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Supplementary Data
**“From bonito to anchovy: a reconstruction of Turkey’s
marine fisheries catches (1950-2010)”**

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The fish & fisheries of turkey**

History of fishing

The first president of Turkey, Mustafa Kemal Atatürk, established the republic of Turkey in 1923; he was also responsible for forming the modern, western-style democratic nation-state. At the conclusion of Turkey’s war of independence in the 1920s, there was a re-settling of populations; notably, ethnic Greeks previously residing in Turkey and ethnic Turks, previously residing in Greece, were forced to re-settle in Greece and Turkey, respectively. The topic of whether the departure of Greek minorities resulted in a stagnation of Turkish fisheries has been explored elsewhere (Knudsen, 2009).

In an assessment of the top 53 fishing countries, which together land 96% of global marine catches, each country’s adherence to the voluntary FAO (UN) Code of Conduct for Responsible Fisheries was assessed and scored (Pitcher *et al.*, 2008, 2009). Turkey ranked 46 out of 53 evaluated countries. Like most other countries, Turkey’s ‘intentions’ scored better than their ‘implementation’ of the UN Code of Conduct.

Black Sea

Since the 1960s, the Black Sea large marine ecosystem (LME) has been faced with increasing environmental stressors such as pollution, eutrophication, over-fishing, the introduction of alien species, removal of top predators and the subsequent trophic cascade, as well as climatic variations (GFCM, 2011a). **Much of the pollution** stems from the Danube River which drains 1/3rd of continental Europe into the catchment area of the Black Sea [UNDP, 2012. www.undp-drp.org/drp/danube_danube_delta.html]. Also, the construction of many dams on the Kızılırmak and Yeşilirmak rivers have significantly reduced nutrient availability to the Turkish continental shelf (Zengin, 2006), which resulted in decreased marine productivity of the area.

Turkey has a very narrow and limited section of the continental shelf on its Black Sea coast. Since the weakening of the Soviet Union (who used to be a prominent fishing power) in the 1980s, Turkey has dominated the fisheries within the Black Sea (GFCM, 2011a). Due to the large area of the Black Sea, and also its rough seas, monitoring and control have been a challenge, but have improved within the last 5-10 years, since the Coast

Guard took over as the control authority. Corruption between the authorities and large-scale commercial fishers, however, still presents a problem for small-scale fishers.

Since 1950, many different types of aid were handed to the fishing industry. Many entrepreneurs took advantage of these handouts while continuing to self-invest and expand their business in times of profit. The owners of fishing boats continually invest in larger boats, fishing nets and newer technology in order to remain competitive (Knudsen, 2009), although most owners are heavily indebted. Fishing technology is continually evolving requiring less manpower to catch the same amount of fish in the commercial sector. Technology has outpaced natural population growth in most fish stocks.

There were around 100 purse seiners operating in the Marmara and Black Sea in 1998; the anchovy purse-seiners have 20-25 crew on board each boat; the large-pelagic seiners have around ten crew with one seine net, and their investment (in 1986) was about U.S. \$32,000 or U.S. \$3,200 per person (Berkes, 1986). The investment required to be a player in the commercial/industrial fisheries is now impossible for small-scale fishers to attain due to the advancement of fishing technologies, resource depletion, and the lack of profitable intermediate technologies (Knudsen, 2009). The job security and economic security of the small-scale sector are both greatly at risk. Due to the limited selectivity of purse seiners, larger fish often block the mesh of the nets, and consequently the smaller fish get stuck inside. This is just one problem associated with multi-species fishing, which is increasingly reflected by the vast amounts of undersized fish for sale in Turkey.

From 1950 to 2010, Turkey’s population grew from 21 million (www.turkstat.gov.tr) to 74 million people [Trading Economics, 2012. www.tradingeconomics.com/turkey/population]. Along with this substantial population growth, an urbanization trend has also occurred since the 1950s. In 1950, 18.7% of the population lived in cities (Keles, 1982); by 2010, this increased to 70% of the total population. The bulk of Turkey’s population lives in the coastal area, 18% of the population living in Istanbul [City Population, 2012. www.citypopulation.de/Turkey-Istanbul.html], and along the western coast.

Seafood consumption varies greatly with location; *per capita* consumption is highest in the Black Sea re-

gion, averaging 25 kg · person⁻¹ · year⁻¹; in metropolitan areas, the rate is around 16 kg · person⁻¹ · year⁻¹; and in east and southeast Anatolia seafood consumption is the lowest, at 0.5 kg · person⁻¹ · year⁻¹ (Knudsen, 2006). Anchovy (*Engraulis encrasicolus*) is the most popular fish in all regions, and is usually consumed fresh. Coastal areas have a higher consumption and greater selection due to proximity and availability of resources (Rad, 2002). Fish is preferred as fresh as possible and is usually served whole with the head attached.

