ACTUAL AND PERCEIVED DECLINE OF FISHERY RESOURCES IN TURKEY AND CYPRUS: a HISTORY WITH EMPHASIS ON SHIFTING BASELINES

by

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ABSTRACT

The FAO global statistics on fisheries catches is an important tool used to track overall patterns, as it represents the only global account of fisheries catch records from all member countries. However, the database is only as complete as the data sent to them by member countries, which often lack catch amounts from non-commercialized sectors.

The aim here for Chapters 2 and 3 were to comprehensively account for total fisheries removals for Turkey and Cyprus from 1950-2010, by estimating catches for previously unaccounted sectors, using best available data. It was found that the total reconstructed catch for Turkey was about 80% higher (33 million t) than the 18.4 million t reported to FAO during the period from 1950 to 2010. The total reconstructed catch for Cyprus was about 2.6 times higher (243,000 t) than the 93,200 t reported to FAO for Cyprus for the same period, which thus excluded catches from the north of the country from 1974 to 2010.

For Chapter 4, using total reconstructed catches and annual fleet dynamics statistics, total effort and Catch Per Unit Effort (CPUE) were calculated for Turkey as a whole, and each of its seas. Next, from field survey results from Turkey and Cyprus, each fisher's ratio of initial to current CPUE and perceived change in resource abundance was computed for their career span, according to sector. Lastly, the two trends in ratio of initial to current CPUE and perceived change in resource abundance were compared to determine if 'shifting baselines' had occurred. For Turkey as a whole total effort increased by over 700% from 25 million kW days in 1967 to nearly 190 million kW days in 2010, while CPUE declined by about 380% from nearly 16 $kg \cdot kW^{-1} \cdot day^{-1}$ in 1967 to 4 $kg \cdot kW^{-1} \cdot day^{-1}$ in 2010. Shifted baselines were evident in all but two surveyed sectors (i.e., the bottom trawlers of Turkey, and artisanal fishers of South Cyprus). The artisanal and recreational sectors of Turkey experienced the most severe changes, with declines in CPUE of about 40 times since about 1950.

PREFACE

Daniel Pauly, my research supervisor helped to conceptualize each chapter and its associated methodology. With the exception of the bookend Chapter 1 and part of bookend Chapter 5, each chapter in this thesis has been prepared as a stand-alone manuscript. While all of the preliminary research and data acquisition was completed by myself, a few local scientists helped with some field data collection, and each co-authors' share of the contributions are detailed below. All of the background research, data entry, analyses, and writing was completed by myself.

List of publications arising from work presented in the thesis:

Chapter 2. Turkish Reconstruction. A version of Chapter 2 has been published.

Ulman A, Bekişoğlu Ş, Zengin M, Knudsen S, Ünal V, Mathews C, Harper S, Zeller D and Pauly D. 2013. From bonito to anchovy, a reconstruction of Turkey's marine fish catches (1950-2010). *Mediterranean Marine Science.* 14(2): 309-342. The contributions of the co-authors were as follows: Şahin Bekişoğlu provided me with the raw fisheries catch data for Turkey from 1967-2010; Mustafa Zengin provided me with several unpublished discard rates from the Black Sea from his work and helped to assign individual taxonomic groups according to sector; Stale Knudsen helped develop the history of fisheries section and provided useful comments on fisheries governance; Vahdet Ünal provided me with his study on recreational fishing in the Dardanelles and helped establish anchor points for the recreational fisheries; Christopher Mathews provided me with some recent unpublished work on the same topic to use as reference; and Sarah Harper, Dirk Zeller and Daniel Pauly provided guidance in establishing the necessary anchor points and with editing of the text.

Chapter 3. Cyprus Reconstruction. A version of Chapter 3 has been published.

Ulman A, Çiçek BA, Salihoglu I, Petrou A, Patsalidou M, Pauly D and Zeller D (2014). Unifying the catch data of a divided island: Cyprus's marine fisheries catches, 1950-2010. *Environment, Development and Sustainability* 16(4): 23. The contributions of the co-authors were as follows: Burak Çiçek surveyed 140 fishers from the artisanal sector in the Turkish north of the island for the study; Burak Çiçek and Ilkay Salihoglu both interviewed the Department of Fisheries in the north and delved into the historical fisheries archives for the study; Antonis Petrou and Maria Patsalidou provided some of the necessary raw data for the Greek south of the island, answered my queries and validated my assumptions. All of the data entry, data analyses, and write-up was done solely by myself. Dirk Zeller and Daniel Pauly advised on the methodology, and helped to organize and edit the manuscript.

Chapter 4. Evidence of declining catches and shifted baselines for Turkish and Cypriot fisheries. A version of Chapter 4 has been submitted.

Ulman A and Pauly D (submitted). Conveying memories into knowledge: Using history to reset the shifted baselines of Turkish and Cypriot fishers. I completed approximately 85% of the field surveys with local fishers, and completed all of the data analyses and the write-up myself. Dawit Tesfamichael, Ayana Johnson and Terre Satterfeld helped structure the survey design. Statistical advice was first provided by Rick White, managing director of SCARL, Department of Statistics, UBC. My supervisor Daniel Pauly also provided statistical advice and helped with the editing and sculpting of the manuscript.

Chapter 5. Conclusion. Ulman, A. (2014). Urgent change in management measures required to save Turkish fisheries from collapse. *Journal of Coastal Development*, 17(1). DOI: 10.4303/1410-5217.1000386. This short communication piece was written solely by myself and was edited by Dirk Zeller. A portion of this manuscript was used in this conclusion.

Ethics

The Behavioural Research Ethics Board (BREB) from the University of British Columbia certificate number is H13-00012, and approved of the research conducted in Chapters 3 and 4.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

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I also express extreme appreciation for both my committee members, Rashid Sumaila and William Cheung for their advice, positive outlooks and particularly, their inspiration. These three role models combined taught me that to make a difference, one must think outside the box, and also be quite daring.

I also thank my supervisor of the *Sea Around Us*, Dirk Zeller for his remarkable editing skills, and, of course, for his friendship.

As per classmates and co-workers, both old and new, I would like to sincerely thank Sarah Harper, Mathieu Colléter, Anna Schuhbauer, Vicky Lam, Claire Hornby, Yago Coll, Catarina Wor, Chiara Piroddi, Beau Doherty, Dana Miller, Dyhia Belhabib and Robin Ramdeen both for their academic inputs and supportive friendships.

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Keskin, Antonis Petrou, Sezgin Tunca, Metin Ulman, Baba Yalçin and Tefik Yilmaz. We also thank Terre Satterfield, Katy Seto and Dawit Tesfamichael for their help with the survey design. In addition, the completed interviews and associated data were only made possible by the generosity and compassion of the fishers.

Lastly, I thank my father Metin Ulman for instilling on me his love and passion for the aquatic realm, and for sharing his distress about how some of us treat our planet. Special thanks are owed to both my parents, who sacrificed their early adulthood so that I had the freedom and the means to chase my passions.

DEDICATION

For my extended family, who share the same passion for the sea and all of its wonderful creatures.

1: INTRODUCTION

The context

Most fishers who have worked in the Eastern Mediterranean Sea for a long period of time would explain that the local fish stocks have been severely compromised, yet sources documenting these changes are rare. This is due in part to the lack of comprehensive (and hence accountable) fisheries statistics necessary to determine overall and individual trends in catches, a lack of interest from local fisheries scientists to understand or study how far from the natural baseline they have shifted, and a general unawareness of the public about the state of the marine ecosystem due to a lack of education in marine ecology.

Before the degree of change could be documented, two national fisheries catch reconstructions were first completed, one for Turkey (Chapter 2) and one for Cyprus (Chapter 3) for the 1950-2010 period to assess their total marine fishery extractions. To complete this task, fisheries removals for each sector were considered. The fisheries statistics voluntarily provided by member countries' to the Food and Agriculture Organization (FAO) of the United Nations are used to make inferences on global fisheries (FAO 2010, 2012; Garibaldi 2012). Nevertheless, for most countries, the catches from non-commercial sectors are missing from the data, causing the global statistics to underestimate total catches. The results of the catch reconstructions for both Turkey and Cyprus are now included in the *Sea Around Us* global database of marine catches (freely available at www.seaaroundus.org).

After having established a more accountable and comprehensive time-series of fisheries statistics for both Turkey and Cyprus, total CPUE was calculated for Turkey and for each sea, along with total effort to illustrate the potential decline in relative abundance of fisheries resources in the area; then fishers were surveyed in Turkey and Cyprus to document their ratio of initial to current CPUE over their careers, and their perceived change in resource abundance (Chapter 4). Next, the two trends were compared to determine if their baselines had shifted (i.e., if they were unaware of past changes to the ecosystem).

Shifting baselines refers to the phenomenon that as resource abundance gradually declines, each new fisher perceives the status of the marine ecosystem based on their personal experience during their fishing career. If each generation of fishers begins their career with an already compromised ecosystem, this can soon lead to a general unawareness of past changes, and hence rapidly declining resources and biodiversity loss can go unnoticed.

My connection

I have a unique connection which enabled me to focus on the key portions of this research. My father, Metin Ulman, was of the first generation of Turkish navy scuba divers circa 1955 which allowed him to be one of the first people to explore the pristine underwater realm of the Turkish Straits in the 1950s, a time well-before recreational snorkelling and scuba diving were introduced. Then, the Bosphorus contained a pristine ecosystem, turquoise as the Aegean Sea is now often with over 100 foot visibility. It was then blanketed with large mussels on each inch of the seafloor (Gürtürk 1972) which kept it clean, and was also graced with many incredible large pelagics such as swordfish (*Xiphias gladius*), and 25 kg bonitos (*Sarda sarda*), along with a plethora of invertebrates, which were then all too easily caught. My father was also an avid skin diver and fisher throughout his life which gained him a valued perspective of the change most others are unaware of. Metin Ulman was active in many aspects of this research, especially by passing down his stories, validating some early assumptions on the historical ecosystem, and introducing me to his fellow fishers from his hometown, most of whom were interviewed for Chapter 4.

The study areas

The FAO includes both Turkey and Cyprus in FAO statistical area 37 (Mediterranean and Black Seas), which is further divided into sub-areas: 37.3.1 ('Aegean Sea'); 37.3.2 (eastern portion of the Mediterranean Sea, which included Cypriot waters and is here referred to as the 'Levantine Sea'); 37.4 ('Black Sea') which is further divided into 37.4.1 ('Marmara Sea'), 37.4.2 (the 'Black Sea' proper), and 37.4.3 (the 'Sea of Azov', not discussed here).

Turkey, by far has the largest inshore fishing area (IFA) in the Mediterranean and Black Seas with just over 56,520 km^2, and Cyprus has an IFA of 3,113 km^2 (www.seaaroundus.org). The IFA is defined as waters to 200 m in depth or 50 km distance from the coast, whichever comes first (Chuenpagdee *et al.* 2006).

Turkey

Turkey is a country spanning Europe and West Asia, whose shoreline touches three major seas: the Black Sea, the Aegean Sea and the Levantine Sea in the eastern Mediterranean, and one inland territorial sea, the Sea of Marmara (Figure 1.1).

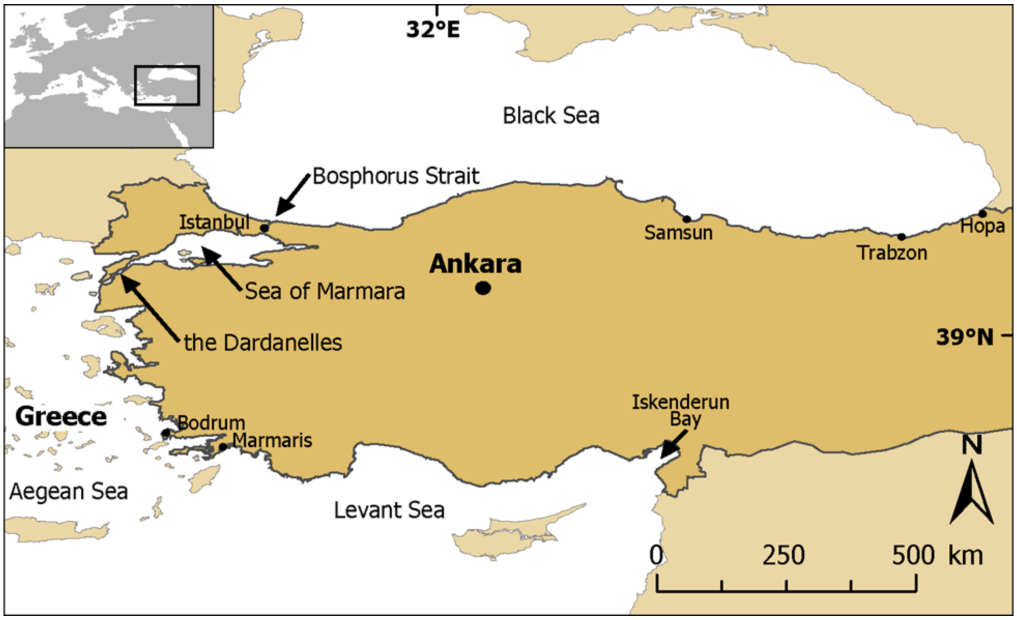

Figure 1.1. Turkey and its four surrounding seas: the Black Sea, the Sea of Marmara, the Aegean Sea and the Levantine Sea. Also shown are cities and straits discussed in this chapter.

The Black Sea

An old connotation from the Ottoman language for either 'great' or 'terrible' (the latter possibly due to its roughness), is thought to give the Black Sea its name. It could also be named for its great depths (over 2,200 meters) leading to very low visibility. Others suggest the sea is named from ancient maps from the European Steppe people; wherein, the north compass which points to the sea, is black (King 2004). Aside from Turkey, Bulgaria, Romania, Ukraine, Russia and Georgia also border and share the Black Sea. The uppermost 150 meters of the water column represent an area of great biological productivity, while the lower 90% of the basin, or depths below 100-150 m are naturally anoxic (very little or no dissolved oxygen), and have likely been anoxic since the Bosphorus (or possibly spillover from the Caspian Sea) inundated this basin. The influx of large amounts of freshwater from rivers (Danube, Dnieper, Dniester, etc.), raised the water level about 150 meters and created a lower density surface layer which inhibits mixing.

During the 1980s, the anoxic layer, the largest in the world, increased due to massive agricultural runoff from the eastern bloc countries (Kideys 2002) and also due to increased eutrophication from the many European rivers that drain central Europe, particularly the Danube, which emptied into the Black Sea. Nutrient input levels have decreased since the mid-1980s and the ecosystem has been showing some signs of recovery since the early 1990s. Another important feature of the Black Sea is the presence of a sharp thermocline; the surface temperature decreases up to 10°C in the mid-thermocline layer (Zengin 2006). This thermocline layer exists in summer at depths of 40-70 m and is beneficial in enhancing the growth of many small pelagic species such as anchovy (*Engraulis encrasicolus*), sprat (*Sprattus sprattus*) and whiting [*Merlangius merlangus*] (Zengin and Knudsen 2006). This thermocline is, in part, responsible for making this Large Marine Ecosystem (LME) so productive for small pelagics.

At present, this sea has a low average salinity of 18 psu because there are many large rivers that flow into the Black Sea (such as the Danube), but only one way for the water to exit, and that is southwards via the Bosphorus Strait (`*Istanbul Bogazi*` in Turkish). In 2010, catches from the Black Sea represented 68% of total Turkish catches.

The Sea of Marmara including the Bosphorus and the Dardanelles

Beginning at the south-end of the Black Sea, the Bosphorus Strait has a two-layer flow: brackish water at the surface flows into the Mediterranean; and seawater enters along the bottom layer from the Sea of Marmara to the Black Sea, thus connecting the two seas. The Bosphorus, along with the Sea of Marmara and the Dardanelles connect 'East' to 'West', but also separate Europe from Asia (or Anatolia), with Asia to their 'East' and Europe to their 'West'. Turkey, whose territory covers both sides of the Bosphorus is thus, with Russia, the only country that straddles both Europe and Asia. The 30 km long Bosphorus Strait (Figure 1.1) has always been of strategic and economic interest due to its unique position on an important maritime trade route. The Bosphorus is the world's most narrow strait, and is used intensely for shipping. The city of Istanbul, bustling with 17 million inhabitants, spans the southern half of the strait. The Bosphorus most likely also formed the same time as the Black Sea, between 5,000 and 8,000 years ago, due to rising sea levels (Zaitsev and Mamaev 1997).

The Sea of Marmara is Turkey's small (only 11,350 km^2 in area) inland sea, which also separates 'Europe' from 'Asia'. Salinity increases to about 22 psu at the south end of this sea. The Marmara Sea was named after the Greek world for marble (i.e., *marmaros*), which has been mined from its islands since antiquity. In this report as well as in the official statistics, the catches of the Bosphorus Strait (Istanbul) and the Dardanelles are included in the catches of the Sea of Marmara. The Marmara Sea is the smallest of Turkey's four seas, occupying only 4.5% of Turkey's total fishing area. The Sea of Marmara differs from Turkey's other seas in that it is entirely surrounded by heavy industry and population densities in Turkey. Boat traffic is also an issue since as many as 50,000 vessels each year travel through this sea to or from the Bosphorus.

South of Marmara Sea, the Dardanelles are another natural strait, roughly twice the length of the Bosphorus, which connect Marmara Sea to the Aegean Sea, and which together with the Bosphorus, make up the 'Istanbul Straits System'. The Dardanelles, due to its narrow and winding nature, in combination with strong currents, is considered to be one of the most hazardous and dangerous waterways to navigate in the world. In 2010, this area provided 18% of Turkish marine fishery catches.

The Aegean Sea

From the south of the Dardanelles, the Aegean Sea begins and encompasses the west coast of Turkey to the Turkish city of Marmaris, on Turkey's south-western coast. The Aegean Sea is located in the north-eastern Mediterranean (Figure 1.1). In contrast to the Black Sea, the Mediterranean is known as the 'White Sea' in Turkish, i.e., '*Ak Deniz*' (King 2004). Greece lies to the north and west; and Turkey to the east. It includes over 1,400 islands, most of them belonging to Greece. The Turkish sector of the Aegean is very small and narrow, and varies in width from approximately 50 km in the north, to around 10- 15 km for the remainder. The Aegean Sea is known for its turquoise and clear waters due to its extremely low nutrient levels and, consequently, its low marine fishery catches. In 2010, the catches of the Aegean Sea represented less than 9% of Turkey's total commercial fish catches.

The Levant Sea

Finally, the southern coast of Turkey, in the easternmost part of the Mediterranean, is also called the 'Levantine Sea', after the Levant Basin of which it is a part (Figure 1.1). The Turkish share of this sea consists of a narrow coastal strip which spans from the city of Marmaris in the west, to the Syrian border in the east. The continental shelf is between 50-200 m deep and only between 10-20 km wide, which is suitable for demersal fishing. From the Turkish city of Mersin, eastwards, the continental shelf widens to 80 km, which is called Iskenderun Bay, a popular fishing ground for bottom trawlers. The remainder of Turkey's national waters in this area are very deep and only suitable for pelagic fisheries. Due to three rivers which bring terrigenous nutrients to the continental shelf area in south-eastern Turkey (the Seyhan, Ceyhan and Goksü), this portion of the basin used to be very abundant in terms of marine life

(Kosswig 1953); and Iskenderun Bay was perceived being a very productive fishing grounds in the early 1950s. In 2010, this sea represented 5% of Turkish total marine catches.

Cyprus

Cyprus is the third largest island in the Mediterranean after Sicily and Sardinia. Technically, the island is divided into three segments: The Republic of Cyprus, which has an internationally recognized government and is situated on the southern two-thirds of the land area; The Turkish Republic of Northern Cyprus, which is situated on the northern third of the island; and the buffer zone controlled by the United Nations that separates the two sides.

For the purpose of this study, 'north' refers to the people and area north of the 'Green Line', while 'south' refers to the people and area south of the 'Green Line' (Figure 1.2). 'United Cyprus' is the term given to the period from 1950-1973 when the island was unified, after which the term 'Two solitudes' is used to represent the island's period since its division.

The history

Turkey

The first president of modern Turkey, Mustafa Kemal Atatürk, established the republic of Turkey in 1923 and was responsible for transforming the country into a 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.

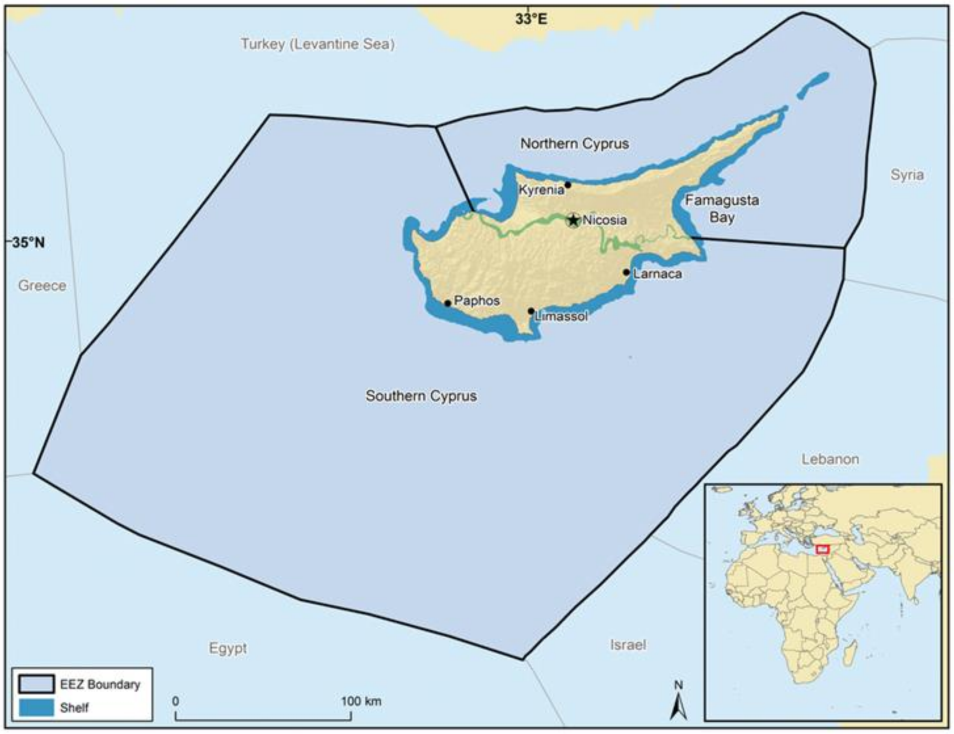

Figure 1.2. The island of Cyprus, showing the 'Green Line' which divides the north and the south, the capital city (Nicosia), fishing ports in the biggest cities/towns, and the Exclusive Economic Zones (EEZ) in the north and south (light blue) as assumed by the *Sea Around Us* project based on a basic, non-binding interpretation of fundamental UNCLOS principles, and the continental shelf (darker blue).

From 1950 to 2010, Turkey's population grew from 21 million (www.turkstat.gov.tr) to 74 million people (www.tradingeconomics.com/turkey). Along with this massive population growth, an urbanization trend also occurred since the 1950s. In 1950, only about one fifth of the population lived in cities, while four fifths lived rurally (Keles 1982), but by 2010, approximately 70% of the total population lived in a city. The bulk of Turkey's population now lives either in Istanbul (which houses about 18% of the population) or coastally along the western shore[1].

[1] www.citypopulation.de/Turkey-Istanbul.html

Cyprus

Cyprus had its earliest inhabitants arrive during the Neolithic period (the end of the Stone Age), known for the commencement of farming. It was likely settled from the coastal areas of the Eastern Mediterranean, such as present-day Syria and Anatolia. Since then, several groups of people of different ethnic origins have settled. The island's natural resources such as copper combined with the availability of arable land, attracted early farmers as well as with copper miners and processors to the island. Since Cyprus holds a strategic location in the eastern Mediterranean, it has been occupied by many major powers during its long history, such as Assyrians, Egyptians, Phoenicians, Hittites, Achaeans, Romans, Byzantines, Crusaders, Turks and British. Ancient Greeks settled in Cyprus as early as the second millennia B.C., and legend has it that these were heroes from the Trojan War (Brown and Cattling 1986). St. Barnabas, originally a Jewish-Cypriot who guided St. Paul to Cyprus, is thought to have brought Christianity to the island in 45 A.D. (Hill 1949), while the first encounter of Cyprus with the Islamic religion began in 632 A.D. when the Arab invaders under Abu Bakr (according to Arab and Greek chronicles) presented themselves in Cyprus capturing the Byzantine city Salamis (Constantia) and converted the large basilica of St. Epiphanios into a mosque. Cyprus was under Ottoman rule from 1570-1878, during which time many Turks settled on the island (Gazioğlu 1990). In 1878, Cyprus came under British rule, which lasted until 1960.

On August 16, 1960, Cyprus became independent as 'The Republic of Cyprus'. In 1963 tension and conflict arose on the island between the Turks & Greeks. In 1963, a United Nations officer drew a cease-fire line partitioning the island's capital Nicosia, on a map using a green crayon, ever since referred to as the 'Green Line'. The 'Green Line' runs east-west through Cyprus and Nicosia, thus bisecting the capital, and making it the only divided capital in the world (Figure 1.2).

On July 20, 1974, the first president of Cyprus, Archbishop Makarios, was overthrown in a coup d'état by rebels backed by the then ruling Greek junta, and this led to the death of several hundred Greek and Turkish Cypriots. This provided the Turkish government with a pretext to send in troops to protect the Turkish Cypriot population; these troops have since occupied the northern third (37%) of the island. Around 180,000 Greek-Cypriots moved from the north to the south of the island, and approximately 40,000 Turkish-Cypriots moved from the south to the north. The previous homes of Greek-Cypriots in the north were distributed to the new Turkish settlers (Kacowicz and Lutomski 2008), but many homes in the north remained deserted as the number of displaced Turkish Cypriot's represented close to half the previous Greek Cypriot population. The absorption of Greek Cypriots into the south was disadvantaged by their larger population and a smaller inventory of vacated properties (Kacowicz and Lutomski 2008). Both parties lost all of their possessions and required assistance.

In 1983, the north was unilaterally declared the 'Turkish Republic of Northern Cyprus (TRNC)', which is recognized as a separate state only by Turkey. Since 2003, a handful of check-point crossings on the 'Green Line' in Nicosia were opened, granting entry to either side. In April 2004, the entire island of Cyprus was admitted into the European Union, but only the south is protected by EU legislation until the current political problem is resolved. The Republic of Cyprus has the only internationally recognized government on the island. Cyprus lies on many geopolitical fringes, between Greece and Turkey, Christianity and Islam, East and West, Europe and Asia, and now inside and outside the EU (Papadakis *et al.* 2006). In 2011, the north was comprised of approximately 60,000 Turkish Cypriots and about 150,000 Turkish immigrants (www.windowoncyprus.com/politics.htm), and the population of the south in 2011 was 803,000[2].

[2] www.indexmundi.com/cyprus/demographics_profile.html

The history of fishing

Turkey

In the early 1900s, Greeks, Lazes (people from the south-eastern Black Sea coast) and Armenians made up the majority of fishers in Turkey (Aflalo 1911); the Greeks and Armenians even introduced the purse seine net to Istanbul in 1885 (Knudsen 2011). Turks generally replaced these fishers after the exchange of populations that followed the last war between Greece and Turkey (1919-1922), and after a hefty tax was imposed on wealthy non-Muslims in 1942. With Istanbul's constant growth, many migrants were pulled to Istanbul from central Anatolia, thus many new Turkish fishers lacked a historical maritime connection. Old Turkish fishers (>80 years old) are a rarity in Turkey, except for the few who have managed to invest in their business and technology in times of profit and with state-handouts to purchase larger, more efficient vessels. These men are the fathers and grandfather of industrial fishers of today.

The first detailed description of Turkish fish and fisheries is '*Balık ve Balıkcılık*' (Deveciyan 2006). In this book, first published in French in 1923 as '*Pêche et pêcheries en Turquie*' and again in 2006 in Turkish, species composition in relation to their sales was recorded from 1909 to 1923 from the Istanbul fish market, including weight and price. Mean annual marine catches were approximately 9,500 metric tonnes (t) annually, estimated from the Istanbul fish market. The fish most abundantly caught and sold during this period were bonito and Atlantic mackerel (*Scomber scombrus*).

In the 1930s, total national reported catches were between 25,000 and 30,000 t (Üstündağ 2010). The main species caught at this time throughout the Aegean, Marmara and Levantine Seas were primarily bonito and Atlantic mackerel, and secondly, anchovy, European pilchard (*Sardina pilchardus*) and turbot (*Scopthalmus maximus*). Bonito was such a staple, that in 1937, they comprised 18,000 of Istanbul's

26,000 t of marine landings (Üstündağ 2010), or over two thirds of total catches. Anchovy was the most important catch from the Black Sea region at this time; one author estimates annual anchovy catches at around 1,500 t from one among many cities along the Black Sea coast (Sayilir and Babuçoğlu 1972). Excess anchovy catches from years with high abundance were utilized as manure and fertilizer. Catch capacity for all species was under-developed, as fishing gear was very simple; it consisted of rowboats, fish traps and cotton fishing nets (Knudsen 1995). According to an early fisheries report from Istanbul from the 1940s (İstanbul Belediyesi undated), about half of the total marine landings from 1944-1948 consisted of bonito. In the 1950s, coastal artisanal fishing typically involved nets and lines, purse seining for anchovy, beach-netting and the shooting of dolphins (Knudsen 2009).

From 1953-1958, total national reported fishery landings varied between 100,000 and 110,000 $t \cdot year^{-1}$ and peaked in 1956, with 140,000 t (Üstündağ 2010). In this period, fisheries statistics were notoriously inaccurate since reported landings were derived from estimates based on sales records of some fish markets, and after that they were based on sub-sampling surveys, rule of thumb and 'guesstimates' as described in Chapter 2 in the section on 'Unreported and under-reported catches'.

Many fisheries soon became over-exploited due to the development of industrial practices, which initially developed in parts of Turkey in the 1950s, such as in Iskenderun Bay where a drop in catch per unit of effort (CPUE) was noticed along with the increasing effort by the bottom trawling fleet (Gücü and Bingel 2011), although the majority of industrial effort commenced in the 1970s and 1980s. With the aid of new technologies, subsidies and tax credits to the fishing industry, the rapid growth of fishing capacity was encouraged. Due to overfishing in the early 1960s and 1970s, the structure of catches shifted significantly from larger, valuable fish species (bonito, Atlantic mackerel, large bluefish *Pomatomus saltatrix*) to smaller, less valuable ones (such as anchovy and sprat). Consequently, fishing fleets started targeting smaller species, resulting in by-catch of the larger, less abundant fish species (BSERP 2007).

The late 1970s saw a huge increase of anchovy catches, with demand following suit in the 1980s. This was largely influenced by the economy of Turkey changing from a state-led to a market-based economy during the 1980s (Zengin and Knudsen 2006). The year with the highest reported marine fish and invertebrate catches in Turkey was 1988 with 623,404 t, not 676,000 t, as stated in "The present status of fisheries in Turkey" (Harlioğlu 2011). State-led investments in the fisheries increased dramatically during this time, for example, credit to the fisheries sector totalled around $ 4 million US in 1976 and peaked at around $ 30 million US annually by the late 1980s (Knudsen 2009). Many anchovy processing plants were quickly constructed along the Black Sea coast to deal with this 'new', highly abundant fish resource, many of which received a 40% investment grant from the government (Knudsen 2009). In 1983, there were just two anchovy factories, which increased to 25 by 1995 (Üstündağ 2010).

The late 1980s saw a collapse of fish catches in the Black Sea, which decreased from almost 500,000 t in 1988 to 190,000 t by 1991 (TÜİK 1967-2010), due to the overcapacity of Turkish fishing vessels, increased eutrophication and also an alien invasion (under jellyfish in 'Major fish stocks' later in this chapter). This was deemed a national 'fishery crisis' that changed people's perception of the status of fisheries resources, which they began to regard as fragile, rather than inexhaustible. However, the crisis also resulted in a shift in target fisheries from small pelagics (purse seiners) to demersal fish (bottom trawlers) in the Black Sea (Knudsen, 2009), and then subsequently to a decline in catches of demersal fish species. Details of the anchovy collapse from the 'fishery crisis' are discussed under 'anchovy' in the `Major fish stocks' section.

Many bottom trawl vessels, after experiencing low catches throughout the 1990s, switched their target fisheries again from demersal fish to small pelagics such as sprat. While more abundant, yet much less valuable, sprat are not used for direct human consumption, but rather for fish meal/oil production (European Commission 2007; Zengin *et al.* 2011).

Species composition has dramatically changed in the last fifty years. In the 1950s and 1960s, most fisheries landings were composed of larger, valuable species such as Atlantic bonito, Atlantic mackerel, bluefish, grey mullet (Mugilidae), turbot, red mullet (*Mullus barbatus*), pike-perch (*Sander lucioperca*), and seabream (*Diplodus* spp.) (Hinrichsen 1998), and around 35% of total catches consisted of smaller forage fish such as anchovy or sprat. The situation is now reversed, as most of the larger fish species have been removed from the system, while anchovy, sprat and pilchard together accounted for 78.5% of total fish catches in 2010 (TÜİK 2010). Bluefin tuna (*Thunnus thynnus*) and Atlantic mackerel ceased their annual migrations to the Black Sea roughly 20-30 years ago (Knudsen *et al.* 2007), but can still be found, albeit in drastically reduced numbers. This loss of biodiversity and especially top predators has substantially reduced the stability of the marine ecosystem. The amount of commonly caught commercially valuable species has also declined; for example in the 2000s, over 90% of the total catch consisted of only eight species; European anchovy, horse mackerel, bonito, grey mullet, twaite shad (*Alosa fallax*), whiting, red mullet and turbot. This number decreased from 21 species in the 1980s (Harlioğlu 2011) and 26 during 1960- 1970 (Zengin *et al.* 1998).

Turkey shares the Mediterranean and Black Seas with many other countries, which poses challenges to the management of trans-boundary resources. In an assessment of the top 53 fishing countries, which together land 96% of global marine catches, each contributing countries' 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.

The Black Sea

Major fisheries of the Black Sea include purse seining, trawling, set nets and dredging. The purse seine fleet began in Turkey in the early 1930s (Gücü 2001). Since the 1950s, growth of this fleet accelerated due to technological advancements, state-sponsored credit and infrastructure improvements (Knudsen 2003, 2009). Consequently, purse seines have dominated the fisheries of the Black Sea since the 1960s. Net size and engine power have continually increased. In 1998, a typical purse seiner had two 700 hp (or more) engines and carried two different nets each 1,000 fathoms long, i.e., 1.8 km (Knudsen 2003).

The industrial sector operates mainly in the Turkish portion of the Black Sea, although some boats venture seasonally to Georgian waters and the Mediterranean Sea. Many Black Sea purse-seiners are actively involved in the bluefin tuna fishery in the Mediterranean, which is very profitable. Juvenile bluefin tuna are caught in the eastern Mediterranean and sent to 'tuna ranches' where they are fattened for export to eastern markets (Stergiou *et al.* 2009). Industrial fisheries can fish at sea for months at a time and use the following gear types for their target species: bottom trawls target whiting, red mullet, turbot, bluefish, horse mackerel (*Trachurus* spp.), thornback ray (*Raja clavata*) and shark (Selachiimorpha); pelagic trawls target sprat; mid-water trawls target anchovy and sprat; and purse seines target anchovy, horse mackerel, bonito, bluefish and larger tuna species.

The artisanal fisheries operate closer to shore and use the following gear types for their target species: bottom gillnets target whiting, red mullet and turbot; surface gillnets target bonito, grey mullet (Mugilidae), bluefish and garfish (*Belone belone*); and dredges target sea snail (*Rapana venosa*). Bottom trawling, despite being illegal in the eastern Black Sea, continues to occur (Knudsen 2009). Although small-boat fishers oppose illegal trawling, corruption and bribes allow these destructive business practices to continue (Knudsen 2009).

Since the 1960s, the Black Sea Large Marine Ecosystem (LME) has been faced with increasing environmental stressors such as pollution, eutrophication, overfishing, the introduction of alien species, removal of top predators and the subsequent trophic cascade, as well as climatic variations (GFCM 2011b). Much of the pollution stems from the Danube River which drains 1/3rd of continental Europe into the catchment area of the Black Sea[3]. Also, the construction of many dams on the Kizilirmak and Yeşilirmak rivers have significantly reduced nutrient availability to the Turkish continental shelf (Zengin and Knudsen 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 2011b). 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 got took over as the control authority. Corruption between the authorities and industrial commercial fishers, however, still presents a problem for artisanal fishers.

Since 1950, many different types of government aid was 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

[3] UNDP, 2012. www.undp-drp.org/drp/danube_danube_delta.html

one seine net, and their investment (in 1986) is about U.S. $32,000 or U.S. $3,200 per person (Berkes 1986). The required investment needed to be a player in these commercial/industrial fisheries is now impossible to attain for artisanal fishers 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 artisanal 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.

The fishing operations of the Black Sea are primarily industrial and operated by purse seines and pelagic trawlers. Demersal species in the Black Sea only occur to depths above the anoxic layer, due to the presence of H_2S gas, lower salinity and absence of oxygen levels (Zengin 2006). The Black Sea previously hosted very healthy demersal and pelagic fish populations and was considered a highly productive ecosystem at all trophic levels until the mid-1980s, but conditions have rapidly deteriorated (Kalayci *et al.* 2010). There is an account of one large trap (or weir; *dalyan*) in operation in the Turkish Black Sea area in the 1840s that used to catch immense quantities of fish; as many as 20,000 bonito and 500 swordfish were often caught within 24 hours (Knudsen 2004). The Black Sea coast had the lowest reported annual marine catches in 1968 with 82,245 t, and the highest in 1988 with 480,400 t. From a 2010 report (S. Bekişoğlu, unpublished data), during the 1967-2009 reporting period, the Black Sea was responsible for 77.5% of the catches of Turkey, although in terms of average productivity, the Black Sea was second to the Sea of Marmara, until recently.

Sea of Marmara

Traditionally, the fisheries of this sea have mainly targeted pelagic and migratory species. The shrimp fishing fleet includes over 200 medium-sized boats including illegal trawlers and beach seiners targeting deepwater rose-shrimp (Parapenaeus longirostris; Zengin and Akyol 2009), consequently many demersal stocks are over-exploited, and overall catches are not known precisely.

