

Unifying the catch data of a divided island: Cyprus's marine fisheries catches, 1950–2010

Aylin Ulman · Burak Ali Çiçek · Ilkay Salihoglu ·
Antonis Petrou · Maria Patsalidou · Daniel Pauly ·
Dirk Zeller

Received: 5 April 2014 / Accepted: 18 August 2014 / Published online: 26 August 2014
© Springer Science+Business Media Dordrecht 2014

Abstract 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.

A. Ulman (✉) · D. Pauly · D. Zeller
Sea Around Us, Fisheries Centre, University of British Columbia, 2202 Main Mall, Vancouver,
BC V6T 1Z4, Canada
e-mail: a.ulman@fisheries.ubc.ca

B. A. Çiçek
Eastern Mediterranean University, TRNC, via Mersin 10, Famagusta, Turkey

I. Salihoglu
The University of Kyrenia, TRNC, via Mersin 10, Kyrenia, Turkey

A. Petrou · M. Patsalidou
AP Marine Environmental Consultancy Ltd, Nicosia, Cyprus

Keywords Catch reconstruction · Discards · IUU · Mediterranean Sea · Unreported catches · Sustainable development

1 Introduction

Cyprus is the third largest Mediterranean island after Sicily and Sardinia, and lies approximately 75 km south of Turkey and about 1,450 km south-east of the Greek mainland in the eastern Mediterranean. Cyprus lies on many geopolitical intersections, between Greece and Turkey, Christianity and Islam, East and West, Europe and Asia, and now inside and outside the EU (Papadakis et al. 2006).

To assess an area's total catches, fisheries removals from each sector must be 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 2012, 2010; Garibaldi 2012). Yet for most countries, the catches from non-commercial sectors are omitted from the data, causing the global statistics to underestimate total catches. Hence, here for Cyprus, we have estimated the 'total reconstructed catch' for the entire island from 1950 to 2010, also included in the *Sea Around Us* global database of marine catches (freely available at www.seaaroundus.org). 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' (Fig. 1). United Cyprus represents the period from 1950 to 1973 when the island was unified, after which each side's catches were estimated, as they were then separate.

1.1 Recent history of Cyprus

On August 16, 1960, Cyprus gained independence as 'The Republic of Cyprus'. In 1963, conflict arose on the island between the Turkish and Greek populations, and the UN negotiated with a cease-fire line, first outlined in green crayon on a map, now referred to as the 'Green Line'. The 'Green Line' is the dividing line that runs east–west across the island, including through its capital, Nicosia (Fig. 1).

In 1974, the president of Cyprus was overthrown in a coup d'état. Turkish troops were sent to the island to protect the Turkish Cypriot population after which the Turkish population was re-located to the northern portion of the island, and the Greek population was re-located to the southern portion (Kacowicz and Lutomski 2008). In 1983, the north unilaterally declared itself the 'Turkish Republic of Northern Cyprus (TRNC)', recognized as a distinct state only by Turkey. In April 2004, the entire island was admitted into the EU, but only the south is protected by EU legislation until the current political situation is resolved.

1.2 History of fishing

1.2.1 United Cyprus

From 1950 to 1973, the island was unified and both artisanal and industrial commercial catches were reported. In 1950, the Cypriot fishing fleet contained 320 non-motorized sailboats, 19 motorized sailboats and 10 trawlers, which together directly employed 960