Dominant species

Several commercially important species in the Black Sea are discussed in detail below such as anchovy, dolphin (Delphinidae spp.), sprat, turbot (*Psetta maximus*), Mediterranean horse mackerel, Atlantic mackerel (*Scomber scombrus*), striped Venus clam, jellyfish (*Mnemiopsis leidyi*) and sturgeon (Acipenseridae spp.). Other commercially important taxa will be discussed for each of the other seas.

Anchovy (*Engraulis encrasicolus*)

Around 1950, Turkey's second most important fishing hub, next to Istanbul was in Trabzon, Turkey. Anchovy supplies much of the local Black Sea population with protein and is enjoyed by all classes in this area (Knudsen, 2006). The Trabzon culture identifies strongly with anchovy (*hamsi*), both in their culture as well as their folklore; there are songs, poems, and even a cult dedicated to this small migratory pelagic fish (Knudsen, 2006). Anchovy can be said to embody the region's characteristics, namely its "high energy and vigor" (Knudsen, 2006).

Anchovy catches increased significantly from the early time period compared to recently (Fig. 4). In 1954, 50,000 t of anchovy were caught annually, decreasing to 8,000 t in 1955, and stabilizing at around 15,000 t from 1956 to 1958 (Üstündağ, 2010). Between 1970 and 1977, anchovy catches averaged between 70,000-80,000 t; however, by 1980, these landings increased to 250,000 t, and by 1987 to 300,000 t.

Over a five year period, from 1975-1979, the Black Sea's total marine fishery landings sharply increased by over 400% (TÜİK, 1967-2010), mostly attributable to the increase in anchovy catches. There are several biological explanations for these increased catches such as increased eutrophication in the northern Black Sea, which intensified drastically in the late 1960s and early 1970s (Zaitsev & Mamaev, 1997), which led to large plankton blooms that temporarily increased the carrying capacity of the ecosystem (Daskalov, 1998). Additionally, the Black Sea experienced an exploitation of its mackerel stocks and declines in many other top predator popula-

tions such as bonito, bluefish and dolphins. A third explanation may be attributable to a change in anchovy spawning grounds from the north-western Black Sea to the southern Black Sea. Turkey's neighbours (e.g. Bulgaria, Romania and Russia) have since witnessed localized collapses of their anchovy stocks (Kideys, 2002; Ancha, 2008). The higher landings were also attributable to increased fishing capacity from the mid-1970s due to state-sponsorship in the sector in the form of investment in fishing harbours, subsidized credits, grants, and import tax exemptions (Knudsen, 2009).

Anchovy is caught exclusively by purse seiners, ranging from 15 m to 50 m in length, with a net mesh size of 16 mm (Oztürk *et al.*, 2011). Most anchovy is consumed within Turkey while 10-30% is sent to factories for processing into fishmeal and fish oil. In the 1950s and 1960s, it was used as fertilizer for tobacco crops (Knudsen, 2009), and in the 1960s and 1970s for hazelnut crops (M. Zengin, pers. obs.). Like other small pelagics, biomass fluctuates considerably from year to year, and this is also reflected in the national fishery landing statistics. Anchovy and sprat stocks seem to have recovered since the national fisheries crisis of the early 1990s (GFCM, 2011b).

Dolphin

The Black Sea dolphin fishery was intense from the 1870s for about a century, especially during the 1950s (Zengin, 2011). The main species of dolphin targeted were the short-beaked common dolphin (*Delphinus delphis*), and to a lesser extent, the harbour porpoise (*Phocoena phocoena*) and bottlenose dolphin (*Tursiops truncatus*). The oil from the blubber was used to light up homes and streets, and the carcasses were used as fertilizer for tobacco plants (Deveciyan, 1915). The hunting of dolphins was the principal income for many Turkish fishers on the Black Sea until the early 1980s, and was so profitable for some that other fish stocks were not targeted. Most Black Sea countries banned the hunting of dolphins in 1963 (Berkes, 1977), but Turkey did not join the ban until 1983.

Dolphins have been regarded as either a benefit to fishers, since they help chase fish towards the shore, or a nuisance, since they compete with fishers for fish (Zengin, 2011). Their precise population is not known precisely but estimates range from 10,000 to 100,000 individuals in the Black Sea (www.iucnredlist.org). Dolphins are mentioned here because of their important role in Turkish fisheries in early periods; however, this study does not include estimates of marine mammal catches.

Sprat (*Sprattus sprattus*)

In the early 1900s, it was noted that although sprat looks similar to anchovy, the taste is more bitter (Deveciyan, 1915/2006); some fishers during this period were known to try to disguise sprat as juvenile anchovy (since sprat is of much less value), in order to be able to sell the catches. Sprat catches have been primarily discarded in Turkey until the mid-1990s, evidenced by the fact that the species was not even recorded in the national catch statistics until 1994.