When bottom trawling became prohibited in 1971, bottom trawl nets were to be phased out eventually and replaced by alternative types of fishing gear. However, trawlers in fact stayed in the Marmara Sea as, once at sea, they were difficult to apprehend for the authorities (Ali Çemal Gücü, pers. comm.). The bottom trawl sector took off during the 1980s, when seafood demand increased and infrastructure improved (Knudsen *et al.* 2010), until the mid-1990s, when catches and profits ceased to increase. Bottom trawl catches of shrimp in Marmara Sea where highest from 1988 to 1990, with 4,000-6,000 t landed annually (TÜİK 1967-2010), more on this in Chapter 4. Industrial trawlers and the artisanal sector often compete for the same species, as trawlers (often illegally) operate very close to shore. The low selectivity of bottom trawl gear caused radical changes in the species composition of fish in the areas trawled. Fish that were once plentiful included swordfish, tuna, bluefish, Atlantic mackerel and sea bream (Sparidae); however, now anchovy and sprat are the dominant catches.

Landings as a whole have recently declined in the Sea of Marmara. For instance, in 2006 total landings were 70,000 t and in 2010 total landings were 36,000 t. The Sea of Marmara's portion of Turkey's total marine catches has also been declining; in the late 1960s, it contributed 19% to the nation's total catches, but declined to 14% by 1980 and just 9% by 2010. The Sea of Marmara's lowest reported landings (over the 1967- 2010 period) were in 1968, with 7,143 t, and highest in 1999 with 81,005 t.

Overall, the Sea of Marmara's health is rapidly deteriorating, mainly due to pollution (notably, domestic waste), and declining fisheries due to overfishing and illegal fishing[4].

Commercial fishing is technically banned during the summer months; however, before re-opening in 2010, 50 bottom trawlers were seen actively fishing (H.T. Çinarçiğil, pers. comm.). 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 (Zengin and Akyol 2009).

Beam trawls are forbidden in the Aegean and Mediterranean Seas (ICES 2006); although they are commonly used to catch shrimp (Penaeidae) and sea cucumber (Holothuroidea) in the Sea of Marmara and sea snail in the Black Sea.

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 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. Turkeys shrimp production is dominated (72%) by catches from this sea (Zengin *et al.* 2007). Increasing

[4] http://www.tudav.org/index.php?option=com_content&view=category&id=34&Itemid=37&lang=tr

shrimp catches in the early 1980s, reached a peak in 1989 of over 8,300 t, and have since declined due to increased fishing effort, including widespread illegal bottom-trawling (M. Zengin, pers. obs.).

Aegean Sea

The fisheries of the Aegean are dominated by the artisanal (artisanal) sector that uses small wooden boats, 5-12 m in length (Ünal *et al.* 2011), and are crewed by one to two fishers. Their daily fish catches range from 2.0 – 7.2 $kg \cdot day^{-1}$. These artisanal vessels primarily deploy gill nets, trammel nets, long lines and lift nets (Ünal and Erdem 2009) and target horse mackerel, bluefish, grouper (Serranidae), common dentex (*Dentex dentex*), chub mackerel (*Scomber japonicus*) and swordfish.

There is also a minor industrial sector operating in the Aegean Sea, which includes trawlers and purse seiners. Most of these industrial vessels are not indigenous to the area, but rather come from the Black Sea to fish opportunistically in the Aegean. Fishing with beach seines was popular, until a 2001 ban prohibited their use in Turkish Aegean waters (Anonymous 1999), as demanded by local artisanal fishers. Driftnets were also popular in this sea. The industrial sector targets small pelagics such as anchovy and European pilchard as well as some larger pelagics such as bonito.

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 breams 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, one such fisher was seen stockpiling hundreds of black grouper into his vessel on his first pass with hookah (M. Ulman, pers. comm.).

The artisanal 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 and Akyol 2009). In 2007 alone, Bodrum received approximately one million tourists (Kiliç and Aydoğan 2009).

Levant Sea

In the 1930s a local purse seine fleet began to develop. A fleet of two bottom trawlers was established as early as the 1940s, and increased to 14 vessels in just over a decade (Gücü and 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 to the potential for 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).

The artisanal sector here uses predominantly trammel nets, gill nets and longlines. Fishers often use two different size mesh trammel nets to target a wider range of species, i.e. a small mesh for small species such as mullet, and a larger mesh net for others (Berkes 1986); many demersal species such as seabreams, bass, mullet and grouper are landed. Longlines are used to target swordfish and large tuna species; stingrays are often caught as by-catch and then discarded since there is no local consumption of these species (M. Ulman, pers. comm.).

Industrial operations in the Levant Sea include trawlers, purse seiners and beach seiners. Iskenderun Bay is approximately 80 km wide and it is illegal for trawlers to operate within three miles from the coast; however, this is not enforced. Trawlers often ignore this rule and invade the small continental shelf area shared with the artisanal sector, further aggravating relations between the two sectors. The industrial boats operating here have the ability to be away from port for weeks. The Levantine coast has the lowest reported landings out of the four seas and represented 6.2% of Turkey's total commercial landings in 2010.

Reported marine landings in the Levantine Sea were lowest in 1973 at 2,311 t and the highest in 1993 at 42,289 t. Annual commercial landings averaged for the 1967-2010 period were 14,000 $t \cdot year^{-1}$ (Ş. Bekişoğlu, unpublished data).

Cyprus

The fishing history of Cyprus since 1950 is presented in three distinct time periods: [British] Colonial Cyprus (1950-1960); United Cyprus (1961-1973) and Two Solitudes (1974-2010), where applicable.

Colonial Cyprus (1950-1961)

Basic fisheries laws were enacted in 1931 in Cyprus. Some of the most important sections were (Fodera 1961):

- Section 3: every fishing vessel was to be licensed, which was free of charge. Penalties for fishing without a license were up to three months imprisonment or a £25 fine, or both;
- Section 5: the use of poison and explosives was prohibited, and the transport and sale of fish caught with these methods was also prohibited. Penalties included up to two years imprisonment or fines of up to £100, or both;
- Section 7: vessels would be confiscated if owned by a person convicted of an offense in Section 5, or if were used to fish with the use of poison or dynamite.

During the colonial period, although the use of dynamite carried a heavy penalty, regulations at this time were poorly enforced due to insufficient monitoring and inaccessibility issues. In 1950, the Cypriot fishing fleet consisted of 320 sailboats, 19 motorized sailboats and 10 trawlers, which together employed 960 people and caught 460 t of fish (Anonymous 1951) . Only the coastal area was fished, which extended two miles out to sea (Anonymous 1960). Catches increased slightly, and averaged just under 500 $t \cdot year^{-1}$ for the late 1950s. In 1961, the artisanal sector landed about 40% of the catch (Fodera 1961), the rest being landed by the trawlers, which are deemed part of the industrial sector since they 'actively' fish. By 1960, there were approximately 700 fishers in total (Fodera 1961), the majority being Greek Cypriots. The fishing sector was under-developed at this time due to a lack of natural ports and shelters for vessels. In the past, the road network was not connected to the sea in many places, thus limiting transport. Historically, villages were built at a distance from the coast, due to frequent raids from pirates. Only demersal inshore stocks were exploited due to a steep continental shelf and limited pelagic stocks, mainly using destructive fishing techniques such as dynamite fishing, which was common. Some stocks experienced declines in their catches, along with reductions in average fish size (Fodera 1961). Pelagic fishing was not practiced, and hence populations of, e.g., greater amberjack (*Seriola dumerili*) were abundant in coastal waters (Fodera 1961). Demersal fishing lines to target shark and other large pelagics were made from hemp, with the top end secured to a “dried hollow pear-shaped pumpkin” as a float (Fodera 1961), and hemp was used for all demersal longlines at this time.

From 1951-1960, the national seafood consumption rate increased by a factor of three due to an increase in fish imports. The per capita seafood consumption rate for Nicosia circa 1961 was 8 $kg{\cdot}person^{-1}{\cdot}year^{-1}$ (Fodera 1961), and seafood contributed 7.4% of total protein consumption. Fishing contributed 0.17% to the Gross National Product (GNP) and commercial fishers made-up 0.12% of the population in 1960 (Fodera 1961). From 1950-1960, under colonial rule, most artisanal and industrial commercial catches were reported.

United Cyprus (1961-1973)

Cyprus’s main harbour, the Bay of Famagusta, was the islands largest natural harbour (Figure 1.2). It had a wharf length of 1,750 feet and berthed vessels up to 20 feet long. Two other significant harbours during this period were in Paphos and Kyrenia (Figure 1.2). Boats sought shelter by hauling out onto beaches for protection from stormy seas (Fodera 1961). Moorage was an issue on the island in the past, and still remains an issue in the north. The north-eastern coast of Cyprus was not suited for bottom trawling, but was excellent for line, basket and net fishing. The bottom trawl fleet was limited to 12 vessels, two of which were reserved for the Turkish Cypriot community (Fodera 1961).

Two solitudes (1974-2010)

North

There were only about 30-40 Turkish-Cypriot fishers on the island at the time of its division in 1974 (E. Sinay, Department of Animal Husbandry, unpubl. data), but post-1974, more Turkish Cypriots took to fishing as they had access to freshly-abandoned gear in the north. The number of artisanal fishers gradually grew to reach approximately 410 fishers in 2012.

Bottom trawling was only practiced in the north from 1993-1997 and was prohibited in 1998, due to the observed damage that trawling directly inflicted on the environment and its resources (Çiçek 2011). Trawling had actually ceased completely one year earlier, in 1997, due to a government enactment of a 3-mile trawling limit from the coast. In 2012, about 5 fishers in the north used drift nets with mesh sizes > 65 cm to target large pelagics such as swordfish, bluefin tuna and other large pelagics (B.A. Çiçek, pers. comm.).

Approximately 500 families in the north rely solely on fishing for survival (Çiçek 2011), while many families have had to exit the industry due to declining resources and hence diminishing profits. Some issues affecting these fishers include low marine productivity, lack of insurance, inadequate cold storage facilities, no access to more modern fishing techniques and a lack of monitoring and control and surveillance to deter illegal fishing. There is also a scarcity of fish markets in the north, thus requiring the use of a middleman to market their catches in the south; middlemen which make over a 100% profit and do not purchase low-value catches due to spatial restrictions on their transport vehicles. The continental shelf is narrower in the north than the south, which further decreases inshore fishing opportunities.

South

The Department of Fisheries and Marine Research (DFMR) provided assistance to the fisheries sector of the south in 1974 with subsidies for new vessels and equipment to help improve food security since their effective fishing area was reduced by about 40% from 1300 km^2 to 800 km^2 (Garcia and Demetropoulos 1984). By the late 1980s, Cyprus' reported fisheries catches (representing data from the south) exceeded their catches prior to the division (Solsten 1993), and doubled in both heavily trawled and other areas (Garcia and Demetropoulos 1984; Garcia 1986a, 1986b). This was in part due to the great success of a seasonal trawling ban and the offshore expansion of fishing area, which commonly occurred across the globe during the 1980s and 1990s (Swartz *et al.* 2010). The commercial fleet has four main sectors: artisanal, multi-purpose, large pelagic, and bottom trawl; the last three of these are considered industrial, due to vessel lengths greater than 12 m (Martin 2012). Since the early 2000s, there has been an increase in albacore tuna (*Thunnus alalunga*) in Cypriot waters for which sport-fishing operators have recently been trying to create a new market. See Table 1.1 for a comparison of fishers and vessels for the north and south in 2010.

Table 1.1 Number of fishers and vessels engaging in commercial and recreational sectors in the north and south, 2010.

Sector	North[a]	South[b]
Industrial vessels	-	4 trawlers, 25 multi-purpose
Artisanal vessels	410	1,134
Recreational vessels	1,425	2,000
Anglers[e]	2,000	No data available
Spearfishers	346	2,200

The artisanal fishery, as defined by the national Fishery Law 132(I)/2007, is conducted by vessels 4-12 m, by use of trammel nets, bottom gillnets and bottom longlines to target demersal species (European

Union 2007). The artisanal sector fishes exclusively inshore and their average effort increased by a factor of 8 from 1967-1984, measured in horsepower (hp) times the number of fishing days (Garcia and Demetropoulos 1984). Total catches for this sector were stable from 1967-1982 (averaging 500-800 t per year), despite a 3.5 fold increase in average hp (Garcia and Demetropoulos 1984), which led to a decline in catch per unit effort (CPUE). Since the early 1980s, this increase in effort was enhanced by modernization of fishing gear and technology, i.e., the introduction of hydraulic nets and longline haulers (Garcia and Demetropoulos 1984). The proportion of artisanal catches in total reported commercial catches increased from 40% in the 1950s to 70% by the late 1980s (Hannesson 1988). One third of their catches were represented by 6 species: red mullet, striped red mullet, pandora (*Pagellus erythrinus*), red porgy (*Pagrus pagrus*), parrotfish (*Sparisoma cretense*) and bogue (*Boops boops*) (Anonymous 2010), all fished by trammel net. Another significant trend worth noting is that the composition of catches shifted from high-valued species to low-valued species from 1975-1984 (Garcia and Demetropoulos 1984); higher priced species valued at $ 8.03 U.S./kg and above declined from 36% of total catch composition to 21%, while low-valued species valued below $ 1.56 U.S./kg increased from 42% to 63%. In the 2000s, there was a limit of 500 permitted artisanal vessels (Rousou 2009)[5], with enforced minimum landing sizes and gear restrictions in place (European Union 2007).

Multi-purpose vessels are between 12-24 m in length and use passive fishing gear such as nets, bottom longlines, and occasionally drifting surface longlines[7] which target both inshore demersals and large pelagics (European Union 2007). Minimum landing sizes only exist for bluefin tuna, but limited entry, closed seasons and gear restrictions are also used as management measures (European Union 2007). The large pelagic fishery uses mainly drifting longlines to target swordfish, bluefin tuna and albacore tuna and operates in waters around Cyprus and the eastern Mediterranean. Longline hooks traditionally were baited with fresh squid (*Loligo vulgaris*) and octopus (*Octopus vulgaris*, as in the north), but have

[5]http://www.fao.org/fi/oldsite/FCP/en/CYP/profile.htm

recently switched to imported sardines and squid (A. Petrou, pers. comm.). Bottom otter trawlers are between 21-27 m in length and have engines between 220-750 hp. They are licensed for either their inshore fishing area (Exclusive Economic Zone, EEZ) or for international waters of the eastern and central Mediterranean (European Union 2007).

In 2003, 144 full-time fishers were employed on 8 inshore trawlers and 14 offshore trawlers[6]. Since 2006, there have been four active bottom trawlers operating in territorial waters which land about 30% of the total commercial catch (in value), and 8 operating in international waters. Bottom trawling expanded in depth, engine size and range during the 'United Cyprus' and 'Two Solitudes' periods. An expansion first occurred into depth, to target hake (*Merluccius merluccius*) and shrimp, then mean engine size increased from approximately 160 to 240 hp by 1983 (Garcia and Demetropoulos 1984). Also the geographical range expanded, with the area trawled increasing from an average of 2.8 $km^2 \cdot day^{-1}$ in 1967 (Fodera 1961) to 4 $km^2 \cdot day^{-1}$ by 1984, despite the 40% reduction in fishing grounds due to the split of Cyprus in 1974 (Garcia and Demetropoulos 1984).

The declining catches of the artisanal sector are attributable to bottom trawlers landing a high proportion of juvenile fish (i.e., growth overfishing). Trawlers have been known to illegally fish inshore, i.e., under the 30 fathom limit, to catch picarel, which frequently damaged the trammel nets of the [artisanal] inshore fishery (Garcia and Demetropoulos 1984), creating further tension between the two sectors. Since 2004, adherence to European Union (EU) regulations and their Vessel Monitoring System (VMS) has ensured trawlers operate at depths greater than 50 m.

[6] www.fao.org/fi/oldsite/FCP/en/CYP/profile.htm

The key fish stocks

Please see Appendix table 1 (fish) and Appendix table 2 (invertebrates) for a complete list of taxa used in the Turkish study, which includes the current English names (validated in FishBase, www.fishbase.org), the scientific names, and the Turkish names. Please see Appendix table 3 (fish) and Appendix table 4 (invertebrates) for a complete list of taxa used in the Cypriot study, which includes their current English, Turkish, Greek-Cypriot and scientific names.

Turkey

Anchovy: anchovy are caught exclusively by purse seiners ranging from 15 m to 50 m in length and use a net mesh size of 16 mm (Oztürk *et al.* 2011). Most anchovy is consumed within Turkey while between 10-30% of the catch is sent to factories for processing into fishmeal and fish oil. 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 abundances and hence catches (see Chapter 4 on Black Sea CPUE graph for more details). Although of much less value, anchovy catches sustained purse seine fisheries for some time. But each year, this fishery has been worsening and the future looks grave. According to one concerned local scientist, the 2010-2011 fishing season brought catches of 240,000 t of anchovy, the 2011-2012 season only 200,000 t, and the 2012-2013 season only 126,000 t (GFCM 2013; Ulman 2014). While there are still some anchovy, there are about 10 times more fishers than before. With local stocks much reduced, the Turkish anchovy season has shrunk from 3 months to just 30 days per year over the last decade, and much of Turkish fishing effort and capacity has shifted (uncontrolled) from Turkish waters to Georgian waters. Without a system of total allowable catches and quotas, each vessel takes as much fish as they can carry. Sadly, in the 2012-2013 season, over 40% (by weight) of the 60,000 t of anchovy caught in Georgia were undersized (too small even for fish meal and oil processing) and were hence discarded (GFCM 2013). There is incredible wastage occurring, as these fish should have been allowed to grow and generate higher catches. In the 2013-2014 fishing season, most industrial commercial vessels returned to port 2 months before the end of the commercial season as there were no fish left to catch.

Atlantic mackerel: Atlantic mackerel was traditionally caught using traditional fish weirs or *dalyans*. On October 8, 1913, the *Bulbulderesi dalyan* (a fishing weir stationed in the Bosphorus) caught a record 520,000 mackerel in one afternoon; it was normal to catch between 4 million and 5 million mackerel annually in the early 1900s from this one dalyan (Deveciyan 2006). Catches were limitless up until the late 1960s in Turkey. And the importance of this species 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. They are still caught in very small numbers in the Istanbul Bosphorus along with chub mackerel, 1-10 singles at a time, according to one fishers log, but are caught in slightly higher amounts in the Dardanelles and Aegean (B. Yalcin, pers. comm.).

Bluefin tuna: 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 at least to the 15th century when traps, hand-lines and spears were commonly used to capture this species (Karakulak and 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). Fishers recall that this was the most important Black Sea and Marmara sea fish species, and how the waters used to boil with them. In the 1980s, each bluefin tuna caught in the Marmara Sea weighed approximately 300-400 kg, see Chapter 4 for more details (Karakulak and Oray 2009); fishers are now catching small to medium specimens weighing between 25-45 kg. Since the mid-1980s, the bluefin fishery relocated from Marmara Sea, first to the northern, and then to the southern Aegean Sea. Since the early to mid-2000s, bluefin have been spawning between Cyprus and the Turkish Mediterranean coast (see Chapter 4).

Bluefish: bluefish or *lufer* in Turkish is highly valued for its flavour and is the staple preferred fish to eat in Istanbul (Knudsen 2006). Bluefish are migratory pelagic predators that occur along all Turkey's coasts. They are targeted mainly by the artisanal sector who catches them by 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. Bluefish have shrunk from a mean caught size of 1 kg to just 100 g in recent years, most too small even to spawn. In the early 19th century, it was a favourite pastime of the people of the Bosphorus to catch this fish from August to October (Deveciyan 2006) by handlines, and used horse hair as fishing line. Total sales of bluefish at the Istanbul fish market, at this time, varied between 50 t and 380 t per day (Deveciyan 2006). As anchovy represents Black Sea culture, bluefish deeply relates to Istanbul culture.

Bonito: In the early 1900s, bonito were caught using 14-18 yard long fishing lines, spun from horse hair (Deveciyan 2006). Up until the 1960s, there were much larger bonitos being caught, `*torik*`, some up to 25 kg in size evidenced from early photos, a size class which has entirely disappeared today. 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). 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 and Dinçer 2006). From 2007-2010, annual bonito catches ranged from 5,000-9,400 t (TÜİK, 1967-2010). 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 and Dinçer 2006), although the last three peaks occurred each 6 to 7 years (1998-1999, 2005-2006, and 2012-2013). The average size of caught bonito today ranges from 0.5 to 1 kg.

Jellyfish: In the early 1980s, an alien species of warty comb jelly (*Mnemiopsis leidyi)* was introduced to the Black Sea, most likely from ballast water. These 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 each 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 (either naturally or not) 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.

Mediterranean horse mackerel: 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 declined to under 10,000 t annually, i.e., to the same level as catches during the 1950-1975 time period, before the start of industrial fishing (Daskalov 2002). 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 (i.e. *Trachurus trachurus* and *Trachurus mediterraneus*, respectively) species. When immature (5 to 10 cm), the Mediterranean horse mackerel is called `*Istavrit kraça*`. Only immature *kraça* are now caught.

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%[7]. 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 $t \cdot year^{-1}$. Thirty-nine vessels were equipped with hydraulic dredges targeting striped Venus clam in Turkey in 2004 (Dalgiç *et al.* 2005).

Turbot: turbot were once very abundant in the Black Sea. In the coastal town of Samsun, in the early 1900s, fishers caught up to 3,000 turbots 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

[7] Source: www.friendofthesea. org/fisheries.asp?ID=16

alternative. The highest turbot catches in the entire Black Sea region were recorded between 1955 and 1969 (Mikhailov and 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). The commercial turbot fishery has crashed in the Black Sea since the mid-2000`s. Many fishers blame a vacuum-type device (the `*Elif*`) which sucks up the striped-Venus clam for disturbing and killing juvenile turbots.

Cyprus

Since the early 1990s, annual stock assessments of the five most commercially important demersal fish species have been undertaken: bogue, red mullet, striped red mullet, common pandora and picarel (Hadjistephanou and Vassiliades 2004), which together account for over 60% of demersal catches (DFMR 2007). Four of which have been ‘fully exploited’ from the mid-1980s to present, with the exception of picarel stocks, which are considered healthy and some years even under-exploited (DFMR 2007).

Fisheries management

Turkey

The main fisheries laws are based on Fisheries Law No. 1380, enacted in 1971. This law defined the sectors and created rules and regulations to follow such as mandatory licensing for all commercial vessels. Some control measures which are in place include: minimum mesh sizes, minimum size limits, closed areas, closed seasons, protected species, banned fishing gears, gear restrictions. Almost all of these rules are ineffectual and not adhered to, since the country is lacking ample investment in the Monitoring, Control and Surveillance (MCS) of its fisheries. The only catch limits in place are in regulation to the bluefin tuna ICCAT (International Commission for the Conservation of Atlantic Tuna) quota, and the recreational fishers on Galata Bridge in the Golden Horn, although it is likely that neither quota is adhered to. Governmental policy towards this sector has generally focussed on the increase of catches (Duzgunes and Erdogan 2008) instead of long-term sustainability of the fisheries.

Cyprus

North

The Cyprus issue led to a stagnation of economic development in the north, triggering a decrease in GDP and economic recession throughout the 1980s and 1990s. This recession pushed many Turkish Cypriots towards urbanization, leaving many rural areas abandoned. Since the government operates with very limited resources and personnel, services are essentially only provided for urban areas, which have pulled people away from rural ones. Famagusta used to be one of the Mediterranean's most popular tourist destinations, but post-1974, it resembles a 'ghost town'. In 2010, the Global Heritage Fund, who strives to protect, preserve and sustain the most significant and endangered cultural heritage sites named Famagusta city "on the verge" of irreparable loss and destruction[8]. However in the 2000s, due to the stabilization of the Turkish Lira and also the opening of its borders, the mean economic growth rate in the north between 2003-2009 was nearly 6.5%, showing much faster economic growth than most European countries (www.investinnorthcyprus.org).

South

In November 2004, the Republic of Cyprus was accepted into the European Union and thus their fisheries management plans were aligned with EU's objectives. The EU's Mediterranean Regulation was adopted by the EU in 2006, operational as of 2010, and applied to the 7 EU member countries which

[8]www.globalheritagefund.org/onthewire/taglist/Famagusta

border the Mediterranean: Spain, France, Italy, Slovenia, Greece, Cyprus and Malta[9]. The entire island is considered part of the European Union; however, since the Republic of Cyprus (south) does not have control of the northern portion of the island, EU legislation is suspended in the north[10]. If a solution to the "Cyprus Problem" is found, this suspension will be lifted. Turkish Cypriots are regarded as EU citizens even though they reside in areas outside of governmental jurisdiction.

Cyprus was to be one of the first European countries to solicit help in combatting illegal fishing. The Cyprus government has paid close to £1 m ($ 1.33 million US) to provide a GPS-based fisheries management system to the Department of Fisheries and Marine Research, to monitor the activity of 500 licensed small fishing boats <15 m operating in Cypriot waters, so that unlicensed vessels fishing in the area could be more easily detected[11], but unfortunately there were legal hurdles and this is not yet operational.

Turkey's (lack of a defined) EEZ

Turkey, along with less than a handful of other countries (Israel, Syria, United States and Venezuela), chose not to sign and ratify the 1982 United Nations Convention on the Law of the Sea (UNCLOS). UNCLOS granted each country exclusive rights over the marine resources within their Exclusive Economic Zone (up to 200 nautical miles from their coasts). However, Turkey's potential membership to the EU would be contingent upon signing. Turkey's issues with this law are primarily related the Aegean and Mediterranean coastal waters, since many Greek islands are situated very close to Turkish lands (for example the Greek Dodecanese island of Kastelorizo is only 2 km away from the Turkish mainland). Greece on the other hand, ratified UNCLOS in 1995.

[9] www.eubusiness.com/topics/fisheries/mediterranean.806
[10] www.mof.gov.cy/mof/customs/customs.nsf/All/05AEEF243C9BFC8BC22572BF002D0A28?OpenDocument
[11] www.cybit.co.uk/News/Cybit-Win-Vessel-Tracking-Contract-With-Cyprus-Dep.aspx

Turkey's concerns about UNCLOS include the definition of the Exclusive Economic Zone, the range of its territorial sea, and the delimitation of the continental shelf (Oral 2009). Turkey is also concerned that signing may block some of the country's traditional and physical access to the sea, and to its resources. While Turkey continues to struggle with the UNCLOS framework in the Mediterranean (which has not prevented it from claiming an EEZ in the Black Sea), it has signed the Convention on International Trade for Endangered Species (CITES) of Wild Fauna and Flora (Knudsen et al. 2007).

Cyprus EEZ's

The territorial sea boundary at 12 nm was established in 1964[9], and any catches taken beyond this limit were considered 'international waters' in Cyprus. For the purposes of this study, all catches taken within the EEZ, or EEZ equivalent for years prior to EEZ declaration[12], which is 200 nm out to sea, or the equidistant line drawn between two countries coastlines if less than 200 nm (as is the case between Turkey, Egypt, Israel, Lebanon and Syria), are considered catches taken within Cyprus's EEZ or EEZ equivalent.

North

The territorial sea was expanded to 12 nm in January 2002[13]. In 2011, Turkey a delineated their maritime boundaries in the eastern Mediterranean, as a direct response to the South's commencement of exploratory oil drilling in its EEZ.

[12] Cyprus declared an EEZ in 2003. (www.un.org/Depts/los/LEGISLATIONANDTREATIES/STATEFILES/CYP.htm)
[13] www.jag.navy.mil/organization/documents/mcrm/cyprus.pdf

South

Cyprus's EEZ was declared in 2003[9]. Cyprus has made agreements with Egypt (2003)[10], and Israel (2010) delineating their respective EEZ's. An agreement has not yet been reached with Lebanon, due to Lebanon's dispute with Israel over their delineation between their EEZ's[14].

Current issues impeding the fisheries

Turkey

A recent study on Atlantic horse mackerel (Kalayci *et al.* 2010), suggested that purse-seines and bottom trawls are the fishing methods which are the source of most undersize fish in markets. Many species of fish are caught as juveniles, before they have had a chance to grow and reproduce, thus leading to both growth and recruitment overfishing (Ricker 1975; Pauly 1984). The percentage of Atlantic horse mackerel caught under the minimum legal landing size (MLLS) of 13 cm was 61% by purse seine, 65% by bottom trawl, 10% by gillnet, 39% by mid-water trawl and 20% by fishing line. These under-sized fish, are then either discarded or marketed illegally, and most likely not included in the catch data (V. Ünal, pers. comm.). Undersized fish are not unique to Atlantic horse mackerel, but are an issue for most commercial species, especially bluefish[15].

Illegal fishing in this sea has resulted in undersized fish being dominant in catches (i.e. growth overfishing). The dominant fishery catches from 1950-2010 in the Turkish Black Sea were anchovy, bonito, whiting, bluefish, horse mackerel and sprat while the important invertebrate landings were sea snail, cockle, and striped Venus clam.

[14] Source: www.cyprus-mail.com/lebanon/lebanon-has-no-eez-quibble-cyprus/20120317
[15] Source: www.eurasianet.org/node/65453

Turkey and Cyprus

The Eastern Mediterranean is host to many populations of 'Lessepsian' fish species, which have migrated from the Red Sea, through the Suez Canal to the Mediterranean. In Cyprus, a total of 133 non-native species have been found, and of these, 109 are Lessepsian migrants (EastMed 2010), four of which are considered invasive: dusky spinefoot (*Siganus luridus*), marbled spinefoot (*Siganus rivilatus*), silver-cheeked toadfish (*Lagocephalus sceleratus*) and blue-spotted cornetfish (*Fistularia commersonii*). The number of Lessepsian species found in catches was much greater in the 2000s than the 1980s, and increased at a rate of about one per year. This may indicate that there is either increased awareness in 'Lessepsian migrants', or increased scientific interest, or that these Lessepsian species are out-competing local pelagic species, or are increasingly retained by fishers (EastMed 2010).

The silver-cheeked toadfish has negatively affected the fishing and fishers in Cypriot waters. Pufferfish contain a very complex neurotoxin called tetrodotoxin (TTX) in their liver, gonads, intestines and skin, fatal if ingested (EastMed 2010), with no known antidote. Fishers are increasingly affected by this species, as the toadfish get entangled in nets, damage nets and lines with their large beaks and fused front teeth, swallow copious amounts of fishing hooks, target commercial fish species (competition with fishers), and are toxic to eat and thus have no commercial value. Their reproductive success may be attributed to their fast growth, early reproduction (2 years), high adaptation, lack of fishing pressure, and absence of predators (EastMed 2010).

A bylaw titled 'The Green Line Trade Regulation' in Cyprus, operational in 2008, granted fishers from the north rights to sell their catches in the south. At present, 10 fishers and 8 middlemen market catches from the north, in the south (in 2012; E. Sinay, pers. comm.). Some middlemen purchase fish directly from Turkey and sell both in the north and south (although it is not allowed to sell catches from Turkey directly to the south). The Cypriot government seems suspicious about some sales of catches possibly emanating from Turkey but cannot prove this, especially for specific taxa such as rabbitfish, i.e., dusky spinefoot and the marbled spinefoot, which have no demand in Turkey, but are highly valued in Cyprus[16]. In 2010, the following taxa were traded from the north to the south (E. Sinay, unpubl. data): bogue (35.2 t), rabbitfish (12.7 t); red mullet (11.5 t), dusky grouper (7 t), common dentex (4.7 t), picarel (4.7 t); red porgy (3.9 t); white seabream (*Diplodus sargus*; 3.9 t); and salema (*Sarpa salpa*; 2.9 t).

Some species which are very expensive in other countries are very inexpensive in the north, namely bluefin tuna, bonito, and other tuna-like species. These species sell for between U.S. $1.70-2.85 per kilo, i.e., the same as picarel.

Fishing effort & overcapacity

Turkey

There is presently tremendous overcapacity in Turkey with respect to the size and power of the fishing fleet which contrasts with 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 second World 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 as well as 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

[16] Siganidae sell for 45 TL (U.S. $ 25.26) per kilo in the north, and 45 € (U.S. $ 59.54) per kilo in the south (E. Sinay, pers. obs.). In the south €20 is the normal price per Kg at Fishmonger level.

the transportation of goods, building ports, created 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 increased 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 opening credits given to fishers (Üstündağ 2010), which particularly benefitted the industrial fishing sector; Knudsen explains (2004) "that there was a legal void that, gave almost free rein to the growing fleet of purse seiners and trawlers". The purse seiners evolved swiftly due to aid from technology, 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 them (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 2004). 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, landings 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 constructed.

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 and Duzguneş 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 increases catch capacity; as one fisher expressed it, "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, and $ 11 million US in 2010 was spent for it (TÜİK 2010). In 2002, the Turkish government introduced a diesel fuel subsidy; the normal diesel fuel price is 3.34 Turkish lira (TL)/litre ($ 1.90 US) and the subsidized price is 1.26 TL/litre ($ 0.71 US; Anon., unpublished data). Almost all commercial/industrial boats take advantage of this diesel fuel subsidy, while less than 35% of boats <12 meters do (Üstündağ 2010). This is because the diesel is sold by large tankers to customers who buy large quantities, thus disqualifying the artisanal sector. This diesel subsidy is the single most-important instrument that is allowing commercial fisheries to continually operate, and without it, 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.* 2010b); 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.* 2010a). It is often these artificially increased profits that allow these industrial fishers to continue to operate when they would be normally be operating at a loss, and be forced to stop operating and over-exploiting without this form of aid, skewing the bio-economic equilibrium.

From 1991-2008, Turkey tried to control its fishing fleet by launching a moratorium on new fishing licenses. However, the moratorium was lifted thrice (1994-1996, 1997-1999 and 2001), whilst the outcome was that the fishing fleet actually more than doubled in size (from 8,200 boats in 1994 to 18,100 boats in 2002, see Chapter 4 for a visual illustration of this effort increase). Over 4,700 boats have entered the fishery since 2001 (Figure 2.7). The licensing system has since been reinstated, but 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% in all of Turkey's seas combined (C.P Mathews, unpublished data). 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%, while Turkey's other seas have an excess capacity of ≥500%.

Fleet capacity management, can be a strategically and technically powerful 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 programs. The other strategy more commonly practiced, is to hand out long-term subsidies to fishers, which, greatly exceeds the costs of capacity control. There is currently a buyback scheme in place for the commercial fisheries of Turkey, and it is working to some degree, although it is completely voluntary. The government pays $ 4,600 US (10,000 TL) for vessels ranging from 10-19.9 m, $ 6,900 US (15,000 TL) for vessels ranging from 20-29.9 m and 30+ m vessels receive $9,200 US (30,000 TL). One purse seiner (T. Sengün, pers. comm.) complained that he would never use the buyback scheme since the government does not reimburse for them for all of the equipment added to the boat, which can be extremely costly for industrial fishers.

The European Union has been experimenting with ways to best 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 to reform itself 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 annually report on the balance between the capacity of their fleets and the resources available, and if they fail to do so, it will result in a 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, 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 artisanal sector, only lending of financial help to sustainable initiatives and a strict control mechanism which will exclude any perverse funding of illegal activities or overcapacity [17].

Lessons 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

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[17]Source:2012.europa.eu/rapid/pressReleasesAction.do?reference=IP/11/873&format=HTML&aged=0&language=EN&guiLanguage=en

into industry, and also limits the expansion of effort. Learning from both the (unsuccessful and successful) trials of other nations battling the issue of overcapacity will benefit the implementation of an effective program. 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 geographically expand their ranges to fish new areas, as commercial fishing has traditionally done. With other stresses the ocean is facing such as climate change, ocean acidification, de-oxygenation and shifting baselines (see Chapter 4), overcapacity is perhaps the easiest of these to understand and address.

Another possible management measure is to introduce individual quotas, which allot a maximum allowable catch of a species. Before this can be implemented however, the existing stock must be assessed from stock assessments, which are costly. Quota management exists for turbot and sprat fisheries in the Black Sea and their total allowable catches are allocated based on historical catches (GFCM 2011b). Since stock assessments have not been completed for most species; it is unlikely that 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.

Cyprus

North

Trawlers and purse-seiners have been banned since 1999 (Çiçek 2011) and the areas trawled prior to that were negligible, but likely negatively affected Mediterranean seagrass meadows (*Posidonia oceanica*), a keystone species which much other marine life depends on (Ilkay Salihoglu, pers. obs.). Prior to 1974, the trawlers operated at depths greater than 45 m, and later at depths from 8 m to 45 m.

South

There is currently a Fishing Effort Adjustment Plan[18] (FEAP) which was crafted by the Department of Fisheries and Marine Research (DFMR), the governmental body in charge of conducting fisheries research and data collection continues according to the relevant EU regulation. (Anonymous 2010). The FEAP aims to reduce inshore fishing effort for all sectors to alleviate pressure exerted on coastal stocks, and to adjust the fishing fleet in accordance with the sustainability of the stocks. The FEAP is funded by the European Fisheries Fund in compliance with the Common Fisheries Policy. To adjust fishing effort, the following measures are currently being implemented: the decommissioning of vessels, using selective fishing gear and methods, increasing the allowable net mesh size, reducing the number of fishing licenses, reducing the types of allowable fishing gear, creating areas protected from fishing disturbances, and imposing tighter controls (Anonymous 2010). The Department of Fisheries and Marine Research (DFMR) was contacted during the writing of this report but unfortunately was not willing to share any information which was not already publicly available.

Thesis goal and objectives

This research had two main goals:

The first goal of this research was to conduct an in-depth study of the quality and scope of fisheries catches reported by both Turkey and Cyprus to the FAO from 1950-2010, and then provide best available estimates of other types (of previously unreported) fisheries removals to assess total national fisheries removals for the 1950-2010 period. This was completed for Turkey (Chapter 2) and for Cyprus (Chapter 3). A “re-estimation” approach was used to approximate the historical catch trends using best available peer-reviewed literature, grey literature and knowledge of local experts. Thus, accounting for

[18] The FEAP is funded by the European Fisheries Fund in compliance with the Common Fisheries Policy.

total catches can better measure the significance of the formal and informal value of the resources which many inherently depend on for sustenance.