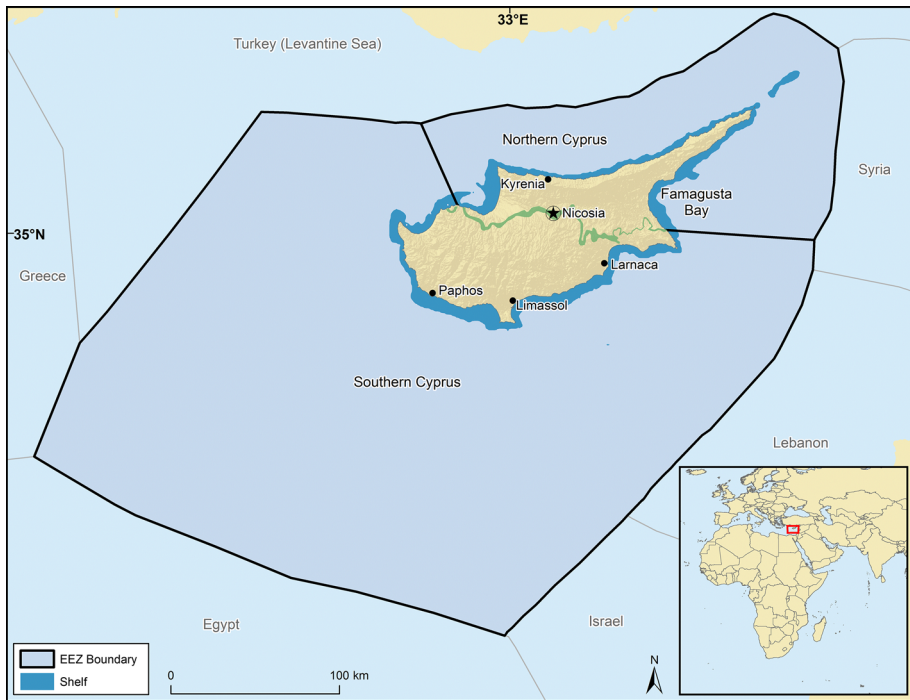


Fig. 1 The island of Cyprus, showing the ‘Green Line’ which divides the north and the south, the capital city (Nicosia), fishing ports in the biggest cities/towns, and the Exclusive Economic Zones (EEZ) in the north and south, as theoretically assumed by the *Sea Around Us* based on a basic, non-binding interpretation of fundamental UNCLOS principles

fishers and crew with a total reported fish catch of 460 t year^{-1} (Anon 1951). Only coastal demersal species were targeted which were caught by use of spear, trammel nets, hand-lines, longlines, wire baskets, bottom gillnets and sometimes by destructive dynamite fishing (Fodera 1961). The fished area in this period extended approximately two miles from the coast (Anon 1960). The fishing sector was under-developed at the time due to a lack of natural ports, shelters for vessels, and an incomplete road network, thus limiting transport (Fodera 1961).

1.2.2 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 increased to reach approximately 410 fishers in 2012.

Bottom trawling was only practiced in the north from 1993 to 1997 and was prohibited in 1998 due to the observed direct damage that trawling inflicted on the environment and its resources (Çiçek 2011). Trawling had actually ceased completely 1 year earlier, in 1997, due to a government enactment of a 3-mile trawl limit from the coast.

1.2.3 South

The Department of Fisheries and Marine Research (DFMR) provided assistance to the fisheries sector of the south in 1974 with subsidies and new vessels to help improve food security since their effective fishing area was reduced by about 40 % from 1,300 to 800 km² (García and Demetropoulos 1984). By the late 1980s, Cyprus's reported fisheries catches (representing data from the south) exceeded their catches prior to the division (Solsten 1993). 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 (small-scale), multi-purpose, large pelagic, and bottom trawl, the last three of which are considered industrial or large-scale, due to vessel lengths >12 m. Since the early 2000s, there has been an increase of albacore tuna (*Thunnus alalunga*) in Cypriot waters for which sport-fishing operators have recently been trying to create a new market. See Table 1 for a comparison of fishers and vessels for the north and south in 2010.

Since the 2000s, the most urgent issue affecting the fisheries of Cyprus is the population explosion of invasive silver-cheeked toadfish (*Lagocephalus sceleratus*), a pufferfish species that migrated into the eastern Mediterranean through the Suez Canal. This species has no natural predators in the Mediterranean, can grow up to 1 m in length, weigh up to 7 kg, and is highly toxic (DFMR 2011). Their population explosion in recent years has aggravated fishers for several reasons, notably, much of the prey examined in *L. sceleratus*'s stomach were already entangled in nets, indicating that *L. sceleratus* seeks out entangled fish as prey (DFMR 2011); they often tear nets by biting through them with their fused teeth, and also swallow countless baited longline hooks, costing fishers time and money (EastMed 2010). In 2010, the government of the north paid fishers a bounty of US \$1.11 (2 Turkish Lira) for each caught pufferfish, and thus rewarded US \$20,243 over a 6-year period, accounting for over 18,000 caught pufferfish specimens (Department of Animal Husbandry, unpubl. data). The government of the south, based on EU subsidies, also placed a bounty for this species during its spawning season, paying €1 per fish, or €3 per kilo¹ in summer 2012.