Sprat in very recent times (early 2000s) has become the second largest fishery in Turkey in terms of catch volume. Expansion of this fishery was likely driven by the drastic decline of larger, more valuable fish making sprat a viable alternative target species, which is a typical case of 'Fishing Down Marine Food Webs' (Pauly *et al.*, 1998). Furthermore, improvements in mid-water trawl technologies have allowed for improved sprat catches. Prior to 1995, sprat was not used for human consumption or for fish meal/oil, and the vast majority (85-90%) of catches were discarded at sea (M. Zengin, pers. obs.). An analysis of Black Sea fish stocks revealed that sprat had a massive biomass increase in the late 1970s to mid-1980s (Daskalov, 1998), which is thought to be related to the decline in top predators in the Black Sea around the late 1960s and early 1970s (Daskalov & Prodonov, 1995). Sprat is a major target species for most of the other Black Sea countries and their populations have been significant since the late 1970s.

According to national statistics, in the late 1990s, sprat catches averaged less than 1,000 t annually, which rapidly increased to 57,000 t in 2010 (TÜİK, 1967-2010). Stock assessments have only been completed for a couple of fish stocks in the Black Sea region as of 2010, sprat and turbot (Daskalov & Ratz, 2010).

Turbot (*Psetta maxima*)

Turbot stocks were once very abundant in the Black Sea. In the coastal town of Samsun, in the early 1900s, fishers caught up to 3,000 turbot a week (Knudsen *et al.*, 2010). Wild turbot is one of the highest-priced fish in Turkey, but farmed turbot, mainly from Bulgaria, now provides a cheaper alternative. The highest turbot catches in the entire Black Sea region were recorded between 1955 and 1969 (Mikhailov & Papaconstantinou, 2006). Turbot catches have since decreased considerably in the last few decades, along with their mean size, from 41.9 cm in 1990 to 30.4 cm in 2005 (Knudsen *et al.*, 2010).

Mediterranean horse mackerel (*Trachurus mediterraneus*)

Over the last 40 years, the highest Black Sea catches of Mediterranean horse mackerel preceded the jellyfish

invasion (discussed below) of the Black Sea (1989-1990). Between 1985-1988, Black Sea catches were between 90,000 and 100,000 t annually (TÜİK, 1967-2010); between 2001-2006, catches drastically declined to under 10,000 t annually, the same level as catches during the 1950-1975 time period, before the start of industrial fishing (Daskalov & Ratz, H. J., 2010). Catches have increased only slightly to around 10,000-15,000 t annually, for the 2006-2010 period. Note that this corresponds to an 85-90% reduction in catches. It is likely that intensive fishing in Turkish waters in 1985-1989 led to the reduction of the stock and catches in the following years (Daskalov & Ratz, 2010).

Istavrit is the name given to both Atlantic and Mediterranean horse mackerel species. When immature (5 to 10 cm), the Mediterranean horse mackerel is called *Istavrit kraça*.

Atlantic mackerel (*Scomber scombrus*)

Atlantic mackerel was traditionally caught using traditional fish weirs or *dalyans*. On October 8, 1913, the *Bulbulderesi dalyan* caught a record 520,000 mackerel in one afternoon; it was normal to catch between 4 million and 5 million mackerel annually in those years (Deveciyan, 1915/2006). The Atlantic mackerel was very abundant in the 1950s and 1960s (Peired, 2006), and has almost disappeared since 1969. At the height of their abundance, these fish measured 25 cm in length and recreational catches were easily two to four kg · day⁻¹ per fisher in the 1960s (M. Ulman, pers. comm.). The importance of this fish as food became embedded in Turkish culture. Since their decline (i.e., for the last forty years) Atlantic mackerel has been imported from Norway to meet the demand, particularly in Istanbul and other major cities.

Jellyfish (*Mnemiopsis leidyi*)

In the early 1980s, an alien species of warty comb jelly was introduced to the Black Sea, most likely from ballast water. These relatives of jellyfish, but actually ctenophores, had no natural predators in the Black Sea basin prior to their arrival. They consume mainly zooplankton and, to a lesser extent, the larvae of planktivorous fish such as anchovy and sardines (Oguz *et al.*, 2008), making them both a competitor and a predator of small pelagic fish. In 1988, comb jelly populations blossomed to over 500,000 t when extrapolated over the entire Black Sea basin (Oguz *et al.*, 2008). This jellyfish bloom is thought to have been the principal reason behind the extremely low anchovy catches along with the national 'fishery crisis', which were less than 30,000 t for the 1990-1991 winter fishing season (Knudsen, 2009). [Note that since the anchovy season is from November to February of every year, one year's catch is spread out over a two year

period. Thus, the low catch of the 1990-1991 seasons is thus not reflected in the national catch data].

Biologists then toyed with the idea of introducing another species of ctenophore, the brown comb jelly (*Beroe ovata*, a predator of *Mnemiopsis leidyi*) as a natural form of population control to help suppress the population of *Mnemiopsis leidyi*'s, but later decided that the idea was too risky. In the 1990s, the same ctenophore that was to be introduced (*Beroe ovata*), somehow naturally established itself in the Black Sea which led to a massive decline in *Mnemiopsis leidyi* populations. The *Mnemiopsis leidyi* abundance eruption in the Black Sea is seen as one of the most extreme jellyfish invasion events in the world, and has insightful implications for ecosystem operations (Kideys, 2002).