The next part of the research (Chapter 4) was to evaluate how much the fisheries have changed in both Turkey and Cyprus by interviewing fishers themselves. About 180 fishers were surveyed in Turkey and 82 in Cyprus to measure if the perceived rate of change of the Catch per Unit Effort (CPUE) throughout one's career was similar to their actual change in CPUE. This research is important because it provides evidence that profound changes in the fisheries have indeed occurred, and also that for several sectors, the 'Shifting baselines' phenomenon is evident, which allows the past to be forgotten due to the non-transformation of traditional knowledge.

Chapter 5 is the final chapter, presenting a synthesis of the key results of this thesis, along with an explanation of the strengths and limitations this research provides. It also discusses how this research can be used to benefit the fisheries of Turkey and Cyprus.

2: TURKISH RECONSTRUCTION

SYNOPSIS

Turkey's marine fisheries catches were estimated for the 1950-2010 time period using a reconstruction approach, which estimated all fisheries removals, including unreported landings, recreational landings and discards. These estimates were added to the 'official' data, as reported in TURKSTAT, which are also available from the United Nations' Food and Agriculture Organization (FAO). The total reconstructed catch for the 1950-2010 time period (inclusive of the reported data) is approximately 33 million t, or 80% more than the 18.4 million t of reported data. This added about 14.5 million t to the reported data, consisting of 9.7 million t of unreported landings, nearly 2.6 million t of discards, and 1.5 million t of recreational catches and 1.2 million t of subsistence catches. In 2010, total reported marine landings for Turkey were 445,617 t and the total reconstructed catch was 780,100 t. The main unreported taxon by tonnage was European anchovy due to its large contribution to the catch. The major reasons for underreporting include a general distrust fishers have towards the system, combined with inefficient fisheries monitoring and surveillance capabilities. Accounting for all fisheries components is crucial in understanding the development of fisheries resources, improving management, and reducing threats to the domestic food security of Turkey.

Turkey's fisheries catches in 2007, based on the official data, represent approximately 0.6% of world fisheries landings (Diffey 2007). The total reconstructed catches calculated here signify that Turkey caught over 1% of global fisheries landings. According to the latest published statistics in 2010 (TÜİK, 2010) anchovy dominated total reported marine catches (51%), followed by sprat (13%), European pilchard (6%), striped Venus clam (6%), Mediterranean horse mackerel (3%), whiting (3%), and sea snail (2%).

INTRODUCTION

Given the growing emphasis on ecosystem-based management (Levin and Lubchenco 2008), it is important to have a comprehensive understanding of total fishery removals in order to assess long-term trends and make more informed decisions regarding resource use. Accurate baseline catch data are fundamental for assessing the current and future amounts and uses of fisheries resources. Publicly available national data sources and those provided to the United Nations' Food and Agriculture Organization (FAO), account only for a portion of what is removed from the marine environment (see section on unreported and under-reported catches). The aim of this study is to provide a time series of catches for all of Turkey's marine fisheries sectors and components since 1950. This will help provide the foundation necessary for sustainable management of this important national resource. The data are presented here by the four marine regions associated with Turkey's coastline. The methods and total reconstructed catches are then presented by region and then by country as a whole. Turkish distant-water fisheries are only discussed for the Black Sea as no evidence (i.e., anecdotal, grey literature or published) was found on Turkish catches elsewhere in the Mediterranean.

METHODS

Here, a reconstruction of Turkey's fisheries is presented for the years 1950-2010, using the methodology as described in Zeller *et al.* (2007).

Thus, for the purpose of documenting Turkey's marine fisheries catches, four different marine regions of Turkey are presented: (1) the Black Sea coast, from which about 75% of Turkey's total fishery landings originate; (2) the Sea of Marmara, (which includes the Dardanelles, and also Istanbul and the Bosphorus Strait, which is the site of a large recreational/subsistence fishery); (3) the Aegean Sea to the city of

Marmaris;(4) and the Levantine Sea. This study focuses only on wild marine fish and invertebrate capture fisheries, and thus does not include mariculture.

Officially reported landings

The FAO's Fishstat Plus database is the only publicly available resource presenting Turkish marine landings for the entire 1950-2010 period. National 'Turkstat" data are only available from 1967 onwards (TÜİK 1967-2010), although Turkey has been reporting landings data to the FAO since 1950. The reported landings were compared from 1950-2010 between the two available sets (national and FAO data), and were found to be almost identical, thus implying a good transfer of data from the Turkish government to the FAO (Figure 2.1).

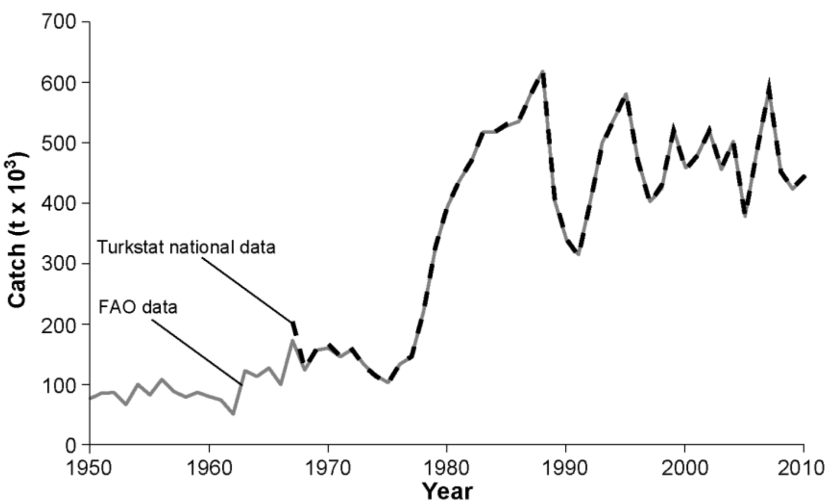


Figure 2.1. Reported FAO data compared to national TURKSTAT data, 1950-2010.

Annual totals from the FAO database (as sent to FAO by Turkey) were used as the reported baseline from 1950-1966, as national data reported by sub area (i.e., by sea) could neither be located by any of our associates nor from the Turkish Ministry of Agriculture and Rural Affairs (MARA) for the 1950 to 1966 period. The annual totals from 1950 to 1966 in the FAO database were presented as one annual total sum for the country. The Turkish Ministry of Commerce collected statistics at that time (Üstündağ 2010); however, the species composition, and allocation to corresponding sea is no longer available. Catches were disaggregated by region (i.e. sea) and by species using average proportions from the closest available national landing statistics (the 1967 to 1971 period). The geographic allocation of catches used for the reported data during the 1950-1966 period was Aegean Sea (2.7%), Black Sea (75.4%), Levant Sea (3.2%), and Marmara Sea (18.7%). All national Turkstat catch statistics (www.turkstat.gov.tr) for the 1967 to 2010 time period were made available to us and were used as the reported baseline, since they contained better spatial detail than the FAO data.

Catches outside Turkish national waters

Some Black Sea turbot catches were taken outside Turkey's Exclusive Economic Zone (EEZ), which extends 200 nautical miles out into the Black Sea (www.blacksea-commission.org). These catches, although not caught in Turkish waters, are recorded as Turkish landings and therefore do not accurately represent Turkish catches from a spatial point of view. Thus, turbot catches, which were recorded as Turkish catches in national statistics, were re-allocated here to the waters of the countries from which they were caught, i.e., Romania, Bulgaria, and Ukraine (www. blacksea-commission.org/_publ-SOE2009-CH9.asp). The reconstructed total catch for turbot will therefore reflect only catches attributed to Turkey fishing within its own exclusive national fishing grounds in the Black Sea, allowing inferences to be made regarding national fisheries catches and resource trends. Turkish fisheries in areas other than those mentioned here, e.g., in the Western Mediterranean, are not considered in this study.

Taxonomic breakdown

Based on ‘Turkstat’ national reported data, the catches from the eastern and western Black Sea were combined to represent ‘the Black Sea’. Turkstat data were used as a baseline rather than FAO data since it contained a more detailed spatial allocation of catches, i.e., according to sea.

In Turkey, catches are recorded using common names. For most years the English equivalent was given, but these were not always consistent (See Appendix Tables 1a and 1b for a list of fish and invertebrates used in this report). For instance, ‘*istavrit karagöz’* corresponds to Atlantic horse mackerel (*Trachurus trachurus*) and ‘*istavrit kraça’* corresponds to Mediterranean horse mackerel (*Trachurus mediterraneus*). It is understood that ‘*mezgit’* corresponds to whiting (*Merlangius merlangus*); and ‘*bakalorya*’ and ‘*berlam*’ correspond to European hake (*Merluccius merluccius*, see also www.fishbase.org). The catches for ‘*bakalorya*’ and ‘*berlam*’ were combined in the reported data from 2001 onwards; and these catches were assigned to European hake.

The various fish species of mullet (*Mugil cephalus, Mugil soiuy, Liza saliens, Chelon labrosus, Moolgarda seheli,* etc.) belong to the family Mugilidae, while ‘*barbunya’* is the red mullet (*Mullus barbatus*) and ‘*tekir’* is the striped red mullet (*Mullus surmuletus*), both of the family Mullidae.

For the Turkish ‘*köpek baliği*’, the provided English translation is ‘smooth-hound sharks’; these fish were mostly classified as piked dogfish (*Squalus acanthias*), since they are the major shark species caught in Turkey[19]. Some species of tuna including bullet tuna (*Auxis rochei*), little tunny (*Euthynnus alletteratus*) and albacore tuna (*Thunnus alalunga*) were only added to the data collection process as of 2004, so their previous catches remain unknown.

[19] www.flmnh.ufl.edu/fish/organizations/ssg/sharknews/sn11/shark11news12.html

It is most likely that the catches of round sardinella (*Sardinella aurita*) and European pilchard are grouped together in the reported data and therefore make it difficult to detect catch trends of either species. However, some local experts have explained that round sardinella populations are expanding northwards in the Aegean Sea and its catches are increasing. Only marine fish and invertebrates were used in this report, which thus excludes jellyfish, sponges, turtles and dolphins.

Industrial vs. artisanal catch

Complete enumeration was carried out covering all registered professional fishers between 1967 and 1969 and again from 1972 until 1980. From then on, the State Institute of Statistics (SIS) gathered data on fishery landings, fishing fleets, equipment and the status of those engaged in the industry. After 1980, the Ministry of Agriculture and Rural Affairs (MARA) took over data collection (although both of the above-mentioned bodies did have some corresponding collection of data until recently) and the statistical collection methods remained the same, to cover industrial fishers (boats over 10 meters in length or with more than five crew members) by full enumeration, but changed from covering artisanal (artisanal) fishers by full enumeration to a 'sub-sampling' procedure (TÜİK, 1989).

The majority of the registered fishing boats are from the artisanal sector; for example in 2010, 85% of the registered Turkish fleet were small boats under 10 m in length (TÜİK, 2010). The Aegean and Levant coasts are mainly exploited by artisanal fishers, whilst the Black Sea and Marmara Sea are dominated by both industrial and artisanal operations (www.oecd.org/dataoecd/9/29/34431494.pdf).

The standard artisanal operation uses trammel net, gillnet, longline, and dredgers, or some variation of these. Larger-scale operations include trawlers, purse seiners and carrier vessels (to transport anchovy catches from the seiner to the processing plant). Beach seiners (Anonymous 1985) were important until the most recent decades. Beam trawlers are used mainly for sea snail and hydraulic dredges are used to gather cockle in the inshore Black Sea. The Black Sea hosts most of Turkey's industrial fishing due to its large stocks of small pelagic fish, which are caught mainly by purse seine.

The activities of the industrial (industrial) sector within Turkey are defined here as trawlers, purse seiners, and any other registered fishing boat greater than 10 m in length. While 12 m is the required minimum length a boat must be to apply for a trawling license, the national data categorizes boats as 5-9.9 m in length and 10 m-19.9 m in length (among other length classes), making it difficult to separate for the 12 m length class. As national statistics do not relate catches to a particular fishing sector, this was performed by assigning species (or more precisely percentages of species) to either the artisanal or industrial sub-sectors, and the percentages are based on expert knowledge and experience (see Appendix tables 1 for fish and 2 for invertebrate classification to sector).

Unreported and under-reported catches

Illicit fishing activities are problematic for management, as they combine criminal activities with fisheries management. For the past decade, the term IUU (Illegal, Unreported and Unregulated) fishing has often been misleadingly used as synonyms of "illegal fishing" (Bray 2000). Due to the complexity of the legalities which surround fishing enforcement accountability, from now on the suggested approach to illegal fishing, as proposed by the United Nations Office on Drugs and Crime (UNODC), is to separate the components of the term IUU; to have illegal fishing handled directly by law enforcement, and unreported and unregulated fishing to be dealt with by the fisheries management sector, as they both relate to fishery mandates (UNODC 2011). Several fishing activities in Turkey can be regarded as IUU fishing: fishing with an unlicensed vessel, fishing in closed areas/seasons, catching prohibited species, using forbidden equipment, and catches or revenue that are not reported may all be considered IUU practices (Ünal *et al.* 2009). Here, unreported catches are the main concern.

There seems to be a consensus between scientists, the government and people employed by the fishery industry in Turkey that unreported catches account for somewhere between 30-100% in addition to the reported landings (see below). In this section, the unreported catches of the commercial artisanal and industrial sectors are addressed. Unreported recreational and subsistence sector catches will be estimated in subsequent sections.

The following is a compilation of available accounts of misreporting, including scientific papers and interviews/consultations with key fishery experts and fishers:

- "Fishery landing statistics may represent only 30- 50% of actual catch, while the non-reported catch is likely to include more undersized, 'out of season' and/or prohibited species." (Diffey 2007);
- Hamdi Arpa, an aquatic products engineer for the Turkish Ministry of Agriculture and Rural Affairs (MARA), estimates that the unreporting of data accounts for between 30-40%, due to the pitfalls of the data collection system (Ş. Bekişoğlu pers. comm.);
- "The EU Fishery Commission and mostly all fishers share the opinion that at least 30% of total fishery catches are not declared to the government"(Ş. Bekişoğlu pers. comm.);
- Ramazan Özkaya, the president of the Turkish fishery co-operatives, estimates that the unreported amount of fish is much more than 30%, and probably closer to or greater than 50% (Ş. Bekişoğlu pers. comm.);
- From 1950-1966, the national statistics sent to the FAO were based on inquiries to provincial government officials, and on the sales records of provincial fish markets. It explicitly states that the true catch of fish could not be reflected by the data collected by the Ministry of Commerce during this period due to insufficient coverage (TÜİK, 1968). Unfortunately, the details of how these data were calculated are no longer available (Uğuzhan Türkoğlu, Turkstat employee, pers. comm.,

March 18, 2011). Sales have, undoubtedly, occurred directly from boats and piers; and directly to restaurants throughout this period, all unreported; and

- Many Turkish scientists do not agree with the collection methodologies of the fisheries department and realize that the real catches may be 50-75% more than reported (M. Zengin, pers. obs.).

Given all the above evidence, the official Turkish fisheries statistics were considered to be an underestimate of total commercial catches. Based on a synthesis of the above information, 40% was added to total catches reported for the period 1950-2010, in order to account for a significant unreported/underreported commercial catch component. The motivation to underreport catches may be attributed to the heavy taxes and levies imposed on fish sales and income of fishers and the way in which fish is marketed. Evidence of this includes:

- Brokers impose an 8-10% sales tax (depending on the species) on catches sold through the fish hall/bazaar. Fishers often avoid this method of sale in order to avoid the tax;
- Income tax, varies according to annual income and profit margin; the maximum rate of income tax that can be applied is 30%;
- Fish agents and wholesalers do not declare the 'true' amount of wholesale and retail fish sales to the government (Ministry of Finance). The Turkish government is lacking an effective control system. Government officials and some economists suggest that at least 40-50% of the nation's products and income have not been accurately declared (Ş. Bekişoğlu, pers. obs.); and
- An additional 10% tax is imposed on a commercial fisher's total catches (referred to as 'resource rent'), and is to be paid directly to the Ministry of Finance upon returning to shore. This tax is supposed to be collected at landing sites. Most fishers evade this tax by under-reporting their catches by about 30% on average, for fear of being taxed on their total landings (S. Bekişoğlü, pers. obs.; M. Ulman pers. comm.).

While there is clearly some incentive to under-report catches, inadequacies in catch data may also be attributed to data collection methods. Such methods that may negatively influence the quality of the data include:

- For the 1950–1966 period, only fish sold through select markets were used in the national catch data; fish sold at places other than those select fish markets are not accounted for here;
- Total catches are often simply a memory-based reflection on the previous year's catch. Additionally, catches made out of season, using illegal gears, in prohibited areas, under legal size or sold directly by the fisher, are likely never declared;
- Artisanal fisheries catches from 1970 and 1971, and 1980 to the present are estimated by an annual sub-sampling method. This method of data collection, unless scaled-upward to account for the entire year and all fishers, results in underreporting; and
- Discrepancies also exist between reported landings and exports of the same species. For instance, sea snail, according to export records are vastly underreported by as much as 50% during the 1985-2004 time period, and around 1000% in 1995 alone (Knudsen *et al.* 2010).

According to a report from Ünal and Erdem (2009), authorities reported that 2.5 t of grouper, 1 t of common dentex and 1.5-2 t of European seabass (*Dicentrarchus labrax*) were caught annually in Turkey's first designated 'Marine Protected Area' and 'No Take Fishing Zone' (as of 2009), at night by illegal recreational spear fishers, where up to hundreds of illegal spearfishers likely operate. It is also worth mentioning, based on a study done on managing grouper catches from the same region (Ünal *et al.* 2009), that the illegal catches of the above-mentioned species are equal or larger than the local fishery co-operatives' annual legal catch of the same species. There are many layers of illegal fishing which occur at times simultaneously in Turkey, all stemming from a lack of MCS.

Recreational and Subsistence catches

Recreational catches have never been included in the collection of fishery statistics for Turkey. The first study of recreational fisheries activities in Turkey by Ünal *et al.* (2010), from the Çanakkale region, provided valuable insight and data; specifically, the number of recreational fishers, catch rates, and species composition.

At a recent workshop of the General Fisheries Commission for the Mediterranean (GFCM) on recreational fisheries (GFCM 2011a), a standardized definition of recreational fishing was produced. In this definition recreational fisheries are: "Fishing activities exploiting marine living aquatic resources from which it is prohibited to sell or trade the catches obtained." Subsistence fishing is generally understood as the exploitation of marine aquatic resources for personal consumption (stats.oecd.org/glossary). Subsistence and recreational fishing are not easily separated into distinct categories, but rather form part of a continuum. These components were estimated separately but recognize that catches from one sector may encompass some catches of the other. Subsistence fishing (for necessity) developed into recreational fishing (for leisure and to supplement the diet) as social and economic conditions evolved. Although the legal framework for these sectors is defined in 'Fisheries Law No. 1380 Aquaculture and Fisheries Communiqué', the majority of fishers in these sectors are unaware of these rules. Anyone can obtain an Amateur Fishing Certificate, although it is not legally required in order to fish, which leads to difficulties in monitoring this sector (M. Zengin, unpublished data). Here recreational and subsistence fisheries catches for Turkey were estimated using a detailed account of fishing in Çanakkale (Ünal *et al.* 2010) in combination with assumption-based estimates to expand this estimate to the entire country.

Çanakkale

Çanakkale, with a population of 70,000, is increasingly becoming a popular coastal city for both recreational and commercial fisheries. In the Ünal et al. (2010) study, 190 recreational fishers were surveyed, and then total catches were scaled up to reflect total catches of the recreational fishers in the region. The percentage of recreational fishers from this region was found to represent 9.9% of the population and their average number of recreational fishing days was 77·year^{-1}. Their catch rate resulted in an average of 0.645 t·fisher^{-1}·year^{-1}. The study also suggested that most recreational fishers are neither subsistence nor 'true sport' fishers, since 45% of shore-based, 73% of underwater fishers and 75% of boat-based recreational fishers sell their catches. Conflicts often arise between commercial and recreational fishers for this reason (ICES 2006). The total number of recreational fishers estimated for this study was greater than the reported number of commercial fishers (6,922 and 5,987, respectively).

The total human population of the region was obtained from Populstat data (www.populstat.info) for the period 1950-2010, and the data were interpolated between the closest available years. The annual population amount was divided by 9.9%, to represent the percentage of fishers in the study (Ünal *et al.* 2010), which was then multiplied by the calculated catch rate to get annual recreational catch totals. The catch rate per fisher for 1950 was obtained by doubling the catch rate for 2010, which yielded 1.29 t·fisher^{-1}·year^{-1}; the intermediate values were then obtained by interpolating linearly to the 2010 values (0.645 t·year^{-1}, see above). This higher catch rate in the past was attributable to higher fish abundances and also larger mean fish sizes resulting from less competition in 1950. Recreational catches were assigned taxonomically using the same species composition as the Ünal *et al.* (2010) study.

Istanbul

Istanbul is, by far, the most populated city in the country. From 1950 to 2010, the city of Istanbul has grown in population from 1.2 million people to 13.3 million people (www.turkstat.gov.tr), and it is now the 22nd largest city in the world.

Istanbul has thousands of anglers fishing daily on the Bosphorus Strait, which is a very prominent fishing corridor. Many pelagic stocks make their annual migrations from the Aegean Sea, through the Sea of Marmara and then the Bosphorus Strait, to the Black Sea, and return via the same route back to the Mediterranean Sea. To calculate the number of recreational fishers for this area, the assumption that 1% of the population fishes recreationally was used (S. Bekişoğlu, pers. obs.), changing with population trends over time so that in 1950, Istanbul had an estimated 11,665 recreational fishers, and in 2010 an estimated 129,000 recreational fishers.

In earlier years, fishers in Istanbul were richly rewarded for their efforts. An angler could finish a fishing 'day' in one hour in the 1960s, each fish weighing between 4-6 kg (M. Ulman, pers. comm.). The average catch rate at present is about 1 $kg \cdot fisher^{-1} \cdot day^{-1}$, although considerable day-to-day variation occurs (A. Safahi, pers. comm., recreational angler from Istanbul). For 1950, a catch rate of 2 $kg \cdot day^{-1}$ was conservatively assumed (due to more abundant fish stocks, and less overall fishing pressure). A linear interpolation was used to derive a time series of catch rates from the 1950 rate of 2 $kg \cdot person^{-1} \cdot day^{-1}$ and the rate in 1999 of 1 $kg \cdot person^{-1} \cdot day^{-1}$. The 1999 catch rate was held constant to 2010. The increasing population of Istanbul and associated increase in fishing effort likely resulted in lower catch rates per person, due to lowered abundance and the existence of smaller-sized fish, which is reflected in our assumption-based estimated catch rate. The same number of fishing days were assumed per year as presented in Ünal et al. (2010) of 77 fishing $days \cdot year^{-1}$. Although higher catch rates (5 $kg \cdot day^{-1}$) are presented for recreational anglers catching horse mackerel from a Galata Bridge survey (Zengin, 2011), experience of fishers and timing of survey likely influenced these high catch rates and, thus, our estimation remains conservative in comparison. The Çanakkale species breakdown (based on Ünal *et al.*, 2010) was also used to disaggregate the recreational catches of the Istanbul (Bosphorus) fishing area, since both areas share similar taxa.

The entire Turkish coast

To estimate the number of recreational fishers in Turkey (excluding the Çanakkale and Istanbul provinces, which have been estimated separately), human population data from Populstat data's provincial dataset was used. The population of the coastal provinces in each of the four regions considered here (Black Sea, Marmara Sea, Aegean Sea, and Levantine Sea) was calculated based on census data (as presented by Populstat) for the period 1950-2000. For 2001-2010, the total known population trend was inferred to each coastal region. The percentages of the population living coastally (Çanakkale and Istanbul provinces excluded) ranged from 40% in 1997 to 45% in 1950.

To account for the number of recreational fishers in the coastal population, it was assumed that 2% of the coastal population fishes recreationally in both the Aegean Sea and Levant Sea, to account for less productive seas than the study area, which equals 1/5th the percentage of recreational fishers of the Ünal et al. (2010) study on recreational fishers. For the Sea of Marmara, 3.3% of the coastal population was assumed to fish recreationally; and for the Black Sea region, 1% of the coastal population was assumed to recreationally fish since subsistence/recreational fisheries are known to be much lower in this region. The amount of recreational fishers varied over time along with population trends for each of the provinces.

The recreational catch rates applied to the coastal populations of the Black Sea, Aegean Sea and Levant Sea were one fifth that of the Çanakkale study site, or 0.129 t·fisher^{-1}·year^{-1} in 2010. The catch rate was doubled to 0.258 t·fisher^{-1}·year^{-1} in 1950. A linear interpolation between catch rates of 0.258 t·fisher^{-1}·year^{-1} in 1950 and 0.129 t·fisher^{-1}·year^{-1} in 2010 was applied. The catch rate applied to the Marmara Sea was three quarters that of the study site, since the productivity of these regions are more similar, or 0.483 t·fisher^{-1}·year^{-1} in 1950 (to remain conservative), which was reduced by half in 2010 to 0.241 t·fisher^{-1}·year^{-1} and the catch rate was interpolated between 1950-2010.

Subsistence catches

To distinguish the recreational and subsistence sectors for accounting purposes, it was assumed that in 1950, this sector was dominated by people fishing exclusively for subsistence purposes. Therefore, in 1950, the ratio of subsistence to recreational fisheries catches was assumed to be 9:1 for all regions. Given the substantial developments in the economy of Turkey since 1950 (GDP per capita was $ 1,299 US in 1950, www.nationmaster.com), and the fact that GDP had risen to $ 13,800 US by 2010 (www.indexmundi.com), a subsistence to recreational catch ratio of 1:9 was assumed. Then, a linear interpolation between these two ratios was performed to derive a sub-sector breakdown for the entire 1950-2010 time period.

Taxonomic allocation of recreational/subsistence catches

To allocate recreational/subsistence catches to individual fish species/groups for the Aegean, Marmara and Levant Seas, the species composition from the reported TURKSTAT 1980 commercial catch data was used as a baseline to assign catches to the same percentage of occurrence per species.

Some of these individual species ratios were slightly adjusted after consultation with local experts, fishers and analyzing all the peer-reviewed literature to account for different target species between commercial and recreational fisheries. For example, anchovy and other small pelagics are not caught by the recreational sector (S. Knudsen, pers. obs.), so these were excluded from recreational catches for all seas. For the Black Sea, annual trends in the catch data as well as expert knowledge were used. For the years between 1950 and 1966, the species composition was averaged from the closest available statistical years (1967-1971). Select popular recreationally-caught taxa were given a higher allocation percentage for recreational catches (Table 2.1).

Table 2.1. Taxonomic allocation of recreational/subsistence catches (%) in Turkey, from 1950-2010.

Taxa	1950-1980	1981-2010
Aegean & Levantine Sea:[a]		
Grouper (Serranidae)	20	10
European seabass (*Dicentrarchus labrax*)	20	10
Common dentex (*Dentex dentex*)	5	10
BlackSea:[b]		
Bonito (*Sarda sarda*)	40 until 1968	3-49 from 1969-2010

a) From Ünal and Erdem (2009); b) From S. Knudsen, unpublished data.

Discards

Discards were separated into three components: 1) discards from bottom trawl fisheries; 2) discards from highgrading; and 3) all 'other' discards.

Turkey has reported some discard amounts in their annual statistical reports (as fish that are 'not processed or consumed') from 1998-2008. The reported discard rate was calculated from 1998-2008, and the discard rate ranged from 0.5% in 2000 to 3.24% in 2006, averaging 1.6% for the 11 year period. Due to the random process of the statistical sampling programme, and the annual form that commercial fishers are required to fill out (normally from memory alone), it is highly unlikely that these figures represent actual discard rates.

According to Kelleher (2005), fisheries around Turkey have the following discard rates: trawl fisheries (45- 50%), artisanal fisheries (<15%), mid-water trawlers targeting small pelagics (5.1%), sea snail dredge fishery (11.5%), and coastal encircling nets (7.4%). Additionally, the following discard rates were found for Turkey: 35.5% discards from the coastal shrimp beam trawl fishery in Turkey (Zengin and Akyol 2009), 77% discards from the commercial prawn trammel net fishery in the Aegean (Gökçe and Metin 2007), 77.8% discard rate for monofilament nets, 22.8% for multifilament net fishing in the gillnet fishery in the Turkish Aegean Sea (İlker *et al.* 2008), 38% discards from bottom trawl fishing in the Turkish Aegean Sea (A.Ç. Gücü, unpublished data), 37% discards from demersal trawling in Turkish waters (Özbilgin *et al.* 2006), and 36% discards from Black Sea bottom trawling (Özbilgin *et al.* 2006). Available discard information was converted into discard rates for each of the discard components.

Bottom trawling discards

Bottom trawling is one of the most destructive gear-types. Some of the well-documented impacts of bottom trawling include damage to benthic habitat, destruction of essential fish habitat, increased siltation, reduced biodiversity and reduced species richness over a short time period (Thrush and Dayton 2002). Unfortunately, no such study on bottom trawling impact on the benthic system has been completed for Turkey; but this type of research is urgently needed.

Black Sea

Bottom trawling is illegal in the eastern Black Sea; but legal in the western Black Sea region. For all bottom trawling operations in the Black Sea, there are specific 'target' fisheries. From fieldwork on discard rates in the Black Sea (2004-2006), the following discard percentages were applied (Table 2.2, Zengin and Knudsen 2006). These percentages mostly represent the ratio of under-sized fish that are discarded due to minimum legal landing size, fishing season, and market price.

Table 2.2. Discard rates applied to taxa from bottom trawling on the Turkish Black Sea coast, 1950-2010.

Taxon	Discard rate (%)
Whiting (*Merlangius merlangus*)[a]	45.3
Red mullet (*Mullus barbatus*)[a]	25.7
Turbot (*Scopthalmus maximus*)[a]	27.5
Mediterranean horse mackerel (*Trachurus mediterraneus*)[a]	25.8
Atlantic horse mackerel (*Trachurus trachurus*)[a]	22.2
Piked dogfish (*Squalus acanthias*)[a]	16.6
Sea snail (*Rapana venosa*)[b]	11.5

a) From Zengin and Knudsen (2006); b) From Kelleher, (2005).

The Black Sea does not have a 'target' shrimp (Penaeidae) fishery, but shrimps are caught as by-catch and retained by bottom trawlers (Zengin and Knudsen 2006). The Black Sea's shrimp contribution is negligible and reported zero catches in 2010. No additional discards for shrimp have been calculated for the Black Sea region.

Marmara Sea

Discards from bottom trawling were calculated as 37% of the reported catches for five specific target species (Table 2.3, Özbilgin *et al.* 2006). Shrimp are fished in the Sea of Marmara using trammel nets and bottom trawls. The discard rate used for the shrimp fisheries in this sea was averaged from two published discard rates for shrimp fishing in Turkey (Gökçe and Metin 2007; Zengin and Akyol 2009); the resulting discard rate of 56% was then applied to shrimp catches to get a total discarded amount, which was then allocated to the following species (Table 2.3, Metin *et al.* 2009): swimming crab (Portunidae 29%); blue crab (*Callinectes sapidus* 17%); annular seabream (*Diplodus annularis* 15%); angular crab (*Goneplax rhomboides* 15%); mantis shrimp (*Squilla mantis* 12%); and purple-dye murex (*Bolinus brandaris*, 12%).

Table 2.3. Discard rates (%) applied to taxa from bottom trawling in the Sea of Marmara and Aegean Seas, 1950-2010.

Taxon	Marmara Sea %	Aegean Sea %
Mullet (Mugilidae and Mullidae)[a]	37	38
Turbot (*Scopthalmus maximus*)[a]	37	38
Atlantic mackerel (*Scomber scombrus*)[a]	37	38
Smooth-hound (*Mustelus mustelus*)[a]	37	38
Sea snail (*Rapana venosa*)[a]	37	38
Shrimp fishery discard rate (56%), applied to following taxa:		
Swimming crab[b]	29	29
Blue crab[b]	17	17
Mantis shrimp[bd]	12	12
Annular seabream[bd]	15	15
Angular crab[bd]	15	15
Purple-dye murex[bd]	12	14

From Özbilgin et al. (2006); [b)] From Gökçe and Metin (2007); [c)] From Zengin (2009);
[d)] From Metin *et al.* (2009).

Aegean Sea

Trawlers fish in their 'home' fishing grounds (the Western Black Sea), and as the fishing season finishes their fishing grounds expand to the Aegean and Levant Seas. The trawling discard rate for the Aegean Sea is a little lower than for the Levant Sea, at 38% (Stergiou *et al.* 1998, A.C. Gucu, unpubl. data). This 38% discard rate was applied to the same target species listed above in the Marmara Sea section. In addition, the shrimp trawling discards have been allocated to the same taxa and percentage (56% of shrimp fisheries) as in the previous section on the Sea of Marmara (Table 2.3).

Levant Sea

Bottom trawl data for this region were recently evaluated for the past 40 years (A.Ç. Gücü, unpublished data; Table 2.4) to establish trends in discard rates over time. In the 1980s, the discard rate from bottom trawling was 40.9%, on average, which increased to 48.3% by 2007-2010. A constant discard rate of 40.9% was assumed for the 1950 to 2006 time period, which increased to 48.3% from 2007-2010. In the recent period, discarding has increased in the Levant and Aegean Seas as evidenced by the increasing availability of undersized fish; and a maximum discard rate of 93.5% was even sometimes reached (A.Ç.

Gücü, unpublished data). The shrimp trawl fishery had a higher discard rate in this sea at 71% (Duruer *et al.* 2008), which was applied to the taxa in Table 2.4 for the 1950-2010 period.

Table 2.4. Discard rates (%) applied to bottom trawling in the Turkish Levantine coast, 1950-2010.

Taxon	1950-2006	2007-2010
Red mullet[a]	40.9	48.3
Atlantic horse mackerel[a]	40.9	48.3
Mediterranean horse mackerel[a]	40.9	48.3
Shrimp fishery discard rate 71%[b], applied to following species:		
Swimming crab	50	50
Blue crab	35	35
Mantis shrimp	15	15

[a)] From Dr. Ali Çemal Gücü, unpublished data; [b)] From Duruer *et al.* (2008).

Discards from highgrading

Highgrading is defined as the discarding of a marketable species in order to retain the same species at a larger size and price, or to retain another species of higher value or the retention of only those species with the greatest market value (Alverson 1994). Until very recently, some non-target fish species have been almost entirely discarded (Zengin *et al.* 2011). After the Turkish fishery 'resource crisis' of the late 1980s, some previously discarded species became target species and have only recently become marketable due to a marked decline in the catches of larger, more valuable fish.

From 1950-1995, nine times the reported amount of the following species were likely discarded (M. Zengin, pers. obs.): scorpionfish (Scorpaenidae), gobies (Gobiidae), stingrays (Dasyatidae) and sprat. From 1996-2010, at least two times the reported amount of these select species were discarded (Zengin and Knudsen 2006; Zengin *et al.* 2011), since a portion of these are now landed, but the majority continue to be discarded at sea (Table 2.5). Sprat is the exception, which has now shifted to being a 'tar-get' fishery; sprat has a 15% discard rate post-1996 (M. Zengin, pers. obs.). Although a targeted fishery now exists for sprat, their geographical range overlaps for about one month during the year with that of anchovy and sprat is therefore caught incidentally, and then discarded at the market.

In a recent study by Ali Çemal Gücü[20], based on anchovy size comparisons between landed sizes and sampled-at-sea sizes, it was estimated that 41% of anchovy (by weight), and 76% (by number) were likely discarded at sea due small sizes resulting from highgrading during the 2012-2013 fishing season. Since anchovy are the largest Turkish fishery, this high amount was assumed to have been covered through the estimations of unreported catches and discards.

Table 2.5: Discard rates (%) applied to highgrading for all seas, 1950-2010.[a]

Taxon	1950-1995	1996-2010
Scorpionfish	900	200
Goby	900	200
Stingray	900	200
Sprat	900	15

a) From M. Zengin, pers. comm.

'Other' discards

Kelleher (2005) suggested that the anchovy fishery, the largest fishery in Turkey, has no discards as the fish are caught by purse-seines and anything not sold is sent to one of 25 fish meal and fish oil processing plants. However, on closer inspection, fish processing plants occasionally refuse to process small pelagic catches when the facility is at capacity, resulting in the spoiling and discard of excess catches, or if the catches presented are juveniles, as they do not yet have enough oil for processing. Therefore, for anchovy and all 'other' commercial marine species that have not yet been mentioned, a discard rate of 5% was applied. This rate was guided by taking the weighted average global discard rate of 8%, and deducting Turkey's average reported discard rate (1.6%). The resulting rate of 6.4% was conservatively reduced to 5%. Mid-water trawlers targeting small pelagic fish have a weighted discard rate

[20] http://hamsi.ims.metu.edu.tr/sunumlar/4-IUU-GFCM[ACG].pdf

of 5.1% (Kelleher 2005), which is suitable for the discards of all 'other' species, most of which are small pelagics. Although it may seem that discarded species are not of general importance, they may have an important role in the ecosystem (Akyol 2011). Other catch adjustments

Sea cucumber

There were some minor discrepancies concerning the data collection that need mentioning. Sea cucumbers (Holothuridae) are commercially harvested, but have not been included in the national landing statistics. It is highly unlikely that sea cucumbers were included in the 'Miscellaneous marine invertebrates' category in the reported Turkstat data, since for most years there is a discrepancy, there is not a great enough amount in the miscellaneous category to cover these commercial activities. They generated between 19 to 77 t of processed product annually between 1996 and 2007 (Aydin 2008); their weight was assessed mostly while the animals were fresh. Processing involves a combination of freezing, drying and salting; the final product is then exported to the Asian seafood market.

Sea snail

The Rapa whelk (*Rapana venosa*) is an invasive snail species that was first recorded in the Black Sea during the 1940s (Sağlam *et al.* 2009). They are top predators with a ferocious appetite, and the diversity of bivalves in the Black Sea declined two-fold since their introduction (Vershinin 2007). This sea snail is associated with a marked decline in range and density of native mussel settlements, near both the Anatolian and Caucasus coasts on the Black Sea, originally biologically rich areas (Öztürk 1999).

Rapa whelk has been fished either by dredging or by diving since the 1980s, mostly by artisanal fisheries. Dredging for sea snails most likely damages benthic habitats, but this has not yet been studied. This species was first included on its own in the national fisheries statistics in 1988, and was under the ‘others’ column for invertebrates some years before that (Rad 2002). This animal is not consumed in Turkey, but instead exported to Asian markets.