An extensive description of Cyprus's catch reconstruction can be found in the detailed technical report by Ulman et al. (2013b), freely available at <http://fisheries.ubc.ca/node/4660>, which presents a more detailed history of the island, the fisheries, the methodology, and also a list of all taxa used in the database, including their English, Greek, Turkish and scientific names.

To reconstruct total marine fisheries extractions from the entire island of Cyprus from 1950 to 2010, the data reported on behalf of Cyprus to the FAO were used as our baseline, to which non-commercial (previously unreported) sectors have been estimated to determine the island's total catch. 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 (Ulman et al. 2013a; Cisneros-Montemayor et al. 2013; Schiller et al. 2014; Belhabib 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.

¹ <http://www.cyprus-mail.com/cyprus/cyprus-declares-war-pufferfish/20120314>.

Table 1 Fishing fleet and recreational sector comparison between north and south, 2010

Sector	North	South
Industrial vessels	–	4 trawlers, 25 multi-purpose vessels
Artisanal vessels	410	1,134
Rec. vessels	1,425	2,000
Anglers	2,000	data unavailable
Spearfishers	346	2,200

2 Materials and methods

The following steps were taken 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.

2.1 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 some discards and additional commercial catches are omitted from the data provided to the FAO, as are 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 to future management decision. Hence, the catches reported to FAO from 1950 to 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 to 2005. Thus, the reported catches were allocated as 60 % industrial from 1950 to 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. One purse seiner was recently licensed to fish in the south in the summer of 2013 but was unable to find small pelagics at the depths it was restricted to (first >50 m, and later to >40 m), so the vessel is currently operating instead as a longliner targeting albacore tuna.

2.2 Unreported catches

2.2.1 *United Cyprus*

2.2.1.1 *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 and 576 t 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 under-reported ratio in our study, catches were doubled for the north from 1950 to 1973, and for the south from 1950 to 1979. The under-reported estimate for the south from 1980 to 2010 is explained below.

2.2.2 *North*

2.2.2.1 *Industrial* After the division of the island, separate unreported components were estimated for the north from 1974 to 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 year⁻¹ with a catch of about 8 t vessel⁻¹ 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 5 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 2-month period in 2002. The former operator of the seiner provided us with catch estimates of between 20 and 30 t day⁻¹ which were exported to Turkey (Department of Animal Husbandry, unpubl. data).² We assumed this purse seiner to have fished 20 days month⁻¹ for the 2 months, and used the averaged catch rate of 25 t day⁻¹.

² These data are from records held in the Ministry of Animal Husbandry, and E. Sinay, who has long worked for the ministry personally contacted the former operator of the purse seiner on our behalf to verify the catch composition.

2.2.2.2 Artisanal (1974–2010) While some artisanal catch data were collected in the north beginning in 2004, they were not deemed reliable (Table 2). 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 2). 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).³

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 $0.571 \text{ t vessel}^{-1} \text{ year}^{-1}$ 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). The per capita Gross National Product (GNP) in the north also displayed linear behaviour from 1980 to 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 were 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 between 60 and 180 m), but in 2013, the lead author surveyed artisanal fishers from the north, and found them to currently use between 8 and 50 *zembils* (from 480 m to 8 km 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 $0.571 \text{ t vessel}^{-1} \text{ year}^{-1}$ 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 $0.571 \text{ t vessel}^{-1} \text{ year}^{-1}$ (i.e., 2000: $1.71 \text{ t vessel}^{-1} \text{ year}^{-1}$, 1990: $2.85 \text{ t vessel}^{-1} \text{ year}^{-1}$, 1980: $5.71 \text{ t vessel}^{-1} \text{ year}^{-1}$, 1974: $11.42 \text{ t vessel}^{-1} \text{ year}^{-1}$). The catch rates were linearly interpolated for intervening years and were determined by multiplying the number of fishing vessels by the adjusted catch rates from 1974 to 2000, and then using weighted averages of the four fisher classes and number of vessels from 2001 to 2010.