Jellyfish catches have been reported in the catch statistics from 1986 to 2006, for the moon jelly (*Aurelia aurita*). These are mainly caught by pelagic fisheries as by-catch and some may have been exported to south-east Asia. Jellyfish catches have been excluded from this study.

Striped Venus clam (*Chamelea gallina*)

Striped Venus clam is harvested by hydraulic dredge. The by-catch associated with this gear consists mainly of undersized clams, smaller than 17 mm, black mussels and crabs, which are all discarded. The estimated maximum discard rate for this fishery is 8%, with an average of 5% [Friends of the sea, 2012. www.friendofthesea.org/fisheries.asp?ID=16].

Their catches were first noted in the landing statistics in 1990 with a reported 13,000 t. Landings were highest in 2006, with 46,600 t. In the most recent decade (2000s), striped Venus clam catches have been (on average) 27,000 t. Thirty-nine vessels were equipped with hydraulic dredges targeting striped Venus clam in Turkey in 2004 (Dalgıç *et al.*, 2005).

Sturgeon (Acipenseridae spp.)

The Sturgeon family has existed for over 100 million years. They are anadromous fish which spend most of their lives in freshwater but migrate to brackish water later in life. They are a highly valued species (especially for their eggs or *caviar*), and are also easy to catch.

The Black Sea, including the Sea of Azov, was a major contributor to global sturgeon biomass, but this has changed in recent decades (Ustaoğlu & Okumuş, 2004). Sturgeon stocks in the southern Black Sea have been either extirpated or drastically reduced since the end of the 1950s. All present sturgeon species living along the Black Sea Turkish coast are considered to be "Endangered" (www.iucnredlist.org).

There were six species of sturgeon (*Huso huso*, *Acipenser gueldenstaedtii*, *Acipenser stellatus*, *Acipenser*

sturio, *Acipenser nudiventris* and *Acipenser ruthenus*) in the southern Black Sea basin until the end of the 1970s. Due to the damming of the Kızılırmak and Yeşilirmak rivers, the number of local sturgeon species decreased to four (*H. huso*, *A. gueldenstaedtii*, *A. stellatus*, *A. sturio*) at the end of the 1980s, and was further decreased to three species (*H. huso*, *A. gueldenstaedtii*, *A. stellatus*) by the beginning of the 2000s (M. Zengin, unpublished data).

Despite many legal measures to protect sturgeons, they are mainly caught as by-catch, especially due to the increasing power and pressure of the bottom trawl fishery, and to a lesser extent from sea snail dredges and extension nets in the Samsun region (Zengin *et al.*, 2011). Any sturgeons caught are marketed illegally. The only year sturgeon were reported in the national catch statistics was in 1967, with 190 t (TÜİK, 1967-2010).

Marmara Sea

History of Fishing

Traditionally, the fisheries of this sea have mainly targeted pelagic and migratory species. Consequently many demersal stocks are over-exploited, and these overall catches are unknown. The shrimp fishing fleet consists of over 200 medium-sized boats, including illegal trawlers and beach seiners targeting deepwater rose-shrimp (*Parapenaeus longirostris*; Zengin & Akyol, 2009).

Bottom trawling was technically banned in 1971 (A.Ç. Gücü, pers. comm.) in the Sea of Marmara, but the ban has not been enforced. From the reported data, it is obvious that bottom trawlers have been reporting catches from the Sea of Marmara each year since 1971. Illegal bottom trawling also occurs in the Bosphorus Strait. The late 1980s had the highest number of trawlers in the Sea of Marmara, with 269 trawlers in 1986 and 296 in 1987. Commercial fishing is also technically banned temporarily during summer months; however, before re-opening in 2010, 50 bottom trawlers were seen actively fishing (H.T. Çinarçiğil, pers. comm.).

Anchovy is the most abundant pelagic fishery species, followed by horse mackerel, bonito, bluefish and mullets, while shrimp and mussel are the most abundant invertebrate species in the Sea of Marmara. Turkey's shrimp production is dominated (72%) by catches from this sea (Zengin *et al.*, 2007). Shrimp catches increased in the early 1980s, peaked in 1989 at over 8,300 t, and have since declined due to increased fishing effort, including widespread illegal bottom-trawling (M. Zengin, pers. obs.).

Bluefin tuna (*Thunnus thynnus*)

Bluefin tuna, like many other large pelagic species, historically migrated from the Sea of Marmara to the

Black Sea. The bluefin tuna fishery in Turkey dates back to the 15th century when traps, hand-lines and spears were commonly used to capture this species (Karakulak & Oray, 2009). Turkey had 26 tuna traps in operation in the Bosphorus region in the early 20th century, which confirms a massive presence of this species in the eastern Mediterranean region (Natale, 2010).