In the Black Sea, illegal fishing for this species is common: “Although illegal, most boats use two or even three dredges simultaneously and operate at night (which is also illegal); although dredging is illegal in the summer, this is when the fishery is most intense, when catches are best” (Knudsen *et al.* 2010). The months with the highest sea snail catches are also the summer months when dredging (and trawling) activities are supposedly banned (M. Zengin, unpublished data). Formal state regulations to a large extent are circumvented with regards to the sea snail fishery of the Black Sea.

In the easternmost Black Sea, sea snail fisheries ceased operating from 2005 until recently due to the diminishing mean size of the animal, which decreased from 62 mm in 1991 to 47 mm in 2005 (Knudsen *et al.* 2010). In 2008, the owners of three of the largest sea snail processing plants in Samsun (Black Sea coast), all complained about the hardships of finding buyers for sea snails for the last two to three years, due to their declining mean size; the fishers also complained that the reduced mean sizes meant they increasingly found themselves returning many smaller sized individuals to the sea (Knudsen *et al.* 2010). Sea snail exports were found to be higher than reported landings over a twelve year period in between 1986-1988 and 1993-2003, but not including the years between 1989 and 1992 because the export statistics could not be verified (Knudsen *et al.* 2010). Unfortunately, export data from 2004 onwards group sea snails with a larger taxonomic category, so the export amounts for this species could not be verified. The year with the highest discrepancy was 1995, as exports were almost eleven times higher than the reported landings (12,988 t and 1,198 t, respectively). Data collection for this fishery should be more precise given the limited amount of snail-processing plants on the Black Sea coast.

Turbot in the Black Sea

There is a notable decline in reported Turkish turbot catches from the Black Sea starting in 2002. It is widely acknowledged that Turkish fishers were illegally fishing for turbot in the north-western Black Sea, in Bulgarian, Romanian and Ukrainian waters (where between 1,000 and 2,000 t were taken annually) in the period 1993-2001 and also 2009-2010. Some (fatal) accidents involving the maritime police and illegal Turkish fishers temporarily stopped this illegal fishing problem. The catches were sold on the Turkish market and reported as Turkish catch. Turkish fishers also catch turbot in the Abkhazia region of Georgia, a run-away Georgian state (S. Knudsen, pers. comm.). After 2001, Turkish fishers have had to rely more on their own 'narrow and exhausted' Black Sea continental shelf for turbot, due to these escalated conflicts, hence the reduction of Turkish reported turbot catches (Llope *et al.* 2011).

Turbot catches caught by Turks in waters other than their own were estimated to be about 2.4 times higher than the reported landings averaged for the 2002-2010 period (Zengin *et al.* 2011). For each of the eleven years (1993- 2001, 2009-2010), the reported catch data was adjusted with the minimum estimated amount (1,000 $t \cdot year^{-1}$) of foreign-caught turbot catches (since these catches were not caught in Turkish waters), and the catches must be allocated to the waters of the countries in which they were caught.

Unreported Mediterranean mussel

Mediterranean mussel (*Mytilus galloprovincialis*) has always been a part of traditional Turkish cuisine. The majority of mussel catches have gone unreported and were estimated here for the first time. Through surveys conducted in 2013, details of this fishery were obtained, and four types of mussel fishers and their catch rates were derived from: 1) *Elif* fishers; 2) Dredgers; 3) Scuba divers; and 4) Skin divers.

It is illegal to catch mussel from the Bosphorus Strait, Marmara Sea and the Dardanelles, unless one has a special license for mussel, which are challenging to obtain. Hence, the bulk of the fishery operates illegally and (very) often has to pay penalties to the local authorities. There are many local news articles about mussel fishers being caught and fined in recent years, but since the population density is so high (especially in Istanbul), and control is very sparse, the majority of this illegal fishery goes unnoticed.

'Elif' fishers*:* This is a new type of vacuum-style compressor called an '*Elif*'. There are three known *Elif* compressors operating in Turkey beginning in 2009, two in the Sea of Marmara and one in the Aegean Sea. They operate from May to September, and can collect 4 x 26 kg bags of mussel a minute, or a total of 1,500 bags a day, which results in 39 $t{\cdot}vessel^{-1}{\cdot}day^{-1}$. Out of the five-month fishing season, it was assumed that each of these three boats collects mussel 30 days a season (this is a part-time operation, conducted between holding other jobs) resulting in ~1,170 $t{\cdot}vessel^{-1}{\cdot}year^{-1}$ of unreported mussels. Thus, for 2009 and 2010, 2,340 $t{\cdot}year^{-1}$ (i.e., two operators) of mussel was allocated to the Sea of Marmara and 1,170 $t{\cdot}year^{-1}$ (one operator) was allocated to the Aegean Sea. These mussel catches and the dredger catches below were allocated as unreported artisanal commercial catches.

Dredgers: There are several known mussel landing and processing centers located on the Bosphorus Strait from which dredgers operate (A. Ulman, pers. obs.). One such area on the Bosphorus collected between 1,000 and 1,500 $bags{\cdot}day^{-1}$, with each bag containing approximately 26 kg of mussels. To be conservative, an average of 1,000 bags was used, which equalled 26 $t{\cdot}day^{-1}$ for this site alone. This site operated daily from May to September and was thus assumed to operate 120 $days{\cdot}year^{-1}$, equating to 3,120 $t{\cdot}year^{-1}$ of catches. It was assumed that there were at least 5 such illegal processing sites on the Turkish Black Sea coast, 6 in the Bosphorus-Marmara-Dardanelles region, and one on the Aegean Sea coast. The dredgers interviewed in 2013 by A.U. began collecting mussels around 1965, but their catch rate was reduced by 25% (i.e., to 2,340 $t \cdot year^{-1}$) in 1965 to reflect lower fishing pressure due to lower demand imposed by the lower human population, but by 1980, 3,120 $t \cdot year^{-1}$ per site was deemed appropriate and used.

Scuba gear: One professional scuba diver collects ~0.7 $t \cdot day^{-1}$ and operates about 20 $days \cdot year^{-1}$ (as an income supplement, A. Ulman, pers. obs.) which equates to catches of 14 $t \cdot diver^{-1} \cdot year^{-1}$. All mussel collectors using scuba were assigned half this catch rate in 1950 (7 $t \cdot diver^{-1} \cdot year^{-1}$), which was linearly increased to 14 $t \cdot diver^{-1} \cdot year^{-1}$ by 1980 and this rate was held constant until 2010. It was assumed that in 1950, there were 100 scuba divers collecting mussels in the Marmara Sea region (including Istanbul and the Dardanelles), which was linearly increased to 500 by 1980, and was held constant to 2010. The Black Sea was assumed to have 20 mussel scuba divers in 1950, which was linearly increased to 200 divers by 1980, and held constant to 2010. The Aegean Sea was assumed to have 10 divers in 1950, which was linearly increased to 50 by 1980 and held constant to 2010. Mussels were not known to be collected from the Turkish Levantine coast (Mediterranean coast).

Skin divers: Mussels collected for bait by skin divers were estimated at 20 $kg \cdot fisher^{-1} \cdot day^{-1}$ for 100 $days \cdot year^{-1}$, equating to 2 $t \cdot fisher^{-1} \cdot year^{-1}$. It was assumed that there were 100 such skin diving fishers operating in the Istanbul, Marmara and Dardanelles areas beginning in 1965, which was linearly increased to a (very conservative) 1,000 $fishers \cdot year^{-1}$ by 1980, which was held constant to 2010. The Aegean Sea was assumed to have 20 skin diving fishers in 1950, which was linearly increased to 200 by 1980, and held constant to 2010. Other seas were not considered here. These mussel catches and catches using scuba gear were allocated as recreational catches.

Accounting for uncertainty

To account for uncertainty from the quality of the data used, the guidelines first derived by the Intergovernmental Panel on Climate Change were used (Table 2.6). First, each sector's contribution to the total reconstructed catch was independently scored by three of the co-authors of this reconstruction, which were then averaged, for three periods in time (1960 to represent the period from 1950 to 1969, 1980 to represent the period from 1970 to 1989, and 2000 to represent the period from1990 to 2010)

Table 2.6. Presents our criteria for scoring the quality of the data used in this reconstruction for three separate time period.

'Score' for evaluating the quality of time series of reconstructed catches, with their confidence intervals (IPCC criteria from Figure 1 of Mastrandrea *et al.* 2010)				
Score		**-%**	**+%**	**Corresponding IPCC criteria***
4	Very good	10	20	High agreement & robust evidence
3	Good	20	30	High agreement & medium evidence **or** medium agreement. & robust evidence
2	Bad	30	50	High agreement. & limited evidence **or** medium agreement & medium evidence.
1	Very bad	50	90	Less than high agreement & less than robust evidence

*Mastandrea et al. (2010) note that "confidence increase" [and hence confidence intervals are reduced] "when there are multiple, consistent independent lines of high-quality evidence".

RESULTS

The total reconstructed results are first presented by sea and component, followed by adjustments, and then the total reconstructed catch for the nation as a whole, by component.

Total reconstructed catches

The Black Sea

<u>Industrial and artisanal catches</u>

For the 1950-2010 period, total reported landings for the industrial fishing sector were ~13.1 million t (89%) from the Black Sea, while the artisanal sector landed a total of ~1.7 million t (11%)

The major taxa landed by the industrial sector for the 1950-2010 period include anchovy (69%); Mediterranean horse mackerel (9%); bonito (4%); whiting (3%); Atlantic horse mackerel (2%); cockle (2%); and bluefish (2%). Anchovy catches from the Black Sea region were exclusively caught by purse seiners from the industrial sector.

The major taxa landed by the artisanal sector for the 1950-2010 period are grey mullet (10%); bonito (9%); whiting (8%); Mediterranean mussel (8%); turbot (6%); bluefish (5%); and Mediterranean horse mackerel (4%).

<u>Unreported catches</u>

The total unreported component for the Turkish Black Sea amounted to approximately 5.6 million t for the 1950-2010 period. Of this total, 94% was allocated to the industrial sector and 6% was allocated to the artisanal sector. The taxonomic allocation for the unreported catches is the same as the industrial and artisanal reported components above.

<u>Recreational and subsistence catches</u>

Total estimated Black Sea recreational and subsistence catches totalled slightly over 77,500 t, or specifically ~39,300 t for the recreational and ~38,200 for the subsistence sectors, for the 1950-2010 period. The portion of this attributed to the subsistence sector was much higher (90%) at the beginning of the study period than at the end (10% in 2010). Recreational catches had the opposite trend, whereby in 1950, they accounted for 10% which increased to 90% by 2010. The dominant species caught in the Black Sea by the recreational sector over the 1950-2010 time period were: bonito (28%); Mediterranean horse mackerel (16%); Atlantic horse mackerel (12%); bluefish (7%); grey mullet (7%); and seabream (4%).

Discards

Total discards for the Black Sea amounted to 2.14 million t for the 1950-2010 period. Total discards from bottom trawling in the Black Sea (for the 1950-2010 period) totalled ~740,600 t. The taxonomic composition of discards included Mediterranean horse mackerel (65%), Atlantic horse mackerel (14%), red mullet (8%), turbot (5%), sharks (4%), sea snail (3%), and shrimp (1%).
The total discards from highgrading in the Black Sea (for the 1950-2010 period) totaled approximately 590,500 t and had the following composition: rays (56%); scorpionfish (20%); gobies (13%); and sprat (11%).

The total discards from all of the ‘other’ fisheries in the Black Sea for the 1950-2010 period, totalled around 558,300 t; of which 80% were from the anchovy fishery; 5% were from the bonito fishery; 3% were from the bluefish fishery; 3% were from the cockle fishery; 2% were from the red mullet fishery; and the remaining 7% were from ‘other’ fisheries.

Marmara Sea

Industrial and artisanal catches

For the 1950-2010 period, industrial fishing operations landed approximately 738,000 t of total reported catches (30%) from the Sea of Marmara, while the artisanal sector landed more than 1,423,500 t (70%). The major species landed by the industrial sector for the 1950-2010 period include anchovy (~140,300 t); grey mullets (~84,400 t); European pilchard (~78,000 t); silversides (~Atherinidae, 45,000 t); chub mackerel (~31,000 t); bonito (~26,000 t); and bluefish (~17,700 t).

The major species landed by the artisanal sector for the 1950-2010 period include Mediterranean mussel (1.1 million t); cockle (~46,000 t); mussel (~40,400 t); shrimp (~33,350 t); chub mackerel (~33,000 t); mullets (~31,300 t); bonito (~24,300 t); and bluefish (~20,200 t).

Unreported catches

The total unreported component for the Sea of Marmara amounted to ~872,000 t for the 1950-2010 period. Of this total, 63% was allocated to the industrial sector and 37% was allocated to the artisanal sector. The taxonomic allocations for the unreported catches are the same as the industrial and artisanal reported components above.

Recreational and subsistence catches

The total reconstructed catch for the entire Marmara Sea region for the recreational and subsistence sectors for the 1950-2010 period was ~3 million t, or specifically, ~2 million t for the recreational and ~1 million for the subsistence sector, for the 1950-2010 period.

The catch is distributed between the three different sub-areas in the following manner: the total reconstructed catch for the recreational sector in the Marmara Sea region (excluding Istanbul and Çanakkale) for the 1950-2010 period totalled ~2.5 million t (85% of the regions total catch); the recreational/subsistence catches for the Çanakkale region for the entire 1950-2010 period totalled just over 225,000 t; and the recreational/subsistence catches for the Istanbul region for the same period totalled just over 325,000 t.

Recreational catches for the Çanakkale region were dominated by bluefish (15%), picarel (*Spicara smaris* 12%), sea snail (10%), mussel (6.8%), sea cucumber (6.7%), axillary seabream (*Pagellus acarne*; 6.2%), grey mullet (4.6%), horse mackerel (3.6%), gilthead seabream (*Sparus aurata*; 3.4%), Atlantic mackerel (3%), and smooth-hound shark (2.9%).

The dominant recreationally-caught species in the rest of the Marmara Sea region by the recreational for the 1950-2010 period were: Mediterranean mussel (30%); bluefish (15.9%); bonito (7 %); Mediterranean horse mackerel (6.9%); picarel (6.5%); chub mackerel (5.9%); mullets (5.4%); sea snail (5.4%); horse mackerel (4.9%); and 'other' marine species (12%).

Discards

Total discards from bottom trawling for the 1950-2010 period were estimated to be ~87,000 t (on average, ~5,100 t·year^{-1} for the 2000s). Discards had the following taxonomic composition: Mediterranean horse mackerel (41.2%); shrimp fishery discards (24.7%); Atlantic horse mackerel (21.6%); red mullet (6.5%); sharks (3.3%); turbot (2.5%); and sea snail (0.2%).

Total discards from high-grading in Marmara Sea (for the 1950-2010 period) totalled ~127,000 t and had the following taxonomic composition: rays (42%); scorpionfish (35%); gobies (21%); and sprat (2%).

Total discards from ‘other fisheries’ in the Marmara Sea (for the 1950-2010 period) totalled just over 98,000 t, and had the following taxonomic composition: 37% anchovy; 9% bonito; 8% European pilchard; 8% bluefish; 5% whiting; and 33% from all ‘other’ fisheries.

Aegean Sea

Industrial and artisanal catches

For the 1950-2010 period, industrial fishing operations landed just over 1 million t (75%) of total reported commercial catches from the Aegean Sea while the artisanal sector landed ~337,300 t (25%).

The major taxa landed by the industrial or industrial sector for the 1950-2010 period are: European pilchard (~335,000 t); anchovy (~164,000 t); grey mullet (~89,000 t); blue whiting (~63,150 t); chub mackerel (~54,000 t); bogue (~40,000 t); and bonito (~24,150 t).

The major taxa landed by the artisanal sector for the 1950-2010 period are grey mullet (~48,000 t); seabream (~30,100 t); mussel (~30,050 t); European seabass (~20,750 t); bogue (~15,550 t); twaite shad (~11,100 t); and common octopus (8,750 t).

Unreported catches

The total unreported component for the Aegean Sea amounted to nearly 553,000 t for the 1950-2010 period. Of this total, 75% was allocated to the industrial sector and 25% was allocated to the artisanal sector. The taxonomic allocations for the unreported catches are the same as the industrial and artisanal reported components above.

Recreational and subsistence catches

The total reconstructed catch for the recreational and subsistence sectors from the Aegean Sea for the entire 1950-2010 period was ~143,450 t, (on average, 3,700 t·year^{-1} in the 2000s). Total recreational catches amounted to ~79,900 t (59%) over the 1950-2010 period, while subsistence catches accounted for ~63,550 t (41%). The dominant taxa caught in the Aegean Sea by the recreational and subsistence sectors were groupers (13%); grey mullet (11%); seabream (12%); horse mackerel (12%); European seabass (12%); common dentex (11%); bogue (6%); and Mediterranean horse mackerel (5%).

Discards

Discards from bottom trawling in the Aegean Sea (for the 1950-2010 period) totalled nearly 70,000 t. The discards had the following composition: Mediterranean horse mackerel (30%); red mullet (25%); Atlantic horse mackerel (20%); shrimp fishery discards (20%); sharks (5%); sea snail (1%); and turbot (0.1%).

Total discards from the shrimp fishery totalled just over 8,900 t and specifically had the following taxonomic composition: swimming crabs (29%); blue crab (17%); annular seabream (15%); angular crab (15%); mantis shrimp (12%); and purple-dye murex (12%).

The total discards from highgrading in the Aegean Sea (for the 1950-2010 period) totalled nearly 86,000 t. The discards had the following taxonomic composition: scorpionfish (49%); gobies (29%); rays (20%); and sprat (2%). The total discards from ‘other fisheries’ in the Aegean Sea (for the 1950-2010 period) totalled just over 58,400 t. Discards had the following taxonomic composition: European pilchard (29%); anchovy (12%); mullets (11%); European seabass (7%); shi drum (*Umbrina cirrosa*, 6%); and the remaining 35% were from other taxa.

The Levantine Sea

Industrial and artisanal catches

For the 1950-2010 period, industrial fishing operations landed nearly 483,000 t (64%) of reported catches from the Levantine Sea, while the artisanal sector landed nearly 270,000 t (36%).
The major reported taxa landed by the industrial sector in the Levantine Sea during the 1950-2010 period were European pilchard (15%); mullets (7%); silversides (7%); chub mackerel (6%); anchovy (5%); picarel (3%); and bluefin tuna (3%).

The major reported taxa landed by the artisanal sector in the Aegean Sea during the 1950-2010 period were European barracuda (15%); seabream (11%); grey mullet (11%); leerfish (*Lichia amia* 7%); European seabass (5%); shrimp (4%); and common cuttlefish (*Sepia officinalis* 4%). Annual marine reported landings were highest in the Levantine Sea in 1993 with ~50,000 t and lowest in 2001 with ~11,800 t (TÜİK 2010).

Unreported catches

The total unreported component for the Levantine Sea amounted to ~306,000 t for the 1950-2010 period. Of this total, 75% was allocated to the industrial sector and 25% was allocated to the artisanal sector. The taxonomic allocation for the unreported catches is the same as the industrial and artisanal reported components above.

Recreational and subsistence catches

The reconstructed catch for the recreational and subsistence sectors from the Levantine Sea region for the entire 1950-2010 period was ~95,750 t (on average, just over 2,000 t·year^{-1} in the 2000s). Total recreational catches amounted to just above 53,500 t over the 1950-2010 study period, while subsistence catches accounted for ~43,600 t.

The major taxa caught in the Levantine Sea by the recreational and subsistence sectors through the 1950-2010 period were European barracuda (~14,250 t); grouper (nearly 13,200 t); picarel (just over 12,400 t); common dentex (~9,550 t); European seabass (~9,550); gobies (~7,200 t); shark (~6,150 t): and leerfish (~2,100 t).

Discards

Discards from bottom trawling in the Levantine Sea (for the 1950-2010 period) totaled nearly 44,500 t (on average, 810 t·year^{-1} for the 2000s). The discards had the following taxonomic allocation: red mullet (33%); Atlantic horse mackerel (13%); crabs (13%); Mediterranean horse mackerel (10%); shark (9%); and the shrimp trawl fishery (22%). The discards from the shrimp fishery (included in the above bottom trawling estimations) amounted to ~8,250 t.

The total discards from high-grading in the Levantine Sea (for the 1950-2010 period) totaled nearly 247,000 t. The discards had the following taxonomic allocation: gobies (72.8%); rays (15%); scorpionfish (12%) and sprat (0.2%).

The total discards from 'other' fisheries in the Levantine Sea (for the 1950-2010 period) totaled 32,240 t. The majority of discards had the following taxonomic allocation: European pilchard (16%); European barracuda (7%); mullets (6%); swordfish (5%); picarel (5%); cuttlefish (5%); and the remaining 56% were from other taxa.

Other catch adjustments

The other catch adjustments were as follows:

Table 2.7. Results of 'Other catch adjustments' by taxon, tonnage, and year(s).

Taxon group	Total adjustment (t)	Year(s) applied
Sea cucumber	228.6	1996-2007
Sea snail	61,592	1985-1987, 1994-2003
Bluefin tuna	1,384	2006
Turbot	11,000	1993-2001, 2009-2010
Mediterranean mussel	1,072,000	1950-2010

Turkey as a whole

The total reconstructed catch for the 1950-2010 time period is approximately 33 million t, adding 14.5 million t to the total reported landings of around 18.4 million t (Figure 2.2, Appendix table 7).

Thus, reconstructed total catches were 63% more than the officially reported data. Our reconstruction of Turkey's total catch from 1950 to 2010 combines the reported landings presented in the national data submitted to the FAO with our best estimates of additional unreported and under-reported catches (Figure 2.3, Appendix Table 7).

Using Table 2.6 as a scoring guide, the following uncertainty scores were calculated for the quality of the data used for this reconstruction: for 1960, -46% (as the lower score) and +78% (as the upper score), for 1980, -21% and +32%, and for 2000, -20% and 30%. Each following component comprised the following tonnages of total catch reconstruction: reported FAO data, 18.4 million t; unreported catches ~9 million t; discards ~2.6 million t, recreational catches ~1.45 million t; and subsistence catches of ~1.15 million t. As of 2010, out of a total of 16,650 registered fishing vessels, only 2,583 (15%) were industrial fishing vessels, i.e., over 10 m in length. However, the industrial sector was estimated to land 90% of the total reported fishery landings for the 1950-2010 period (Figure 2.4, Appendix table 7).

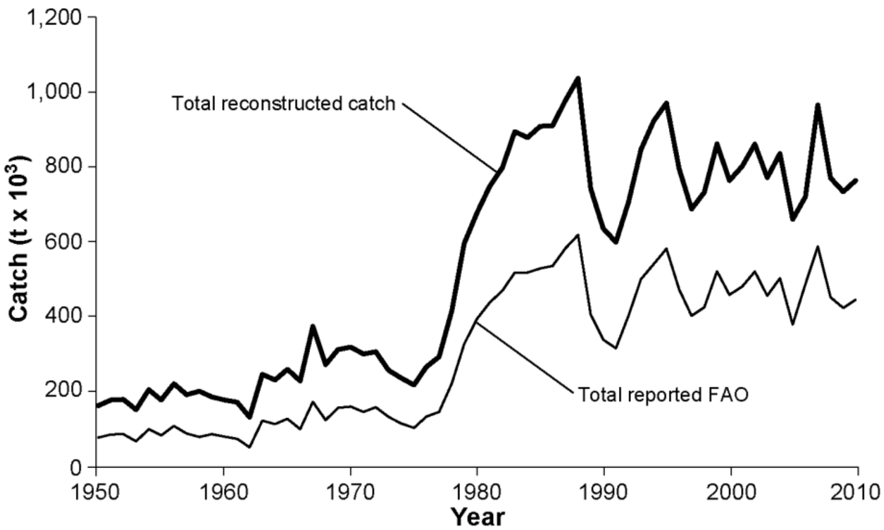


Figure 2.2. Total reconstructed catch compared to total reported catch, 1950-2010.

From the total reconstructed catches (inclusive of the reported data) for the 1950-2010 period (Figure 2.4, Appendix table 8), anchovy was the largest single-taxonomic contribution to total marine landings with 14 million t; horse mackerel contributed 3.7 million t; Mediterranean mussel contributed 2.5 million t; bonito 1.6 million t; whiting 1.1 million t; bluefish 1.1 million t; European pilchard nearly 1 million t; and sprat around 330,000 t (included in data from 1996-2010 only).

It is clear from Figure 2.4 that the catches of small pelagics have increased dramatically since around 1980 (sprat, whiting, European pilchard and anchovy), while the larger pelagics (bonito, mullet, horse mackerel and bluefish) have been on a declining trend since the late 1970s. Marine landings for Turkey, when plotted as a time-series, appear to be semi-stable (Figure 2.4), however, once the very low-valued anchovy and sprat catches are excluded, it is apparent that the majority of catches besides anchovy and sprat have been on a downward declining trend since 1989 (Figure 2.5).

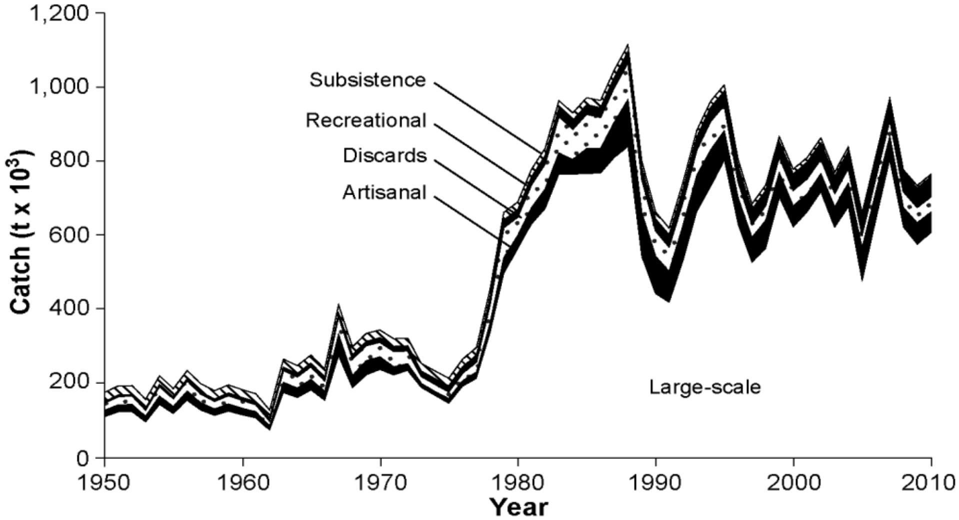


Figure 2.3. Total reconstructed catch by sector, 1950-2010.

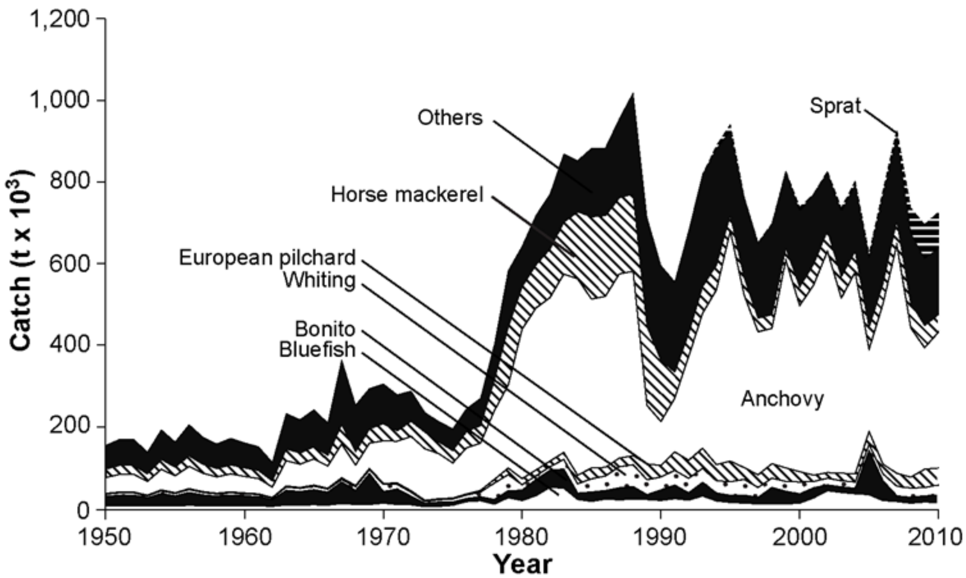


Figure 2.4. Total reconstructed catch by major species or taxa, from 1950-2010.

Unreported landings

Of the contributed adjustments, unreported catches were the largest component. This 40% unreported adjustment totalled to approximately 7.4 million t for the 1950–2010 period (Appendix table 7). The major unreported species throughout the 1950-2010 period were anchovy (~3.6 million t);

Mediterranean horse mackerel (~520,000 t); bonito (~266,000 t); European pilchard (~220,000 t); and whiting (~200,000 t).

Recreational/Subsistence Catches

The estimated recreational and subsistence catches for the 1950-2010 period were just over 2.6 million t (Figure 2.3, Appendix table 7). Of this amount 1.45 million t was from the recreational sector and 1.15 million t was from the subsistence sector. Of the total reconstructed catch, the Marmara Sea region (including both Istanbul and Çanakkale regions) accounted for ~2.3 million t (88%); the Aegean Sea accounted for ~139,000 t (5%); the Levantine Sea accounted for ~251,000 t (10%); and the Black Sea region accounted for ~76,000 t (2%).

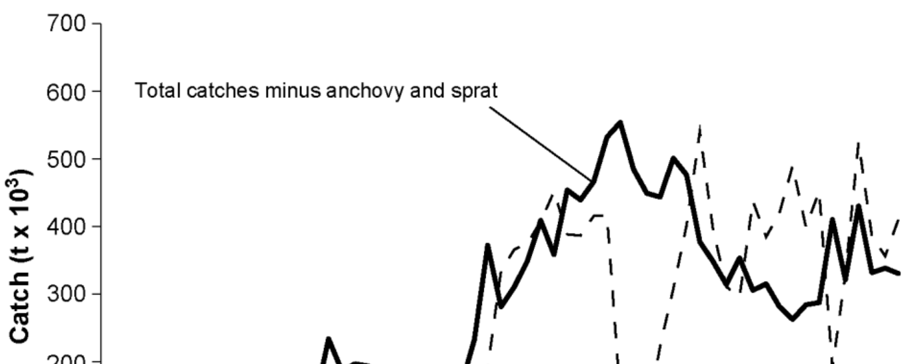


Figure 2.5. Fishery reported catches (t) in Turkey, total landings and anchovy and sprat, 1950-2010.

The major species caught by the recreational sector throughout the 1950-2010 period were bluefish (~590,000 t); bonito (~288,000 t); Mediterranean horse mackerel (~272,000 t); picarel (~239,000 t); and chub mackerel (~229,000 t). Overall, recreational and subsistence catches as a fraction of total reconstructed catches accounted for nearly 9% of the total reconstructed catch (Figure 2.4).

Discards

Total discards for all components (Figure 2.6, Appendix Table 7) estimated was approximately 2.7 million t over the 1950-2010 time period. Discards from highgrading were most substantial, totalling 1.3 million t for the entire study period. Discards due to bottom trawling represented the second largest discard component totalling 730,000 t, and discards came third for all 'other' fisheries which totalled nearly 800,000 t for the same period. The major species discarded throughout the 1950-2010 period were rays (587,000 t); anchovy (472,000 t); Mediterranean horse mackerel (399,000 t); scorpionfish (267,000 t); and Atlantic horse mackerel (118,000 t). Overall, discards as a fraction of total reconstructed catches accounted for 9% of total reconstructed catches (Figure 2.6, Appendix Table 7).

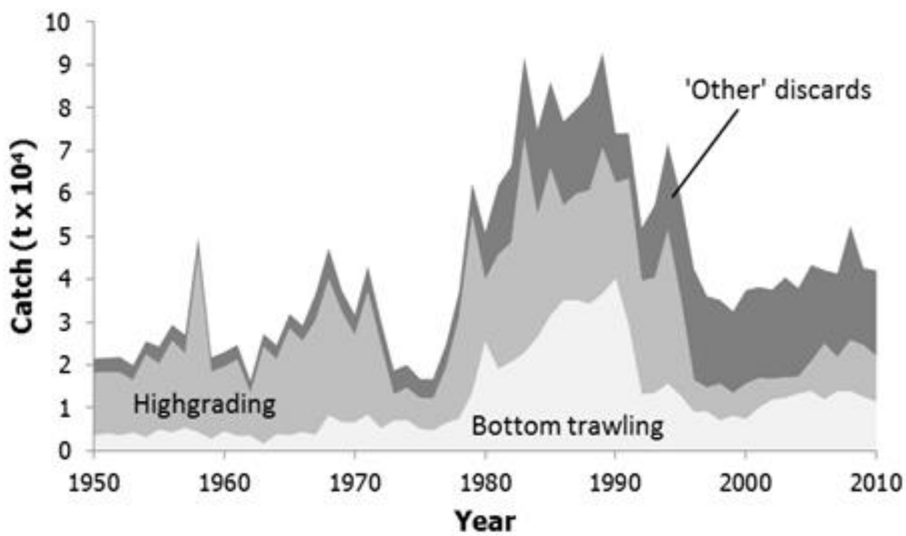


Figure 2.6. Discard components for Turkey, 1950-2010.

DISCUSSION

Turkey's total reconstructed catches over the 1950-2010 time period were estimated to be approximately 33 million tonnes, adding over 14 million tonnes to the officially reported landings presented by the FAO on behalf of Turkey. The discrepancy between the reported and reconstructed data was largely due to unreported catches, which accounted for about 9 million t, discards accounted for 2.6 million t, recreational catches accounted for 2.2 million t, and subsistence catches accounted for 1.15 million. This study highlights the need for improved data collection procedures for Turkish fisheries statistics. Current and past methods of data collection have not accounted for total fisheries removals, which are urgently needed in order to assess fisheries impacts on marine ecosystems. Successful fisheries management plans depend, in large part, on the accuracy of the available data (Ünal and Franquesa 2010). As Turkey aspires to become a member of the EU, addressing missing catch data must be a priority. An overhaul of the statistical data collection system is already under way. However, understanding past catches is important to understanding Turkey's fisheries. Since the fisheries represent less than 1% of the GDP, the Turkish government has not given these natural resources the special attention they require. However, such measures as GDP undervalue the true value of marine resources to a country especially when they fail to incorporate the unreported, recreational and discarded components, i.e., the three main components of this reconstruction. Below are some recommendations to enhance the accuracy for each component.

Of the contributed adjustments, unreported catches were the largest component. The substantial unreported landings estimated during this study appear to be the result of inefficient monitoring, control and surveillance (MCS) systems in Turkey. Furthermore, fishers may under-report their catches due to the present taxation system. It would be a worthwhile government investment to address the loopholes in the reporting system, by making sure that fishers only land their catches at the specific ports offices equipped to verify catches against logbook data, and correcting current issues in the Vessel Monitoring System. To improve the accuracy of reporting, 100% observer coverage on all commercial vessels should also be implemented (INTERPOL 2010; Zeller *et al.* 2011). If Turkey was granted entry into the European Union (EU), these discrepancies would likely be resolved the quickest, as Turkey would have to align their policies with the Common Fisheries Policy of the EU. Illegal fishing, on the other hand, should not be a matter of fisheries management, but of law enforcement (UNODC 2011). Overall, unreported landings accounted for 30% of total reconstructed catches. Illegal, unreported, unregulated fishing presents one of the biggest problems affecting fisheries management. The 'unreported' and 'unregulated' catches should be addressed by fishery managers, while 'illegal' fishing should be addressed by law enforcement.

Currently, unreported and mostly unregulated, Turkey's recreational sector was found here to have significant catch amounts, particularly in the recent period in the Sea of Marmara and the Bosphorus Strait. Recreational catches, for some species, were comparable in magnitude to commercial landings (i.e. picarel catches in the Sea of Marmara). Management measures urgently needed for this sector include surveys to estimate catch and a licensing system, which could improve regulation effort in this sector. Long-term monitoring of the recreational sector can be accomplished in as little as once every 4-5 years (for cost-effectiveness) by completing roving surveys such as creel or angling surveys, or aerial surveys to provide necessary baseline data on fishing effort and catch per unit effort (see Brouwer *et al.* 1997).

The Istanbul recreational/subsistence sector estimation is low compared to the Çanakkale study (Ünal *et al.* 2010), since the population of the study site is only about 6.4% that of Istanbul's, and yet the total estimated catches of Çanakkale are 377% that of Istanbul's. This is partly because only 1% of the population of Istanbul was estimated to fish recreationally while the study found 9.9% of the population in the Çanakkale region to be recreational fishers, and a much lower catch rate was used for the Istanbul region than the Çanakkale region to account for the fact that fishers generally use simple fishing rods and hand lines in Istanbul, but more sophisticated boats and nets in the Çanakkale region. Also, it is understood that the study region is a much more biologically productive corridor than the Bosphorus Strait, since many species have discontinued their migration routes to the latter for various reasons.

Discards represent the third main component in this reconstruction. It has been estimated that 2.6 million t of marine life have been discarded in Turkey for the 1950-2010 period, which is close to five years' worth of total marine catches. Bottom trawling for shrimp and other species had the highest studied percentages of discards, and is also known to be highly destructive of the benthic fauna and flora composition. Mixed-species fisheries are considered wasteful as they catch substantial amounts of non-target species, which are often discarded. Most fishing methods in Turkey are mixed-species fisheries, which have high levels of associated discards, especially of under-sized commercial species. These factors have undoubtedly contributed to the nation-wide 'growth overfishing' dilemma. Putting an end to illegal trawling in the nation should significantly aid the many perilous marine stocks.

Previous studies conducted on pelagic and demersal fish stocks around the coasts of Turkey indeed show that catches are comprised mainly of juvenile and sub-adult fish (Lok *et al.* 2002). Fish markets sampled along the Black Sea coast from 1990-1995 (Zengin *et al.* 1998) found that one third of the anchovy for sale in the region were below the minimum legal catch size of 9 cm; and in the Black Sea, 90% of bluefish are caught before they have a chance to reproduce. The minimum landing size (MLS) for bluefish was 14 cm (Ceyhan *et al.* 2007), but this species does not begin to reproduce until it is between 20-25 cm in length. Local fishers were worried about this 'growth overfishing' problem and started a national campaign (with the aid of Greenpeace) to raise public awareness regarding under-sized fish (Ceyhan *et al.* 2007). Due to this highly-publicized campaign (which provided rulers to measure fish length), the minimum legal landing size was increased to 20 cm for bluefish, but public pressure is mounting for the minimum legal landing length to be increased further to 25 cm. Since most fishers barely turn a profit, they instead try to 'think outside the rules'; Knudsen (1995) reported that in Samsun, on the Black Sea coast, "most trawlers use an additional inner trawl bag that is 2 mm less than the legal mesh size of 18mm. Consequently, there is heavy overfishing of undersized fish". If the species has commercial value, even though it is under-sized, it may still sell at the market (V. Ünal, pers. obs.).

