35,132 km²; Keskin et al. 2015).

One of the first protected areas in Bulgaria was declared in Cape Kaliakra in 1941. In 1966, this MPA passed from a designation as Natural Park to a strict nature reserve of 0.53 km². In 1980, the reserve was extended to 6.88 km², which includes 4 km² of marine ecosystems. A small buffer zone of 1.1 km² was included three years later. The reserve is a no-take area, which prohibits mining, harvesting of any fauna and flora, and destroying bird nests and animal lairs, among other activities (Marine Conservation Institute 2020).

While some progress has been made in terms of designating Natura 2000 sites, some challenges regarding their management exist. For example, in the most northern district of Dobrich, where the Reserve of Kaliakra is located, a large fraction of the nominally protected areas is affected by the consequences of poor planning and management and lack of public awareness (Stancheva et al. 2016).

“Education and information programmes, as well as regulations aimed at restricting visitor behaviour, may be necessary in addition to limits of use. New skills and tools need to be developed by management authorities in Bulgaria to address the challenges that emerge from planning, monitoring and managing protected areas and historical sites along the coast” (Stancheva et al. 2016).

**Romania**
The marine fisheries catches by Romania from 1950 to 2010 were reconstructed by Bănaru et al. (2015, 2016). We document here how these were updated to 2014, then carried forward to 2018.

Romania has an intensive trawl fishery until 1989 when the fishery collapsed. Since then, the Romanian fishing industry has consisted of relatively small-scale commercial and subsistence fisheries (Bănaru et al. 2015).

**Reported data**
Official marine fisheries catches were available by year and taxa for 2011-2014 from the FAO database. The total catch started increasing after 2011 due to landings of *Rapana venosa*, a large sea snail (Radu et al. 2013a; Radu et al. 2013b). *R. venosa* is caught by beam trawlers, which are classified as ‘small-scale’ in Romania, but which are here considered as ‘industrial’ following Martín (2012).
Unreported catch

The 2010 ratio of coastal to total population was used to estimate the coastal population of Romania from 2011 to 2014 based on updated population data from the World Bank. The annual unreported subsistence catch rate was extrapolated forward to 2014 and multiplied by the coastal population to estimate subsistence catch. The 2010 taxonomic breakdown of subsistence catches was maintained to 2014.

Discards from artisanal landings were calculated for 2011-2014 using the original methods.

Transition from 2014 to 2018

The catch reconstructed to 2014 was carried forward to 2018 using the semi-automated procedures outlined in Noël (2020), based on FAO landings data to 2018. Semi-automated reconstructed catch data will later be replaced by a more detailed, research-intensive update.

Marine biodiversity protection

Romania has agreed to protect its biological diversity through the international Convention on Biological Diversity (Aichi) and the Ramsar Convention on Wetlands of International Importance (Marine Conservation Institute 2020). Romania is also a signatory to Regional Treaties and Agreements such as the Natura 2000, and it is also part of the international network of UNESCO Man and the Biosphere (Marine Conservation Institute 2020).

Romania has 21 MPAs and three marine managed areas. The MPAs’ extent is 1,530 km² (Marine Conservation Institute 2020), which represents 5% of the entire EEZ (29,756 km²; Bănaru et al. 2016). When planning and establishing MPAs in Romania, one of the first steps was to identify the marine habitat types, according to the Habitats Directive, and elaborate a specific typology for the Romanian Black Sea. Moreover, biological diversity protection in Romania also counts with the so-called ‘Romanian Network of MPAs’ (RO). Within this network “the scientists started from the main target of MPAs: preserving the marine resources (biodiversity and underwater landscape) for the benefit of the present and future generations. It was assumed that the implementation of proper management could ensure permanent benefits in these marine areas while minimizing eventual conflicts with the users. The RO scientists also considered the necessity of preserving the species and habitats of European importance, including in the network the marine sites already proposed to be part of the NATURA 2000 network” (Marine Conservation Institute 2020).

The Danube Delta MPA is the only UNESCO-MAB Biosphere Reserve in Romania and is of great importance for the fisheries of the country. The fisheries are dominated by the small-scale sector since the Common Fisheries Policy was introduced and the industrial fleet completely disappeared (Teodorescu and van den Kommer 2020).

“Bad management of the Danube Delta and stories of corruption scandals do not make it easier to implement policies and strategies or to utilize available funds to their fullest potential. Hence, a balance between nature conservation and sustainable use of fish stocks and more economic opportunities for local small-scale fisheries is still, in the short run, inconceivable. Given the importance of the Danube Reserve as a conservation area for a region that is wider than the Romanian borders, it is not very likely that environmental regulations of the Danube Reserve, such as the sturgeon ban and policies on restricted fishing areas, will be lifted in the near future” (Teodorescu and van den Kommer 2020).
There are also other threats that affect marine habitats and species in this reserve. The pollution that occurred in the Danube Delta Biosphere Reserve over time has various sources, including improper management of industrial, agricultural and domestic discharge, as well as accidental water pollution (Despina et al. 2020).