Purse-seining for bluefin commenced in the Sea of Marmara in the 1950s (Iyigunor, 1957) when they were known to migrate from the Sea of Marmara through the Bosphorus to the Black Sea (Slastenenko, 1956). Bluefin tuna were extirpated from the Black Sea and the Bosphorus in 1988 (Natale, 2010). For the next two decades until 2007, there were no reported bluefin tuna catches in either the Black Sea or the Sea of Marmara (Oray & Karakulak, 1997), most likely directly due to both the declining state of the Black Sea environment, and also indirectly due to fishery issues (Natale, 2010). In 2007, a few specimens were caught in the Marmara and Black Seas and some small juveniles (about 700 grams each) were found for sale in the İstanbul fish market in the same year (Natale, 2010). Moreover, a small shoal of about 200 were caught in the Black Sea in 2011 (S. Knudsen, pers. obs.).

Due to extremely high market prices for bluefin, this fishery developed rapidly in the 1980s, in fleet size, vessel size and engine power; echo-sounders, sonar devices and bird radars were also commonplace in the hunt (Karakulak & Oray, 2009). In the 1980s, each bluefin tuna caught in the Marmara Sea weighed approximately 300-400 kg (Karakulak & Oray, 2009); fishers are now catching small to medium specimens weighing between 25-45 kg. Since 1989, the bluefin fishery relocated, first to the northern, and then to the southern Aegean Sea, along with the changing migration habits of bluefin. From 2002 onwards, most bluefin tuna catches have been caught in the northern Levant Sea (Karakulak & Oray, 2009). The minimum catchable size of bluefin tuna recommended by MARA is 90 cm (Oray & Karakulak, 1997). In addition to a decrease in size, catch per unit effort (CPUE) for bluefin has been decreasing since 1998, while the number of fishing days has increased. (Karakulak, 2003).

Due to tremendous unreliability of abundance and distribution data bluefin tuna stocks, a proper risk assessment of extinction probability is not likely.

Bonito (*Sarda sarda*)

The earliest records available for catches in the Bosphorus are from the time of the Trojan War; Homer, in the Iliad, had Agamemnon offer Achilles the riches of the Bosphorus fishing grounds as an enticement to keep the hero fighting at Troy. From the 8th to 6th century B.C. (Roesti, 1966), there were three thriving tuna export centres - Byzantium and Cyzicus on the Bosphorus and Aby-

dos on the Hellespont (the Dardanelles), which supplied Europe with affordable tuna, most likely bonito. Between the 1st and 3rd centuries A.D., Byzantine coins were stamped with imprints of bonito and bluefin tuna (Tekin, 1996; Karakulak, & Oray, 2009), forever embedding these species as symbols of their civilization. Two ancient philosophers, Pliny and Strabo, also commented on the vast amounts of fish found in the Golden Horn—an estuary near the southern end of the Bosphorus Strait; Pliny (23 to 79 A.D.) suggested that it was the supply of fish found within the Golden Horn that gave the Golden Horn its name, while Strabo (63 B.C. to 23 A.D.) described the fish as being so plentiful in the Bosphorus that they could even be caught by hand (Tekin, 1996). In the early 1900s, bonito were caught using 14-18 yard long fishing lines, spun from horse hair (Deveciyan, 1915/2006).

In 1960, bonito catches in Turkey were so plentiful that cold-storage facilities quickly filled to capacity and fishers were forced to take a break from fishing bonito (Roesti, 1966). Examination of long-term catch statistics reveals that bonito catches started to decline in 1980 and that bonito populations exhibit peaks in population size, once every five years (Zengin & Dinçer, 2006).

Bonito catches in Turkey peaked in 1969 with over 50,000 t and in 2005 with over 70,000 t. In recent years, huge numbers of juvenile bonito were landed which had not yet had the chance to reproduce (Zengin & Dinçer, 2006). From 2007-2010, annual bonito catches ranged from 5,000-9,400 t (TÜİK, 1967-2010).

Bluefish (*Pomatomus saltatrix*)

Bluefish or *lufer* in Turkish is highly valued for its flavour and is the staple preferred fish to eat in İstanbul (Knudsen, 2006). Bluefish are migratory pelagic predators that occur along Turkish coasts. They are targeted mainly by the artisanal sector and caught using hand lines, encircling nets and gillnets in all seas, by otter trawls in the Black Sea, by purse-seines in the Sea of Marmara (Ceyhan *et al.*, 2007), and by recreational anglers.

In the early 20th century, it was a favourite pastime of the people of the Bosphorus to catch this fish from August to October (Deveciyan 1915/2006) using handlines, with horse hair as fishing line. Total sales of bluefish at the İstanbul fish market, at this time, varied between 50 t and 380 t per day (Deveciyan, 1915/2006). As anchovy represents Black Sea culture, bluefish deeply relates to İstanbul culture. Bluefish is the most popular traditional fish species in restaurants of İstanbul (Knudsen, 2009).

Aegean Sea

Turkey's artisanal fishery uses many types of nets that, when accidentally discarded or lost, continue fishing unmanned ('ghostfishing'). Gears associated with

ghostfishing include small seine, trammel net and gillnet. Worldwide, lost gillnets amount to approximately 1% of global lost fishing nets annually (Laist, 1995); however, in Turkey the occurrence is much higher, and an annual loss rate of up to 14.5% was reported for trammel and gill nets in the Turkish Aegean (Ayaz *et al.*, 2010). Although of concern, the fishing mortality associated with this type of “discarding” is negligible and therefore not included here in our estimate of total fisheries removals.