The shrimp fishery would also benefit from having minimum landing sizes, so that individuals could be targeted which have already had a chance to reproduce, enhancing sustainability of the stock.

Minimum landing sizes would be more effective if the regulations coincided with fishing net mesh restrictions that would exclude catching juveniles of the target species to avoid waste in the fishery. Of course, there would have to be sufficient monitoring and control to enforce minimum mesh sizes, and also control measures are needed in fish markets, to prevent the sale of juvenile species.
It should underlined that although marine fish landings in Turkey appear relatively stable (reported landings around 500,000 t·year^{-1} since the early 1990s), during the 2005-2010 period, small pelagics averaged to contribute 80% of total landings, while the larger-sized pelagics made up less than 20%. It should be emphasized that much of this anchovy and sprat caught is processed into fish flour and fish meal and is not made accessible to the growing population to help address food security concerns. Another important issue is that many of these larger pelagics have substantially decreased in size in recent decades, so that they themselves have almost become small pelagics, especially Mediterranean horse mackerel, Atlantic horse mackerel, and bluefish.

In Turkey, industrial and artisanal fleets often fish in the same areas and target the same species, aside from small pelagics such as anchovy and sprat (which are taken exclusively by industrial fleets). The artisanal sector, however, represents most of the employment. Overcapacity in Turkey's seas needs to be addressed as practically all catches (even anchovy) are currently declining. Until fishing capacity is restricted, the well-being and resilience of Turkish marine ecosystems will continue to be compromised. The industrial fishing fleet has continued to grow uncontrollably (most notably after the 1980s; Figure 8), which has been detrimental to the declining stocks of target species (Gücü 2001).

The combined landings of all demersal species from the Levantine region drastically declined from 10,000 t·year^{-1} in 1992 to 2,000 t·year^{-1} from 2001 onwards. This is most likely due to decades of intense trawling in combination with increased fishing effort. The data collection system must account for all species caught. For example dolphinfish (*Coryphaena hippurus*) are known to migrate through the Levantine basin in the summer months; and palometa (*Orcynopsis unicolor*) are known to exist in the Aegean and Mediterranean Seas, both of which can be found for sale in Istanbul fish markets. Also, sea cucumbers are caught, processed and then exported to Asia. Yet, all these taxa are not included the official data collection system.

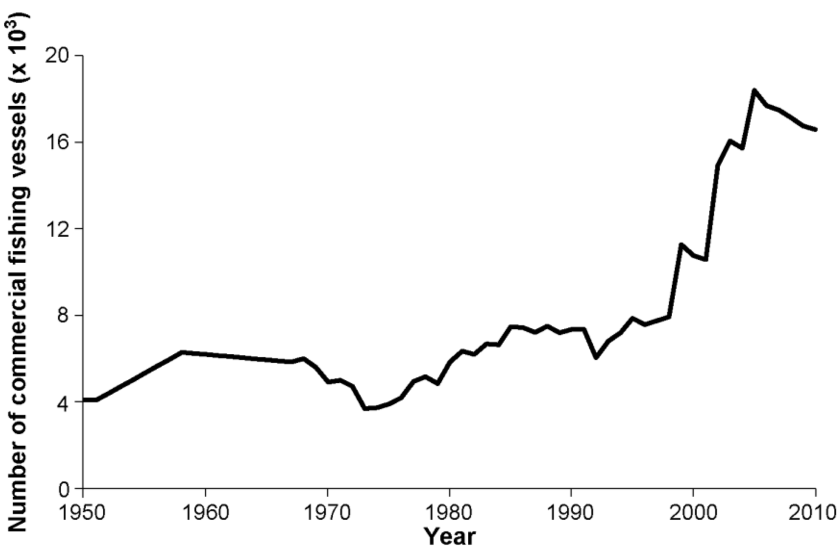


Figure 2.7. The number of licensed commercial fishing vessels in Turkey, 1950-2010.

The larger, more valuable species such as grouper, turbot, and red mullet have been overfished and many traditional fisheries such as Atlantic mackerel have collapsed. Both the Black and Marmara Seas have experienced dramatic shifts in the composition of species and the quality of their ecosystems has declined within the last 30 years. Fishers are now targeting smaller, less valuable species such as sprat, whiting and gurnards, which were not consumed by Turks in the past, but which have now found their way to fish markets. In addition to declining fish stocks, mean fish sizes are getting smaller, as demonstrated with turbot, bluefish and anchovy. The health of Turkish fisheries is declining and will continue to do so until issues such as overcapacity, destructive fishing techniques (bottom trawling) and pollution are seriously addressed.

Key to improving management and moving towards more sustainable fisheries is an understanding of the history of fishing in an area. The current lack of adequate and reliable fisheries catch data, and the uncertainties associated with the available data have been major obstacles in the development of effective management plans (Koşar 2009). Over the period from 1930 to 1980, Turkey's main fisheries catches changed from primarily bonito (a high trophic level, large fish), to primarily anchovy (a low trophic level, small fish), in the Istanbul and Marmara regions, which is an exemplary case of 'fishing down marine food webs' (Pauly *et al.* 1998). Now it is also probable that much of Turkey's anchovy catches are not even coming from their own waters, as the anchovy are being driven out due to the highly-efficient technologies. Bonito had been the staple resource responsible for supplying Istanbul and the Marmara region with considerable wealth and food security for millennia, but its portion of total catch, along with many other larger fish such as swordfish, bluefin tuna and Atlantic mackerel have all but disappeared. A comprehensive time series of fisheries catches, such as presented in this report, is therefore essential to understand, and to help improve, the state of Turkey's fisheries.

3: CYPRUS RECONSTRUCTION

SYNOPSIS

The island of Cyprus has been divided since 1974 into the Turkish Cypriot north and the Greek Cypriot south. Here, we have reconstructed the total marine fishery removals for the island in its entirety, and then for each side. Cyprus's total marine fisheries catches were reconstructed for the 1950-2010 time period by estimating all fishery removals, including unreported commercial, subsistence and recreational catches, and major discards. These estimates were added to the 'officially reported' data, as represented by data submitted by countries to the Food and Agriculture Organization (FAO). Such data were submitted by the south, but were absent from the north for years following the 1974 partitioning of the island. The total reconstructed catch for 1950-2010 was nearly 243 000 t, which is 2.6 times the 93 200 t officially reported by FAO on behalf of Cyprus. The unreported components consisted of nearly 57 000 t of large-scale commercial landings, 43 000 t of small-scale commercial landings, 11 000 t each for recreational and subsistence landings and nearly 28 000 t of discards. Improving the accuracy of fishery statistics by accounting for all removals is fundamental for better understanding fisheries resource use thus increasing the opportunities for sustainable development through enhancing fisheries management capacity.

INTRODUCTION

To reconstruct total marine fisheries extractions from the entire island of Cyprus from 1950-2010, the data reported on behalf of Cyprus to the FAO was used as our baseline, to which non-commercial (previously unreported) sectors have been estimated to determine the island's total catch. In order to approximate historic catch time series data when there is some information lacking, we follow the approach used by Zeller et al. (2007), and many others (Cisneros-Montemayor et al. 2013; Ulman et al.

2013a; Belhabib et al. 2014; Schiller et al. 2014), which use a "re-estimation" approach. However, given its non-recognition by the international community, catches for the 'north' have not been reported to FAO since the partitioning of the island in 1974, but were estimated and included here. This study provides a detailed summary of each sector's likely catches for each side of the island, thus providing important baseline data, which can help improve on the management of these renewable resources.

METHODS

The following steps were taken in order to complete the catch reconstruction of Cyprus's fisheries (See also: Pauly 1998; Zeller et al. 2007):

- Identify existing time-series of catches submitted on behalf of Cyprus to the FAO;
- Determine what sectors and fisheries components were included in the FAO data;
- Compare national data (where applicable) to the data reported to FAO to determine if there was a good transfer of data;
- Identify local fisheries scientists willing to provide local expertise and help validate assumptions;
- Review all existing peer-reviewed, grey literature, and older (i.e., colonial) reports;
- If necessary, conduct local fisheries survey to establish reliable anchor points;
- Determine best-available anchor points for effort and catch rates to estimate missing sectors;
- Use interpolations to fill in missing years, then combine sectors;
- Compare with data reported to FAO and provide estimate of total fisheries removals.

Officially reported landings

The data reported by Cyprus for the 1950-2010 period included commercial artisanal and industrial catches. Catches from the recreational and subsistence sectors, plus discards and some additional commercial catches were omitted from the data provided to the FAO, as were all catches in the north after 1973.

Two distinct continuous time-series' of catch data for both north and south for the 1950-2010 period were generated to establish a historical baseline for each of the two parts, which were later combined to represent the ENTIRE island, AND to which future catches can be compared for future management decision. Hence, the catches reported to FAO from 1950-1973 (United Cyprus) were first split into 'north' and 'south' components based on each parts percentage of available fishing area, used to spatially allocate reported catches. The fishing areas were defined as 545 km2 or 40% for the north and 816 km2 or 60% for the south (Garcia and Demetropoulos 1984).

To allocate the reported catches to sector, trawlers accounted for 60% of Cyprus's reported catches in the late 1950s (Fodera 1961), which were the only industrial fishing method used at this time. Total industrial catches in the 2000s (which included trawlers, longliners, multi-purpose and pelagic vessels), accounted for 44% of reported catches, averaged from the DFMR National catch data from 2003-2005. Thus, the reported catches were allocated as 60% industrial from 1950-1961, and then were linearly decreased to 44% for the 2003-2010 period, the remainder being artisanal.

Industrial catches in the south in the 2000s included the bottom trawlers (21-27 m), bottom longliners (about 16 m), multi-purpose vessels, and pelagic swordfish and bluefin tuna vessels, while all vessels <12 m were considered artisanal.

Unreported catches

United Cyprus

Industrial and artisanal

During the colonial period, fisheries statistics were collected and compiled by the Chief Port Officer. Data were collected from a sub-sample of artisanal fishers at the end of each year, and from trawlers after each trip, but these data were “unchecked and severely underestimated” (Fodera 1961). To validate the reported catches at the end of the colonial period, an FAO expert multiplied the actual number of artisanal fishers and trawlers by their average catch rates (Fodera 1961), which assessed artisanal catches at 480 $t \cdot year^{-1}$ and 576 $t \cdot year^{-1}$ for trawlers, and hence concluded that ‘true’ catches for both commercial sectors were actually more than double (i.e., around 1,050 t) the reported amount of 500 t in 1960 (Fodera 1961). To account for this underreported ratio in our study, catches were doubled for the north from 1950-1973, and for the south from 1950-1979. The underreported estimate for the south from 1980-2010 is explained below.

North

Industrial

After the division of the island, separate unreported components were estimated for the north from 1974-2010. During 1974, all industrial fishing vessels (operated by Greek Cypriots at that time) left the waters of the north. Hence, no industrial fishing occurred in the north between 1974 and 1992. From 1993 until 1997, five bottom trawl vessels <15 m in length operated in the north (Department of Animal Husbandry, unpubl. data). These trawlers operated from September to May, approximately 150-180 $days \cdot year^{-1}$ with a catch of about 8 $t \cdot vessel^{-1} \cdot day^{-1}$, the latter suggested by the former vessel operator. To calculate annual bottom trawler catches, the number of trawlers was multiplied by the average of 165 fishing days·year^{-1}, and then by the catch rate of 8 t·vessel^{-1}·day^{-1}. This catch rate was assumed constant for each of the five years (1993-1997), as trawling was practiced only for a short period, hence, the likelihood of immediate declines in catch/effort from repeated trawled areas would be low.

The only other industrial catches in the north were from one exploratory purse-seine vessel hired from Turkey for a two month period in 2002. The former operator of the seiner provided us with catch estimates of between 20-30 t·day^{-1} which were exported to Turkey (Department of Animal Husbandry, unpubl. data). We assumed this purse seiner to have fished 20 days·month^{-1} for the two months, and used the averaged catch rate of 25 t·day^{-1}.

Artisanal (1974-2010)

While some artisanal catch data were collected in the north beginning in 2004, they were not deemed reliable (Table 3.1). Only a fraction of fishers report their catches (or parts of) to the Department of Animal Husbandry. Even the Department's fully expanded estimates, which were multiplied by a factor of 2-3, were deemed misleading of actual catches by local officials.

Table 3.1. North: Locally reported artisanal catches (t) and estimated total catches for the north of Cyprus.

Year	Locally reported artisanal catches (t)	Estimated total catches by Dept. of Animal of Husbandry (t)
2000	-	450-500
2001	-	400-450
2002	-	450
2003	-	400
2004	130	400-450
2005	165	400
2006	162	400
2007	186	400

Source: Department of Animal Husbandry.

Due to the unreliable nature of the available 'official' artisanal data in the north, an interview survey using a categorization of the artisanal commercial sector into four fisher classes was conducted by one of us in 2013 to evaluate this sector (B. Çiçek, unpubl. data). For this survey, 36% (n = 150) of all registered artisanal fishers (n = 410) were interviewed (for main results see Table 3.2).

Table 3.2 Categorization of the artisanal fishers in the north of Cyprus[a].

Class	Experience level	Labour type	% of fishers	Avg. # fishing days per year	Annual catches ($t \cdot vessel^{-1} \cdot year^{-1}$)
1	Expert	Full-time	11	283	2.70
2	Experienced	Part-time	31	166	0.62
3	Experienced	Part-time	46	98	0.16
4	Inexperienced	Occasional	12	59	0.06

[a]Source: Survey results, (B.Cicek, pers. obs.), 2013.

To create a time-series of the number of artisanal vessels in the north, 40 Turkish Cypriot artisanal vessels were assumed to actively fish in 1974 (E. Sinay, Department of Animal Husbandry, unpubl. data), and this number of active vessels was linearly increased from 40 in 1974 to the reported 269 artisanal vessels in 2007 (Department of Animal Husbandry, unpubl. data). An average catch rate of 0.571 $t \cdot vessel^{-1} \cdot year^{-1}$ was used as the 2010 CPUE anchor point, derived from the 2013 artisanal survey data, averaged from the weighted catch rates for each class of fishers (Table 3.2).

The per capita Gross National Product (GNP) in the north also displayed linear behaviour from 1980-2003, but grew more rapidly post-2003 due to the UN acceptance of Cyprus into the EU, and the opening of the Green Line border, both of which reduced the isolation of the north. The assumption that artisanal vessels and GNP were related is based on the notion that to enter the commercial sector, a vessel is needed (unless shared), and therefore some disposable start-up income is required. The vessel numbers were linearly increased in the 2000s which was not directly linked to the strong rise in GNP in the 2000s, because the fisheries were then understood to be saturated, i.e., most artisanal fishers are only marginally surviving, which would impede new players from entering the fishery.

The average length of gillnets (effort) used has substantially increased in recent decades to overcome the progressive decline of artisanal catches (B.A. Çiçek, unpublished data). Gillnets are packaged according to length or '*zembil*'. One *zembil* is 60 m, and fishers can request any number of *zembils* be strung together. Three decades ago, fishers used either 1, 2, or 3 segments of *zembil* (i.e., for a total gillnet length of between 60-180 m), but in 2013, the lead author surveyed artisanal fishers from the north, and found them to currently use between 8-50 *zembils* (from 480 m to 8 km in total gillnet length). Despite this marked increase in fishing effort, the fishers still noticed a significant drop in catch/effort over the decades. The artisanal catch rate was adjusted from the 0.571 t·vessel^{-1}·year^{-1} in 2010 backwards to 1974 using known changes in fishing net length as a proxy (Ulman *et al.* 2013b). Thus, the 2000, 1990, 1980 and 1974 artisanal catch rates in the north were assumed to have been three times, five times, ten times and twenty times higher than the 2010 catch rate of 0.571 t·vessel^{-1}·year^{-1} (i.e., 2000: 1.71 t·vessel^{-1}·year^{-1}, 1990: 2.85 t·vessel^{-1}·year^{-1}, 1980: 5.71 t·vessel^{-1}·year^{-1}, 1974: 11.42 t·vessel^{-1}·year^{-1}). The catch rates were linearly interpolated for intervening years and were determined by multiplying the number of fishing vessels was multiplied by the adjusted catch rates from 1974-2000, and then by using weighted averages of the four fisher classes and number of vessels from 2001-2010.

South (1979-2010)

Industrial and Artisanal

Although systematic under-reporting likely occurred at all times (Garcia and Demetropoulos 1984), the reporting system was known to gradually improve from 1980 onwards in the south (A. Petrou, AP

Marine Consulting, pers. comm.). Thus, the under-reported percentage was linearly interpolated from 100% in 1979 to 20% by 1996, as we assume this 80% reduction in under-reported catches conservatively addresses the improvements in the system without overestimating them. As some unreporting is understood to continue, this 20% unreported component was held constant from 1996 to 2010. For the north, the generalised 100% under-reporting rate was only applied from 1950-1973.

Recreational and subsistence catches

Recreational fishing is defined here as fishing which is neither targeted primarily for commercial purposes, nor for subsistence purposes (Pawson *et al.* 2007), but rather for enjoyment and 'sport fishing' is commonly used to describe recreational activities. Subsistence fishing is defined as fishing for the primary purpose of providing food for either one's self or ones family.

United Cyprus (1950-1973)

In 1960, there were approximately 50 recreational fishing vessels on the island, with an average catch rate of 0.128 $t \cdot vessel^{-1} \cdot year^{-1}$ and a combined total catch of 6.4 $t \cdot year^{-1}$ (Fodera 1961). Thus, the 6.4 $t \cdot year^{-1}$ recreational catch was assumed constant from 1950 to 1973, and 40% was assigned to the north and 60% to the south, which equated to 2.56 $t \cdot year^{-1}$ for the north and 3.84 $t \cdot year^{-1}$ for the south.

Two solitudes (1974-2010)

North

For the north beginning in 1974, recreational catches were calculated for three separate fishing methods: recreational vessels, spearfishers and shore-based anglers. Data were available on recreational fishing effort from 2007-2010 (Table 3.4).

Table 3.3. North: Data on recreational fisheries (2007-2010)[a]

Year	2007	2008	2009	2010
Recreational fishing boats	207	227	242	281
Recreational fishing licenses	205	217	220	263
Recreational additional fishers	138	146	157	221
Recreational angler	205	217	220	263
Spearfishing licenses	306	384	208	368

[a] Provided by the Department of Animal Husbandry.

Most vessels registered with the Directorate of Ports and Harbours were known to fish recreationally in 2013 (B.A. Çiçek, pers. obs.), after interviewing the managers of several fishing shelters, it was understood that about 80% (i.e., 1,425) of registered vessels actively fished in 2010, with an assumed catch rate of 0.2 t·vessel^{-1}·year^{-1}, which equated to 285 t of vessel-based recreational catches for 2010 (B. A. Çiçek and I. Salihoglu, pers. obs.). To estimate spearfish catches, there were 368 licensed spearfishers in 2010, which were separated into two groups: the experts or high-liners (10% of the number of spearfishers), with 150 fishing days·year^{-1}, and a catch rate of 20 kg·fisher^{-1}·fishing day^{-1}, and average-skilled spearfishers, (90% of the spearfishers), with an average of 75 fishing days·year^{-1} and a catch rate of 4 kg·fisher^{-1}·fishing day^{-1}. Combined, this equated to 209.4 t of spearfish catches in 2010. The catch rates were derived from the results of local interviews with about 20 spearfishers from the north in 2013 (A. Ulman, B. Çiçek, pers. obs.).

For shore-based recreational fishers in 2010, it was estimated that at least 2000 people were engaged in angling for approximately 20 weeks·year^{-1} with a catch rate of 3 kg·fisher^{-1}·week^{-1} (B. A. Çiçek and I. Salihoglu, pers. obs.), which equated to 120 t of shore-based recreational catches in 2010. Thus, for 2010, total estimated recreational catches were 614.4 t (i.e., the sum of vessel-based, spearfishing and shore-based angling). For the 1973 to 2010 time period, we linearly interpolated between the 1973 recreational catch (i.e., 2.56 t·year^{-1}) and the 2010 value of 614.4 t·year^{-1} to establish a time-series of recreational catches in the north.

South

The DFMR (Hadjistephanou and Vassiliades 2004) estimated that recreational catches were equivalent to approximately 15% of annual reported commercial catches. Thus, for the south, recreational catch was linearly increased from 3.84 t·year^{-1} in 1973 to the equivalent of 15% of the annual reported commercial catches for the south by 1990, which was held constant to 2010. This recreational catch estimation was assumed to include catches caught by vessel, spearfisher, and angler.

Furthermore, to differentiate between recreational and subsistence fishing for all 'recreational' catches estimated here (for both north and south), in 1950, 80% of the estimated 'recreational' catches were assumed to be caught for subsistence purposes and 20% for purely recreational purposes, and by 2010, 40% of catches were assumed to be caught for subsistence purposes and 60% for recreational purposes. The two rates were linearly interpolated between 1950 and 2010 for both sides. All recreational and subsistence catches were allocated to the following taxa: common dentex (30%), dusky grouper (25%), mottled grouper (*Mycteroperca rubra*, 20%), bonito (15%), greater amberjack (*Seriola dumerili*, 6%) and leer fish (4%).

Furthermore, a small percentage of industrial catches from the trawlers (~5%), which existed in both north and south when the island was united, were consumed by crew and went unreported (Garcia and Demetropoulos 1984). The same percentage (5%) of take-home consumption was assumed for the artisanal sector, and was applied to the north from 1950-1973, and the south from 1950-2010, and were allocated the same taxonomic resolution as the reported data, since it is understood that individual fish preferences are similar to commercial preferences, and generally, fishers would take home fish that were damaged or otherwise not marketable (Ulman et al. 2013b).

Discards

North (1950-2010)

Discards may include both commercial and non-commercial species, and have gone unreported. In the north, some taxa were constantly discarded, such as moray eels (Muraenidae), dogfish, stingrays (Rajidae) and picarel, while other species are frequently used as bait to bait hooks and traps (B.A. Cicek, pers. comm.). While 'baitfish' are not technically 'discarded', their catches go unreported and hence, are also considered here as discards, since they are neither sold commercially, nor directly consumed. From the results of our 2013 artisanal study in the north, a 10% discard rate for 'true' discarding (See Table 3.4 for taxonomic allocation) and a 5% 'bait-fish' discard rate were applied.

Table 3.4. Discard allocation. Industrial and artisanal sectors: North (1950-2010); South (1950-1973).

Taxon	%
Batoidea	20
Muraena helena	20
Selachimorpha	20
Spicara maena[a]	20
Anguilla anguilla	05
Coris julis	04
Thalassamo pavo	04
Scorpaena scrofa	03
Macroramphosus scolopax	01
Euechinoidea	01
Asteroidea	01
Dardanus megistos	01

[a]Source: Expert assessment combined with artisanal survey results.

The baitfish composition consisted of *Diplodus annularis* (22%), *Serranus scriba* (14%), *Serranus cabrilla* (12%), *Octopus vulgaris*, *Eledone* spp., *Sepia officinalis*, *Illex coindetii* and *Loligo* spp. (10% each), and *Sardinella maderensis* (2%). The two discard rates (10% from Table 3.4 plus 5% for baitfish were combined) were applied to reported and unreported artisanal commercial catch components from 1950-2000 for the north. Due to the increasing impact of invasive species, discarding patterns changed in the early 2000s and thus details of discards from 2001-2010 are detailed below in the 'South' section.

The bottom trawlers which operated from 1993 to 1997 were only allocated the 10% 'true' discard rate (See Table 3.4), and the results from a 2003 exploratory trawl survey in the north with detailed taxonomic detail were used to allot the discarded amounts to specific taxa (Benli *et al.* 2003). Our bottom trawl discard estimates are minimal estimates (but see relatively low discard rate for southern bottom trawlers below). The single purse seiner which operated for 2 months was deemed to have zero discards, as it was an exploratory vessel to determine if pelagic fish abundances would support such a fishery, therefore, it was assumed all catches would have been retained and recorded.

South (1950-2010)

In the south, the pelagic longline fishery had an average discard rate of 10% (European Union 2007), with ocean sunfish (*Mola mola*), pelagic stingray (*Pteroplatytrygon violacea*), and thresher shark (*Alopias* spp.) as the major discarded species. The bottom trawl fishery had a 13% discard rate, with common pandora and picarel (European Union 2007) as the major discarded taxa. For the artisanal fishery, as in the north, a 10% discard rate was assumed (A. Petrou, pers. obs.), with crustaceans as the dominant discarded taxa (Rousou 2009). In light of the above published discard rates for the south, a conservative 10% discard rate was applied to all reported and unreported commercial catches from 1950-2010. Artisanal discards from 1950-1973 were allocated to the same taxa as the north (Table 3.4) and artisanal discards from 1974-2010, and from the industrial sector from 1950-2010 are listed in Table 3.5, based on European Union (2007) and Rousou (2009).

Table 3.5. Discard allocation. Artisanal (1974-2010) and industrial sectors (1950-2010): South

Taxon	%
Spicara smaris	0.29
Pagellus erythrinus	0.16
Dasyatidae	0.20
Mola mola	0.12
Alopias spp.	0.05
Murex scolopax	0.03
Boops boops	0.01
Mullus barbatus	0.01
Mullus surmuletus	0.01
Serranus cabrilla	0.02
Bolinus brandaris	0.05
Echinoidea	0.03
Maja squinado	0.02

Lessepsian discards (2001-2010)

In the 2000's, discard rates for the artisanal sector in the north, and for the artisanal and industrial sectors in the south were adjusted to account for two major invasive species ('Lessepsian migrants') which had established themselves from the Indian Ocean and Red Sea, the silver-cheeked toadfish (*Lagocephalus sceleratus*) and the redcoat (*Sargocentron rubrum*, a squirrelfish).

L. sceleratus was first observed in Cypriot waters in 2000, its presence became 'more intense' by 2004 (DFMR 2011), established a sizeable population by the 2007-2008 season (Nader *et al.* 2012) which has since increased, owing to a lack of natural predators. Thus, *L. sceleratus* was estimated to account for an additional 5% of total commercial catches (as in reported and unreported commercial catches) in 2003, which was linearly increased to 50% of commercial catches by 2008, held constant to 2010 for both the north and south (B.A. Çiçek, 2013 artisanal fisher survey results, A. Petrou, pers. obs., Table 3). As of 2012, this species contributed to approximately 50% of total catches by weight (B.A. Çiçek, 2013 artisanal fisher survey results, A. Petrou, pers. obs.), and was most often caught in gillnets. The redcoat was estimated to account for 3% of discards in 2001, which was linearly increased to 9% from 2007-

2010.For a summary of anchor points used to estimate each unreported catch component, the area(s) applied, the sector referred to, and the reference(s) used, see Table 3.6.

RESULTS

Reconstructed catch for the whole island

The total reconstructed catch for the entire island from 1950-2010 amounted to nearly 243 000 t, which was 2.6 times the FAO reported landings for Cyprus of 93 200 t (Figure 3.1, Appendix table 9). From the total reconstructed catch, the sectors which had the highest estimated total fishery removals were the industrial (40%), and the artisanal (39%), while discards (12%), subsistence (6%), and recreational (3%) sectors contributed less significant proportions. The main taxa caught by Cyprus were picarel, seabream, red mullet, cephalopods and silver-cheeked toadfish (Figure 3.2, Appendix table 10).

Table 3.6. Data sources, available time-series data, and data anchor points used for catch reconstruction of Cyprus. N=North; S=South; DAH=Department of Animal Husbandry, North; Department of Fisheries and Marine Research=DFMR.

Area	Sector	Year(s)	Source	Reported data	Missing data (unreported)	Catch (t)
N	Commercial	1950-1973	FAO	x		7 552
S	Commercial	1950-2010	FAO	x		159 300
N	Commercial	1950-1973	Fodera, 1961		x	9 850
S	Commercial	1950-1979	Fodera, 1961		x	21 550
S	Commercial	1980-2010	A. Petrou		x	34 330
N	Industrial	1993-1997, 2002	DAH		x	34 000
N	Artisanal	1974	DAH		x	
N	Artisanal	2010	B. Çiçek, 2013 survey		x	16 700[a]
N	Recreational	2007-2010	DAH		x	6 100
N	Subsistence	1950-1973	Fodera, 1961		x	440
N	Subsistence	1974-2010	DAH, Fodera, 1961		x	12 400
S	Subsistence	1950-2010	Fodera, 1961		x	9600
S	Recreational and Subsistence	1974-2010	DFMR		x	1 130
N	Discards	1950-2010	B. Çiçek, 2013 survey			8 600
S	Discards (all)	1950-2010	European Union, 2007; Rousou 2009		x	11 700
N & S	Discards (Pufferfish)	2003-2010	DFMR, 2011, Nader *et al*; 2012; B. Çiçek, 2013 survey			6 800

a) North: Artisanal unreported catch amount from 1974-2010.

Reconstructed catch for the north

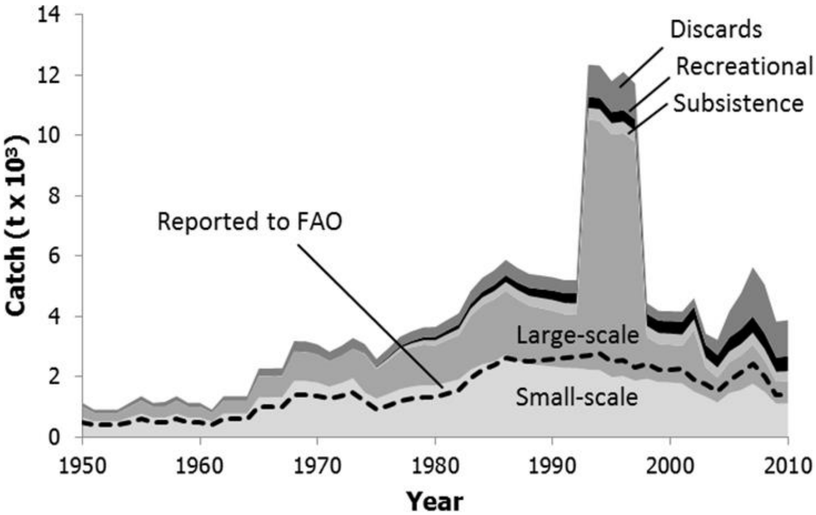
The total reconstructed catch in the north was approximately 84,000 t for the 1950-2010 period. The 7,550 t of catches reported to the FAO from 1950-1973 contributed over 9% to the North's total reconstructed catch, 57% of which were industrial and 43% of which were artisanal. About 76,000 t of catches were not reported to the FAO from 1950-2010 (Figure 3.2a, Appendix table 11, see Appendix table 12 for major landed taxa). Thus, total reconstructed catches for the north were over 11 times the amount reported to FAO on behalf of the northern area of Cyprus from 1950-1973.

From 1950-2010, industrial unreported landings amounted to 34,000 t (>40% of total reconstructed catch for the north), mainly driven by the short-lived bottom trawl fishery from 1993-1997 (6,600 t·year^{-1}, Figure 3.2a). Artisanal unreported landings totalled approximately 26,500 t (>25% of total reconstructed catch). Total subsistence and recreational catches from 1950-2010 each contributed about 6,000 t (each contributing about 7% to total reconstructed catches, Figure 3.2a). Total industrial discards were about 3,400 t and artisanal discards amounted to approximately 5,000 t (contributing about 4% and 6% to the total reconstructed catch, respectively). Most artisanal discards in the last decade were attributable to the invasive silver-cheeked toadfish (see Table 3.7).

Reconstructed catch for the south

The total reconstructed catch in the south was about 164 000 t for the 1950-2010 period, which included 60% of reported FAO data from 1950-1973 and 100% of reported FAO data from 1974-2010, plus the unreported sectors, and discards (Figure 3.2b). Thus, the reconstructed total catches for the south of 159,300 t were 86% higher than the approximately 86,000 t of reported data for the time-series.

a)



b)

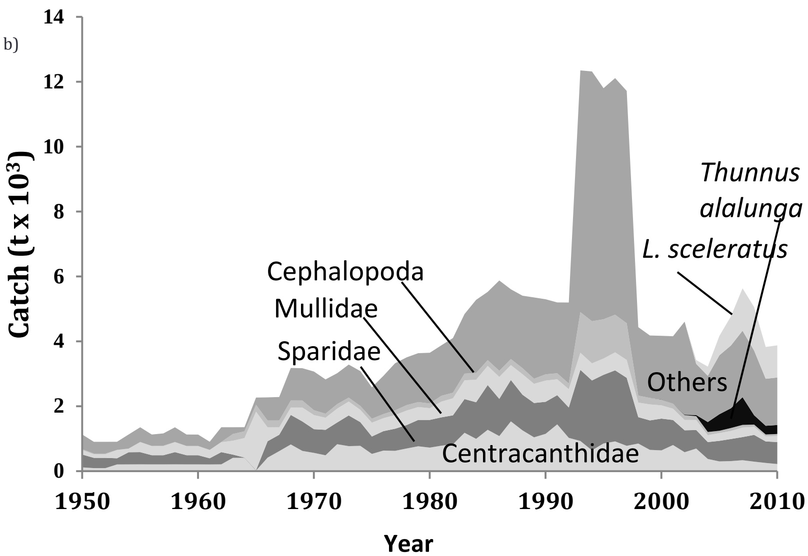


Figure 3.1. Total reconstructed catch for the island of Cyprus for 1950-2010, by a) fishing sectors plus discards. Note that data reported by FAO are overlaid as line graph; and b) major taxa, with the 'Others' category containing 56 additional taxa.

Landings in the south were almost equally distributed between the industrial and the artisanal sectors. The industrial sector totalled around 65,500 t or just over 40% of total landings for 1950-2010, and the artisanal sector totalled around 64,300 t or just over 40% for the same period (Figure 3.2b, Appendix Table 13, also see Appendix Table 14 for major taxa).

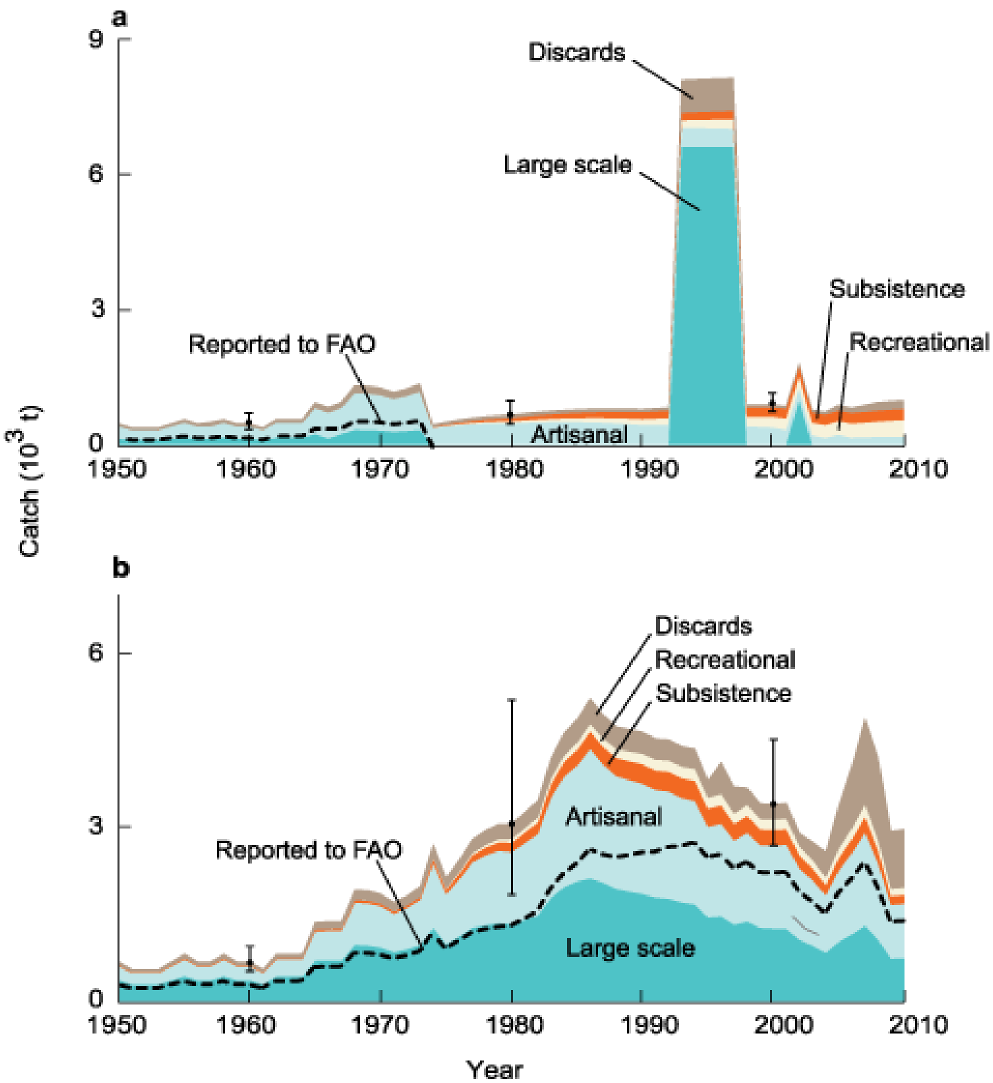


Figure 3.2. Total reconstructed catch for a) the northern part of Cyprus by fishing sectors plus discards for 1950-2010; and b) for the southern part of Cyprus by fishing sectors plus discards for 1950-2010. Note that data reported by FAO (as assigned to each island part) are overlaid as line graphs. Confidence intervals have been included for 1960, 1980 and 2000, which were assessed by the quality of the data used to derive assumptions (See Table 2.6 for computation of confidence intervals).