³ The Behavioural Research Ethics Board (BREB) from the University of British Columbia provided guidance of the survey structure (H13-00012).

Table 2 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

2.2.3 South (1979–2010)

2.2.3.1 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. obs.). 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 generalized 100 % under-reporting rate was only applied from 1950 to 1973.

2.2.3.2 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, ‘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 one’s family.

2.3 United Cyprus (1950–1973)

In 1960, there were approximately 50 recreational fishing vessels on the island, with an average catch rate of $0.128 \text{ t vessel}^{-1} \text{ year}^{-1}$ and a combined total catch of 6.4 t year^{-1} (Fodera 1961). Thus, the 6.4 t 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 year^{-1} for the north and 3.84 t year^{-1} for the south.

2.3.1 North (1974–2010)

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 to 2010 (Table 4). Most vessels registered with the Directorate of Ports and Harbours were known to fish recreationally in 2013 (B.A. Çiçek, pers. obs.),⁴ after interviewing the managers of several fishing shelters, it was

⁴ To approximate this, in 2013, B.A. Çiçek visited over 8 recreational fishing shelters to approximate what percentage of registered vessels actively fish recreationally.

Table 3 Categorization of the artisanal fishers in the north of Cyprus

Class	Experience level	Labour type	% of fishers	Avg. # fishing days per year	Annual catches (t vessel ⁻¹ 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

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

understood that about 80 % (i.e., 1425) 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⁻¹ 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 2,000 people were engaged in angling 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 1973–2010 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.

2.3.2 South (1974–2010)

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, 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 (*Dentex dentex*, 30 %), dusky grouper (*Epinephelus marginatus*, 25 %), mottled grouper (*Mycteroperca rubra*, 20 %), bonito (*Sarda sarda*, 15 %), greater amberjack (*Seriola dumerili*, 6 %) and leer fish (*Lichia amia*, 4 %).

Furthermore, a small percentage of industrial catches from the trawlers ($\sim 5\%$), which existed in both north and south when the island was united, was 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 to 1973, and the south from 1950 to 2010, and was 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).

2.4 Discards

2.4.1 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 (Squaliformes), stingrays (Rajidae) and picarel (Centracanthidae), while other species are frequently used as bait to bait hooks and traps (B.A. Cicek, pers. obs.). 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 5 for taxonomic allocation) and a 5% ‘bait-fish’ discard rate were applied. 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 (15% combined) were applied to reported and unreported artisanal commercial catch components from 1950 to 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 to 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 5), 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 that all catches would have been retained and recorded (A. Petrou, pers. obs.).

2.4.2 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 (*Pagellus erythrinus*) 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 to 2010. Artisanal discards from 1950 to 1973 were

Table 4 North: data on recreational fisheries (2007–2010)

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

Provided by the Department of Animal Husbandry

allocated to the same taxa as the north (Table 5) and artisanal discards from 1974 to 2010, and from the industrial sector from 1950 to 2010 are listed in Table 6, based on European Union (2007) and Rousou (2009).

2.4.2.1 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, 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 (*Sargocentron rubrum*) was estimated to account for 3 % of discards in 2001, which was linearly increased to 9 % from 2007 to 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 7.

3 Results

3.1 Reconstructed catch for the whole island

The total reconstructed catch for the entire island from 1950 to 2010 amounted to nearly 243,000 t, which was 2.6 times the FAO reported landings for Cyprus of 93,200 t (Fig. 2a, Appendix Table 10). 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 (Centracanthidae), seabream (Sparidae), red mullet (Mullidae), cephalopoda and the silver-cheeked toadfish (Fig. 2b).

The officially reported data of just over 93,200 t for the 1950–2010 period pertain to the south only for periods after 1973 (Fig. 2a). There was a decline in reported landings from 1973 to 1975 during the tumultuous period surrounding the 1974 division of the island.