**Russia (Black Sea)**

Russia has coasts on the Arctic, North Atlantic, and Pacific oceans, and two semi-enclosed seas (the Baltic and Black Seas). An earlier reconstruction of fisheries catches in what was previously the Russian Black Sea EEZ for 1950-2010 was presented by Divovich et al. (2015, 2016). Here, we document how this initial reconstruction was updated to 2014, then carried forward to 2018.

The initial reconstruction, which covered the years 1950 to 2010, did not account for the fact that the Crimea (annexed by Russia from the Ottoman Empire in 1783) was a part of Russia until 1954 when it was handed over to Ukraine at a time when both countries were part the Union of Soviet Socialist Republics (USSR). Consequently, its 2014 re-annexation by Russia is not considered here, i.e., fisheries catches around the Crimea are considered Ukrainian catches from 1950 to 2018. This is unsatisfactory; a more elegant solution, which will be implemented in the next update, would be to identify the catches made by Russian, Ukrainian, and Crimea-based vessels around the Crimea (including part of the Sea of Azov) from 1950 to the present, which can then be assigned to either country or none, depending on the framework of the analysis that is performed.

**Reported data**

Official marine fisheries catch data were reported by year and taxon for the Black Sea EEZ of Russia by the FAO database and were used here as the reported data baseline. The reported catch was disaggregated into the artisanal and industrial sectors using the same ratios in 2010 from the original reconstruction (Divovich et al. 2015). The overall percentage catch contribution of the industrial and artisanal fisheries to total reported catch was applied to disaggregate the miscellaneous group ‘Marine Fishes nei’.

**Unreported commercial catch**

Following Divovich et al. (2015), unreported catch for all taxa were calculated at 150% of reported landings except valuable sturgeon (*Acipenser* spp.) and turbot (*Scophthalmus maximus*).

The FAO data do not report sturgeon catches for 2011-2014, but it is unlikely that the fishery just stopped. Here, it was assumed that the total reconstructed landings of sturgeon remained at the 2010 level for 2011-2014 following Divovich et al. (2015).

The reconstructed catch of turbot from 2010 was used as a baseline, and catch were assumed to increase or decrease in proportion to follow the Turkish trend of FAO-reported turbot catch for 2011-2014 to estimate the unreported catch of turbot.

**Discards**

Discards were estimated according to the original reconstruction. Discard rates were estimated by target species, species distributions, and by artisanal and industrial sector categorization (Divovich et al. 2015).

**Subsistence and recreational**

Subsistence and recreational catches were derived by applying a per capita consumption rate of fish to a select population.
Estimates of the local Russian population\(^\text{15}\) were updated to 2014; the ratio of the population living along the Black Sea coast was maintained at the 2010 ratio. The Russian population living along the Black Sea within urban and rural areas was updated for 2011-2014 based on 52% urban and 47% rural according to Russia’s 2010 census\(^\text{16}\). Following the methods by Divovich et al. (2015), it was assumed that the tourist population continued to be equivalent to an estimated 25% of the calculated Russian Black Sea population for 2011 to 2014.

The recreational catch was calculated based on the assumption that 3% of tourists engaged in recreational fishing and that there was a catch-per-unit-effort of 49 kg, per fishing tourist per year, following the original reconstruction (Divovich et al. 2015).

The Organisation for Economic Co-operation and Development (OECD 2013) estimated the annual Russian per capita consumption of fish at 21.2 kg. Following the original methods by Divovich et al. (2015), the proportion of fish consumption caught within the Black Sea by the rural population for subsistence remained at 26% for 2011-2014.

**Transition from 2014 to 2018**

The catch reconstructed to 2014 was carried forward to 2018 using the semi-automated procedures outlined in Noël (2020), based on FAO landings data to 2018. Semi-automated reconstructed catch data will later be replaced by a more detailed, research-intensive update.

**Marine biodiversity protection**

Russia has agreed to protect the biological diversity of its waters in the Black Sea through the international Convention on Biological Diversity (Aichi), the United Nations Convention on the Law of the Sea, the Ramsar Convention on Wetlands of International Importance and the World Heritage Convention (Marine Conservation Institute 2020). Russia is also a signatory to the international network of UNESCO Man and the Biosphere, and its commitments extend to intergovernmental organizations such as the Helsinki Commission (HELCOM; Marine Conservation Institute 2020).