The recreational sector often fished with dynamite in the 1950s, and fishers easily gathered hundreds of grouper and sea bream from the surface (M. Ulman, pers. comm.); black grouper (*Mycteroperca bonaci*) were so plentiful that it was a common food. The 1960s saw the introduction of scuba gear, but it was costly and not readily available until much later. In the late 1960s, hookah diving was introduced, and consequently groupers and other large sedentary fish populations were easily decimated (M. Ulman, pers. comm.).

The small-scale fishery in the tourist town of Bodrum collapsed in the 1970s after expansion of the trawling fleet. The trawlers left once stocks became depleted, but stocks never rebounded. Berkes (1986) blames this decline in abundance on the booming tourist trade for encouraging too many unlicensed part-time fishers (Ceyhan & Akyol, 2009a). In 2007 alone, Bodrum received approximately one million tourists (Kiliç & Aydoğan, 2009).

Driftnets

In 2003, the International Commission for the Conservation of Atlantic Tuna (ICCAT) banned the use of driftnets in the Mediterranean, making ICCAT member countries legally bound to the moratorium [WWF, 2012. mediterranean.panda.org/news/?12028/Long-awaited-total-driftnet-ban-in-the-Mediterranean-a-major-victory]. Although Turkey is an ICCAT member, some Turkish fishers have been reluctant to stop this fishing method. In 2009, ‘Oceana’, an environmental NGO, identified at least 30 Turkish vessels using driftnets in the Aegean and Mediterranean, targeting both swordfish and bonito; at the same time they estimated that there were 70 to 150 driftnet vessels operating in the country [Oceana, 2012. oceana.org/en/blog/2010/09/turkey-to-eliminate-driftnets-in-2011]. After intense campaigning from *Oceana*, Turkey announced that they will put an end to the use of driftnets in 2011. Driftnets cause an abnormally high number of cetacean, shark and sea turtle fatalities.

Swordfish (*Xiphias gladius*)

Swordfish are considered a delicacy in Turkey. The earliest records of the swordfish fishery in Turkey date back to the early 1900s. Fishers used row boats at this

time and had to grab hold of the tail of the swordfish (due to the potential danger of the sword), and the dragged the fish back to shore (Deveciyan, 1915/2006). Swordfish were very abundant especially at the north and south ends of the Bosphorus Strait where they were caught with surface nets and driftnets on moonless nights between September and November (Ceyhan & Akyol, 2009a); they were also often caught by harpoon and *dalyan*. Swordfish disappeared from the Sea of Marmara and Black Sea about two decades ago, so the swordfish fishery has relocated to the Aegean and Levant Seas where they are mostly caught by drift gillnets and longlines (Ceyhan & Akyol, 2009b); the drift nets used in this fishery vary from 3-7 km in length. Swordfish can only be commercially fished each year from February 1st to the end of September in all Turkish waters according to the Turkish Fishery Regulation Circular; their minimum legal landing size is 130 cm (Ceyhan & Akyol, 2009b).

Driftnets have technically been banned in Turkey since 2006; yet most swordfish fishers claim that traditional small-scale drift nets are more size-selective, (i.e. catch less juveniles) than using longlines (Ceyhan & Akyol, 2009a).

Levantine Sea

History of Fishing

In the 1930s a local purse seine fleet began to develop, and a fleet of two bottom trawlers was established as early as the 1940s, which increased to 14 vessels in just over a decade (Gücü & Bingel, 2011). Consequently, a drop in the catch per unit effort (CPUE) of demersal fish was noted in the Gulf of Iskenderun and the authorities were first alerted about potential overfishing in the mid-1950s (Gücü, 2001).

Strict restrictions on bottom trawling within the 3 mile zone in the early 1980s resulted in increased purse seine activity in Iskenderun Bay. Seine boats come to the Levantine Sea from the Black Sea in periods of high pelagic species abundances to fish (Bingel *et al.*, 1993).

Reported marine landings in the Levantine Sea were lowest in 1973 at 2,311 t and highest in 1993 at 42,289 t. In the 1967-2010 period, annual commercial landings averaged 14,000 t · year⁻¹ (Ş. Bekişoğlu, unpublished data).

Production vs. landings

Furthermore, the general Turkish concept of ‘production’ incorrectly frames the fisheries within an agriculturalist approach (Knudsen, 2009). This agricultural mentality is used to putting additional ‘input’ into the system in order to receive a greater ‘output’. It must be understood that a fishing vessel is not an ‘input’ for fish stocks, but rather similar to ploughing in agriculture. This system

seemed to have worked, until the thresholds were compromised, and (most) fishery catches started (and continue) to decline. Fortunately, since the alignment process with the European Union Common Fisheries Policy began, this agriculturalist approach has been reduced, and needs to be completely eliminated.