Table 5 Discard allocation. Industrial and artisanal sectors: North (1950–2010); South (1950–1973)

Taxon	%
Batoidea	20
<i>Muraena helena</i>	20
Selachimorpha	20
<i>Spicara maena</i>	20
<i>Anguilla anguilla</i>	05
<i>Coris julis</i>	04
<i>Thalassamo pavo</i>	04
<i>Scorpaena scrofa</i>	03
<i>Macroramphosus scolopax</i>	01
Euechinoidea	01
Asteroida	01
<i>Dardanus megistos</i>	01

Source: Expert assessment combined with artisanal survey results

Overall, total reconstructed catches were lowest in the early 1950s, averaging about 580 t year⁻¹, steadily increasing to peak in 1996 with about 5,200 t of catches, after which, catches steadily declined until 2004 to about 2,500 t year⁻¹, after which they increased again to nearly 4,900 t in 2007, owing mostly to pufferfish discards and newly targeted albacore tuna (Fig. 2b).

3.1.1 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 to 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 to 2010 (Fig. 3a). 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 to 1973.

From 1950 to 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 to 1997 (6,600 t year⁻¹, Fig. 3a). Artisanal unreported landings totalled approximately 26,500 t (>25 % of total reconstructed catch, Fig. 3a). Total subsistence and recreational catches from 1950 to 2010 each contributed about 6,000 t (each contributing about 7 % to total reconstructed catches, Fig. 3a). 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 8).

3.1.2 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 to 1973 and 100 % of reported FAO data from 1974 to 2010, plus the unreported sectors, and discards (Fig. 3b). 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.

Table 6 Discards, South; artisanal (1974–2010) and industrial (1950–2010) sectors

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

Source: (European Union 2007; Rousou 2009)

^a From 2001 to 2010, *Spicara smaris* catch contributions were decreased to allow for some discards to be allocated to *Sargocentron rubrum*, a 'newer' lessepsian migrant

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 (Fig. 3b).

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 (Fig. 3b). Estimated subsistence and recreational catches for the south from 1950 to 2010 were just over 5,100 and 5,000 t, respectively, both of which slightly increased throughout the time series (Fig. 3b).

4 Discussion

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 Fig. 2b), 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 (Fig. 2b) and the south (Fig. 3b), rather than the north (Fig. 3a). 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.

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

Table 7 Data sources, available time series data, and data anchor points used for catch reconstruction of Cyprus

Area	Sector	Year(s)	Source	Official data (reported)	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	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	9,600
S	Recreational and Subsistence	1974–2010	DFMR		x	1,130
N	Discards	1950–2010	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; Çiçek 2013 survey			6,800

N North, S South, DAH Department of Animal Husbandry, North, DFMR Department of Fisheries and Marine Research

^a North: Artisanal unreported catch amount from 1974 to 2010

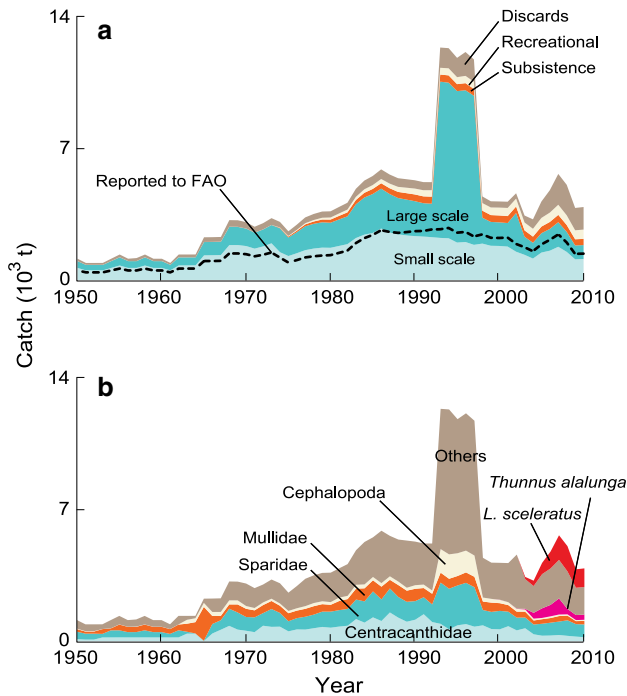


Fig. 2 Total reconstructed catch for the island of Cyprus for 1950–2010, by **a** fishing sectors plus discards. Note that data reported by FAO are overlaid as line graph; and **b** major taxa, with the 'Others' category containing 56 additional taxa

rethinking. A species may not have commercial value, yet, may have significant ecological value warranting special protection.