“The Post-War fishing history of Russia in the Black Sea was additionally characterized by crisis phenomena in the Russian fishery sector manifested in the operation of the Fishery Protection Agencies, serving to control and monitor the harvesting. This resulted in widespread poaching on commercially valuable fish species in coastal waters of the former Soviet Union and within its territorial water area by both Russian and foreign commercial fishermen from the early 1990s onwards” (Fashchuk 2019).

Between 1993 and 1994, a number of Presidential Decrees relevant to ‘Integrated Coastal Zone Management’ (ICZM) were adopted. After this, the ICZM considering the Task of Rational Use of Natural Resources in the Black Sea and Adjacent Territory was prepared and approved. Nevertheless, the programme was suspended in 1997 (Vlasyuk 2005). “In the Russian Federation’s legislation, the coastal zone is not yet regarded as an integral, natural ‘land-sea’ complex. Instead, there are various sectoral regulations for the protection and management of coastal and marine resources and various government bodies are responsible for their implementation. This situation is not beneficial for the implementation of an integrated management approach, which is listed in the Maritime Doctrine of Russian Federation 2020 (27 July 2001) as one of the

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\(^\text{15}\) [http://www.gks.ru/bgd/regl/b15_12/IssWWW.exe/stg/d01/05-01.htm](http://www.gks.ru/bgd/regl/b15_12/IssWWW.exe/stg/d01/05-01.htm)

principles of the future national maritime policy (an ‘integrated approach to maritime activities’)” (Goriup 2017).

**Ukraine**
Total marine fisheries catches for Ukraine were reconstructed from 1950 to 2010 by Ulman et al. (2015, 2016); this section documents how this initial reconstruction was updated to 2017, then carried forward to 2018. The initial reconstruction did not account for the fact that the Crimea (annexed by Russia from the Ottoman Empire in 1783) was a part of Russia until 1954, when it was handed over to Ukraine at a time when both countries were part the Union of Soviet Socialist Republics (USSR). Consequently, the 2014 re-annexation of Crimea by Russia is not considered here, i.e., all fisheries catches around the Crimea are considered Ukrainian catches from 1950 to 2018. This is unsatisfactory; a more elegant solution, which will be implemented in the next update, would be to identify the catches made by Russian, Ukrainian and Crimea-based vessels around the Crimea (including part of the Sea of Azov) from 1950 to the present, which can then be assigned to either country or none, depending on the framework of the analysis performed.

**Reported catch**
Marine fisheries catches were reported by year and taxa by the FAO database on behalf of Ukraine and were considered to solely represent industrial catch.

**Unreported commercial catch**
Unreported catches of sturgeon (*Acipenser* spp.) were assumed to be included from 2009 in the reconstructed catch estimates for each sector and were therefore not reconstructed separately. An additional 20% of unreported industrial landings was assumed in addition to the reported landings for 2011-2017.

Catches by the artisanal sector were estimated for 2011-2017 using the methods of Ulman et al. (2015). The number of commercial fishers was calculated for 2011-2017 based on the 2010 ratio of the total Ukrainian population available from the World Bank. The percentage of artisanal fishers was maintained at 60% of total fishers, as for 2010 (Ulman et al. 2015). The 2010 artisanal catch rate of 1.5 t-fisher⁻¹-year⁻¹ was held constant to 2017 and applied to the number of artisanal fishers. Artisanal landings were disaggregated by taxa for 2011-2017 based on the 2010 taxonomic disaggregation.

**Discards**
Discards were estimated for artisanal fisheries at 1% of total reconstructed artisanal landings and for industrial fisheries at 1% of reconstructed industrial landings for 2011-2017 based on the original methods used for 2010 (Ulman et al. 2015). Discards were calculated separately for the pelagic trawl fishery for European sprat (*Sprattus sprattus*), where the 8% discard rate from 2010 was carried forward to 2017. These discards were assumed to be composed of juvenile sprat and whiting (*Merlangius merlangus*), as described for 2010 by Ulman et al. (2015).

**Recreational and subsistence fishing**
Recreational and subsistence fisheries catches were reconstructed for 2011-2017 following the methods of the previous reconstruction (Ulman et al. 2015). The updated number of fishers was estimated at 1% of the Ukrainian population (available from the World Bank). The 2010 catch rate (49 kg-fisher⁻¹-year⁻¹) and the taxonomic disaggregation for recreational and subsistence fishing were carried forward to 2017. The subsistence and recreational catches were split 30% and 70% respectively for 2011-2017 based on 2010 figures.
Illegal fishing
The annexation of Crimea by Russia (see above) may have caused a sharp decline in industrial landings in 2014 because total reported catches were at their lowest; the catches have been increasing again since then. While Turkey appears to continue to fish illegally in Ukrainian waters, representatives from both countries formed a Joint Ukrainian-Turkish Committee on Fisheries which recently discussed strategies to combat Illegal, Unreported, and Unregulated (IUU) fisheries in the Black Sea\textsuperscript{17}. Catches from IUU fisheries in Ukrainian waters are reconstructed for Turkey in a separate report (Ulman et al. 2013).