Fishing effort & overcapacity

Since the onset of the industrial revolution, fisheries worldwide have been severely expanding their fishing grounds and consequently altering the balance of ecosystem dynamics worldwide (Swartz *et al.*, 2010; Anticamara *et al.*, 2011). There is presently tremendous overcapacity in Turkey with respect to the size and power of the fishing fleet in comparison to the diminished state of most fish stocks.

In 1938, a tax break was introduced on imported boat engines and fishing gear to promote fishing (Üstündağ, 2010) which stayed in effect until 1996. The effect of this subsidy was not noticeable at first, due to the war, but took off after 1948. Consequently, from 1938 to 1956, fishery landings increased by a factor of nine (Üstündağ, 2010).

The Marshall Plan (around 1950) delivered fishers financial and technical aid for organizing themselves into fishery-co-operatives (Knudsen, 2009). The Marshall Plan also benefitted the fishery sector by directly financing capital investments such as boats, building major roadways, which facilitated the transportation of goods, building ports, creating cold storage facilities, and also by removing the state tax which was previously imposed on fish catches.

In the 1950s, the fishing fleet doubled in size to 6,283 boats (Üstündağ, 2010), and the 1960s saw an adoption of engines. Despite these initiatives, reported fish catches did not increase much during the 1950s and 1960s (Knudsen, 2009). In 1961, 70% of Turkey's fishing boats were motorless (Roesti, 1966). In just a decade, by 1970, over 90% of Turkey's fishing fleet had motors (TÜİK, 1967-2010), and 99.9% by 2001. In 1976, the Agricultural Bank increased the amount of start-up credits given to fishers (Üstündağ, 2010), which particularly benefitted the industrial fishing sector; S. Knudsen explains, "that there was a legal void that, gave almost free rein to the growing fleet of purse seiners and trawlers" (Knudsen, 2004). The purse seiners evolved swiftly due to technological advancements, increased demand, and state-sponsored infrastructure and credit (Knudsen, 2004).

The trawling fleet was additionally encouraged by a relaxation of the three-mile coastal limit to accommodate the fleet (Berkes, 1986). The length of net per fisher also increased by a factor of five along the coast of south-west Turkey between 1950 and 1980 (Tudela, 2000). Fishing

boats got the opportunity to exploit new areas by extending their reach during this time.

In the 1970s, with the help of new technologies, catch capacity began to exceed demand (Knudsen, 1995). Since fish is marketed fresh, both regionally and nationally, the bumper catches of anchovy and horse mackerel were initially difficult to sell. To respond to the increased landings, the State Planning Organization supplied fishing co-operatives and entrepreneurs with generous credits (40% of investment costs) to establish anchovy processing plants. Over twenty new anchovy processing plants were established.

Since the fisheries were very lucrative at this time, successful fishing companies were able to increase their size and number of boats. Efficiency was increased due to increased engine power (Sağlam & Duzgüneş, 2010) and the adoption of radar, sonar and satellite by the commercial industry (see Jacquet *et al.*, 2010). Knudsen (2003) reported that all fishers accept that sonar has a damaging effect because it increases catch capacity; as one fisher noted, "there is no such thing as fishing luck any longer" (Knudsen, 2009). **In recent years, the government has encouraged the adoption of sonar to increase fishing capacity (Knudsen, 2003).** The banning of sonar use is another idea to help restrict fishing capacity but would be very difficult to enforce. The most significant reduction in fishing capacity is expected to result from structural aid for the decommissioning of boats, if and after Turkey is allowed to join the EU (Knudsen, 2008).

By-far, the highest cost to Turkish fishers is gasoline, which cost US \$11 million in 2010 (TUIK, 2010). In 2002, the Turkish government introduced a diesel fuel subsidy; the normal diesel fuel price is 3.34 Turkish lira (TL)/litre (US\$1.90) and the subsidized price is 1.26 TL/litre (US\$ 0.71; Anon., unpublished data). Almost all commercial/industrial boats take advantage of this diesel fuel subsidy, while less than 35% of boats smaller than 12 meters do (Üstündağ, 2010). **This is because the diesel is sold by large tankers to customers who buy large quantities, thus disqualifying the small-scale sector.** This diesel subsidy is the single most-important instrument allowing commercial fisheries to operate continuously; without the subsidy, fishing would be much less economically viable. Also, this diesel fuel subsidy encouraged an increase in total engine power, adding to the overcapacity issue (Knudsen *et al.*, 2010).

Fuel subsidies contribute 23% of the world total in fishery subsidies, and are viewed as 'capacity enhancing' subsidies (Sumaila *et al.*, 2010); beneficial subsidies also exist which enhance sustainability through conservation, monitoring, control and surveillance. Fuel subsidies directly influence overcapacity by subsidizing the cost of operation and artificially increasing the profit margin (Sumaila *et al.*, 2010). **It is often these artificially increased profits that allow these industrial fishers to con-**

tinue to operate when they would normally be operating at a loss, and be forced to stop operating and over-exploiting without this form of aid, thus distorting the bio-economic equilibrium.