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 2). 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).

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).⁵ 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

⁵ <http://www.eubusiness.com/topics/fisheries/mediterranean.806/>.

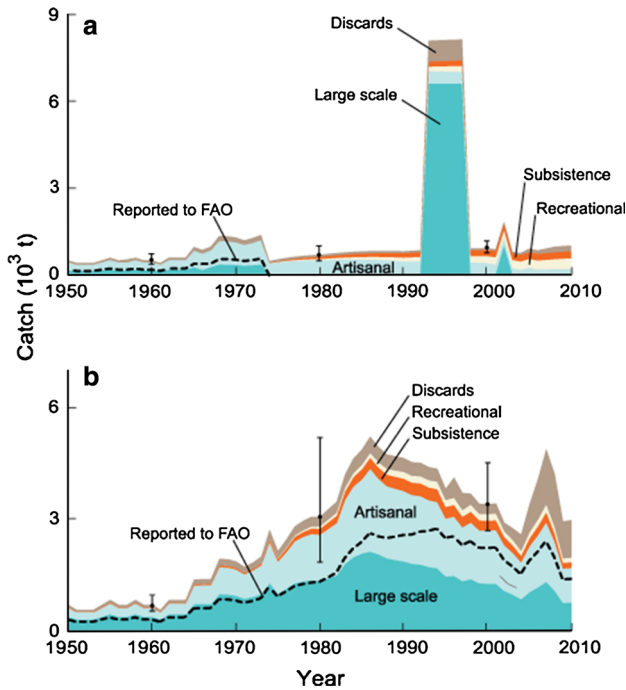


Fig. 3 Total reconstructed catch for **a** the northern part of Cyprus by fishing sectors plus discards for 1950–2010; and **b** for the southern part of Cyprus by fishing sectors plus discards for 1950–2010. Note that data reported by FAO (as assigned to each island part) are overlaid as line graphs

Table 8 Discards of the invasive silver-cheek toadfish in the north and south of Cyprus (t)

Year	North	South
2003	13	104
2004	28	257
2005	75	521
2006	78	820
2007	112	1,195
2008	146	1,195
2009	149	831
2010	150	840

suspended in the north.⁶ 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 jurisdiction¹¹.

A significant proportion (54 %) of the unreported catches from Cyprus’s catch reconstruction were due to the catches from the north post-1973 being absent from the data

⁶ <http://www.mof.gov.cy/mof/customs/customs.nsf/All/05AEEF243C9BFC8BC22572BF002D0A28?OpenDocument>.

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.

Table 9 presents our criteria for scoring the quality of the data used in this reconstruction for three separate time period. 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 Fig. 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 monitor only 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 5 years to provide necessary baseline data on both fishing effort, fishing area and catch per unit effort (see Brouwer et al. 1997).

The reduction of industrial effort for both sides⁷ 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. 2010). 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 spearfishing, 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 spearfishers 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 spearfishers 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. Another issue pertinent to the south is that rapid growth of the aquaculture industry has caused severe environmental degradation of coastal communities (Hadjimichael et al. 2014). The health of the wild stocks should take precedence as this will help improve long-term food security concerns. Both sides face the same issues such 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

⁷ As of late 2013 in the south, there were only two active bottom trawlers and no active purse seiners in operation.

Table 9 ‘Score’ for evaluating the quality of time series of reconstructed catches, with their confidence intervals (IPCC criteria from Fig. 1 of Mastrandrea et al. 2010)

Score		– %	+ %	Corresponding IPCC criteria ^a
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

^a 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”

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 (*Thunnus thynnus*), 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 regard 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.