Industrial landings increased from 360 t·year^{-1} in 1950 to peak at over 2,100 t·year^{-1} in 1986, before declining to 740 t·year^{-1} by 2010. Artisanal catches increased steadily from 240 t·year^{-1} in 1950 to a peak at around 2,200 t·year^{-1} in 1986, before declining to 940 t·year^{-1} by 2010. Estimated subsistence and recreational catches for the south from 1950-2010 were just over 5,100 t and 5,000 t, respectively, both which slightly increased throughout the time-series.

Table 3.7. Discards of the invasive silver-cheek toadfish in the north and south of Cyprus (t).

Year	North[a]	South[b]
2003	13	104
2004	28	257
2005	75	521
2006	78	820
2007	112	1195
2008	146	1195
2009	149	831
2010	150	840

DISCUSSION

North

The fisheries management team which exists under the umbrella of the Department of Animal Husbandry in the north operates on an extremely inadequate budget, thus lacking data collection, control, and surveillance capabilities. The data reported to the Department from the fishers are inconclusive and represent only 10-20% of our total reconstructed catch estimates, while the Department's own estimation of total catches reaches closer to 50% of the findings from the present study (Table 3.1). The 'unreported' fishing component is certainly high and needs addressing to track the status of local stocks and evaluate how conservation measures are performing.

It is exemplary that industrial fishing practices (i.e., bottom trawling and purse seining) were banned early in the north, as industrial fishing benefits few, and have substantial ecological and monetary costs associated with them (Pauly 2006).

South

In November 2004, the Republic of Cyprus was admitted into the European Union and hence their fisheries management plans were aligned with EU plans. The EU's Mediterranean Regulation was adopted in 2006, active as of 2010, and applied to the 7 EU member countries bordering the Mediterranean (Spain, France, Italy, Slovenia, Greece, Cyprus and Malta). The entire island is now considered part of the European Union; however, since the Republic of Cyprus (south) does not have any control over the north, EU legislation is suspended in the north. If a solution to the "Cyprus Problem" is found, the suspension of legislation in the north will be lifted. However, Turkish Cypriots are regarded as EU citizens even though they reside outside the governmental jurisdiction.

Whole Island

A significant proportion (54%) of the unreported catches from Cyprus's catch reconstruction was due to the catches from the north post-1973 being absent from the data reported to FAO. This is the first instance artisanal catches in the north were assessed, and the details of the (short-lived) industrial sector were first recorded outside of Cyprus.

For the confidence scoring of the data used, the scores were averaged from 3 independent reviewers which assessed both north and south, the scores were then weighed by the relative contribution of each sector to the catch for each sector to derive the confidence interval for those years. See Figures 3 a and b for confidence interval results where the values for each period are displayed (i.e., 1960 for 1950-1969, 1980 for 1970-1989, and 2000 for 1990-2010).

Seeing as most countries only monitor their commercial fishing sectors, yet, recreational and subsistence sectors also contribute significant proportions to overall catches, snapshot assessments of Cyprus's non-commercial sectors (recreational with boat, recreational from shore, subsistence, and spear) would contribute a great deal to the scientific and especially the fisheries community. These assessments could be accomplished by completing either roving creel or angling surveys once every five years to provide necessary baseline data on both fishing effort, fishing area and catch per unit effort (see Brouwer *et al.* 1997).

Total catches for Cyprus as a whole have been on a declining trend since the mid-1990s, if the discards of the invasive silver-cheeked toadfish are excluded (see Figure 3.1b), and total catches for Cyprus have declined by 22% in the last decade alone. The declining trend is more apparent for the island as a whole (Figure 3.1) and the south (Figure 3.2b), rather than the north (Figure 3.2a). This was likely due to the reconstruction approach used for the north, which only first properly assessed the artisanal sector in 2013, and hence, simplifying assumptions had to be made to determine historical catches, thus potentially missing past peak catches. However, fishers in the north have clearly reported massive declines in their catch/effort, especially over the last two decades (A. Ulman & B.A. Çiçek, pers. obs.) which strongly suggests that stocks in the north are declining. It is understood that Mediterranean fisheries catches have been declining for the last two decades, and seemingly even earlier in the western Mediterranean (Pauly *et al.* 2014), surely to be exacerbated by surging local tourism pressure and its associated demand for seafood.

To battle the declining state of the resources, a focus towards embracing ecosystem-based management (EBM) in global fisheries, meant to maintain the health of the whole ecosystem by acknowledging the interconnectedness of ecosystem components needs to be prioritized by national and regional management. For example, we feel that a statement from the EU, describing the discards of the pelagic longline fishery in Cyprus as not significant since the discarded species were of no commercial value [yet included endangered loggerhead turtle] (European Union 2007), is mis-aligned with EBM and needs rethinking. A species may not have commercial value, yet, may have significant ecological value warranting special protection.

The reduction of industrial effort for both sides is well-aligned with EBM framework especially relating to bottom trawling, which is known to damage benthic habitats. The reduction of effort is deemed 'good' for the sustainability of the resource whereas fuel subsidies are deemed 'harmful' for the future of the resource because fuel subsidies mask the 'true cost' of fishing by artificially enabling fishers to continue fishing when otherwise it would not be economically viable (Sumaila and Pauly 2006). Generally, the increasing global cost of fuel would inhibit many marginalized fishers from fishing, thus encouraging natural resource conservation (Sumaila *et al.* 2010b). Instead, re-allocating this public money (i.e., harmful subsidies) to improved monitoring and enforcement capacity on both sides would benefit rather than harm the future of the resources.

Another issue is spear-fishing, which is increasing in popularity amongst both locals and tourists, as a wide-ranging variety of equipment can be found at most tourist stores. Many locals are alarmed that novice spear-fishers kill a high proportion of coastal juvenile fish, detrimental to the future viability of stocks. The spear-fisheries would benefit from improved regulation and a requirement for spear-fishers to understand which species and sizes could be sustainably targeted.

The fact that the island remains divided remains a major obstacle affecting future sustainability of stocks. After being accessed into the EU, the south adopted many EU fisheries policies such as stock assessments, EU minimum catch sizes, etc., which would be more effective if the entire island applied the same policies. Both sides face the same issues such as that of the pufferfish invasion and illegal fishing, and are conducting similar conservation programs such as the installation of artificial reefs and the creation of marine protected areas, yet each deal with their problems independently of each other, foregoing the loss of nearby local expertise. One last issue also pertains to the division of the island hindering sustainability is that since the north is not internationally recognized, they do not receive an individual European ICCAT (The International Commission for the Conservation of Atlantic Tunas) quota for bluefin tuna, as in the south. This may further harm the Atlantic bluefin tuna stock as many bluefin are caught in the north, which go unreported (to ICCAT), weakening regional stock assessment and consequently scientific advice.

This study has highlighted some of the differences and commonalities with regards to the fisheries of the two halves of the island of Cyprus, and presents a continuous time-series of total fisheries extractions for the entire island of Cyprus, as well as its two components. It has been noted that both north and south have become increasingly proactive in marine resource conservation, and may indeed be on a path towards more sustainable fisheries, a direction that will benefit both the marine environment and fishers around Cyprus. With tourism projected to increase, achieving and maintaining sustainable marine fisheries should be a national priority which could help provide and guarantee a local protein source to many for generations to come.

4: SHIFTING BASELINES OF TURKISH AND CYPRIOT FISHERIES

"That men do not learn very much from the lessons of history is the most important of all the lessons of history."

Aldous Huxley

… But it is past time we begin.

SYNOPSIS

New evidence for 'shifting baselines' from different fisheries in Turkey and Cyprus is presented, based on field interviews of local fishers. First, the total reconstructed catch, total fishing effort, and national catch per unit effort (CPUE) trends are presented for Turkey as a whole, and by sea. Then using survey data gathered for each fisher, the ratio of initial to current CPUE of individual fishers are presented along with their shifts in perceived change in resource abundance by sector, for both Turkey and Cyprus. For Turkey as a whole, total effort increased by over 700% from 25 million kW days in 1967 to nearly 190 million kW days in 2010, while CPUE declined by about 380% from nearly 16 kg·kW·day^{-1} in 1967 to 4 kg·kW·day^{-1} in 2010. For most sectors, perceived change in resource abundance was found to significantly decline. The exceptions were Turkish purse seine fishers and South Cypriot artisanal fishers; the former was due to a major ecosystem regime shift, and the latter possibly due to early changes to the resources, which this survey could not capture. The artisanal and recreational sectors of Turkey were shown to experience the most profound changes, with declines in ratio of initial to current CPUE of about 40 times since about 1950.

INTRODUCTION

Humans have altered ecosystems since they started hunting (rather than being hunted) hundreds of thousand years ago (Liebenberg 2013), and this 'alteration' massively increased 12,000 years ago, when farming began (Montgomery 2007). Although the exploitation of nearshore marine animals dates back over 100,000 years (Jackson *et al.* 2001; Richter *et al.* 2008), systematic transformation of marine ecosystems by humans really began with the deployment of steam-powered trawlers around the British Isles in the 1880s, i.e., with the application of fossil energy (here coal) to what is still equivalent to hunting (Pauly *et al.* 2002).

In the Eastern Mediterranean, the wave of biomass decline and local extinctions from the transition to fossil fuel (rather than muscle and wind power) manifested itself only in the 1950s. Indeed, what is likely the only underwater film from the 1940s shows an abundance of sharks and other underwater life in Greek waters that is unimaginable today (Zogaris and De Maddelena 2014). This shark abundance was similar for the Black Sea, which Turkish trawlers heavily exploited in the early 1970s. Massive increases in human populations and hence demand for resources was satiated by major increases in the power of fishing vessels, which acquired not only the ability to catch whole fish schools, but to render these species commercially extinct. The process took decades, however, and hence the perception was affected by shifted baselines (Pauly 1995). Here, we compare how marine ecosystems have shifted both in quantitative (i.e., 'objective' or ratio of initial to current CPUE) terms, and in subjective terms, i.e., in the perception and memories of Turkish and Cypriot fishers ('perceived change in resource abundance').

With a gradual decline of resources, each new fisher perceives the ecosystem state at the beginning of their career as the norm to which they compare future changes. If stories about earlier ecosystem states are not passed down from older fishers, long-term change can go unnoticed, a phenomenon called 'Shifting Baselines Syndrome' (SB) first coined by Pauly (1995). Indeed, global fisheries catches have been declining since the late 1990s according to FAO (FAO 2012), or even earlier (Watson and Pauly 2001), but most publications still focus on the 'sustainability' of fisheries, instead of the rebuilding aspect (Pitcher and Pauly 2001).

There are many articles about shifting baselines (Greenstein *et al.* 1998; Baum and Myers 2004; Sáenz-Arroyo *et al.* 2005; Sáenz–Arroyo *et al.* 2005; Ainsworth *et al.* 2008; Bunce *et al.* 2008; Humphries and Winemiller 2009; McClenachan 2009; Parsons *et al.* 2010), but several of these articles (i.e., Greenstein *et al.* 1998; Baum and Myers 2004; Humphries and Winemiller 2009; McClenachan 2009) misunderstood the term to only represent the sequential loss of biodiversity, without the gradual shift in the perception of the resources which accompanies it. Learning from history when data are scarce demands that we make the best possible use of the available information (Papworth *et al.* 2009), i.e., traditional ecological knowledge . Such knowledge is acquired and strengthened throughout fishers' career, and thus can be used to determine how far away from reasonably pristine an ecosystem may have devolved (Berkes and Folke 1998). Modern fishery management often relies on the changes in fish population size measured against available historical reference points; thus, using incorrect reference points is perilous, and can lead to mismanagement. Thus, a historical perspective is necessary to inform policy makers of the potential productivity of fish stocks (Rosenberg *et al.* 2005).

Only recently have marine scientists begun to systematically document historical changes in the abundance of exploited marine resources; in the process, they have created a new discipline, 'historical marine ecology' (see contribution in Jackson *et al.* 2011; Kittinger *et al.* 2014). In recent decades, we have increased our impacts on the ocean and its resources, first demonstrated by the removal of larger predators and consequent decline in the mean trophic level of mixed fisheries (www.fishingdown.org, Pauly and Palomares 2005). The fishes of higher trophic level declined by at least one order of magnitude since the mid-20th century (Sumaila and Pauly 2011), but many of these species declines went unnoticed (Dulvy and Polunin 2004).

Technological improvements enabled fishers to operate further offshore and in deeper waters, often using illegal gear, which have in some places seriously perturbed ecosystem functioning (Watling and

Norse 1998). A top-heavy trophic structure (i.e., high predator biomass) with high biodiversity and resilience are key elements of healthy marine ecosystems (Knowlton and Jackson 2008). Overfishing and ecological extinction of species can precede the collapse of ecosystems (Jackson *et al.* 2001), highlighting a higher propensity for ecosystem collapse today than the past (Sala *et al.* 1998), as resilience has been reduced by simplification of food webs. If not detected and counteracted in time, a buildup of gradual changes can transform entire large marine ecosystems in structure and function as occurred in the Black Sea (Eremeev and Zuyev 2007). The Mediterranean and Black Seas are some of the most impacted marine ecosystems worldwide (Costello *et al.* 2010). The loss of diversity, complexity, and hence resilience is giving way to undesirable algal blooms, dead zones, disease outbreaks, and species invasions, all of which contributing to a potential disaster (Lotze *et al.* 2006).

Papworth *et al.* (2009) are among those who understand the importance of correctly identifying shifting baselines, actual measurable biological changes need to have occurred, but stakeholders should fail to accurately notice them. In this thesis, 180 fishers from Turkey and 82 fishers from Cyprus were interviewed to assess how each fisher's actual change in CPUE varied throughout their careers, and the results were compared to their degree of perceived change (Maunder *et al.* 2006), to determine if the change in perception adequately represented the actual degree of change in marine ecosystems. First, total reconstructed fisheries catch and fishing effort, and national CPUE trends (i.e., a measure of fishery resource abundance) are presented for Turkey to help frame the issue. Then, the occurrence of shifting baselines is examined by sector for Turkey and Cyprus.

Historical abundances from anecdotes

With increased urbanization, many of us have lost our sense of connectedness with the natural world, and this has had negative effects on biodiversity (Turner *et al.* 2004). In the early 1960s, 'real' fishers would hunt swordfish with harpoon, making them equal opponents, both "armed with spear" (Koray

1962). Fishing of such top predators, during their spawning season was destructive and soon led to their depletion (Koray 1962). In Koray's time, Istanbul had a population of approximately 1 million people, about 1/15th today's size, and the per capita Gross Domestic Product (GDP) stood at US $1,300 (www.nationmaster.com). People were generally poor, but the massive migrations of pelagic fish ensured that most of Istanbul's inhabitants could eat high-quality protein. Kemal (1985) described threats facing the fisheries in the early 1970s, which saw the deployment of industrial cannery ships, radar and even machine guns (to hunt dolphin), as first steps in the demise of the fisheries. In the mid-1970s, after sturgeon (Acipenseridae) and turbot were fished out in the Black Sea, shark populations were soon decimated by trawlers (Can 2013).

The early 1980s were the most successful years for purse seiners. Mr. Ismail Kelefat (pers. comm. to A.U.), explained that with just one year's purse seine catches in the early 1980s, he was able to purchase two oceanfront houses on the Bosphorus Strait. In 1982, many purse seine vessels began using colour sonars from Japan, allowing fishers to differentiate between different species. Only one year later in 1983, they had decimated coastal stocks such as chub mackerel, shi drum and large bluefish or '*kofana*' and had to move their vessels offshore to fish, a concept previously unimaginable.

The Bosphorus

Homer, in the Iliad, was the first to write about the superabundances of fish in the Bosphorus, when he had Agamemnon offer Achilles the riches of the Bosphorus fishing grounds among other treasures as a bribe to keep the hero fighting against Troy (Champion 2011). Gilles (2000) described the Bosphorus as the best place in the world to fish in the 16th century, as (inexperienced) women and even children could fish from their windows using basket (Özdağ 2013). Inscribed on a fountain on the Bosphorus in the 17th century, writes "*Baliği bol bousporus*", i.e., "the Bosphorus is full of fish". Old fishers explained that the 'golden years' of fishing in Turkey lasted until the late 1950s, as anyone could catch as much swordfish and Atlantic mackerel as they could carry. However, those stocks were decimated, followed by sturgeon, then bluefin tuna, chub mackerel and large bonito or '*torik'*. Once one species was overfished, the next one, of lesser value was targeted, and the lost species often forgotten (A. Ulman, unpubl. data).

The Golden Horn

In the 1st century, Pliny stated that the Golden Horn (an inlet in the southwest of the Bosphorus) was named so because it was once laden with so many fish that its surface appeared "golden" (Tekin 1996).

Nationally, recreational catches were extremely high in the 1950s and 1960s. Fishers from Galata Bridge in the Golden Horn explained how they used to cast a *çapari* line (a handline with 10 hooks) off the bridge, and in a few minutes there would have caught 10 diverse and valuable fish such as bonito, two-banded seabream, turbot, bluefish and large garfish; today the same line would land 2-3 juvenile horse mackerels, just one quarter their earlier caught size.

Marmara Sea

The mid-1980s saw the overfishing and local extirpation of several migratory species, notably bluefin tuna, which fishers say was the "shepherd of the sea" as it herded many other species close to shore for them to catch. Turkish people never targeted bluefin tuna themselves, but in just one day in 1984, when hundreds upon hundreds of large bluefin individuals were spawning in Marmara Sea, 19 purse seine vessels caught nearly 300 of them (jointly 55 t). The sea was red from slaughter and bluefin never again returned here to spawn (Can 2013), resulting from a recent 100-fold bluefin tuna price increase from US$ 1.30$\cdot$kg^{-1} to 130\cdot$kg^{-1}.Fishers say due to bluefin tuna`s departure from Marmara Sea, other species got heartbroken ('*küsmek*') and chose not to return to the area. Purse seine fishers now struggle to maintain their income, due to an almost entire collapse of the stocks of migratory pelagics, aside from anchovy and bonito.

The advent of certain destructive types of fishing such as dynamite fishing and illegal bottom trawling, combined with sophisticated technology such as high-voltage lights, radars and sonars facilitated the decimation of stocks in the Sea of Marmara, the heart of its Turkish commercial fisheries (Özdağ 2013). This is where most migratory stocks would spawn (Galtsoff 1924; Caddy and Griffiths 1990), but when small-scale fisheries were replaced by industrial fisheries, sustainability went (Koray 1962). For example, shrimp used to be fished by basket from Marmara Sea, but in the mid-1980`s the '*Algarna*' trawling method was introduced. The manager of 'Water Products' then explained to the fishers that "the bottom is just like a parsley field, the more you cut, the more shrimp will come." The number of *Algarna* trawlers increased from 30 to 500 in the small inland sea, and initially combined they would catch 15 $t \cdot shrimp \cdot day^{-1}$, which diminished to about 1 $t \cdot shrimp \cdot day^{-1}$ in just 6 months' (Can 2013). Mirrored around the world, the collapse of fisheries is the latest in a very-long history of unregulated exploitation, the result of managers and fishers not understanding the consequences of their actions (Roberts 2010).

The aim here is to document, beyond the anecdotes mentioned above, the rate and severity of change of the fisheries of the eastern Mediterranean by comparing the trajectories of catch, total effort, and actual and perceived changes in CPUE of the fishers in Turkey and Cyprus.

The Dardanelles

The Dardanelles are the last affected area from the cessation of many migratory species which used to travel from the Aegean to the Black Sea, and hence still has the best fishing. The only species still being caught today in the Dardanelles which were predominantly targeted species 40 years ago are two-banded seabream, common dentex, and Atlantic mackerel. The two-banded seabream now has a drastically reduced geographical range, the dentex has seen its catches decline by over 90% in the last four decades, and the Atlantic mackerel's commercial fishing days have just about finished. Thus, this trajectory does not look hopeful.

METHODS

Local data collection

The Turkish and 'North' Cyprus surveys with fishers were conducted from May 5 to August 25, 2013, and 'South' Cyprus from January 10 to February 20, 2014. Data were collected on initial catches, perception of change, effort and recent catches. The Behavioural Research Ethics Board (BREB) from the University of British Columbia approval identification number is H13-00012.

In Turkey, a total of 180 fishers were surveyed from 4 different sectors and 82 fishers from Cyprus were surveyed from two sectors, totalling 262 respondents. To track their perception of change, the majority of Turkish interviews were conducted along two of the busiest pelagic migratory corridors (i.e., the Istanbul Bosphorus and the Dardanelles), understood to have undergone the greatest changes. See Figures 4.1 and 4.2 for cities sampled.

After commencing the field surveys, the focus shifted from finding stratified age samples of only commercial fishers to surveying each sector as best as possible, as it was apparent that the fishers of some sectors had remarkably different perspectives. In Turkey, the surveyed sectors were commercial (purse-seiners, trawlers and artisanal fishers), and recreational (land and boat-based anglers and spearfisher). In Cyprus, only the artisanal and recreational sectors were surveyed, as no industrial fishing currently occurs in the north and industrial fishing in the south was recently reduced to just two active trawlers. Overall, 13 fishing communities were surveyed in Turkey (Figure 4.1) and 8 in Cyprus, four from each side (Figure 4.2).

Figure 4.1. Map of Turkey showing all survey sites, and the continental shelf in dark blue.

Figure 4.2. Map of Cyprus showing all of the survey sites, the 'Green Line' and the continental shelf in dark blue.

The respondents were selected for their varying experience levels (when known), at random by purposive sampling (approaching certain types of fishers by targeting the marinas where they berth their boats), or by snowball sampling (i.e., chain referral sampling) when there were many fishers in the same area. While some fishers responded that they began to fish when they were children (between 4-9 years old), these ages were scaled up to a minimum age of 10 years for each fisher, since prior to age 10, most kids experience infantile amnesia, while by age 10, memories are 'crystallized'[21].

Catch rates from fisher interviews were converted to either kilograms or tonnes to allow for comparison between respondents. If the reply was in 'cases' of fish, the fisher was specifically asked how many kg equate to a 'case' for that species, i.e., which was 10 kg for most species (i.e., bonito, bluefish, sardine). Measurements in *okes* and *kulaç* were converted to metric units using 1 *oke* = 1.28 kg and 1 *kulaç* = 1.83 m.

Total reconstructed catches

The results from the catch reconstruction for Turkey (Figure 2.3, Appendix table 7, Ulman 2014) which included estimates of all previously unreported sectors was used to gain a comprehensive view of total marine fishery catches from 1950-2010, as the data collected by each country and sent to FAO normally only account for commercial fisheries, underestimating total catches. The total reconstructed catch results for Turkey were used to calculate CPUE by country and by area (i.e., each sea).

Total effort and CPUE for Turkey and by sea

Boat engine power is used as a measure of effort. Horsepower was reported for Turkey in separate size classes. To calculate average horsepower (hp) for motorized vessels within a given class, the geometric mean was used for each given size class, and multiplied by the number of vessels to get total hp per class. Total hp per class was then summed for all classes annually to get total hp (annual fishing effort). As the data suggested from its gear breakdown, from 1967-2004, half the vessels > 100 hp were

[21] http://www.livescience.com/14106-infant-amnesia-childhood-memories.html

assumed to be trawlers and the mean trawler hp of 351 (Table 4.1) was used; the other half assumed to be purse seiners, and a mean 1,364 hp (or 1,107 kW) was used. From 2005-2010, a new category of '500+' hp was introduced; all these vessels were assumed to be purse seiners, hence 1,364 hp was applied; the 200-500 hp range were assumed to be trawlers (as above); for the 100-200 hp category the geometric mean hp was applied. After total hp was calculated by year, it was converted to kW using the conversion rate of 0.7456. Next, total kW was multiplied by the average number of days fished for each sector (Table 4.1) to determine total kW days. Finally, the total reconstructed catches for Turkey, had total kW·days divided by total reconstructed catches each year to determine the CPUE, i.e.,

$kg \cdot kW^{-1} \cdot day^{-1}$.

The purpose of illustrating national CPUE trajectories is to show the profound change of stock abundance suggested by this indicator. Many fisheries managers solely look at catch trends; however, the inclusion of effort explains more about overall impacts and pressure exerted on the environment. Due to incomplete effort data for Cyprus, national CPUE could not be computed.

Observed change in CPUE

A ratio was applied using each fisher's initial CPUE (measured either catch per fisher per year or per day, the year they began their career) and current CPUE (for 2013), further referred to here as 'Ratio of Initial to Current CPUE'. This ratio was plotted for each fisher's year they started their career to assess the change in CPUE over time.

Table 4.1. Turkish fishing fleet characteristic, results from field 2013 survey.

Recreational vessel (n=22)	Vessel length (m)	Total hp	Age	Age started	# years fished	Fishing days/year	Catch/year (t)
Minimum	5.5	6.5	45	8	4	20	0.13
Maximum	12.0	80	82	50	64	330	1.60
Mean	9.4	33	60	25	38	106	0.52
Artisanal (n=60)							
Minimum	6.4	9	25	6	7	90	0.15
Maximum	13.0	380	74	40	69	365	400
Mean	8.9	86	52	16	36	202	11.1
Purse seiners (n=20)							
Minimum	12	420	30	12	14	100	10
Maximum	51	3000	78	20	68	240	2500
Mean	35	1364	49	16	26	203	403.7
Trawlers (n=21)							
Minimum	9.5	140	24	13	9	90	10
Maximum	28	730	61	31	43	210	400
Mean	25	351	52	17	28	181	88.5
Angler (n=32)							
Minimum	-	-	12	10	0	5	0.01
Maximum	-	-	73	62	63	315	0.80
Mean	-	-	47	26	20	120	0.34
Spearfisher (n=20)	Depth fished (m)						
Minimum	3	-	19	6	3	4	0.03
Maximum	35	-	65	39	51	150	1.20
Mean	12.8	-	34	16	17	49	0.38

Table 4.2. Cyprus fishing fleet characteristics, results from 2013-2014 field survey.

Recreational vessel (n=12)	Vessel length (m)	Total hp	Age	Age started	# Years fished	Fishing days/year	Catch/year (t)
Minimum	5.0	20	37	10	8	7	0.09
Maximum	10.5	85	61	35	45	320	4.50
Mean	8.5	35	51	15	21	122	2.60
Artisanal (n=55)							
Minimum	7	45	28	12	9	50	0.02
Maximum	10.5	136	72	35	63	320	5.00
Mean	9.8	81.5	56	17	25	162	1.45
Spearfisher (n=15)	Depth fished (m)						
Minimum	10	-	20	10	8	12	0.01
Maximum	34	-	55	24	45	200	1.00
Mean	26	-	36	15	21	65	0.36

Perceived change in abundance

Each fisher was asked to rate resource abundance from 1 to 100 (1 being the worst and 100 being the highest possible, as in a pristine ecosystem), both for their initial year fishing and for the 'current year' (2013). A 1 to 100 scoring system was used to allow for more variability in the responses than a 1 to 10 scoring system. The score given for their initial year had the 2013 score subtracted, and the resultant value was plotted at each fishers' first year fishing defined from their 'perceived change in resource abundance'.

Shifting baselines

For the shifting baselines phenomenon to be demonstrated, the resource itself must have declined, i.e., demonstrated here by the decline in ratio of initial to current CPUE, along with a decline in the perceived change in resource abundance as well. As an additional hypothesis, it is expected that when there is a higher percentage of 'younger' than 'older' fishers from the mean experience level of each sector, perceived change in resource abundance would tend not to decrease significantly; this was measured in Tables 4.3 and 4.4.

Table 4.3. Shifting baselines (SB) associated variables for Turkey; the difference between maximum and minimum mean year at start of career (by sector).

Sector	Mean year began fishing	% older fishers	% younger fishers	SB predicted	SB occurring
Recreational	1990	43	57	No	Yes
Artisanal	1978	54	46	Yes	Yes
Bottom trawl	1980	60	40	Yes	Yes
Purse seine	1983	50	50	Y/N	No

Table 4.4. Shifting baselines (SB) associated variables for Cyprus; the difference between maximum and minimum mean year at start of career (by sector).

Sector	Mean year began fishing	% older fishers	% younger fishers	SB predicted	SB occurring
Recreational/ North Cyprus	1979	63	37	Yes	Yes
Artisanal/ North Cyprus	1979	59	41	Yes	Yes
Artisanal/ South Cyprus	1980	45	55	No	No

After careful consideration, the bottom trawler survey results from the Gulf of Iskenderun were excluded from the analysis since the area has a much longer trawling history than our other sites (the Black Sea and Sea of Marmara), thus significant changes likely occurred to this ecosystem prior to our subjects beginning their careers. For the purse seiners, since their temporal trends of CPUE showed non-linear behavior, a multiple linear regression (with a squared term) was suggestively used to fit the data.

Statistical analysis

The following analyses were applied to the data:

Pearson product correlation coefficients were calculated to quantify the strength of the association between variables, i.e., perceived change in resource abundance & ratio of initial to current CPUE and time. Then, a linear regression was applied to ratio of initial to current CPUE and perceived change in resource abundance vs time for each sector, by country, and the slope of each regression was tested for its significant difference from zero. Finally, the slopes of ratio of initial to current CPUE and perceived change in resource abundance vs. time were used (via a t-test) to test the hypothesis that the Mediterranean artisanal fishers of Turkey and Cyprus experienced similar declines in catches. However, a full statistics test to measure the differences in the regressions could be completed using ANCOVA.

Methods thought by Turkish and Cypriot fishers to improve the status of fisheries were given by fishers from an open ended question on how to improve the national fisheries and ranked as most popular replies.

RESULTS

Total catches, effort and CPUE in Turkey and its seas

Figure 2.4 shows the total reconstructed catch from Turkish waters, which was about 157,000 $t \cdot year^{-1}$ in 1950, peaked at just over 1 million t in 1987 and 1988, and then declined to about 775,000 $t \cdot year^{-1}$ in the late 2000s (Ulman et al. 2013).

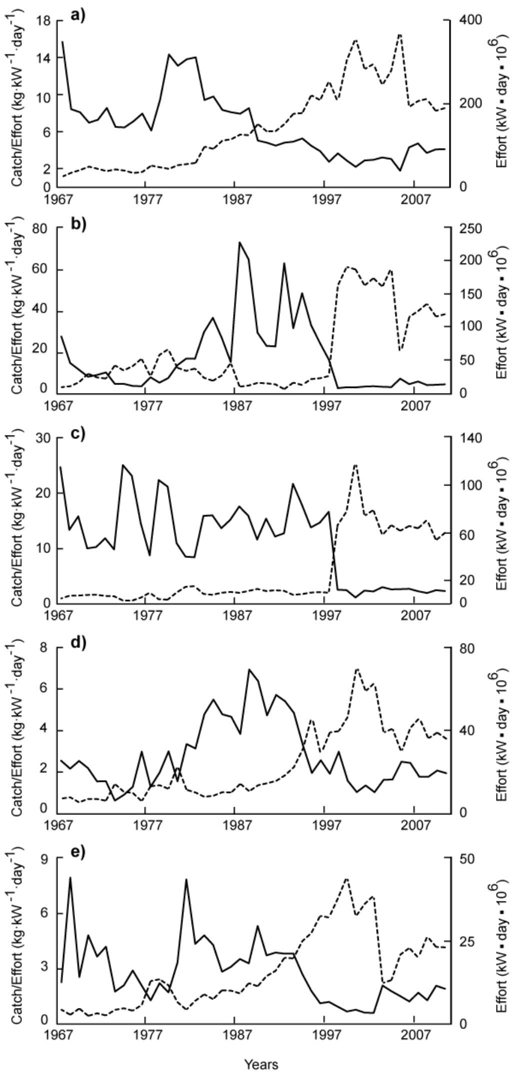
Total effort (Figure 4.3a), was about 9.5 million total kW days in 1950, gradually increased until 1997, then the increase accelerated, reaching 380 million total kW days by 2005, and then declined to under 200 million total kW days by the late 2000s.

For Turkey, CPUE (Figure 4.3a) initially declined by half from nearly 16 $kg \cdot kW \cdot day^{-1}$ in 1967 to 8 $kg \cdot kW \cdot day^{-1}$ in 1968, mainly due to the removal of previously abundant species in this first detailed year of fisheries statistics such as garfish*,* with an over 90% decline in catches in one year, stingray (Dasyatidae) catches which decreased by 80%, and sturgeon that were never again reported after 1967. CPUE has been steadily declining since 1982, and averaged just 4 $kg \cdot kW \cdot day^{-1}$ in the late 2000s.

Black Sea

The reconstructed catch from Turkish waters in the Black Sea was just under 100,000 t in 1950, peaked at 777,000 t in 1988 and declined to about 520,000 $t \cdot year^{-1}$ in the late 2000s (Ulman et al. 2013).

Total effort in the Black Sea (Figure 4.3b) was about 9.4 million total kW days in 1967 and hovered around 15 million total kW days in the late 1980s, before rapidly increasing to over 200 million total kW days in the mid-1990s. It has since declined to just under 125 million total kW days in the late 2000s.



Figures 4.3.a-e. Total effort in Turkey (represented by secondary Y-axis in dotted line) and Total catch/effort (represented by primary Y-axis and solid line) derived from total reconstructed catches for Turkey for a) all of Turkey; b) Black Sea; c) Marmara Sea (including catches of Bosphorus and Dardanelles); d) Aegean Sea; and e) Levantine Sea.

Since over two-thirds of Turkey's fisheries catches stem from the Black Sea, it is not surprising that CPUE levels are over triple those than Turkey as a whole (Figure 4.3b). CPUE declined in the Black Sea from the late 1960s from an average of 18 kg·kW·day^{-1} to a low of 3.5 kg·kW·day^{-1} in 1976, likely attributable to the removal of large predatory fish, and then quickly increased to peak at nearly 73 kg·kW·day^{-1} in 1987 due to the increase in populations of former prey, including anchovy and sprat. CPUE then crashed to just over 20 kg·kW·day^{-1} from 1989-1991, due to the invasion of the warty comb jelly *Beroe ovate*, which consumed much of the small pelagic fish in their zooplanktonic stage. The system partially recovered soon after, to nearly 63 kg·kW·day^{-1} in 1992, and has since steadily declined from 48 kg·kW·day^{-1} in 1994 to 5 kg·kW·day^{-1} by 2010. From its peak CPUE in 1987, CPUE in the Black Sea declined by over 94% by 2010.

Marmara Sea

The reconstructed catch for the Marmara Sea was about 50,000 t in 1950, peaked at 198,000 t in 1999 and declined to about 140,000 t·year^{-1} in the late 2000s (Ulman et al. 2013).

Effort in the Sea of Marmara (Figure 4.3c) was about 4.6 million total kW days in 1967 and increased slightly to average about 10 million total kW days in the 1980s until 1997, when it rapidly increased to nearly 66 million total kW days in just one year in 1998, peaked at over 120 million kW days in 2000 and has since declined to average just over 60 million total kW days·year^{-1} in the late 2000s.

Although the CPUE in the Sea of Marmara (Figure 4.3c) varied from 1967 until 1993, a declining trend is apparent from 1974, when CPUE peaked at 25 kg·kW·day^{-1}, to current levels of 2.36 kg·kW·day^{-1}, a 90% decline.

Aegean Sea

The reconstructed catch from the Turkish part of the Aegean Sea, was about 5,000 t in 1950, peaked at 106,000 t in 1993, then declined to about 70,000 t·year^{-1} in the late 2000s (Ulman et al. 2013).

Total effort in the Turkish Aegean (Figure 4.3d), was less than 7 million total kW days in 1967, which doubled to about 15 million kW days by the early 1990s, then increased rapidly to peak at 70 million total kW days in 2000. Effort has since declined to about 35 million total kW days·year^{-1} in the late 2000s.

Turkish CPUE in the Aegean (Figure 4.3d) steadily increased from 1967 and peaked at 6.3 kg·kW·day^{-1} in 1995. After peaking, CPUE steadily decreased to about 1 kg·kW·day^{-1} in the early 2000s, and increased to 2 kg·kW·day^{-1} in the late 2000s.

Levant Sea

The reconstructed catch from the Turkish part of the Aegean Sea, was about 5,000 t in 1950, peaked at 75,000 t in 1992 and 1993 and declined to about 40,000 t·year^{-1} in the late 2000s (Ulman et al. 2013).

Total effort in Turkish part of the Levant Sea (Figure 4.3e) was at 4 million kW days in 1967, which steadily increased to peak at 44 million kW days in 1999, before declining to average 24 million kW days by the late 2000s.

The corresponding CPUE (Figure 4.3e) declined from about 8 kg·kW·day^{-1} in 1968 to a low of 1.2 kg·kW·day^{-1} in 1977, increased back to 8 kg·kW·day^{-1} in 1981, before declining to average 1.6 kg·kW·day^{-1} in the late 2000s.

Observed change in ratio of initial to current CPUE vs. perceived change in resource abundance

Turkey

Recreational sector

The ratio of initial to current CPUE and perceived change in resource abundance of recreational fishers decreased significantly (Figure 4.4a; $r = -0.755$, and Figure 4.4b; $r= -0.722$, respectively, $p<0.01$ in both cases). The larger percentage of younger recreational fishers suggested that shifting baselines should not be significant, signifying stronger decreases in perceived change in resource abundance than expected. The data suggest that ratio of initial to current CPUE (Figure 4.4a) decreased by a mean factor of about 40 times since the 1960s, and the perceived change in resource abundance (Figure 4.4b) decreased by about 85% since the 1960s.

Artisanal sector

The ratio of initial to current CPUE and perceived change in resource abundance of artisanal fishers decreased significantly (Figure 4.4c; $r = -0.354$; Figure 4.4d; $r = -0.612$, respectively, $p<0.01$), and the perceived change in resource abundance decline (shifting baselines) behaved as predicted, as there were more ‘older’ fishers than ‘younger’ in the sample size. The data suggest that ratio of initial to current CPUE decrease by a factor of about 40 times since the 1960s and the perceived change in resource abundance (Figure 4.4d) declined by about 65% in the last 60 years.

Bottom trawl sector

The ratio of initial to current CPUE (Figure 4.4e) did not decrease significantly over time (although it did appeared to decline), but the perceived change in resource abundance (SB) did decrease significantly

(Figure 4.4f, r= -0.645, p<0.05). The perceived change in resource abundance trend behaved as predicted, given a higher proportion of 'older' fishers. The data suggest that ratio of initial to current CPUE declined by a factor of about 25 times, while the perceived change in resource abundance decline was about 70% since the early 1970s.