From 1991-2008, Turkey tried to control its fishing fleet by introducing a moratorium on new fishing licenses. This control method had three suspensions of the moratorium (1994-1996, 1997-1999 and 2001), whilst the outcome was that the fishing fleet actually doubled in size (from 8,200 boats in 1994 to 18,100 boats in 2002). Over 4,700 boats have entered the fishery since 2001 (Fig. 8). The licensing system has since been reinstated, but it is not the solution to restricting fishing effort (Ünal, 2004), since loopholes were found such as allowing boats to increase the size and the engine power of their vessels by 20% (Koşar, 2009).

Recently, biological and bio-economic assessments were made using catch data (from 1991-2008) to estimate the status of marine fish stocks and to provide estimates for optimal fleet capacity. The results suggest an excess in capacity of over 350% for all of Turkey's seas combined. In the Black Sea, anchovy fishing capacity exceeds by 200%, and the Black Sea fishery for all species combined has excess capacity of approximately 250%. Turkey's other seas have an excess capacity of $\geq 500\%$. If overcapacity is not addressed soon, catch per unit effort, fish length, and stock sizes will continue to decline as they are at present.

Fleet capacity management, is both strategically and technically the most powerful and least costly method for managing fisheries; however, it is rarely practiced because fishery managers do not want to deal with the short term political problems associated with fleet reduction programmes. The other strategy more commonly practiced, is to hand out long-term subsidies to fishers, which greatly exceeds the costs of capacity control.

The European Union has been experimenting with ways to reduce fishing capacity for decades. Previous attempts at reducing overcapacity have failed because a 'one size fits all' solution was applied, which resulted in smaller boats getting decommissioned but left overall fishing capacity unchanged. The Common Fisheries Policy (CFP) of the EU has been in place for 28 years but has largely failed to save fisheries. The policy is accepting proposals and is due for reform by 2013. The new OCEAN 2012 campaign is one such proposal to make the CFP effective by aiming to promote low-impact fishing and the elimination of destructive and unsustainable practices. Member countries are required to report annually about the balance between the capacity of their fleets and resource availability, and if they fail to do so, it will result in the denial of access to these resources. Other proposals for a reformed EU Common Fisheries Policy include sustainability and long-term measures such as bringing all fish stocks to sustainable levels by 2015,

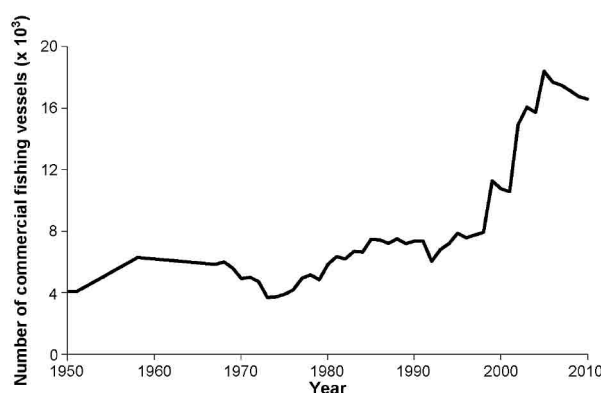


Fig. 8: Total number of registered fishing boats in Turkey, 1950-2010.

adopting an ecosystem approach for all fisheries, setting defined targets and time frames to end overfishing, putting an end to discards, protection measures for the small-scale sector, only providing financial help to sustainable initiatives and a strict control mechanism which will exclude any perverse funding of illegal activities or overcapacity [Europa, 2012.europa.eu/rapid/pressReleasesAction.do?reference=IP/11/873&format=HTML&aged=0&language=EN&guiLanguage=en] from EU buyback schemes, where fishing boats are bought for their removal from the industry, have shown to be unsuccessful unless accompanied by a method which prohibits the re-entry of boats into industry, and also limits the expansion of effort. Learning from both the (unsuccessful and successful) trials of other nations battling with the issue of overcapacity will benefit the implementation of an effective programme. Without management measures aimed at more sustainable fishing practices, catch potential, revenue and jobs will continue to decline. The people who will suffer the most are the many artisanal fishers, who cannot afford to expand their fishing ranges to new areas, as commercial fishing has traditionally done. Compared to the other stresses that the ocean is facing, such as climate change, ocean acidification, de-oxygenation and shifting baselines (i.e. the gradual change in trophic structure, only noticeable over time, www.shiftingbaselines.org), overcapacity is the easiest stressor to address.

Another possible management measure is to introduce Total Allowable Catch (TAC) quotas, which allocate an individual, vessel or company a maximum allowable catch of a species. Before this can be implemented, the amount of existing stock must be assessed from stock assessments, which are costly. This is in operation for turbot and sprat fisheries in the Black Sea and their total allowable catches are allocated based on historical catch amounts (GFCM, 2011b). Since stock assessments have not been completed for most species; it is unlikely that TAC quotas will be able to begin anytime in the near future to help alleviate some of the fishing pressure. For

this method, control and inspection would have to be functioning parts of management, and loopholes would need to be addressed and closed.

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