Acknowledgments We thank everyone in both halves of the island who contributed valuable knowledge and insight to this study. Particular thanks go to Ercan Sinay (Department of Animal Husbandry, TNRC), and Nefice Yildiz for her assistance with the history of the island. We thank the *Sea Around Us*, a scientific collaboration between the University of British Columbia and The Pew Charitable Trusts, for funding A.U., D.P. and D.Z.

Appendix

See Table 10.

Table 10 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

Table 10 continued

Year	Reported FAO	Industrial	Artisanal	Subsistence	Recreational	Discards	Total reconstructed
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

Table 10 continued

Year	Reported FAO	Industrial	Artisanal	Subsistence	Recreational	Discards	Total reconstructed
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

References

- Anon. (Ed.). (1951). *Colonial Annual Reports (Cyprus 1946–1950)*. London: His Majesty's Stationary Office.
- Anon. (Ed.). (1960). *Colonial Annual Reports*. London: His Majesty's Stationary Office.
- Belhabib, D., Koutob, V., Sall, A., Lam, V. W. Y., & Pauly, D. (2014). Fisheries catch misreporting and its implications: the case of Senegal. *Fisheries Research*, 151, 1–11.
- Benli, H., Cihangir, B., Katagan, T. (2003). The bio-ecological properties of the surrounding waters of the Turkish Republic of Northern Cyprus. Translated from Turkish report titled 'Kuzey Kıbrıs deniz alanlarının biyoekolojik araştırmaları'. (pp. 90). İzmir: Dokuz Eylül Üniversitesi.
- Brouwer, S. L., Mann, B. Q., Lamberth, S. J., Sauer, W. H. H., & Erasmus, C. (1997). A survey of the South African shore-angling fishery. *South African Journal Marine Science*, 18, 165–177.
- Çiçek, B. A. (2011). Artificial reefs in North Cyprus: An opportunity to introduce fishermen to sustainable development. In S. Bortone, R. P. Brandini, G. Fabi, & S. Otake (Eds.), *Artificial reefs in fishery management* (pp. 141–153). Florida, USA: CRC Press.
- Cisneros-Montemayor, A. M., Cisneros-Mata, M. A., Harper, S., & Pauly, D. (2013). Extent and implications of IUU catch in Mexico's marine fisheries. *Marine Policy*, 39, 283–288.
- DFMR (2011). Annual Report 2010. *Department of Fisheries and Marine Research* (pp. 18). Nicosia, Cyprus.
- EastMed (2010). Report on the technical meeting on the Lessepsian migration and its impact on eastern Mediterranean fishery. *Scientific and Institutional Cooperation to Support Responsible Fisheries in the Eastern Mediterranean* (pp. 140). Athens, Greece, December 7–9, 2010: FAO.
- European Union (2007). Pilot study report on the evaluation of discards of the Cyprus fishery. *As part of Cyprus's national fisheries data collection programme* (pp. 41): EU Data Collection Regulation (DCR) No 1543/2000, No 1639/2001 and No 1581/2004.
- FAO (2010). The state of the world fisheries and aquaculture 2010. (pp. 218). Rome, Italy: Food and Agriculture Organization of the United Nations.
- FAO (2012). The state of the world fisheries and aquaculture 2012. (pp. 230). Rome, Italy: Food and Agriculture Organization of the United Nations.
- Fodera, V. (1961). Report to the government of Cyprus on fishery development possibilities. *Expanded program of technical assistance* (pp. 82). Rome, Italy: Food and Agriculture Organization of the United Nations.
- Garcia, S., & Demetropoulos, A. (1984). Management of Cyprus fisheries. (pp. 51). Rome, Italy: FAO Fisheries Report.
- Garibaldi, (2012). The FAO global capture production database: a six-decade effort to catch the trend. *Marine Policy*, 36, 760–768.