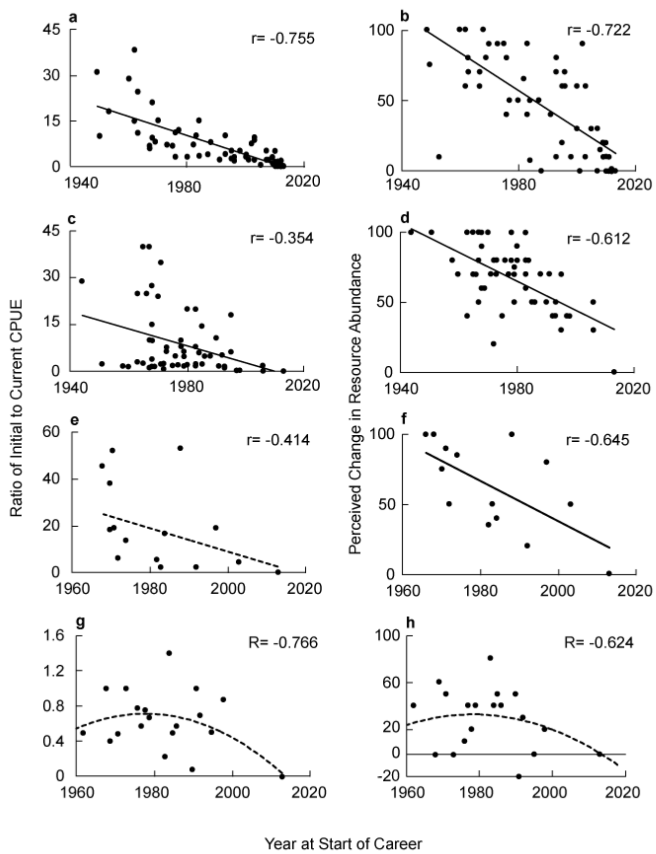


Figure 4.4a-h. Observed change in CPUE (left panels) and perceived change in CPUE (right panels) experienced by the fishers of Turkey, according to sector: a&b) recreational fishers; c&d) artisanal fishers; e&f) bottom trawl fishers; and g&h) purse seine fishers. The Y-axis is the relative amount of change experienced per fisher throughout their career from dividing their current catch by their initial catch. Positive values for increases in CPUE over time are expressed as very low values (between 0 and 1). The Y-axis describes the relative change in CPUE as experienced by fisher by dividing their current catch rate by their initial catch rate. Solid linear regression lines represent that the slope was significantly different from 0 (p<0.01 for a and b, and p<0.05 for c-h), and dotted linear regression lines represent that changes in CPUE were not significantly different from 0 (p>0.05). The multiple regression (with a squared term) was used to fit the data for purse seiners (g and h, p>0.05).

Purse seine sector

Both ratio of initial to current CPUE (Figure 4g) and perceived change in resource abundance (Figure 4h) did not decrease significantly ($p<0.05$); the relationship between ratio of initial to current CPUE & perceived change in resource abundance and time appear to be non-linear. A multiple regression was used here to suggestively show the experienced responses from this sector, although a non-parametric test could also have been applied.

North Cyprus, recreational sector

The ratio of initial to current CPUE (Figure 4.5a) did not decrease significantly over time (although it appeared to decline), but the perceived change in resource abundance did decrease significantly (Figure 4.5b; $r= -0.461$, $p<0.01$). The perceived change in resource abundance results behaved as predicted, given a higher proportion of ‘older’ fishers sampled. The data suggest that the ratio of initial to current CPUE was about 7 times higher than today’s catches (Figure 4.5a) and the perceived change in resource abundance decreased by about 80% (Figure 4.5b), both since the early 1970s (Figure 4.5b).

North Cyprus, artisanal sector

The ratio of initial to current CPUE did not decrease significantly over time (Figure 4.5c), but the perceived change in resource abundance did decline significantly (Figure 4.5d, $df=52$, $r= -0.605$, $p<0.05$). The perceived change in resource abundance results behaved as predicted, owing to a higher proportion of ‘older’ fishers. The data suggest that the ratio of initial to current CPUE declined by over 10 times (Figure 4.5c), while the perceived change in resource abundance (Figure 4.5d) decreased by 40% since 1970.

South Cyprus, artisanal sector

Both the perceived change in resource abundance and the ratio of initial to current CPUE did not decrease significantly over time (Figure 4.5 e and 4f, $p<0.05$). The perceived change in resource abundance results behaved as predicted, owing to a higher proportion of 'younger' fishers in the sample.

All Cyprus, artisanal sector

For all Cyprus (results of the north and south computed together), the ratio of initial to current CPUE did not decrease significantly over time, while the perceived change in resource abundance did decrease significantly (Figure 4.5g and h, respectively; 4.5h, $r= -0.351$, $p<0.05$).

Comparing Mediterranean artisanal fishers of Turkey with Cyprus

Using a t-test, the slopes of both ratio of initial to current CPUE and perceived change in resource abundance between Mediterranean artisanal fishers from Turkey and Cyprus were found to be dissimilar. The data suggest that the mean ratio of initial to current CPUE for Mediterranean Turkey from 1950 was about 14 times the 2013 reported amount, with a mean decline of only 5 times for Cyprus from the late 1950s to 2013. The overall mean decline in perceived change in resource abundance was 75% for Turkey and just 31% for Cyprus.

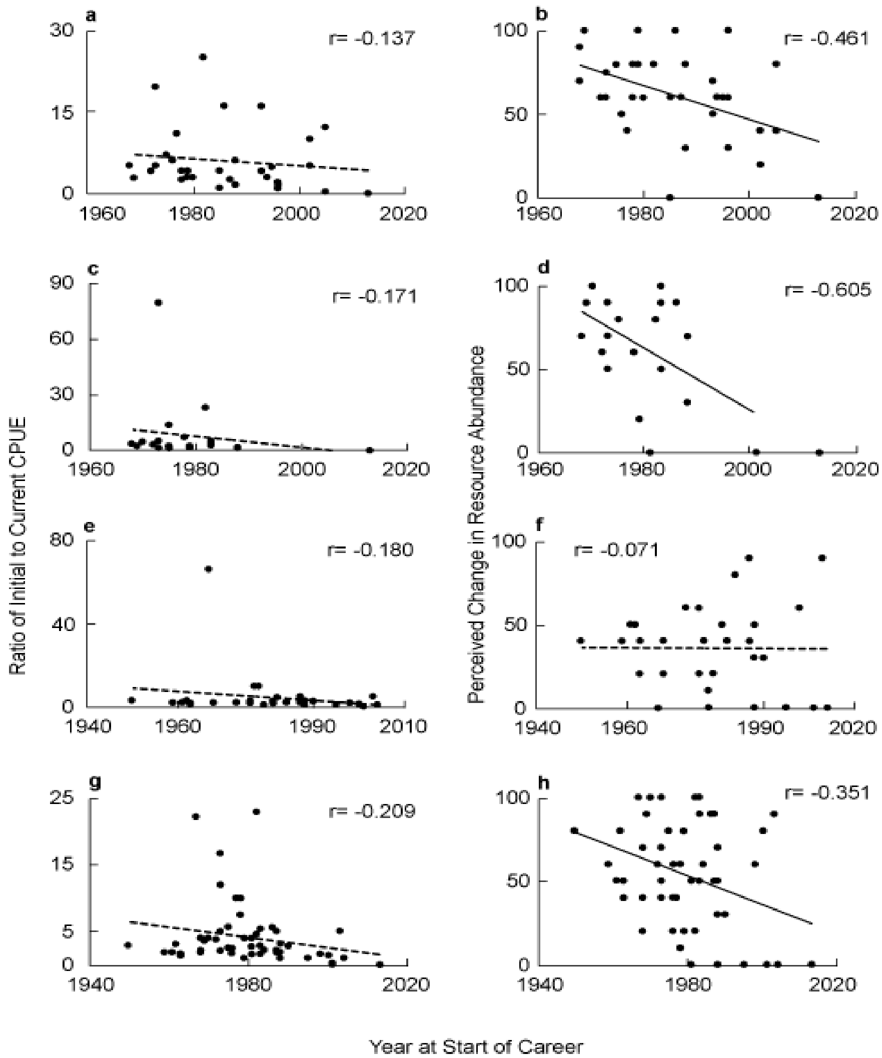


Figure 4.5a-h. Observed change in CPUE (left panels) and perceived change in CPUE (right panels) experienced by the fishers of Cyprus, according to sector: Relative change in fisheries (left panels) and perceived change in fisheries (right panels) for Cyprus: a&b) North Cyprus (recreational sector); c&d) North Cyprus (artisanal sector); e&f); South Cyprus (artisanal sector); g&h) Entire Cyprus (artisanal sector). The Y-axis describes the relative change in CPUE as experienced by fisher by dividing their current catch rate by their initial catch rate. Solid linear regression lines represent that the slope was significantly unlike 0, and dotted linear regression lines represent that changes in CPUE were not significantly different from 0.

How to improve fisheries

Some quotes gathered during the field interview describe some fishers' general frustrations or feelings about the fisheries are given in Table 4.3.

Table 4.5. Interesting quotes fishers told to first-author. T=Turkey and C=Cyprus.

T: Recreational fishers	"Education is needed about past larger size possibilities of bluefish and bonito, then people can see how wrong it is to eat the babies."
	"We need a Ministry of Fisheries, and they should receive input from fishers who understand the sea."
T: Artisanal fishers	"30 years ago, 3 months of fishing would leave your pockets full for the other 9 months, now we fish every day and can barely put food on the table."
	"Fishers use 100 times more nets now than before. If there is fish, you should only need one net, more nets ≠ more fish."
T: Bottom trawl fishers	"If we finish all the fish in the sea, boats will be forced to stop fishing, and only then will the fish have a chance to replenish themselves."
	"Before the government wanted bigger boats and invested in them, now they are having a hard time going backwards."
T: Purse-seine fishers	"50 years ago we were guaranteed many riches as fishers, life was insured with abundances of fish, now we don`t even enjoy fishing anymore."
	"If our waters were full of fish, Turkish fishers can empty the seas in 1 day, capacity is that huge! How are their no restrictions on catch amounts."
C: Recreational fishers	"We have seen the best fishing years imaginable, but our children will only know those years through encyclopaedias."
	"Barely any freshwater nutrients are reaching the sea anymore; the ecosystem needs these as building blocks."
C: Artisanal fishers	"In Kyrenia, 25 years ago, sponge divers caught almost all of the groupers, in 48 hours they took 3 truckfulls of grouper, now you have to dive to 35 m+ to find them."
	"We must decrease our capacity massively: as in total net length, hp and number of vessels."

Methods thought by Turkish and Cypriot fishers to improve the status of fisheries are given in Table 4.6. These responses were given by the fishers from an open ended question and ranked as most popular suggestions.

Table 4.6. Top 11 Methods thought by Turkish and Cypriot fishers to improve the status of fisheries

Turkey	# of cases	Cyprus	# of cases
End illegal fishing	44	More MPAs	24
Ban bottom trawling	38	Improve control	14
Improve control	33	Increase min. mesh size	11
Ban purse seining	23	More artificial reefs	8
Restrict capacity/control effort	18	Protect spawning seasons	6
Ban sonar	14	Restrict capacity/control effort	8
Install quotas	10	Educate	4
Control undersized fishing	7	Increase fines	3
Protect spawning seasons	7	Increase temporal closures	6
Ban purse seine lights	5	Ban sonar	2
Educate fishers/consumers	5	Decrease corruption	2

DISCUSSION

The current fisheries of the eastern Mediterranean and Black Sea provide only a glimpse into what the fisheries resembled just half a century ago, as fisheries have pushed these marine ecosystems far from their natural historical baseline of abundance and diversity. Thus, overall in Turkey, CPUE – which reflects abundance when catchability remains constant - declined by about 380%, from 15.7 $kg{\cdot}kW{\cdot}day^{-1}$ in 1967 to 4.1 $kg{\cdot}kW{\cdot}day^{-1}$ in 2010, while total effort increased by over 700%, from 25 million kW days to nearly 190 million kW days. CPUE is shown not to reflect abundance when CPUE remains high, while abundance is actually declining, which is termed 'hyperstability' (Hilborn and Walters 1992).

The decrease in abundance is also clearly reflected in the declines in ratio of initial to current CPUE and perceived change in resource abundance of both Turkish and Cypriot fishers. In fact, only the Turkish purse seiners and the artisanal fishers of Southern Cyprus did not experience significant declines in perceived change in resource abundance. In most cases, the 'older' fishers noted a higher degree of change in ratio of initial to current CPUE and perceived change in resource abundance than 'younger' fishers, whereas all ‘very new’ fishers (<2 years’ experience) were unaware of prior changes to the marine ecosystem. Hence it can be said that the shifting baselines phenomenon is occurring in both Turkey and Cyprus.

Using fishers to describe environmental change demonstrated the shifting baselines syndrome quite well, as newer fishers were generally unaware of the past riches of the ecosystem and apparently quite content with their (actually) dismal catches, although catches would have been at least one order of magnitude more just half a century ago. Some older fishers remarked that they did not attempt to pass older stories down to younger fishers, because the stories of lost species no longer appear relevant to today’s activities. Thus, although highly pertinent to understanding fisheries, these stories are being lost as well. The failure to pass these historical anecdotes onto the current generation has been described as general amnesia (Papworth *et al.* 2009). As these older fishers retire, the baseline resets itself, and the past is thus forgotten. This in part explains why massive changes can occur in the fishing industry without effective measures being taken to combat stock declines. In fact, fisheries research even acknowledging the rapid decline of the fisheries is scarce in Turkey, which may be due to the fact that no official Department of Fisheries exists. The people who manage the fisheries are under the umbrella of the Turkish Ministry of Food, Agriculture, and Livestock, and apparently, no one seems to be held responsible for the state and sustainability of marine fish stocks.

Industrial fisheries have been known to typically reduce community biomass by 80% within 15 years of exploitation (Myers and Worm 2003). Moreover, in Turkey, the compensatory increases of fast-growing fish (1970s) lasted only a decade before their catches also began to decline. Turkish purse seiners are proud that they have some of the most advanced technology available, such as *Kaico* Japanese sonars which can detect fish up to a distance of 10 km, which are well-understood to be disastrous for the future fisheries by those who use them. These declining trends in CPUE are not uniquely happening only in Turkey or the Mediterranean, but are being mirrored all over the world, see (Belhabib D *et al.* 2013; Tesfamichael *et al.* 2014) for other similar trends found in the Red Sea and Western Africa.

Yaşar Kemal, an early Turkish environmentalist, wrote of one conscientious fisher in the early 1970s (Kemal 1985) who only caught red mullets at 25 cm in size, leaving the smaller size classes an opportunity to grow, and the larger individuals to produce more new recruits for subsequent fishing years. This method of improving selectivity could be used today to reverse the declining trend in catches, but mesh sizes would have to be strongly controlled. Studies have shown that if fish are only caught at the size which the cohort attains their highest biomass (L_{opt}), growth overfishing can be avoided and long-term catches could increase substantially (Vasilakopoulos *et al.* 2014).

Ending illegal fishing and effectively banning bottom trawling are the two most frequently suggested approaches to improve the state of the Turkish fisheries. Bottom trawling in Turkey, normally occurs illegally, i.e., in prohibited waters, too close to shore, and in prohibited seasons. It has been shown that in most cases, the probability of detection must be over 20% to serve as a deterrent, and fines would have to be increased many-fold to impede further illegal activity (Sumaila and Keith 2005).

Cyprus is taking effective measures to combat the decline of its major species by completely eliminating the industrial fisheries in the north and by drastically reducing the industrial sector in the south (Ulman *et al.* 2014). However, four out of five of their top commercial species (aside from picarel, Centracanthidae) are overfished and thus, additional measures are needed to rebuild stocks. Cyprus fishers seem to understand some solutions such as building more marine protected areas and artificial reefs.

Here we have converted memories into knowledge and have tried to establish some historical precedence of what the pristine ecosystem likely resembled and functioned. As currently no unexploited communities exist, the past may provide some different possible targets for management scenarios

(Pitcher and Pauly 2001), and thus provides a more holistic picture of where we currently stand in relation to past abundances and biodiversity assemblages (Pauly 2011). Historical data are also the main source of reliable information for use in assessments for extinction risk which can lead to the protection of species (McClenachan *et al.* 2012). This loss of traditional ecological knowledge is perilous to the deeper understanding of historical traditions (i.e., culture) and the relationship that exists between them and us, as in culture, thus, this loss is akin to the eternal loss of meaning (McKibbin 1989).

Where nature currently stands was derived by human decision alone; many allowed themselves to slightly degrade the ecosystem further from how they found it, and then adapted to lower quality conditions (Mackinnon 2013). The future is also a choice, the people can continue to live with some short-term (however diminishing) economic gain along with the gradual decline of the natural world which everyone ultimately depends on, or begin to combat the decline by rebuilding to what the natural system once resembled. Since humans have come to rely so heavily on these resources, why not ensure their longevity into the future? More scientific data, which is costly and time-consuming to obtain may not be necessary to plan for rebuilding. What seems to be needed, and is presently mostly lacking, is political will not to let the situation degrade further, and shifting baselines to let us forget about the need for rebuilding.

5: CONCLUSION

This research firstly aimed at establishing a more-accurate historical baseline of total fishery removals for both Turkey and Cyprus, and secondly to determine the current state of fisheries for each country. Chapter 1 provided necessary background information on the different maritime regions for both Turkey and Cyprus such as their geographical areas, underlying policies and main fishery resources. The chapter also included a historical account of the fisheries as well as some current issues facing them. The background material for this chapter was provided to enable the audience to understand the rationale for the specific aims of the research encountered in Chapters 2, 3 and 4. The findings detailed in each of the three main chapters are summarized below, as are the limitations faced during doing this research and also suggestions for further research.

In Chapter 2, Turkey's total reconstructed fisheries catches were calculated and presented from 1950 to 2010, for Turkey as a whole, and also for each maritime region (i.e., each sea) by compiling information about the contributing sectors and assessing each sector's annual total catches by year, to the highest possible taxonomic detail. The results showed an unreported catch amount which was approximately 80% higher than the data reported by Turkey to the FAO. The major unreported catch amount stemmed from a seemingly well understood consensus that most commercial fishers generally under-report their catches from 30-40% (or more) due to a general distrust towards the government and skepticism about owing that money in future taxes. The results also clearly show that despite current catches appearing stable, if anchovy and sprat are excluded from the data (which are of hardly any economic value, also much of which is not even used for human consumption but rather sent for processing into fishmeal and fishoil), that Turkish stocks have been on a declining trend since the late 1980s (Figure 2.5). Catches from the previously unassessed recreational and subsistence sectors, as well as discards were shown to be substantial (Figure 2.3, Appendix table 7), especially emanating from the Istanbul-Marmara Sea-Dardanelles region, and a snapshot assessment of each of these sectors would greatly benefit fisheries managers in depicting local catch trajectories, and also help to warn them about crashing stocks and where to concentrate conservation efforts towards. Overcapacity is thought to have been the major cause of the general decline, especially as the number of commercial vessels actually doubled in the late 1990s due to known loopholes in the system, despite a ban on entry (Figure 2.7), but this issue was explored in further detail in Chapter 4. This work has demonstrated that the current local fisheries management organizations are not effectively seeking to protect the future of this industry as overcapacity has been met with the 'Tragedy of the Commons', which is common in the Mediterranean, with its many shared fish stocks. This has resulted in a major overexploitation of marine resources and collapse of many commercial stocks.

In Chapter 3, Cyprus's total fisheries catches were calculated for each side from 1950-2010, and then later combined to represent the entire island's catches. The catches of the 'North' (the Turkish Republic of Northern Cyprus) were found to be excluded from the global FAO database, seemingly as it is neither a UN member country nor internationally recognized as a distinct state (except by Turkey). The research undertaken here was the first accountable appraisal of the artisanal sector in the north, as approximately 40% of the sector was surveyed for this study. Data limitations for catches in the north from 1975-2009 were lacking, and thus many assumptions were made here, and normally direct linear interpolations were used to link one anchor point with the next (See Table 3.6 for sources of data used and also anchor points). Also, facts about the North's brief industrial sector were learned from the Department of Animal Husbandry and are now recorded for future evaluation of the area. In completing the literature search for Cyprus, colonial annual reports were located and used to assess the fisheries catches of during Cyprus's colonial period (i.e., from 1950-1960), historical treasures none of the associates in Cyprus were aware existed. This research paper was also one of the few and new initiatives to have experts from both the 'north' and 'south' working together for the greater good of science, and it is anticipated that this work will encourage more meaningful collaborations between the two sides. Although not as clear in the north, most likely due to the assumptions based on the newly accumulated data and hence linear interpolations backwards in time, a declining trend for the marine fisheries for the also evident for Cyprus as a whole, and for the South, once catches of *Lagocephalus sceleratus* and *Thunnus alalunga* were excluded. *L. sceleratus* is poisonous and hence, inedible, but was included here for comprehensive purposes, and *Thunnus alalunga*, is a newly targeted species (especially in the sports fisheries) that both sides are now seeking and encouraging a local market for. It is necessary for the people in charge of these resources to fully comprehend how much fish have been and are being removed and by whom, so that appropriate decisions regarding the future of these resources can be made (Pauly *et al.* 2014).

The Fishing Effort Adjustment Plan in the south clearly seems to be taking appropriate measures to drastically reduce industrial fishing. Moreover, the data from these two catch reconstructions are to be used as part of a bigger project, to help assess the total marine fisheries catches of the world due out in 2015 (edited by D. Pauly, and D. Zeller), and the data collected and used, which had many improvements to the data reported by each country to the FAO, such as improved taxonomic detail and errors fixed, are now freely made available on the www.seaaroundus.org website.

In Chapter 4, total CPUE for Turkey as a whole and by sea was illustrated using reported annual fleet dynamics. These results clearly showed that the massive doubling of effort from the 1990s to the early 2000s was likely the principal reason for immediate declines in both total and regional CPUE. Fleet capacity would seemingly have to be reduced to pre-1990 levels if the current stocks are to have a chance at rebuilding. Shifting baselines was found to be evident for the industrial fishers of Turkey and the recreational and artisanal fishers of North Cyprus as these fishers were generally unaware of the drastic changes to the fisheries which likely occurred just before the commencement of their careers/hobbies, these fishers also averaged about 10 years less experience than the other sectors (See Table 4.1). This evidence of shifting baselines is worrisome because this non-transformation of traditional knowledge may impede those who rely on the resources from being fully aware of the severity of the issue, and hence, neglect an urgent call for action. This data has clearly shown that both the artisanal and recreational fisheries have rapidly declined by about a factor of 40 times in Turkey, and by about 20 times for bottom trawlers from the Black and Marmara Seas; although due to a lack of locating older industrial fishers, this latter could potentially be higher than this, which would make for an interesting further study of this topic.

Several reasons exist why the degree of change is likely more severe than illustrated here, one being that 2013 was a year with exceptional fish catches, because bonito catches peaked that year, which is the last remaining migratory fish of economic value. Several purse seiner operators remarked that the bonito fishery is the only thing keeping them in the fishery, as once each 7 years, higher-than-average catches of bonito allow them to pay off some bank loans, enabling them to receive bank credit for the upcoming 6 years, which keeps them afloat. Anchovy also now appears to be overfished, as the season has shrunk from 8 months down to only one month in just 20 years and much of their catches are now discarded due to their small size, and limited lipid content, which prevent them from being processed into fish oil (Ulman 2014)[22]. In addition, as total CPUE was assessed here, which in itself is a very informative measure, it alone is unable to capture other very informative indices such as the gradual substitution of lower-valued commercial species, declining tropic levels, localized commercial

[22] http://hamsi.ims.metu.edu.tr/sunumlar/4-IUU-GFCM[ACG].pdf

extinctions, the foregone economic value of the loss of top predators, and some sort of indices to account for the massive increase in technological capacity such as the inclusion of bird radars, *Kaico* fishfinders, on-board freezers, transport vessels, etc., all of which would also be interesting topics for upcoming research.

Although 5/6 commercial species in Cyprus are considered overexploited, the observed changes in Cyprus were not as drastic as Turkey since they did not have the earlier super-abundances of migratory fish as Turkey did, resulting in less steep declines in both observed and perceived changes in CPUE. Most surveyed fishers in Cyprus were extremely aware of their job security as it constantly has taken more effort to catch a lesser amount of fish. Their financial woes are currently exacerbated by the fairly recent need to replace their fishing nets at least each six months due to increased pufferfish and dolphin damage. Many fishers are very keen about exiting the fishing industry, but generally lack transferable skills required for other professions. One thing is certain, almost all fishers from both sides of Cyprus have heard of, and believe in conservation strategies, a term not yet understood in Turkey, showing promise for the future.

In recent years, catches have been dominated by juvenile fish of the key commercial species, a clear sign of 'growth overfishing'. There is incredible wastage occurring with this growth overfishing dilemma, as fish should be allowed to grow to at least maturity where they would generate higher catches, and higher economic return. In the 2013-2014 fishing season, most industrial vessels returned to port 2 months before the end of the commercial season as there were no fish left to catch. Scientific advice and effective government regulation are urgently needed along with the incorporation of traditional knowledge from the fishers to secure a future for the fisheries. While there are national fisheries rules and regulations on paper, they have been utterly ineffective at halting the decline of this stock and the runaway growth of fishing capacity and effort. The industrial sector is begging for the introduction of catch limits for each major commercial stock, which they feel is the only way to ensure jobs (and fish) in the future, but so far, to no avail. Both the industrial and artisanal fisheries of Turkey appear to be on the brink of collapse and require an urgent shift in management, one that fosters the entire ecosystem and its inhabitants. And yes, it will mean cuts in allowable catches, likely substantial. And yes, many fishers may lose their jobs or livelihoods. But it comes down to this, do Turkish fishers and the Turkish society want healthy and sustainable fisheries for future generations, or only short-term (and increasingly negligible) profit now?

Effective management needs to embed this fishery in an ecosystem-based management setting, which requires that fishery managers balance the demands of all resource users. Given Turkey's massive over-capacity and excessive fishing effort in both industrial and artisanal fisheries, Turkey's fisheries management and resource policy are at a difficult crossroad: continue to conduct business as usual and further impair and damage an ecosystem already under severe strain from excessive and uncontrolled human impacts, or apply controls on all sectors of fisheries in an attempt to stop the decline and start rebuilding stocks. Only the second path can lead to fisheries that are sustainable and embedded in a well-functioning and productive ecosystem. Only such fisheries can guarantee a future for all.

Aside from the main issue illustrating the general decline of fisheries in the Eastern Mediterranean, and the non-transfer on historical knowledge from older to younger fishers, additional focus for forthcoming work should be targeted at utilizing the wealth of traditional ecological knowledge of experienced fishers, and connecting the fishers with policy makers to establish goals and determine total both allowable effort and catches. In addition, economic studies highlighting what specific increases in the investment for Monitoring, Control and Surveillance abilities would negate illegal fishing would also be extremely beneficial for Turkey, as many important laws are already in place, but most do not seem to be adhered to. Seeing as many fishers would benefit from acquiring new skills to help exit the industry, charging much higher fines for illegal fishing, and using that equity to buyback vessels and to train ex-skippers to patrol would help solve many immediate issues.

It is hoped that this research illustrates the severity of the rapidly declining fisheries in the Eastern Mediterranean and demonstrates the necessity to protect and rebuild these stocks to ensure food security for the millions of people who rely on fisheries both as a source of protein and livelihood.

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APPENDIX

Appendix table 1. Turkish fish taxa list. List of English names, scientific names and Turkish names used in this report.

English name	Scientific Name	Turkish name (additional name)
Albacore	*Thunnus alalunga*	Albakor (irigöz)
Anglerfish	*Lophius piscatorius*	Fener baliği
Angel shark	*Squatina squatina*	Keler
Annular seabream	*Diplodus annularis*	İsparoz (ispari)
Atlantic horse mackerel	*Trachurus trachurus*	Karagöz İstavrit
Atlantic mackerel	*Scomber scombrus*	Uskumru
Atlantic saury	*Scomberesox saurus*	Zurna
Axillary seabream	*Pagellus acarne*	Kırma Mercan
Black scorpionfish	*Scorpaena porcus*	Lipsöz
Black goby	*Gobius niger*	Siyah Kayabalığı
Black grouper	*Mycteroperca bonaci*	Siyah Orfoz
Bogue	*Boops boops*	Kupez (kupa)
Bluefish	*Pomatomus saltatrix*	Lüfer (big çinekop)
Bluefin tuna	*Thunnus thynnus*	Orkinoz
Blue jack mackerel	*Trachurus picturatus*	Istavrit
Bonito	*Sarda sarda*	Palamut (torik)
Brown meagre	*Sciaena umbra*	Işkine (mavraşgil)
Bullet tuna	*Auxis rochei*	Yazılı orkinoz
Blue whiting	*Micromesistius poutassou*	Bakalorya
Chub mackerel	*Scomber japonicus*	Kolyoz (kolyozvonozu balığı)
Common dentex	*Dentex dentex*	Sinağrit
Common dolphinfish	*Coryphaena hippurus*	Lambuka
Dusky grouper	*Epinephelus marginatus*	Orfoz
European anchovy	*Engraulis encrasicolus*	Hamsi
European barracuda	*Sphyraena sphyraena*	İskarmoz (baraküda)
European conger	*Conger conger*	Miğri
European pilchard	*Sardina pilchardus*	Saradalya (çiroz)
European plaice	*Pleuronectes platessa*	Pisi
European seabass	*Dicentrarchus labrax*	Levrek
European sprat	*Sprattus sprattus*	Çaça
Frigate tuna	*Auxis thazard*	Gobene
Garfish	*Belone belone*	Zargana
Gilthead seabream	*Sparus aurata*	Çipura
Goatfishes	Mullidae	Paşa barbunu
Gobies	Gobiidae	Kaya baliği
Grey mullet	Mugilidae	Kefal
Groupers	Serranidae	Orfoz
Greater amberjack	*Seriola dumerili*	Avci (sarikuyruk)
Gurnards	*Trigla*	Kirlangiç
Hake	*Merluccius merluccius*	Berlam
John dory	*Zeus faber*	Dülger
Leerfish	*Lichia amia*	Akya
Little tunny	*Euthynnus alletteratus*	Yazili orkinoz
Meagre	*Argyrosomus regius*	Sariağiz
Medit. horse mackerel	*Trachurus mediterraneus*	Sarıkuyruk istavrit
Pacific mullet	*Mugil soiuy*	Rus kefali
Painted comber	*Serranus cabrilla*	Asıl hani
Pandora	*Pagellus erythrinus*	Kırma mercan
Picarel	*Spicara smaris*	İzmarit
Piper gurnard	*Trigla lyra*	Öksüz
Red mullet	*Mullus barbatus*	Barbunya
Round sardinella	*Sardinella aurita*	Sardalya
Saddled seabream	*Oblada melanura*	Melanurya
Salema	*Sarpa salpa*	Sarpa (çitari)
Scorpionfishes	Scorpaenidae	İskorpit
Seabream	Diplodus spp.	Fangri (fanri)
Shad	*Alosa fallax*	Tirsi
Sharpsnout seabream	*Diplodus puntazzo*	Sivriburun karakgöz

Appendix table 1 continued. Turkish fish taxa list. List of English names, scientific names and Turkish names used in this report.

English name	Scientific Name	Turkish name
Shore rockling	*Gaidropsarus mediterraneus*	Gelincik
Sharks	Selachiimorpha	Köpek baliği
Shi drum	*Umbrina cirrosa*	Minekop
Silversides	Atherinidae	Gümüş (çumuka)
Sole	*Solea solea*	Dil
Sprat	*Sprattus sprattus*	Çaça
Striped red mullet	*Mullus surmuletus*	Tekir
Swordfish	*Xiphias gladius*	Kiliç
Thicklip grey mullet	*Chelon labrosus*	Kefal
Thornback ray	*Raja clavata*	Vatoz
Tub gurnard	*Trigla lucerna*	Kırlangiç
Turbot	*Scopthalmus maximus*	Kalkan (saç)
Twaite shad	*Alosa fallax*	Tirsi
White grouper	*Epinephelus aeneus*	Lahoz
White seabream	*Diplodus vulgaris*	Karagöz
Whiting	*Merlangius merlangus*	Mezgit

*Note that the symbols ı, ö, ü , İ, ç, ğ, ş are special Turkish characters which correspond to the English uh, o, u, ee, ch, soft gh, sh sounds respectively.

Appendix table 2. Turkish invertebrate taxa list. List of English names, scientific names and Turkish names used in this report.

English name	Scientific name	Turkish name
Angular crab	*Goneplax rhomboides*	Yengeç
Blue crab	*Callinectes sapidus*	Mavi yengeç
Brown comb jelly	*Beroe ovata*	Deniz anasi (medüz)
Caramote prawn	*Melicertus kerathurus*	Karabiga
Carpet shell	*Ruditapes decussatus*	Akıvades (kum midyesi)
Comb jelly	Ctenophora	Deniz anasi (medüz)
Common octopus	*Octopus vulgaris*	Ahtapot
Common squid	*Loligo vulgaris*	Kalemerya
Deepwater rose shrimp	*Parapenaeus longirostris*	Pembe karides (çimçim)
Edible crab	*Cancer pagurus*	Pavurya
European flat oyster	*Ostrea edulis*	İstiridye
European lobster	*Homarus gammarus*	İstakoz
Giant gamba prawn	*Aristaeomorpha foliacea*	Kırmızi karides
Green tiger prawn	*Penaeus semisulcatus*	Jumbo karides
Great Mediterranean scallop	*Pecten jacobaeus*	Tarak
Horse mussel	*Modiolus barbatus*	Kıllı midye
Mantis shrimp	*Squilla mantis*	Böcek yiyen
Mediterranean mussel	*Mytilus galloprovincialis*	Kara midye
Norway lobster	*Nephrops norvegicus*	Deniz kereviti
Rapa whelk	*Rapana venosa*	Deniz salyangozu
Sea cucumber	Holothuridea	Deniz hıyarı
Sepia	*Sepia officinalis*	Mürekkep
Shrimp	Penaeidae	Karides
Speckled shrimp	*Metapenaeus monoceros*	Erkek karides
Spiny lobster	*Palinurus vulgaris*	Böcek
Striped venus clam	*Chamelea gallina*	Beyaz kum midyesi
Swimming crab	Portunidae	Çalpara
Tun snail	*Tonna galea*	Deniz salyangozu
Warty comb jelly	*Mnemiopsis leidyi*	Deniz anasi

*Note that the symbols ı, ö, ü , ı, ç, ğ, ş are special Turkish characters which correspond to the English uh, o, u, ee, ch, soft gh, sh sounds, respectively.

Appendix table 3. Cypriot fish taxa list. List of English names, scientific names, Cypriot names and Turkish names used in this report.

English name	Scientific name	Cypriot name	Turkish name
Albacore tuna	*Thunnus alalunga*	-	Albakor (irigöz)
Angel shark	*Squatina squatina*	Kyrós	Keler
Anglerfish	*Uranoscopus scaber*	Lychnos	Kurbaga
Annular seabream	*Diplodus annularis*	Sparos	İsparoz (ispari)
Atlantic bonito	*Sarda sarda*	Palamida	Palamut (torik)
Atlantic horse mackerel	*Trachurus trachurus*	Safridi	Istravrit (kraça)
Atlantic mackerel	*Scomber scombrus*	Scumbrί	Uskumru
Axillary seabream	*Pagellus acarne*	Fatsoukli	Kırma Mercan
Big-scale sand smelt	*Atherina boyeri*	Atherina	Gümüş (çumuka)
Black goby	*Gobius niger*	-	-
Blackmouth catshark	*Galeus melastomus*	-	-
Black seabream	*Spondyliosoma cantharus*	Scáthari	Sarigöz
Blackspot seabream	*Pagellus bogaraveo*	-	-
Blotched picarel	*Spicara maena*	Menoulla	İzmarit
Blue butterfish	*Stromateus fiatola*	Stira	-
Blue jack mackerel	*Trachurus picturatus*	-	-
Blue shark	*Prionace glauca*	Cancharίas	Pamuk
Bogue	*Boops boops*	Voppa	Kupez (kupa)
Blue-spotted cornetfish	*Fistularia commersonii*	-	-
Brown meagre	*Sciaena umbra*	Siakos	Işkine
Brushtooth lizardfish	*Saurida undosquamis*	-	-
Bull ray	*Pteromylaeus bovinus*	Actopsaro	Kulaklifolya
Chub mackerel	*Scomber japonicus*	Collίos (Koliós)	Kolyoz
Comber	*Serranus cabrilla*	Channos	Asıl hani
Corb	*Umbrina cirrosa*	Milokopi	Kötex
Common dentex	*Dentex dentex*	Synagrida	Sinağrit
Common guitarfish	*Rhinobatos rhinobatos*	Violopsaro	Iğnelikeler
Common pandora	*Pagellus erythrinus*	Lythrini	Kırma mercan
Common stingray	*Dasyatis pastinaca*	-	Vatoz
Common torpedo	*Torpedo torpedo*	Electryko	Uyuşturan
Common two-banded seabream	*Diplodus vulgaris*	Haratzida	Karagöz
Devil fish	*Mobula mobular*	Selachi kephaloptero	Şeytan
Dogfish	Squaliformes	Skyllos	Köpek balık
Dusky grouper	*Epinephelus marginatus*	Orfos	Orfoz
Dusky spinefoot	*Siganus luridus*	-	Sokan
European anchovy	*Engraulis encrasicolus*	Gávros	Hamsi
European barracuda	*Sphyraena sphyraena*	Sphyrna	İskarmoz (baraküda)
European conger	*Conger conger*	Mougri	Miğri
European eel	*Anguilla anguilla*	Chéli	Yilan
European hake	*Merluccius merluccius*	Backaliaros	Berlam
European pilchard	*Sardina pilchartus*	Sardella	Saradalya (çiroz)
European seabass	*Dicentrarchus labrax*	Lavraki	Levrek
Flying gurnard	*Dactylopterus volitans*	Chelidonopsaro	Uçan
Foureyed sole	*Microchirus ocellatus*	Glóssa	Dil
Four-spot megrim	Lepidorhombus	-	-
Frigate mackerel	*Auxis thazard thazard*	Kopáni	Gobene
Garfish	*Belone belone*	Velonida	Zargana
Gilt-head seabream	*Sparus aurata*	Tsipoura (Çipura)	Çipura
Golden picarel	*Spicara flexuosa*	Tseroulla	-
Greater amberjack	*Seriola dumerili*	Mineri	Avci (sarikuyruk)
Greater pipefish	*Syngnathus acus*	Sacerápha	Deniz ignesi

Appendix table 3 continued. Cypriot fish taxa list. List of English names, scientific names, Cypriot names and Turkish names used in this report.