Transition from 2017 to 2018
The catch reconstructed to 2017 was carried forward to 2018 using the semi-automated procedures outlined in Noël (2020), based on FAO landings data to 2018. Semi-automated reconstructed catch data will later be replaced by a more detailed, research-intensive update.

Marine biodiversity protection
Ukraine has agreed to protect its biological diversity through the international agreements of the Convention on Biological Diversity (Aichi), and the Ramsar Convention on Wetlands of International Importance and the World Heritage Convention (Marine Conservation Institute 2020).

Ukraine has 20 MPAs and 53 marine managed areas. The MPAs cover 1,427 km\textsuperscript{2} (Marine Conservation Institute 2020), which equals about 1% of the entire EEZ (132,414 km\textsuperscript{2}; Ulman et al. 2016). The two greatest MPAs are National Biosphere areas, Chernomorskiy (designated in 1927 with a total marine area of 564 km\textsuperscript{2}) and the Danube Delta (designated in 1998 with a total marine area of 109 km\textsuperscript{2}) (Marine Conservation Institute 2020).

The two largest Ramsar sites are Eastern Syvash (designated in 1995 with a total area of 1,650 km\textsuperscript{2}) and Karkinitska and Dzharylgatska Bays (designated in 1976 with a total area of 870 km\textsuperscript{2}). The Eastern Syvash site belongs to a National Nature Park and is a shallow water bay that is part of a large coastal lagoon with islets and peninsulas. “The area serves as an important nesting, wintering, molting and staging area for internationally important numbers of various species of water birds and waders. A number of these species are rare, vulnerable or endangered” (Ramsar sites information service 2020a).

Karkinitska and Dzharylgatska Bays have the international designation of UNESCO Biosphere Reserve and the national, legal designations of ornithological game reserve, natural reserve and botanical reserve. This site is an embayment of the Black Sea with great importance for migratory and endemic birds providing also nesting habitats. Moreover, “[m]arine mammals include three species of dolphin, all nationally rare, as well as several nationally rare and relic fish species” (Ramsar sites information service 2020b).

Results and Discussion
Figure 1 presents our reconstructed catches within the Black Sea from all countries for 1950-2018.

\textsuperscript{17} \url{http://darg.gov.ua/index.php?lang_id=1&content_id=5695&lp=44}
The Black Sea is a peculiar body of water. Mighty rivers – the Danube, the Dnieper, Dniester, and the Don and numerous smaller ones – discharge vast quantities of freshwater into the Black Sea. Unlike the Mediterranean, where evaporation increases the salinity of surface water which then sinks and aerates its deeper basins, the low-salinity brackish water of the Black Sea forms a cap on the sea’s surface, and its deeper layers are never aerated. The result is that below 150-200 m depth, the Black Sea contains only anoxic water, which is inhabited only by bacteria. Moreover, the relatively shallow layer of water that contains oxygen and can support metazoans was invaded in the 1980s by a comb jelly (Mnemiopsis leidyi) from the US East Coast which initially had no predator in the Black Sea.

By eating the eggs of teleost fish, the comb jelly has had an enormous impact on fish populations. Combined with extremely high fishing pressure from completely unregulated fisheries, this brought about cascading changes in the functioning of the Black Sea ecosystem, resulting in a ‘fished down’ state in the EEZs of all countries surrounding the Black Sea (Daskalov 2002). The large fish (notably sturgeon) are almost entirely gone, as are bluefin tuna (Thunnus thynnus) and bonito (Sarda sarda), both of which historically migrated between the Eastern Mediterranean Sea and the Black Sea. Indeed, even a population of mackerel (Scomber scombrus) migrating between the Black and Marmara Seas was wiped out by overfishing (Pauly and Keskin 2017).

In the meantime, a predator for Mnemiopsis leidyi – another comb jelly (Beroe ovata) – has been introduced into the Black Sea, and some semblance of predator-prey dynamic has now been established. We now know that fish populations can recover when the fishing pressure on them recedes, especially when aided by effective marine protected areas (Pascual et al. 2016).

Thus, while the Black Sea is currently still in deep trouble, there is no reason why its former glory cannot re-emerge. It is only a matter of us letting nature do her work.

**Acknowledgments**

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References (for the Black Sea, then by country)


Bulgaria


Romania


**Russia (Black Sea)**


**Ukraine**


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