- Hadjimichael, M., Bruggeman, A., & Lange, M. (2014). Tragedy of the few? A political ecology perspective of the right to the sea: the Cyprus marine aquaculture sector. *Marine Policy*, 49, 12–19.
- Hadjistephanou, N., & Vassiliades, L. (2004). The present status of fishery and information system in Cyprus. *MedFisis Technical Document*, 4.2(GCP/INT/918/EC—TCP/INT/2904/TD-4.2), 59.
- Kacowicz, A. M., & Lutomski, P. (Eds.). (2008). *Population resettlement in international conflicts: A comparative study*. Lanham, MD: Rowan & Littlefield Publishers Ltd.
- Mastrandrea, M., Field, C., Stocker, T., Edenhofer, O., Ebi, K., Frame, D., et al. (2010). Guidance Note for Lead Authors of the IPCC Fifth Assessment Report on Consistent Treatment of Uncertainties. *IPCC Cross-Working Group Meeting on Consistent Treatment of Uncertainties, Jasper Ridge, CA, USA, 6–7 July 2010* (pp. 7): Intergovernmental Panel on Climate Change (IPCC).
- Nader, M. R., Indary, S., & Boustany, L. (2012). The Puffer Fish *Lagocephalus sceleratus* (Gmelin, 1789) in the Eastern Mediterranean. *Eastmed Technical Documents 10* (pp. 41). Athens, Greece: FAO.
- Papadakis, Y., Peristianis, N., & Welz, G. (2006). Divided Cyprus: modernity, history, and an island in conflict (pp. 256): Indiana University press.
- Pauly, D. (1998). Rationale for reconstructing catch time series. *EC Fisheries Cooperation Bulletin*, 11(2), 4–7.
- Pauly, D. (2006). Major trends in small-scale fisheries, with emphasis on developing countries, and some implications for the social sciences. *Maritime Studies (MAST)*, 4(2), 7–22.
- Pawson, M. G., Tingley, D., Padda, G., Glenn, H. (2007). EU contract FISH/2004/011 on Sport Fisheries (or Marine Recreational Fisheries) in the EU. (pp. 242). Suffolk, UK: Cefas.
- Rousou, M. (2009). *Non-commercial marine invertebrate discards of small-scale coastal fisheries: a case study in Cyprus (Levantine, Eastern Mediterranean Sea)* (pp. 69). MSc, University of Plymouth.
- Schiller, L., Alava, J., Grove, J., Reck, G., & Pauly, D. (2014). *The Demise of Darwin's Fishes: Evidence of fishing down and illegal shark finning in the Galápagos Islands*. Aquatic Conservation: Marine and Freshwater Ecosystems. doi:10.1002/aqc.2458.
- Solsten, E. (Ed.). (1993). *Cyprus a country study* (4th ed.). Washington: US Government Printing Office.
- Sumaila, U. R., Khan, A. S., Dyck, A. J., Watson, R., Munro, G., Tyedmers, P., et al. (2010). A bottom-up re-estimation of global fisheries subsidies. *Journal of Bioeconomics*, 12, 201–225.
- Sumaila, U. R., & Pauly, D. (2006). Catching more bait: a bottom-up re-estimation of global fisheries subsidies. *Fisheries Centre Research Reports* (pp. 121). Vancouver, BC: Fisheries Centre, University of British Columbia.
- Swartz, W., Sala, E., Tracey, S., Watson, R., & Pauly, D. (2010). The spatial expansion and ecological footprint of fisheries (1950 to present). *PLoS One*, 5(12), e15143.
- Ulman, A., Bekişoğlu, Ş., Zengin, M., Knudsen, S., Ünal, V., Mathews, C., et al. (2013a). From bonito to anchovy: a reconstruction of Turkey's marine fisheries catches (1950–2010). *Mediterranean Marine Science*, 14(2), 309–342.
- Ulman, A., Çiçek, B., Salihoglu, I., Petrou, A., Patsalidou, M., Pauly, D., et al. (2013b). The reconstruction and unification of Cyprus' marine fisheries catch data, 1950–2010. (pp. 72). Vancouver: Fisheries Centre Working Paper #2013-09, Fisheries Centre, University of British Columbia.
- Zeller, D., Booth, S., Davis, G., & Pauly, D. (2007). Re-estimation of small-scale fisheries catches for US flag island areas in the Western Pacific: the last 50 years. *Fishery Bulletin*, 105, 266–277.