English name	Scientific name	Cypriot name	Turkish name
Greater weever	*Trachinus draco*	Drákena	Trakonya
Grey gurnard	*Eutrigla gurnardus*	Capóni	Benekli kirlangiç
Grey mullet	Mugilidae	Kefalos	Kefal
Grey triggerfish	*Balistes capriscus*	Gourounópsaro	Çütre
Groupers	Epinephelus	Vlachos	Orfoz
Gulper shark	*Centrophorus granulosus*	-	-
John Dory	*Zeus faber*	Chrystópsaro	Dülger
Largescaled scorpionfish	*Scorpaena scrofa*	-	-
Leerfish	*Lichia amia*	-	Akya
Lesser weever	*Echiichthys vipera*	Drákena	Varsam
Little tunny	*Euthynnus alletteratus*	Palamida (karvòuni)	Yazili orkinoz
Lizardfish	*Synodus saurus*	Skarmos	Zurna
Longspine snipefish	*Macroramphosus scolopax*	-	-
Long-snouted seahorse	*Hippocampus guttulatus*	Alogakí	Deniz aygiri
Madeiran sardinella	*Sardinella madirensis*	-	-
Marbled spinefoot	*Siganus rivilatus*	-	Sokan
Mediterranean horse mackerel	*Trachurus mediterraneus*	Safridi	Istavrit (karagöz)
Mediterranean moray	*Muraena helena*	Smérna	Merina
Monkfish	*Lophius piscatorius*	-	-
Mottled grouper	*Mycteroperca rubra*	-	Orfoz
Ocean sunfish	*Mola mola*	Fegarópsaro	Pervane
Ornate wrasse	*Thalassamo pavo*	-	-
Painted comber	*Serranus scriba*	Perka	Asıl hani
Parrotfish	*Sparisoma cretense*	Skaros	Iskaroz
Picarel	*Spicara smaris*	Marida	Smarida (Izmarit)
Piper gurnard	*Trigla lyra*	Capóni	Mazak
Porbeagle shark	*Lamna nasus*	Cancharías	Dikburun karkarias
Rainbow trout	*Oncorhynchus mykiss*	Pestrofa	-
Rays and skates	*Rajiformes*	Vati	Vatoz
Red mullet	*Mullus barbatus barbatus*	Stryllia	Barbunya
Red porgy	*Pagrus pagrus*	Fangri	Fangri (Mercan)
Redcoat squirrelfish	*Sargocenton rubrum*	Rossos	Hindistan
Round sardinella	*Sardinella aurita*	Sardella	Gümüş
Saddled seabream	*Oblada melanura*	Melana	Melanurya
Salema	*Sarpa salpa*	Salpa	Sarpa (çitari)
Sardinellas	*Sardinella spp.*	Sardella	Gümüş (çumuka)
Scorpionfish	*Scorpaena spp.*	Scorpios	İskorpit
Sharks and dogfishes	*Squaliformes*	Skyllos	Köpek baliği
Sharksucker	*Remora remora*	Collisópsaro	Vantuz
Sheepshead	*Archosargus probatocephalus*	Mytáki	Sivriburun karagöz
Silver-cheeked toadfish	*Lagocephalus sceleratus*	-	-
Small-spotted catshark	*Scyliorhinus canicula*	Skyláki	Mahmuzlu camgöz
Smooth hammerhead	*Sphyrna zygaena*	Pateritza	Cekiç
Spotted flounder	*Citharus linguatula*	Glossa	Dil
Starry ray	*Raja asterias*	-	-
Streaked weever	*Trachinus radiatus*	Drákena	Çarpan
Striped sea bream	*Lithognathus mormyrus*	Mourmoura	Çizgili mercan
Surmullet	*Mullus surmuletus*	Barbouni	Tekir
Swordfish	*Xiphias gladius*	Xifias	Kiliç
Thresher shark	*Alopias vulpinus*	Alepóu	Sapan
Twaite shad	*Alosa fallax*	Fríssa	Tirsi

Appendix table 3 continued. Cypriot fish taxa list. List of English names, scientific names, Cypriot names and Turkish names used in this report.

English name	Scientific name	Cypriot name	Turkish name
White grouper	*Epinephelus aeneus*	Sphyrida	Lahoz
White seabream	*Diplodus sargus sargus*	Sorgos	Karagöz
Whiting	*Merlangius merlangus*	Prosphygák	Mezgit

Appendix table 4. Cypriot invertebrate taxa list. List of English names, scientific names, Cypriot names and Turkish names used in this report.

English name	Scientific name	Cypriot name	Turkish name
Banded-dye murex	*Hexaplex trunculus*	-	-
Common octopus	*Octopus vulgaris*	Octopus	Ahtapot
Common spiny lobster	*Palinurus vulgaris*	Astakos	Böcek
Cuttlefish	*Sepia officinalis*	Soupia	Mürekkep
Deepwater rose shrimp	*Parapenaeus longirostris*	Garida	Pembe karides
European flying squid	*Todorodes sagittatus*	Kalamari	Kalemerya
European lobster	*Homarus gammarus*	-	İstakoz
Four-horned spider crab	*Pisa tetraodon*	-	-
Great Mediterranean scallop	*Pecten jacobaeus*	-	Tarak
Hermit crab	*Dardanus calidus*	-	-
Mantis shrimp	*Squilla mantis*	-	Böcek yiyen
Mediterranean hermit crab	*Paguristes eremita*	-	-
Mediterranean locust lobster	*Scyllarides latus*	Karavida	-
Mediterranean mussel	*Mytilus galloprovincialis*	-	Kara midye
Pencil sea urchin	*Cidaris cidaris*	-	-
Purple-dye murex	*Bolinus brandaris*	-	-
Shrimps	*Penaeidae*	Garides	Karides
Spider crab	*Maja crispata*	-	-
Spiny lobster	*Palinurus vulgaris*	Astakos	Böcek
Squid	*Loligo vulgaris*	Kalamari	Kalemerya
Swimming crab	*Portunidae*	Karkinos	Çalpara
Turban snail	*Bolma rugosa*	-	Deniz salyangozu

Appendix table 5. Turkish fish catch allocation by sector. Percentage of fish caught by artisanal sector, remaining percentage caught by industrial sector. Source: Percentages estimated from collaborative experience of authors.

Fish species (or group)	Artisanal (%)	Industrial (%)
Albacore tuna (*Thunnus alalunga*)	20	80
Anchovy (*Engraulis encrasicolus*)	-	100
Angelshark (*Squatina squatina*)	10	90
Atlantic bonito (*Sarda sarda*)	15	85
Atlantic horse mackerel (*Trachurus trachurus*)	2	98
Atlantic mackerel (*Scomber scombrus*)	25	75
Bluefin tuna (*Thunnus thynnus*)	10	90
Bluefish (*Pomatomus saltatrix*)	15	85
Blue whiting (*Micromesistius poutassou*)	-	100
Bogue (*Boops boops*)	25	75
Bullet tuna (*Auxis rochei rochei*)	20	80
Chub mackerel (*Scomber japonicus*)	25	75
Common dentex (*Dentex dentex*)	100	-
Dusky grouper (*Epinephelus marginatus*)	100	-
European barracuda (*Sphyraena sphyraena*)	100	-
European conger (*Conger conger*)	20	80
European pilchard (*Sardina pilchardus*)	5	95
European seabass (*Dicentrarchus labrax*)	100	-
European sprat (*Sprattus sprattus*)	-	100
Frigate tuna (*Auxis thazard thazard*)	20	80
Garfish (*Belone belone*)	50	50
Gobies (Gobiidae)	10	90
Greater amberjack (*Seriola dumerili*)	10	90
Hake (*Merluccius merluccius*)	25	75
John dory (*Zeus faber*)	50	50
Leerfish (*Lichia amia*)	100	-
Lizardfish (*Synodus saurus*)	70	30
Meagre (*Argyrosomus regius*)	100	-
Mediterranean horse mackerel (*Trachurus mediterraneus*)	2	98
Mullets (Mugil spp.)	30	70
Painted comber (*Serranus scriba*)	40	60
Picarel (*Spicara smaris*)	35	65
Salema (*Sarpa salpa*)	100	-
Sand smelt (Atherinidae)	-	100
Scorpionfishes (Scorpaeniformes)	10	90
Seabreams (Diplodus spp.)	75	25
Sharks (Selachiimorpha)	10	90
Shi drum (*Umbrina cirrosa*)	100	-
Shore rockling (*Gaidropsarus mediterraneus*)	100	-
Sole (*Solea solea*)	20	80
Swordfish (*Xiphias gladius*)	50	50
Thornback ray (*Raja clavata*)	25	75
Twaite shad (*Alosa fallax*)	78	22
Turbot (*Scopthalmus maximus*)	72	28
Whiting (*Merlangius merlangus*)	15	85

Appendix table 6. Turkish Invertebrate catch allocation by sector.
Percentage of invertebrates caught by artisanal sector, and large-sector.

Invertebrate species (or group)	Artisanal (%)	Large scale (%)
Comb jellies (Ctenophora)	-	100
Common octopus (*Octopus vulgaris*)	50	50
Common squid (*Loligo vulgaris*)	50	50
Crabs (Brachyura)	50	50
European flat oyster (*Ostrea edulis*)	100	-
European lobster (*Homarus gammarus*)	90	10
Great Mediterranean scallop (*Pecten jacobaeus*)	100	-
Mediterranean mussel (*Mytilus galloprovincialis*)	100	-
Rapa whelk (*Rapana venosa*)	100	-
Sepia (*Sepia officinalis*)	50	50
Shrimps (Penaeidae)	45	55
Spiny lobsters (Palinuridae)	90	10
Striped Venus clam (*Chamelea gallina*)	10	90

Appendix table 7. Time series of reported marine fisheries catches (t) for Turkey by sub-sector (reported FAO and national data where used), and the estimated unreported, recreational, subsistence, discarded and total reconstructed amounts.

Year	FAO	National	Unreported	Discard	Recreational	Subsistence	Total
1950	77,000	-	30,800	20,467	2,838	25,544	156,649
1951	86,000	-	34,400	22,859	3,194	25,025	171,479
1952	86,600	-	34,640	23,019	3,546	24,509	172,314
1953	67,100	-	26,840	17,835	3,894	24,000	139,669
1954	100,100	-	40,040	26,607	4,263	23,636	194,646
1955	83,000	-	33,200	22,062	4,418	22,197	164,877
1956	108,100	-	43,240	28,733	4,876	22,333	207,283
1957	89,400	-	35,760	23,763	5,312	22,298	176,533
1958	79,401	-	31,760	21,105	5,759	22,252	160,278
1959	87,402	-	34,961	23,232	6,212	22,180	173,987
1960	80,503	-	32,201	21,398	6,675	22,096	162,873
1961	74,602	-	29,841	19,829	7,178	22,095	153,544
1962	51,402	-	20,561	13,663	7,688	22,063	115,376
1963	122,602	-	49,041	32,588	8,209	22,015	234,455
1964	113,302	-	45,321	30,116	8,737	21,942	219,418
1965	127,502	-	51,001	33,890	9,276	21,852	243,521
1966	107,938	-	43,175	28,690	9,829	21,756	211,388
1967	-	204,069	81,628	47,922	10,391	21,640	365,649
1968	-	126,493	50,597	45,380	10,960	21,505	254,934
1969	-	158,679	63,472	40,624	11,536	21,348	295,658
1970	-	167,030	66,812	39,452	12,119	21,175	306,589
1971	-	146,207	58,483	41,701	12,810	21,151	280,353
1972	-	157,491	62,996	34,416	13,516	21,105	289,524
1973	-	130,367	52,147	18,698	14,226	21,022	236,460
1974	-	113,722	45,489	19,839	14,951	20,920	214,922
1975	-	102,024	40,810	17,776	15,681	20,787	197,078
1976	-	133,882	53,553	20,975	16,761	21,058	246,229
1977	-	146,270	58,508	27,405	17,865	21,278	271,326
1978	-	222,302	88,921	51,385	18,994	21,453	403,055
1979	-	328,342	131,337	81,615	20,146	21,582	583,022
1980	-	394,432	157,773	49,687	20,325	20,653	642,870
1981	-	438,284	175,314	62,773	21,345	20,573	718,289
1982	-	469,931	187,972	68,557	22,342	20,426	769,228
1983	-	518,561	207,424	98,667	23,355	20,250	868,258
1984	-	518,546	207,419	81,589	24,372	20,038	851,964
1985	-	531,095	212,438	93,243	25,388	19,787	881,952
1986	-	536,797	214,719	84,925	26,622	19,661	882,724
1987	-	580,453	232,181	94,068	27,867	19,493	954,063
1988	-	620,063	248,025	100,869	29,114	19,281	1,017,352
1989	-	409,316	163,726	90,441	30,366	19,026	712,875
1990	-	340,316	136,126	69,050	31,614	18,727	595,833
1991	-	312,845	125,138	66,143	33,071	18,506	555,702
1992	-	402,176	160,870	64,712	34,524	18,233	680,515
1993	-	496,555	198,622	68,710	35,955	17,902	817,745
1994	-	539,609	215,844	77,717	37,425	17,547	888,142
1995	-	582,150	232,860	69,276	38,876	17,141	940,303
1996	-	470,880	188,352	43,652	43,089	17,840	763,813
1997	-	400,672	160,269	35,215	39,831	15,459	651,445
1998	-	430,223	172,089	40,260	40,956	14,873	698,401
1999	-	520,499	208,200	42,707	41,470	14,060	826,935
2000	-	455,709	182,284	43,111	43,260	13,661	738,025
2001	-	479,649	191,860	41,746	44,329	13,003	770,586

Appendix table 7 continued. Time series of reported marine fisheries catches (t) for Turkey by sub-sector.

Year	FAO	National	Unreported	Discard	Recreational	Subsistence	Total
2002	-	520,267	208,107	39,908	45,396	12,330	826,009
2003	-	458,079	183,232	37,063	46,445	11,640	736,458
2004	-	502,544	201,018	39,818	47,484	10,936	801,799
2005	-	378,759	151,504	36,370	48,512	10,219	625,365
2006	-	486,403	194,561	38,819	49,538	9,492	778,813
2007	-	588,548	235,419	44,944	50,544	8,752	928,207
2008	-	452,383	180,953	43,639	51,379	7,977	736,332
2009	-	424,606	169,842	41,424	52,831	7,286	695,990
2010	-	445,617	178,247	41,329	54,360	6,719	726,272

Appendix table 8. Total reconstructed catch (t) by major taxa for Turkey, 1950-2010. 'Others' grouping includes 66 taxa.

Year	Anchovy	Horse mackerel	Bonito	Whiting	Bluefish	Sprat	Others
1950	38,704	20,718	24,137	5,203	7,961	-	59,925
1951	43,228	22,309	26,484	5,765	8,323	-	65,371
1952	43,530	22,303	26,584	5,794	8,283	-	65,820
1953	33,728	18,475	21,304	4,551	7,284	-	54,326
1954	50,316	24,636	30,079	6,633	8,798	-	74,184
1955	41,720	21,212	25,420	5,542	7,910	-	63,073
1956	54,337	26,047	32,177	7,134	9,169	-	78,419
1957	44,937	22,547	27,206	5,953	8,331	-	67,559
1958	39,911	20,700	24,563	5,322	7,907	-	61,873
1959	43,933	22,275	26,737	5,831	8,343	-	66,868
1960	40,465	21,014	24,921	5,397	8,064	-	63,011
1961	37,499	19,969	23,388	5,027	7,853	-	59,808
1962	25,837	15,631	17,223	3,561	6,814	-	46,309
1963	61,626	29,246	36,322	8,074	10,285	-	88,902
1964	56,952	27,547	33,875	7,488	9,906	-	83,651
1965	64,089	30,315	37,715	8,390	10,649	-	92,362
1966	54,255	26,661	32,516	7,155	9,779	-	81,021
1967	82,705	49,106	53,616	5,820	13,630	-	160,772
1968	50,137	33,425	34,640	9,249	11,338	-	116,145
1969	62,213	35,377	76,319	9,399	11,218	-	101,133
1970	103,745	42,574	28,931	17,561	14,651	-	99,128
1971	102,117	26,081	38,758	11,066	11,340	-	90,992
1972	133,045	37,234	21,375	10,137	10,755	-	76,979
1973	126,099	41,283	9,074	4,722	5,671	-	49,611
1974	109,842	29,396	11,443	5,621	6,550	-	52,070
1975	85,988	30,544	8,509	7,617	9,521	-	54,898
1976	112,802	40,622	8,465	8,312	18,356	-	57,672
1977	115,216	43,450	10,571	11,501	20,462	-	70,126
1978	168,110	75,793	12,133	40,167	12,145	-	94,707
1979	202,764	142,814	17,465	39,484	28,081	-	152,413
1980	365,212	104,702	26,023	13,507	20,984	-	112,443
1981	395,879	105,928	39,807	9,541	32,927	-	134,207
1982	399,258	119,463	42,228	8,757	53,144	-	146,379
1983	435,539	127,300	47,355	23,482	51,355	-	183,227
1984	479,902	164,288	16,007	23,017	23,716	-	145,034
1985	412,635	201,358	23,780	32,148	18,807	-	193,225
1986	417,752	197,441	21,540	35,623	24,591	-	185,776
1987	449,932	186,643	30,112	51,539	22,736	-	213,101
1988	450,396	189,110	31,410	53,599	24,312	-	268,526
1989	142,999	194,092	12,451	36,806	23,394	-	303,133
1990	107,351	150,299	26,521	31,562	21,210	-	258,891
1991	131,424	64,394	33,815	36,214	25,567	-	264,289
1992	253,208	57,534	18,264	35,779	22,004	18	293,707
1993	329,339	66,232	33,721	34,827	32,136	170	321,320
1994	426,906	61,698	20,140	29,921	20,048	7,280	322,149
1995	561,982	41,108	18,123	33,310	16,341	16,328	253,110
1996	421,486	44,149	20,216	38,618	14,741	1,466	223,136
1997	349,450	34,042	16,505	24,505	12,725	758	213,461
1998	330,600	34,195	40,388	22,822	13,237	1,916	255,244
1999	507,500	31,494	31,661	24,208	12,653	656	218,764
2000	406,000	46,258	23,214	29,297	14,697	9,672	208,887
2001	464,000	52,289	25,249	15,402	27,504	227	185,916
2002	540,850	51,341	14,935	16,475	44,920	3,178	154,310
2003	427,750	53,396	14,482	15,014	40,680	9,373	175,763
2004	493,000	52,580	14,042	15,382	37,581	8,477	180,738

Appendix table 8 continued. Total reconstructed catch (t) by major taxa for Turkey, 1950-2010.
'Others' grouping includes 66 taxa.

Year	Anchovy	Horse mackerel	Bonito	Whiting	Bluefish	Sprat	Others
2005	200,925	54,796	108,418	15,286	35,386	8,596	201,958
2006	391,500	51,245	49,091	16,915	20,904	11,332	237,826
2007	558,250	60,997	14,446	23,788	18,627	18,478	233,622
2008	364,929	61,963	15,168	22,717	14,516	61,015	196,023
2009	296,814	55,356	15,845	20,332	17,426	83,196	207,021
2010	332,083	43,599	19,353	25,014	15,649	88,842	201,732

Appendix table 9. United Cyprus: total reconstructed catch (t) by sector, 1950-2010.

Year	Reported FAO	Industrial	Artisanal	Subsistence	Recreational	Discards	Total Reconstructed
1950	500	480	520	30	1	122	1,153
1951	400	384	416	25	1	97	924
1952	400	384	416	25	1	97	924
1953	405	384	417	25	1	98	926
1954	508	481	521	30	1	123	1,156
1955	605	576	625	35	1	145	1,382
1956	505	480	521	30	2	122	1,154
1957	505	480	521	30	2	156	1,188
1958	603	576	624	35	2	145	1,382
1959	503	480	520	30	2	122	1,154
1960	503	480	520	30	2	120	1,152
1961	403	384	416	25	2	100	927
1962	603	573	628	35	2	146	1,383
1963	605	569	632	35	2	146	1,383
1964	610	566	636	35	2	146	1,385
1965	1,019	941	1,073	55	2	247	2,319
1966	1,014	834	1,081	55	2	248	2,324
1967	1,022	937	1,092	55	2	249	2,336
1968	1,425	1,296	1,530	75	2	348	3,251
1969	1,419	1,285	1,535	75	2	347	3,243
1970	1,376	1,235	1,494	72	2	336	3,139
1971	1,268	1,129	1,383	67	2	309	2,890
1972	1,348	1,197	1,484	71	2	330	3,085
1973	1,467	1,295	1,625	77	2	359	3,358
1974	1,190	1,270	1,477	89	16	293	3,145
1975	927	984	1,272	100	31	245	2,633
1976	1,055	1,118	1,422	130	46	275	2,992
1977	1,197	1,269	1,585	161	62	308	3,385
1978	1,260	1,314	1,670	187	78	322	3,570
1979	1,298	1,347	1,718	211	95	330	3,702
1980	1,321	1,331	1,710	234	112	327	3,715
1981	1,439	1,406	1,808	262	130	345	3,951
1982	1,563	1,477	1,904	289	148	363	4,182
1983	1,956	1,792	2,227	329	167	427	4,942
1984	2,216	1,972	2,408	362	187	463	5,391
1985	2,392	2,069	2,499	390	206	482	5,646
1986	2,657	2,119	2,733	421	227	510	6,010
1987	2,553	2,046	2,524	435	248	481	5,733
1988	2,508	1,938	2,418	450	269	459	5,534
1989	2,545	1,893	2,378	469	291	450	5,482
1990	2,587	1,853	2,334	488	314	440	5,428
1991	2,604	1,791	2,289	494	327	430	5,331
1992	2,679	1,769	2,284	508	345	427	5,333
1993	2,696	8,305	2,236	514	359	1,075	12,489
1994	2,765	8,271	2,216	526	377	1,070	12,459
1995	2,508	8,049	1,988	497	372	1,025	11,931
1996	2,550	8,065	2,018	506	388	1,267	12,244
1997	2,312	7,923	1,867	479	383	1,185	11,837
1998	2,420	1,375	1,933	495	405	351	4,560
1999	2,244	1,267	1,818	476	405	328	4,294
2000	2,235	1,254	1,808	478	418	325	4,284
2001	2,245	1,251	1,775	482	434	330	4,272
2002	1,908	2,057	1,501	444	420	281	4,703
2003	1,740	958	1,337	426	420	369	3,511
2004	1,528	837	1,139	404	417	502	3,299
2005	1,889	1,027	1,456	447	462	868	4,262
2006	2,138	1,156	1,557	477	498	1,190	4,879
2007	2,431	1,306	1,764	512	539	1,635	5,757
2008	1,991	1,065	1,493	463	516	1,619	5,157
2009	1,390	736	1,098	397	478	1,187	3,896
2010	1,403	740	1,113	400	495	1,199	3,946

Appendix table 10. United Cyprus: total reconstructed catch (t) my major taxa or family, 1950-2010, the 'Others' grouping contains 56 taxa.

Year	Centracanthidae	Sparidae	Mullidae	Cephalopoda	*L. sceleratus*	*Thunnus alalunga*	Others
1950	116	375	139	26	-	-	497
1951	93	301	111	21	-	-	398
1952	93	301	111	21	-	-	398
1953	207	180	253	5	-	-	281
1954	208	356	106	7	-	-	479
1955	210	357	306	8	-	-	501
1956	208	269	280	7	-	-	390
1957	208	269	280	15	-	-	416
1958	210	357	306	7	-	-	502
1959	208	269	280	6	-	-	391
1960	208	269	280	6	-	-	389
1961	207	180	253	5	-	-	282
1962	210	357	306	7	-	-	503
1963	410	95	427	207	-	-	244
1964	410	9	601	207	-	-	158
1965	17	13	1,801	212	-	-	276
1966	417	510	427	212	-	-	758
1967	617	510	228	212	-	-	769
1968	824	924	228	217	-	-	1,058
1969	624	924	428	217	-	-	1,050
1970	563	770	435	148	-	-	1,223
1971	489	830	373	125	-	-	1,073
1972	830	641	427	140	-	-	1,047
1973	770	915	429	121	-	-	1,123
1974	780	656	380	121	-	-	1,208
1975	532	487	427	122	-	-	1,065
1976	634	537	400	126	-	-	1,295
1977	626	595	421	144	-	-	1,599
1978	698	647	448	167	-	-	1,610
1979	766	708	397	153	-	-	1,678
1980	726	736	362	144	-	-	1,747
1981	785	778	485	181	-	-	1,722
1982	829	817	524	171	-	-	1,841
1983	1,183	947	580	206	-	-	2,026
1984	996	1,059	694	208	-	-	2,434
1985	1,276	1,262	591	178	-	-	2,339
1986	1,081	1,048	676	190	-	-	3,015
1987	1,535	1,184	459	188	-	-	2,367
1988	1,258	968	632	187	-	-	2,489
1989	1,043	930	592	157	-	-	2,760
1990	1,150	872	655	193	-	-	2,558
1991	1,443	779	491	185	-	-	2,433
1992	1,026	829	565	176	-	-	2,737
1993	930	2,076	527	1,253	-	-	7,703
1994	642	2,032	528	1,299	-	-	7,958
1995	854	2,006	503	1,209	-	-	7,359
1996	917	2,036	555	1,158	-	-	7,578
1997	780	1,970	552	1,131	-	-	7,404
1998	851	694	450	214	-	-	2,351
1999	655	805	492	201	-	-	2,141
2000	640	892	409	178	-	7	2,158
2001	806	658	349	154	-	-	2,305
2002	583	1,076	318	148	-	30	2,548
2003	696	468	309	119	117	59	1,743
2004	376	415	212	100	284	350	1,562
2005	300	524	242	69	595	572	1,959
2006	310	563	247	92	898	686	2,083
2007	337	588	294	82	1,306	955	2,194
2008	293	710	248	69	1,340	370	2,126
2009	253	567	158	57	980	351	1,531
2010	220	575	189	59	990	371	1,543

Appendix table 11. North Cyprus: total reconstructed catch (t) by sector, 1950-2010.

Year	Reported	Industrial	Artisanal	Recreational	Subsistence	Discards	Total reconstructed
1950	200	120	280	1	12	60	473
1951	160	96	224	1	10	48	378
1952	160	96	224	1	10	48	378
1953	160	96	224	1	10	48	379
1954	200	120	280	1	12	60	473
1955	240	144	336	1	14	72	567
1956	200	120	280	1	12	60	473
1957	200	120	280	1	12	93	506
1958	240	144	336	1	14	72	567
1959	200	120	280	1	12	60	473
1960	200	120	280	1	12	60	473
1961	160	96	224	1	10	48	379
1962	240	143	337	1	14	72	567
1963	240	142	338	1	14	72	567
1964	240	141	339	1	14	72	567
1965	403	234	572	1	22	121	949
1966	404	130	573	1	22	121	951
1967	406	234	578	1	22	122	956
1968	565	324	806	1	30	170	1,331
1969	564	321	807	1	30	169	1,328
1970	546	309	783	1	29	164	1,285
1971	503	282	723	1	27	151	1,183
1972	536	299	773	1	28	161	1,263
1973	584	324	844	1	31	175	1,375
1974	-	-0	366	7	12	55	440
1975	-	-	402	13	23	60	498
1976	-	-	431	19	33	65	548
1977	-	-	452	26	43	68	589
1978	-	-	464	33	52	70	620
1979	-	-	469	40	62	70	641
1980	-	-	466	47	71	70	654
1981	-	-	481	55	80	72	688
1982	-	-	491	63	89	74	716
1983	-	-	497	71	97	75	740
1984	-	-	500	79	106	75	759
1985	-	-	498	87	114	75	774
1986	-	-	493	96	122	74	785
1987	-	-	483	105	130	73	790
1988	-	-	470	114	137	70	791
1989	-	-	453	123	144	68	788
1990	-	-	431	132	151	65	779
1991	-	-	433	142	158	65	798
1992	-	-	433	152	165	65	815
1993	-	6,600	432	162	171	725	8,090
1994	-	6,600	429	173	177	724	8,103
1995	-	6,600	424	183	183	724	8,114
1996	-	6,600	418	194	189	723	8,124
1997	-	6,600	410	205	194	722	8,131
1998	-	-	401	216	200	60	877
1999	-	-	390	228	205	58	881
2000	-	-	378	239	210	57	883
2001	-	-	325	251	214	60	850
2002	-	1,000	268	264	219	52	1,802
2003	-	-	207	276	223	56	761
2004	-	-	142	289	227	62	719
2005	-	-	218	301	230	121	872
2006	-	-	150	314	234	114	812
2007	-	-	157	328	237	150	871
2008	-	-	168	341	240	186	935
2009	-	-	172	355	243	190	959
2010	-	-	172	369	246	191	978

Appendix table 12. North Cyprus: total reconstructed catch (t) my major taxa or family, 1950-2010. The 'Others' grouping includes 41 taxa or families.

Year	*Spicara smaris*	Sparidae	Mullidae	Epinephelus	*Sepia officinalis*	*Lagocephalus sceleratus*	Others
1950	116	115	1	42	22	-	177
1951	93	92	1	33	18	-	141
1952	93	92	1	33	18	-	141
1953	86	76	1	27	2	-	187
1954	88	150	1	54	2	-	178
1955	90	151	1	54	3	-	268
1956	88	114	1	41	2	-	227
1957	88	114	1	41	7	-	255
1958	90	151	1	54	2	-	269
1959	88	114	1	41	2	-	227
1960	88	114	1	41	2	-	227
1961	86	76	1	27	2	-	187
1962	90	151	1	54	2	-	269
1963	170	42	1	14	82	-	258
1964	170	6	1	1	82	-	307
1965	16	10	1	1	84	-	837
1966	176	210	81	14	84	-	386
1967	256	210	81	14	84	-	311
1968	343	377	161	14	86	-	350
1969	263	377	161	14	86	-	427
1970	238	304	205	13	58	-	467
1971	207	325	168	17	49	-	417
1972	345	268	35	59	55	-	501
1973	322	396	42	55	47	-	513
1974	7	87	60	55	16	-	215
1975	8	98	72	64	18	-	238
1976	9	107	84	72	19	-	257
1977	9	114	94	78	20	-	274
1978	9	119	103	84	21	-	284
1979	9	123	112	88	21	-	288
1980	9	124	119	91	21	-	290
1981	10	130	128	97	22	-	301
1982	10	135	137	102	22	-	310
1983	10	138	145	107	22	-	318
1984	10	141	153	111	22	-	322
1985	10	143	160	114	22	-	325
1986	10	144	167	117	22	-	325
1987	10	144	173	119	22	-	322
1988	9	144	179	121	21	-	317
1989	9	142	184	122	20	-	311
1990	9	139	188	123	19	-	301
1991	9	142	196	127	20	-	304
1992	9	144	203	130	20	-	309
1993	1,857	1,466	210	134	283	-	4,140
1994	1,857	1,468	217	137	283	-	4,141
1995	1,857	1,469	224	140	283	-	4,141
1996	1,856	1,470	231	143	283	-	4,141
1997	1,856	1,471	237	145	283	-	4,139
1998	8	151	243	148	18	-	309
1999	8	151	249	150	17	-	306
2000	8	150	255	152	17	-	301
2001	7	141	255	148	15	-	284
2002	5	130	254	144	12	-	1,257
2003	4	119	253	139	9	13	224
2004	3	107	252	133	6	28	190
2005	4	126	270	148	10	75	239
2006	3	113	268	142	7	78	201
2007	3	117	276	146	7	112	210
2008	3	122	285	151	8	146	220
2009	3	125	293	156	8	149	225
2010	4	128	301	160	8	150	227

Appendix table 13. South Cyprus: Total reconstructed catch (t) by sector, 1950-2010.

Year	Reported FAO	Industrial	Artisanal	Subsistence	Recreational	Discards	Total Reconstructed
1950	300	360	240	18	1	62	680
1951	240	288	192	15	1	49	545
1952	240	288	192	15	1	49	545
1953	240	288	192	15	1	51	547
1954	300	361	240	18	1	63	683
1955	360	432	288	21	1	73	815
1956	300	360	240	18	1	62	681
1957	300	360	240	18	1	63	682
1958	360	432	288	21	1	73	815
1959	300	360	240	18	1	62	681
1960	300	360	240	18	1	60	680
1961	240	288	192	15	1	52	548
1962	360	429	291	21	1	74	816
1963	360	427	294	21	1	74	816
1964	361	424	297	21	1	74	817
1965	604	707	502	33	1	127	1,370
1966	606	704	508	33	1	127	1,373
1967	609	703	515	33	1	128	1,380
1968	848	972	724	45	1	178	1,920
1969	846	964	728	45	1	178	1,916
1970	819	926	711	43	1	172	1,854
1971	754	847	660	40	1	158	1,707
1972	804	898	711	43	1	169	1,822
1973	876	971	781	46	1	184	1,983
1974	1,190	1,270	1,111	76	10	238	2,705
1975	927	984	870	77	18	185	2,135
1976	1,054	1,118	991	98	27	211	2,444
1977	1,201	1,269	1,133	119	36	240	2,796
1978	1,260	1,314	1,205	135	45	252	2,951
1979	1,298	1,347	1,249	150	55	260	3,060
1980	1,321	1,331	1,244	163	65	258	3,061
1981	1,439	1,406	1,327	182	75	273	3,263
1982	1,563	1,477	1,413	200	86	289	3,466
1983	1,956	1,792	1,730	231	97	352	4,202
1984	2,217	1,972	1,909	256	108	388	4,632
1985	2,394	2,069	2,001	276	119	407	4,872
1986	2,642	2,119	2,240	299	131	436	5,225
1987	2,554	2,046	2,041	305	143	409	4,943
1988	2,507	1,938	1,948	313	156	389	4,743
1989	2,546	1,893	1,926	325	168	382	4,694
1990	2,590	1,853	1,902	337	181	376	4,649
1991	2,605	1,791	1,856	336	185	365	4,533
1992	2,681	1,769	1,851	343	193	362	4,518
1993	2,699	1,705	1,804	343	197	351	4,400
1994	2,766	1,671	1,787	349	205	346	4,357
1995	2,511	1,449	1,564	314	188	301	3,817
1996	2,554	1,465	1,600	317	194	545	4,120
1997	2,316	1,323	1,456	285	178	463	3,706
1998	2,423	1,375	1,532	296	189	291	3,683
1999	2,245	1,267	1,428	272	177	269	3,413
2000	2,237	1,254	1,431	268	179	268	3,401
2001	2,251	1,251	1,450	268	182	270	3,422
2002	1,909	1,057	1,233	225	157	229	2,901
2003	1,741	958	1,130	204	145	313	2,750
2004	1,529	837	998	177	128	440	2,581
2005	1,888	1,027	1,238	217	161	747	3,391
2006	2,136	1,156	1,407	243	184	1,076	4,067
2007	2,428	1,306	1,608	274	211	1,485	4,886
2008	1,992	1,065	1,325	223	175	1,434	4,223
2009	1,386	736	926	154	123	997	2,937
2010	1,401	740	941	154	126	1,008	2,970

Appendix table 14. South Cyprus: total reconstructed catch (t) my major taxa or family, 1950-2010. The 'Others' grouping includes 51 taxa or families.

Year	*Centracanthidae*	Sparidae	Mullidae	Epinephelus	*Cephalopoda*	*Lagocephalus sceleratus*	Others
1950	21	308	81	1	55	-	214
1951	17	246	65	1	44	-	172
1952	17	246	65	1	44	-	172
1953	140	125	156	1	24	-	101
1954	144	247	65	1	46	-	180
1955	148	248	188	1	47	-	183
1956	144	187	172	1	36	-	141
1957	144	187	172	1	36	-	142
1958	148	248	188	1	46	-	184
1959	144	187	172	1	35	-	142
1960	144	187	172	1	35	-	141
1961	140	125	156	1	24	-	102
1962	148	248	188	1	46	-	185
1963	271	67	262	1	139	-	76
1964	271	7	369	1	129	-	40
1965	42	11	1,108	1	133	-	75
1966	288	317	263	123	143	-	239
1967	411	317	140	123	143	-	246
1968	551	568	140	246	147	-	268
1969	427	568	263	246	147	-	265
1970	389	457	268	314	178	-	248
1971	340	491	229	258	154	-	235
1972	553	414	262	52	177	-	364
1973	535	612	263	63	153	-	357
1974	884	619	298	79	185	-	640
1975	599	402	336	43	180	-	575
1976	711	443	302	56	197	-	735
1977	712	486	318	63	243	-	974
1978	789	505	343	53	263	-	998
1979	861	597	290	109	252	-	951
1980	819	620	255	122	224	-	1,021
1981	885	642	377	96	259	-	1,004
1982	935	608	415	84	262	-	1,162
1983	1,318	746	472	83	518	-	1,065
1984	1,137	858	589	86	454	-	1,508
1985	1,431	1,080	484	142	317	-	1,418
1986	1,240	815	574	248	267	-	2,081
1987	1,701	921	352	75	330	-	1,564
1988	1,411	720	535	134	343	-	1,600
1989	1,188	676	498	191	434	-	1,707
1990	1,299	632	569	78	477	-	1,594
1991	1,600	567	400	93	400	-	1,473
1992	1,169	583	477	94	506	-	1,689
1993	1,067	647	405	84	624	-	1,573
1994	899	637	407	111	900	-	1,403
1995	1,108	564	382	76	566	-	1,121
1996	1,245	569	441	73	376	-	1,416
1997	1,079	479	439	69	366	-	1,274
1998	1,103	449	367	80	473	-	1,211
1999	761	529	414	69	399	-	1,241
2000	744	625	330	74	360	-	1,268
2001	915	420	282	71	355	-	1,379
2002	672	349	264	64	278	-	1,274
2003	784	255	270	50	223	120	1,048
2004	443	236	186	39	198	324	1,155
2005	376	326	197	56	268	716	1,452
2006	440	375	221	62	288	1,220	1,461
2007	482	375	268	55	318	1,911	1,477
2008	430	491	217	46	223	1,912	904
2009	338	360	122	35	115	1,330	637
2010	306	365	153	35	111	1,344	656